elgra news

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CONTENTS

MORE ABOUT ELGRA:
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Elected on September 6th, 2007

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Sweden

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28359 Bremen
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2200 AG Noordwijk
The Netherlands

THE PRESIDENT'S PAGE

Dear ELGRA Members and attendants of the ELGRA 2009 Symposium,

It is with great pleasure that I welcome you at our Biennial Symposium (and General Assembly) in the historical city of Bonn founded about 11 B.C. Bonn is the birthplace of Ludwig van Beethoven and former capital of West Germany.

The local organizing committee, led by PD Dr. Hemmersbach and Prof. Dr. Willnecker, was and is doing an extraordinary job to make this Symposium both successful and enjoyable.

The interaction of both disciplines is one of the major assets of the ELGRA Symposia. We are pleased to see that also this year we have a good mix of both Physical Sciences and Life Sciences communications. Parallel sessions had to be organized due to both the large number of attendants and the invitation we made to ESA Topical Teams and MAP teams to report on their activities. The opportunity is also used by the Topical Teams to discuss their internal business off line of the Symposium.

During the Symposium, ELGRA will award the winners of the Undergraduate Student competition in both Life and Physical Sciences. Six teams have been selected and invited by ELGRA and ESA to give a short oral presentation and present a poster. The winners of the student contest (one team for Life Sciences and one team for Physical Sciences) will be voted by the audience attending their presentations.

This Symposium is also an opportunity to reward two of our most illustrious and distinguished members. The ELGRA medals will be given this year to Dr. Alberto Passerone, for his outstanding work in liquid-liquid and solid-liquid interfaces and to Prof. Dag Linnarsson, for his exceptional studies on the human pulmonary system under altered gravity conditions.

A major concern of the community is the current ELIPS 3 program that was adopted by the Ministerial Conference in The Hague, end 2008. A dedicated round table with presentations and discussion about the perspectives of low gravity research in Europe is organized on Wednesday afternoon.

The Biennial ELGRA Symposium is the time of the ELGRA General Assembly and the renewal of the Bureau. This year we have to, regretfully, say goodby to Dr. Karapantsios who served the user community via his ELGRA activities for many years. Thank you Thodoris for your contribution. Because of this resignation we received quite some applications to fill in the vacancy. The General Assembly will

be used to vote for a new ELGRA management member. Also all other members of the management committee need to be voted for in the General Assembly.
I hope the ELGRA members will grant me another term as their President but for now I would like to particularly express my thanks to the present Bureau. Discussions and decisions were always made in a spirit of friendly collaboration and cooperative democracy with the aim of promoting (micro-)gravity-related research within Europe and beyond.

During the General Assembly we will also update you on the current status of our Association, in terms of membership and financial situation. We will also inform you on specific activities like the ELGRA participation in the EU ULISSE program, the ESA Fly-Your-Thesis program and your participation as ELGRA Mentor, and the joint effort with ESA in trying to have human physiology as part of the EU FP-7 program.

As ELGRA we would also like to express many thanks to our long term corporate sponsors: ESA (our main contributor), EADS, Galileo Avionica, HTS AG, Kayser-Threde, OHB-system, SSC Esrange and ZARM for their thoughtful financial support of our activities. The Bonn Symposium sponsors, ESA, EADS, DLR, HE-Space, Kayser-Threde, MUSC, Univ. Bonn, Nikon, SpaceX and VEGA are acknowledged for their kind support.

I also want to thank you all as members of our society for your active contribution over the years.

I wish you a very enjoyable stay in Bonn at the ELGRA 2009 biennial Symposium!

Jack J.W.A. van Loon
President of ELGRA

ELGRA MEDAL

PROF. DAG LINNARSSON

Dept. of Physiology and Pharmacology
Karolinska Institutet
SE-171 77 Stockholm, Sweden

DAG LINNARSSON

Dept of Physiology and Pharmacology
Karolinska Institute
SE-171 77 Stockholm, Sweden

Prof. Dag Linnarsson finished his medical studies at the Karolinska Institute in Stockholm, Sweden, in 1970. Four years later he obtained his PhD in physiology on the same institute. During his studies he also worked as assistant teacher in physiology, and as research assistant at the Department of Naval Medicine.

After his PhD he fulfilled the position as assistant professor during which he went to the USA as associate visiting professor at the department of Physiology, at the State University of New York (SUNY) in Buffalo in 1976. After return to the Karolinska Institute he was acting professor at the Department of Medical Engineering and later Professor of Baromedicine, and head of the Section of Environmental Physiology since 1986. Prof. Linnarsson was Vice Chairman of the Department of Physiology and Pharmacology from the Karolinska Institute from 2002 till 2005.

During his career Prof. Linnarsson has been in various spaceflight related advisory boards such as the ESA Life Sciences Working Group, Swedish Astronaut Selection Committee, the ESA High Level Advisory Committee on Hermes Safety, the Space Station Utilization Panel and the ESF - European Space Science Committee. He is also in the Board of Trustees, International Academy of Astronautics and member of the ESA topical teams on Artificial Gravity and the Human Hypergravity Habitat.

Currently, he is the Group Leader of the Environmental Physiology group at the Department of Physiology and Pharmacology. The group has various projects involving mainly research on the pulmonary system, its function under different environmental conditions, such as under altered gravity, both hypo- and hyper-gravity.

FROM BASIC STUDIES OF LUNG PHYSIOLOGY TO STUDIES OF LUNG HEALTH DURING PLANETARY SPACE MISSIONS

The lungs are exceptionally sensitive to gravity since they contain millions of small air-filled spaces which are separated by soft elastic blood-filled walls, and which are connected by a complex network of conducting airways. The traditional text book concept is that gravity deforms the lung tissue in an upright human so that the lower parts are compressed and the upper parts have expanded airspaces.

As a consequence, the lower airspaces can expand more during inspiration than the already expanded upper spaces, creating a larger ventilation in the lower parts. At the same time, the blood vessels in the lungs are expanded by the higher hydrostatic pressure, resulting in relatively more blood flow in the lower parts than in the upper. If these factors were the sole determinants of the distribution of ventilation and blood flow in the lungs, these distributions would be perfectly homogenous in microgravity. During the Shuttle flight STS-55 in 1993, we performed our first measurements of lung function in space. We could show that the distribution of ventilation was far from perfectly homogenous, although more homogenous than in normal gravity. At the same time, we could show in parabolic-flight experiments that the distribution of blood flow in the lungs in microgravity also had a significant residual inhomogeneity, but was more homogenous than in normal gravity. In total, these results show that structural properties of the lung tissue are just as important, if not more important, than gravity as determinants of ventilation and blood flow distributions in the lungs.

Colleagues in our department have shown that trace amounts (10-50 ppb) of nitric oxide (NO) are present in exhaled air. They also showed that exhaled NO was increased in humans with asthma and other inflammatory air diseases, for example after inhalation of toxic dust. There is a risk for exposure to toxic dust on the moon and Mars. We are therefore preparing to use exhaled NO to monitor the lung health in astronauts during planetary space missions. In a first step we have shown that base-line (healthy) exhaled NO is lower in microgravity on the International Space Station (ISS) than on earth. This is likely caused by increased uptake of NO into the blood due to a somewhat more homogenous interface between blood and gas in the lungs in microgravity. In parallel, in ground experiments, we have shown that the exhaled NO is lowered with reduced atmospheric pressure, most likely due to facilitated gas diffusion from the sites of NO formation in the conducting airways into airspaces in contact with blood, and uptake of NO into the blood.

It is likely that future habitats on the moon and on Mars will have reduced atmospheric pressure together with reduced gravity. Our current plan is to study the effects of combined microgravity and low atmospheric pressure on the NO turnover in the lungs.

DR. ALBERTO PASSERONE

Inst. for Energetics and Interfaces - IENI CNR
Via de Marini, 6, 16149 Genoa, Italy

ALBERTO PASSERONE

Personal data: Born in Perinaldo (IM), Italy, August 23rd, 1943

Current position: Director of Research or the Italian National Research Council

Education and Degrees:

- "Laurea" in Chemical Engineering, with honours, Univ.of Genova, 1967.
- "Docteur es Sciences" (Ph.D.), with honours, at the Inst.Nat. Polytech./Univ., Grenoble, 1981.
- "Director of Research", Italian National Research Council (1991).

Dr. Ing. Alberto Passerone, has a recognized expertise in the study of physico-chemical characteristics of interfaces, with a particular reference to the measurement of surface and interfacial tensions in liquid-vapour, liquid-liquid and solid-liquid interfaces, both at room temperature and in the high temperature range. He made specific contributions to the understanding of faceting transitions in liquid-solid metallic systems and to the calculation of their interfacial tension, to the dependence of surface tension on oxygen partial pressure, and setting up new techniques and upgrading existing methodologies for surface tension and contact angle measurements for the study of liquid-vapour and solid-liquid interactions. Wettability studies are particularly devoted to the high temperature interactions in metal-ceramic systems, both from the basic point of view and for application purposes, e.g. for the optimization of joining techniques.
He is the Author of more than 230 papers, in JCR Journals, books, conference proceedings and Patents (2), as well as the Guest-Editor of several J. Materials Science special issues.
He served as the Director of the CNR ICFAM institute from 1994 to 2002, and as the Deputy Director of the Genoa IENI Unit from 2002 to 2009.
He served as the president of the Microgravity Advisory Committee of the European Space Agency, and as a Member of the Scientific Council of the Italian Space Agency.
He served also as ELGRA General Secretary from 1987 to 1992 and as the ELGRA vice-president from 1993 to 1996.
He was and still is engaged in the organization of International Conferences (High Temperature Capillarity series), as well as Chairman and Member of Scientific Committees in many International Symposia.
Dr. Passerone was also responsible or coordinator in many European and national research programs, many of them dealing with research in microgravity conditions on satellites and Space Stations.

2009 ELGRA Biennial Symposium and General Assembly "In the Footsteps of Columbus"

Bonn, September 1st – September 4th, 2009
Universitätsclub Bonn, Germany

Under the auspices of:

DLR, German Aerospace Center
- Institute of Aerospace Medicine
- Microgravity User Support Center

Rheinische Friedrich Wilhelms University of Bonn
- Faculty of Zoology

ACKNOWLEDGEMENTS

The ELGRA Management committee is very grateful to PD Dr. Ruth Hemmersbach, Prof. Dr. Rainer Willnecker, Astrid Herrmann, Gertrud Lütz, Jerzy Zywicki in the team of the DLR Microgravity User Support Center for the local organization of this meeting.

The European Space Agency is acknowledged for continuously supporting ELGRA activities and sponsoring the Student Contest at the ELGRA Biennial Symposium 2009.

General Information

Venue
Universitätsclub Bonn, Germany

Scientific/Organizing Committee
(ELGRA Management Committee)

Dr. Ing. Jack J.W.A. van Loon	President
Prof. Dr. Thodoris D. Karapantsios	Vice-President
Prof. Dr. Hendrik Kuhlmann	General Secretary
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Dr. F. Javier Medina	Member
Dr. Monica Monici	Member
Prof. Dr. Floris L. Wuyts	Member

Local Organizer
PD Dr. Ruth Hemmersbach
Prof. Dr. Rainer Willnecker

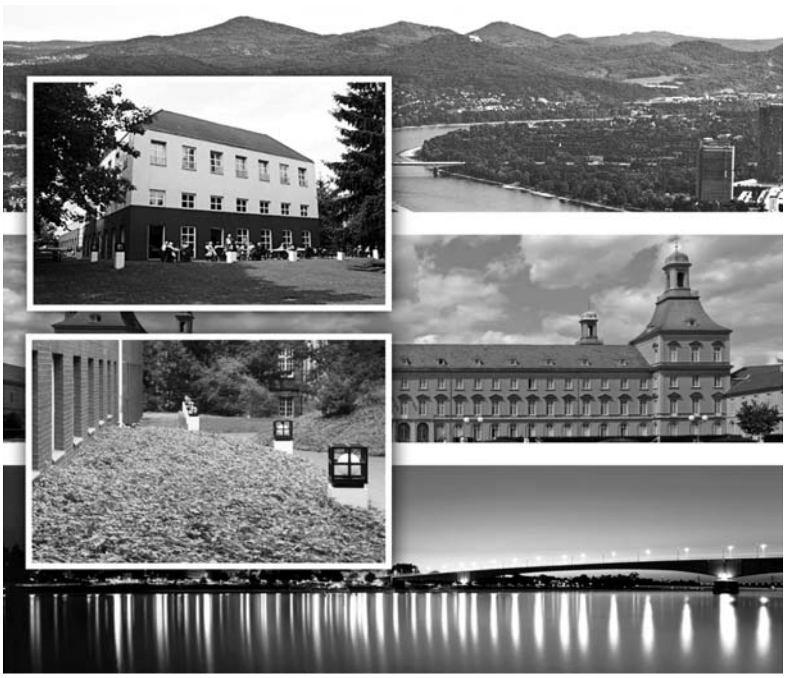
Organizing Secretariat
Astrid Herrmann
Gertrud Lütz

ABOUT THE CONFERENCE SITE

Bonn is the former capital of West Germany and today known as the German United Nations City hosting 17 UN organisations settled at the banks of the Rhine. A history of more than 2000 years has given the city most varied facets. Historical sights, highlights of art can be admired at the different houses of the Bonn Museum Mile, picturesque impressions along the romantic Rhine, the international life or the political life of Bonn, the birthplace of Ludwig von Beethoven, and much more.

Bonn has developed into a hub of international cooperation in particular in the area of environment and sustainable development. The number of UN agencies in Bonn, most of which are based at the newly established United Nations Campus in the city's former parliamentary quarter on the banks of the Rhine, continues to grow. The youngest agency started 2007 in Bonn as the United Nations Platform for Space-based Information for Disaster Management and Emergency Response.

The Rheinische Friedrich Wilhelms Universität Bonn (University of Bonn), founded in 1818, is today one of the largest universities in Germany. The University Club of Bonn, the venue of the Conference, is a beautiful accommodation located a few steps from the river Rhine close to the city centre. It is a pleasant conference site hosted by the University of Bonn and conceived as a meeting point between scientists.



PROGRAMME

Monday, August 31st

16:00 – 19:00 Registration

Tuesday, September 1st

08:30 – 09:00 Registration

09:00 – 09:40 Opening

09:40 – 10:20 ***Plenary Lecture***
Chairperson: Jack van Loon

EUROPE'S HOPE AND EXPECTATION FOR THE INTERNATIONAL SPACE STATION
Reinhold Ewald

10:20 – 10:40 ***ELGRA Medal Ceremony***
For Physical Sciences: Alberto Passerone
For Life Sciences: Dag Linnarson

10:40 – 11:00 ***Coffee Break***

Room A

11:00 – 11:35 ***Plenary Lecture (Physical & Life Sciences)***
Chairperson: Daniel Beysens

MAGNETIC GRAVITY COMPENSATION
V. Nikolayev, D. Chatain, D. Beysens, G. Pichavant

11:40 – 13:00 ***Session Life Sciences (Human Physiology 1)***
Chairperson: Rupert Gerzer

11:40 – 12:00 EUROPEAN CONTRIBUTION TO HUMAN ASPECT INVESTIGATION FOR FUTURE PLANETARY HABITAT DEFINITION STUDIES: FIELD TESTS AT MDRS ON CREW TIME UTILISATION AND HABITAT INTERFACES
Vladimir Pletser, Ludivine Boche-Sauvan, Bernard Foing

12:00 – 12:20 TESTOSTERONE TREATMENT ENHANCES PSYCHO-PHYSICAL PERFORMANCE IN ELDERLY MEN
Massimo Morè, Paolo Magni, Maria Angela Masini, Giovanna Strollo, Iarba Carucci, Felice Strollo

12:20 – 12:40 MICROGRAVITY AND THE BRAIN - FIRST RESULTS
Stefan Schneider, Vera Brümmer, Christopher D. Askew

12:40 – 13:00 DIFFERENT BEHAVIORS IN EUROPEAN AND CHINESE ASTRONAUTS AFTER SHORT-TERM-SPACEFLIGHT
Jiexin Liu, Yongzhi Li, Bart Verheyden, Zhanghuang Chen, Shanguang Chen, André Aubert

Room B

11:40 – 12:40 ***Session Physical Sciences (Fundamental Physics, Heat and Mass Transport)***
Chairperson: Daniel Beysens

11:40 – 12:00 DEVELOPMENT OF THERMOPHORETIC TRAP FOR ASTROPHYSICAL EXPERIMENTS: TESTS IN SHORT DURATION MICROGRAVITY CONDITIONS
Andrei Vedernikov, Andrey Markovich, Anastasia Kokoreva, Nicolas Bastin, Patrick Queeckers, Nikolay Kozlov, Jürgen Blum, Ingo von Borstel, Reiner Schräpler

12:00 – 12:20 THE DROP TOWER BREMEN AS A SOURCE FOR ATOM OPTICAL EXPERIMENTS IN GRAVITATION-FREE CONDITIONS
W. Wenzel, H. Müntinga, T. Könemann, S. Herrmann, C. Lämmerzahl, H. Dittus, S.T. Seidel, W. Herr, Y.P. Singh, N. Gaaloul, T. van Zoest, E.M. Rasel, W. Ertmer, A. Wenzlawski, M. Schiemangk, W. Lewoczko-Adamczyk, A. Peters, N. Meyer, A. Vogel, K. Sengstock, K. Bongs, T. Steinmetz, J. Reichel, T.W. Hänsch, E. Kajari, R. Walser, W.P. Schleich

12:20 – 12:40 EFFECT OF GRAVITY LEVEL ON HEAT TRANSFER FROM SMALL SPHEROIDS
Sotiris P. Evgenidis, Kostantinos Zacharias, Margaritis Kostoglou, Thodoris D. Karapantsios

13:00 – 14:00 ***Lunch***

Room A

14:00 – 14:35 ***Plenary Lecture (Life Sciences)***
Chairperson: Jack van Loon

ARTIFICIAL GRAVITY: IS SHORT RADIUS CENTRIFUGATION THE UNIVERSAL COUNTERMEASURE FOR LONG SPACE MISSIONS?
Laurence R. Young

14:40 – 15:40 **Poster Session 1: Human Physiology, Plants, Technology**

Human Physiology

[P1] THE CLOSED-LOOP AIR REVITALISATION SYSTEM ARES FOR ACCOMODATION ON THE INTERNATIONAL SPACE STATION ISS
Bockstahler Klaus, Funke Helmut, Witt Johannes

[P2] MODELING OF THE DISTURBANCES OF THE BIOLOGICAL RHYTHMS, EUROPHYSIOLOGICAL MECANISMS OF THE STRESS & DEVELOPMENT OF TECHNICS OF ADAPTATION BY BIO-FEEDBACK
Gaudeau de Gerlicz C., Golding J.F, Bobola Ph., Antoine A., Brémaud P.

[P3] DEFINITION OF THE ESA FOOD COMPLEMENT UNIT RACK-LIKE FACILITY: REASONS, BENEFITS AND CRITICAL ASPECTS
Lamantea Matteo, Boscheri Giorgio

[P4] SALIVARY NGF, CORTISOL AND ACTH LEVELS DURING PARABOLIC FLIGHT
Santucci D., Francia N., Viberti C., Aloe L., Alleva E.

[P5] EFFECT OF WEIGHTLESSNESS IN MOVEMENT PERCEPTION: ASYMMETRICAL EVALUATION OF VISUAL STIMULI CORRESPONDING TO UPWARD VERSUS DOWNWARD PITCH
De Saedeleer C., McIntyre J., Bengoetxea A., Lipshits M., Cebolla A., Leurs F., Vidal M., Chaput D., Lorigny E., Berthoz A., Cheron G.

[P6] RESPIRATORY MODULATION AND BAROREFLEX SENSITIVITY OF HEART RATE IN SPACE
Verheyden Bart, Liu Jiexin, Beckers Frank, Aubert André E.

[P7] EFFECT OF SPACE CONDITIONS ON NEURONAL MORPHOLOGY
Pani Guiseppe, Samari N., Saint-Georges L., Meloni M.A., Baatout S., Van Oosveldt P., Benotmane M.A.

Plant Physiology

[P8] CLINOROTATION-RELATED CHANGES OF PEA ROOT MITOCHONDRIA
Brykov Vasyl

[P9] MODELING THE KINETICS OF ROOT GRAVIREACTION
Kondrachuk A.V., Starkov V.N.

[P10] MOLECULAR CHAPERONE HSP90 IN THE DEVELOPMENT OF *ARABIDOPSIS THALIANA* SEEDLINGS UNDER CLINOROTATION
Kozeko Liudmyla

[P11] EXPRESSION OF CYCLIN B1 GENE, A CELL CYCLE REGULATOR, IS ENHANCED IN YOUNG *ARABIDOPSIS* SEEDLINGS GROWN IN ALTERED GRAVITY, UNDER MAGNETIC LEVITATION
Manzano Ana I., Dijkstra Camelia, Larkin Oliver, Anthony Paul, Davey Michael R., Hill Richard J.A., Eaves Laurence, Carnero-Díaz Eugénie, Medina F. Javier

[P12] COMPARATIVE RESEARCH OF EMBRYO DEVELOPMENT OF *BRASSICA RAPA* L. UNDER CLINOROTATION
Popova A.F, Ivanenko G.F.

[P13] CLINOROTATION EFFECT ON RESPONSE OF CRESS TO RED/FAR-RED LIGHT
Rakleviciene Danguole, Svegzdiene Danguole, Losinska Regina

[P14] IMPACT OF CLINOROTATION ON THE ORIENTATION OF MICROTUBULES IN PLANT ROOT CELLS
Shevchenko Galina V.

[P15] COMPARISON STUDY ON GRAVITY-DEPENDENT LONGWISE POSITIONING OF AMYLOPLASTS IN STATOCYTES OF CRESS ROOTS AND HYPOCOTYLS
Svegzdiene Danguole, Rakleviciene Danguole, Koryzniene Dalia

[P16] NEUTRON IRRADIATION ALTERS THE EXPRESSION OF AUXIN ACTIVATED GENES, OF GENES INVOLVED IN STRESS CONTROL, AND IN TUBULIN SYNTHESIS, ACCELERATING SENESCENCE IN *ARABIDOPSIS*
Tassone P., Fortunati A., Meloni M.A., Pipia P., Migliaccio F.

Technology

[P17] THE FASTRACK SUBORBITAL PLATFORM FOR MICROGRAVITY APPLICATIONS
Levine H.G., Ball J.E., Shultz D., Odyssey A., Wells H.W., Soler R.R., Albino S., Meshberger R.J., Murdoch T.

[P18] STUDY OF *CHLAMYDOMONAS REINHARDTII* MUTANTS AS LIFE SUPPORTING SYSTEMS IN SPACE
Antonacci Amina, Margonelli Andrea, Pastorelli Sandro, Lambreva Maya, Johanningmeier Udo, Bertalan Ivo, Ponticelli Fabio, Zanini Alba, Damasso Mario, Rea Giuseppina, Giardi Maria Teresa

[P19] DEVELOPMENT OF TECHNOLOGIES FOR ON ORBIT ANALYSIS
Borst A.G., Leeuwis H., Debrauwer P., Harmsen H.J.M., Dinkla I.

[P20] OMNIHAB: A MULTICOMPARTMENT CELSS (CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM)
Grimm Dennis, Anken Ralf, Hilbig Reinhard

[P21] THE BONN CRITERIA: MIMINAL EXPERIMEN-TAL PARAMETER REPORTING FOR CLINOSTAT AND RANDOM POSITIONING DEVICE EXPERI-MENTS
Hammond Timothy, Allen Patricia

Tuesday, September 1st

[P22] HYPERHAB: A MULTI-PURPOSE CENTRIFUGE SYSTEM FOR EXPERIMENTS ON AQUATIC ORGANISMS
Hilbig Reinhard, Weigele Jochen, Grimm Dennis, Anken Ralf

[P23] BMTC – A CONCEPT FOR STANDARDIZED TISSUE ENGINEERING ON GROUND AND IN SPACE
Kern P., Kemmerle K., Wagner S., Jones D.

[P24] VISUAL HORIZON IN A G-EXCESS STEADY-STATE ENVIRONMENT
Paillard Aurore, Cian Corinne, Denise Pierre

[P25] SPACEX DRAGONLAB AS A PLATFORM FOR MICROGRAVITY RESEARCH
Erin Spengler

15:40 – 16:00 ***Coffee break***

Room A

16:00 – 17:20 ***Session Life and Physical Sciences (Interaction)***
Chairperson: Otfried Joop

16:00 – 16:20 COMBINED MAGNETIC FIELD COUNTERACTS GRAVITY
Kordyum E.L., Kondrachuk A.V., Bogatina N.I.

16:20 – 16:40 EXPERIMENT ON THE JAPANESE EXPERIMENT MODULE "KIBO"
Izumi Yoshizaki, Satoshi Matsumoto, Shinichi Yoda

16:40 – 17:00 MICROGRAVITY RESEARCH DURING THE FIRST 50 ESA PARABOLIC FLIGHT CAMPAIGNS, AN OVERVIEW AND FUTURE PROSPECTS
Vladimir Pletser, Thierry Gharib, Frederic Gai, Christophe Mora, Patrice Rosier

17:00 – 17:20 “FLY YOUR THESIS! – AN ASTRONAUT EXPERIENCE” – ESA PARABOLIC FLIGHT OPPORTUNITIES FOR UNIVERSITY STUDENTS IN COLLABORATION WITH ELGRA
Natacha Callens, Javier Ventura-Traveset, Thomas-Louis de Lophem, Carlos Lopez de Echazarreta, Vladimir Pletser, Jack van Loon

Room B

16:00 – 17:00 ***Session Life and Physical Sciences (Interaction)***
Chairperson: Thodoris Karapantsios

16:00 – 16:20 GROWING FROM SOLUTIONS IN MICRO-GRAVITY: PRESENT RESEARCH WITH ESA'S PROTEIN CRYSTALLISATION DIAGNOSTICS FACILITY AND ESA’S FUTURE PROSPECTS WITH THE SOLUTION CRYSTALLISATION DIAGNOSTICS FACILITY
Vladimir Pletser, Stefano Mazzoni, Olivier Minster, Lothar Potthast, Robert Bosch, Peter Lautenschlager

16:20 – 16:40 DYNAMICS OF VESICLE SUSPENSIONS IN SHEAR FLOW BETWEEN WALLS
Thomas Podgorski, Natacha Callens, Christophe Minetti, Gwennou Coupier, Frank Dubois, Chaouqi Misbah

16:40 – 17:00 ULTRASONIC ENERGY MEASUREMENTS INTO A THIN ACOUSTIC RESONATOR IN PARABOLIC FLIGHTS: APPLICATIONS TO PARTICLE AND CELL SEPARATION
Mauricio Hoyos, Claire Ratier

Room A

17:30 – 19:00 ***Students’ Presentations***
Chairperson: F. Javier Medina

17:30 – 17:45 INFLUENCE OF THE VISUAL INPUTS ON THE CARDIOVASCULAR SYSTEM CONTROL DURING MICROGRAVITY INDUCED BY PARABOLIC FLIGHT
Marais M., Duretete A., Mc Intyre J., Arbeille P., Denise P., Normand H.

17:45 – 18:00 PHYSIOLOGICAL RESPONSE TO TEMPORARY CHANGES IN GRAVITY CONDITIONS ON PLANTS
Pandolfi C., Masi E., Mugnai S., Azzarello E., Renna L., Stefano G., Mancuso S.

18:00 – 18:15 VESTIBULAR LOSS INDUCES BONE LOSS: IMPLICATION IN LONG-DURATION SPACEFLIGHTS
Vignaux G., Besnard S., Vico L., Philoxène B., Allouche S., Denise P.

18:15 – 18:30 EXPERIMENTAL ANALYSIS OF THE BUBBLE-SLUG TRANSITION IN A MINICHANNEL IN MICROGRAVITY CONDITIONS
Arias Santiago, González-Cinca R.

18:30 – 18:45 MICROPARTICLES FOR PROBING THE PLASMA SHEATH DURING HYPERGRAVITY CONDITIONS IN A CENTRIFUGE
Beckers Job, Ockenga T.

18:45 – 19:00 GRAVITY DEPENDED BEHAVIOUR OF GRANULAR MATTER IN DROP-TOWER EXPERIMENTS AND CREATION OF DIFFERENT GRAVITY LEVELS BY PARABOLIC FLIGHTS WITH AN UNMANNED AIR VEHICLE
Hofmeister Paul

19:40 – 21:00 ***Reception Town Hall Bonn***

Wednesday, September 2nd

Room A

09:00 – 09:35 ***Plenary Lecture (Life Sciences)***
Chairperson: Markus Braun

MULTISCALE ANALYSIS OF *ARABIDOPSIS THALIANA* ROOT GROWTH AS A MODEL FOR SYSTEMS BIOLOGY
Palme, K, Aubry, D., Bensch, M., Schmidt, T., Ronneberger, O., Neu, C., Li, X., Wang, H., Santos, F., Wang, B., Paponov, I., Ditengou, F.A., Teale, W.T., Dovzhenko, A.

09:40 – 10:40 ***Session Life Sciences (Plant Physiology 1)***

09:40 – 10:00 A SEQUENTIAL STUDY ON EARLY PLANT DEVELOPMENT UNDER MAGNETIC LEVI-TATION SHOWS EFFECTS OF ALTERED GRAVITY ON CELL PROLIFERATION AND GROWTH
Ana I. Manzano, Camelia Dijkstra, Oliver Larkin, Paul Anthony, Michael R. Davey, Richard J.A. Hill, Laurence Eaves, Eugénie Carnero-Díaz , F. Javier Medina

10:00 – 10:20 GENE EXPRESSION STUDIES UNDER PARABOLIC FLIGHT CONDITIONS - A NEW DIFFERENTIATED LOOKS ON THE MOLECULAR BASIS OF GRAVITY-RELATED PROCESSES IN PLANTS
Nicole Greuel, Jens Hauslage, Katharina Wiemann, Markus Braun

10:20 – 10:40 NEUTRON IRRADIATION ALTERS THE EXPRESSION OF AUXIN ACTIVATED GENES, OF GENES INVOLVED IN STRESS CONTROL, AND IN TUBULIN SYNTHESIS, ACCELERATING SENESCENCE IN *ARABIDOPSIS*
P. Tassone, A. Fortunati, M.A. Meloni, P. Pippia, F. Migliaccio

Room B

09:40 – 10:40 ***Session Physical Sciences (Convection, Interfacial Flow 1)***
Chairperson: Hendrik Kuhlmann

09:40 – 10:00 MARANGONI INSTABILITIES DUE TO CONCENTRATION DEPENDENT TRANSFER PROPERTIES
P.M.J. Trevelyan, V. Pimienta, K. Eckert, A. De Wit

10:00 – 10:20 MARANGONI-DRIVEN CONVECTION AROUND EXOTHERMIC AUTOCATALYTICCHEMICAL FRONTS IN FREE SURFACE SOLUTION
Pauline Assemat, Anne De Wit

10:20 – 10:40 OBSERVATION OF MARANGONI WITH A MINIMUM OF SURFACE TENSION WITH MACH ZEHNDER INTERFERO-METRY AND PARTICLE VELOCIMETRY
A. Cecere, R. Savino, S. Van Vaerenbergh

10:40 – 11:00 ***Coffee break***

Room A

11:00 – 11:35 ***ELGRA Medal Lecture for Life Sciences***
Chairperson: Jack van Loon

FROM BASIC STUDIES OF LUNG PHYSIOLOGY TO STUDIES OF LUNG HEALTH DURING PLANETARY SPACE MISSIONS
Dag Linnarsson

11:40 – 13:00 ***Session Life Sciences (Plant Physiology. 2 / Techn. 1)***
Chairperson: Rüdiger Hampp

11:40 – 12:00 *ARABIDOPSIS* CELL CULTURES INCREASE THEIR CYTO-SCOLIC CALCIUM CONCENTRATION UPON PARABOLIC FLIGHT MICROGRAVITY
Maren Babbick, Zarko Barjaktarovic, Melanie Krebs, Karin Schumacher, Rüdiger Hampp

12:00 – 12:20 EFFECT OF THE CHANGE IN STATOCYTE POLARITY ON CALCIUM-DEPENDANT PATHWAYS (PolCa EXPERIMENT)
V. Pereda, J. Gérard, B. Eche, G. Gasset, D. Chaput, V. Legué

12:20 – 12:40 PLANT CORTICAL MICROTUBULE ORDERING AND CELL ELONGATION IN RECOVERING PROTOPLASTS UNDER SIMULATED MICROGRAVITYCONDITIONS
Jan W. Vos, Martine Oudenhoven, Anne Mie C. Emons

12:40 – 13:00 COLUMBUS/BIOLAB: STATUS AND PERSPECTIVES
Marianne Schuber, Dieter Seibt, Paul Esser, Philipp Wever, Sait Gürsoy, Ralf Anken, Markus Ostrominski, Michael Wirtz, Julie Brisset

Room B

11:40 – 13:00 ***Session Physical Sciences (Topical Team Thermophysical Properties)***
Chairperson: H. J. Fecht

11:40 – 12:00 THE ESA THERMOLAB PROJECT: MEASURE-MENT OF THERMOPHYSICAL PROPERTIES OF LIQUID METALLIC ALLOYS ON BOARD PARABOLIC FLIGHTS AND TEXUS
H.-J. Fecht, R.K. Wunderlich

12:00 – 12:20 ELECTROMAGNETIC LEVITATION FOR THERMOPHYSICAL PROPERTY MEASUREMENTS – EFFECTS AND CONSEQUENCES
Koulis Pericleous, Valdis Bojarevics, Stewart Easter, Alan Roy

12:20 – 12:40 SURFACE TENSION OF LIQUD Al-Cu-Ag ALLOYS
J. Brillo, I. Egry, Y. Plevachuk

13:00 – 14:00 ***Lunch***

Room A

14:00 – 14:35 ***Plenary Lecture Physical Sciences***
Chairperson: Thodoris Karapantsios

COMPLEX PLASMAS – PROBING STRONG COUPLING PHENOMENA AT THE MOST ELEMENTARY LEVEL
Gregor E. Morfill

14:40 – 15:40 ***Session Life Sciences (Technology 2)***
Chairperson: Floris L. Wuyts

14:40 – 15:00 CLINOSTATS – CONFIGURATION AND MODES OF OPERATIONS
Jens Hauslage, Astrid Horn, Kai Waßer, Ralf Anken, Ruth Hemmersbach

15:00 – 15:20 MEANS FOR REPRODUCIBLE EXPERIMENTATION IN BMTC
P. Kern, K. Kemmerle, S. Wagner, D. Jones

15:20 – 15:40 H3: THE LARGE RADIUS HUMAN CENTRIFUGE "A HUMAN HYPERGRAVITY HABITAT"
Jack van Loon, Floris Wuyts

Room B

14:40 – 15:40 ***Session Physical Sciences (Plasma Physics)***
Chairperson: Hiroo Totsuji

14:40 – 15:00 PK-3 PLUS – FUNDAMENTAL RESEARCH IN COMPLEX PLASMAS ON THE INTERNATIONAL SPACE STATION
Hubertus M. Thomas, Gregor E. Morfill, Vladimir E. Fortov, Alexey V. Ivlev, Vladimir I. Molotkov, Oleg F. Petrov, Andrey I. Lipaev, Uwe Konopka, Christoph Räth, Peter Huber, Mierk Schwabe, Ralf Heidemann, Milenko Rubin-Zuzic, Robert Sütterlin, Sergey Khrapak, Sergey Zhdanov

15:00 – 15:20 HEARTBEAT INSTABILITY UNDER MICROGRAVITY CONDITIONS OBSERVED IN THE PK-3 PLUS LABORATORY
Ralf J. Heidemann, Hubertus M. Thomas, Sergey K. Zhdanov, Alexey V. Ivlev, Gregor E. Morfill

15:20 – 15:40 GROUND-BASED EXPERIMENT OF PLASMA PARAMETER MEASUREMENT FOR COMPLEX PLASMAS IN PK-3 PLUS ON THE ISS
Kazuo Takahashi, Hubertus M. Thomas, Gregor E. Morfill, Yasuaki Hayashi, Satoshi Adachi

15:40 – 16:00 ***Coffee break***

Room A

16:00 – 17.40 ***Session Life Sciences (Human Physiology 2)***
Chairperson: John M. Karemaker

16:00 – 16:20 INFLUENCE OF MICROGRAVITY ON LINEAR AND NONLINEAR HRV PARAMETERS OF ASTRONAUTS AFTER SPACE MISSIONS TO THE ISS
Steven Vandeput, Bart Verheyden, Andre E. Aubert, Sabine Van Huffel

16:20 – 16:40 ECCENTRIC RESISTANCE TRAINING AS COUNTERMEASURE IN MICROGRAVITY
N. Barta, G. Adamcik, R. Talla, I.B. Kozlovskaya, H. Tschan, N. Bachl, T. Angeli

16:40 – 17:00 INVESTIGATION OF THE NEUROMUSCULAR SYSTEM IN THE DIFFERENT GRAVITY PHASES OF PARABOLIC FLIGHTS
Matthias Lochmann, Holger Eckhardt, Fritz Bodem

17:00 – 17:20 BRAIN CORTICAL ACTIVITY DURING SEVERAL ARTIFICIAL GRAVITY PHASES IN A SHORT-ARM HUMAN CENTRIFUGE
Vera Bruemmer, Simon Guardiera, Sven Baerwalde, Stefan Schneider

17:20 – 17:40 THE DENSITY DIFFERENCE OF CUPULA AND ENDOLYMPH CHANGES THE MECHANICS OF SEMICIRCULAR CANALS
A.V. Kondrachuk, S.P. Sirenko, R. Boyle

Room B

16:00 – 17:40 ***Session Physical Sciences (Plasma Physics 2)***
Chairperson: Hubertus Thomas

16:00 – 16:20 WAVES IN DUSTY PLASMAS UNDER MICROGRAVITY
Oliver Arp, Kristoffer Menzel, David Caliebe, Alexander Piel

16:20 – 16:40 POSSIBLE OBSERVATION OF CRITICAL PHENOMENA IN FINE PARTICLE (DUSTY) PLASMAS
H. Totsuji

16:40 – 17:00 DISSIPATVE DARK SOLITONS IN THE PK4 EXPERIMENT
S. Zhdanov, R. Heidemann, M.H. Thoma, R. Sütterlin, H.M. Thomas, H. Höfner, K. Tarantik, G. Morfill, A.D. Usachev, O.F. Petrov, V.E. Fortov

17:00 – 17:20 EXPERIMENTS OF FINE–PARTICLE PLASMAS UNDER GRAVITY AND MICROGRAVITY CONDITIONS USING PLANAR-MAGNETRON PLASMA SYSTEMS
Yasuaki Hayashi, Kazuo Takahashi

17:20 – 17:40 PK-4 SCIENCE ACTIVITIES IN MICRO-GRAVITY
M.A. Fink, M.H. Thoma, H. Höfner, A.V. Ivlev, B.A. Klumov, U. Konopka, M. Kretschmer, S. Mitic, R. Sütterlin, S. Zhdanov, G.E. Morfill, A.D. Usachev, V.E. Fortov, O.F. Petrov, A.V. Zobnin, B.M. Annaratone

Room A

17:45 – 18:25 ***ESA Round Table Discussion: Future of Microgravity Research in Europe***
Chairpersons: Jack van Loon, Daniel Beysens

18:30 - 19:40 **ELGRA General Assembly**

<u>Thursday, September 3rd</u>

Room A

09:00 – 09:35 ***Plenary Lecture Physical Sciences***
Chairperson: Hendrik Kuhlmann

DROPS AND SPRAY INTERACTIONS WITH A RIGID SUB-STRATE UNDER THE TERRESTRIAL, MICROGRAVITY AND VARIABLE GRAVITY CONDITIONS
Cameron Tropea, Ilia V. Roisman

09:40 – 10:40 ***Session Life Sciences (Cell Physiology 1)***
Chairperson: Monica Monici

09:40 – 10:00 GRAVITY DETECTION IN SINGLE CELLS
Michael Lebert, Donat-Peter Häder

10:00 – 10:20 CELL SUSCEPTIBILITY DURING PHYSIOLOGICAL ADAPTATION TO LOW AND RANDOMIZED GRAVITY
A. Sundaresan, Anil. D. Kulkarni, Jamail Plumber, Donielle Ford

10:20 – 10:40 MAGNETIC LEVITATION OF HUMAN A431 CELLS
M.J.A. Moes, J.C. Gielen, R. Bleichrodt, J. van Loon, P.C.M. Christianen, J. Boonstra

Room B

09:40 – 10:20 ***Session Physical Sciences (Capillary Flow)***
Chairperson: Hendrik Kuhlmann

09:40 – 10:00 THERMOCAPILLARY FLOW INSTABILITIES IN CYLINDRICAL POOLS HEATED FROM THE FREE SURFACE AND COOL FROM THE RIM
H. Kuhlmann, U. Schoisswohl

10:00 – 10:20 NUMERICAL AND EXPERIMENTAL INVESTIGATION OF CAPILLARY CHANNEL FLOW IN MICROGRAVITY
Joerg Klatte, Aleksander Grah, Michael E. Dreyer

10:20 – 10:40 EXPERIMENTAL AND NUMERICAL INVESTIGATION OF NON-ISOTHERMAL CAPILLARY DRIVEN FREE SURFACE OSCILLATIONS OF LIQUID ARGON
Nikolai Kulev, Michael Dreyer

10:40 – 11:00 ***Coffee break***

Room A

11:00 – 11:35 ***ELGRA Medal Lecture for Physical Sciences***
Chairperson: Jack van Loon

25 YEARS OF SURFACE TENSION MEASUREMENTS IN SPACE
Alberto Passerone

11:40 – 13:00 ***Session Life Sciences (Cell Physiology 2)***
Chairperson: Michael Lebert

11:40 – 12:00 TRIPLE LUX A: GROUND CONTROLS AND PREPARATION OF THE BIOLAB EXPERIMENT
Astrid Horn, Kathrin Huber, Ulrich Kübler, Oliver Ullrich, Ruth Hemmersbach

12:00 – 12:20 MELANOCYTE RESPONSE TO ALTERED GRAVITY: ROLE OF CYCLIC GMP
Krassimira Ivanova, Wasiliki Tsiockas, Jens Hauslage, Birgit Bromeis, Kai Waßer, Ruth Hemmersbach, Rupert Gerzer

12:20 – 12:40 RESCUE OF MICROGRAVITY-INDUCED MORPHOLOGICAL ALTERATIONS OF FIBROBLASTS DURING THE FOTON-M3 MISSION BY SILENCING THE GTPASE RAC1
Pierre Mineur, Alain Guignandon, Zhigang Zhang, Thibaut Neutelings, Christophe Deroanne, Monique Aumailley, Thomas Krieg, Laurence Vico, Betty Nusgens, Charles Lambert

12:40 – 13:00 TISSUE REPAIR: IMPACT OF UNLOADING ON THE REMODE-LING PHASE
Monica Monici, Francesca Cialdai, Giovanni Romano, Franco Fusi, Antonio Conti, Nicola Marziliano, Marcel Egli, Augusto Cogoli

Room B

11:40 – 12:40 ***Session Physical Sciences (TT Dynamics of liquid film/wall interactions)***
Chairperson: Cameron Tropea

11:40 – 12:00 CHEMICALLY GRAFTED SURFACES TO CONTROL THE INCIPIENT FLOW BOILING POSITION
M. Marengo, R. Rioboo, J. De Coninck, S. Dall'Olio, M. Voue

12:00 – 12:20 LIQUID FILM FLOW AROUND CORNERS
R. Yurko, M. Flynn, A. Amirfazli

12:20 – 12:40 ICING MITIGATION STRATEGIES USING SURFACE COATINGS
M. Innocenti, T. Horn, C. Antonini, A. Amirfazli, M. Marengo

13:00 – 14:00 ***Lunch***

Room A

14:00 – 14:35 ***Plenary Lecture Life Sciences and Physical Sciences in Life Support Systems***
Chairperson: Jack van Loon

NECESSARY RESEARCH IN REDUCED GRAVITY FOR THE PREPARATION OF FUTURE LIFE SUPPORT DEVELOPMENT
C. Lasseur, C. Paille, B. Lamaze, P. Rebeyre, S. Raffestin

14:40 – 15:40 **Poster Session 2: Cell Physiology, Animal Physiology, Physical Sciences**

Cell Physiology

[P26] GROWTH OF *ULOCLADIUM CHARTARUM* CULTURES IN SIMULATED MICROGRAVITY CONDITIONS
Gomoiu Ioana, Mogildea Daniela, Hasegan Dumitru, Mogildea George, Mogildea Marian, Vadrucci Sonia, Walther Isabelle, Nobman Peter, Chatzitheodoridis Elias

[P27] GROWTH OF MICRO ALGAE CULTURES AT LOW PRESSURE WITH LUNAR AND MARTIAN SOIL SIMULANT ADDITION
Kempf J., Friedenberger H., Klatt J., Seebah S., Slenzka K.

[P28] POSSIBLE MECHANISMS UNDERLINING THE REDUCTION IN PRESYNAPTIC TRANSPORTER-MEDIATED UPTAKE OF GLUTAMATE UNDER HYPERGRAVITY CONDITIONS
Krisanova Natalia, Borisova Tatiana

[P29] CULTURE IN SIMULATED MICROGRAVITY AFFECTS QUORUM SENSING IN THE LIFE SUPPORT BACTERIUM *RHODOSPIRILLUM* RUBRUM S1H
Mastroleo Felice, Van Houdt Rob, Mergeay Max, Hendrikx Larissa, Wattiez Ruddy, Leys Natalie

[P30] EFFECTS OF MECHANICAL STRETCH ON HUMAN OSTEOBLASTS: ROLE OF THE RHO FAMILY GTPASES IN THE MECHANOTRANS-DUCTION
Neutelings Thibaut, Mineur Pierre, Nusgens Betty, Colige Alain, Lambert Charles

[P31] EFFECT OF SPACE CONDITIONS ON NEURONAL MORPHOLOGY
Pani Giuseppe, Samari Nada, de Saint-Georges Louis, Meloni Maria Antonia, Baatout Sarah, Van Oostveldt Patrick, Benotmane Mohammed Abderrafi

[P32] CD69, A C-TYPE LECTIN RECEPTOR, COULD BE A MARKER FOR LYMPHOCYTES RESPONSE TO RADIATION
Risso Angela, Turello Marina, Antonutto Guglielmo

[P33] PHOTOSYNTHESIS IN SPACE: BETWEEN EVOLUTION AND EXPLORATION
de Vera J.P.

[P34] INFLUENCE OF ALTERED GRAVITY AND RADIATION ON THE STRESS RESPONSE OF MACROPHAGES
Zander Vanja, Horn Astrid, Huber Kathrin, Hellwig Christine E., Hemmersbach Ruth

Animal Physiology

[P35] MOUSE DRAWER SYSTEM: PRELIMINARY BEHAVIOURAL AND NEUROBIOLOGICAL DURING THE 100 DAYS GROUND-BASED TEST
Francia N., Biticchi R., Liu Yi, Cancedda R., Aloe L., Santucci D.

[P36] OTOLITH GROWTH OF DEVELOPING ZEBRAFISH UNDER CENTRIFUGATION AND WALL VESSEL ROTATION
Li Xiaoyan, Wang Gaohong, Anken Ralf, Hilbig Reinhard, Liu Yongding

[P37] SIMULATED MICROGRAVITY ALLOWS NORMAL CARDIOVASCULAR DEVELOPMENT IN LARVAL ZEBRAFISH
Mariotti M., Maier J.A.M.

[P38] EFFECTS OF SPACE FLIGHT ON ERYTHROCYTES AND OXIDATIVE STRESS OF RODENTS: DATA FROM THE MICE DROWER SYSTEM GROUND TESTS
Rizzo A. M., Neuroni M., Montorfano G., Berselli P., Liu Y., Biticchi R., Cancedda R., Berra B.

[P39] SURGICAL STRESS RESPONSE IN SPACE-PROPOSAL FOR STUDIES ON ANIMAL MODEL
Santucci Daniela, Strollo Felice, Pantalone Desireè, Monici Monica

[P40] PARABOLIC FLIGHT AND FETAL MOVEMENTS, HEART RATE PATTERN AND BLOOD FLOW IN UMBILICAL CORD BLOOD VESSELS IN PRECOCIAL RODENT
Sekulić Slobodan, Podgorac Jelena, Martać Ljiljana

[P41] DEVELOPMENT OF THE FLIGHT HARDWARE FOR THE EXPERIMENT XENOPUS ON THE KUBIK BIO4-MISSION
Horn Eberhard, Böser Sybille, Franz Markus, Gabriel Martin, Kübler Ulrich, Porciani Massimiliano, Schwarzwälder A., Zolesi Valfredo

[P42] STUDY OF THE VESTIBULAR PART OF THE INNER EAR SENSORY SYSTEM: 1G VERSUS 0G
Nobelen Florent

Physical Sciences

[P43] EFFECT OF GRAVITY ON MIXING OF LIQUIDS UNDER HIGH-FREQUENCY VIBRATION
Gaponenko Yuri, Shevtsova Valentina

[P44] USING SUPERCONDUCTING MAGNET TO REPRODUCE QUICK VARIATIONS OF GRAVITY IN LIQUID OXYGEN
Pichavant G., Beysens D., Chatain D., Communal D., Lorin C., Mailfert A.

[P45] ON PECULIARITIES OF MICROGRAVITY IMITATION IN MAGNETO-POLARIZABLE MEDIA IN THE PRESENCE OF NON-UNIFORM MAGNETIC FIELDS
Bozhko Alexandra, Putin Gennady, Suslov Sergey, Tynjala Tero

[P46] PREPARATORY RESULTS FOR THE ISS DSC (DIFFUSION AND SORET COEFFICIENTS) EXPERIMENT
Galand Q., Van Vaerenbergh S., Minetti C.

[P47] THERMAL MEASUREMENTS, VISUALIZATION AND NUMERICAL MODELING OF VIBRATIONAL CONVECTION IN HELE-SHAW CELL
Babushkin Igor A., Demin Vitaly A.

[P48] DIAMOND SYNTHESIS UNDER MICROGRAVITY ENVIRONMENT WITH PARABOLIC FLIGHTS BY DAS AND S520-24 ROCKET BY JAXA
Takagi Yoshiki, Abe Yoshiyuki, Usuba Shu, Inatomi Yuko, Suzuki Masaaki, Mori Shinsuke, Suda Yoshihisa, Shimizu Osamu

[P49] MAGNETIC-FIELD MODULATION OF GRAVITY: MARTIAN, LUNAR AND TIME-VARYING CONDITIONS
Lorin Clément, Mailfert Alain

[P50] QUEENSLAND UNIVERSITY OF TECHNOLOGY DROP TOWER FACILITY AND OPPORTUNITIES
Castillo Martin, Ward Nick, Lynn David, Hales Matthew, Steinberg Ted

[P51] CRUSTAL DEFORMATION DEDUCED FROM GRAVITY AND GEODETIC DATA OF HIGH DAM AREA, ASWAN, EGYPT
Hassan G.S.

[P52] THERMAL ACOUSTIC CONVECTION IN CLOSED CAVITY
Lyubimov Dmitriy, Lyubimova Tatyana

[P53] CONVECTION IN A TWO–LAYER SYSTEM WITH DEFORMABLE INTERFACE IN LOW GRAVITY CONDITIONS
Lyubimov Dmitriy, Lyubimova Tatyana, Parshakova Yanina

[P54] INTERACTION OF RIGID PARTICLES IN A PULSATIONAL FLOW
Lyubimova Tatyana, Lyubimov Dmitriy, Shardin Mikhail, Baidin Andrey

[P55] THE WORLD-RECORD SET BY A 11-YEAR-OLD KID FLYING AS TEST SUBJECT IN *LUNAR-GRAVITY*, *MARS-GRAVITY AND ZERO-GRAVITY* FLIGHT CONDITIONS OPENS UP NEW PERSPECTIVE FOR LIFE-SCIENCE RESEARCH
Viberti Carlo

[P56] DESIGN OF A MULTIBUBBLE SONOLUMINE-SCENCE EXPERIMENT FOR A MICROGRAVITY PLATFORM
Garcia Sabaté Anna, Bas Espargaró J., Cortés Catalán E., Fortes Galera E.M., González-Cinca R.

[P57] BUBBLES IN DIFFERENT LIQUIDS IN MICRO-GRAVITY AND OSCILLATING HIPERGRAVITY ENVIRONMENTS
Duarte Laura, Maldonado O., Gallardo B., González-Cinca R.

[P58] JET IMPINGEMENT IN DIFFERENT LIQUIDS
Suñol Francesc, González-Cinca R.

[P59] PARTICLE TRACING OF 3D FLUID FLOWS
Denis Melnikov, Aliaksandr Mialdun, Valentina Shevtsova

15.40 – 16:00 ***Coffee break***

Room A

16:00 – 17:40 ***Session Life Sciences (Cell Physiology 3)***
Chairperson: Alamelu Sundaresan

16:00 – 16:20 DIFFERENT COMPOSITION OF BIOMARKERS RELEASED INTO THE SUPERNATANTS BY ENDOTHELIAL CELLS GROWN UNDER SIMULATED MICROGRAVITY OR GRAVITY FOR ONE AND FOUR WEEKS
Sarah Baatout, Kriss Westphal, Claudia Ulbrich, Johann Bauer, Markus Wehland, Jirka Grosse, Johann Schönberger, Manfred Infanger, Myriam Ghardi, Michaël Beck, Louis de Saint-Georges, Daniela Grimm

16:20 – 16:40 RECOVERY OF MICROTUBULAR NETWORK AT SIMULATED LOW G IN HUMAN MONOCYTES PRETREATED WITH NOCODAZOLE
Maria Antonia Meloni, Giuseppe Pani, Grazia Galleri, Proto Pippia, Augusto Cogoli, Marianne Cogoli-Greuter

16:40 – 17:00 PROTEOMIC ANALYSIS OF FOUR DIFFERENT THYROID CELL TYPES EXPOSED TO SIMULATED MICROGRAVITY
Jirka Grosse, Jessica Pietsch, Richard Kussian, Albert Sickmann, Johann Bauer, Gerhard Weber, Mikkel Nissum, Kriss Westphal, Marcel Egli, Manfred Infanger, Christoph Eilles, Daniela Grimm

17:00 – 17:20 LIVE IMAGING OF OSTEOCLAST ACTIVITIES IN MEDAKA UNDER HYPERGRAVITY
Masahiro Chatani, Issei Kubota, Akira Kudo

17:20 – 17:40 CYTOMECHANICS OF OSTEOBLASTS AND OSTEOBLAST-LIKE CELLS
David Jones

Room B

16:00 – 18:00 ***Session Physical Sciences (Convection, Interfacial Flow 2)***
Chairperson: Steven van Vaerenbergh

16:00 – 16:20 COLUMBUS-EXPERIMENT ‘GEOFLOW’: FROM NUMERICAL SIMULATED FLUID FLOW TO EXPERIMENTALLY OBSERVED FRINGE PATTERNS OF CONVECTION
Birgit Futterer, Christoph Egbers and ESA Topical Team “Geophysical Flow Simulation”

16:20 – 16:40 THE CHEMICALLY-DRIVEN INTERFACIAL CONVECTION EXPERIMENT CDIC II ON MASER 11
A. Heinze, K. Eckert, K. Seidel, R. Sczech

16:40 – 17:00 OUTCOMES FROM THE SCCO EXPERIMENT: IT IS POSSIBLE TO PREDICT THERMODIFFUSION IN MULTICOMPONENT
S. Van Vaerenbergh, Z. Saghir

17:00 – 17:20 IVIDIL EXPERIMENT ONBOARD ISS: MASS TRANSFER UNDER CONTROLLED VIBRATIONS
Valentina Shevtsova

17:20 – 17:40 TWO-PHASE SYSTEMS WITH CYLINDRICAL SYMMETRY: INTERFACIAL FLOW CONTROL AND STABILITY
Ilya Ryzhkov, Valentina Shevtsova

17:40 – 18:00 BUOYANCY INSTABILITIES INDUCED BY A+B→C REACTION
Christophe Almarcha, Philip M.J. Trevelyan, Anne De Wit

19:30 – 22:30 ***Conference Dinner & Boat Tour***

Student Awards

Friday, September 4th

Room A

09:00 – 10:40 ***Session Life Sciences (Animal Physiology 1)***
Chairperson: Ralf Anken

09:00 – 09:20 SEARCH FOR THE BEST ANIMAL MODEL GUIDED RESEARCH ON THE SUSCEPTIBILITY OF NEURONAL SYSTEMS TO MICROGRAVITY
Eberhard Horn

09:20 – 09:40 DROSOPHILA AS A MODEL SYSTEM IN MICROGRAVITY GROUND SUPPORT FACILITIES: A REVIEW OF PROFESSOR MARCO'S LAST YEARS EXPERIMENTS
Raul Herranz

09:40 – 10:00 GENETIC MEDIATORS OF SALMONELLA VIRULENCE DURING SPACEFLIGHT: A NEMATODE MODEL
Patricia Allen, Margaret Gunter, Jeffrey Hammond, Jeanne Becker, John Porter, Timothy Hammond

10:00 – 10:20 ANTIOXIDANT METABOLISM OF THE TARDIGRADE *MACROBIOTUS RICHTERSI* DESICCATED, ACTIVE AND UNDER SPACE FLIGHT
A. M. Rizzo, M. Negroni, G. Montorfano, P. Corsetto, P. Berselli, R. Guidetti, T. Altiero, L. Rebecchi

10:20 – 10:40 THE EXPERIMENT XENOPUS AS PART OF THE KUBIK BIO4-PROGRAM DURING THE TMA13/TMA12 SOYUZ FLIGHT TO ISS IN 2008
Martin Gabriel, Eberhard Horn

Room B

09:00 – 10:40 ***Session Physical Sciences (Liquid Interfaces)***
Chairperson: Valentina Shevtsova

09:00 – 09:20 PHASE CHANGE – INDUCED MOTION OF H_2 VAPOUR BUBBLES UNDER A TEMPERATURE GRADIENT
D. Beysens, G. Pichavant, D. Chatain, V. Nikolayev

09:20 – 09:40 SESSILE DROP WETTABILITY UNDER REDUCED GRAVITY CONDITIONS
A. Diana, N. Donadey, D. Brutin, T.A. Steinberg

09:40 – 10:00 CHEMICO-PHYSICAL PROPERTIES OF MIXED NANOPARTICLE-SURFACTANT LAYERS AT LIQUID-LIQUID INTERFACES RELEVANT FOR EMULSION STABILITY
Libero Liggieri, Eva Santini, Francesca Ravera, Michele Ferrari, Giuseppe Loglio, Mickael Antoni, Reinhard Miller, Jürgen Krägel, Dimitri Grigoriev

10:00 – 10:20 SURFACTANT EFFECT ON DROP OSCILLATIONS
Dmitriy Lyubimov, Tatyana Lyubimova, Vladimir Konovalov, Ivan Egry

10:20 – 10:40 CHARACTERIZATION OF SOLID-STABILIZED EMULSIONS BY SCANNING ELECTRON MICROSCOPY
Stéphanie Limage, Murielle Rozières, Sébastien Vincent-Bonnieu, Christian Dominici, Mickaël Antoni

10:40 – 11:00 ***Coffee break***

Room A

11:00 – 13:00 ***Session Life Sciences (Animal Physiology 2)***
Chairperson: Klaus Slenzka

11:00 – 11:20 SMALL FISH SPECIES TO STUDY BONE PHYSIOLOGY IN SPACE
Marc Muller, Jessica Aceto, Julia Dalcq, Peter Alestrom, Rasoul Nourizadeh-Lillabadi, Roland Goerlich, Viktoria Schiller, Jack van Loon, Christoph Winkler, Jörg Renn, Matthias Eberius, Klaus Slenzka

11:20 – 11:40 EFFECTS OF LONG-TERM MICROGRAVITY ON THE MINERALIZATION OF INNER EAR OTOLITHS OF FISH
Ralf Anken, Reinhard Hilbig

11:40 – 12:00 HABITUTATION OF FISH TO $4X10^{-2}$ AND 10^{-4} G DURING THE TEXUS 45 MISSION AND PARAMETERS OF INNER EAR OTOLITHS
Reinhard Hilbig, Ralf Anken

12:00 – 12:20 HIND LEG MOVEMENTS OF CRICKETS *(ACHETA DOMESTICUS)* DURING PARABOLIC FLIGHT CONDITIONS
Dana Simmet, Eberhard Horn, Martin Gabriel

12:20 – 12:40 ANTIOXIDANT ACTIVITY IS INCREASED IN *XENOPUS* EMBRYOS DEVELOPED IN SIMULATED MICROGRAVITY
M. Negroni, G. Montorfano, P. Corsetto, P. Berselli, S. Zava, A.M. Rizzo

12:40 – 13:00 MATERIAL AND NEUROBEHAVIOURAL REPERTOIRE IN DAMS AND DEVELOPING CD-1 MICE EXPOSED TO HYPER-GRAVITY
S. Petrivelli, N. Francia, D. Santucci, E. Alleva

Room B

11:00 – 13:00 ***Session Physical Sciences (Material Sciences)***
Chairperson: Daniel Beysens

11:00 – 11:20 SOLID SEGREGATION INDUCED BY STOCHASTIC ACCELERATION FIELDS
X. Ruiz, P. Bitlloch, L. Ramirez-Piscina, J. Casademunt

11:20 – 11:40 AGGLOMERATION AND SINTERING OF NICKEL NANOPARTICLES PREPARED FROM THE GAS PHASE
Stefan Lösch, Bernd H. Günther, Edmondo Bassano,
Luigi Carotenuto, Jörg Reimann, Stefan Will

11:40 – 12:00 FREE SURFACES AND INTERDIFFUSION COEFFICIENT MEASUREMENTS UNDER REDUCED GRAVITY CONDITIONS BY MEANS THE SHEAR CELL TECHNIQUE
X. Ruiz, J. Pallarés

12:00 – 12:20 X-RAY DIAGNOSTICS FOR USE IN MICRO-GRAVITY EXPERIMENTS
Y. Houltz, P. Holm, P. Anderson, O. Löfgren, C. Lockowandt

12:20 – 12:40 SIMULATIONS OF VIBRATED GRANULAR MEDIA AND COMPARISONS TO 0G-EXPERIMENTS
R. Liu, M. Hou, P. Evesque

12:40 – 13:00 FLAMMABILITY OF METALLIC MATERIALS IN NORMAL GRAVITY AND REDUCED GRAVITY
David Lynn, Ted Steinberg

13:00 – 14:00 ***Lunch***

14:00 – 17:00 ***Adjourn & Visit to DLR & EAC Cologne***

Annex to the Symposium Program

ESA Topical Team Splinter Meetings

Tuesday, September 1st

Room C

09:00 – 18:00 ***Topical Team ‚Psychosocial and Neurobehavioural Aspects of Human Spaceflight'***

Wednesday, September 2nd

Room C

09:00 – 18:00 ***Topical Team ‚Psychosocial and Neurobehavioural Aspects of Human Spaceflight'***

Room D

14:00 - 18:00 ***Topical Team 'Thermophysical Properties'***

Thursday, September 3rd

Room D

09:00 – 13:00 ***Topical Team 'Complex Plasmas'***

14:00 – 18:00 ***Topical Team ‚DOLFIN'***

ABSTRACTS

Invited Lectures

(Plenary Lectures)

EUROPE'S HOPE AND EXPECTATION FOR THE INTERNATIONAL SPACE STATION

Reinhold Ewald, ESA Astronaut, Head Columbus Mission Integration and Operations, Columbus Control Centre, Munich/Germany

Four days after launch from NASA's Kennedy Space Center on 7 February 2008, ESA's Columbus science laboratory was docked to the ISS. At 22:44 CET (21:44 UT) on 11 February 2008, NASA astronaut and ISS Commander Peggy Whitson together with ESA astronauts Hans Schlegel and Leopold Eyharts initiated final capture of the newly delivered module firmly attaching it to the starboard side of the Node 2 module. From that moment on, Columbus has served as Europe's first permanent human outpost in orbit and Europe has become a full partner of the International Space Station (ISS)

The 1E Columbus mission also carried 2.5 tonnes of ESA science payloads in five internal racks into Space - Biolab, the Fluid Science Laboratory, the European Physiology Modules, the European Drawer Rack and the European Transport Carrier -housing integrated or modular multi-user research facilities

Within the first year of operation additional facilities under NASA responsibility were moved in – the Human Research Facility and the Microgravity Science Glovebox, originally built in Europe. Two more payloads were carried separately in the cargo bay of the Shuttle and are now mounted on Columbus’s external platforms: the Solar observatory and the European Technology Exposure Facility. Other payloads will be added later.

The Columbus Mission Operations

Columbus Control Centre

Inaugurated in 2004 under contract from ESA, the Columbus Control Centre (Col-CC), located at the German Aerospace Center (DLR) facility in Oberpfaffenhofen, Germany, joins the ranks of ISS control centres including Houston and Moscow. Under the call sign 'Munich', Col-CC is responsible for all Columbus systems and for European science activities on board the ISS. Col-CC control teams already began their operational activities as a precursor to Columbus operations during ESA's Astrolab mission to the ISS in 2006.

The three main tasks of Col-CC are:

- Monitoring and control of Columbus systems as an integral module of the ISS
- Coordination of the European experiment and payload operations onboard the ISS
- Operation of the communication infrastructure and communication links in Europe and with the international ISS partners

- If any failure occurs, Columbus mostly relies on redundant systems to be switched on; other actions may include switching off certain systems or stop the payload activities until the fault is diagnosed and fixed.

Columbus payload operations

In comparison to NASA and Russia, the European ISS infrastructure is much more decentralized and is based on nine USOcs located in different European countries contributing to the ESA Human Spaceflight Programme.

The nine USOCs are the contact points for the European scientists conducting experiments on the ISS. The USOCs support preparations and provide working places for the monitoring and control of experiments.

The lecture will give an overview over operational experience gained in one year and over 200 days of continuous Columbus system and payload operations. Obstacles and opportunities will be presented using concrete science experiments as examples. Columbus operations is depending from ISS resources and overall activities which has lead to an unexpectedly high number of planning changes and demands on flexibility for all involved groups and centres. From there recommendations can be derived how to better match experiment needs with ongoing operations.

MAGNETIC GRAVITY COMPENSATION

V. Nikolayev[1,2], D. Chatain[1], D. Beysens[1,2] G. Pichavant[1]
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The magnetic levitation is an alternative mean of achieving reduced gravity conditions. During the last decade, several groups in different countries (UK, Holland, France, Ukraine …) have used magnetic installations to levitate non-ferromagnetic (dia- or para-magnetic) substances. In this presentation, we explain a principle of the magnetic levitation and discuss both its advantages and drawbacks. We show that the magnetic levitation can be controlled in order to achieve microgravity levels of the order of 10^{-2}g during long time periods, recreate the Moon or Mars gravity level and mimic the stopping and reignition of space rockets. Then we review existing results in the fields of physics and biology. New boiling studies obtained by us with OLGA (Oxygen Low Gravity Apparatus) are presented.

ARTIFICIAL GRAVITY: IS SHORT RADIUS CENTRIFUGATION THE UNIVERSAL COUNTERMEASURE FOR LONG SPACE MISSIONS?

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The current countermeasures against the debilitating effects of long duration space flight are both time consuming and of marginal effectiveness. An alternative to dealing with each body system individually (bone, muscle, cardiovascular, etc.) is to provide a gravity substitute, which would elicit the same compensatory mechanisms found when walking on earth. Early artificial gravity concepts involving giant rotating spaceships or tethers are not practical. However, intermittent exposure to centrifugation at higher speeds on a short radius device inside a space module provides an attractive alternative – if it works!
Two major issues need to be resolved. (1) Will it be tolerable without excessive motion sickness and (2) Will it be effective in combating deconditioning, and if so what exposures are needed.
We will show that, with appropriate adaptation exposures, nearly all people can successfully adapt to making head movements while rotating at speeds up to at least 30 rpm (180 deg/sec).
To demonstrate effectiveness of a countermeasure ,prior to actual space trials, we rely on the use of extended head down bed rest as a ground analog for the physiological effects of bed rest – bone and muscle loss, fluid shift, plasma reduction, etc. When combined with exercise, rotation on a centrifugation of only 2 m radius, at speeds up to 30 rpm, providing 1 g of centripetal acceleration at heart level, is found to be reasonably protective. The artificial gravity benefits are compared to alternate countermeasures.

Supported by the National Space Biomedical Research Institute through a cooperative agreement with NASA (NCC 9-58)

MULTISCALE ANALYSIS OF *ARABIDOPSIS THALIANA* ROOT GROWTH AS A MODEL FOR SYSTEMS BIOLOGY

Palme, K., Aubry, D., Bensch, M., Schmidt, T., Ronneberger, O., Neu, C., Li, X., Wang, H., Santos, F., Wang, B., Paponov, I., Ditengou, F.A., Teale, W. T., Dovzhenko, A.

Institute of Biology / Plant Physiology, Centre of Systems Biology (ZBSA), Centre of Biological Signalling Studies (BIOSS), Freiburg Institute of Advances Studies (FRIAS), Faculty of Biology, Institute of Computer Science, Faculty of Applied Sciences, University of Freiburg, Freiburg (Germany)

Arabidopsis root growth is an excellent model for analysis of the gravitropic response of higher plants at different resolution – from subcellular to whole organ levels. The new techniques developed enables identification of the individual genes affected by gravity and further integration of transcriptomics and proteomics data into interaction networks and cell communication events that operate during gravitropic curvature. Using systematic multiscale analysis we have identified regulatory networks consisting of transcription factors, the protein degradation machinery, vesicle trafficking and cellular signalling during the graviresponse. We developed approach allowing to incorporate key features of the root system across all relevant spatial and temporal scales to describe gene-expression patterns and correlate them with individual gene and protein functions. Combination of high-resolution microscopy and novel computational tools resulted in development of the root 3D model in which quantitative descriptions of cellular network properties and of multicellular interactions important in root growth can be integrated for the first time.

COMPLEX PLASMAS –PROBING STRONG COUPLING PHENOMENA AT THE MOST ELEMENTARY LEVEL

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Research into complex plasmas has opened the way to study strongcoupling phenomena in real space and time at the most fundamental kinetic level.The physics of complex plasmas is dominated by the dynamics of slow moving andindividually visible microparticles. In contrast to colloidal suspensions,where the fluid background medium results in huge overdamping, the neutral gasbackground medium in complex plasmas introduces only very little damping sothat processes at all relevant time scales can be studied. This is ofparticular importance for some of the most outstanding questions in the self-organisationof matter and critical phenomena. In this talk we will concentrate on recentadvances in these areas. We will describe the discovery of "electrorheologicalplasmas", including the physics leading to the formation of "string fluids",and the process of phase separation in two-fluid systems – a phenomenon (mathematically)similar to the phase transition at the critical point. We will close with someremarks about the kinetic origin of the observed scale-free and universalproperties of thermodynamic quantities in the vicinity of the critical point – wherecomplex plasma research may be able to address this outstanding fundamentalissue in physics for the first time.

DROPS AND SPRAY INTERACTIONS WITH A RIGID SUBSTRATE UNDER THE TERRESTRIAL, MICROGRAVITY AND VARIABLE GRAVITY CONDITIONS

Cameron Tropea and Ilia V. Roisman
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Drop and spray impacts onto a solid substrate are parts of various industrial applications, including the space technology. In the framework of the ESA Topical Team "Dynamics of liquid film/wall interactions (DOLFIN)" the influence of the surface morphology, wettability and heating on the drop spreading and on the flow in a liquid film is investigated during several ESA and DLR parabolic flight campaigns. One of the main focuses of the study is the effect of the gravity on the film generated by spray impact on the efficiency of spray cooling.
The experimental observations using the high-speed video system allow to understand and model the basic mechanisms of drop spreading [1], interaction with a liquid film [2], corona formation and splash [3]. Moreover, an analytical similarity solution of the Navier-Stokes equations and energy equation for the flow in a spreading drop has been discovered. This solution allows to describe the hydrodynamics and heat transfer of drop spreading in the presence of the near-wall phase transition: evaporation, solidification or target remelting [4]. It explains also the enhanced cooling effect of spray impact caused by the "compression" of the thermal boundary layer by the liquid flow.

1. Roisman I.V., Berberovic E., Tropea, C., "Inertia dominated drop collisions I: on the universal shape of the lamella", Phys. Fluids, Vol. 21, 052103, 2009.
2. Berberovic E., Van Hinsberg N.P., Jakirlic S., Roisman I.V. and Tropea C., "Drop impact onto a liquid layer of finite thickness: dynamics of the cavity evolution", Phys. Rev. E., Vol. 79, 036306, 2009.
3. Roisman I.V., Gambaryan-Roisman T., Kyriopoulos O., Stephan P., Tropea C., "Breakup and atomization of a stretching crown", Phys. Rev. E, Vol. 76, 026302, 2007.
4. Roisman I.V., "Fast forced film spreading on a substrate: flow, heat transfer and phase transition", J. Fluid Mech, submitted, 2009.

NECESSARY RESEARCH IN REDUCED GRAVITY FOR THE PREPARATION OF FUTURE LIFE SUPPORT DEVELOPMENT

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For all past missions in LEO, including ISS, the challenges of life support development were mainly to build an artificial environment compatible with human survival: atmosphere management, waste collection, water and food distribution. The driving forces were of course drive by the metabolic needs and the urgency to deliver resources such as oxygen and to trap gas contaminants (i.e. CO2). If we except a bit of water recovery mainly from water condensate and urine, the main part of the life support consumables were transported from Earth. The waste were mainly collected and inhibited when necessary. For future missions, such as a Moon Base or Mars expedition, such approach, mainly due to consumable mass and safety is just not possible. For information a basic calculation for a mars mission of 1000 days and 6 crew members without recycling technologies would need more than 30 tons of consumables.

Consequently for the last 20 years, ESA has been developing recycling technologies for air, water, waste. As main characteristics, these technologies are multi-phases, intertwined, and with very high requirements in terms of robustness. It is therefore extremely important to reach a very high level of understanding and control of these technologies. This understanding can of course be first performed on ground but, it will need to be perform as well in a representative environment such as reduced gravity.

In this presentation, we briefly recall the key–requirements of regenerative life support and the main family of technologies. We identify the main question mark related to their behaviour in reduced gravity.

SCIENTIFIC SESSIONS:

Tuesday, September 1st
Room A, 11:40 – 13:00

Life Sciences
Human Physiology 1

EUROPEAN CONTRIBUTION TO HUMAN ASPECT INVESTIGATION FOR FUTURE PLANETARY HABITAT DEFINITION STUDIES: FIELD TESTS AT MDRS ON CREW TIME UTILISATION AND HABITAT INTERFACES

Vladimir Pletser[1], Ludivine Boche-Sauvan[2], Bernard Foing[2], EuroGeoMars Crews 76-77
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Human factors are a dominant aspect in space missions, which may strongly influence work results and efficiency. To assess their impact on future long term space missions and to attempt a general quantification, the environmental and technical conditions to which astronauts may be confronted need to be reproduced as closely as possible. Among the stressors that occur during space missions, limited resources, limited social interactions, long term living and working in confined and isolated areas are among the most important for future planetary exploration.

The European Space Agency has a strong interest in obtaining data and insights in human aspects to prepare for future studies on the definition of future Lunar and Martian planetary habitats. In this frame, ESA's Directorate of Human Space Flight was associated to the EuroGeoMars campaign conducted by the Crews 76 and 77 in February 2009 in The Mars Society's 'Mars Desert Research Station' (MDRS) in the Desert of Utah. The EuroGeoMars Campaign lasted five weeks and encompassed two groups of experiments, on human crew related aspects and field experiments in geology, biology and astronomy/astrophysics. The human crew related aspects covered (a) an evaluation of the different functions and interfaces of a planetary habitat, (b) the crew time organization, (c) an evaluation of man-machine interfaces of science and technical equipment. Several forms and questionnaires were filled in by all crew members: time and location evaluation sheets and two series of questionnaires. In addition, the crew participated in another on-going food study where the type of food was imposed and crew impressions were collected via questionnaires.

The presentation will recall the objectives of the human crew related experiments of the EuroGeoMars project and will present the first results of these field investigations. Some recommendations and lessons learnt will be presented and used as first inputs for future planetary habitat definition studies.

TESTOSTERONE TREATMENT ENHANCES PSYCHO-PHYSICAL PERFORMANCE IN ELDERLY MEN

Massimo Morè[1], Paolo Magni[2], Maria Angela Masini[3], Giovanna Strollo[4], Iarba Carucci[1] and Felice Strollo[1]

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RATIONALE. In SL-D2 astronauts we found low testosterone levels in all body fluids. Such condition is known as Late Onset Hypogonadism (LOH) and - especially in the elderly – it often comes along together with the metabolic syndrome (MS). In fact the MS is defined as the association of at least three of the following signs/symptoms: visceral fat accumulation, low HDL and high trygliceride levels, impaired glucose metabolism and high blood pressure. LOH leads to poor overall performance, which may be expressed by the impairment of various functional parameter including reduced handgrip strength (HG) and 6 min walking distance (6MWD) as well as increased Geriatric Depression Scale (GDS) score, Aging Male Symptoms' Rating Scale (AMSRS) score and HOMA-IR (a widely accepted insulin resistance index).
AIM OF THE STUDY: to evaluate any possible changes in these parameters in 40 elderly LOH+MS men after 6 month treatment with either T (low dose, LDT group [n=16] or standard dose, SDT [n=8]) or placebo (control, C group [n=16]). Wilcoxon signed-rank test and two-way ANOVA were used for statistical analysis (SPSS16).
RESULTS: All of the above mentioned parameters improved in both LDT and SDT groups ($p<0.001$) while keeping unchanged in the C group. Interestingly enough, despite a more striking increase in T levels with respect to the LDT group, SDT patients reached up to a significantly better performance result only for HG ($p<0.05$). No adverse effects were noticed including any micturition discomfort or inappropriate increase in red blood cell counts or prostate specific antigen levels.
Conclusions: poor performance was prevented by T at both selected dosages. An explanation for that might be that a clinically relevant effect had been obtained independently of the ability to steadily reach the physiologically targeted lowest reference level for circulating T concentrations. This encourages us to test the possibility to use T as a safe and low cost additional countermeasure in forthcoming long duration space flights or bed rest experiments (*funded by ASI through a grant within OSMA project*).

MICROGRAVITY AND THE BRAIN – FIRST RESULTS

Stefan Schneider(1), Vera Brümmer(1), Christopher D. Askew(2)

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There is growing interest in the effects of weightlessness on central nervous system (CNS) activity. Due to technical and logistical limitations it presently seems impossible to apply imaging techniques as fMRI or PET in weightless environments e.g. on ISS or during parabolic flights. Within this study we evaluated changes in brain cortical activity using low resolution brain electromagnetic tomography (LORETA) during parabolic flights. Results showed a distinct inhibition of right frontal area activity >12Hz during phases of microgravity compared to normal gravity. Changes in frontal lobe activity have recently been associated with emotional reactions. In particular, the model of frontal asymmetry proposes that the left frontal cortex is involved in the experience and expression of positive, approach-related emotions. Conversely, this model proposes that the right frontal cortex is involved in the expression and experience of negative avoidance-related emotions. As such, the inhibition of beta-1 and beta-2 frontal activity during microgravity may serve as a marker of emotional arousal, anxiety and/or indisposition associated with weightlessness.

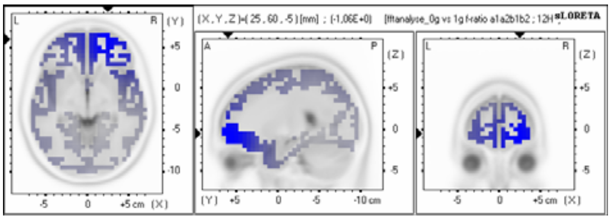

Fig. 1 Statistical parametric maps (SPM) of sLORETA differences in the beta-1 frequency range comparing 1G and 0G activity (n=7). Blue/dark grey colour indicates decreased activity in the 0G condition which was found to be localised in the right Frontal Lobe (Brodman areas 10 and 11). Slices depicting SPMs are based on voxel-by-voxel t-values of differences. Structural anatomy is shown in gray scale. (L left, R right).

DIFFERENT BEHAVIORS IN EUROPEAN AND CHINESE ASTRONAUTS AFTER SHORT-TERM SPACEFLIGHT

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The lack of gravity during spaceflight has been reported to disturb human circulatory control during space missions. One of the most important operational problems inherent to human spaceflight is a reduced post-flight orthostatic tolerance. The purpose of this study is to compare possible changes in circulatory control due to microgravity exposure during short-duration spaceflight in 5 European and 5 Chinese astronauts. Continuous ECG, blood pressure and respiration recordings from 3 scientific ESA-Soyuz missions and 2 Chinese Shenzhou missions were analyzed. Data collection was performed before launch and after return in the supine and standing positions. (1) In the European astronauts, immediate after landing, MAP was well maintained across all experimental sessions; both supine and standing HR increased compared to pre-flight control. There was a reduction in BRS in the standing position with a recovery period of approximately 10 days. (2) In the 5 Chinese astronauts after spaceflight, blood pressure remained well; there was no obvious increase in HR both in the supine and in standing position; BRS was stable in the standing position; but decreased in the supine position. In conclusion: in the Chinese group, there does not seem to be a shift toward increased sympathetic dominance after short-duration spaceflight, in contrast to the European astronauts. This different behaviour might be due to: a) shorter flight duration; b) the different training methods. However, the underlying mechanism still needs to be further investigated.

SCIENTIFIC SESSIONS:

Tuesday, September 1st
Room B, 11:40 – 12:40

Physical Sciences
(Fundamental Physics, Heat and Mass Transport)

DEVELOPMENT OF THERMOPHORETIC TRAP FOR ASTROPHYSICAL EXPERIMENTS: TESTS IN SHORT DURATION MICROGRAVITY CONDITIONS

Andrei Vedernikov[1], Andrey Markovich[1], Anastasia Kokoreva[1],
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Interactions in Cosmic and Atmospheric Particle Systems (ICAPS) is the European Space Agency's scientific program aimed at increasing our knowledge about dust agglomeration in astrophysical processes mostly related to proto-planetary matter formation. These processes are simulated in clouds of solid particles initially composed of about 1μm-sized monomers. Relatively low gas pressure provides intensive enough particle Brownian motion but considerably reduces the experimentation time at normal gravity, while microgravity removes this problem. However, grain diffusion to the chamber walls and residual forces demand efficient cloud trapping and a mechanism of cloud concentrating (squeezing) to grow agglomerates up to 1mm. We develop a new dynamic trap using thermophoresis that provides principal advantages with respect to traditional systems based on electrodynamic balancing (EDB or Paul trap). First tests in microgravity conditions in the Bremen drop tower were in agreement with the theoretical model. The mean particle motion to the center was not detected because of too low trap strength but the tests allowed identifying necessary modifications in trap's geometry and in temperature variator parameters to visualize squeezing effect of the dust cloud in short duration experiments aimed at development of the ICAPS flight instrumentation for the ISS.

THE DROP TOWER BREMEN AS A SOURCE FOR ATOM OPTICAL EXPERIMENTS IN GRAVITATION-FREE CONDITIONS

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(8) Institute of Quantum Physics, University of Ulm, Germany

Since the possibility of trapping and cooling neutral atoms, ultracold quantum degenerate gases have shifted boundaries in a growing field of modern physics appreciated by the Nobel Prizes in 1997 and 2001. The current developments in the domain of atom optics lead to an utilization of ultracold quantum matter techniques in unique practical applications as high-precision atomic clocks, atom interferometer technologies and inertial sensing instruments for gravity field mapping, underground structure detection, autonomous navigation, as well as precision measurements in fundamental physics. The expectations of even higher precision measurements can be performed by arbitrarily extending the time of unperturbed evolution of quantum degenerate systems. In respect thereof weightlessness provides an outstanding basis for such measurements and applications. Motivated by these prospects, many national and international groups have initialised research programs aiming for compact, transportable and ruggedly designed atom optical experiments, which might be launched in parabolic flights and space applications.

Thanks to an easy access to low gravity on earth, realization of quantum degenerate gases in excellent microgravity conditions at the Drop Tower Bremen opened a new kind of perspectives on earth-bound experiments, e.g., to currently achieve longest expansion times of Bose-Einstein condensates (up to one second). Thus, ultracold quantum matter in an environment of weightlessness represents an emerging area of science in quantum engineering with an impressive potential for a future technology and multidisciplinary applications.

We will report on the first experimental demonstration and investigation of rubidium Bose-Einstein condensates in the environment of weightlessness at the Drop Tower Bremen, a facility of ZARM, performed within the QUANTUS collaboration. Our approach is based on

a compact, mobile, robust and autonomous operating drop capsule setup, which has to withstand decelerations of around 50g on every free fall. So far, we have successfully accomplished more than 200 drops with the QUANTUS apparatus since the beginning.
On the basis of the QUANTUS project we are currently engineering a drop capsule setup to realize a new kind of atom interferometer experiment suitable for drop tower operations. We will give a status report of this new project initialized by the PRIMUS collaboration as well.

Both drop tower projects are supported by the German Space Agency (DLR) with funds provided by the Federal Ministry of Economics and Technology (BMWi) under the grant numbers DLR 50 WM 0346 (QUANTUS) and DLR 50 WM 0842 (PRIMUS).

EFFECT OF GRAVITY LEVEL
ON HEAT TRANSFER FROM SMALL SPHEROIDS

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Heat transfer over a sub-millimeter spheroidal solid is of interest in many engineering processes such as manufacturing systems, packed beds and for many electronic components of nearly spherical shape. One important mechanism of heat transfer in the above processes is the natural convection which leads to heat transfer rates many times larger than that of pure molecular diffusion of heat (conduction). Despite the huge literature devoted to natural convection heat transfer rates over spheres (and to a smaller extent over spheroids) there is not a generally accepted correlation especially for relatively small Rayleigh numbers. Existing correlations for external geometries predict a progressively increasing contribution of natural convection to heat transfer with respect to gravity (starting from zero gravity).

To test the validity of these correlations, experiments are performed for the estimation of heat transfer rates at low gravity. Heat pulses are given to a miniature thermistor with a nearly spheroidal shape immersed in a liquid and its thermal response is registered during heating. Several heat pulse strengths have been tested in water and glycerol during the 49th Parabolic Flight Campaign of European Space Agency (November 2008). Similar tests with FC-72 (a refrigerant) and dispersions of polystyrene microparticles crosslinked with divinylbenzene (nominal size 33 and 330 microns) in water are foreseen for the 50th ESA PFC (May 2009). The contribution of natural convection is undoubtedly estimated from runs in which acceleration varies from 0g to 1.8 g.

Surprisingly enough, the experiments showed that the Rayleigh number must take a minimum value before natural convection appears (existence of a critical Rayleigh number). In the absence of natural convection (below Ra_{crit}) the experimental thermal response curves can be successfully described by approximating solutions of the transient heat conduction equation for the spheroidal geometry of the thermistor. In addition, in the range $Ra_{crit}<Ra<250$, which is representative of heating applications with miniature heaters at temperatures below boiling, existing correlations fail to describe the present results. Apparently, additional research is needed regarding the natural convection around sub-millimeter objects for relatively small Rayleigh numbers.

SCIENTIFIC SESSIONS:

Tuesday, September 1st
Room A, 16:00 – 17:20

Life and Physical Sciences (Interaction)

COMBINED MAGNETIC FIELD COUNTERACTS GRAVITY

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At present, magnetic fields of different types are widely used to study gravity sensing in plants. For instance, magnetic levitation of amyloplasts caused by high gradient magnetic field enables us to alter the effective gravity sensed by plant cells. In the given work, we investigated the *Lepidium sativum* and *Pisum sativum* root gravitropic reaction under seedling gravistimulation in a weak combined magnetic field (CMF) (~0.5 gauss, 0-100 Hz). For the first time we showed that the CMF can change the positive gravitropic reaction of the root to the negative one. This effect has the form of resonance and occurs at the frequency of cyclotron resonance of calcium. What is especially interesting is that under gravistimulation in the CMF, the displacement of amylopasts in the root cap statocytes is directed to the upper wall of a cell, i.e. in the direction opposite to the gravitational vector. The displacement of amyloplasts, which contain the abundance of free Ca^{2+} in the stroma, is accompanied by Ca^{2+} redistribution in the cytosol. It should be stressed that the root is bending in the same direction in which amyloplasts are shifting: when gravitropism is positive – downwards, when gravitropism is negative– upwards. This brings the question: what forces can promote amyloplast displacement against gravity? The original approach based on the use of a weak CMF may be helpful for understanding the mechanisms of plant gravisensing.

EXPERIMENTS ON THE JAPANESE EXPERIMENT MODULE "KIBO"

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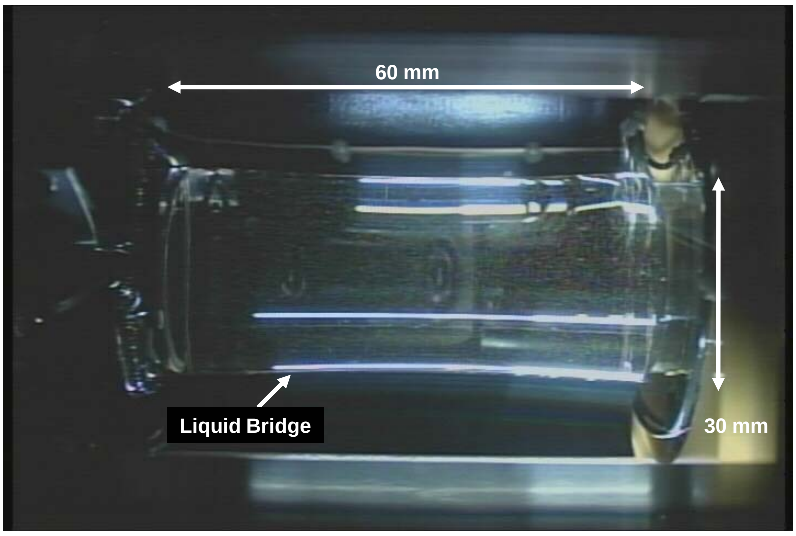
Assembly of the Japanese Experiment Module "KIBO" pressurized facilities was completed during the STS-124 Mission. Now we have two Japanese experiment racks in KIBO. The "Ryutai Rack" is mainly used for fluid physics and crystal growth experiments. It includes the Fluid Physics Experiment Facility (FPEF), Solution Crystallization Observation Facility (SCOF), Protein Crystallization Research Facility (PCRF) and the Image Processing Unit (IPU). The "Saibo Rack" is mainly used for life science experiments, and includes Cell Biology Experiment Facility (CBEF) and Clean Bench (CB).

The first experiment on fluid dymanics started in August 2008 using the FPEF. The objectives in Increment 17 were to test the operation of the hardware, especially the liquid bridge formation and measurement systems and to obtain the critical condition, at which the Marangoni flow exhibits transition from steady to oscillatory flow, for various aspect ratios, that is, the ratio of height to diameter of the liquid bridge. When the temperature difference was imposed stepwise between the cold and hot disks, the Marangoni convection was developed in the liquid bridge. The start of the oscillation was easily recognized by the fluctuation of the signal of the thermocouples and by the observation through the hot disk. All the operating devices and measurement points worked perfectly. The critical condition was successfully obtained for various aspect ratios of the liquid bridge. The image of the 60mm long liquid bridge is shown below.

The next experiment focusing on crystal growth was performed from December, 2008 using SCOF. The objective was to precisely analyze the factors concerning the pattern formation of ice crystal. The ice crystal was nucleated in the nucleation cell, and grew through the glass capillary into the crystal growth cell. The crystal growth cell temperature was controlled in a certain supercooling rate, and the crystal growth was observed from two directions. The thermal diffusion field around the growing crystal was monitored by interferometry. More than 130 experiments were carried out in various supercooling rate. The crystal growth velocity, morphology, and the thermal diffusion field around the crystal are now being analysed.

Some life science experiments were also performed in KIBO. We will introduce the experiments, facilities, and operations of KIBO.


60 mm
30 mm
Liquid Bridge

MICROGRAVITY RESEARCH DURING THE FIRST 50 ESA PARABOLIC FLIGHT CAMPAIGNS, AN OVERVIEW AND FUTURE PROSPECTS

Vladimir Pletser[1], Thierry Gharib[2], Frederic Gai[2], Christophe Mora[2], Patrice Rosier[2]
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Aircraft parabolic flights provide repetitively up to 20 seconds of reduced gravity during ballistic flight manoeuvres. Parabolic flights are used to conduct short microgravity investigations in Physical and Life Sciences and in Technology, to test instrumentation prior to space flights and to train astronauts before a space mission. The use of parabolic flights is complementary to other microgravity carriers (drop towers, sounding rockets), and preparatory to manned space missions.
The European Space Agency (ESA) has organized since 1984 fifty parabolic flight campaigns for microgravity research experiments utilizing six different airplanes. 600 experiments were successfully conducted during more 4500 parabolas, representing a cumulating time of 25 h of weightlessness, equivalent to more than 16.6 low Earth orbits. The experiments spanned several fields in Physical Sciences and Life Sciences, namely Fluid Physics, Combustion Physics, Material Sciences, fundamental Physics and Technology tests, Human Physiology, cell and animal Biology, and technical tests of Life Sciences instrumentation.
Since 1997, the Airbus A300 'Zero G' is used in Europe for short microgravity investigations by ESA, the French space agency CNES, the German Space Agency DLR, the Japanese Space Agency JAXA and by industrial customers. The Airbus A300 is the largest airplane in the world used for this type of experimental research flight.
This paper presents the short duration microgravity research programme of ESA. The experiments conducted during these campaigns are summarized, and the different airplanes used by ESA are shortly presented. The technical capabilities of the presently used aircraft by ESA, the Airbus A300 Zero-G, are addressed. Some of the Physical Science and Technology experiments performed during the last ESA campaigns are presented to show the interest of this unique microgravity research tool to complement, support or prepare microgravity physical investigations during space flights. Future potential developments are addressed.

"FLY YOUR THESIS! – AN ASTRONAUT EXPERIENCE" - ESA PARABOLIC FLIGHTS OPPORTUNITIES FOR UNIVERSITY STUDENTS IN COLLABORATION WITH ELGRA

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"Fly Your Thesis!" is a new programme launched by ESA's Education Office which consists in offering a unique opportunity for European students to design, build, and eventually fly, a scientific experiment to be performed in microgravity, as part of their last year of University, Master or PhD thesis.

For the first version of this programme, a Review Board, composed of experts from ELGRA and ESA, selected 16 teams and invited them to elaborate a detailed scientific proposal, with the support of an ELGRA scientific mentor. The teams presented their projects during a dedicated workshop and the Review Board made the selection of the four winning teams. ESA will financially support the cost of the Microgravity Research Campaign, part of the hardware, necessary travel and accommodation, and participation in a conference. The use of other platforms (Drop Towers and the ESA-ESTEC Large Diameter Centrifuge (hyper-gravity of up to 20g)) is under assessment.

This paper will introduce this new ESA Education programme, explain the role of ELGRA experts, as well as give information for students interested in the future editions. Experiments selected to fly during the ESA Microgravity Research Campaign of Autumn 2009 and their related scientific-value will be explained in details.

SCIENTIFIC SESSIONS:

Tuesday, September 1st
Room B, 16:00 – 17:00

Life and Physical Sciences (Interaction)

GROWING FROM SOLUTIONS IN MICROGRAVITY: PRESENT RESEARCH WITH ESA'S PROTEIN CRYSTALLISATION DIAGNOSTICS FACILITY AND ESA'S FUTURE PROSPECTS WITH THE SOLUTION CRYSTALLISATION DIAGNOSTICS FACILITY

Vladimir Pletser[1], Stefano Mazzoni[2], Olivier Minster[2], Lothar Potthast[3], Robert Bosch[3], Peter Lautenschlager[3]
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[3] Astrium, Friedrichshafen, Germany

The Protein Crystallization Diagnostics Facility (PCDF) is an instrument developed by Astrium under an ESA contract to observe and study with advanced diagnostics nucleation and crystallisation processes of molecules from solutions in long duration microgravity on board the International Space Station. The first experiment PROTEIN performed with PCDF aims at unravelling physical processes and relating the formation of defects in crystals to their growth conditions. This PCDF experiment is flying presently on the ISS, integrated in the European Drawer Rack and is followed and teleoperated by the supporting science teams from User Support Operation Centers on ground.
The PCDF mission forms an important milestone and a basis for future experiments. On the occasion of the 2004 Announcement of Opportunity, new proposals in crystallisation and growth have been selected, targeting a broader range of systems like synthetic zeolites and model colloidal systems. The thorough preparatory activities carried out within the relevant Topical Teams, identified a common need for scattering techniques, ranging from traditional state of the art dynamic and static light scattering to sophisticated multi-speckle techniques based on multipixel sensors. This led to the idea of upgrading the process unit of PCDF with a set of diagnostic techniques and interfaces capable of serving a broader scientific community. The feasibility study of this instrument, called Solution Crystallisation Diagnostics Facility (SCDF) has been recently kicked-off by ESA, aiming at a consolidated instrument conceptual design in 2010. SCDF will be uploaded in ISS tentatively in 2013 and will allow on-orbit sample exchange to cope with the future up/download limitations.

DYNAMICS OF VESICLE SUSPENSIONS IN SHEAR FLOW BETWEEN WALLS

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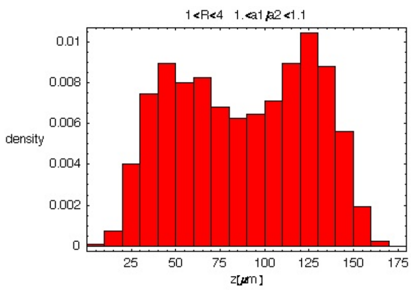
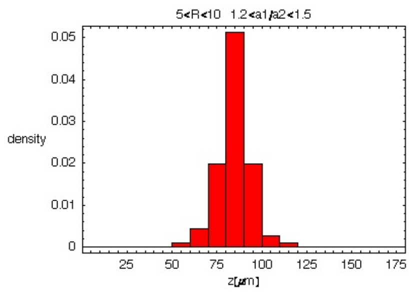
The dynamics of a vesicle suspension in shear flow was investigated by digital holographic microscopy [1] in parabolic flights and in the MASER 11 sounding rocket. Vesicles are lipid membranes which mimic the mechanical behaviour of cells, such as red blood cells in flow. In a simple shear flow between parallel walls, a lift force of purely viscous origin pushes vesicles away from walls. Our parabolic flight experiments [2] reveal that the lift velocity in a dilute suspension is well described by theoretical predictions by Olla. As vesicles gather near the center of the flow chamber due to lift forces from both walls, one expects hydrodynamic interactions of pairs of vesicles to result in shear induced diffusion in the suspension. The BIOMICS experiment in the MASER 11 sounding rocket revealed a complex spatial structure of a polydisperse vesicle suspension due to the interplay between lift forces from the walls and hydrodynamic interactions. These phenomena have a strong impact on the structure and rheology of blood in small vessels, and a precise knowledge of the dynamics of migration and diffusion of soft particles in flow can lead to alternative ways to separate and sort blood cells.

(a)



(b)



Spatial distribution of vesicles across the channel thickness in a polydisperse sample (MASER 11 experiment). (a) small, nearly spherical vesicles, (b) large, deflated vesicles.

1. Dubois, F., Schockaert, C., Callens, N., Yourrassowsky, C., "Focus plane detection criteria in digital holography microscopy by amplitude analysis", Opt. Express, Vol. 14, pp 5895-5908, 2006
2. Callens, N., Minetti, C., Coupier, G., Mader, M.-A., Dubois, F., Misbah, C., Podgorski, T., "Hydrodynamics lift of vesicles under shear flow in microgravity", Europhys. Lett., Vol. 83, p. 24002, 2008

ULTRASONIC ENERGY MEASUREMENT INTO A THIN ACOUSTIC RESONATOR IN PARABOLIC FLIGHTS: APPLICATIONS TO PARTICLE AND CELL SEPARATION

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Abstract: Manipulation of particulate materials like solid microspheres, blood cells, bacteria, vesicles, flowing through a thin channel, can be performed by using ultrasonic standing waves. When a piezoelectric transducer is placed in such a way that the wave propagation occurs in the channel thickness, particles in the acoustic field undergoing a radiation force pushing them toward the nodal or antinodal pressure planes depending on the sign of the acoustic impedance contrast. The precise position of the final focusing plane coincides with the nodal or antinodal planes when only the acoustic force is applied but that position differs if a transversal force like gravity is also acting on. Using thin channels for separating micron-sized species generated only by sedimentation, as in gravitational SPLITT fractionation, requires the knowledge of particle trajectories along the channel but those trajectories are highly modified when an ultrasonic field is superimposed. In order to follow the transversal selective transport by using ultrasonic standing waves combined to gravity for particle fractionation, it is necessary to precisely determine the acoustic radiation energy. We performed an experimental study in parabolic flights at the ZeroG airbusA300, in order to determine the influence of the acoustic radiation force on particle transport in a Hele Shaw channel. We present a method of ultrasonic manipulation of particles of 5 to 15 μm undergoing standing waves of 2MHz frequency flowing in a channel of dimensions 50x10x0.4 mm^3. The method allows *in situ* observing the 3D concentration profile of particles by means of a Digital Holographic Microscopy with partially coherent illumination, when the experiment is in microgravity conditions but also during hypergravity periods of 1.8 g. By the precise determination of particle focusing position, the acoustic energy and force have been deduced without using external probes. Acoustic focusing is also used in this work for precisely determine the sedimentation velocity of particles in microchannels of high aspect ratio. Using microscopic holography allows bypassing the difficulties encountered by the normal microscopy, for *in situ* visualizing transport phenomena in the thickness of such a channels. The determination of the acoustic energy and the acoustic radiation force, will allow optimizing the separation parameters for succeeding continuous sorting of blood cells and biomimetic objects.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room A, 09:40 – 10:40

Life Sciences
(Plant Physiology 1)

A SEQUENTIAL STUDY ON EARLY PLANT DEVELOPMENT UNDER MAGNETIC LEVITATION SHOWS EFFECTS OF ALTERED GRAVITY ON CELL PROLIFERATION AND GROWTH

Ana I. Manzano[1], Camelia Dijkstra[2], Oliver Larkin[2], Paul Anthony[2], Michael R. Davey[2], Richard J.A. Hill[3], Laurence Eaves[3], Eugénie Carnero-Díaz[4] and F. Javier Medina[1]*
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Plant cell proliferation and growth are basic and fundamental cellular functions, which are essential for the developmental program of the plant. They are interconnected and mutually depending to one another. Furthermore, there are reliable markers for assessing their variations in the root meristem, such as the rate of local cell production (No. of cells · mm^{-1} along the root) or the use of reporter genes coupled to markers of cell cycle regulation (for cell proliferation), and the estimation of the rate of ribosome biogenesis (for cell growth). In previous experiments in real and simulated microgravity (ISS and RPM, respectively), we have shown that weightlessness decouples cell proliferation and cell growth, inducing an increase of the proliferation rate and a decrease of the growth rate. This work is a more complex study, using a super-conducting magnet with a closed-cycle liquid helium cooling system and a 5 cm diameter bore (Oxford Instruments, Abingdon, UK), capable of producing a very high magnetic field of 16.5 T. This instrument offers the unique opportunity of studying simultaneously three different levels of effective gravity (0 g*, 1 g* and 2 g*), as well as the effects of the high magnetic field. The cellular parameters were studied sequentially on early developing seedlings, from seeds germinated within the magnet and sampled 2 and 4 days after seed soaking. Seeds were from a transformed line in which the promoter of the cyclin B1 gene, a cell cycle regulator controlling entry into mitosis, was linked to the β-glucuronidase (*gus*) gene. Results from samples grown in the 0 g* position were essentially similar to the previous experiments mentioned above, with minor differences in some parameters indicating a slightly weaker effect. Therefore, our previous conclusions on the alterations induced by microgravity on these cellular functions were fully confirmed. Regarding hypergravity (2 g* position) the most conspicuous feature was the thickening of the root tip, together with a depletion of the cyclin B1 expression observed at the 4th day, but not at the 2nd day of culture. Finally, all parameters of the 1 g* sample were essentially similar to those recorded out of the magnet, which would indicate a very weak, if any, effect of the magnetic field alone. There was a striking exception, namely the expression of cyclin B1, which appeared significantly depleted.

GENE EXPRESSION STUDIES UNDER PARABOLIC FLIGHT CONDITIONS – A NEW DIFFERENTIATED LOOKS ON THE MOLECULAR BASIS OF GRAVITY-RELATED PROCESSES IN PLANTS

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The gravity-related adjustment of plant organs is genetically programmed and any deviation from the original orientation is sensed by specialized cell types, the statocytes. In these cells starch-filled dense particles, so-called statoliths, sediment along the gravity vector onto the lower cell flank where they activate gravireceptor molecules. Activation of the gravireceptors creates a physiological signal that initiates a stimulus-specific signal-transduction cascade and eventually results in the gravitropic curvature response, namely, the correction of the growth direction. Parabolic plane flight experiments provided evidence that gravireceptor activation in plant cells does not require pressure mediated through the weight of sedimented statoliths but relies on direct interactions of the receptor with components on the statoliths' surface. The results of recent gene expression studies on plants (Arabidopsis) during parabolic plane flights supported these findings and provided new insights into the molecular basis of plant gravity sensing. Increasing the acceleration level resulted in only moderate alterations of gene expression patterns whereas vibrations and fast acceleration changes typical for parabolic plane flights strongly altered the expression of a multitude of genes. The expression patterns of genes, however, which are specifically regulated upon changing the direction of gravity, were only marginally altered by hypergravity and microgravity conditions.

NEUTRON IRRADIATION ALTERS THE EXPRESSION OF AUXIN ACTIVATED GENES, OF GENES INVOLVED IN STRESS CONTROL, AND IN TUBULIN SYNTHESIS, ACCELERATING SENESCENCE IN ARABIDOPSIS

P. Tassone[1], A. Fortunati[1], MA. Meloni[2], P. Pippia[2], F. Migliaccio[1]
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A study of the effect of neutron irradiation on the acceleration of senescence in Arabidopsis, and on the involvement of the hormone AUXIN in the process was performed. To this scope seedlings were subjected to irradiation at the Frascati (Rome) neutron accelerator for 4 hours, then collected, RNA extracted, and submitted to qPCR to determine the expression of genes involved in auxin action, and in the senescence. The results showed that three genes from the *ARF* family (*ARF1,2,19*) were down-regulated, whereas a gene from the *AUX/IAA*s family (*AUX/IAA7*) was strongly up-regulated. This was considered a sign of inhibition of the auxin action, since it was shown that the AUX/IAAs proteins should be degraded before the ARFs can activate physiological processes. It was found also that genes directly related to aging (*SAG12* and *SAG13*) were up-regulated, as well as genes involved in the defense from oxidative stress (*FeSOD, CAT1, CAT2*). Furthermore, up-regulation was seen also in genes encoding the synthesis of tubulin (*TUA4*, *TUA6* and *TUB2)*, i.e. the structure of the cells. The action of neutron irradiation thus resulted negative on the Arabidopsis wild-type plants. By contrast, in some auxin mutants, i.e. *EIR1*, *AUX1 and ARF2,* the effects on the above genes were milder or absent, and senescence was not always accelerated. Consequently, the utilization of some mutants as plants to grow in space looks as a concrete possibility.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room B, 09:40 – 10:40

Physical Sciences
(Convection, Interfacial Flow 1)

MARANGONI INSTABILITIES DUE TO CONCENTRATION DEPENDENT TRANSFER PROPERTIES

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We consider two immiscible liquids inside a Hele-Shaw cell. A chemical species initially dissolved in an organic phase crosses the interface into the aqueous phase. In the aqueous phase this chemical reactant reacts to produce a surfactant which undergoes micellisation when the critical micelle concentration is reached. These micelles increase the solubility which in turn increases the interfacial transfer rate and hence favours additional formation of micelles. To model such an autocatalytic increase of solubility, we consider here that the partition coefficient is a function of the surfactant concentration. Through the solutal Marangoni effect, this surfactant can induce tangential stresses leading to interfacial motion. The aim of our study is to theoretically examine the conditions for an instability in such a system. In particular, we seek to understand whether Marangoni effects can be observed because of a concentration dependent partition coefficient in a system that would be stable in the case of a constant partition coefficient according to the classical stability conditions of Sternling and Scriven (AIChE J., 5, p.514, 1959).

MARANGONI-DRIVEN CONVECTION AROUND EXOTHERMIC AUTOCATALYTICCHEMICAL FRONTS IN FREE SURFACE SOLUTION

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Spatiotemporal distributions of heat and mass across exothermic chemical fronts propagating in solutions layers can initiate Marangoni-driven convection. The goal of our work is to theoretically investigate the dynamics arising from such a coupling between exothermic autocatalytic reactions, diffusion, and Marangoni-driven flows. To do so, we numerically integrate the incompressible Navier-Stokes equations coupled through the tangential stress balance to conservation equations for the concentration of the reaction product and for the temperature.
A solutal and a thermal Marangoni number (resp. Mas, Mat) measure the coupling between reaction-diffusion processes and convection due to surface forces. The asymptotic dynamics in the case of an isothermal front is a steady vortex surrounding, deforming, and accelerating the front if (Mas< 0) and can be described by a so-called return flow when (Mas> 0)[1].
We address here the influence of thermal effects on the dynamics of the system in both the cases of cooperative and competitive solutal and thermal effects. We show that exothermic fronts can exhibit new types of dynamics in the presence of convection, particularly when the solutal and thermal effects are antagonistic, leading to temporal oscillations of the concentration, temperature, and velocity fields in a reference frame moving with the front. The influence of the Lewis number measuring the ratio between thermal and molecular diffusivity is investigated.

1. L. Rongy, A. De Wit and G. M. Homsy, "Asymptotic structure of steadynonlinear reaction-diffusion-Marangoni convection fronts",Phys. Fluids, Vol 20, 072103, 2008.

OBSERVATION OF MARANGONI WITH A MINIMUM OF SURFACE TENSION WITH MACH ZEHNDER INTERFEROMETRY AND PARTICLE VELOCIMETRY.

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The Marangoni flows in dilutes aqueous solutions of fatty alcohol are studied. These systems present a minimum of surface tension as function of temperature [1] , and it is thought that inverse Marangoni flows are to be observed above the minimum although paradoxical observations have been obtained in the past [2].

The systems studied are water-heptanol; and water-butanol, in a cell designed to favour 2 D flows. The cell also allows good thermal boundary condition, visualization for velocimetry and interferometry, and minimization of the liquid meniscus. It also presents a configuration close to heat transfer applications [3].

A nearly 2 D flow is observed. From interferometry, the thermal field is quantified and it is possible so to obtain as well the actual surface tension gradients. Results are discussed

1. R. Vochten, G. Pétré, " Study of heat of reversible adsorption at the air-solution interface", J. Coll. Interf. Sci. , Vol. 42, p. 320, 1973
2. G.Pétré, K.Tshinyama, A.Azouni, S. Van Vaerenbergh, "Determination of non-equilibrium surface tension gradients in Marangoni thermal flows; application to aqueous solutions of fatty alcohols",FDMP, 2007
3. R. Savino, A. Cecere, R. Di Paola, "Surface tension-driven flow in wickless heat pipes with self-rewetting fluids", International Journal of Heat and Fluid Flow Vol. 30, p 380, 2009.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room A, 11:40 – 13:00

Life Sciences
(Plant Physiology 2/Technology 1)

ARABIDOPSIS CELL CULTURES INCREASE THEIR CYTOSOLIC CALCIUM CONCENTRATION UPON PARABOLIC FLIGHT MICROGRAVITY

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In previous studies we reported specific changes in unspecialized *Arabidopsis thaliana* (A.t.) cell cultures with regard to both gene and protein expression in response to different gravitational fields. From these data we assumed that calcium plays a role in the signal transduction pathway between the gravitational stimulus and altered gene and protein expression. To unravel possible gravity-dependent calcium signatures in these cells, we used transgenic *A.thaliana* cell cultures, which constitutively express a calcium sensor, Yellow Cameleon 3.6. Exposing these cells, we were able to monitor calcium fluctuations during 1g-2g-µg-2g-1g transitions on parabolic flights. We show that cytosolic calcium increases transiently during the 20 s µg-period. The presence of the calcium channel blocker, lanthanum chloride, abolished these effects. This indicates uptake of extracellular calcium. Expression analyses of calcium responsive genes exhibited an ambiguous pattern in response to lanthanum chloride exposure, i.e. regulation by calcium from extracellular as well as intracellular sources. In addition, we report on gravity-related changes in the degree of phosphorylation of Ca-regulated proteins. These data indicate that gravitational stress affects the turnover of reactive oxygen species.

EFFECT OF THE CHANGE IN STATOCYTE POLARITY ON CALCIUM-DEPENDANT PATHWAYS (PolCa EXPERIMENT)

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It has been widely demonstrated that statocytes (located in the centre of the root cap) are the gravisensing cells in plants. The statocyte contains voluminous organelles (the statoliths) that contain large starch grains (amyloplasts). Statoliths sediment under the influence of gravity(1). The root statocyte shows a polar distribution of organelles. This polarity provides interactions between amyloplasts and the endoplasmic reticulum membranes (ER)(2). Studying the statocyte ultrastructure has led to the hypothesis that the ER should be involved in the trasduction of the gravistimulus. The contact of the amyloplast on the ER tubules could induce a Ca^{2+} efflux from these tubules to the cytoplasm in the lower side of the gravisensing cell and activate Ca^{2+}-dependent proteins that could trigger the transduction of the stimulus (3).
Until now, there is no clear evidence that a change in amyloplasts-ER interactions could lead to a modification in transduction signal. The objective of PolCa experiment is to study the implication of amyloplasts displacement and calcium signalling in root gravisensing. We will report on the preliminary results of the PolCa experiment, conducted using *Brassica napus* seedlings on March 2009, to understand the effects of statocyte polarity on dependant pathways like the distribution of cytoplasmic free Ca^{2+} and the calmodulin localisation.

References

1. Perbal G, Driss-Ecole D (2007) Development and gravitropism of lentil seedling roots grown in microgravity. In: Brinckmann E (ed) Biology in Space and Life on Earth. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim, pp 71–121
2. Driss-Ecole D., Lefranc A. and G. Perbal, 2003. A polarised cell: the root statocyte. Physiologia Plantarum, 118, 305-312.
3. Evans ML, Moore R, Hasenstein KH. How roots respond to gravity. Sci Am. 1986.Dec; 255(6):112–119.

PLANT CORTICAL MICROTUBULE ORDERING AND CELL ELONGATION IN RECOVERING PROTOPLASTS UNDER SIMULATED MICROGRAVITY CONDITIONS

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The cytoskeleton and the cell wall both play key roles in plant cell growth and division, determining and consolidating the plant's final shape and performance. It is known that under microgravity conditions, in vitro tubulin does not self-organize in the ordered patterns observed in 1g [1]. At the same time, our data on tobacco BY-2 protoplasts and published results on Brassica napus protoplasts [2] show that microtubules in protoplasts (plant cells without walls) in microgravity fail to organize in parallel arrays, required for proper cell elongation. However, results of our space experiment (TUBUL 2006) shows that the cortical array of isolated walled plant cells from a suspension culture is unaffected by microgravity (Sieberer et al., submitted) [3]. The combined results points to a role for the cell wall, or its production machinery, in structuring the microtubule cytoskeleton. Although crosstalk exists between the microtubules in the cell cortex and the cellulose synthase complexes in the plasma membrane that produce the cellulose microfibrils in the adjacent wall, the exact relationship is not known. Since microgravity appears to interfere with this crosstalk, to get insight into this relationship we are using microgravity, combined with drugs that inhibit microtubule polymerization and/or cellulose production, on recovering protoplasts under simulated weightlessness conditions on an RPM.

1. Papaseit, C., Pochon, N. Tabony, J., "Microtubule self-organization is gravity-dependent" Proc. Natl. Acad. Sci. U.S.A. 97, 8364-8368 (2000)
2. Skagen, E.B. Iversen, T.-H., "Simulated weightlessness and hyper-g results in opposite effects on the regeneration of the cortical microtubule array in protoplasts from *Brassica napus* hypocotyls" Physiol. Plant. 106, 318-325 (1999)
3. Sieberer, B.J., Emons, A.M.C. Vos, J.W., "Culturing immobilized plant cells for the TUBUL spave experiments on the DELTA and 12S Missions" Microgravity Sci. Technol. 19, 45-49 (2007)

COLUMBUS/BIOLAB: STATUS AND PERSPECTIVES

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After the successful mounting of the COLUMBUS module to the ISS in February 2008, the first commissioning of the payloads inside COLUMBUS was performed. One payload inside COLUMBUS is the BIOLAB. As a multi-user biology laboratory it allows experiments on cells, tissues, small plants and animals. The core part of the BIOLAB is the incubator with a life support system which provides defined environmental parameters; the two rotors inside the incubator provide different g levels up to 2xg and video-observation. For manual operations by the astronaut a bioglovebox is available. The biosamples are accommodated in experiment containers which are supplied by the life support system. Automated on-board analysis is possible by means of a microscope and a spectrophotometer. A robotic arm is capable of transferring e.g. liquids between incubator and automated cooler and a.m. analysis instruments. Moreover, an interactive mode of operation between astronaut in space and ground crew by means of telescience and teleoperations is enabled. These capabilities were used for the WAICO#1 experiment. The next experiments will be: YING, ARTEMISS., TRIPLELUX, WAICO#2. The BIOLAB Facility Responsible Center MUSC is cooperating with the astronauts on ISS and the ground segment, e.g. Facility Support Center BIOTESC and COLUMBUS Control Center.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room B, 11:40 – 13:00

Physical Sciences
(TT Thermophysical Properties)

THE ESA THERMOLAB PROJECT: MEASUREMENT OF THERMOPHYSICAL PROPERTIES OF LIQUID METALLIC ALLOYS ON BOARD PARABOLIC FLIGHTS AND TEXUS

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The thermophysical properties relevant for the analysis of solidification and casting processes of a series of industrial Ni-, Ti-, Cu- and Fe-based alloys were measured with an electromagnetic levitation device on board parabolic flights and TEXUS. Parabolic flights provide about 20 seconds of reduced gravity which are sufficient to heat, melt process in the liquid phase and cool a 6 to 7 mm diameter specimen to solidification. In the free cooling phase with the heating field turned off, magentic field pulses for the excitation of surface oscillations are applied. Because of the much reduced positioning forces under micro-g conditions, turbulent fluid flow is absent or strongly reduced, which is a necessary condition for the evaluation of the viscosity from the damping time constant of the surface oscillation. This method is particularly siuted for high temperature reactive alloys where container reactions will affect the results obtained with conventional methods such as the sessile drop or rotating cup method for surface tension and viscosity measurements, respectively. The measurement method and data analysis will be discussed. Results for the viscosity and surface tension of the relevant alloys will be presented. The experiments were performed within the framework of the ESA-ThermoLab project which is concerned with the measurement of the thermophysical properties of industrial alloys in the liquid phase.

ELECTROMAGNETIC LEVITATION FOR THERMOPHYSICAL PROPERTY MEASUREMENTS – EFFECTS AND CONSEQUENCES

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The MSL-EML experiment on the ISS uses separate locating and heating coils to compute thermophysical properties of electrically conductive liquid droplets suspended under microgravity. Analytic formulae are used to deduce surface tension from triggered frequency and viscosity from damping rate. It is assumed damping due to flow, or advection of heat are negligible. But, even under these conditions flow is generated due to the weak Lorentz force and due to thermocapillary effects. Under full gravity, the problem is more acute as the flow becomes turbulent and the suspended droplet loses its spherical shape as the Lorentz force has to balance gravity. We have developed a unique numerical framework that allows us to compute the instantaneous behaviour of the suspended droplet, including internal flow, heat transfer, melting/solidification as the liquid envelope adjusts its shape to accommodate the changing electromagnetic force[1]. The software allows us to investigate suspension in full or zero gravity, in a DC, AC field combination[2], or in a gradient DC field for paramagnetic materials[3]. It has been used to validate analytical expressions and devise corrections. Secondary effects due to shape deformation, rotation, or even surface evaporation can be studied and knowledge of these effects can assist the extension of microgravity techniques to terrestrial laboratories if necessary.

REFERENCES

V. Bojarevics, K. Pericleous. *Modelling Electromagnetically Levitated Liquid Droplet Oscillations*, ISIJ International, 2003, vol. 43, 6, pp 890-898.
K. Pericleous and V. Bojarevics. "Pseudo-spectral solutions for fluid flow and heat transfer in electro-metallurgical applications". Progress in Computational Fluid Dynamics, 2007, vol. 7, N 2/3/4, p. 118-127
V. Bojarevics and K. Pericleous. "Droplet oscillations in high gradient static magnetic field". Microgravity – Science and Technology, 2008. ISSN 0938-0108 (Print) 1875-0494 (Online).

SURFACE TENSION OF LIQUID AL-CU-AG ALLOYS

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Keywords: Liquid Al-Cu-Ag Alloys; Surface Tension; Electromagnetic Levitation; Regular Solution

We report on surface tension measurements of liquid binary and ternary Al-Cu-Ag alloys. The surface tensions were measured in electromagnetic levitation experiments using the oscillating drop technique. The samples were processed containerlessly and contamination from contact with container walls was avoided.
Top view images of the oscillating sample were recorded by a fast digital CMOS-camera (400 fps). The surface tension was determined from an analysis of the frequency spectrum according to the rule of Cummings and Blackburn.
A linear temperature dependence with a negative slope was found for all stoichiometric compositions. The surface tension monotonically increases if the copper concentration is increased. The observed behaviour with respect to both, temperature and concentration, is in agreement with thermodynamic model calculations using the regular solution approximation.
It is a result of the present work that even small changes in the silver concentration can drastically change the thermodynamic behaviour of the system. Moreover, the role of impurities will be discussed in detail.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room A, 14:40 – 15:40

Life Sciences
(Technology 2)

CLINOSTATS – CONFIGURATION AND MODES OF OPERATIONS

Jens Hauslage, Astrid Horn, Kai Waßer, Ralf Anken, Ruth Hemmersbach
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Our working group at the German Aerospace Center (DLR) provides access to various experimental platforms which enable the alteration of the influence of gravity on ground (clinostat and centrifuge devices). In order to prevent sedimentation and thus achieve the status of functional weightlessness, we use clinostats with one rotation axis, which is perpendicular to the direction of the gravity vector. This approach allows a clear calculation of the residual acceleration acting on the exposed sample. Depending on the experimental demands, different clinostats have been developed: **Portable clinostats for parallel operation of up to ten sample containments in a defined environment (pipettes), submersed clinostats for aquatic systems, a clinostat microscope for direct observation of the sample during rotation and a clinostat for online fluorescence measurements within cell cultures.** Experimental results on different cellular, plant and small animal systems have demonstrated the efficiency of clinostats as an important prerequisite for space experiments with respect to the identification of gravisensitive processes and the specific preparation of experiments in real microgravity. However, it is poorly understood, what really happens during clinorotation. Thus, we exposed different cellular systems on a clinostat microscope and observed behavioural responses as well as the intracellular movement of dense particles under different acceleration speeds of the clinostat. Depending on the mode of operation – fast or slow rotating clinostat – significant changes in the radius of the circular paths of intracellular particles were observed, thus proving that the term “simulated microgravity” has to be used quite carefully.

MEANS FOR REPRODUCIBLE EXPERIMENTATION IN BMTC

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ESA is developing the BMTC (Biotechnology Mammalian Tissue Culture Facility) ground demonstrator in order to:

- establish a terrestrial platform for tissue engineering under defined, reproducible conditions
- prepare for tissue engineering experiments under micro-gravity conditions using proven, well characterised, modular equipment.

The BMTC is highly automated system which provides standardized experiment hardware for tissue cultivation and stimulation under controlled conditions and the reproducible execution of the experiment according pre-programmed protocols.

This paper gives an overview on the technical aspects and analytical tools used to provide controlled and reproducible cultivation conditions. Typical examples are:

- Reactor design
    - 3 different types have been developed
    - I/F for sterile in-process analysis
    - Mobile reactor units
- Well defined gas exchange
    - Operational limitations
- Accurate flow induced shear stress
    - Fluid dynamical limitations
    - Design implementation
- In-situ monitoring of cultivation parameters
    - Sterile measurement of pO2 and pH in medium flow
- Liquid handling and quasi-continuous medium resupply
- Automated seeding of reactor
- Compression device to active convective medium supply to cartilage samples
- Uni-axial stimulation of the bone or cartilage samples

All these topics are implemented in the BMTC demonstrator models as mandatory pre-requisite for reproducible cultivation conditions.

H3: THE LARGE RADIUS HUMAN CENTRIFUGE
‘A Human Hypergravity Habitat’

Coordinators:
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Other team participants: N. Bäcker (DE), J. Berte (BE), K. Bok (NL), J. Bos(NL), R. Boyle (US), N. Bravenoer / (NL), A. Chouker (DE), G. Clement (FR), P. Cras (BE), D. Denise (FR), M. Eekhoff (NL), D. Felsenberg (DE), K. Fong (UK), C. Fuller (US), E. Groen (NL), M. Heer (DE), H. Hinghofer-Szalkay (AU), S. Iwase (JP), J.M. Karemaker (NL), D. Linnarsson (SE), C. Lüthen (NL), M. Narici (UK), P. Norsk (DN), W. Paloski (US), M. Rutten (NL), R. Saggini (IT), A. Stephan (DE), O. Ullrich (CH), V. Vautmans (BE), L. Young (US).

Over the last decades a significant amount of knowledge has been accumulated on the adaptation of the human body going into near weightless conditions and on its re-adaptation to 1×g Earth conditions after space flight. Ground-based paradigms for microgravity simulation have been developed such as head down tilted bed rest and dry-immersion. In such systems the adaptations to long term immobilization and to head-ward fluid shifts have been studied.

Questions we address here are: can long-term ground-based centrifugation help us to understand and even predict the adaptations to long-term increased gravity conditions? How does the body adapt to chronic (days, weeks or longer) exposure to a hypergravity environment? And, once the body has fully adapted to a hypergravity environment, how does it re-adapt going from a hypergravity state back to a relatively hypo-gravity condition of 1×g, or even going from a centrifuge / hypergravity environment into a bed-rest setting? Can such transitions in well-controlled studies bring us closer to understanding the consequences of gravity transitions that the crews will likely experience going to the Moon or to Mars. Is hypergravity a good model to study the effect of re-entry in gravitational environments after long duration space flight?

In an ESA – supported Topical Team we will focus on all organ systems so far known to change directly or indirectly by altered gravity conditions. We will identify to which gravity levels the human body can be exposed for longer periods of time and what protocols could be applied to address the questions at hand. We also need to identify the technology required to accomplish such long duration hypergravity and re-adaptation studies. Issues like ethics, safety and required logistics should be addressed. As there is limited experience with exposure of human test subjects to prolonged periods of moderately increased g-forces, unexpected harm may occur. Therefore, the information, disclosure and informed consent procedures need special attention. Active or potential astronauts, military personnel and scientists as research subjects should be considered "vulnerable populations", because they are highly motivated and willing to submit to substantial risk. Therefore, possible exposure of research subjects to harm will be formally discussed in the protocol and as the knowledge base in this field grows, test subjects will be informed on regular occasions.

The final outcome of the Topical team will be a clear answer about the feasibility of the use of hypergravity as a tool and analogue for space research, and if and how hypergravity studies can provide useful knowledge to support future space flight on the one hand and current medical issues in the ageing population (osteoporosis, cardiovascular diseases, obesity) on the other hand.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room B, 14:40 – 15:40

Physical Sciences
(Plasma Physics 1)

PK-3 PLUS – FUNDAMENTAL RESEARCH IN COMPLEX PLASMAS ON THE INTERNATIONAL SPACE STATION

Hubertus M. Thomas [1], Gregor E. Morfill [1], Vladimir E. Fortov [2], Alexey V. Ivlev [1], Vladimir I. Molotkov [2], Oleg F. Petrov [2], Andrey I. Lipaev [2], Uwe Konopka [1], Christoph Räth [1], Peter Huber [1], Mierk Schwabe [1], Ralf Heidemann [1], Milenko Rubin-Zuzic [1], Robert Sütterlin [1], Sergey Khrapak [1], and Sergey Zhdanov [1]

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The research of complex plasmas on the ISS has a long tradition. In a joint Russian-German program funded by ROSKOSMOS and DLR the first experiments have been performed by Expedition 1 in 2001 with the PKE-Nefedov laboratory. This lab was operational for more then four years as the first long term investigation of complex plasmas under microgravity conditions. In 2005 it was replaced by the second generation lab PK-3 Plus in 2005, which has advanced hard- and software and much better diagnostics. Moreover, a much better homogeneity of the complex plasma can be achieved, which allows more detailed investigations and new insights into the plasma state of soft matter [1]. Typical recent results are related to the 3-D crystalline structure of homogeneous and isotropic complex plasmas, the melting and crystallisation transition as well as electrorheological plasmas [2], lane formation [3] and phase separation [4], all phenomena of fundamental interest in physics. Those recent results will be presented and an outlook will be given to list the future perspectives of research of complex plasmas under microgravity conditions.

Thomas, H. M. et al., “Complex plasma laboratory PK-3 Plus on the International Space Station”, New Journal of Physics **10**, 2008

Ivlev, A. V. et al., “First observation of electrorheological plasmas”, Physical Review Letters **100** (9), 2008

Sütterlin, K. R. et al., “Dynamics of lane formation in driven binary complex plasmas”, Phys. Rev. Lett. **102**, 085003, 2009

Ivlev, A. V. et al., “Fluid phase separation in binary complex plasmas”, EPL 85, 45001, 2009

HEARTBEAT INSTABILITY UNDER MICROGRAVITY CONDITIONS OBSERVED IN THE PK-3 PLUS LABORATORY

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In many experiments that were performed with the PK-3 Plus setup on board of the International Space Station the so called heartbeat instability could be observed. Under microgravity conditions the microparticles in a complex plasma arrange themselves in a vast cloud that spreads nearly all over the available inter-electrode space. In the middle of the plasma chamber a void is often formed[1,2]. The void is completely free of particles. Under certain conditions the complex plasma becomes unstable and rhythmically pulsates in the radial direction[3,4]. In given experiments the instability has been observed in a wide parameter range. Measurements where performed with MF particles of different diameters from 6.81μm to 15μm in Argon as well as in Neon plasma at different discharge powers. The gas pressure varies between 8Pa and 100Pa. The frequency of the observed oscillation ranges from 0.8Hz to 7Hz. At the lower frequencies oscillations are strongly nonlinear. The oscillation frequency increases linearly with plasma power and with the neutral gas pressure. The correlation of the particle motion and the recorded plasma parameters is discussed.

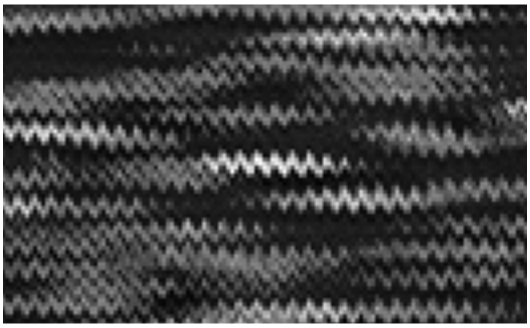

Figure1. Visualization of microparticle oscillations affected by the heartbeat instability

1. D. Samsonov and J. Goree, Phys. Rev. E 59, 1047 (1999).
2. A. Lipaev *et. al.*, Phys. Rev. Lett. 98, 265006 (2007)
3. M. Kretschmer *et. al*., Phys. Rev. E 71, 056041 (2005).
4. M. Mikikian *et. al*., NJP 9, 268 (2007).

GROUND-BASED EXPERIMENT OF PLASMA PARAMETER MEASUREMENT FOR COMPLEX PLASMAS IN PK-3 PLUS ON THE ISS

Kazuo Takahashi[1], Hubertus M. Thomas[2], Gregor E. Morfill[2], Yasuaki Hayashi[1], Satoshi Adachi[3]
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2Max-Planck-Institut für extraterrestrische Physik, 85741 Garching, Germany
3Department of Biology and Microgravity Sciences, Japan Aerospace Exploration Agency (JAXA), 2-1-1 Sengen, Tsukuba, Ibaraki 305-8505, Japan

In plasmas, dust particles should be levitated by balance of forces (by electric field, ion drag, and gravity) acting in plasmas. On the ground, the dust particles are strongly affected by gravitational force of the order same as electrostatic or ion drag forces. Therefore, the dust particles are trapped in strong electric field of pre-sheath or sheath region. On the other hand, without gravity, bulk plasma can contain the massive dust particles. To analyze dust particle behavior in bulk plasmas achieving complete charge neutrality, complex plasma experiments have been done in microgravity condition boarding on parabolic flight and the International Space Station (ISS) in recent years. The experiments for dust acoustic wave on the ISS (PKE-Nefedov) were reported [1,2]. The utility for complex plasmas on the ISS was replaced a new setup (PK-3 plus) at the end of 2005. In the PK-3 plus, an importance of plasma diagnostics (to measure parameters, plasma density, electron temperature, ion temperature, and so on) comes to the project for understanding phenomena in further detail. In this study, electron density was measured by using frequency shift probe in PK-3 plus chamber set on the ground (at Kyoto Institute of Technology). The Coulomb coupling between dust particles depending on electron density will be discussed.

1. S. Khrapak, *et al*., Phys. Plasmas 10 (2003) 1.
2. V. V. Yaroshenko, *et al*., Phys. Rev. E 69 (2004) 066401.

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room A, 16:00 – 17:40

Life Sciences
(Human Physiology 2)

INFLUENCE OF MICROGRAVITY ON LINEAR AND NONLINEAR HRV PARAMETERS OF ASTRONAUTS AFTER SPACE MISSIONS TO THE ISS

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The clinical hallmark post-spaceflight orthostatic intolerance with postural tachycardia suggests that the autonomic nervous system might be involved. Linear and nonlinear heart rate variability (HRV) parameters are used as a noninvasive marker to investigate the autonomic modulation of heart rate and how this system is influenced when returning on Earth. 24h heart rate data of 8 astronauts, measured pre-flight and twice post-flight, were included in the study. For nearly all the parameters, the changes and evolution from before, immediately after and one month after space flight were quasi identical for day and night measurements. Heart rate increased while the different parameters linked with the vagal modulation of heart rate (RMSSD, pNN50 and HF) showed a significant decrease after spaceflight (Figure 1). The condition of weightlessness in space induced a significant effect upon return, namely an increase of LF/HF and a decrease of pNN50 and RMSSD, which was more pronounced during night time, possibly due to the dominant role of the parasympathetic modulation during that period. Significant differences were also found in fractal dimension, correlation dimension, sample entropy and in Poincare characteristics. The effect on heart rate and vagal modulation, present the first week after the return, was mostly disappeared after one month.

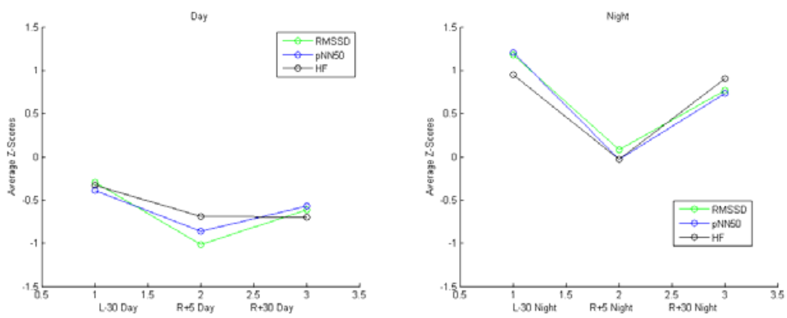

Figure 1. Z-scores for RMSSD, pNN50 and HF power before (L-30) and after spaceflight (R+5 and R+30). The affected vagal modulation is recovered one month after return.

ECCENTRIC RESISTANCE TRAINING AS COUNTERMEASURE IN MICROGRAVITY

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[2]State Scientific Center of the Russian Federation, Institute of Biomedical Problems of the Russian Academy of Sciences (Khoroshevskoye Shosse 76, R-123007 Moscow, Russia)
[3]Faculty of Sport Science, Department of Sport and Exercise Physiology, University of Vienna (Auf der Schmelz 6, A-1115 Vienna, Austria)

Exercise regimens used in space up to now could show to be feasible in supporting certain physiological parameters but have not been very effective in slowing bone atrophy especially for trunk and lower extremities. It is considered that the loading intensity might not have been high enough with these countermeasures.
The project MDS (Multifunctional Dynamometer for Application in Space) is an international collaboration of the University of Vienna (Faculty of Sport Science, Department of Sport and Exercise Physiology), the Russian Academy of Sciences (Institute of Biomedical Problems) and the Technical University of Vienna (Institute for Engineering Design and Logistics Engineering) with the aim to develop a training and diagnostic device that counteracts the muscle and bone loss during long term space flights.
The MDS is designed to provide various training exercises (e.g. leg press, calf raise, squat, dead lift, back extension, abdominals, bench press, rowing exercise, lat pull,...) under ergonomic conditions. The training force is generated by an electrical motor and thus force, position and speed of the training bar can be controlled. This enables an isotonic training in which it is possible to vary the training load as a function of the position and the speed. Thus elevated eccentric forces and a physiological force-length function can provide an optimized stimulus. A linear and a rotational guiding system in combination with an isokinetic or an isometric training enable diagnostics for the trunk, lower and upper extremities.
Summarized the MDS is a compact training and diagnostic device focusing on the musculoskeletal deterioration due to long term space missions providing a variety of exercises which can be combined with different training modes.

INVESTIGATION OF THE NEUROMUSCULAR SYSTEM IN THE DIFFERENT GRAVITY PHASES OF PARABOLIC FLIGHTS

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[2] Department of Orthopaedic Surgery, University of Mainz, Germany

Purpose

In previous parabolic flight experiments we tested the properties of a special bicycle ergometer training system designed for countermeasures against muscle function decay in long term spaceflight missions. All test subjects exhibited different muscle activation patterns in weightlessness as compared to normal gravity. In order to gain more insight into the gravity dependent muscle coordination underlying this effect we employed in a follow – up parabolic flight experiment a bicycle ergometer with a mechanism enabling controlled locking and unlocking of the pedals. The test subject can thus exert cycling torque with the right and left leg independently. As this condition imposes an even greater demand on the coordination of the leg muscles in cycling, it is well suited for the investigation of changes induced by different gravity conditions.

Methods and Materials

Within the 13th parabolic flight mission of the German Aerospace Center (DLR) we implemented experiments with the special bicycle ergometer mounted in the Airbus A – 300 Zero – G aircraft in all gravity phases (1g, 1.8 g, 0g) of 90 flight parabolas. 6 subjects carried out exercise at different cycling powers with the pedals locked and unlocked according to a defined experimental protocol. The subjects were fixed to the ergometer with heavy duty straps. The EMG activity of 5 muscles (tib. ant., gastrocn., vast. med., rect. fem., biceps fem.) of either leg, the ergometer pedal movement parameters, and a high resolution (64 electrodes) EEG were recorded. For the signal recording and processing we configured a special airborne measuring system and elaborated a dedicated software package including special statistical signal analysis procedures.

Results

All 6 subjects met the experimental conditions in all phases of the parabolic flights without any difficulties even at physically exhaustive cycling power levels. In normal gravity (1 g) the activity pattern of all investigated muscles and the pedalling kinematics exhibited considerable differences as compared to exercise at the same cycling power in microgravity and, in particular, in hypergravity. The quality of the subject's body fixation to the ergometer device seems to take considerable effect on the muscle activation changes during the microgravity phase.

Discussion and Conclusion

The results of this study confirm and specify our earlier findings that the exact properties of muscle training equipment for manned space flight can only be reliably evaluated in microgravity itself. This is important for the preflight planning of dedicated muscle training programs to be carried out during a long term stay in microgravity as on the International Space Station ISS. Bicycle ergometer exercise of any kind cannot, however, provide an adequate substitute for the missing natural muscle training of everyday terrestrial walk with its individually specific intermuscular coordination.

BRAIN CORTICAL ACTIVITY DURING SEVERAL ARTIFICIAL GRAVITY PHASES IN A SHORT-ARM HUMAN CENTRIFUGE

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[2] Institute of Physiology and Anatomy, German Sport University Cologne
[3] Institute of Aerospace Medicine, Biomedical Support Center, German Aerospace Center

Introduction: Exposure to a weightless environment is known to result in a loss of muscle and bone mass, as well as cardiovascular deconditioning. One recent idea to overcome these problems is to provide astronauts with artificial gravity by using a short-arm human centrifuge (SAHC). Centrifugation is supposed to stimulate the muscular and bone system in order to prevent deconditioning and is known to result in an activation of the cardio-vascular system. However, effects on the central nervous system so far remain unclear. Methods: Electro-cortical activity as well as peripheral physiological data were recorded in one female subject. Acceleration lasted for 52 minutes and consisted of several gravity phases. Beneath determination of peak alpha frequency (PAF) data was analysed using standardised low resolution brain electromagnetic tomography (sLORETA). Results: An increase of frequency as well as amplitude of PAF was noticeable during acceleration with no differences in between gravity conditions (Fig.1). sLORETA showed an increase in activity in the beta-2 frequency range (18-35Hz) (Fig. 2) and a shift of gamma activity (35-48Hz) to frontal brain areas at 3G (Fig. 3). Conclusions: We conclude that artificial gravity provided by a SAHC results in a physical vitalisation with specific changes in electro-cortical activity. Further research should evaluate whether this is positively correlated to mental and perceptual motor performance.

Figures

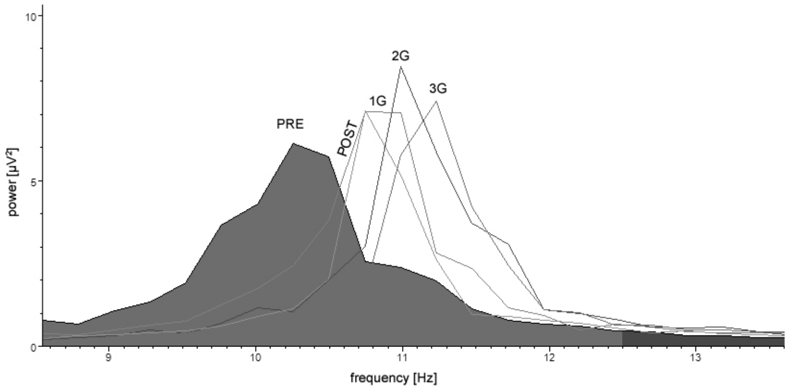

Fig. 2: Peak alpha frequency (PAF) for pooled O1,O2,Oz electrodes. PRE: two minute rest EEG measurement prior to acceleration; POST: after centrifugation; 1G, 2G, 3G: two minute rest EEG measurement at $1G_{\text{centre of mass (COM)}}$, $2G_{COM}$ and $3G_{COM}$.

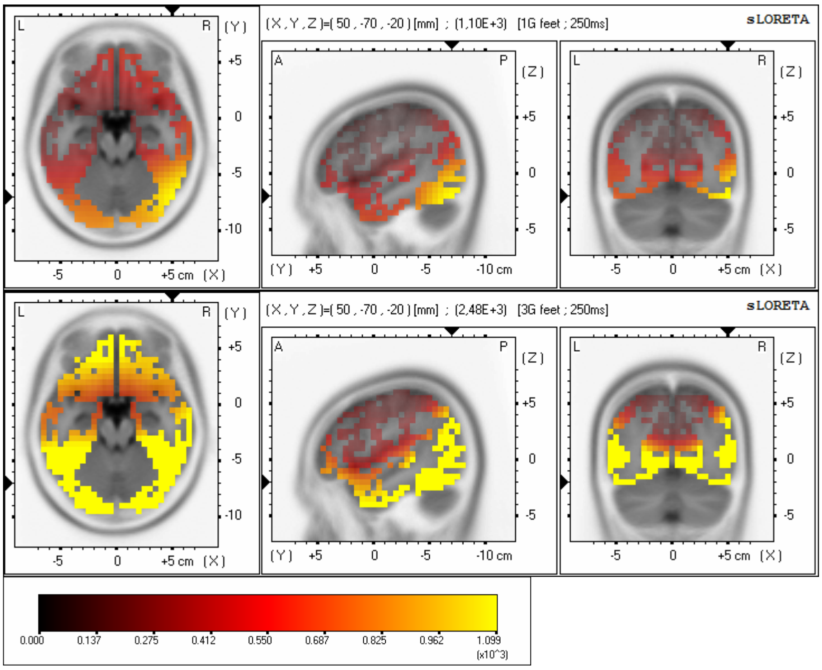

Fig. 2: Computed sLORETA current densities (μA^2) in the beta-2 frequency range. Left: current density at $1G_{COM}$. Right: current density at $3G_{COM}$. Displayed are slice views of areas showing highest intensities in current density. Red and yellow colours indicate intensity (see scale below). Structural anatomy is shown in grey scale (L left, R right, A anterior, P posterior).

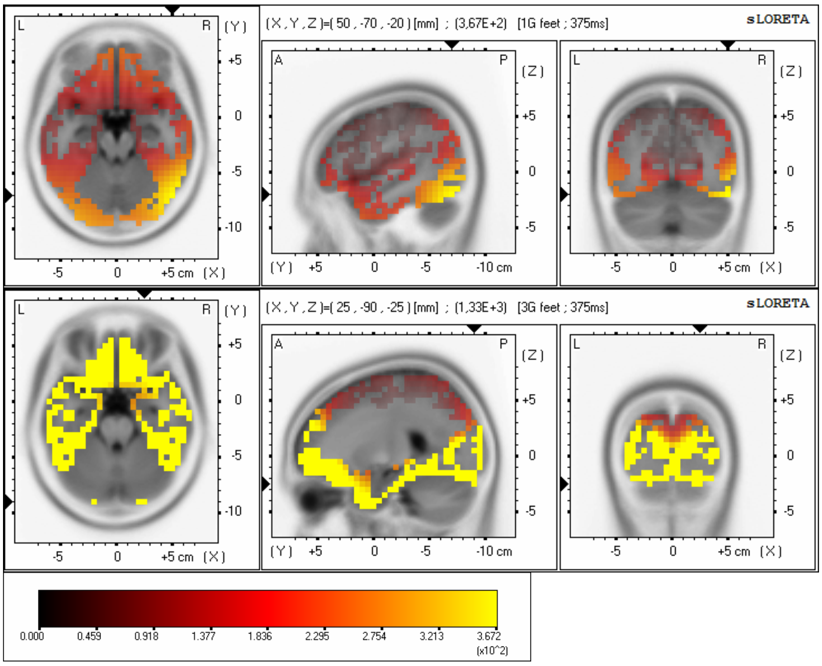

Fig. 3: Computed sLORETA current densities (μA^2) in the gamma frequency range. Left: current density at $1G_{COM}$. Right: current density at $3G_{COM}$.

THE DENSITY DIFFERENCE OF CUPULA AND ENDOLYMPH CHANGES THE MECHANICS OF SEMICIRCULAR CANALS

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[(1)] Institute of Physics, Natl. Acad. Sci., Kiev, Ukraine, kondr@kondr.kiev.ua
[(2)] BioVIS Technology Center, Ames Research Center, NASA, Moffett Field, CA, USA

A precise balance of cupula and endolymph densities is key to the proper functioning of semicircular canals (SC) which sense angular rotations. Estimates show that the density difference of cupula and endolymph (DD) as small as $\sim 10^{-4}$ g/cm^3 is sufficient to make SC sensitive to gravity (1) and centrifugal forces if they are comparable with gravity. It may result in vestibular disorders. There are many reasons why the DD may even exceed this value (2). One of them is a change of intra-labyrinth pressure that may take place during a spaceflight. The effect of the DD on the SC dynamics is considered using a simplified one-dimensional toroidal mathematical model of a canal in the cases of rotation with constant and harmonically oscillating angular velocities. The DD results in: the dependence of cupula dynamics on the orientation of both the gravity vector relative to the SC plane and the axis of rotation, as well as on the distance between the axis of rotation and the center of the SC; the shift of the cupula to a new position of equilibrium that depends on the gravity vector and the parameters of head rotation; the onset of cupula oscillations with multiple frequencies under harmonic stimulation. The effect of the DD may be important in the conditions of artificial gravity when the directions of centrifugal forces, comparable with the Earth gravity, the orientations of the axis of rotation of a space station and the axes of the SCs are changing in time during the movements of individuals and their habitat.

1. Goldberg, J.M., and Fernandez, C., “Responses of peripheral vestibular neurons to angular and linear accelerations in the squirrel monkey”. Acta Otolaryngol., Vol.80(1-2), pp.101-110,1975
2. Kondrachuk, A.V., Sirenko, S.P., Boyle, R., “Effect of difference of cupula and endolymph densities on the dynamics of semicircular canal”, J.Vestibular Research, Vol. 18(2-3), pp.69-88, 2008

SCIENTIFIC SESSIONS:

Wednesday, September 2nd
Room B, 16:00 – 17:40

Physical Sciences
(Plasma Physics 2)

WAVES IN DUSTY PLASMAS UNDER MICROGRAVITY

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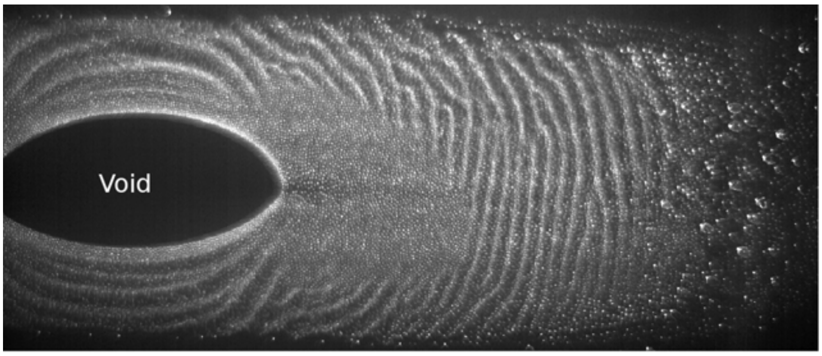
A dusty plasma is an ionized gas containing small solid particles, which offers a unique possibility for studying fundamental dynamic phenomena of many-body systems. The dust particles attain a negative electric charge from the plasma and are coupled to each other via shielded Coulomb forces. Due to their large mass-to-charge ratio, the dynamics of the particles is slow and can be analyzed easily by video microscopy techniques. As a consequence of gravity, dusty plasmas in the laboratory are usually flat pancake-like dust clouds with only a small vertical extension. In contrast, experiments performed under weightlessness offer an important opportunity for studying large three-dimensional dust clouds, which show a wealth of interesting phenomena.



Of particular interest are dust density waves, which have been investigated in recent experiments carried out on parabolic flights. The waves are excited by streaming ions inside the plasma and propagate outwards from the boundary of the dust-free "void" [1]. Their complex three-dimensional structure and dynamics has been analyzed by means of Fourier and statistical methods. Further, a special camera system has been used for the first time, which allows to observe the dust and the glow of the plasma simultaneously. A significant influence of the dust on the plasma has been detected.

1. Piel, A. *et al.*, "Obliquely propagating dust-density waves", Phys. Rev. E, Vol. 77, 026407, 2008.

POSSIBLE OBSERVATION OF CRITICAL PHENOMENA IN FINE PARTICLE (DUSTY) PLASMAS

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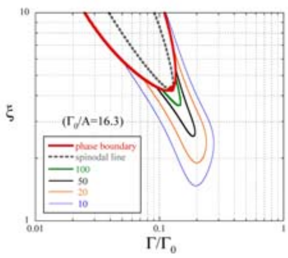
Fine particles (dusty) plasmas are mixtures of fine particles (dusts) and the ambient plasma (of ions and electrons). Fine particles usually have large negative charges there and, when the coupling between fine particles becomes very strong, it is expected that the isothermal compressibility of the whole system (fine particles, ions and electrons) diverges and we have a phase separation and related critical point[1]. It is also pointed out that this critical point could be in the solid phase when appropriate conditions are satisfied.

When charged particle systems are modeled as the one-component plasma (OCP), they are known to have a divergence in the compressibility in both classical and quantum cases. The divergence, however, has been regarded as an artifact of the OCP model which does not pay proper attention to the other charge-neutralizing component (the background). In fine particle plasmas, one might observe this divergence as a property of the whole system (including the background) under difficult but possible conditions, extremely strong coupling between fine particles and the environment of microgravity. The latter is necessary to have a three-dimensional bulk homogeneous mixture including macroscopic fine particles.

We will discuss expected observations and experimental conditions from various aspects. Shown below is an example of enhancement of density fluctuations near the critical point[2].



Here $\Gamma = (Qe)^2/ak_BT_P$, $\Gamma_0 = (Qe)^2/r_pk_BT_P$, $\xi = a/\lambda$, and $A = (n_iT_i + n_eT_e)/n_pT_p$; $-Qe$, n_p, r_p, T_p are the charge, density, radius, and temperature of fine particles, $a = (3/4\pi n_p)^{1/3}$, their mean distance, n_i, T_i, the density and temperature of ions, n_e, T_e, those of electrons, and λ, the screening length.

[1] H. Totsuji, J. Phys. A: Math. Gen. 39, 4565(2006); Phys. Plasmas 15, 072111(2008); Plasma and Fusion Research, 3, 046(2008).
[2] H. Totsuji, to appear J. Phys. A: Math. Theor., 2009.

DISSIPATIVE DARK SOLITONS IN THE PK4 EXPERIMENT

S. Zhdanov[1], R. Heidemann[1], M.H. Thoma[1], R. Sütterlin[1], H.M. Thomas[1], H. Höfner[1], K. Tarantik[1], G. Morfill[1], A.D. Usachev[2], O.F. Petrov[2], and V.E. Fortov[2]

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[2] Joint Institute for High Temperatures, Russian Academy of Sciences, 125412 Moscow, Russia

We present the observation of dark solitons in a three dimensional dc complex plasma. The experiments are performed in the PK4 experiment during parabolic flights using neon gas at a pressure of 18 Pa and melamine-formaldehyde particles with a diameter of 3.4 µm. The waves are exited by a short pulse, produced by the circular electrical-manipulative electrode integrated inside the discharge glass tube. They propagate at a wave speed of approximately 15 mm/s. The observed dark soliton's propagation time is circa 10-15 times longer than the damping time.

EXPERIMENTS OF FINE–PARTICLE PLASMAS UNDER GRAVITY AND MICROGRAVITY CONDITIONS USING PLANAR-MAGNETRON PLASMA SYSTEMS

Yasuaki Hayashi, Kazuo Takahashi Department of Electronics, Kyoto Institute of Technology (Matsugasaki, Sakyo-ku. Kyoto, Japan)

Although fine -partcile plasmas show interesting physical phenomena, they are mostly observed in limited regions, i. e., piled up in lower regions unde gravity and pushed outward forming a void under microgravity. In order to control the behavior of fine parctiles in a palsma, we developed a planar-magnetron plasma system. A planar-magnetron plasma was generated on a radio-frequency (RF) electrode. A loop of high density plasma was generated due to the confinement of electrons by the ExB drift on the surface of the RF electrode. The high denisty plasma diffuses toward the center and then upward. It is expected that fine particles are transported upward by electrostatic and ion drag forces, leading to being suspended under the force balance with the gravity without the formation of void. Fine-particles of 6.5μm in diameter in an argon plasma were observed to be three-dimensionally ordered (Fig.1). Experiments under microgravity condition were carried out using a remodeled planar-magnetron plasma system, which is compact and shaped cubic, by the use of the drop experiment facility in Micro-Gravity Laboratory Japan (MGLAB). Fine-particles transported upward to the center of the cubic plasma chamber under gravity were expanded upward as well as sideward during microgravity owing to the release of gravitational compression force.

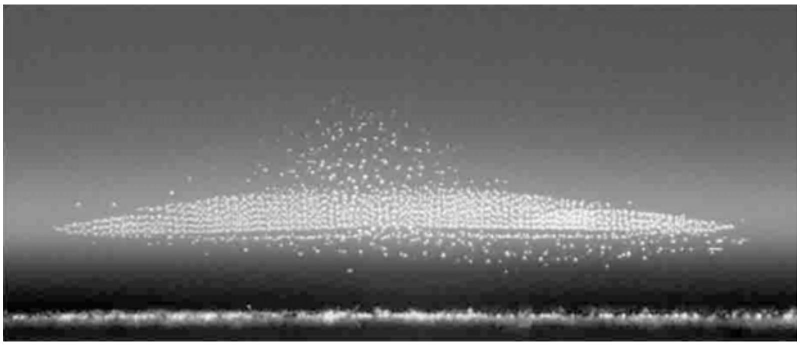

Fig.1 Fine-particles of 6.5μm in diameter suspended in a planar magnetron plasma.

PK-4 SCIENCE ACTIVITIES IN MICRO-GRAVITY

M.A. Fink[1], M.H. Thoma[1], H. Höfner[1], A.V. Ivlev[1], B.A. Klumov[1], U. Konopka[1], M. Kretschmer[1], S. Mitic[1], R. Sütterlin[1], S. Zhdanov[1], G.E. Morfill[1], A.D. Usachev[2], V.E. Fortov[2], O.F. Petrov[2], A.V. Zobnin[2], B.M. Annaratone[3]

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[2] Jonit Institute for High Temperatures of Russian Academy of Sciences, Moscow, 125412, Russia
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PK-4 is a multi-functional plasma discharge source. Three setups exist for operating plasma discharge experiments on parabolic flight campaigns as well as in laboratory (two at MPE, one at JIHT). Another setup for use on the International Space Station ISS is planned. The plasma can be created by a dc-discharge as well as by rf-discharges, coupled inductively and capacitatively. There exist various possibilities to manipulate the introduced microparticles: mechanical (glass-nozzle), optical (high power laser), electrical (EM-pulse-electrode, rf-electrodes, polarity-switching) and thermal (heating coil) manipulation. Several different types of experiments have already been done with PK-4 in parabolic flights:

- Lane-Formation (cloud collisions)
- Nozzle-Experiments (particle jets, transition between fluid and single particle behaviour)
- String-Fluids (electro-rheological fluids)
- Boundary free clusters (formation of particle clusters using rf-pulses)
- Shock waves and solitons (excitation of shock waves applying electric pulses using the EM-electrode)
- Experiments with rod-like particles

SCIENTIFIC SESSIONS:

Thursday, September 3nd
Room A, 09:40 – 10:40

Life Sciences
(Cell Physiology 1)

GRAVITY DECTECTION IN SINGLE CELLS

Michael Lebert and Donat-Peter Häder
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Euglena gracilis is a photosynthetic flagellate which uses several environmental hints to reach and stay in regions of the water column which are optimal for growth and reproduction. Light and gravity are the most important factors.

In recent years *Euglena* became a model system for the understanding of the effects of gravity on single cells an issue which is not understand up to now. The cells show a clear negative gravitaxis, i.e. a movement away from the centre of gravity. A couple of years ago it was in space experiment shown that only 20 % of the observed reaction was based on an uneven mass distribution (buoy effect). The remaining 80 % require an intact signal transduction chain. The molecular analysis revealed that TRP-like channel and a specific calmodulin are involved. The knockdown of the related proteins resulted in non-gravitactic cells. New results indicate an importance of protein phosphorylation for the gravity response. Inhibitor studies as well as knockdown (RNAi) experiments showed that a specific protein kinase is first of all required for gravitaxis. Secondly, not only gravitaxis was impaired, but phototaxis (i.e. the light-controlled movement reactions), too. This might mean that this specific protein kinase is close to the integration point of the two signal transduction chains (light and gravity).

While *Euglena* is a very good model system for the molecular analysis of gravity responses it can be used also in artificial life support systems (Controlled Environmental Systems, CES) as an oxygen source and a carbon dioxide and nitrogen sink. In the same time the cells can be used for the further enhancement of the understanding of gravitaxis. In a recent spaceflight (Foton M3) a CES (OMEGAHAB) was very successfully tested.

CELL SUSCEPTIBILITY DURING PHYSIOLOGICAL ADAPTATION TO LOW AND RANDOMIZED GRAVITY:

A.SUNDARESAN[1] ,ANIL.D.KULKARNI [2] , JAMAIL PLUMBER[1] AND DONIELLE FORD[1].
[1] College of Science and Technology, Texas Southern University, Houston, Texas, [2], Space Life Sciences, NASA/JSC, Houston, Texas
sundaresana@TSU.edu, 713-313-7926,
Presenting and Corresponding author-A,Sundaresan.

Specific genetic response suites in human lymphocytes in response to microgravity are necessary to further study for physiological adaptation to new milieu. Blood traverses through most organs and hence is an overall physiological predictor. Human lymphocytes were cultured in 1g (T flask) and modeled microgravity (MMG, rotating wall vessel) for 24 and 72 hours. Cell samples were collected and subjected to gene array analysis using the Affymetrix HG_U95 array. Data was collected and subjected to a two-way analysis of variance. Genes related to the immune response, cardiovascular system and stress response were then analyzed. These three groups focus on human adaptation to new environments. The phosphoinositide kinase (PI3K/Akt) and Raf/MEK/ERK signal transduction cascades are pivotal in transmitting signals from membrane receptors to downstream targets that regulate apoptosis, gene expression, and cell growth. Our results show down regulation of key genes in this pathway. This pathway has also been shown by others to be sensitive to ionizing radiation. Members of the oxidative stress and inflammatory pathways such as NK-kβ, TRAF-1, IFN genes and Interleukins were analyzed. Differential responses immune response, cardiovascular biomarkers, and stress response genes will be presented. These studies are especially relevant to civil aviation, defense (fatigue studies), space exploration and high altitude environments.

Funding source: NASA grants
NNA06CB14H
NNJ06HA40G

MAGNETIC LEVITATION OF HUMAN A431 CELLS

M.J.A. Moes[1], J.C. Gielen[2], R. Bleichrodt[1], J.J.W.A. van Loon[3*], P.C.M. Christianen[2], J. Boonstra[1]

1: Institute: Cellular Architecture and Dynamics, Utrecht University, NL. www.bio.uu.nl . 2: High Field Magnet Laboratory (HFML), Radboud University Nijmegen, NL. www.hfml.ru.nl/peterc, 3: Dutch Experiment Support Center (DESC) @ Dept. Oral Cell Biology, ACTA, Vrije Universiteit, Amsterdam, NL. www.descsite.nl.

During the last decades a wide variety of experiments during space flights have demonstrated that gravity has profound effects on whole organisms, organs and tissues. Interestingly, the virtual absence of gravity also had profound effects on the cellular and molecular level, including changes in cell morphology, modification of gene expression, changes in signal transduction cascades and even changes in the self-organisation of tubulin. One of the gravity sensitive components in cells appears to be actin. Our experiments in real microgravity using sounding rockets revealed a modified actin cytoskeleton of A431 epidermoid carcinoma cells in space resulting in the rounding of these cells and an increased polymerization of actin. Actin is a major component of the cytoskeleton and has important functions, amongst other in signal transduction, motility, attachment, and cell morphology.

The aim of the present research was to use magnetic fields as analogues for real microgravity to study the effect of levitation on the actin cytoskeleton in human A431 cells, in order to establish the potential of magnetic levitation as a simulation of microgravity conditions. We compare the results with data found in the past in real microgravity and in simulated microgravity using the fast rotating clinostat and RPM. During magnetic levitation cells are exposed to high magnetic fields. Therefore we studied also the effect of such a magnetic field on the cells without levitation. Human A431 cells were exposed to magnetic levitation for different time intervals and chemically fixed while levitation was ongoing. Subsequently the actin morphology and behaviour of focal adhesions were investigated using fluorescence microscopy. The behaviour of focal adhesions is an indicator for attachment and rounding or spreading of cells. Identical results were obtained in the RPM studies and magnetic levitation studies. However, controls for the effect of the magnetic field raised concern about the potential of magnet simulated microgravity and indicated the importance of this control.

This study was supported by SRON-NWO grant MG-059 and MG-057 and part of this work has been supported by EuroMagNET under EU contract RII3-CT-2004-506239.

SCIENTIFIC SESSIONS:

Thursday, September 3nd
Room B, 09:40 – 10:20

Physical Sciences
(Capillary Flow)

THERMOCAPILLARY FLOW INSTABILITIES IN CYLINDRICAL POOLS HEATED FROM THE FREE SURFACE AND COOL FROM THE RIM

H. Kuhlmann and U. Schoisswohl
Institute of Fluid Mechanics and Heat Transfer, Vienna University of Technology, Resselgasse 3, 1040 Vienna, Austria

The incompressible thermocapillary flow in an open cylindrical container is considered. The flow is generated by a non-uniform and time-independent heat flux imposed on the free surface. For simplicity, we assume that the heat flux is axisymmetric with a maximum on the centerline and has a parabolic profile. The resulting convective/diffusive heat transport leads to a non-uniform surface tension which drives a flow from the center of the free surface to the rim of the pool. A radial inward return flow is found in the lower half of the pool. The linear stability of this steady axisymmetric two-dimensional flow is calculated. A variety of instabilities is found. For low Prandtl numbers the flow typically becomes unstable due to centrifugal effects. The instability is three-dimensional and stationary. At high Prandtl numbers the basic flow becomes unstable to hydrothermal waves. In the limit of vanishing Prandtl number two other instabilities are found in the case when the pool is very shallow. One instability is centrifugal and the critical mode is a rotating wave with high azimuthal wave number. The other instability is steady and it is caused by the deceleration of the radial inward return flow as it approaches the axis. In the paper we explain why the incompressible flow can be decelerated as it converges and we compare the present results with available experimental observations.

NUMERICAL AND EXPERIMENTAL INVESTIGATION OF CAPILLARY CHANNEL FLOW IN MICROGRAVITY

Joerg Klatte, Aleksander Grah, Michael E. Dreyer
ZARM (Center of Applied Space Technology and Microgravity)
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In this work we investigated experimentally and numerically forced liquid flows through open capillary channels under microgravity conditions. The experimental investigations focused on the profile lines of the free surface contour and the maximum flow rate through the channel without a collapse of the free surface which is defined as the critical flow rate.

An open capillary channel is a structure that establishes a liquid flow path when the capillary pressure caused by surface tension forces dominates. To maintain a steady flow through the channel the capillary pressure of the free surface has to balance the pressure difference between the liquid and the surrounding constant pressure gas phase. Due to convective and viscous momentum transport the pressure along the flow path of the liquid decreases and causes the free surface to bend inwards.

The maximum flow rate through the channel is reached when the free surface collapses and gas ingestion occurs at the outlet. This stability limit depends on the geometry of the channel and the properties of the liquid. We present an experimental setup which is used in the low gravity environment of the Bremen Drop Tower. Experiments with convective dominated systems have been performed where the flow rate was increased up to the maximum value.

In comparison to this we present three-dimensional computations to determine important characteristics of the flow, such as the free surface shape and the limiting flow rate.

Figure: Comparison of a convective dominated free surface flow in microgravity with 3-d numerical computations using a VOF Method.

References:
Klatte J., Haake, D., Grah A., Dreyer, M. E.: "Flow rate limitation of steady convective dominated open channel flows through a groove", Microgravity Sci. Tec., (submitted 2009)
Klatte J., Haake, D., Weislogel, M. M., Dreyer, M. E.: "A fast Numerical Procedure for Steady Capillary Flow in Open Channels, Acta Mech., DOI 10.1007/s00707-008-0063-1, 2008

EXPERIMENTAL AND NUMERICAL INVESTIGATION OF NON-ISOTHERMAL CAPILLARY DRIVEN FREE SURFACE OSCILLATIONS OF LIQUID ARGON

Nikolai Kulev, Michael Dreyer
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Knowledge of dynamic behaviour of cryogenic fluids under microgravity is of key importance for cryogenic propellant management in space vehicles. Apart from this, their very low viscosity makes them scientifically interesting for exploring the vicinity of the inviscid flow limit.

In this work we present experimental and numerical investigation of the capillary driven free surface oscillations of liquid argon (T_{sat}= 87.3 K @ 1 atm) under non-isothermal boundary conditions. Such oscillations take place during the reorientation of the equilibrium position of the free surface upon step reduction of gravity. The aim was to investigate the influence on the oscillation and its characteristics by the temperature difference between the cryogenic liquid and the vessel's hot wall in the absence of an overlaying non-condensable gas.

The experiments were performed at the Bremen Drop Tower. Axial wall temperature gradients of averaged 0.1 K/mm - 0.82 K/mm between vapour and liquid space were implemented. A general dependence was indeed observed, concerning e.g. the apparent contact line rise and velocity, the frequency and damping of free surface oscillation. The liquid layer formed behind the apparent contact line was found to be also affected. At present a temperature gradient dependence of the oscillation behaviour in relation to the apparent dynamic angle is known only for the case with a non-condensable gas. Numerical simulations of the drop tower experiments utilizing the VOF method were exploited in search for similar explanations. Simulation results and comparison to the experiment are also presented.

References:
Wölk, G., Dreyer, M., Rath, H.-J, Weislogel, M.M..: *Damped Oscillations of a Liquid/Gas Surface upon Step reduction in Gravity*, J. of Spacecrafts and Rockets, 34, 110, 1997
Gerstmann, J., Dreyer, M.: The dynamic contact angle in the presence of a non-isothermal boundary condition. Microgravity Sci. Technol. XIX, 3–4 (2007)
Krahl, R., Gerstmann, J., Behruzi, P., Bänsch, E., Dreyer, M.E.: Dependency of the apparent contact angle on nonisothermal conditions. Phys. Fluids 20, 042101 (2008)

SCIENTIFIC SESSIONS:

Thursday, September 3nd
Room A, 11:40 – 13:00

Life Sciences
(Cell Physiology 2)

TRIPLE LUX A: GROUND CONTROLS AND PREPARATION OF THE BIOLAB EXPERIMENT

Astrid Horn[1,3], Kathrin Huber[2,3], Ulrich Kübler[4], Oliver Ullrich[2,3], Ruth Hemmersbach[1]

[1]German Aerospace Center, Institute of Aerospace Medicine, Linder Hoehe, 51147 Cologne, Germany
[2] University of Zurich, Institute for Anatomy, Winterthurerstr. 190, 8057 Zurich, Switzerland
[3]Institute of Mechanical Engineering, Faculty of Mechanical Engineering, Otto-von-Guericke University Magdeburg, Universitätsplatz 2, 39106 Magdeburg, Germany
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Space flights are the first number of choice to study the impact of microgravity. In order to gain optimal results, ground preparations including ground simulation-methods and carefully designed control experiments are absolutely necessary. The experiment TRIPLE LUX A deals with the impact of altered gravity on the functioning of mammalian macrophages, in order to increase the information about the characteristics of the immune system during space flight. During an innate immune reaction, the production of reactive oxygen species (ROS) is measured by a luminescence reaction with a photomultiplier. On ground, the kinetics of the response was investigated a) under 1g conditions, b) on a clinostat with variable rotation speed and c) under vibration. Clinorotation was performed on a clinostat with one horizontal rotation axis. A photomultiplier technique – comparable to the one used in the TRIPLE LUX hardware designed to be implemented into BIOLAB - was integrated to enable online measurements during clinorotation. Rotation speed could be linearly varied from 2 rpm to up to 100 rpm to compare the impact of speed (slow and fast rotating clinostat). In addition, the possible effect of mechanical stimulation was tested by shaking and vibrating system according to the vibrations during parabolic flight. Finally, the experimental setup will be tested in a parabolic flight to gain information about the response in real microgravity. First results showed a dramatic reduction of the luminescence signal by up to 66% of the original value by permanent clinorotation (60 rpm). Slower rotation (2 rpm) reduced the signal strength even more by up to 90% of the original strength. In contrast, hypergravity as well as vibration led to a significant signal increase. The results demonstrate a clear effect of altered gravity on the immune response of the macrophages. As of whether this is direct or indirect has to be further investigated in the future.

MELANOCYTE RESPONSE TO ALTERED GRAVITY: ROLE OF CYCLIC GMP

Krassimira Ivanova, Wasiliki Tsiockas, Jens Hauslage, Birgit Bromeis, Kai Waßer, Ruth Hemmersbach, Rupert Gerzer
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Human epidermal melanocytes represent a protective barrier against oxidative stress by generating the pigment melanin. The melanin is also known as a photosensitizer, which may initiate depigmentation or oncogene cell transformation. In previous studies we found that the second messenger cyclic GMP (cGMP), which is synthesized by the catalytic action of the guanylyl cyclases (GC), plays an important role in melanocyte (patho)biology. It is involved in nitric oxide (NO)-induced perturbation of melanocyte-extracellular matrix interactions that may support depigmentation or melanoma metastasis. Interestingly, hypergravity (up to 5xg for 24 h) stimulated cGMP efflux in normal human melanocytes and non-metastatic, but not in metastatic melanoma cells due to an increase in mRNA and protein levels of the multidrug resistance proteins 4 and 5 (MRP4/5), which may confer resistance to nucleobase and nucleoside analogs used in anticancer therapy. In addition, hypergravity differentially stimulated pigmentation in human melanocytic cells. Finally, the effects of reduced gravity on the melanocyte morphology and expression profiles of genes involved in cGMP signaling are currently under investigations. The estimation of the gravity impact on the melanocyte function may contribute to asses the risk of astronauts to develop pigmentary disorders particularly melanoma.

RESCUE OF MICROGRAVITY-INDUCED MORPHOLOGICAL ALTERATIONS OF FIBROBLASTS DURING THE FOTON-M3 MISSION BY SILENCING THE GTPASE RAC1.

Pierre Mineur[1], Alain Guignandon[2], Zhigang Zhang[3], Thibaut Neutelings[1], Christophe Deroanne[1], Monique Aumailley[3], Thomas Krieg[4,5], Laurence Vico[2], Betty Nusgens[1], Charles Lambert[1].
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Integrins and focal adhesions (FA) transduce mechanical signals into biochemical messages through multiple pathways, including those mediated by RhoGTPases that control cytoskeleton (CSK) dynamics and several related cellular functions. Our working hypothesis is that RhoGTPases are key mediators in cell reactivity to mechanical signals, including gravity. The role of RhoA, Rac1 and Cdc42 in microgravity (µg)-induced CSK and phenotype alterations was investigated by silencing each of them with small interfering RNA in ground-based experiments, and during the Biobox 6/Foton-M3 mission. To evaluate the effects of vibrations and hypergravity during launch, and to discriminate them from those induced in µg, some WI26 cells were fixed 15 min before Soyuz launch (L-15) and after increasing time in µg or in 1g onboard centrifuge. An unfortunate technical failure prevented the centrifuge to run eliminating some of the relevant controls. We therefore compared the L-15 samples taken as controls to the samples having experienced µg for increasing time. Quantitative analysis of the samples by phase contrast and fluorescence microscopy after labeling of the CSK and FA, showed that Rac 1 silencing prevented µg-induced alterations observed in the other cells, while cells in which Cdc42 was silenced were the most affected. These results point out the particular role of Rac1-dependent pathways in the sensing of microgravity-related conditions.

TISSUE REPAIR: IMPACT OF UNLOADING ON THE REMODELING PHASE

Monica Monici[1] , Francesca Cialdai[2], Giovanni Romano[2], Franco Fusi[2], Antonio Conti[2], Nicola Marziliano[3], Marcel Egli[4], Augusto Cogoli[5]

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In the next future will increase the number of astronauts involved in long-lasting missions and extra-vehicular activities. Consequently will increase the chance of injury due to traumatic events or unexpected emergency surgery. On the other hand, medical evacuation times to earth will be prolonged, if not prohibitive. Therefore increases the need to address requirements for surgery and trauma care in non terrestrial environments. In this frame, tissue repair in µg must be regarded as a major problem because it is actually an almost unknown subject. Wound healing is a complex multi-step process, crucial to the survival of the organism. It starts with an inflammatory phase followed by a remodeling phase. During repair the extracellular matrix (ECM) is sequentially remodeled by the concerted action of different cell types in order to rebuilt an increasingly complex and ordered structure. The available literature concerning wound healing with mechanical unloading presents controversial results. However, the most part of the studies indicate impairment of healing processes, with deficits both in inflammatory and remodeling phases.

We present a study on the behaviour of cells involved in the remodeling phase, e.g. fibroblasts, endothelial and human mesenchymal stem cells (hMSc). In particular we investigated adhesion/migration, production of ECM molecules and hMSc differentiation.

Moreover we experimented with treatments able to favour tissue repair.

In µg , we observed alterations in production of ECM molecules and organization of their network. The increase in fibronectin and laminin was possibly the cause for impaired cell migration and increased adhesion. The concerted action of growth factors (yeast plasmolysat) and photomechanical stress (by pulsed Nd:YAG laser) increased collagen production, induced the organization of fibronectin network and the differentiation of hMSc towards cellular elements belonging to tissues with antigravitational function.

SCIENTIFIC SESSIONS:

Thursday, September 3nd
Room B, 11:40 – 12:40

Physical Sciences
(TT Dynamics of liquid/film wall interactions)

CHEMICALLY GRAFTED SURFACES TO CONTROL THE INCIPIENT FLOW BOILING POSITION

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The increase in functionality and power consumption of electronic components and microdevices creates a problem: heating. This heat energy has to be removed in order to insure the reliable working of these devices, without negatively affecting their performance. One of the techniques used in electronics and microfluidic devices, utilizes so–called "phase-change cooling systems" (PCCS). Among possible PCCS, the heat pipe, for example, has the advantage of being "passive", yielding a very high degree of long term reliability[1,2]. In each PCCS, there is a zone where liquid, solid and gas are all present together, allowing surface features, such as wettability and roughness, to play an im-portant role[3,4]. Much of the thermal effectiveness of PCCS's is related to the characteristics of their evaporation and condensation zones, their length, the thickness of the thin evaporating film and the dynamic contact angle[5]
Fixing the liquid/solid/vapor contact line to predefined positions may, then, help to enhance the thermal efficiency of PCCS. This can be performed by means of heterogeneities of the surface[6].
This paper shows the first experimental evidence that the position of the active nucleation sites can be controlled through chemical patterning of smooth surfaces: in this study, the heated surfaces are chemically grafted with alkylsilane self-assembled monolayers (less than 10nm) by microcontact printing. The analysis of the propagation of the bubble zone area quantitatively show that the bubbles remain localized on top of the grafted zone and that, in the initial phase of the experiment, the centre of mass of the bubble zone only moves along the vertical axis, without lateral drift.
An experiment for ground and microgravity environment is under preparation in order to quantify in a rigorous way the heat fluxes under the different conditions and the ability of the grafting to "pilot" the position of the nucleation sites.

LIQUID FILM FLOW AROUND CORNERS

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Film flows are of significant industrial importance, for example, in evaporative cooling or separation technology. As such, there is a large body of literature that has studied falling films using vertical and slanted surfaces. Such films have also been examined in reduced gravity environment to gain insights into their stability. However, to date, film flow about corners is rarely investigated. This study presents a first attempt at understanding the intricacies of a liquid film as it encounters an open corner. A custom-built experimental apparatus has been fabricated; through preliminary experiments with water as the fluid, it has been found that depending on the film thickness, flow rate, corner radius of curvature and wettability of the substrate, three main regimes can be identified. These are: (1) a film that fully negotiates the corner; (2) a semi-detached film, and (3) a fully detached film. The stability of each of these three regimes is sensitive to the surface wettability, as with past film flow studies, amongst other factors that will be discussed. Also, the role of reduced gravity to enable better understanding of such complex phenomenon will be elaborated upon.

ICING MITIGATION STRATEGIES USING SURFACE COATINGS

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Anti-icing and de-icing are the conventional active (i.e. energy consuming) techniques for reducing or avoiding ice accretion of surfaces below water freezing temperature. A passive (i.e. zero-energy consuming) technique for mitigating icing is proposed. It makes use of hydrophobic coatings to reduce water drops adhesion to the surface and enhance water re-entrance in the external flow field before allowing the drop to freeze.
Results of an experimental study in a small icing wing tunnel are presented. The airfoils were exposed to a water drop cloud at -17°C (air static temperature), to simulate an icing event. The airfoils were either untreated aluminum or coated by a hydrophobic layer. An electrical heater was present in the leading edge, to simulate an anti-icing system.
Results show that energy consumption for combating icing can be reduced up to 80% for the case of a coated airfoil, compared to the uncoated one (Fig. 1). Also, runback is significantly reduced as a result of application of coating. The result are encouraging for application in wind turbines, antenna for telecommunication and indirectly for aeronautical applications.

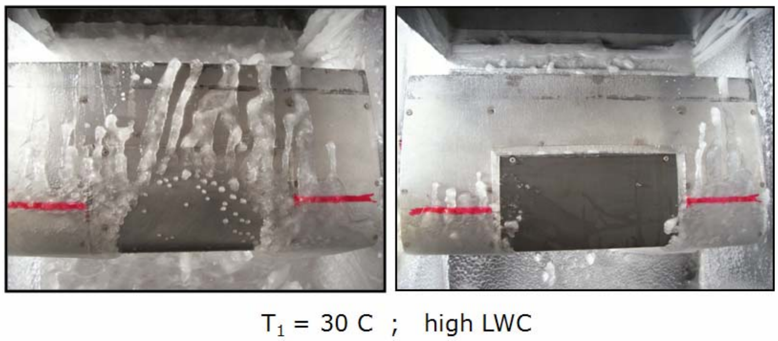

Figure 1 The ice formation on a uncoated (right) and coated (left) aluminim surface with a LWC of 8.7 g/m^3 and with a fixed local temperature of the leading edge. The temperature is varying along the profile cord.

SCIENTIFIC SESSIONS:

Thursday, September 3nd
Room A, 16:00 – 17:40

Life Sciences
(Cell Physiology 3)

DIFFERENT COMPOSITION OF BIOMARKERS RELEASED INTO THE SUPERNATANTS BY ENDOTHELIAL CELLS GROWN UNDER SIMULATED MICROGRAVITY OR GRAVITY FOR ONE AND FOUR WEEKS.

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Recently, we described a delayed type of formation of three-dimensional structures by endothelial cells under simulated microgravity (Grimm et al., Tissue Engineering, 2009, in press). The process was initiated, when EC were cultured on a Desktop-RPM for five days. After two weeks, tube-like structures became visible in these cultures, which included a lumen and elongated during another two weeks of culturing. The structures had the unique feature that their walls consisted mainly of single-layered EC like a natural intima. In order to learn more about this kind of 3D structure formation by ECs, possible changes of the cellular microenvironments were investigated. For this purpose multiplexed bead-based immunoassays were applied to simultaneously determine 90 biomarkers in the supernatants of endothelial cell cultured for 7 and 28 days either on gravity or under simulated microgravity. Comparing the results obtained by analysing the supernatants of cells cultured under simulated microgravity and 1g gravity, significantly reduced quantities of soluble factors in simulated microgravity supernatants were measured for sCD40, sCD40L, sICAM-1, sVCAM-1, von Willebrand Factor, sTNF-RII, adiponectin, GM-CSF-alpha, beta-2 microglobulin and TIMP-1 after 7 days. After 28 days of culturing the quantities of these factors released into the supernatants were still higher in 1g cultures, but the differences were significantly smaller. The biological impact of these changes of biomarker secretion activity is currently investigated.

RECOVERY OF MICROTUBULAR NETWORK AT SIMULATED LOW G IN HUMAN MONOCYTE PRETREATED WITH NOCODAZOLE

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Early investigations in space and in simulated low gravity have shown that gravity changes affect important cellular functions, including, but not limited to, proliferation, gene expression, cytoskeletal architecture and motility. Both cell shape and the cytoskeleton are affected by altered gravitational conditions; microfilaments are altered in low gravity as well as microtubules (1). Changes in cell architecture are responsible for a different response to their environment. Cells rely on intact microtubule network for their structure, transport of organelles and process of cell division. Microtubules (MT) typically grow into long tubular polymers consisting of αβ-tubulin dimers binding together in a specific orientation. They exist in dynamic equilibrium, growing and shrinking by the addition or loss of tubulin dimers. Their orientation and growth is a process that profoundly affects living cells. MT stability is crucial for maintaining polarity and controlling the directional migration of adherent cells. In this work we have studied the reorganization of microtubules in J-111 monocytes in modelled low gravity after they have been first depolymerized by exposure to the antimicrotubule agent nocodazole. Earlier studies indicated that alterations in MT dynamics are likely mediated through a reversible tubulin dimer-nocodazole interaction. Analysis by immunofluorescence technique and a quantification of β-tubulin fluorescence intensity revealed remarkable differences in microtubule pattern reorganization in cells pretreated with nocodazole and exposed to modelled low gravity for 1 and 4 h compared to 1g controls. Moreover, despite the difference in the microtubules structure arborization an evident recovery was observed after 24h at modelled low gravity conditions, although they are not completely reorganized compared to cells exposed for 24h to 1g where β-tubulin filaments appeared completely recovered. Our results could confirm earlier data (1) on the disturbances of the microtubules in J-111 monocytes by a short time exposure to modelled low gravity and the following reorganization of the microtubules within 24h in RPM modelled low gravity. This described reorganization of β-tubulin might represent an adaptative mechanism and might have relevance in the process of cell adaptation to gravitational unloading.

Research supported by Italian Space Agency (MoMa grent)
Meloni M.A. et al. (2006) Protoplasma 229, 243-249

PROTEOMIC ANALYSIS OF FOUR DIFFERENT THYROID CELL TYPES EXPOSED TO SIMULATED MICROGRAVITY

Jirka Grosse[1], Jessica Pietsch[2], Richard Kussian[3], Albert Sickmann[4], Johann Bauer[5], Gerhard Weber[6], Mikkel Nissum[3], Kriss Westphal[7], Marcel Egli[7], Manfred Infanger[8] Christoph Eilles[1] and Daniela Grimm[2,9]

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[7]Space Biology Group, ETH Zurich, Technoparkstr. 1, 8005 Zurich, Switzerland

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The aim of this study was to detect proteins, which are differently expressed under simulated microgravity. Therefore, proteomes of the four human thyroid cell lines FTC-133, CGTH W-1, ML-1 and HTU-5 were analyzed, after the cells had been cultured under conditions of simulated microgravity using the random positioning machine (RPM) and under normal gravity for 72h. The cultured cells were sonicated first and the cell suspension fluid was separated from the cell fragments by centrifugation afterwards. Then the various protein mixtures were fractionated according to the free-flow isoelectric focusing (FF-IEF) regime. Subsequent SDS-gel electrophoresis and mass spectrometry revealed 235 proteins of human thyroid cells, of which about 50% received Mascot scores higher than 500. Free Flow electrophoresis (FFE)-separation procedure was so reproducible that identical bands were seen on two neighboring SDS-PAGE lanes, when we fractionated protein samples of cells, which had been incubated in microgravity or gravity, independently according to FF-IEF and subjected identical FFE fractions to SDS-PAGE in a way that both samples ran side a side. If pairs of identical bands were cut out and subjected to mass spectrometry, most of them showed identical proteins with similar Mascot scores. However, some proteins showed differences, which pointed to proteins being differently expressed under microgravity.

LIVE IMAGING OF OSTEOCLAST ACTIVITIES IN MEDAKA UNDER HYPERGRAVITY

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ISS microgravity environment has been reported to enhance bone resorption in human, however, the gravity effect on bone remodeling is not well understood. To study the osteoclastogeneis *in vivo*, we use medaka, which is a genetically accessible vertebrate with an optically clear embryo permitting high-resolution *in vivo* imaging, and recently we reported that mature osteoclasts exist in medaka(1). To investigate osteoclasts *in vivo*, we linked the medaka *TRAP* promoter to enhanced green fluorescent protein (EGFP), and microinjected this construct to generate a stable osteoclast specific medaka transgenic line. GFP-positive fluorescent osteoclasts were observed in the pharyngeal region, along the inner aspects of the neural and hemal arches of the vertebral column, which overlapped the TRAP (Tartrate-Resistant Acid Phosphatase) staining. Using time-lapse imaging and histological analysis of the transgenic medaka, we traced the behavior of osteoclasts under 5G hypergravity and a control 1G condition, and found that hypergravity enhanced the osteoclast activities. Taken together, our *in vivo* system employing medaka is a suitable animal model for the analysis of bone metabolism under hyper- or micro- gravity, such as the space experiment project.

(1)Nemoto Y et al Multinucleate osteoclasts in medaka as evidence of active bone remodeling″
Bone 40:399-408(20

CYTOMECHANICS OF OSTEOBLASTS AND OSTEOBLAST-LIKE CELLS

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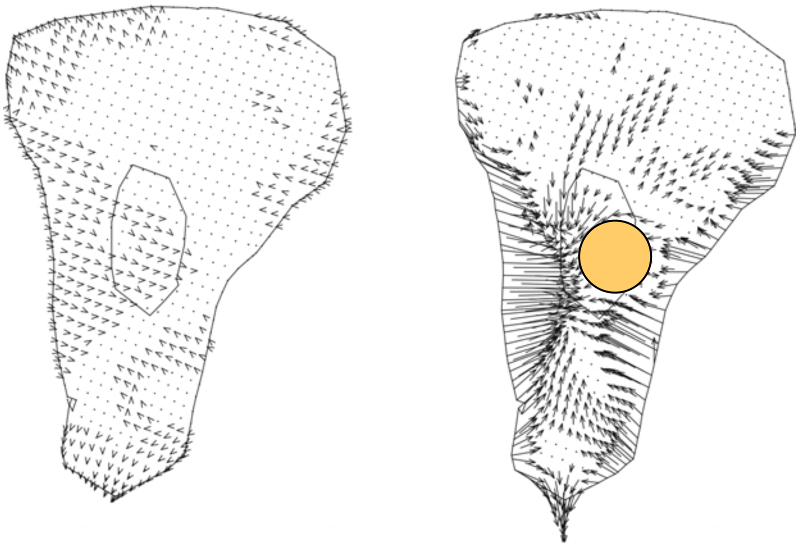
Inst. Experimental Orthopaedics and Biomechanics
Philipps University, Marburg

Cells exert very small forces due to their mass on the substrate, roughly 0.6pN per cell (1). Since they are in a salt solution only their dry weight contributes to this force as they are to a large extent buoyant. However gravity acting on this mass is enough to cause suspended cells to quickly settle (in a typical cell culture with medium 3mm high 30 -40 minutes). Given enough time the constant force of gravity can influence the settling even of gas molecules. Thus over time cellular organelles will drop through the cell, or rise, depending on their relative buoyancy. It is theoretically possible that any cell could sense the presence or absence of gravity.

Using traction force microscopy we can show how much force is used by the cell once attached, between 100,000 and 2 million times their own mass. Cells sense the stiffness of the substrate by applying these very high forces and use the information to partly determine which differentiation pathway to follow and also for durataxis. Durataxis is the property of many cells to sense the substrate stiffness over a very small part of the cell and direct movement onto a stiffer substrate from a softer one. Combined with a special atomic force microscope combined with traction force measurements we applied varying forces to cultured osteoblasts (see figure below) These experiments showed that only the very base of the cell, less than 500nm thick, is there any significant tension apparatus and the rest of the cell is highly visco-elastic. Together with other experiments we conclude that the classic mechano-sensor is associated with the high stress actin-myosin system and is not involved in gravisening.

Given that those astronauts (cosmonauts) who actually lose bone, lose it in the legs and not in the arms or head, it is difficult to conceive of a general gravisensing mechanism that is site dependent, while a better explanation is that of disuse. Our limited experience of microgravity experimentation also finds no evidence for any direct gravity response in these cells.



Traction force –AFM showing substrate force changes with applied force reaching 90% of the cell thickness

References,
Vico et al. Calcif Tissue Int (2001) 68:1–10

SCIENTIFIC SESSIONS:

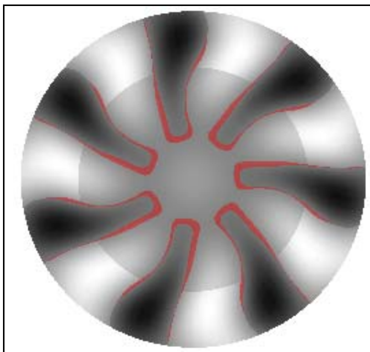
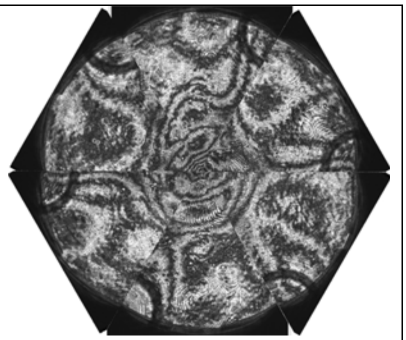
Thursday, September 3nd
Room B, 16:00 – 18:00

Physical Sciences
(Convection, Interfacial Flow 2)

COLUMBUS´ EXPERIMENT 'GEOFLOW': FROM NUMERICAL SIMULATED FLUID FLOW TO EXPERIMENTALLY OBSERVED FRINGE PATTERNS OF CONVECTION

Birgit Futterer, Christoph Egbers and ESA Topical Team "Geophysical Flow Simulation"
Brandenburg University of Technology Cottbus, Department of Aerodynamics and Fluid Mechanics, Siemens-Halske-Ring 14, 03046 Cottbus, Germany

'GeoFlow' is the first experiment in Fluid Science Laboratory of International Space Station's European module COLUMBUS. Motivated by convection phenomena in the inner Earth, it deals with the exploration of thermal convection in a cavity between two concentric spherical shells, being also rotable. Fluid dynamics of the experiment is splitted into a non-rotating and a rotating case. For both cases direct numerical simulations were accomplished. In the steady state regime of non-rotating case different convective patterns are co-existing. Transition to chaos is in form of a sudden onset. In the rotating case bifurcation scenarios are from steady via periodic to chaotic temporal behaviour. Convection patterns are characterized by the mode number, which is increasing with the parameter sets. The experimental runs have scanned the numerical explored parameter regime at all stages of regular and irregular parameter regimes. Used optical diagnostics method for the observation is the Wollaston shearing interferometry. This special set-up of an interferometry delivers images, of which the principal content are fringes. These fringes are connected to up- and downstreams in convection occurring in the spherical cavity. Procedure of pattern evaluation and interpretation in comparison to numerical simulated parameters are presented.

	
Numerical simulated velocity field for rotating spherical shell convection, view at top of the sphere. Dark shading marks positive values.	Experimentally observed interferogram image. Fringes mark up-stream flow at the polar region.

THE CHEMICALLY-DRIVEN INTERFACIAL CONVECTION EXPERIMENT CDIC II ON MASER 11

A. Heinze, K. Eckert, K. Seidel, R. Sczech

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We present results of the CDIC II experiment (*C*hemically-*D*riven *I*nterfacial *C*onvection) flown on the MASER 11 mission of ESA in May 2008. The flight hardware included two different subexperiments. The first experiment, analysing the chemo-Marangoni convection in capillaries, is only briefly discussed. The focus of the presentation is on the second experiment, combining two phenomena intensively discussed in the past. The first one is the Marangoni convection occurring during the mass transfer of a surface-active species A across a liquid-liquid interface. The second phenomenon is a chemical reaction $A + B \rightarrow S$, leading in experiments on ground, to a self-generating interface, the reaction front, which propagates into the aqueous phase. By means of a parabolic flight experiment we could proof that the front propagates faster with increasing level of the gravitational acceleration indicating that a buoyancy-driven roll travels with the front. The CDIC II experiment was performed in two Hele-Shaw cells of a special design [1], each placed in a lateral shearing interferometer. Both cells were interactively filled by telecommand. The experiment shows clearly (i) that a *propagating* reaction front does not exists under microgravity (i.e. the reaction stays located at the interface), and (ii) even more importantly it allows to follow quantitatively the onset and development of Marangoni convection in the presence of a chemical reaction.

1. Shi, Y., Eckert, K., "A novel Hele-Shaw cell design for the analysis of hydrodynamic instabilities in liquid-liquid systems", Chem. Eng. Sci. 63, pp. 3560-3563

OUTCOMES FROM THE SCCO EXPERIMENT: IT IS POSSIBLE TO PREDICT THERMODIFFUSION IN MULTICOMPONENT

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The SCCO experiment was carried on the FOTON M3 mission in 2007. Among them, a set of binary to quarternary systems where studied in order to find possible mixing rules. The samples have been processed during 210 hours. Once retrieved, they have been analyzed with a suitable NMR implementation.
Results are presented and compared to the predictions performed thanks to the Firoozabadi-Saghir thermodynamic theory. At the same time, simple rules seem to provide with a fair accuracy the thermodiffusion coefficients of a n+1 solution as a function of the thermodiffusion coefficients of the n components solutions.
Prospects can be given so, in particular to the test case of crude oil reservoirs. Also, emerging questions for the prediction have a better basis and are discussed.

1. S. Van Vaerenbergh, J.C. Legros, J.L. Daridon,T. Karapantsios, M. Kostoglou, Z.M. Saghir, “Multicomponent transport studies of crude oils and asphaltenes in DSC program”, Microgravity sci. technol. XVIII-3/4 , p. 5, 2006.
2. S. R. Van Vaerenbergh, M.Z. Saghir, J.L. Daridon, M. Luhmer, G. Galliero, F. Montel, J. Bickert, J.C. Legros, “Experimental microgravity Soret Coefficients effect in multicomponent systems: towards mixing rules”, High Temperature High Pressure, 2009

IVIDIL EXPERIMENT ONBOARD ISS: MASS TRANSFER UNDER CONTROLLED VIBRATIONS

Valentina Shevtsova

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Precise measurements of heat and mass transport coefficients under terrestrial conditions are often perturbed by buoyancy-induced flows. The microgravity environment minimizes the effect of gravity, but the background g-jitter encountered in many space experiments may alter the benefits of microgravity environment. The ability of numerical modeling to provide reliable predictions of vibrational effects for the interpretation and planning of future space experiments is still limited by a lack of well-documented experimental results. This situation might be somewhat recovered by completion of IVIDIL (Influence of Vibration on Diffusion and Thermo-diffusion in Liquids) experiment, which is scheduled to be performed onboard ISS in fall 2009 in the frame of the ESA Physical Science program. One of the objectives is to examine how strong the imposed *controlled* vibrations may change the measured coefficients of mass transport. Finding the limiting parameters when g-jitter is not important for diffusion controlled phenomena is another important objective. Preparation of the experiment is undertaken in three different ways: numerical simulations, laboratory investigation of slow process (diffusion) and study of fast processes (vibrational convection) during Parabolic flights [1]. The experiment is scheduled to fly during ELGRA meeting.

REFERENCES
Mialdun A., Ryzhkov I. I., Melnikov D., Shevtsova V. Experimental evidence of thermal vibrational convection in a non-uniformly heated fluid in a reduced gravity. 2008, Phys. Rev. Lett.; 101, 084501.

TWO-PHASE SYSTEMS WITH CYLINDRICAL SYMMETRY: INTERFACIAL FLOW CONTROL AND STABILITY

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In this work, we perform a theoretical study of thermocapillary flows and their stability in a two-phase system of infinite liquid column surrounded by the gas layer. This study is a complementary step in the JEREMI project (Japanese–European Research Experiment on Marangoni Instability), which is devoted to the development of efficient means for controlling thermocapillary flows and the onset of instability in liquid bridges (columns). The flows are controlled by applying mechanical stresses to the free surface and varying the interfacial heat exchange by blowing gas around the liquid. The performance of space experiments on the International Space Station is scheduled to 2011.

The analytical solution describing stationary velocity and temperature profiles in the liquid and gas is derived. It is shown that liquid motion can be completely suppressed by the gas flow. The linear stability analysis of stationary flows is performed. It is shown that when the gas flow is opposite to that of liquid on the interface, the system becomes more stable. The stabilization occurs due to mechanical stresses applied to the interface and interfacial heat exchange between liquid and gas. It is shown that consideration of liquid bridge with the surrounding gas provides better agreement with experimental results [1] than previous calculations without gas phase [2].

This work is supported by the PRODEX programme (Belgium) and Interdisciplinary project of SB RAS № 116.

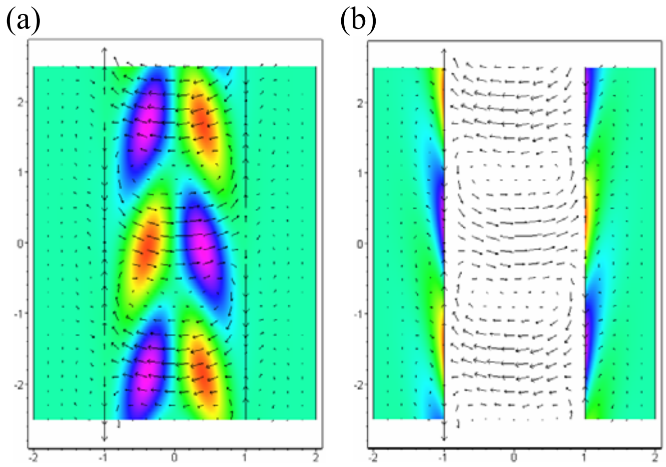

Figure 2: Critical perturbations of velocity and temperature in the liquid column and gas layer (a). The amplitude of perturbations in gas is much smaller than in liquid, so these perturbations are shown separately (b). The gas is blown upwards.

1. D. Schwabe. Hydrothermal waves in a liquid bridge with aspect ratio near the Rayleigh limit under microgravity. Physics of Fluids, Vol. 17, 112104, 2005.
2. J.J. Xu and S.H. Davis. Convective thermocapillary instabilities in liquid bridges. Physics of Fluids Vol. 27, pp. 1102-1107, 1984.

BUOYANCY INSTABILITIES INDUCED BY A+B→C REACTION

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Classical Rayleigh-Taylor or double diffusive instabilities can be triggered by a simple A+B→C chemical reaction when two miscible solutions each containing one reactant are put in contact in the gravity field. A linear stability analysis of the evolving base state profiles is performed using a quasi-steady state approximation. This allows one to classify the various sources of instabilities as a function of the parameters which are the Rayleigh numbers and the ratio of diffusion coefficients of the chemical species. The resulting nonlinear dynamics due to this chemo-hydrodynamic feedback are then systematically analyzed to highlight how the chemical reaction can trigger or modify the hydrodynamical instabilities. It is also shown to what extent the resulting buoyancy-driven instabilities enhance the total reaction rate. Finally, related experiments are also performed in a vertical Hele-Shaw cell with an acid-base reaction.

SCIENTIFIC SESSIONS:

Friday, September 4th
Room A, 09:00 – 10:40

Life Sciences
(Animal Physiology 1)

SEARCH FOR THE BEST ANIMAL MODEL GUIDED RESEARCH ON THE SUSCEPTIBILITY OF NEURONAL SYSTEMS TO MICROGRAVITY

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Research in Space Biology lacks the chance to repeat or modify experiments according to the obtained results. Optimization of research strategies is mandatory. The analysis of mechanisms of a biological process such as osteoporosis requires other strategies than the search for basic and common principles about the susceptibility of organisms for microgravity. Research about osteoporosis can be best done in a single species such as rat. The discovery of fundamental principles, however, needs the comparative approach and, thus, the use of the best model. In some instances, exotic animals such as scorpions offer best chances. For convincing reasons, they were considered for research about effects of space conditions on biological clocks [3]; they are also an excellent animal model for research about basic principles of neuronal, motor and sensory adaptation to microgravity.

During my 20-years lasting period of research focussing on the impact of microgravity on neuronal and sensory systems, I have used 6 animal species to find out how animals adapt to microgravity on the behavioural, neurophysiological and morphological level. Animals were chosen according to features for a reliable and quantitative data collection. On the behavioural level, g-sensitivities can be studied best for gravity-related head or eye movements as shown by crickets and aquatic vertebrates (*Xenopus*, *Oreochromis*, *and Pleurodeles*) [1]. The specific use of one or the other species was related to the velocity of embryonic development that is faster in *Xenopus* than in *Pleurodeles*. For the study of microgravity effects on the physiology and structure of individual neurones, insects (*Acheta*, *Drosophila*) offer better possibilities than vertebrates. Some of their neurones are large, less numerous in the nervous system; thus, they can easily be detected and identified in different individuals [2]. Crickets, in particular, offered the possibility to study in individual animals the physiological µg-susceptibility of an identified neurone that is linked in the conduction of gravity-related behaviour [1]. In case of short-lasting biological processes such as target directed movements in microgravity, insects such as crickets are suitable animal models to support human studies related to the accuracy of target finding.

References

Horn, E.R., The development of gravity sensory systems during periods of altered gravity dependent sensory input. Adv. Space Biol. Med., Vol. 9, pp. 133-171, 2003.
Kirschnick, U., Agricola, H.J., Horn, E., Effects of altered gravity on identified pepti-dergic neurons of the cricket *Acheta domesticus*. Gravit. Space Biol., Vol. 19, pp. 135-136, 2006.
Riewe, P.C., Horn, E.R., The scorpion. An ideal animal model to study long-term microgravity effects on circadian rhythms. In: *Space Technology and Applications International Forum* (El-Gerk, M.S., Ed.), American Institute of Physics, Melville, New York, pp. 383-388, 2000.

Since 1989, the author was supported by the German Space Agency (DLR)

DROSOPHILA AS A MODEL SYSTEM IN MICROGRAVITY GROUND SUPPORT FACILITIES: A REVIEW OF PROFESSOR MARCO´S LAST YEARS EXPERIMENTS

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The MDBML (Madrid Developmental Biology Microgravity Laboratory) was founded by Professor Roberto Marco and headed by him from 1981, when he published his first Space biology paper (1), until his premature passing last year. In 2003 the lab was awarded to participate with two experiments (GENE and AGEing, preliminary results published in 2,3) in the Spanish Cervantes Soyuz mission to the ISS. In these experiments we performed the analysis of both the ageing process of young (2 days) and mature (2 weeks) flies. Furthermore we determined the gene expression profile using whole genome microarrays when drosophila is exposed to microgravity during development (specifically during the 4-5 days needed for late larvae to become imagoes, the metamorphosis process). Because that was the last Space mission in which Prof. Marco had the opportunity to contribute, we carried out further studies using microgravity (and hipergravity) simulation on ground in order to replicate and extend the results obtained in the framework of the Cervantes Soyuz Mission. In this report, it is my goal to put together and share out to the space biology community all the results and resources (included in four manuscripts in different steps of the publication process and a total of 188 microarray samples) that bring out during the last 5 years of MDBML activities before the UAM lab closing next October.

REFERENCES

1. Marco, R, "Ciencia y Sociedad: Microgravedad y Biologia", Investigación y Ciencia, Vol. 59, pp. 42-43, 1981.
2. Herranz, R., Benguria, A., Fernández-Pineda, E., Medina, F.J., Gasset, G., van Loon, J.J., Zaballos, A., Marco, R, "Gene Expression Variations During Drosophila Metamorphosis in Space. The GENE Experiment in the Spanish Cervantes Mission to the ISS", J Gravit Physio, Vol. 12, pp. 253-254, 2005.
3. de Juan, E., Benguría, A., Villa, A., Leandro, L.J., Herranz, R., Duque, P., Horn, E., Medina, F.J., van Loon, J.J., Marco, R, "The "AGEING" Experiment in the Spanish Soyuz Mission to the International Space Station", Microgravity Science and Technology, Vol. 19 (3-4), pp. 170-174, 2007.

GENETIC MEDIATORS OF SALMONELLA VIRULENCE DURING SPACEFLIGHT: A NEMATODE MODEL.

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Salmonella infects the nematode *C elegans*, yielding a model system to test the molecules which determine virulence of *Salmonella* strains in both the infecting bacteria and the nematode host. Wild type and Tol1 deletion nematode eggs and worms were exposed during spaceflight, clinostat culture or static controls to *Salmonella*, with and without specific gene deletions. Use of three chamber glass tubes with pass through valves (Bioserve Fluid processing apparatus) allowed preparation of bacteria, nematodes and fixative in separate chamber prior to launch, mixing of nematodes and bacteria 20 hours following launch, with addition of fixative 48 hours later.For the first time ever, direct study of an inflight infection model using nematodes and *Salmonella* demonstrates: (1) under the conditions we utilized, *Salmonella* grows at the same rate static on the ground, in flight, and in clinostats; (2) *Salmonella* increases in virulence during both spaceflight and clinostat culture; (3) deletion of pathogenicity island 3 or 5 but not pathogenicity island-1 genes reduces *Salmonella* virulence during spaceflight; (4) virulence changes during space flight are dependent on the Tol1 gene in the nematode host; (5) the increased virulence of *Salmonella* during clinostat culture is mediated by difference gene pathways than the virulence effects of spaceflight.

ANTIOXIDANT METABOLISM OF THE TARDIGRADE *MACROBIOTUS RICHTERSI* DESICCATED, ACTIVE AND UNDER SPACE FLIGHT

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Solar radiation or low wavelength electromagnetic radiations (such as gamma rays) from the Earth or space environment can split water to generate the hydroxyl radical, which can initiate chain reactions. These reactive free radicals (ROS) can react with the non-radical molecules, leading to oxidative damage of lipids, proteins and DNA, involved in various diseases, such as cancer, cell degeneration, and inflammation.

To verify these damages, we have carried out experiments on an invertebrate, *Macrobiotus richtersi*, belonging to Tardigrada. This phylum includes many anhydrobiotic species, which can survive in very dry or cold environmental conditions and also show a high tolerance to a number of other unnatural conditions, including ionizing radiations. This makes tardigrades a candidate for experimental exposure in space.

The aim of these experiments was to determine if *M. richtersi* is provided by antioxidant metabolism counteracting space radiations both in desiccated and active animals. Moreover animals from “TARSE” experiment, flown during the mission LIFE on FOTON-M3, were analyzed. Desiccated (in microcosm or on paper) and hydrated tardigrades (fed or starved) have flown for 12 days, allowing for the first time to compare the effects of space environment on both desiccated and active animals. Data on antioxidant enzyme contents and activities have been compared between flown and on Earth control tardigrades. Space flight induced in Desiccated animals (microcosm) a decrease of GSH content and of its related enzymatic activities. Catalase increases with space flight, while SOD and TBARS do not change. Opposite effects were induced in active hydrated animals (starved) with an induction of GSH system and with significative reduction of SOD and Catalase. The reasons for these opposite effects are still under investigation.

This Work is supported by A.S.I., MoMa – ASSC Grants to A. M. Rizzo and L. Rebecchi.

THE EXPERIMENT XENOPUS AS PART OF THE KUBIK BIO4-PROGRAM DURING THE TMA13/TMA12 SOYUZ FLIGHT TO ISS IN 2008

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Vestibular functions are strongly affected by space flight. Studies in animals (fish, amphibia) have clearly revealed that the extent of vestibular reflexes and swimming is modified by microgravity in an age-related manner. In the amphibian Xenopus laevis, a morphologicalmodification, the so-called tail lordosis, became also visible after space flights; it disappeared after return to Earth within a couple of days [1, 2].

The experiment XENOPUS was a continuation of a series of 3 experiments performed on the Shuttle flights STS-55 (German D2-mission; 1993) and STS-84 (Shuttle-to-Mir misison; 1997) and on a Soyuz flight to ISS (French Andromède mission; 2001). For these missions, developmental stages were chosen that were either not able to perform the so-called roll-induced vestibuloocular reflex (rVOR) at onset of the mission, or have just developed it. For the experiment XENOPUS, two older stages were chosen that were defined by the extent of leg development. In the younger group (stage 47; n=20 tadpoles), the hind limb buds became just visible, in the older ones (stage 50; n=16) also the forelimb buds. The experiment was part of the Kubik-BIO4 package that flew on the Soyuz flight TMA13 (upload) and TMA12 (download) to ISS. The main interest was related to modifications of the rVOR, the extent of tail lordosis and swimming behaviour. A parallel ground experiment was included. Swimming behavior was video recorded at the landing site, about 1 hour after Soyuz touch down while rVOR recordings started about 24 hours after termimation of microgravity. General development (size, stage) was also monitored.

The main observations were (1) that 35 out of 36 tadpoles landed safely, (2) that looping swimming was seen at the landing site and for additional 2 days exclusively in the young group, (3) that microgravity induced tail lordosis developed only in the young group and disappeared in surviving tadpoles within 10 days, and (4) that in both tadpole groups, the rVOR recorded during post-flight days 1 to 4 was not affected by microgravity.

These observations are in line with and will be discussed in relation to the results obtained from the ealier missions. Special attention is given to so-called critical periods during development.

References

1. Horn, E., Microgravity-induced modifications of the vestibuloocular reflex in Xenopus laevis tadpoles are related to development and the occurrence of tail lordosis. J. Exp. Biol., Vol. 209, pp. 2847-2858, 2006.
2. Sebastian, C., Esseling, K., Horn, E., Altered gravitational forces affect the development of the static vestibuloocular reflex in fish (Oreochromis mossambicus). J. Neurobiol., Vol. 46, pp. 59-72, 2001.

Supported by DLR, grant no. 50WB0630 to Horn

SCIENTIFIC SESSIONS:

Friday, September 4th
Room B, 09:00 – 10:40

Physical Sciences
(Liquid Interfaces)

PHASE CHANGE – INDUCED MOTION OF H_2 VAPOUR BUBBLES UNDER A TEMPERATURE GRADIENT

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The thermocapillary (Marangoni) motion of vapour bubble under a temperature gradient cannot be effective in a pure fluid,. However, phase transition, evaporation on the hot side, condensation on the cold side, can occur that makes a bubble apparently move. We report such phenomena in liquid hydrogen under a temperature gradient, far and close to its critical point (33 K) and discuss the results with the existing theories. The experiment has been performed in the facility of magnetic compensation of gravity at CEA-Grenoble. A transparent Plexiglas tube holds liquid H_2 with a small bubble. Initially both liquid and vapour bubble are at the same temperature. Then the temperature of the top of the tube, or the bottom or both is changed. The bubble is seen to move either upwards or downwards but eventually stop after a short time.
In order to understand the above behaviour, a numerical simulation is performed. The temperature distribution inside the tube containing a vapour plug is analyzed numerically in a 1D approximation, for the case where the system is close to the liquid-gas critical point under weightlessness conditions.

SESSILE DROP WETTABILITY UNDER REDUCED GRAVITY CONDITIONS

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Evaporation is a process commonly encountered in numerous areas of nature including, the development of coffee and salt "spots", the application of weed killers and in many industrial processes like cooling, welding, drying (of paints and other films), desalinisation, micro-electronics and evaporators, etc. The heat transfer occurring during evaporation is typically much larger than that obtained with traditional techniques without phase change. During evaporation the mass and heat transfer across the fluid interfaces and their optimization are often a vital objective. The control of these processes where changes in the liquid-vapour phase occur is presently still poorly characterised though it is commonly used in industry to transfer heat fluxes and control processes. A clear identification of the physical phenomena and a better knowledge of the role of the parameters involved will make it possible increase the efficiency of current systems and, at the same time, develop smaller and more powerful systems than those presently in existence.
In the current work, liquid drops are created on different substrates pasted onto aluminium blocks. The test cell is made out of an Acetal® block with Polycarbonate® windows to prevent convection and external air flow effects. This experimental setup ensure a homogeneous temperature inside the test cell. Investigated is the influence of different parameters such as drop volume, substrate nature (aluminium, PTFE, glass) and liquid nature (distilled water, ethanol, HFE-7100...) on the drop formed and its interaction with the substrate. Experiments are conducted under normal gravity and reduced gravity where the formed drop is recorded by high definition video (resolution of 1920*1080, 30 frames/sec). These drop pictures are then analyzed with software in order to extract the contact angle and the drop shape as a function of the experimental parameters varied. The reduced gravity environment was produced while the experiments were in free fall within a drag shield inside a new second drop tower at the Queensland University of Technology. This drop tower allows large experiments to be conducted in reduced gravity for a period of up to two seconds. The full paper will present the work performed on the sessile drop contact angle behaviour in both normal gravity and reduced gravity. In normal gravity, it is shown that the sessile drop contact angle produced by modifying the drop interface has a strong influence on the evaporation mass flux and the appearance of convection cells. In reduced gravity, the contact angle is not be modified for small

drops of typical diameter below the capillary length. For drop of diameters above the capillary length the interface location is also modified. No database of contact angles of sessile drops in reduced gravity exists; while such a database is fundamental for further developments in reduced gravity that are addressing heat and/or mass transfer.

CHEMICO-PHYSICAL PROPERTIES OF MIXED NANOPARTICLE-SURFACTANT LAYERS AT LIQUID-LIQUID INTERFACES RELEVANT FOR EMULSION STABILITY.

Libero Liggieri[1], Eva Santini[1], Francesca Ravera[1], Michele Ferrari[1], Giuseppe Loglio[2], Mickael Antoni[3], Reinhard Miller[4], Jürgen Krägel[4], Dimitri Grigoriev[4]

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Emulsions have a large diffusion in many products and technologies, such as, oil production, pharmaceuticals, cosmetics, foods. They are disperse systems of immiscible liquids, stabilised against separation by the presence of surface active species, which segregate at the liquid-liquid interface and slow-down the droplet coalescence process. Besides the traditional additives, such as surfactants, polymers or proteins, the utilisation of solid nano/microparticles is being investigated as a promising technology. In fact emulsions stabilised by particles (Pickering emulsions) are well known in nature and can show outstanding stability features, as it is, for example, for some crude oils.

In spite an overall picture of the mechanisms involved in such stabilisation has been drawn, many details are still the subject of speculations, in particular those concerned with the properties of particle layers at the liquid interface. Further studies and modelling are then needed to progress in the scientific and technological aspects related to particle-stabilised emulsions, in order to optimise the utilisation of additives in the formulation or, where needed, to achieve an efficient separation of the components of stable emulsions.

Here we report an investigation about different chemico-physical aspects concerned with mixed layers composed by nanoparticles and surfactants at water-oil interface. These properties are then correlated to features of the corresponding emulsions.

The work has been performed in the framework of the ESA MAP-FASES (Fundamental and Applied Studies in Emulsion Stability) and in support to the interpretation of experiments that will be performed on board the International Space Station, to investigate in detail droplet interaction during emulsion destabilisation.

SURFACTANT EFFECT ON DROP OSCILLATIONS

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The effect of a surfactant absorbed in the surface liquid layer on small free capillary oscillations of a spherical drop is considered. The results are obtained for a widespread case of small volume viscosity of a liquid. The corrections to the natural frequencies caused by the small volume and surface viscosities are obtained. It is known that the presence of a surfactant in the surface layer of a liquid is, by itself, the reason for essential increase of viscous dissipation which is related to a change in the boundary condition of tangential stress balance. The small shear surface viscosity results in the increase of the damping increment leaving the frequency of free oscillations unaffected. Small dilatation surface viscosity practically has no effect on the natural frequencies. A detailed consideration is given to a limit of the small volume and finite surface viscosity unstudied in the literature. The finite surface viscosity together with the mechanism of the absorption effect on the surface tension can lead to a substantial damping of the free drop oscillations. Depending on the system parameters, for each angular dependence, there exist either three aperiodic damped modes or one aperiodic and one oscillatory damped modes.

CHARACTERIZATION OF SOLID-STABILIZED EMULSIONS BY SCANNING ELECTRON MICROSCOPY

Stéphanie Limage [a], Murielle Rozières [a], Sébastien Vincent-Bonnieu [b], Christian Dominici [c], Mickaël Antoni [a]
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The structure of water-in-oil emulsions stabilized by both cationic surfactant (CTAB) and silica nanoparticles is investigated through scanning electron microscopy (SEM) observations. The freeze-fracture technique is employed. Emulsions stabilized by CTAB and silica nanoparticles were investigated in recent studies [1,2]. Depending on the relative concentrations of CTAB and silica particles, a transition occurs in the shape of the droplets that from spherical become polymorphous [1]. The aim of the present work is to understand the origin of this deformation. To achieve this goal we propose to visualize experimentally the organization of the silica nanoparticles inside the droplets with SEM experiments after partial sublimation of water. We evidence how the interplay between nanoparticles, surfactant and interfacial properties generates microstructures inside the droplets acting as a skeleton that explains their deformation. For figure 1(a), the ratio of CTAB and silica nanoparticles in the dispersed phase is such that the droplets are non-spherical, whereas for the sample of figure 1(b) the composition of the dispersed phase yields spherical droplets. For non spherical droplets, nanoparticles organize themselves into layers acting like a skeleton that bridges the droplets from part to part.

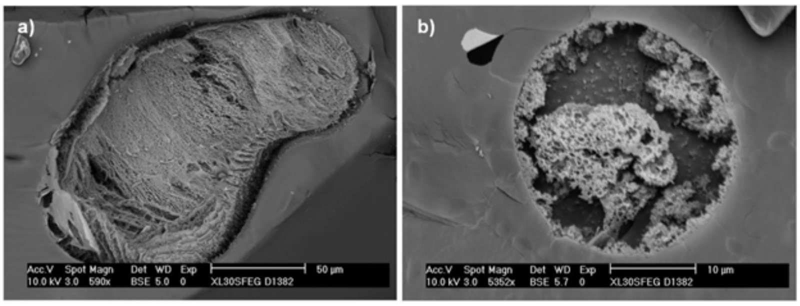

Figure 1 : Cryo-SEM images of water droplets in a paraffin oil matrix. For both emulsions the concentration in silica nanoparticles is 25 g/L and the concentration in CTAB is 0.05 g/L in (a) (distorted droplets) and 1.28 g/L in (b) (spherical droplets).

1. Binks, B.P., Rodrigues, J.A., Frith, W.J., "Synergistic Interaction in Emulsions Stabilized by a Mixture of Silica Nanoparticles and Cationic Surfactant", Langmuir, Vol. 2, pp. 3626-3636, 2007.
2. Schmitt-Rozières, M., Krägel, J., Grigoriev, D.O., Liggieri, L., Miller, R., Vincent-Bonnieu, S., Antoni, M., "From spherical to polymorphous dispersed phase transition in water/oil emulsions", Langmuir, Vol. 25, pp.4266-4270, 2009.
3. Limage, S., Rozières, M., Vincent-Bonnieu, S., Dominici, C., Antoni, M., "Characterization of solid-stabilized emulsions by scanning electron microscopy", preprint, 2009.

SCIENTIFIC SESSIONS:

Friday, September 4th
Room A, 11:00 – 13:00

Life Sciences
(Animal Physiolgy 2)

SMALL FISH SPECIES TO STUDY BONE PHYSIOLOGY IN SPACE.

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Small fish models, mainly zebrafish (*Danio rerio*) and medaka (*Oryzias latipes*), have been used for many years as powerful model systems for vertebrate developmental biology. They present many experimental advantages, such as transparency of the embryos, external development, for large-scale mutagenesis screening, rapid development. Characteristics particularly useful for space research include the large number of embryos from one single clutch, small size, easy containment in water tanks, utilization of existing instrumentation. Recent studies have shown that many fish genes play very similar roles in bone development and homeostasis compared to their homologs in mammals.
We investigate the changes induced by microgravity in small fish species, as a model system for vertebrates. Whole genome approaches are now available in these species, such as microarray expression analysis, proteomics or chromatin immunoprecipitation (ChIP). We analyzed the modulation of gene expression in several microgravity simulation conditions on ground with a special emphasis on bone related genes. Our aim is to compare these results to the changes observed in space. Furthermore, we generate transgenic fish lines expressing fluorescent reporter proteins in bone structures, to perform automated *in vivo* real time observations in microgravity.

EFFECTS OF LONG-TERM MICROGRAVITY ON THE MINERALIZATION OF INNER EAR OTOLITHS OF FISH

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A series of own, ground-based experiments using late larval stages of cichlid fish (*Oreochromis mossambicus*) suggested that, after commencement of the vestibular system, the biomineralization of otoliths is adjusted towards the environmental gravity vector by means of a neurally guided feedback loop. Especially, we found that increased gravity slows down otolith growth.

Here, we address effects of weightlessness during 12 days of space flight (FOTON-M3) on cichlid fish larvae as compared to 1g controls.

Maintenance under microgravity resulted in significantly larger than normal otoliths. Moreover, displacement of calcium during the experiment was considerably less pronounced in otoliths of space reared samples.

The finding that otolith growth/mineralization is adjusted towards functional weightlessness clearly supports the existence of the aformentioned feedback mechanism and indicates that mineralization of fish otoliths is stimulus dependent.

Acknowledgement: This work was financially supported by the German Aerospace Center (DLR) (FKZ: 50 WB 0527).

HABITUATION OF FISH TO $4X10^{-2}$ AND 10^{-4} G DURING THE TEXUS 45 MISSION AND PARAMETERS OF INNER EAR OTOLITHS

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During weightlessness, humans often suffer from motion sickness (a kinetosis like, e.g., sea-sickness). Using fish as vertebrate model system, we have shown earlier that the percentual ratios of normal versus kinetotic swimming highly differed depending on the degree of diminished gravity (10^{-6}g, drop-tower; High Quality Microgravity, HQM vs. 0.03-0.05g, parabolic aircraft flights; Low Quality Microgravity, LQM). The present study was designed to clarify (1) if the time-course of a habituation to diminished gravity depends on the respective G-level and if (2) an individually different regulation of inner ear otolith calcification may play a role in this process.
Therefore, late larval cichlid fish (*Oreochromis mossambicus*) were kept at 10^{-4} g (HQM, platform) and at $4x10^{-2}$ g (LQM, slow-rotating centrifuge) aboard TEXUS 45.
Habituation occurred faster in animals at LQM as compared to HQM. Otoliths of kinetotic animals were generally larger than those of normally swimming/habituating samples. Moreover the relative asymmetry (right – left differences) in normal swimming fish did not exceed 2.7% at HQM and 4.8% at LQM, whereas asymmetry ranged around 10% in kinetotically swimming animals. This finding indicates that an individually different predisposition of otolith mineralization is of considerable importance regarding an individual susceptibility to kinetosis.
Acknowledgement: This work was financially supported by the German Aerospace Center (DLR) (FKZ: 50 WB 0527).

HIND LEG MOVEMENTS OF CRICKETS (*ACHETA DOMESTICUS*) DURING PARABOLIC FLIGHT CONDITIONS

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Sensorimotor control systems for target directed movements and walking have to take into consideration the weight of arms and legs to obtain a required accuracy. On ground, the gravity effect is completely compensated by feedback systems including sense organs, neuronal networks and muscles. In Space, absence of the gravity (weight) component modifies, therefore, the effectiviness of these sensorimotor control systems. Weight-loading is also an important principle in mechanisms of gravity perception in both insects and vertebrates including man. Thus, sensory information originating in particular from proprioceptors of the legs that monitor gravity induced dislocations of the body can serve as additional measure for the gravitational input besides that originating from "classical" gravity sense organs. We tested the hypotheses whether absence of g-effects on the trajectory of leg movements are caused by changes of muscular activity, or whether absence of g-effects on muscular activity modifies the leg trajectory during a step.

We used step movements of the cricket's (*Acheta domesticus*) hind leg during periods of altered gravity as experimental model. Special attention was given to the impact of microgravity and hypergravity on the stance that produces the animal's propulsion during walking, and on the subsequent swing by which the leg is quickly brought back to its initial position at the beginning of a step. We furthermore tested the impact of body weight on stance and swing periods by allowing body displacements along the cricket's vertical axis or by blocking this degree of freedom of movement. Movements of one hind leg were video taped. In addition, the activity of femur muscles responsible for movements of the tibia during a step was recorded by means of an electromyogram (EMG). Steps were induced by air puffs directed towards the end of the cricket's body. The experiments were performed during the 47th ESA Parabolic Flight Campaign in December 2007.

Main results: (1) With the sequence of parabolas the duration of the stance increased but not that of the swing phase; this held exclusively in µg and if the body weight affected the proprioceptors of the leg. (2) For large angles of the femur-tibia joint, i.e., when the tibia is stretched and the stance performance comes to the end, and only in microgravity the amount of muscular activity was reduced compared to small femur-tibia angles, i.e., when the stance just began. Relations between spontaneous walking activity during periods of microgravity, hypergravity and 1g-gravity could not be investigated due to the necessary air puff stimulation of the animals. - The results give evidence (1) that adaptation of biological systems during the course of alteration between the different periods of g-levels of parabolic flights can take place as shown by the increase of stance duration with the number of flown parabolas, and (2) that target directed movements of crickets adapt to microgravity by modifying the motor output of the underlying sensorimotor network.

Supported by DLR, grant 50WB0640 to Horn

ANTIOXIDANT ACTIVITY IS INCREASED IN *XENOPUS* EMBRYOS DEVELOPED IN SIMULATED MICROGRAVITY

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One of the major risk for humans during long term space flights is radiation exposure. Some studies have discussed the possibility that the microgravity condition, which elicits well-recognized changes in a number of important biological processes, might also modify sensing of radiation damage and its subsequent processing. Potential mutagenic effects from space radiation exposure result from direct DNA damage or indirectly from the production of reactive oxygen species (ROS).
For these reasons we investigated the effect of simulated microgravity on endogenous antioxidant enzymes.
Xenopus laevis embryos of different ages were exposed to simulated microgravity using a Random Positioning Machine (RPM).
As during space flight embryos exposed to microgravity have axial malformations. For what biochemical assays concern it can be definitively conclude that: μg (RPM) did not cause an increase of mortality compared with controls.Our data demonstrated that embryos developed for 6 day on a random positioning machine, to simulate microgravity, have an increased content of glutathione and a higher activity of antioxidant enzymes. These results indicate the presence of a protective mechanism in living organisms, that increases the total antioxidant system activity, which might play an important role for animals to adapt the environmental stress of microgravity and may help to counteract the presence of ROS induced by space radiation. To better investigate the proteins involved in this process, a proteomic approach was applied. Two-dimensional protein maps were obtained for head and tails of Xenopus embryos exposed to microgravity (RPM). Two-dimensional map of Xenopus embryos grown in normal condition was kept as a control (CTR). The 2D-map of RPM proteome shows 651 spots while the 2D map of CTR proteome shows 619 spots.
Spots present exclusively in CTR (30 spots) and in RPM (15 spots) were highlighted.
The results show that 105 proteins are increased, while 82 are decreased in RPM on a total of 651 spots as compared to CTR.
This Work is supported by A.S.I., MoMa –ASSC Grant to A. M. Rizzo

MATERNAL AND NEUROBEHAVIOURAL REPERTOIRE IN DAMS AND DEVELOPING CD-1 MICE EXPOSED TO HYPERGRAVITY

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Exposure to altered gravitational environment, especially during critical ontogenetic phases, may affect neurobehavioural development in mammals. Data from life science missions clearly indicate that rodents are able to provide parental care to their offspring while in the space, and that dam and neonates can interact successfully under conditions of microgravity. However, improvements are needed in the nest-area in order to facilitate mother-offspring interactions and guarantee a proper pups development. In the present work CD-1 dams with their litters were exposed to 1 hr rotational induced hypergravity (1 or 2 g) and maternal behaviour before, during and after the rotation was observed. Moreover, somatic and behavioural profile of developing pups was assessed recording the ultrasonic vocalization pattern, exploratory performance in an open-field test and social interactions. Finally, long-term effects of early hypergravity exposure on learning capabilities were assessed in aged mice. Several items of the maternal repertoire were selectively affected by hypergravity exposure, and the somatic growth of rotated pups as well as ultrasonic vocalization profile appeared clearly compromised by exposure to rotational stimuli. Changes in exploratory and social behaviour were also observed confirming subtle but consistent effects of early exposure to changes in gravitational environment on mouse neurobehavioural profile as a whole. Data will be discussed in term of habitat development, appropriate experimental paradigms and systematic ground-based testing prerequisites to future research with young postnatal rodents in space.

SCIENTIFIC SESSIONS:

Friday, September 4th
Room B, 11:00 – 13:00

Physical Sciences
(Material Sciences)

SOLID SEGREGATION INDUCED BY STOCHASTIC ACCELERATION FIELDS

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In μg crystal growth, the analysis of the possible correlations existing between the dopant segregation in the solid phase and the external acceleration is a capital issue. Restricting the gravity action to the vertical direction and assuming that for typical growth samples the microgravity vector could be considered spatially uniform, a narrow-band noise has been introduced as a first approximation to describe the large amplitude and high-frequency components of the residual acceleration found in typical microgravity environments [1]. Under this approximation the nondimensional stochastic buoyancy term could be written as $B(t) = \frac{Ra}{Pr} \cdot \left\{ S_1(t) \cdot \cos 2\pi f \cdot t + S_2(t) \cdot \sin 2\pi f \cdot t \right\} \cdot \theta$ being $S_i(t)$ two uncorrelated Ornstein-Uhlenbeck processes of zero average, Pr the Prandtl number, $Ra = \frac{\beta^T \cdot \Delta T \cdot H^2 \cdot \sqrt{2 < \mu g^{*2} > \cdot \tau^*}}{\nu \cdot \sqrt{\alpha}}$ the stochastic Rayleigh number, f the characteristic frequency at which the noise is peaked, τ^* its correlation time and $< \mu g^{*2} >$ the variance of the power spectrum of the noise [2]. To avoid transient effects, the stochastic disturbances have been applied when the crystal length are roughly a half of the total length. Using typical realistic values and tacking into account the values of the different physical parameters for three technologically interesting materials, Ge : Ga, GaAs : Te and Sn : Bi [3], the discussions of the present work have been based on averages over an ensemble of twenty five statistically independent realizations.

[1] J. Ross Thomson, J. Casademunt, F. Drolet, J. Viñals, "*Coarsening of solid-liquid mixtures in a random acceleration field*", The Physics of Fluids, Vol. 9, pp. 1336 - 1343, 1997.
[2] J. Ross Thomson, J. Casademunt, J. Viñals, "*Cavity flow induced by a fluctuating acceleration field*", The Physics of Fluids, Vol. 7, pp. 292 - 301, 1995.
[3] X. Ruiz, "*Modelling of the influence of residual gravity on the segregation in directional solidification under microgravity*", Journal of Crystal Growth, Vol. 303, pp. 262 - 268, 2007.

AGGLOMERATION AND SINTERING OF NICKEL NANOPARTICLES PREPARED FROM THE GAS PHASE

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Agglomeration of air-borne metal nanoparticles occurs under the combined action of diffusional effects and various interparticle forces. In this study pulsed laser irradiation (Nd:YAG, 532nm, 10Hz/4ns) is used to modify the agglomerates' morphology in-situ via heating/sintering effects. For this purpose nickel aerosols were prepared by evaporation / condensation in a laminar inert gas flow (50….300 mb). It is shown that with pulsed laser irradiation modification of nickel aggregates can be obtained partially resulting in stronger conncetions between the individual particles. Optical diagnostics has been realized to observe the thermal radiation of the laser-heated particles spectrally and temporally resolved. For achieving extended and well-defined agglomeration times, buoyancy effects must be suppressed that exist due to the presence of strong thermal gradients. With parabolic flight experiments agglomeration times of buoyancy-free aerosols up to 10s could be realised. Particularly interesting is the formation of necklace-like chains, if the mean particle size exceeds a certain limit. 2D numerical modelling of the magnetic agglomeration shows that the ratio of thermal and magnetic energy of the magnetic dipoles is an important parameter determining the transition between fractal- and chain-like morphology.

FREE SURFACES AND INTERDIFFUSION COEFFICIENT MEASUREMENTS UNDER REDUCED GRAVITY CONDITIONS BY MEANS THE SHEAR CELL TECHNIQUE

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The shear cell technique is an excellent way to measure interdiffusion coefficients under reduced gravity conditions. But it is important to be cautious with the apparition of free surfaces in order to avoid masking effects generated by uncontrolled solutal Marangoni flows [1, 2]. In order to quantitatively characterize the impact of these flows on the determination of the diffusion coefficients, the present numerical work uses a recently reported nondimensional time dependent indicator %D(t) [3]. Capillary disturbances have been incorporated in only one side of the domain, the upper one, and in a symmetric way at both sides of the contact line of the diffusion couple in the centre of the cell. Different free surface extents have been considered, but always being a small percentage of the total cell length. No oxidation effects have been introduced, so solutal Marangoni flows remains active all along the calculations. Gravity orientation has been defined always orthogonal to the concentration gradient. Intensive computation has been the only way to properly solve both the transient character of the interdiffusion measurements and the strong initial numerical gradients in the flow. In all cases, the above-mentioned time dependent indicator %D(t) depends not only on the solutal Marangoni number but also on the free surface considered.

[1] H. Müller, G. Müller-Vogt, "*Investigation of Additional Convective Transport in Liquid Metals and Semiconductors During Diffusion Measurements by means of the Shear Cell Technique*", Crystal Research and Technology, Vol. 38, pp. 707 – 715, 2003.
[2] R. Roşu, W. Wendl, G. Müller-Vogt, S. Suzuki, K.H. Kraatz, G. Frohberg, "*Diffusion Measurements Using the Shear Cell Technique. Investigation of the Role of Marangoni Convection by Pre-flight Experiments on the Ground and during the FOTON M2 Mission*", ELGRA News, Vol. 24, p. 163, 2005.
[3] X. Ruiz, J. Pallarés, F.X. Grau, "*On the accuracy of the interdiffusion measurements at low and moderate solutal Rayleigh numbers. Some theoretical considerations*", Journal of Crystal Growth, 2009 (Submitted).

X-RAY DIAGNOSTICS FOR USE IN MICROGRAVITY EXPERIMENTS

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The development of compact micro-focus x-ray tubes and high-resolution digital x-ray sensors has made the utilization of real-time x-ray diagnostics on board microgravity rockets possible. These systems can offer image resolutions down to 5 µm. The selection of anode materials for the x-ray tubes offers different radiation spectra that facilitate diagnostics of different materials and composites. High resolution x-ray images can be obtained at speeds up to 3 Hz for extended time periods.

Swedish Space Corporation develops a series of systems for in-situ X-ray radiography diagnostics for metallurgy experiments in order to study solidification phenomena and metal foaming in microgravity. These systems are adapted for sounding rocket flight experiments, experiments have also been performed in parabolic flight with good results.

The radiation protection system used for the microgravity rocket MASER 11 and in parabolic flight has been verified to fulfil the EU requirements for personnel safety.

The present status of X-ray diagnostic systems:
- XRMON Metal foam experiment on MASER11 and parabolic flight ESA 46 PFC, 2007-2008:

  The experiment used an X-ray system consisting of a tungsten microfocus X-ray source and a high-resolution digital flat-panel x-ray sensor. Images of aluminium metal foam generation and stabilization were recorded at 1 Hz with 20 µm resolution during the microgravity phase and stored on board.

- XRMON Diffusion experiment is being developed for use on MAXUS 8 in 2009:

  For this experiment the same type of hardware is used as in the metal foam experiment, with different radiation energy and beam geometry. Three diffusion couples will be studied simultaneously.

- A Gradient Solidification Experiment is being developed within the ESA GSTP-study

  “X-ray Diagnostics for Space”, planned first use on MASER 12, 2010:

  This system utilizes a molybdenum microfocus X-ray source. A new digital X-ray camera with increased resolution will be used, featuring a newly developed structured scintillator based on a patented design. The system aims to perform realtime visualization with 5 μm resolution of metal structures in an Al-Cu alloy, and has already shown that this is possible.

The experiment modules with X-ray radiography are developed under contract from European Space Agency, ESA. The presentation will focus on the technical part of the experiments and the development of the improved system.

SIMULATIONS OF VIBRATED GRANULAR MEDIA AND COMPARISONS TO 0G-EXPERIMENTS

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3-d dynamics of spheres have been simulated in a vibrated container for different shapes of boundary motions, and of different ratios of ball numbers, ranging from 0.2 layer to 10 layers about and as a function of restitution coefficient. Results are summarized in term of space distribution function of the different physical quantities of the ball packing such as the position, the mean speed, total momenta, local temperature and pressure. Results are displayed in term of the normal excitation speed V_m of the boundary. Obviously, the results depend not only on the shape of wall motion but also on its local symmetry. We exemplify this trend using symmetric and non symmetric wall motion, with either saw tooth motion or with a periodic series of two opposite arches of parabola (simulating an approximate sinus motion). We give in Figs.1 and 2 typical results.
Results are compared with 3d experiments in 0g.
These results contradict most previous simulations, those which did not observe/notice any difference/anomaly as a function of the vibration shape.
These simulations violate also classic macroscopic continuum laws made continuous theory of dissipative gas.

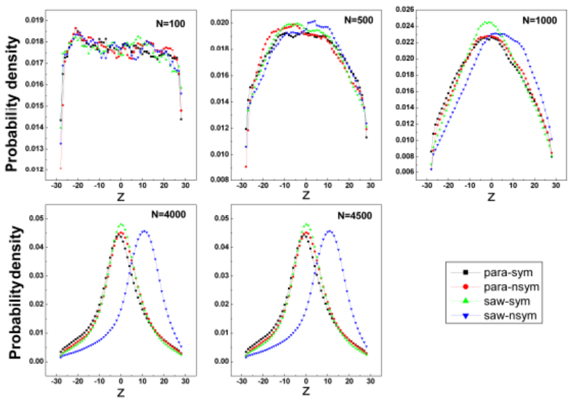

Fig. 1: 1-ball Density distribution in the direction of vibration. Direction of vibration is 0z.

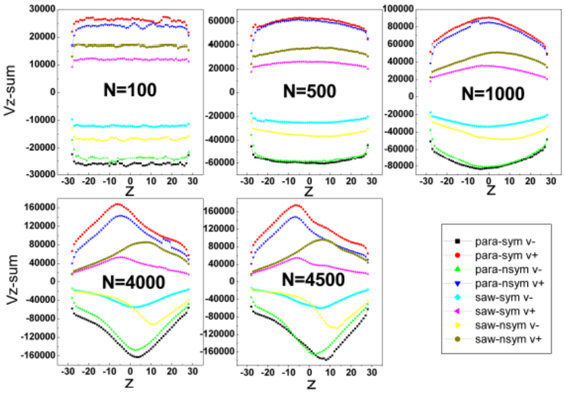

Fig. 2: Distribution of the local total momentum $p_z = m \sum v_z$ in the z direction, as a function of z position. Mass m is taken as unity.

FLAMMABILITY OF METALLIC MATERIALS IN NORMAL GRAVITY AND REDUCED GRAVITY

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Gravity is thought to influence metal flammability, with faster regression rates observed under reduced gravity (as compared to normal gravity). The flammability of metals is typically assessed using a promoted-ignition test, in which a test sample is forcefully ignited at one end, and burning (if flammable) is evidenced by propagation along the test sample. All relevant international standards define a burn criterion whereby flammability is indicated by burning further than an pre-specified length. The short test times that are generally available for reduced gravity experimentation, (resulting in shorter burn lengths) has meant that researchers have been limited in their ability to designate metals as flammable or non-flammable in reduced gravity. Presented in this paper is normal gravity and reduced gravity data on the burning of metals in accordance with international standards. The burning under these two gravity conditions is contrasted and discussed in terms of their flammability as defined in these standards.

POSTER SESSION 1

THE CLOSED-LOOP AIR REVITALISATION SYSTEM ARES FOR ACCOMMODATION ON THE INTERNATIONAL SPACE STATION ISS

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The Closed-Loop Air REvitalisation System ARES is a regenerative life support system for closed habitats. With regenerative processes the ARES covers the life support functions:
Removal of carbon dioxide from the spacecraft atmosphere via a regenerative adsorption/desorption process,
Supply of breathable oxygen via electrolysis of water,
Catalytic conversion of carbon dioxide with hydrogen to water and methane.

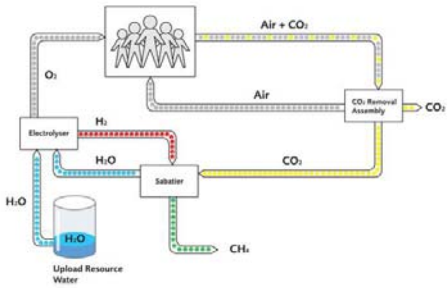

Figure-1: Closed Loop System with ARES

Figure-2: ARES Rack (Architecture View)

ARES will be accommodated in a double ISPR Rack which will contain all main and support functions like power and data handling and process water management. It is foreseen to be installed onboard the International Space Station (ISS) in the Columbus Module in 2013. After an initial technology demonstration phase ARES shall continue to operate in support to the ISS Life Support System. Due to its regenerative processes ARES will allow a significant reduction of water upload to the ISS.
The paper will describe the system architecture of ARES and its underlying technologies as well as the integration into the ISS systems.

MODELING OF THE DISTURBANCES OF THE BIOLOGICAL RHYTHMS, NEUROPHYSIOLOGICAL MECANISMS OF THE STRESS & DEVELOPMENT OF TECHNICS OF ADAPTATION BY BIOFEEDBACK

C.Gaudeau de Gerlicz [(1)], Golding J.F [(2)], Ph. Bobola [(3)], A. Antoine [(1)], P. Brémaud [(1)]

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An important problem of long duration spaceflight is the confinement and the isolation of the crew and perturbation in circadian and supra-circadian rhythms inducing stress.The astronaut exposures in extrem environment require an analysis of psychological and physiological responses, as developped previously in an ESA Topical TEAM GAUDEAU & al (1) to modelize the Space Motion Sickness (SMS) in order to develop adapted responce methods.The adaptation process implies a stress reaction as H. SELYE (2) describe it.
This stress can be leading, in a sucessfull way, to a strategic modification by the basal homeostasis, or, unsuccessfull, to induce a condition of distress.The subjects are submitted to different biological rhythms wich are studied by COSINOR 2 method and present global response needing to be analysed. But different subjects may manage the same (biological or psychological) stress in a different way depending on their previous experience and their eventual capability to cope to conditions of stress. Previous works (GAUDEAU & al) have modelized the stress by interconnecting a system of fonctional neurophysiological blocks by using information adhering directly to the scientific litterature and experimental data. A modelling system expert has been developped : Expert System GENESYX
The proposed stress indicators will be :

electrodermal activity, tonic and phasic skin conductance levels. J. GOLDING (3) indicates sympatic autonomic responces to mental and emotional arousal such as excitement, anxiety, sensory stimuli.
A variety of stress-related hormones as the salivary cortisol.
Clinical and psychological states questionary

Previous works (Cowings & al) (4) developped biofeedback and autogenic control that is successful in 85 % of training subjects. During parabolic flight estimated salivary cortisol has been tested for biofeedback control of stress from external measures Method of detecting change in electrophysiological signal has been studied in order to reduce the suceptibility of individual and interpersonal reactions on confinement and isolation through Electrophysilogical Biofeedback training permitting estimation of cortisol.

We modelise neurophysiological mecanisms of stress and interactions between various physiological and psychological indicators of a group of subjects.
The efficacity of electrophysiological biofeedback training was highlighted by Andrea Kübler and Coll (5) for subjects with amyohophic lateral sclerosis in order to enable to communicate without motor activity.

REFERENCES
Gaudeau. C., Golding. J.F., Lucas. Y., "Space Motion Sickness & Stress training simulator using Electrophysiological Biofeedback"
Selye. H., "The General adaptation Syndrome & the disease of the adaptation." J.Clin. Endocrinol. Metab. 6:117; 1946
Golding. J.F., "Phasic Skin Conductance Activity & Motion Sickness". Aviat. Space Environ. Med. 63 (3), 165-171 ; 1992
Cowings. P.S., Naifeh. K.H., Toscano. W.B. « The Stability of individual patterns of Automatic Responses to motion sickness Simulation" Aviat. Space Environ. Med. 61 (5), 399-405 ; 1990
Kübler. A., Kotchoubey. B., Hinterberger. T., Ghanayim. N., Perelmouter. J., Schauer. M., Fritsch. C., Taub. E., Birbaumer. N., „The Thought translation device: a Neurophysiological approch to communication in total motor Paralysis" . Exp. Brain Res. (124), 223-232 Springer – Verlag 1999

DEFINITION OF THE ESA FOOD COMPLEMENT UNIT RACK-LIKE FACILITY: REASONS, BENEFITS AND CRITICAL ASPECTS

Matteo Lamantea, Giorgio Boscheri
Thales Alenia Space – Italia, Torino

The development of bio-regenerative systems is at the forefront of the space research, aiming at making sustainable the human exploration missions: they allow to reduce logistics, providing fresh resources for crew metabolic and hygienic consumptions and, simultaneously, to minimize unrecoverable wastes and cost for their final disposal. In this context, the exploitation of the plants plays a leading role with the possibility to recover the CO_2 and the wastes produced by the crew activity, synthesizing fresh food and oxygen while filtering water. This paper briefly reports on an ESA study for a Food Complement Unit (FCU) and an analysis of the breakeven points, with emphasis on the possible technological enhancements to increase competitiveness of such a kind of systems. The main FCU characteristics are: 1) Capability to produce some percent of the overall nutritional needs of the ISS crew as fresh food; 2) Possibility to perform batch as well as continuous production; 3) Possibility to evaluate intra-canopy and inter-canopy compatibility, interaction and competition, and to study the root zone; 4) Compatibility with the ISS resources and with safety aspects; 5) Minimization of the logistic support; 6) Modularity with easy system re-configuration with the kind of crops to grow. The FCU facility is expected to play a leading role: 1) in gaining on orbit experience in plant growth for fresh food consumption in microgravity and 2) in providing a facility to validate technologies for plant growth and study growth processes. The activities are carried on in the perspective to realize affordable, safe and reliable systems to support human space missions and to spin off on terrestrial applications.

SALIVARY NGF, CORTISOL AND ACTH LEVELS DURING PARABOLIC FLIGHT

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Nerve growth factor (NGF) and brain-derived neurotrophic factor (BDNF) are involved in the development and maintenance of peripheral and central populations of neuronal cells. In the central nervous system, NGF acts as trophic factor for those neurons which are known to degenerate in disorders, such as Alzheimer's disease, which is becoming progressively more frequent due to the longer lifespan of the western population. NGF target cells have been identified in the nervous, immune, and endocrine systems, and an increasing body of evidence suggest that NGF, in addition to its role as a neurotrophic agent, may operate through multiple paths to ultimately regulate physiological homeostasis and behavioural coping. In order to evaluate NGF levels and others neurochemical parameters known to be involved in the responses to stress, we collected saliva samples before, during and after parabolic flight with Lunar-, Mars-, and Zero-gravity conditions. In agreement with previous studies on parachutists and on astronaut experiencing stress related to skydiving and space mission, experimental subjects showed an increase in salivary levels of NGF only during specific phases of the flight. Moreover, individual as well as age-related differences have been observed. Overall data will be discussed in terms of the role of NGF in copying/adaptative response to stress experienced during parabolic flights.

EFECT OF WEIGHTLESSNESS IN MOVEMENT PERCEPTION: ASYMMETRICAL EVALUATION OF VISUAL STIMULI CORRESPONDING TO UPWARD VERSUS DOWNWARD PITCH.

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Human's adaptation to terrestrial conditions over their lifetime produces a known asymmetrical effect on the estimation of pitch movements that is polarized with respect to gravity, i.e. downward pitch stimuli produce stronger sensations than do upward ones. This vertical plane (pitch) asymmetry is greater than any left-right (yaw) asymmetry in the horizontal plane on Earth. The effect stems probably from the use of an external orientation reference frame derived from the prevailing axis defined by gravity.

When the gravitational terrestrial environment is changed for a weightless environment such as the one occurring onboard the International Space Station (ISS), the orientation reference frame can be disturbed. In this study, we focused on changes that could occur on vertical asymetry estimation when submitted to microgravity. For this, subjects observed visual stimuli corresponding to what they would see when passing through a curved tunnel and were asked to reconstruct the direction and angle of the curve. They were isolated from external visual cues on Earth and in orbit by looking at the computer screen through a formfitting face. They were further isolated from gravitational cues by performing the experiment on the ISS and from tactile and proprioceptive cues about their orientation within the ISS by performing the experiment in a free-floating posture. Subjects performed the experiment multiple times during each of the pre-flight, in-flight and post-flight phases of the mission.

Preliminary results showed modifications in the up/down asymmetry for pitch perception for early in-flight measurements and a contrast between free-floating and attached postures aboard the ISS. These initial results, if confirmed, indicate that the reference frames used by humans to perceive self-motion are perturbed during initial exposure to space flight, with an adaptation over the course of several days to alternate reference frames or the adjustment of weighting given to different sensory signals within a multimodal reference frame.

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RESPIRATORY MODULATION AND BAROREFLEX SENSITIVITY OF HEART RATE IN SPACE

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During everyday life, baroreflex-mediated cardiovascular adjustments are essential in maintaining blood pressure control on a beat-to-beat basis. In astronauts in space, gravitational pressure gradients do not arise in the circulation so that baroreflex function remains chronically unchallenged. The aim of this study was to assess how the lack of gravity in Space may affect neural cardiovascular control

We studied nine male cosmonauts who each took part in seven different space missions aboard the ISS (age 40 – 52 yrs, height 1.69 – 1.85 m, weight 67 – 90 kg). Data collection was performed between 30 and 45 days before launch in the standing and supine positions, and after 8 days into spaceflight. Cosmonauts were carefully trained to perform in-flight data collection by themselves. They were instructed to pace their breathing to a fixed rate of 12 breaths per minute (0.2 Hz) for a total duration of 3 minutes. The electrocardiogram and beat-by-beat finger arterial blood pressure were recorded at 1-kHz sample rate. Respiratory rate was evaluated using an abdominal pressure sensor. We used power spectral analysis to calculate respiratory sinus arrhythmia (RSA) as well as the low-frequency (0.04 - 0.15 Hz) powers of spontaneous oscillations in heart rate and systolic blood pressure. Baroreflex sensitivity (BRS) was estimated in the time domain using cross-correlation analysis.

Heart rate and mean blood pressure in space adapted to the pre-flight supine reference values. This was also true for the low-frequency powers of systolic blood pressure variability and of heart rate variability, as well as for RSA and spontaneous BRS. In-flight cardiovascular data differed significantly from the pre-flight standing position, excepted for the optimal time delay of cardiac BRS.

Our data show that both heart rate and blood pressure in space correspond to pre-flight supine values. In-flight cardiovascular control is further characterized by chronically increased vagal-cardiac modulation and suppressed sympathetic vasomotor activity, compared with the upright posture on Earth. Whether prolonged baroreflex latencies in space may lead to blood pressure instability predisposing to orthostatic syncope in astronauts upon return to Earth remains to be investigated.

CLINOROTATION-RELATED CHANGES OF PEA ROOT MITOCHONDRIA

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The aim of this study was to determine whether simulated microgravity affects the mitochondrion structure in *Pisum sativum* root growth zones. Seeds germinated in tubes from filter paper placed on slow horizontal clinostat (2 rpm) and seedlings grew for 5 days in the darkness. The structure of mitochondria in meristematic, distal and central elongation zones of the embryonal roots was evaluated with a transmission electron microscope Jeol 1200EX. The obtained results showed the absence of clinorotation effect on the volume, shape and internal structure of mitochondria in meristematic cells. But at the same time, some changes in mitochondria were observed in the elongation zone, especially in its distal zone under clinorotation, namely: volume of mitochondria reduced, increase in matrix electron density and crista volume was observed. We showed that mitochondria of meristematic and distal elongation zones cells have different sensitivity to simulated microgravity. A role of mitochondria in adaptation of seedlings under simulated microgravity conditions is discussed.

MODELING THE KINETICS OF ROOT GRAVIREACTION

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The mathematical model of the following mechanism of gravireaction of the roots of higher plants is proposed. The graviperception is supposedly related to statoliths sedimentation in statocytes in the root cap region. This produces the signals in response to the change of the root axis orientation relative to the gravity vector G. These signals initiate the changes of the relative growth rates of the upper and lower flanks of the root in two regions called Distal Elongation Zone (DEZ) and Central Elongation Zone (CEZ), It results in the bending of the root in the line of G and thus in the change of the signal in the cap region. The CEZ and DEZ are located at the significant distances from the cap (thousands microns for some plants). It causes the time delays between the relocation of statoliths in statocytes and the change of the growth rates in elongation zones. In the present model the kinetics of a root apex bending (angle A) in response to the time (t)-dependent change of the G orientation is described by the integro-differential equation in A(t). Good correlation between the results of the modeling and known experimental data (Barlow et al, 1993, Stochkus, 1994, Mullen, 1998) was found. This allowed us to estimate and analyze the parameters of the model and investigate how these parameters could be modified to simulate the behavior of a root in the conditions of altered gravity.

MOLECULAR CHAPERONE HSP90 IN THE DEVELOPMENT OF *ARABIDOPSIS THALIANA* SEEDLINGS UNDER CLINOROTATION

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Stability of growth, development and tolerance of plants in space environment is basis for working up of technologies for life-support systems. Plant development is highly plastic: morphologies vary dramatically with even moderate changes in environment. Heat shock protein 90 (Hsp90) has been supposed to have a role in linking environmental changes to the developmental dynamics that govern plant morphogenesis. The requirement of many principal regulatory proteins (for example, kinases and transcription factors) for this molecular chaperone renders entire signal transduction pathways sensitive to decreases in its function. Hsp90 is essential and abundant in cells at normal conditions and induced by stress.

In the preliminary study, a time-dependent increase in the Hsp90 level in pea seedlings under 2D-clinorotation was demonstrated [1]. In this report we describe the effects of clinorotation on the gene expression of Hsp90, its localization in *Arabidopsis thaliana* seedlings and the Hsp90-dependent phenotypic plasticity. Plates with seeds (Col-0) were cold treated for 48 h and then placed on the 2D-clinostat at 22ºC and 16h light cycle, seedlings analyzed after 8 days of clinorotation. Seedlings grown in the stationary conditions served as a control. The gene expression of Hsp90s was carried out by RT-PCR, proteomic analysis – by Western blot after 2D-electrophoresis. GUS-reporter gene was used to assess localization of the Hsp81-2 expression in the seedlings. Hsp90-dependent phenotypic plasticity under clinorotation was investigated using pharmacological inhibition of Hsp90 function with geldanamycin. Changes in Hsp90 gene expression and localization in the seedlings under clinorotation and significant dependence of seedling morphology from Hsp90 function were shown. The results suggest that clinorotation could affect in a combinatorial fashion with Hsp90.

1. Kozeko L.Ye., Kordyum E.L., “Heat shock proteins Hsp70 and Hsp90 in pea seedlings under clinorotation of different duration”, J. Gravitational Physiol., Vol.14, N 1, pp. 115-116, 2007.

EXPRESSION OF CYCLIN B1 GENE, A CELL CYCLE REGULATOR, IS ENHANCED IN YOUNG *Arabidopsis* SEEDLINGS GROWN IN ALTERED GRAVITY, UNDER MAGNETIC LEVITATION

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In eukaryotic cells the cell cycle is regulated at multiple checkpoints, in which cyclins and cyclin-dependent kinases (CDKs) are involved. Cyclin B1 is a regulator of the cell cycle acting in G2-M transition, which is closely associated with high cell proliferation rates [1]. Cell proliferation is a cellular activity which is essential for the developmental program of the plant. In previous studies in real and simulated microgravity it was shown that the gravity alteration induces a change in the rates of cell proliferation [2]. In order to determine with higher precision the magnitude of this alteration an experiment of quantitative PCR for the assessment of the expression of the cyclin B1 gene was carried out on *Arabidopsis thaliana* seedlings cultured for 4 days after seed sowing in a super-conducting magnet capable of providing three levels of effective gravity, namely 0 g*, 1 g* and 2 g*. Total RNA extracted from entire seedlings was used for the experiment. The results showed an increase in the expression of this gene in the samples grown in the magnet with respect to the control; the increase is higher in 1 g* and 2 g* samples than in 0 g* sample. An analysis *in situ* of the expression of the gene using a transformed line containing the reporter gene GUS under the control of the cyclin B1 promoter showed that the seedling organs mostly contributing to the signal are the two cotyledons, in which an activity of cell proliferation peaking at the 4th day of germination has been described [3]. The quantification of the GUS signal in cotyledons, in an experiment replicating the culture conditions of the qPCR experiment showed levels of cyclin B1 in cotyledons similar to those recorded by qPCR for the entire seedlings, except in the conditions of 1 g* within the magnet. Interestingly, the effect of gravity alteration on cell proliferation recorded in cotyledons is the opposite of the effect described in the root meristem [2]. This may be caused by the gravitropic condition of the root, which is apparently not present in cotyledons. In these organs, proliferation is induced by cytokinins [3], whereas in roots the induction is effected by auxin, whose distribution is known to be highly sensitive to gravity changes [4].

REFERENCES

1. Dewitte W, Murray JAH, *Annu. Rev. Plant Biol.* 54, 235 (2003).
2. Manzano AI et al., *Microgr. Sci. Technol.* In press. DOI:10.1007/s12217-008-9099-z (2009).
3. Stoynova-Bakalova E et al., *New Phytol.* 162, 471 (2004).
4. Aarrouf J et al., *Physiol. Plantarum* 105, 708 (1999).

COMPARATIVE RESEARCH OF EMBRYO DEVELOPMENT OF *BRASSICA RAPA* L. UNDER CLINOROTATION

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Experiments with plant organisms in microgravity were carried out with the purpose to study the peculiarities of plant ontogenesis under the absence of gravity. This is necessary for carrying out the plant biotechnology in microgravity, including autotrophic link of controlled ecological life-support systems. Model experiments under clinorotation make it possible to study the consequent stages of embryo formation that is not always possible in spacefligth. Experiments with *Brassica rapa* L. under slow horizontal clinorotation showed that differentiation of embryos is similar to laboratory control. However, the certain disturbances are revealed during embryo differentiation in this variant. In particular, the formation of abnormal forms of cotyledons or an absence of bends of radicles and cotyledons, as well as absence of their green colouring that is not peculiar to laboratory control. Delay in the rate of reserve nutrient substance accumulation and their quantity, as well as their utilization, especially of the starch grains, was established at the late stages of embryo development. Changes in protein spectrum, in particular the occurrence of the new forms with molecular weight of 20 kD and 43 kD is marked under clinorotation. The obtained data might testify the decrease of biosynthetic processes and /or certain inhibition of embryo trophic under clinorotation that is similar to processes taking place in real microgravity.

CLINOROTATION EFFECT ON RESPONSE OF CRESS TO RED/FAR-RED LIGHT

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The objective of the present study is to ascertain the significance of gravity to photophysiological responses of garden cress (*Lepidium sativum* L.) induced by red (660nm) and far-red (735nm) light. The experiments were performed using a centrifuge-clinostat complex and a vertical control device, which were equipped with an original light emitting diodes (LEDs) system for the cultivation containers (Fig. 1).

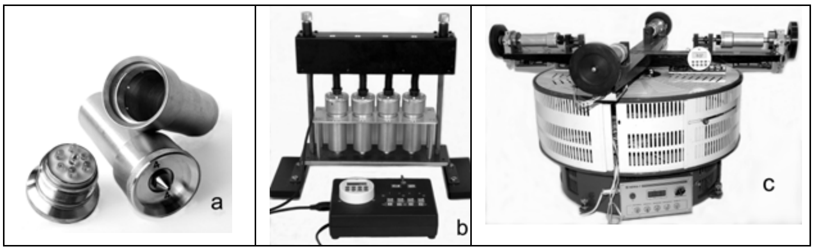

Fig. 1 Containers (a), vertical control device (b) and centrifuge-clinostat complex (c).

After a 5-day growth under 50-rpm horizontal clinorotation or vertically at 1*g* in both 12 h/d light photoperiod and without illumination, parameters of seedlings growth, stomata development, histology, tropic reactions of first leaves were tested. Inhibition of hypocotyl elongation and promotion of leaf expansion caused by the applied lighting were stated for both 1-*g* and clinorotated plants. However, the area and elongation of 1-*g* leaves in red/far-red light appeared to be smaller in comparison with clinorotated leaves by approximately 20% and 10%, respectively. Mobile amiloplasts, which function as statoliths in endodermic cells of hypocotyls, were for the first time identified in leafstalks of garden cress. In the light, the unfolding of leafstalks was more intensive on clinostat than at 1*g*. It shows a negative impact of gravity on photophysiological response related to movement of leafstalks. The obtained data support the opinion about gravity and light stimuli integration in plants (Corell, Kiss, 2002).

References: 1. Corell M. J., Kiss J. Z. Interactions between Gravitropism and Phototropism in Plants, J. Plant Growth Reg., Vol. 21, pp.89-101, 2002.

IMPACT OF CLINOROTATION ON THE ORIENTATION OF MICROTUBULES IN PLANT ROOT CELLS

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Ordered organization of the cortical microtubules is essential for the certain cell shape. In root cells growing almost isotropically (meristem) MTs are highly ordered in transverse arrays. Microtubules commonly reorient to oblique and longitudinal directions in cells in the elongation root zone. Switch from transverse to oblique and longitudinal orientation of MTs start to take place in the distal elongation root zone (DEZ). The mechanisms driving the developmental reorientation of microtubules and its functional significance are unknown. It is hypothesized that these mechanisms involve the partial detachment of the dynamic microtubules from the plasma membrane. Since it is known that phospholipase D (PLD) promotes the attachment of cortical MTs to the plasma membrane (1,2), we propose to apply PLD inhibitor *n*-butanol (2) to *Arabidopsis* seedlings with MT reporter GFP-MAP4 and investigate the arrangement of MTs, actin filaments and cell growth parameters in altered gravity. We suggest that application of *n*-butanol under clinorotation will promote the rearrangement of MTs, impact the organization of microfilaments and therefore, somehow prevent cytoskeleton elements from participating in cell growth and maintenance of proper cell shape. Impact of *n*-butanol on MT and microfilament arrangement and cell growth are currently under investigation.

1. Wang, X., "Regulatory functions of phospholipase D and phosphatidic acid in plant growth, development and stress responses", Plant Physiology, Vol. 139, pp. 566-573, 2005.
2. Dhonukshe, P., et al., "Phospholipase D activation correlates with microtubule reorganization in living plant cells", Plant Cell, Vol. 15, pp.2666-2679, 2003.

COMPARISON STUDY ON GRAVITY-DEPENDENT LONGWISE POSITIONING OF AMYLOPLASTS IN STATOCYTES OF CRESS ROOTS AND HYPOCOTYLS

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Despite a great deal of experimental evidences demonstrating an interplay between amyloplasts and actomyosin system in early gravitropism phases in roots, there are no convincing conclusions on this process in stem-like organs (Kumar et al., 2008). In order to compare gravisensing in negatively and positively gravitropic organs, a relation between the parameters of gravity and amyloplasts (statoliths) positioning along statocytes in roots and hypocotyls of cress (*Lepidium sativum* L.) seedlings after growth at 1*g* and in weightlessness simulated by fast clinorotation (50 rpm) was studied. Gravitropic stimulation for 6 min was applied by an exposition of the former seedlings to weightlessness or 180° inversion, the second ones – to the 1-*g* action in root-tip or root-base direction.

After 2 min of both 1-*g* seedlings treatments, a significant shift of statoliths in proximal direction from the initial position at original cell bottom was determined in root statocytes and hypocotyls endodermic cells. Later on, this proximal plastid displacement slowed down in weightlessness but proceeded under the inversion.

In statocytes of seedlings grown on clinostat, the movement of amyloplasts away from the initial central position proceeds significantly towards the cell bottom or in the proximal direction within the 2-min period of 1-*g* stimulation in root-tip or root-base direction, respectively. Later on, suchlike movement of plastids continued until the end of stimulation in endodermic cells of hypocotyls. In statocytes of roots, the statoliths resumed their motion only after the 4th minute and moved more rapidly to the proximal cell wall as compared to the original cell bottom.

The data allow a supposition that in common with the gravity the elastic forces generating by the cytoskeleton act actively transporting the amyloplasts along the gravity sensing cells not only in positively but in negatively gravitropic organs, too.

References
1. Kumar, N.S., Stevens, M.H., Kiss, Z.J., “Plastid movement in statocytes of the *ARG*1 (*ALTERED RESPONSE TO GRAVITY*) mutant”, Am. J. Botany, Vol. 95(2), pp. 177-184, 2008.

NEUTRON IRRADIATION ALTERS THE EXPRESSION OF AUXIN ACTIVATED GENES, OF GENES INVOLVED IN STRESS CONTROL, AND IN TUBULIN SYNTHESIS, ACCELERATING SENESCENCE IN ARABIDOPSIS

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A study of the effect of neutron irradiation on the acceleration of senescence in Arabidopsis, and on the involvement of the hormone AUXIN in the process was performed. To this scope seedlings were subjected to irradiation at the Frascati (Rome) neutron accelerator for 4 hours, then collected, RNA extracted, and submitted to qPCR to determine the expression of genes involved in auxin action, and in the senescence. The results showed that three genes from the *ARF* family (*ARF1,2,19*) were down-regulated, whereas a gene from the *AUX/IAA*s family (*AUX/IAA7*) was strongly up-regulated. This was considered a sign of inhibition of the auxin action, since it was shown that the AUX/IAAs proteins should be degraded before the ARFs can activate physiological processes. It was found also that genes directly related to aging (*SAG12* and *SAG13*) were up-regulated, as well as genes involved in the defense from oxidative stress (*FeSOD, CAT1, CAT2*). Furthermore, up-regulation was seen also in genes encoding the synthesis of tubulin (*TUA4*, *TUA6* and *TUB2)*, i.e. the structure of the cells. The action of neutron irradiation thus resulted negative on the Arabidopsis wild-type plants. By contrast, in some auxin mutants, i.e. *EIR1*, *AUX1 and ARF2,* the effects on the above genes were milder or absent, and senescence was not always accelerated. Consequently, the utilization of some mutants as plants to grow in space looks as a concrete possibility.

THE FASTRACK SUBORBITAL PLATFORM FOR MICROGRAVITY APPLICATIONS

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The FASTRACK suborbital experiment platform has been developed to provide a capability for utilizing 2.5-5 minute microgravity flight opportunities anticipated from the commercial suborbital fleet (currently in development) for science investigations, technology development and hardware testing. It also provides “express rack” functionality to deliver payloads to ISS. FASTRACK fits within a 24” x 24” x 36” (61 cm x 61 cm x 91.4 cm) envelope and is capable of supporting either two single Middeck Locker Equivalents (MLE) or one double MLE configuration. Its overall mass is 300 lbs (136 kg), of which 160 lbs (72 kg) is reserved for experiments. FASTRACK operates using 28 VDC power or batteries. A support drawer located at the bottom of the structure contains all ancillary electrical equipment (including batteries, a conditioned power system and a data collection system) as well as a front panel that contains all switches (including remote cut-off), breakers and warning LEDs.

STUDY OF *CHLAMYDOMONAS REINHARDTII* MUTANTS AS LIFE SUPPORTING SYSTEMS IN SPACE

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The ionizing radiation is dangerous factor in space that generates reactive oxygen species damaging the cells. Using a directed evolution approach to produce a huge amount of random mutants and *on ground* neutron and proton irradiations to select survivors, we isolated a set of *C. reinhardtii* D1 protein mutants resistant to ionizing radiations (Fig. 1).

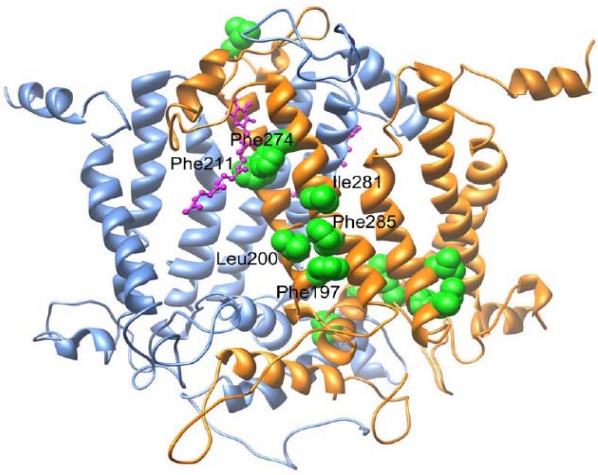

Figure 1. Homology-based modelling of Chlamydomonas D1-D2 heterodimer. The identity and the position of the mutated aminoacid are also indicated (Rea et al., submitted).

Interestingly, in high light (HL) and high temperature (HT) conditions, some of these selected mutants showed a higher maximum quantum yield of PSII photochemistry compared to control reference strain. These data indicated a correlation between radiation tolerance and HL-HT stability. Finally, to study the effect of space environment on photosynthetic apparatus we recorded the changes in PSII efficiency in *C. reinhardtii* during the Foton-M3 mission, 2007 (Damasso et al., 2008). We exploited both D1 and *non photochemical quenching* mutants, being the latter impaired in some carotenoids biosynthesis. In order to find a molecular mechanisms supporting the capability of the mutants to counteract the superimposed stresses, we studied the xanthophyll cycle whose activation is well known to be induced in protection to high light (Holt et al., 2005). In addition to guarantee an efficient thermal energy dissipation, the cycle provides a source of valuable anti-oxidant compounds that in long-term space missions could strongly improve the quality of the astronauts life and help to prevent aging and degenerative diseases. To these purposes, we determined the carotenoids content by HPLC and biosynthetic gene expression profile by q-RT PCR. These procedures allowed the identifications of highly performant strains into environmental extreme conditions.

REFERENCES

1. Damasso, M., Dachev, T., Zanini, A., Falzetta, G., Rea, G., and Giardi, M.T., “The space radiation environment observed by Liulin-Photo and R3D-B3 spectrum-dosimeters inside and outside Foton-M3 spacecraft”, submitted to Radiation Measurements, 2008.
2. Holt, N.E., Zigmantas, D., Valkunas, L., Li, X.P., Niyogi. K.K., and Fleming, G.R.,“Carotenoid cation formation and the regulation of photosynthetic light harvesting”, Science, Vol. 307, pp. 433-6, 2005.
3. Rea, G., Polticelli, F., Antonacci, A., Scognamiglio, V., Katiyar, P., Kulkarni, S.A., Johanningmeier, U., and Giardi M.T.. “Structure-based design of novel *Chlamydomonas reinhardtii* D1-D2 photosynthetic proteins for herbicide monitoring”. Submitted.

DEVELOPMENT OF TECHNOLOGIES FOR ON ORBIT ANALYSIS

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A consortium of Dutch companies has been formed to study the possibilities for On Orbit Analysis in the framework of a national study. This initiative is driven by the scientific relevance of analysing samples or performing experiment analysis *in situ*, for instance in the ISS as well as during long missions to the Moon and Mars. Another driver for the technology developments is the future reduction in download capacity that will influence the ISS experiment design and performance since the Space Shuttle will be taken out of service. This development calls for innovative technology developments taking into account the space flight safety aspects and microgravity environment. We present the study status and results of the project identifying available technologies and specific experiment developments.

In this study Bioclear is responsible for the definition of the experimental needs, LioniX and TNO provide the micro system technology and micro-fluidics that is regarded essential to develop the OOA technological needs. Dutch Space is responsible for the implementation and systems engineering aspects required to allow the experiments system concepts to be integrated in the ISS.
One of the examples of an On Orbit Analysis application is the conceptual Biodetect system. This system is intended to allow Q-PCR analysis of surface and ISS crewmember samples. This conceptual system enables the monitoring of the hygiene of surfaces within the ISS interior allowing direct feedback actions in case of the presence of potential pathogens. Besides the monitoring of the ISS interior hygiene the facility also allows the direct Q-PCR analysis of experiments. For example for the SAMPLE experiment, in which under responsibility of the UMCG kits were used for collecting ISS samples during several missions. These kits had to be downloaded for subsequent analysis. Using the Biodetect system the download of sample material will no longer be needed and the data will be directly available. Specific issues like the containment and the liquid handling that are influenced by the microgravity environment will be explained and breadboard test data will be presented.

OMNIHAB: A MULTICOMPARTMENT CELSS (CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM)

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Aquatic life support systems (e.g., Aquacells and OMEGAHAB, flown on FOTON-M2 and –M3) are highly suitable devices for experiments to be carried out on a variety of organisms (bacteria, plants, animals) in the course of space missions. Here, we provide first results on ecological parameters of OMNIHAB, a newly developed, modular system.
Ground based investigations with the OMNIHAB concerning the life operation time, water chemistry (ammonia, nitrite, nitrate, pH, conductance, O_2) and growth of plants and animals were carried out. The setup of OMNIHAB used comprised three tanks (combined modularly) containing three chambers each. In OMNIHAB, the coexistence of several plants (Ceratophyllum submersum, Vesicularia dubyana, Najas spec.) and animals from different trophic levels (Oreochromis mossambicus, Danio rerio, Biomphalaria galabrata, Neocardina denticulata, Procambarus spec.) was examined.
In general, we were able to keep the system running for up to 3 months. Beginning with the 5th week of operation, however, non-cyclic fluctuations in oxygen concentration (9.0 to 2.6mg/l) were obvious. In the course of the operation time, a three-fold increase of plant mass and a reproduction of the snails and crustaceans were documented.
OMNIHAB thus proved in 4 runs - using different numbers of tanks (2-4) combined in each case with different numbers of organisms - to be a very stable system, at least for the first 5 weeks of operation. It can be anticipated that an improved version can sustain ecological stability for several months, which could be implemented for long-term experiments on the effects of spaceflight on organisms and their ecological interaction.
Acknowledgement: This work was financially supported by the German Aerospace Center (DLR) (FKZ: 50 WB 0527).

THE BONN CRITERIA: MIMINAL EXPERIMENTAL PARAMETER REPORTING FOR CLINOSTAT AND RANDOM POSITIONING DEVICE EXPERIMENTS.

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The nomenclature of clinostats and random positioning devices remains imprecise as different labs follow word-of-mouth determinations or manufacturers designations as to whether a device is a clinostat, rotating wall vessel or bioreactor or which mode random positioning devices utilization represents. Failure to report minimum physical and chemical data on how experiments are performed frequently makes it impossible to determine specific hardware utilized or to calculate forces delivered. This makes experimental comparisons difficult, and isolation of critical methodological differences between experimental results impossible. For random positioning device experiments the minimum experimental parameters to be reported should include: angular velocity of rotation (between 30° and 115°/s); and operating mode (random (0.1-2 rad/sec), centrifuge (0.1-20 rpm) and clinostat (0.1-20 rpm) or freely programmable mode). For both clinostat and random positioning devices experimental reporting should include the properties of the culture vessel, culture media and carrier beads. These should include dimensions and rotation speed of vessel, chemical consistency including density and viscosity of media, and size, density, and porosity of beads, as well as operating temperature, and gas content. A minimum set of parameters to be reported in clinostat or random positioning devices is proposed.

HYPERHAB: A MULTI-PURPOSE CENTRIFUGE SYSTEM FOR EXPERIMENTS ON AQUATIC ORGANISMS

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HYPERHAB was designed to provide a multi-purpose, multi-user platform for experiments focussing on effects of long-term hypergravity on aquatic organisms. Under video observation, a controlled, aquatic life support system can accommodate aquatic plants as well as aquatic animals ranging from 0.2 to 50mm in length, which can be maintained within 4 individual tanks for up to 4 weeks at 1.5-6g. In several runs, fish larvae were raised in these tanks during their critical developmental phase of commencement of the vestibular system, and the ontogenetic development of their swimming behaviour was assessed. The successful completion of this experiment clearly demonstrates the suitability of HYPERHAB for studies on aquatic organisms under conditions of increased gravity.
Acknowledgement: This work was financially supported by the German Aerospace Center (DLR) (FKZ: 50 WB 0527).

BMTC – A CONCEPT FOR STANDARDIZED TISSUE ENGINEERING ON GROUND AND IN SPACE

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ESA is developing the BMTC (Biotechnology Mammalian Tissue Culture Facility) ground demonstrator in order to:

- establish a terrestrial platform for tissue engineering under defined, reproducible conditions
- prepare for tissue engineering experiments under micro-gravity conditions using proven, well characterised, modular equipment.

Meanwhile, the industrial BMTC team has finalised the first model.

The BMTC is highly automated system which provides standardized experiment hardware for tissue cultivation and stimulation under controlled conditions and the reproducible execution of the experiment according pre-programmed protocols.

The BMTC consists of an incubator for the control of the experiment environment. Internally it offers all experiment relevant subsystems:

- two Cultivation Units consisting of:
  - 8 Experiment Chamber Modules
    - Medium storage and circulation
    - Gas exchanger
    - Quasi-continuous medium replacement
    - Cassettes carrying one bioreactor each
  - Medium Circulation Pump for continuous medium flow
  - multiplexed optical in-situ sensors for pO2 and pH
  - compression unit for chondrocyte samples to allow convective medium supply
- the Liquid Handling Device
  - for medium exchange
  - for taking of medium samples
- the handling devices for the internal transport of the experiment chamber modules to different experiment services
- workstations for
  - uni-axial loading of tissue samples; ZETOS (for bone tissue) / CHONDROS (for cartilage tissue)
    - provision of reproducible displacement profiles
    - measurement of the resulting forces

        - computation of the visco-eleastic properties of the samples
    - fluorescence microscope

Three types of reactors will be available:

- flat reactor for 2D- and flat 3D-cultures with flow induced shear stress stimulation
    - compatible with microscope
- cylindrical 3D-reactor for cultivation of vital bone and cartilage samples
    - compatible with un-directional stimulation / analysis by ZETOS / CHONDROS.

These two types of tissue reactors are examples only. The modular, flexible design of the system allows the servicing and accommodation of a wide range of other experiment specific reactors, while the standard experiment chamber modules are used to provide the general services.

Functional principles and essential design features will be reported.

Additionally the preliminary flight concept will be provided.

VISUAL HORIZON IN A G-EXCESS STEADY-STATE ENVIRONMENT

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During exposure to linear acceleration of the body in the dark, subjects integrate resultant force (GiA) as the new vertical, which could be explained by otolithic signals. Although individuals would perceive GiA as the vertical, some authors showed an underestimation [1] of GiA direction whereas other authors identified an overestimation of GiA direction (G-excess effect, 3). Our objective was to compare same body tilts perception in a steady-state environment (without Coriolis effects). Subjects (N=10) were submitted to two GiA intensities (1G, 1.3G) and three body tilts relative to GiA (0°, 20°, 40°). They were instructed to set a luminous target to subjective horizon (visually perceived eye level, VPEL). Results (see Figure 1) highlighted a VPEL shift downward with hypergravity which could be explained by G-excess effect (ie. for a same body tilt, shearing of the otolith is increased beyond 1G). While small body tilts were overestimated, 40° body tilts tended to be underestimated. These last results could be discussed in terms of Aubert effect [2]. However, increasing GiA elevated more consistently horizon settings compared to upright orientation relative to GiA. This suggests an enhancement of Aubert effect in hypergravity.

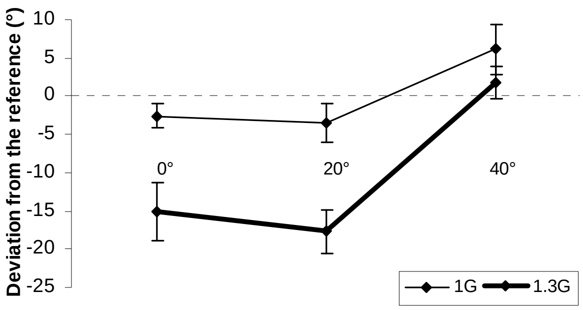

Figure1. Mean errors and standard deviation of VPEL errors estimation relative to GiA intensities and body tilt angles.

References
1. Carriot, J., Barraud, P.A., Nougier, V., Cian C., 'Difference in the perception of the horizon during true and simulated tilt in absence of semi-circular canal cues', Experimental Brain Research, Vol. 174, pp. 158-166, 2006.
2. Bringoux, L., Tamura, K, Faldon M., Gresty M.A., Bronstein, A.M., 'Influence of whole-body tilt and kinaesthetic cues on the perceived gravity-referenced eye level', Exp Brain Res, Vol. 155, pp. 385-392, 2004.
3. Schöne, H., 'On the role of gravity in human spatial orientation', Aerospace Medicine, Vol. 35, pp. 764-772, 1964.

SPACEX DRAGONLAB AS A PLATFORM FOR MICROGRAVITY RESEARCH

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Microgravity experimentation and utilization are of interest to many fields of scientific research, engineering development and commercial manufacturing. Although many flown payloads have yielded highly successful and promising results, infrequent flight opportunities and irregular re-flight options have impeded the development of sustained research programs or plausible commercial business models.

The SpaceX Falcon 9 launch vehicle and Dragon spacecraft are slated for inaugural flights in 2009 and early 2010, with multiple missions annually thereafter. Flights will be to the ISS and also as commercial free-flyer missions, dubbed "DragonLab", specifically for in-space experimentation. Both pressurized and unpressurized payloads can be accommodated with recovery of pressurized payloads as a standard service. DragonLab's flexible capability and launch rate will make access to microgravity significantly more frequent and affordable. The prospect of routine access to space will enable researchers in a variety of fields to expand their microgravity research while fostering the growth of new industries and research possibilities.

SpaceX has added to its manifest two free-flying missions of its "DragonLab" spacecraft. This improvement in access to the orbital microgravity environment has piqued the interest of the scientific community as microgravity research opportunities abound in both the physical and life sciences. Potential areas of physical science research include the material, fluid and combustion sciences among others. Crystal growth and metallic deposition are examples of specific material science fields where significant possibilities are known to exist with crystals grown in microgravity exhibiting more diverse structures with fewer defects and inclusions than otherwise possible. Vast life science research possibilities include fundamental biology, biotech and space medicine. Many of these processes have been found to be modified or enhanced in a microgravity environment and may be critical to manned missions to the moon and beyond.

POSTER SESSION 2

GROWTH OF ULOCLADIUM CHARTARUM CULTURES IN SIMULATED MICROGRAVITY CONDITIONS

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The study of the growth of *Ulocladium chartarum* under microgravity conditions is one of the goals of the experiment Coloured Fungi in Space (CFS-A) which will be performed on-board ISS in 2009. Preliminary studies were done with 0, 2 and 4 days old cultures of *Ulocladium chartarum* in 60mm Φ Microcells grown in simulated microgravity conditions for the length of the mission (12 days). Cultures were integrated in biocontainers installed on the Random Positioning Machine. Ground Controls were also incubated, in the same room under the same environmental conditions. The rate of growth was estimated from photos taken at 0, 4, 8 and 12 days. The results demonstrate that colonial growth is not affected by simulated microgravity, possibly due to the fact that the fungus has both substrate and aerial mycelium. The 0 day old culture at time of the experiment start can be considered as a pattern to demonstrate that in microgravity conditions a fungal colony is able to grow and colonize on a substrate. It also demonstrates that spores are able to germinate, to generate hyphae and mycelium to become mature, to make spores and to assure species survival. However, it is interesting to note that in RPM samples optical microscopy has revealed abnormal shapes of the spores, enlarged hyphae that are unable to branch, random branching, oblique and horizontal position of conidiophores.

REFERENCES

1. Hasenstein, K.H., "Gravisensing in plants and fungi", Adv. Space Res. Vol. 24, pp. 611-685,1999
2. Hendrickx,L, et al, "Microbial ecology of the closed artificial ecosystem MELiSSA(Micro-Ecological Life Support System Alternative):Reinventing and compartmentalizing the Earth"s food and oxygen regeneration system for long-haul space exploration missions, Research in Microbiology,Vol. 157, pp. 77–86, 2006
3. Jingl, L., et al,"Space-flight mutation of *Streptomyces gilvosporeus* for enhancing natamycin production", Chin. J. Chern. Eng.,Vol. 15, pp. 720—724, 2007
4. Kern, V.D., "Gravitropism of basidiomycetous fungi -on earth and in microgravity", Adv. Space Res. Vol. 24, pp. 697-706. 1999
5. Schimekl, C., et al., "Protein crystals in *Phycomyces* sporangiophores are involved in graviperception" Adv. Space Res. Vol. 24, pp. 687-696, 1999

GROWTH OF MICRO ALGAE CULTURES AT LOW PRESSURE WITH LUNAR AND MARTIAN SOIL SIMULANT ADDITION

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Future exploratory missions are enforcing the development of sustainable oxygen distribution devices for long term life support modules in space crafts and on outer space bodies. An outstanding role for the earth oxygen allocation is the O_2 release by micro algae. Micro algae cultured in fluidic bioreactors are able to provide sufficient oxygen to support closed life support system. First studies were performed on the wild type of *Chlamydomonas reinhardtii* cultured for 14 days at reduced pressure (600mbar) and supplemented with lunar and martian soil simulant (JSC-1a, Mars-1a) concentrations. Photosynthetic activities were monitored online by Pulse Amplitude Modulated Fluorometry (PAM). It was observed that the Ratio between non flagellated and moving flagellated cells decreased from beginning to end of experiment. Photosynthetic activity increased at lower cell number, which was detected by increasing chlorophyll concentration and fluorescence analysis by PAM (Fig.1 a, b). These first results contribute to the impression that micro algal cell cultures supplemented with lunar and martian soil simulant tolerate the substrate by surrounding the soil (Fig.2) and increasing their metabolism and proliferation rates. Thus micro algae cultures are the fundamental approach for space exploration scenarios as well as increasing the application on Earth.

POSSIBLE MECHANISMS UNDERLINING THE REDUCTION IN PRESYNAPTIC TRANSPORTER-MEDIATED UPTAKE OF GLUTAMATE UNDER HYPERGRAVITY CONDITIONS

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Excitatory neurotransmitter glutamate is distributed between vesicular and cytosolic pool of nerve terminals. Uptake of ambient glutamate into cytosol is mediated by Na^+-dependent glutamate transporters of the plasma membrane, then the neurotransmitter is accumulated in synaptic vesicles by special vesicular transporters. The present study focused on the mechanisms underlining the reduction in the activity of Na^+-dependent glutamate transporters in brain synaptosomes isolated from rats exposed to hypergravity conditions (10 G for 1 hour). 10% decrease in mean intensity of acridine orange fluorescence at steady state level was revealed by flow cytometric analysis showing changed ability of synaptic vesicle to accumulate the neurotransmitter in hypergravity that may be one of the causes influencing transporter-mediated glutamate uptake. To test the suggestion we applied bafilomycin A_1 that is a highly specific inhibitor of V-type ATPase, which impacts accumulation of neurotransmitters into synaptic vesicles by disturbance of proton gradient generation across synaptic vesicle membrane. We have found that the treatment of synaptosomes with 200 nM bafilomycin A1 essentially decreased the initial velocity of L-[^{14}C]glutamate uptake from 2.5 ± 0.2 nmol x min-1 x mg-1 of proteins to 1.1 ± 0.2 in control, whereas under hypergravity this value lowered from 2.05 ± 0.2 nmol x min-1 x mg-1 of proteins to 0.9 ± 0.2. Bafilomicin A1 similarly inhibited glutamate uptake by plasma membrane transporters by means of specific disturbance of synaptic vesicle proton gradient and this treatment did not covered difference in transporter-mediated uptake in control and hypergravity. Thus, it may be suggested that a decrease in acidification of synaptic vesicles, which is known to be coupled with neurotransmitter loading, is not the main cause of decreased Na^+-dependent uptake by nerve terminals under hypergravity conditions.

CULTURE IN SIMULATED MICROGRAVITY AFFECTS QUORUM SENSING IN THE LIFE SUPPORT BACTERIUM RHODOSPIRILLUM RUBRUM S1H

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Background. MELiSSA, which stands for 'Micro-Ecological Life Support System Alternative', is a closed regenerative life support system for future space flights under development by the European Space Agency. It consists in interconnected processes (*i.e.* bioreactors, higher plant compartments, filtration units, *etc.*) targeting the total recycling of organic waste into fresh water, oxygen and food. Among the challenges of the project, the functional stability of the bioreactors under space flight conditions is of paramount importance for the efficiency of the life support system and therefore for the crew safety.
Material and methods. *R. rubrum* S1H was cultivated for 10 days (common space mission time frame) in dark aerobic minimal medium conditions using both the rotating wall vessel (RWV) and the random positioning machine (RPM) technologies. The cultures were analysed and compared with their corresponding control at both the transcriptomic and proteomic level using respectively a *R. rubrum* whole genome oligonucleotide microarray and high throughput gel free proteomics using the Isotope-Coded Protein Label approach.
Results. At the transcriptomic level, no genes were found to be down-regulated. Only 13 genes were found overexpressed in the RWV samples and all 13 were included in the more pronounced response of 235 overexpressed genes of *R. rubrum* to the RPM cultivation. On the other hand, at the proteomic level, only a few common proteins were found to be differentially expressed in RWV and RPM while the RWV appeared to induce a higher number of significantly regulated proteins. However, the transcriptomic and the proteomic approaches appeared to be complementary pointing out the likely interrelation between quorum sensing, cell pigmentation and cell aggregation. As an example, the gene encoding for a quorum sensing synthase molecule was the most up-regulated gene in both modeled microgravity experiments.
Conclusion. The cultivation of *R. rubrum* S1H in modeled microgravity in the RWV and the RPM induces quorum sensing molecule synthesis and cell pigmentation. These processes are of importance for it's application within the MELiSSA loop.

EFFECTS OF MECHANICAL STRETCH ON HUMAN OSTEOBLASTS: ROLE OF THE RHO FAMILY GTPASES IN THE MECHANO-TRANSDUCTION

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Bone loss is a major health problem for astronauts in microgravity. Osteoblasts cultured *in vitro* also react to microgravity, in particular by remodelling their cytoskeleton (CSK). Small GTPases of the Rho family are key players in the shaping of the CSK. Our working hypothesis is that these molecules participate in the response to mechanical forces, including gravity. To analyze this hypothesis in ground-based studies, Rho GTPases, namely RhoA, Rac1 and Cdc42, were silenced by means of siRNA in the MG-63 human osteoblast cell line. Cells were submitted to cyclic mechanical stretching for 24h using a Flexercell. RNA was extracted and a DNA microarray was performed. 919 genes were significantly regulated in stretched vs control static cells. Among them, the guanine nucleotide exchange factors 5 and 2, known activators of the Rho GTPases, IL-1α and the matrix metalloproteinase (MMP) 3 were upregulated and the MMP-1 expression was most significantly increased. The other genes were mainly involved in cancer and cell survival and proliferation. Silencing of RhoA in stretched cells resulted in a modulation of 247 genes, that of Rac1 of 373 genes and that of Cdc42 of 1397 genes in comparison to cells transfected with a neutral siRNA. Most of these genes are involved in signalling networks related to cancer, cytoskeleton, survival and proliferation. Our data indicate that mechanical forces and Rho GTPases profoundly affect MG63 cell phenotype. A detailed analysis of these alterations is under way.

EFFECT OF SPACE CONDITIONS ON NEURONAL MORPHOLOGY

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Due to the cosmic environment a space travel is known to induce various deleterious effects on astronauts (1;2). The aim of this work is to investigate the particular effects of space conditions on the mature neuronal network in order to evaluate the risk of long space missions (like aboard the International Space Station (ISS) or towards Mars or short sojourns in the Space Shuttle or Soyuz) on human behavior. In particular, exposure of neuron cells to cosmic environment during long journeys could compromise neuronal plasticity and connectivity. In this context, the impact of microgravity and cosmic radiations are currently investigated at the cellular and molecular levels in established neuronal network. To study cell motility and internal transport, as well as neuronal network defects we use fetal mouse primary cell cultures (cultivated for 5 days) and mouse embryonic stem cells differentiated into mature neurons. The determination of the gene profiles and metabolic pathways involved in such stresses will allow to evaluate the health risk for astronauts and to develop new appropriate strategies for the maintenance of high behavioural and cognitive performances. Our preliminary results with fluorescence techniques show morphological alterations after exposure of mature neurons to radiation (180 µGy/day corresponding to a one day exposure on the ISS) (3) or simulated microgravity (Random Positioning Machine, RPM Dutch Space). Further gene expression experiments will allow to understand the effect of space conditions at the molecular level and will help to develop new appropriate strategies for the maintenance of highly performant neuronal network to prevent behavioural and cognitive defects.

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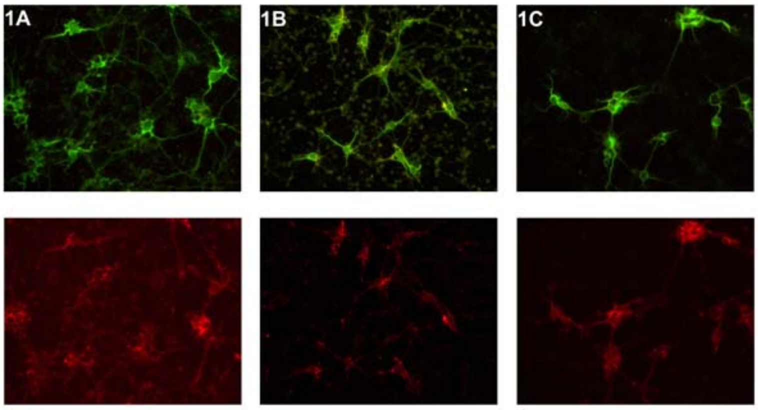

References

(1) Cogoli A., “Cell Biology And Biotechnology In Space”, ISBN: 0444507353, 2002.

(2) Cucinotta FA, Durante M., “Cancer risk from exposure to galactic cosmic rays: implications for space exploration by human beings”. *Lancet Oncol.* 7(5):431-5, 2006.

(3) Vanhavere F., Genicot J.L., O'Sullivan D., Zhou D., Spurny F., Jadrnickova I., Sawakuchi G.O., Yukihara, E.G. “DOsimetry of BIological EXperiments in SPace (DOBIES) with luminescence (OSL and TL) and track etch detectors”. *Radiation Measurements* 43(2):694-697, 2008.

CD69, A C-TYPE LECTIN RECEPTOR, COULD BE A MARKER FOR LYMPHOCYTES RESPONSE TO RADIATION.

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CD69 is the earliest activation marker of human lymphocytes and its expression can also be induced in resting, CD69 negative lymphocytes by heat shock and by gamma radiation with a rapid kinetics, i.e., in 2-4 hours (1-2). In microgravity, lymphocyte activation is impaired, but very early activation steps of human lymphocytes are not compromised, since CD69 is expressed by activated T cells at a level comparable with the one observed on 1*g* activated lymphocytes and with a similar kinetics (3-4). We exposed whole blood or isolated lymphocytes from healthy donors to different doses of X radiation, 100, 488 and 1070 cGray. Then, after a subsequent incubation at 37°C for one or two hours, the expression of CD69 on cell surface was investigated by the cell reactivity with anti-CD69 monoclonal antibody and evaluated by flow cytometry. After two hours incubation at 37°C since the exposure to 488 cGy radiation, 14.5± 5 % of irradiated leukocytes analysed in blood samples vs. 1.5±2 % of control samples expressed CD69. Appropriate gating on lymphocytes and the analysis of separated lymphocytes indicated this subset as responsible of the increase of CD69 expression in the whole leukocyte population. The effect of radiation was dose-dependent. In view of the ability of lymphocytes to express CD69 in microgravity, this membrane molecule could be regarded as a marker related to effects of radiation on astronauts exposed to galactic cosmic rays.

REFERENCES

1 Risso A., Smilovich D, Capra MC, Baldissarro I et al.. CD69 in resting and activated T lymphocytes: its association with a GTP binding protein and biochemical requirements for its expression. Journal of Immunology vol 146, pp 4105-4114, 1991
2 Chen J., Davis BH, Leon MA, Leong LC. Gamma radiation induces CD69 expression on Lymphocytes. Cytometry vol 30, pp 304-312, 1997.
3 Hashemi BB, Penkala JE, Vens C, Huls H, Cubbage M, Sams CF. T cell activation responses are differentially regulated during clinorotation and in spaceflight. Faseb J. Vol 13, pp 2071-2082, 1999.
4 Risso A, Tell G, Vascotto C, Costessi A, et al. Activation of human T lympocytes under conditions similar to those that occur during exposure to microgravity: a proteomics study. Proteomics vol 7, pp 1827-37, 2005

PHOTOSYNTHESIS IN SPACE: BETWEEN EVOLUTION AND EXPLORATION

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Photosynthesis has been developed on Earth about 3.5 Billion years ago by cyanobacteria. These first photosynthesising organisms have transformed our Planet by its oxygen production and triggered the follow on evolution of all other organisms. The presence of ozone in the upper terrestrial atmosphere is due to the fact that in the Early Earth cyanobacteria have produced the essential oxygen molecules. For this reason oxygen, especially ozone could also be used as biosignature for the search of life on other probably extra-solar planets in the universe. Current results are demonstrating the fact, that some photosynthesising life forms are also able to resist space parameters as UV radiation and vacuum after space exposure. This has been shown by experiments on BIOPAN 6 on the satellite FOTON M3 and by space simulation tests. New results are expected to be obtained by the recent space experiment "LIFE" on EXPOSE/ISS. Surprisingly for some organisms photosynthesis seems to work in a Martian environment with low water supply or in a frozen environment up to – 30° C. Simulation tests of the Martian atmosphere and low pressures down to 6-11 mbar in the Mars simulation chamber HUMILAB (DLR Berlin) have shown these characteristics. It seems that for some terrestrial organisms the Martian atmosphere, radiation, low temperature and low pressure will not be the limiting factors for relevant life processes to be conducted by the photosynthesising microorganisms. These matters of facts are implicating the question if CO_2-rich atmospheres on other extra-solar planets may probably just hide existing photosynthesising organisms because of the incorrect evolutionary time window and misinterpretation of data (e.g. high CO_2 concentration), we would get from new discovered planets.

On the other hand the research on photosynthesis in future space investigations is prerequisite for a successful development of life supporting systems in manned space flight missions. By photosynthesis plants are able to produce oxygen for breathable air and food. The use of plants in space is also an important psychological factor for astronautic crews because of refreshing and breaking up the appearance of the interior of future space stations in orbit or on other planets. Therefore photosynthesis must be also of interest for technical use in future space exploration missions.

INFLUENCE OF ALTERED GRAVITY AND RADIATION TO THE STRESS RESPONSE OF MACROPHAGES

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The innate immune system plays an important part in reconditioning deposing pathogens and as a consequence defending the organism in the early phases of infections and diseases. A malfunction in the immune response can increase the hazard of infections and thus diseases, cancer and the regeneration of the organism. The principal task of an innate immune system is the immediate recognition and removal of objects such as pathogen bacteria, infected, apoptotic or mutated cells within the organism. This function is performed by macrophages, which absorb and dissolve intracellular pathogens and cell debris in phagolysosoms during phagocytosis. The decomposition of these particles comes along with an oxidative burst, which can be detected by chemical reactions such as a chemo-luminescence reaction. The process of phagocytosis in macrophages (cell line NR8383) was analysed during clinorotation in previous experiments. In the frame of the diploma thesis of Vanja Zander detailed kinetic measurements of phagocytosis and oxidative burst are currently under investigation. Therefore, a clinostat with one rotation axis has been equipped with a photomultiplier to allow online registration of the chemo-luminescence reaction within the cells. In addition, the clinorotated sample can be exposed to X-ray source (RS225, Gulmay Medical, UK) in a radiation source, thus allowing the investigation of the effects of clinorotation and radiation.

MOUSE DRAWER SYSTEM: PRELIMINARY BEHAVIOURAL AND NEUROBIOLOGICAL DURING THE 100 DAYS GROUND-BASED TEST

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The conquest of space, which started with the dog Laika in 1957, has witnessed an increasing numbers of both vertebrates (tadpoles, frogs, rats mice etc.) and invertebrates (flies, scorpions, protozoa) species exposed to 0-g levels. Animals are sent into orbit to proactively foresee possible health problems in humans. The issue of animal exposure to un-physiological gravity is of primary importance to i) understand behavioural and physiological adaptations in such environment as well as ii) develop countermeasures attempting to minimize the suffering of animals used in space research. Preliminary ground-based experiments have been conducted with wild-type (wt) and transgenic mice (tg) housed in the Mouse Drawer System (MDS), an Italian facility, for 100 days in order to investigate mechanisms underlying bone mass loss in microgravity. Behavioural repertoire of wt and tg mice has been videorecorded (acquisition rate 10 frames/second, with the Observation SubSystem, which allows to monitor animal's behaviour), and finely analysed at several time points during the 100 days of the experiment. Behavioural profiles have been related to level of neurobiological markers involved in stress response, and NGF and BDNF levels measured in central nervous system, adrenal gland and limbs. Overall, data indicated that both genotype and housing environmental conditions affected behavioural response as well as levels of NGF and BDNF.

OTOLITH GROWTH OF DEVELOPING ZEBRAFISH UNDER CENTRIFUGATION AND WALL VESSEL ROTATION

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Previous studies have shown that the growth of inner ear otoliths of larval cichlids (*Oreochromis mossambicus*) and zebrafish (*Danio rerio*) is strongly affected by hypergravity (growth slowed down) by means of a negative-feedback mechanism, provided that a developmental stage is used which already has developed a working vestibular system (or commencement appears during the experimental time-span; the vestibular system in zebrafish commences operation within ca. 2 days at 28+/-0.5°C). Microgravity (spaceflight) yielded an opposite effect on otoliths (growth accelerated) of later-staged swordtails (*Xiphophorus helleri*). The present study was designed to parallely investigate otolith growth in developing zebrafish both at (5g) hypergravity by means of a centrifuge and at “randomised gravity” using a rotating wall vessel. Animals were kept at experimental conditions for 3, 6, 9 or 12 days, beginning 10hrs after fertilization (vestibular system not yet functional) at 28+/-0.5°C. The results gained are fully in line with those communicated earlier, since hypergravity slowed down otolith mineralization, whereas wall vessel rotation (WVR) yielded larger than normal otoliths, especially after 3 and 6 days of exposure. From a technical point of view, the results suggest that WVR may be regarded to provide functional weightlessness. Overall, the findings clearly support the existence of the aforementioned feedback mechanism and reinforces the assumption that mineralization of fish otoliths is stimulus dependent.
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SIMULATED MICROGRAVITY ALLOWS NORMAL CARDIOVASCULAR DEVELOPMENT IN LARVAL ZEBRAFISH

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We evaluated the effects of simulated microgravity on cardiovascular development of zebrafish. Fertilized eggs (one-cell stage) have been exposed to simulated microgravity for 24, 48 and 72 hours post-fertilization (hpf), a time lag necessary to complete the maturation of the vascular system. The forming vessels were visualized using a whole-mount staining for the endogenous alkaline phosphatase, a specific marker of differentiated endothelial cells. We found no alterations in the architecture of the vascular network both in the head and in the trunk blood vessels of embryos in simulated microgravity. Interestingly, head vessels are formed by vasculogenesis while trunk vessels are formed by angiogenesis.

To analyze the integrity of the vascular tree, we injected fluorescent beads in the sinus venosus of live embryos and the perfused vessels have been observed using a fluorescence stereo-microscope. The blood vessel of embryos in microgravity were correctly perfused and no alteration in permeability or integrity of the vessel wall was detectable. These data indicate that, within the first days of development, simulated microgravity has no effects on vascular architecture, vessel formation and structure.

EFFECTS OF SPACE FLIGHT ON ERYTHROCYTES AND OXIDATIVE STRESS OF RODENTS: DATA FROM THE MICE DROWER SYSTEM GROUND TESTS

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The Mice Drawer System (MDS) is an Italian Space Agency (ASI) facility developed by Thales-Alenia Space, which is able to support mice onboard the International Space Station during long-duration missions (from 100 to 150-days). The principal experiment will investigate the genetic mechanisms underlying bone mass loss in microgravity.
This research will also contribute to the research on microgravity effects on body systems through a tissue sharing program.
Erythrocyte (RBC) and hemoglobin loss have been observed during space missions; these observations have been summarized as “space anemia”. Erythrocytes exposed to microgravity have a modified rheology and undergo greater hemolysis. We can suppose that microgravity together with space radiation causes variations of cellular shape, plasma membrane composition, and peroxidative stress, that can be responsible of space anemia.
For these reasons we will participate to the tissue shearing program of MDS and we run analysis on samples from mice housed in MDS for 20 and 100 days during ground tests performed in Genova. We analyzed RBC antioxidant potential and lipid composition.
Two kind of mice were used the Wild Type (WT) and a transgenic type (OSF-1).
During the 20 day simulation the content of glutathione was decreased in OSF while a significant increase of GSH reductase and peroxidase was measured in WT mice; this might indicate that WT animals are more resistant to the stress during MDS housing.
On the contrary after 100 days of housing the two type of mice were very similar in their antioxidant enzymes. In particular a relevant increase of Glutathione peroxidase was induced by the MDS simulation. Still relevant is the increase of Induced TBATS in OSF mice after 100 days of MDS, that might indicate a lower antioxidant potential in RBC cells of these animals.

SURGICAL STRESS RESPONSE IN SPACE_ PROPOSAL FOR STUDIES ON ANIMAL MODEL

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Presently, the goal in the treatment of traumatic injuries and other serious surgical problems during space missions is stabilization and damage control pending rapid and safe return to earth. This strategy is suitable for earth's orbit or lunar missions, but in long lasting missions, when the return to earth is not an option, the most serious situations may necessitate a different operative capability. Predicting the expected incidence and kind of medical events has been difficult, due to the small number of astronauts who have completed long lasting missions. Anyway with the increase in duration of missions and distance from earth, medical and surgical events will become inevitable. Although NASA has conducted a number of operative studies to assess the feasibility of open and video surgery as well as many other procedures (intravenous fluid infusion, Foley catheter drainage, laceration closure, chest tube insertion and suction, percutaneous tracheostomy and crichothyrotomy, diagnostic peritoneal lavage and others), to the best of our knowledge no studies are presently available on surgical stress in space. The stress response is the name given to the hormonal and metabolic changes which follow injury or trauma. The stress response to surgery is characterized by increased secretion of hormones and activation of the sympathetic nervous system. The endocrine response is activated by afferent neuronal impulses from the site of injury. The overall metabolic effect of the hormonal changes is increased catabolism which mobilizes substrates to provide energy sources, and a mechanism to retain salt and water and maintain fluid volume and cardiovascular homeostasis. Over the past 20 yr, great efforts have been made in order to understand the role of cytokines in the response to surgery, the interaction between the immunological and neuroendocrine systems, the outcome of surgical stress. Animal models, the mouse species in particular, represent a useful tool for studying such stress/recovery response in microgravity conditions, also in term of neuro-endocrine-immunological modulation. The possibility to exploit these models might help in understanding underlying mechanisms related to the neuronal pathway modulating pain response and healing of traumatic injuries.

PARABOLIC FLIGHT AND FETAL MOVEMENTS, HEART RATE PATTERN AND BLOOD FLOW IN UMBILICAL CORD BLOOD VESSELS IN PRECOCIAL RODENT

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Sooner or later human pregnant females will be exposed to an altered gravitational regime. Because of this it is necessary to learn the effects of micro, hypo and hypogravity on intrauterine development of the human fetuses. Estimation of the condition of human fetus during second half of gestation in clinical practice is based on: quantitative assessment of fetal movements, assessment of fetal heart rate pattern, and changes in blood flow in the umbilical cord blood vessels (1). Pregnant precocial rodents such as guinea pig, chinchillas, and spiny mouse represent models to investigate influence of an altered gravitational regime on human fetuses during second half of gestation (2). Parabolic airplane flight provides a series of short periods of hypergravity and microgravity conditions. Ultrasound investigation of the influence of altered gravitational regime on fetal movements, fetal heart rate pattern, and changes in blood flow in umbilical cord blood vessels among pregnant rodents during parabolic flight could be the next step in investigation of influence of altered gravitational regime on the fetus. Data from literature shows that such an experiment is technically possible to perform (3).

1. Nijhuis, J.G. Fetal behavior. Neurobiol Aging, Vol. 24, pp. 41-46, 2003.

2. Sekulić, S.R., Bozic, A., Borota, J., Milka, C. Precocial rodents as a new experimental model to study the effects of altered gravitational condition on fetal development. Micrograv Sci Tech, Vol.3/4, pp. 223-225, 2006.

3. Turner, A.J., Trudinger, B.J. Ultrasound measurement of biparietal diameter and umbilical artery blood flow in the normal fetal guinea pig. Comp Med, Vol. 50, pp. 379-384, 2000.

DEVELOPMENT OF THE FLIGHT HARDWARE FOR THE EXPERIMENT XENOPUS ON THE KUBIK BIO4-MISSION

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To use aquatic animals for space flight experiments, the flight hardware has to scope with biological requirements and with the technical feasibility. A strong biological requirement is that the hardware has to be adapted to various developmental stages because - in some sense - animals at the different stages of development can be considered as different organisms with respect to their demands for survival. Embryos need for a certain period of their life no food supply; they have their food by the yolk, while older stages need additional food. In aquatic animals, this fact *per se* requires life support systems with a highly efficient control for water cleanness and steady food supply. Together with all the other biological requirements, an intensive interdisciplinary cooperation between biologists and engineers is mandatory and the steps of the technical development needed careful biological tests in the course of the construction of a flight hardware.

The hardware developed for the experiment XENOPUS on Soyuz TMA13 to ISS is an example of a successful albeit sometimes stressful cooperation between scientists and Space companies from Germany and Italy. Requirements from the neurobiologists including in particular automatic feeding and clean water drove the first step of flight hardware development. The basic technical and biological work led to the concept of the EADS SUPPLY Unit [1] adapted to the miniaquarium technique [2]. It allowed *Xenopus* tadpoles to survive for 1 month. On the breadboard level, the system worked in darkness made it independent on the integration of aquatic plants. From the technical point of view, an exhausted SUPPLY unit can be exchanged by a new one increasing life duration of the system. The transformation to flight hardware used for the experiment XENOPUS (XNP) on the Soyuz TMA13 flight in 2008 was performed by Kayser Italia. Biological tests on the Science Modul (SM-XNP) led to significant improvements within the Flight Modul (FM-XNP) and were the basis for the fact that 35 out of 36 launched tadpoles returned safely and in excellent physiological condition after the 11-days lasting flight to ground.

References
Franz, M., Böser, S., Hiesgen N., Horn, E., Kübler, U., Lämmlein, S., Schwarzwälder, A., A new concept of a life support system for aquatic animals using the miniaquarium technic. Gravit. Space Biol. Bull., Vol. 17(1), p. 31, 2003.
Horn, E., Sebastian, C., A comparison of normal vestibulo-ocular reflex development under gravity and in the absence of gravity. ESA SP, Vol. 1222, pp. 127-138, 1999.
The development of the SUPPLY Unit was part of an EADS-Astrium research project. Transformation to flight application was done by Kayser Italia under contract with ESA. Horn was supported by DLR.

EFFECT OF GRAVITY ON MIXING OF LIQUIDS UNDER HIGH-FREQUENCY VIBRATION

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Behaviour of two miscible liquids entering into contact via horizontal interface inside a container under high-frequency vibration essentially depends on gravity environment. We consider the phenomena of interaction between natural and vibrational convection in a system with low diffusion by numerical simulation. The mathematical model is described by averaged Navier-Stokes equations. The aim of this study is to analyze the physical mechanism by which gravity and vibration affect the mixing characteristic of two stratified miscible fluids. The translational periodic vibrations are imposed to a rigid cell filled with two different mixtures. The vibrations with a constant frequency and amplitude are directed along the interface and the gravity is perpendicular to this one. Obtained results highlight the strong interplay between gravity and vibrational impact, the relative weight of each effect is determined by ratio vibrational and classical Rayleigh numbers. In this system the added vibration of vessel generates an inertial force which acts like a gravity and leads to different phenomena such as instability, interface displacement and deformation etc. The relative importance of each effect is determined by vibration impact (frequency and amplitude), properties of mixture components (viscosity and diffusion) and initial distribution of composition. The influence of these parameters on the onset, development of mass transfer and mixing characteristics is the main subject of the present study.
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USING SUPERCONDUCTING MAGNET TO REPRODUCE QUICK VARIATIONS OF GRAVITY IN LIQUID OXYGEN

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We have investigated for a decade the behaviour of cryogenic fluids (H_2 and O_2) under gravity compensated by magnetic fields. In this context, two facilities have been developed. The first facility (HYLDE) is used to compensate gravity in a few mm^3 of hydrogen and the second facility (OLGA) can compensate gravity in a few cm^3 of oxygen. Recently, the power supply of the OLGA superconducting magnets has been modified to perform very fast (100 ms) current variations, corresponding to the variations of acceleration that are encountered in the stopping and reignition phases of space rocket engines. This is a particularly difficult task as varying rapidly the current in a superconducting magnet induces extremely large voltage. The facility and some experimental results concerning the behaviour of liquid oxygen in the reservoir of a space rocket during the changes of magnetic field amplitude will be presented.

ON PECULIARITIES OF MICROGRAVITY IMITATION IN MAGNETO-POLARIZABLE MEDIA IN THE PRESENCE OF NON-UNIFORM MAGNETIC FIELDS

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The use of superconducting magnets [1] in conjunction with centrifugal forces [2] for levitating magnetizeable materials is a perspective method of gravity compensation. However if the medium becomes non-isothermal or non-uniform e.g. during the protein crystal growth, thermo-magnetic or magneto-concentrational convection may arise [3]. Therefore it is essential to understand the physical nature and parametric characteristics of magneto-convection in order to control the behavior (in particular, heat and mass transfer) of non-conducting dia- and paramagnetic fluids in magnetic fields. Both magnetic compensation and pondermotive forces are caused by the spatial variation of magnetic susceptibility of the medium. They are proportional to the gradient of the applied magnetic field [4]. The present paper investigates magneto-convection arising in ferrocolloid. This practically important fluid serves as an amplifier of magnetic effects in ground-based experiments on one hand and it can be used as heat carrier or coolant in microgravity conditions on the other.

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REFERENCES
1. Beaugnon, E., Tournier, R., “Levitation of organic materials”, Nature, Vol. 349, p. 470, 1991.
2. Lorin C., Maifert A. “Magnetic compensation of gravity and centrifugal forces”, Microgravity Sci. Technol, Vol. 21, pp. 123-127, 2009.
3. DeLucas, L.J., Tillotson, B.J., “Diamagnetic control of convection during crystal growth”, 12th European and the 6th Russian Symposium on Physical Science in Microgravity, St. Petersburg, June 15-21, 1997.
4. Rosensweig, R.E., “Ferrohydrodynamics”, Cambridge University Press, 1985.

PREPARATORY RESULTS FOR THE ISS DSC (DIFFUSION AND SORET COEFFICIENTS) EXPERIMENT

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Multicomponent diffusion differs from binary diffusion by several essential aspects, not the less being the analytical tools required and the ever possible quenching of multi-diffusive instabilities during the evolution of the composition profiles.
These studies where started with crude oils as test case, but we soon considered that ternary systems where first to be deeply investigated and further on to allow deducing un-lumping process (mixing rules) [1].
The first proven results in ternary non diluted molecular mixtures have been obtained with the Open Ended Capillary technique [2,3], but still it is not granted that convection has not participated to the mass transport. Therefore, microgravity data, to be obtained fall 2009 in the ISS Glovebox with the DSC experiment, are essential for further progress.
The microgravity set up is a thermodiffusion cell, in which a thermal gradient allows to build an initial composition profile for further observation of diffusion in the isothermal state. Visualization of composition profiles is performed by a two color Mach-Zehnder interferometer. We present here the experiments performed on ground and specific developments performed for the full implementation of the technique.

S. Van Vaerenbergh, J.C. Legros, J.L. Daridon, T. Karapantsios, M. Kostoglou, Z.M. Saghir,"Multicomponent transport studies of crude oils and asphaltenes in DSC program", Microgravity sci. technol. XVIII-3/4, p. 5 , 2006.
Q. Galand, S. Van Vaerenbergh, F. Montel, Measurement of Diffusion Coefficients in Binary and Ternary Mixtures by the Open Ended Capillary Technique, Energy & Fuels, 22 (2), 2008.
Q. Galand, M. Luhmer, S. Van Vaerenbergh, Diffusion Coefficients in Multicomponent Organic Liquid Mixtures by the Open Ended Capillary Technique, High Temperature High Pressure, 2009.

THERMAL MEASUREMENTS, VISUALIZATION AND NUMERICAL MODELING OF VIBRATIONAL CONVECTION IN HELE-SHAW CELL

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Convective flows in Hele – Shaw cell are investigated by experimental and theoretical methods when the cavity is heated from below and subjected to the influence of high frequency vibrations. Non-acoustic approximation is applied for numerical modeling of averaged convective flows and to analyze the scenarios of transition to chaotic regimes. The boundaries of stability have been calculated numerically and measured experimentally for mechanical quasi-equilibrium state, different stationary and time-dependent convective flows. The results of theoretical research confirm experimental data. Oscillatory four-vortex regime with periodical reunification of corner vortices has been considered specially. The symmetry break-down of this flow takes place for definite range of governing parameters.
Also the influence of short vibrational signals on convective flows in Hele – Shaw cell is studied theoretically and experimentally. In this case the cavity is periodically heated from below by dotted thermopile. Such heating technique permits to improve the accuracy of thermal measurements. “Full” non-averaged equations have been used to calculate oscillatory regimes of thermal vibrational convection. The temperature and velocity fields are received for vertical and horizontal vibrational signals by the numerical method of finite difference. The results of calculations have been used to design the sensor that will be intended for registration of low-frequency microaccelerations of the seismic origination.

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References:

Demin V.A. Vibrational convection in an inclined fluid layer heated from below // J. Fluid Dynamics, Vol. 40, No. 6, pp. 865–874 (2005).

Demin V.A., *Babushkin I.A.* Vibrational convection in the Hele-Shaw cell. Theory and experiment // J. of Applied Mechanics and Technical Physics, Vol. 47, No. 2, pp. 183-189 (2006).

DIAMOND SYNTHESIS UNDER MICROGRAVITY ENVIRONMENT WITH PARABOLIC FLIGHTS BY DAS AND S520-24 ROCKET BY JAXA

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Diamond synthesis under microgravity environment with parabolic flights by Diamond Air Service (DAS, Japan) and rocket by JAXA will be reported. Compare with terrestrial gravity environment, under microgravity, gaseous species on the reaction chamber were detected and analyzed with OES (optical emission spectroscopy) was changed, and we expected that synthesized diamond particles might be have some deferent morphology with terrestrial conditions, this particular launch was not retrieved.
The sounding rocket "S-520-24" will realize *in-situ* measurements of temperature, convection and synthetic gas as well as emission spectroscopy of diamond.
We will try to grow diamond crystal in microgravity environment with modulate of fluid environment more than natural gravity. And this experimental project was designed for clarify of mechanism in high quality diamond synthesis in microgravity environment.
We use graphite rod as solid carbon source, and the completely closed reaction chamber, and hydrogen for reaction gas. Reaction chamber and other equipments will set up in the sounding rocket top as shown in Fig.1.
To synthesis diamond in low-gravity environment, thermal convection of synthetic gas will be repressed, the growth rate of diamond will be clarified mechanism of diamond synthesis. We will present key points of this work in the presentation.


Fig. 1 Experimental apparatus of diamond synthesis installed on the sounding rocket top

REFERENCES

1. Y. Takagi, Liya L.R., Willam R.W., "New Method for Diamond Film Deposition under Different Gravity Conditions", Trans. Mater. Res. Soc. Jpn. 24, 513 1999
2. M. Uede, Y. Takagi, "In situ analysis of gaseous species for chemical vapor deposition diamond synthesis and the possible reaction model", J. Mater. Res., Vol.16 No.11 3069 Nov 2001

MAGNETIC-FIELD MODULATION OF GRAVITY: MARTIAN, LUNAR AND TIME-VARYING CONDITIONS

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Magnetic compensation of gravity can be used to simulate, on Earth, gravity conditions that occur on Moon, Mars, or in interstellar space. This magnetic method has been mainly considered so as to develop based-ground devices enabling one to simulate micro-gravity conditions. Recent studies focus also on transient gravity compensation (acceleration or deceleration phases of spaceships) [1].
In this paper, a magnetic field distribution made up of both a dipolar and a quadrupolar components, independently controlled, is considered. Indeed, a magnetic force density can be created in a para- or dia-magnetic substance with only the help of the first two spatial harmonics of the magnetic field, whether it be in cylindrical geometry (translational invariance) [2] or in axisymmetric geometry (rotational invariance) [3]. As an example, the concept of a particular set of coils, designed for variable levitation of one litre of liquid oxygen, is presented. This device may allow quasi perfect gravity compensation (micro-gravity), partial gravity compensation (Lunar or Martian gravity) and time-varying gravity compensation.

1. Pichavant, G., Beysens, D., Chatain, D., Communal, D., Lorin, C., Mailfert, A., “Quick variation of gravity in liquid oxygen using superconductive magnet.**”** submitted to ELGRA Biennal Symposium, 2009

2. Lorin, C., Mailfert, A., "Magnetic levitation in two-dimensional geometry with translational invariance", Journal of Applied Physics, Vol. 104, 103904, 2008.

3. Lorin, C., Mailfert, A., "Magnetic compensation of gravity by using superconducting axisymmetric coils: Spherical Harmonics Method", Journal of Physics: Conference Series, Vol. 97, 012199, 2008.

QUEENSLAND UNIVERSITY OF TECHNOLOGY DROP TOWER FACILITY AND OPPORTUNITIES

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The Queensland University of Technology (QUT) has recently opened the 1.95 s (~20 m) drop tower facility in Brisbane, Australia. This facility consists of a double capsule type configuration, wire release system, and air bag breaking system. The inner capsule experimental module has an effective volume of 63.5 cm^3 and the payload weight is limited to 150 Kg. The inner capsules can be built to any user specifications whereas multiple experiments can be configured into a rack. The level of microgravity has been tested to 10^{-6} G during free fall and the duration of high gravity experienced during breaking is on the order of milliseconds. The support staff for the facility is available 24 hours a day and can accommodate multiple drop campaigns. Initial projects include droplet formations of alcohols which is a precursor experiment that will be flown aboard the Chinese Soyu (2011) [1]. QUT is a low cost drop tower facility that is open to international research collaborations and opportunities.

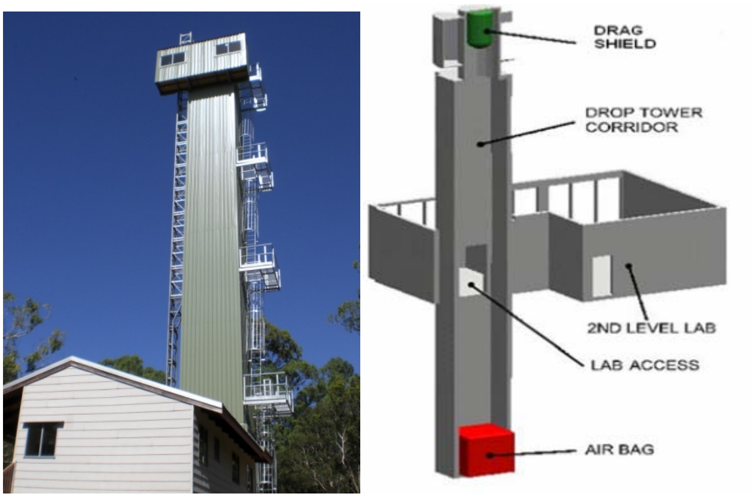

Figure 1.0 Photographs and schematics of the Queensland University of Technology ~2 s drop tower facility.

References
1. Brutin, D., Tadrist, L., "Destabilization mechanisms and scaling laws of convective boiling in a minichannel", Journal of Thermophysics and Heat Transfer, Vol. 20, (4), 850-855, 2006.

CRUSTAL DEFORMATION DEDUCED FROM GRAVITY AND GEODETIC DATA OF HIGH DAM AREA, ASWAN, EGYPT.

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After occurrence of November 14,1981 earthquake, Aswan area had been subjected to various geophysical and geodetic studies, due to their importance for some vital projects. Gravity studies were performed in the form of detailed measurements, in order to determine the basement relief in this area.
In addition, the gravity measurements were accomplished by the GPS and leveling measurements, in order to determine the accurate height of the points of gravity. The resulted gravity data were adjusted and processed and the bouguer anomaly map of the area was established. The resultant depths to the basement surface are ranging between few meters and 200 meters. Also good information about the distribution of the fault system in the study area was concluded .
The type of the prevailing faults in the area is normal faulting, while the main trends of faults are the N-S, E-W and NE –SW directions. GPS and leveling measurements with is accuracy of 23 cm. The low level of earthquake occurrences and the low strain rates indicate that the rate of the deformation in the study area is small.

THERMAL ACOUSTIC CONVECTION IN CLOSED CAVITY

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The model of thermal acoustic convection (thermal vibrational convection in a compressible fluid) is developed. It is shown that the shape of container is important: in a rectangular container subjected to the translational vibrations parallel to any container wall, thermal acoustic convection does not arise. The situation is different for horizontal cylinder of circular cross-section subjected to the vibrations orthogonal to the cylinder axis. We have considered thermal acoustic convection for this configuration. For the pulsational fields we found the exact solution and the problem for average fields was studied numerically, by finite difference method. The calculations made for zero gravity conditions show that in this case vibrations generate two-vortex flow; in the parameter range under consideration the intensity of this flow demonstrates linear growth with the increase of acoustic Grashof number. Numerical investigation of the coupling of thermal buoyancy and thermal acoustic mechanisms of flow generation shows that flow transformation with the increase of thermal and acoustic Grashof numbers is accompanied by the hysteresis phenomena. Stability map of the two-vortex average flow on the parameter plane thermal Grashof number – acoustic Grashof number is obtained.

CONVECTION IN A TWO–LAYER SYSTEM WITH DEFORMABLE INTERFACE IN LOW GRAVITY CONDITIONS

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Onset of thermal convection in a two-layer system of superposed horizontal layers of immiscible fluids with close densities subjected to vertical temperature gradient is studied for the case of fixed thermal flux at the boundaries. Generalized Boussinesq approach allowing correct accounting for the interface deformations is applied. It is found that in low gravity conditions, long-wave monotonic or oscillatory instability may develop. Moreover, two different types of monotonic instability exist. For the first instability type the onset of convection in each of the layers is typical such that the interface remains nearly undeformable. The second monotonic instability type is substantially related to the interface deformations. The system of non-linear amplitude equations describing the behaviour of long-wave regimes at arbitrary interface perturbations and arbitrary supercriticalities is obtained. Analytical and numerical investigation of these equations shows that stable non-trivial stationary solutions are absent, after the transient process at least one of the layers is splitted into the areas non-connected each other. Non-linear regimes of cellular convection are studied numerically by finite volume method.

INTERACTION OF RIGID PARTICLES IN A PULSATIONAL FLOW

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Behaviour of the rigid particles suspended in a liquid in a container subjected to the translational vibrations is considered. It is shown that in the case of two similar particles the interaction type substantially depends on the distance between the particles. If this distance exceeds the viscous Stokes length then the vibrations parallel to the line connecting the particle centers lead to the particle repulsion and under vibrations normal to the center line the particles attract each other. For distances shorter than the Stokes length, the behaviour is opposite. Inclined vibrations results in the change of particle pair orientation such that the center line becomes perpendicular to the vibration direction. This type of interaction leads to a non-trivial behaviour of the ensemble of particles. This behaviour is studied numerically by the molecular dynamics method, applying pair interaction approximation. The calculations made for homogeneous initial distribution of particles over the volume, show that one or several clouds of particles strongly elongated in the direction normal to the vibration axis are formed. The formation of these clouds and the dependence of their characteristics on the parameters of particles and vibrations and on the initial particle distribution are studied.

THE WORLD-RECORD SET BY A 11-YEAR-OLD KID FLYING AS TEST SUBJECT IN *LUNAR-GRAVITY*, *MARS-GRAVITY AND ZERO-GRAVITY* FLIGHT CONDITIONS OPENS UP NEW PERSPECTIVE FOR LIFE-SCIENCE RESEARCH

Dr. Eng. Carlo Viberti – SpaceLand Mission Commander

In general, research in life-sciences can be drastically accelerated at negligible costs in the "*flying laboratory*" engineered and operated by the SpaceLand program.

Thanks to the particular features of its flight profile, the vehicle employed provides users with *microgravity and low-gravity conditions* to enhance research, analysis, design, development, testing and qualification of *equipment, systems, methodologies and processes which are influenced by gravity* or which are *gravity-dependent*, addressing most *chemical, physical, biological* and *physiological* research issues and themes.

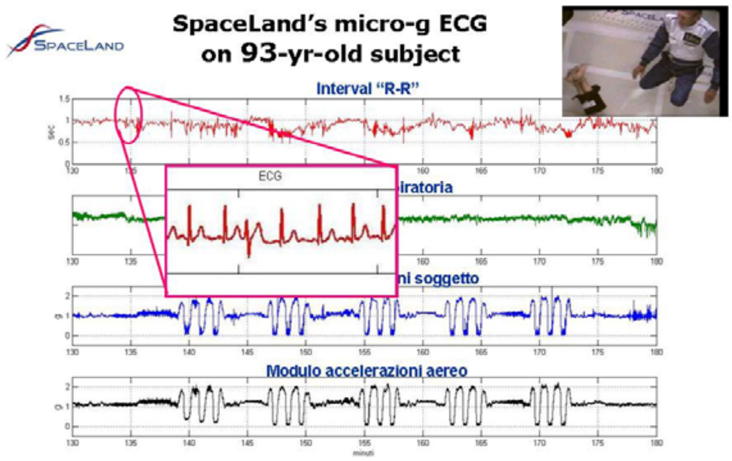
Similarly to what happens in the field of osteoporosis, muscular atrophy, proprioceptive and neuro-vestibular systems, cardiology and many other research areas, also neurobiology is a research area which can greatly benefit from research campaigns in varying gravity levels as well as in weightlessness: in particular, hormones production and correlated neuro-biological functions are strongly affected by the stress related to such flight conditions, providing a great deal of experimental results with potentially major implications on neurobiology.

At the end of 2008 a new SpaceLand research flight campaign was implemented to support neurobiological studies of the Italian National Health Institute "Istituto Superiore di Sanità" (ISS) related to the on-going analysis by ISS , jointly with the University of Milan as well as CNR / EBRI (European Brain Research Institute) Neurobiology Department to understand during such extreme situations the mechanisms which are believed to pay the way to the onset of neurological pathologies such as Alzheimer's.

In particular, for the sampling before, during and after the flight campaign a group of members of the public was trained by SpaceLand and included the world's youngest test subject (11-year-old) to board a research flight in so-called Moon-gravity (1/6 g), Mars-gravity (1/3 g), Zero-gravity and hyper-gravity conditions (this latter at approximately 2 g) where g equals 9,81 m/s2; the results of such tests, assessing quality and quantity of hormones released by humans in such a range of age and gravitational stresses before, during and after the respective flight parabolas have been presented at the ELGRA 2009 Congress by Dr. Santucci.

The mission took on September 28th from the NASA Space Shuttle L.F. at Cape Canaveral, with scientists and test subjects selected among the public and extensively trained on ground simulators and underwater by the SpaceLand engineers a few days before the flight at the SpaceLand training camps. One Mars-gravity, two-Moon-gravity and twelve Zero-gravity parabolas where flown, as pictured in the attached diagram.

This paper features also other interesting results from neurovestibular and acupressure technique tests uses on board and casts some promising light on the future of stem cells and chemiotherapy research in weightlessness.



93-year-old test subject ECG during SpaceLand research flight April28, 2007 in Mars-G,Moon-G, 0-g
jointly with Polo Tecnologico Fondaz. Don Gnocchi Milano Italy

Next series of OPEN SpaceLand Missions shall be implemented
every 3 months from Winter 2009 at NASA KSC and in EUROPE

- Open to children from 8 years of age up to elderly passengers as old as 95 years of age, including people with physical disabilities
- Full insurance coverage of 1 Million USD per passenger, as for standard commercial airplanes
- *Mission profile:* from 20 to 40 flight phases characterized as follows (where *G equals* = $9.81\ m/s^2$):
    - Zero-G periods lasting 20 seconds each for a total of more than 13 minutes of Zero-G
    - Lunar-G periods (0.16 G) lasting 30 s each for a total of up to 20 minutes of Moon-G
    - Martian-G periods (0,32 G) lasting 40 s each for a total of up to 26 minutes of Mars-G

- Up to <u>6 (six) flights per week</u>
- Refurbishment and experiments turnover in <u>2 hours</u>
- *<u>On board resources</u>*
    - Seats for 35 passengers (scientists, managers, students, space-tourists)
    - Six fixed video-cameras
    - Electrical power: 110 V - 60 Hz
    - NASA & Federal Aviation Administration (FAA) *9-G-qualified* accommodation racks
    - Experiment room: 15 m x 3.5 m x 2.2 m (to be confirmed w.r.t. to payload already booked)
    - Pilots, coaches, flight surgeon, safety and operations engineers
    - Further resources available upon request

<u>Logistics</u>
<u>Selection of experiments and flyers</u>: first by Internet-first (pass-no pass on experimental procedures and operational characteristics and, for humans, check on medical and ethical requirements) followed by individual interviews
<u>Basic Training</u>: 2-day underwater & ground psycho-physical and operational training tests in the SpaceLand Camps in Italy, starting with medical tests and a new stress-ECG (providing a valid "*sport competition for water-diving*"-medical certificate is mandatory); such training is carried out in the form of a shortened astronaut basic training period, in order to formally qualify the candidates to fly
<u>Advanced Training</u>: 1 or 2 day (depending on experiment complexity) carried out in multi-axis trainers, Space Shuttle simulators, Moon-walkers, deep neutral buoyancy tanks, microgravity wall training, etc. in order to prepare in particular for kinematics and dynamics in Moon-gravity and Mars-gravity and go through experimental procedures on the experimental hardware flight model
<u>Mission Training</u>: 1 day rehearsal, in particular on experiment procedures using the experimental hardware flight model and then integraton with Flight Readiness Review and Safety Review in the aircraft
For complex payload – experimental hardware, a longer process is needed, by implementing a PDR, CDR, Safety Review 1 system prior to QR and shipment to the AIV site nearby the the Flight Operations site
In alternative to the SpaceLand Basic & Advanced Training Camps in North of Italy and Belgium and Mission Training & Flight Operations at KSC Florida, from late Summer 2009 all of this might likely takes place in Italy, with the support of the national space agency.
Provision, directly and/or through SPACELAND industrial support contractors, of the following services related to a SPACELAND Lunar/Martian/Zero-Gravity research & educational flight campaign:

1. Program management
2. Aerospace authorities interface management
3. Industrial subcontractor management
4. SpaceLand campaign requirements analysis and feasibility study tailored to customers' requirements
5. Study contract, world plan definition, implementation and reporting
6. Support to preliminary experimental payload design
7. Support to experiment payload-to-system interface analysis and analytical integration
8. Support to detailed payload and subsystems design
9. Support to experimental hardware engineering and development
10. Overall mission system engineering
11. Support to hardware assembly integration, verification and qualification
12. On-board physical and functional integration
13. Flight crew selection and basic training
14. Mission-specific training
15. Overall mission and hardware certification with aviation and airport authorities
16. Support to on-board research hardware/software - payload and system operations
17. Zero-G vehicle and crew shuttle commissioning, management and operations support
18. Ground and flight facilities commissioning
19. Mass media (if required) and monitoring equipment integration and operational support
20. Insurance services via vehicle owner/operator
21. Pilot crew, coaches and technicians services
22. Flight crew logistics and ground shuttle services at Cape Canaveral
23. Hotel accommodation support services at Cape Canaveral
24. Mission operations support together with vehicle owner/operator
25. Support to flight-related medical drugs provision
26. On-board medical assistance
27. Flight suits provision
28. Pre.flight data collection and operations
29. Post-flight data collection and operations
30. Mission science debrief support

World's 1st disabled woman testing hand-free ICT experiments

Kim Marco (11 yr-old) being sampled for Rita Levi-Montalcini Foundation / EBRI (European Brain Research Institute), CNR and Istituto Superiore della Sanità

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PARTICLE TRACING OF 3D FLUID FLOWS

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We report on results of computer modelling of a liquid flow and of dynamics of the particles, non-isodense with respect to the liquid, entrained by the convective flow in enclosures. We analyze motion of both liquid and solid tracers in a cubic cell filled with a liquid subject to translational vibrations in presence of the temperature gradient. We compare results on particle tracing with the experimental observations obtained during the parabolic flight experiments [1]. A numerical study of the dynamics of solid tracers helps us to understand the experimentally recorded trajectories of particles. Three-dimensional and time variable velocity field was calculated via solving system of full Navier-Stokes equations. Assuming that we have a dilute suspension of rigid spherical particles, we employ a simplified form of the Maxey-Riley model for describing their motion. This equation was integrated in time using algorithm based on fourth degree Runge-Kutta method and linear interpolation of velocity from the computational grid's nodes onto the particle's current location. This approach was proven to be accurate (see [1]). The work was carried out in frame of preparation of IVIDIL international experiment to be performed on board the International Space Station.

REFERENCES

1. Mialdun A., Ryzhkov I. I., Melnikov D., Shevtsova V. Experimental evidence of thermal vibrational convection in a non-uniformly heated fluid in a reduced gravity. 2008, Phys. Rev. Lett.; 101, 084501.
2. Melnikov, D. E. and Shevtsova, V. M., "Liquid Particles Tracing in Three-dimensional Buoyancy-driven Flows", FDMP: Fluid Dynamics & Materials Processing, Vol. 1, No. 2, pp. 189-200 (2005).

STUDENT CONTEST

INFLUENCE OF THE VISUAL INPUTS ON THE CARDIOVASCULAR SYSTEM CONTROL DURING MICROGRAVITY INDUCED BY PARABOLIC FLIGHT

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Otolithic control of the cardiovascular system is now well established in terrestrial environment [1, 2] and during parabolic flights [3]. In vestibular lesioned cats, removal of the visual cues worsens blood pressure stability during nose-up tilt [4]. In Man, Wood and al. [5]
showed significant decreases in mean blood pressure during illusory tilt, simulating a passive head-up tilt, on several subjects. These transient responses are consistent with the hypothesis that visual-vestibular input contributes to the initial cardiovascular adjustment to a change in posture in Humans. Then, the aim of our study was to investigate the effects of visual inputs on the cardiovascular system in Human during microgravity (which causes an otolithic inactivation) induced by parabolic flight (Fig. 1). Fifteen healthy volunteers (13 males and 2 females, 26.8 ± 6 years) were studied in supine position, the head aligned with the trunk (Fig. 2), during three parabolic flight campaigns supported by the French Space Agency (CNES). Two different visual stimulations were applied in 1 g and 0 g: the normal visual environment of the aircraft (open condition) and a virtual visual environment (static condition) which was given by a head mounted display. Gravity, arterial blood pressure and heart rate (HR) were continuously measured during the flight (Fig. 3). During normal gravity (before each parabola) and last ten seconds of microgravity phase (during each parabola), calf blood flow (CBF) was measured by strain
gauge plethysmography. Mean arterial pressure (MAP) and calf vascular resistance (CVR) were calculated for each CBF measurement. All the data were statistically analyzed by a 2 way repeated measure analysis of variance with Holm-Sidak method. In open condition (Fig. 4), microgravity induced a significant decrease in MAP by 18% ($P<0.001$). HR was significantly increased by 7.3% ($P<0.01$) and CBF was strongly increased by 42.6% ($P<0.01$) during 0 g periods. Thus, the CVR was significantly decreased by 37% during microgravity ($P<0.001$). In static condition (Fig. 4), microgravity produced the same significant decrease in MAP ($P<0.001$) and CVR ($P<0.001$) than in open condition but HR and CBF were not altered ($P=0.305$ and $P=0.132$ respectively) during 0 g. Moreover, our results showed a significant interaction ($P=0.039$) between gravity environment (1 g or 0 g) and visual condition (open or static condition) for CBF.

Decrease in MAP and CVR might be related to the increase in central baroreceptors stimulation induced by a blood shift in the thoracic compartment, and/or the otolithic inactivation. Whatever the origin, it might be related to a decrease in sympathetic activity which causes peripheral vasodilatation. Depending on visual cues, HR and CBF increase or not during microgravity indicating that visual inputs are used to modulate the cardiovascular activity in the absence of otolithic stimulation.

1. Normand H, Etard O and Denise P. Otolithic and tonic neck receptors control of limb blood flow in humans. J Appl Physiol, 1997, 82(6): 1734-8.
2. Shortt TL and Ray CA. Sympathetic and vascular responses to head-down neck flexion in humans. Am J Physiol, 1997, 272(4 Pt 2): H1780-4.
3. Herault S, Tobal N, Normand H, Roumy J, Denise P and Arbeille P. Effect of human head flexion on the control of peripheral blood flow in microgravity and in 1 g. Eur J Appl Physiol, 2002, 87(3): 296-303.
4. Jian BJ, Cotter LA, Emanuel BA, Cass SP and Yates BJ. Effects of bilateral vestibular lesions on orthostatic tolerance in awake cats. J Appl Physiol, 1999, 86(5): 1552-60.
5. Wood SJ, Ramsdell CD, Mullen TJ, Oman CM, Harm DL and Paloski WH. Transient cardio-respiratory responses to visually induced tilt illusions. Brain Res Bull, 2000, 53(1):25-31.

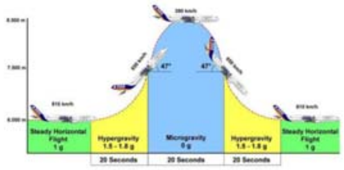

Fig. 1: Representation of one parabola during parabolic flight

Fig. 2: Photography of the experimental installation during parabolic flight

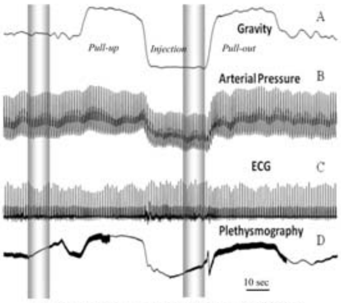

Fig. 3: Typical record of our experiment during one parabola

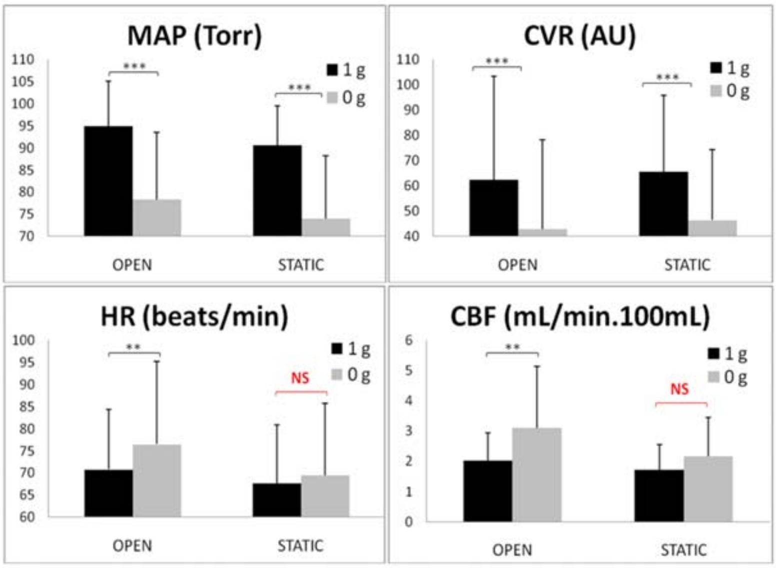

Fig. 4: Histograms of MAP, HR, CVR and CBF in static and open condition during 1 *g* and 0 *g* phases

PHYSIOLOGICAL RESPONSE TO TEMPORARY CHANGES IN GRAVITY CONDITIONS ON PLANTS

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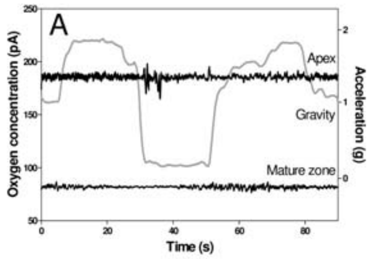
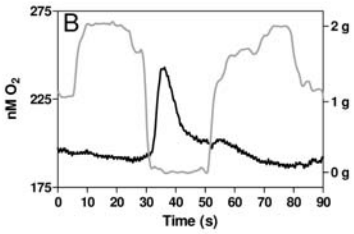
Gravity is the main factor that influences the direction of growth of plant organs, and has also a direct effect on the plant metabolism. When an organ, mainly roots, is turned by between 0° (vertical) and 90° (horizontal), the change of orientation is perceived by its organs producing the so-called gravitropic reaction (Perbal and Driss- Ecole, 2003), which involves a strong metabolic response. In order to study these reaction in real microgravity conditions, some experiments have been set up during six ESA parabolic flight campaign. Oxygen concentration in the solution where roots of Zea mays were placed have been constantly monitored during normal, hyper- and microgravity conditions. An evident burst in oxygen fluxes started just 2.0 ± 0.5 s after the imposition of microgravity conditions. No significant changes were noticed neither in normal nor in hypergravity conditions. Moreover, oxygen bursts were detected only in the root apex zone The significance of these results is dramatic on the nature and location of the graviperception. This spike-like activation/deactivation of oxygen when growing roots were exposed to microgravity situation can be detected at each parabola with the same results, whereas the hypergravity situations, which are imposed inbetween, do not intefere with the microgravity-induced bursts.

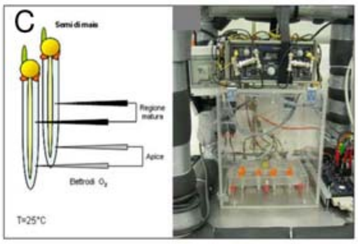
Concerning the different location of the selective oxygen microlectrodes, oxygen bursts happened only in the root apex, whereas no changes in the physiological activity was never identified in the mature zone of the root, showing a clear role of the root apex region in detecting environmental changes, which is the case of microgravity conditions. Moreover, control treatments without roots showed no responses in both the microelectrodes placed at root apex and mature region levels confirming the real and effective role of root apex. Concurrently measurments of oxygen consumption of root apex were done using oxymeters, a difference in oxygen consumption was aspected during the different gravity conditions, but measurments revealed the onset of long lasting oxygen bursts appearind only during microgravity, demonstrating once again the result obtained with the oxygen electrodes.

Although the chemical nature of these oxygen bursts is sill unknown, they may implicate a strong generation of reactive oxygen species as they exactly match the microgravity situation. Thus, our data strongly suggest that the sensing mechanism is not related to a general mechano-stress, which was imposed also during hypergravity, but is very specific of the microgravity situation. Moreover, it is well-known that stress rapidly induces reactive oxygen bursts which are associated with oxygen influx and reactive oxygen efflux from stressed plant tissues.

Thus, our data indicate that microgravity represents a stress situation for plants, especially root apices and these bursts, probably ROS, are initiating and integrating adaptive responses of plant roots which resemble other unrelated stress situations.
A parallel experiment has been done using the MEA (Multi-Electrode Array) System in order to examine synchronized electrical activities under temporary changes of gravity conditions. As no previous data on the use of MEA system in microgravity conditions have been ever reported in literature, one of the main goals was to check the capability of the system to optimally perform continuous monitoring of root electrical activity. Results showed a clear overall root electrical activity, with differences in rates observed both during the same flight and among different ones. Moreover, the electrical activity (namely spike rate) tended to be significant lower in microgravity in comparison with the normal conditions, while hyper-gravity conditions seemed to be less effective in decreasing the spike rate. As a conclusion, the trial was successful, with gravity changes proving to affect spike rate generated by maize root tips. Further analysis will be conducted to investigate the correlations between the changes in gravity conditions and the appearance of synchronous phenomena.



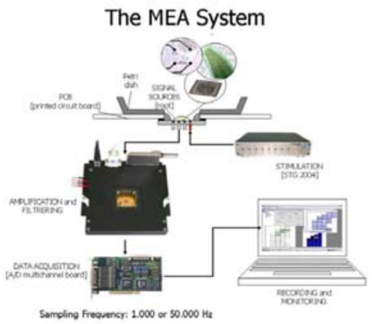


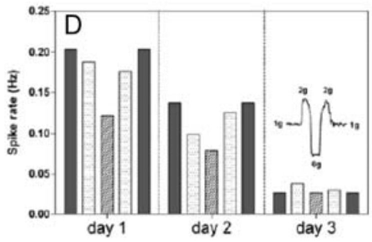


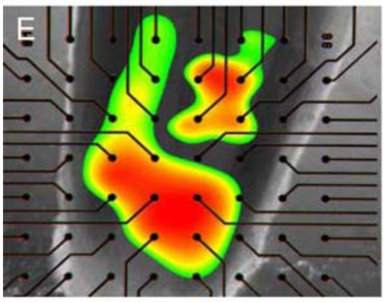
A - Oxygen spikes are detected during a microgravity event only in the apical region, whereas in the mature zone oxygen concentration remains constant

B –Oxygen consumption of six root apex in a saline medium has been measured in a close chamber, and significant oxygen bursts are recorded only during the microgravity condition

C - Scheme of oxygen electrodes positioning in the apical and mature zone of maize seedlings







D – Average electrical activity per second (Hz) Roots showed a clear and detectable overall electrical activity during each experiment. Differences in rates were observed both during the same flight and among different ones. In the first case, differences seemed to be related to the changes in gravity conditions whereas in the latter one were probably due to different sample biological spontaneous activities. Correlations between spikes and acceleration were analyzed. Results showed that the electrical activity (namely spike rate) tended to be significant lower in 0g in comparison with the normogravity conditions.

E – Root apex electrical activity detected in specific elecrodes of the MEA System

VESTIBULAR LOSS INDUCES BONE LOSS: IMPLICATION IN LONG-DURATION SPACEFLIGHTS

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Introduction Bone loss (BL) reported in astronauts is a major problem for long-term spaceflights[1;2]. The changes of mechanical and proprioceptive stimuli in microgravity can only explain one part of BL. We recently highlighted the influence of the vestibular system on bone remodeling under normogravity environment3. Here, we aimed to quantify the proportion and localization of BL induced by irreversible vestibular deafferentation and to look for a gender difference. The second objective was to test two pharmacological countermeasures: a bisphosphonate (risedronate) and a non selective beta-blocker (nadolol). Methods Females and males rats were respectively experimented as followed: i) Shamovariectomized (Sh ovx) and ovariectomized (Ovx) ± risedronate, Sham-bilabyrinthectomized (Sh bilab) and bilabyrinthectomized (Bilab) ± risedronate, Sh bilab ± nadolol and Bilab ± nadolol ii) Sham-orchidectomized (Sh orch) and orchidectomized (Orch) ± risedronate, Shambilabyrinthectomized and bilabyrinthectomized ± risedronate. Risedronate and nadolol were administrated per os for the first month of the study respectively at dose of 35mg/kg/week and 20 or 100mg/kg/day. BL was evaluated at 0, 1, 2 and 4 months by tomography for whole body (WB), spine, distal femoral epiphysis (DFE) and femoral diaphysis (FD). BL was also measured for trabecular and bone volumes and thickness by micro-CT at 1 month. Biological markers of bone synthesis or resorption (alkaline phosphate [AP] and cross-linked C-terminal telopeptides [CTX] respectively) were measured from serum at 0, 1 and 2 months. Bilabyrinthectomy was performed by bilateral injection of 0.1mL of p-arsanilic acid at 50mg/L. Results BL was homogeneously reported (WB, spine, FD and DFE) in Ovx and in a lesser extend in Orch at 1 and 2 months. BL was selectively observed on DFE in Bilab (- 13.0% in female and -11.9% in male) and on FD in Bilab female group at 1 month and persisted on DFE in Bilab until 4 months (-10.6% in female and -3.5% in male) (figure1). BL was observed by tomography but no microarchitectural differences were observed with micro- CT. AP was increased in Ovx and female Bilab compared to Sh groups at 1 and 2 months as it did in Orch and male Bilab at 1 month but in a lesser extend. CTX was increased both in gonadectomy and Bilab groups compared to sham without gender difference at 1 month (figure2). Risedronate over couterbalanced BL in gonadectomized and Bilab groups. Nadolol at 20mg/kg/day normalized bone mineral density in Bilab groups on DFE and FD while it counteracted BL on FD only at 100mg/kg/day (figure3). Conclusion we showed that irreversible inhibition of the vestibular inputs induced strong regional BL focused on bearing bones with gender difference compared to a model of diffuse osteoporosis. BL was prolonged over 4 months later and reported on bone mineral density without changes on bone morphology. BL was counterbalance by nadolol suggesting a sympathetic pathway via the osteoblasts for vestibular related bone modeling. Moreover a bisphosphonate (inhibition of osteoclasts) is encouraging for application during long-term space travels.

1. Leblanc, A.D., "Skeletal responses to space flight and the bed rest analog: a review", Journal of musculoskeletal & neuronal interactions, Vol. 7, pp. 33-47, 2007.
2. Sibonga, J.D., "Recovery of spaceflight-induced bone loss: bone mineral density after long-duration missions as fitted with an exponential function", Bone, Vol. 41, pp. 973-978, 2007.
3. Levasseur, R., "Labyrinthectomy decreases bone mineral density in the femoral metaphysic in rats", Journal of vestibular research, Vol. 14, pp. 361-365, 2004.

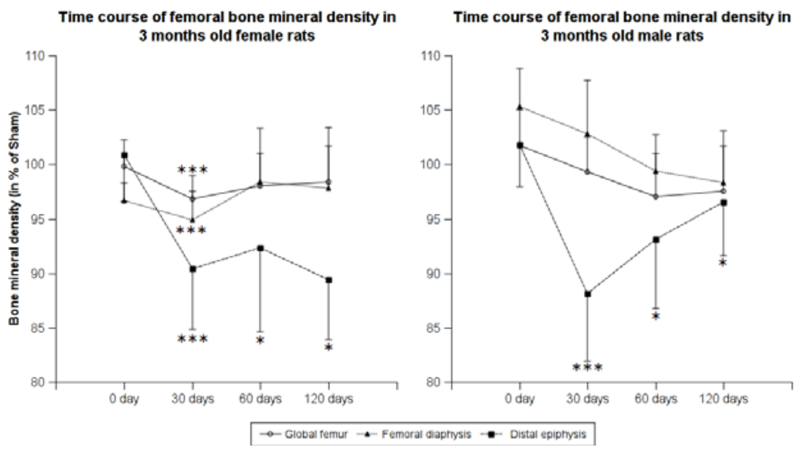

Figure1: Time course of BMD femoral bone (global femur, distal femoral epiphysis and femoral diaphysis) in male and female bilabyrinthectomized.

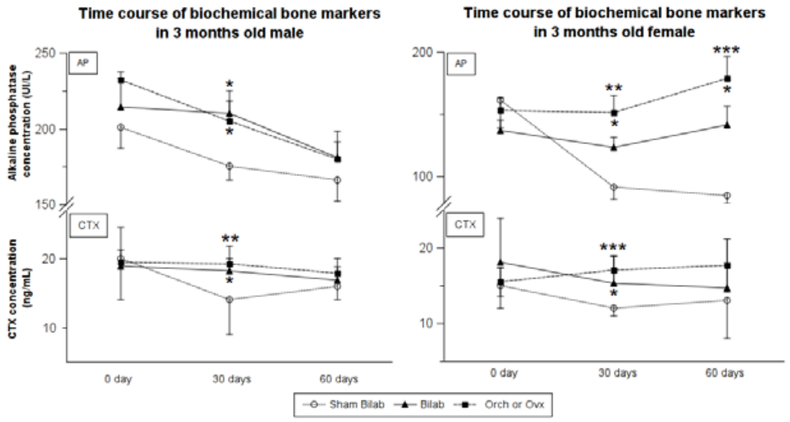

Figure2: Time course of biochemical bone markers (alkaline phosphatase, AP and crosslinked C-terminal telopeptides, CTX) in male and female bilabyrinthectomized

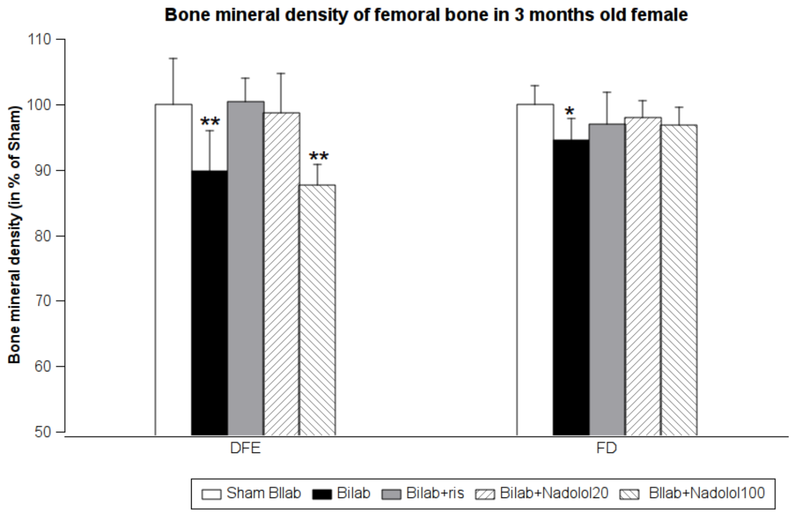

Figure3: BMD of distal femoral epiphysis (DFE) and femoral diaphysis (FD) measured by tomodensitometry 1 month after bilabyrinthectomy in female group

EXPERIMENTAL ANALYSIS OF THE BUBBLE-SLUG TRANSITION IN A MINICHANNEL IN MICROGRAVITY CONDITIONS

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Extended abstract

Three main different flow patterns were found for twophase gas-liquid flow in microgravity conditions: bubble, slug and annular flow [1,3]. Each of these patterns presents unique features that made it interesting for variety both scientific and technological applications. And even if several method have been proposed in the past to define the two-phase flow patterns [4,7], a better understanding of it is still required. To such end, further studies regarding the mechanisms of transition between regimes are essential.

This work is focused in the experimental study of the bubble-slug transition in minitubes on ground in microgravity conditions. A previously presented injector [8], where water and air are injected in a 1 mm capillary T-junction, was used. The generation and detachment of the minibubbles is provided by the liquid cross-flow (Fig. 1-a). In nominal conditions small Bond number and small Weber number are achieved for an air/water mixture flow. Therefore, capillary forces dominate over buoyancy and inertial forces [9].

We performed experiments at several water volumetric flow rates values ranging from Q_l = 2 up to 80 ml/min. For each value of Q_l a large number of values of air volumetric flow rates Q_g, ranging typically from 0.25 to 80 ml/min, were employed. For each chosen couple of values Q_l, Q_g images were taken by the high velocity camera. Analysis of the films permitted to measure the gas velocity, U_G, and additionally to classify the obtained flows in bubble or slug type. Churn and annular flows were also observed, but are not considered here.

The bubble-slug transition is very susceptible to the investigator subjectivity. In order to overcome this difficulty, we considered that the bubble-slug transition occurs when the minibubble diameter is larger than 1 capillary diameters, according with the classification proposed by Dukler et al [1]. Fig. 1-a and 1-b show representative photographs of slug and bubbly flows. No pattern with simultaneously the characteristics of bubbly and slug flow was observed in our experiments in any case.

Fig. 2 shows the gas velocity, U_G, with respect to the mixture velocity, $U_{SG}+U_{SL}$, being U_{SG} and U_{SL} the superficial gas and liquid velocities, respectively. A simple linear relation holds in its dependence on the mixture velocity and therefore a drift-flux relationship can be assumed [3]:

$$U_G = C_0\left(U_{SG} + U_{SL}\right) \tag{1}$$

where C_0, the distribution coefficient, fits to the value 1.22. A consequence of the previous conclusion is that the transition may be expressed as

$$U_{SL} = U_{SG}\frac{1 - C_0\alpha_c}{C_0\alpha_c} \tag{2}$$

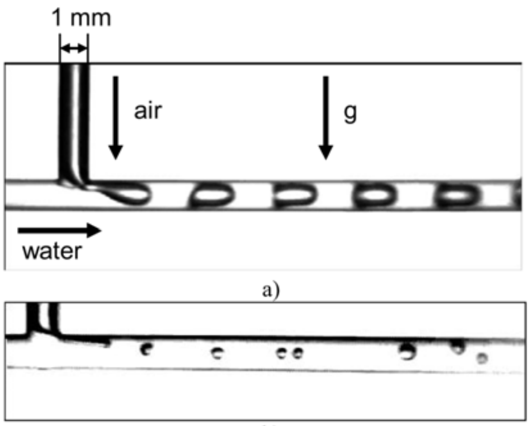
being $\acute{\alpha}_c$ the required critical value of the void fraction for the bubble-slug transition to occur. A two-phase flow bubble/slug patterns map based on the gas/liquid superficial velocities is plotted in Fig. 3 by using our experimental data. As shown, the data fit well for the bubbly and slug regions of the map for c= 0.2.

Finally, with U_{SG} and U_G known, the mean void fraction can be determined as follows:

$$\varepsilon = \frac{U_{SG}}{U_G} \tag{3}$$

Fig. 4 shows the void fraction calculated with Eq. 3 vs. the gas/liquid superficial velocities ratio, U_{SG}/U_{SL}. Again, the data corresponding to the bubble and slug flow fit well to the plotted 0.2 void fraction line.

Further details and comparison of the experimental data withnowadays data and models will be provided at the congress.



a)

b)

Figure 1. Representative photographs of flow patterns in the 1 mm circular diameter tube: a) slug flow; b) bubbly flow.

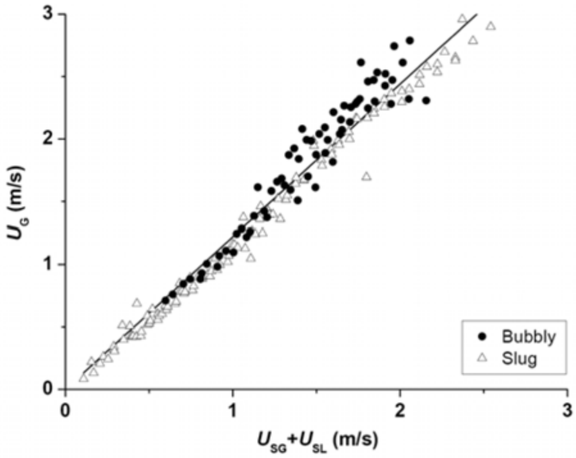


Figure 2. Gas velocity vs. mixture velocity. *Symbols:*experimental results, *line:* linear fit.

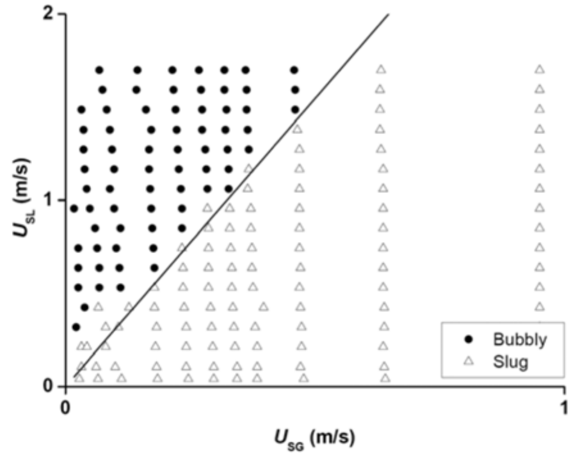


Figure 3. Bubbly and slug flow patterns. *Symbols:* experimental results, *line:* transition line corresponding to void fraction equal to 0.2.

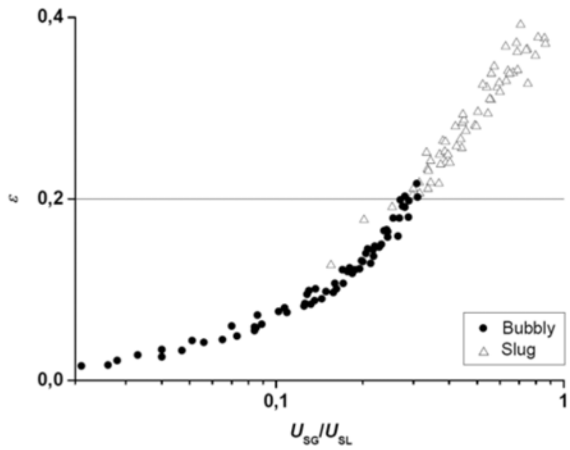


Figure 4. Void fraction vs. gas/liquid superficial velocities ratio, *USG/USL*. *Symbols:* experimental results, *line:* void fraction corresponding to 0.2.

Acknowledgements

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References

[1] A.E. Dukler, J. A. Fabre, J. B. McQuillen, R. Vernon, Gasliquid flow at microgravity conditions: flow patterns and their transitions, International Journal of Multiphase Flow 14 (1988) 389–400.
[2] Zhao, J.F., A review of two-phase gas-liquid flow patterns under microgravity conditions. Adv. In Mech. (Chinese) 29 (1999) 369-382.
[3] J. McQuillen, C. Colin and J. Fabre, Ground-based gas-liquid flow research in microgravity conditions: state of knowledge, Space Forum 3 (1998) 165-203.
[4] C. Colin, J. Fabre, A. E. Dukler, Gas–liquid flow at microgravity condition – I (dispersed bubble and slug flow), International Journal of Multiphase Flow 17 (1991) 533–544.
[5] L. Zhao, K. S. Rezkallah, Gas–liquid flow patterns at microgravity conditions, International Journal of Multiphase Flow 19 (1993) 751–763.
[6] W. S. Bousman, J. B. McQuillen, L. C. Witte, Gas–liquid flow patterns in microgravity: effects of tube diameter, liquid viscosity and surface tension, International Journal of Multiphase Flow 22 (1996) 1035–1053.
[7] S. S. Jayawardena, V. Balakotaiah, L. C. Witte, Flow pattern transition maps for microgravity two–phase flows, AIChE Journal 43 (1997) 1637–1640.
[8] S. Arias, X. Ruiz, L. Ramírez-Piscina, J. Casademunt and R. González-Cinca, Experimental study of a microchannel bubble injector for microgravity applications, Microgravity – Science and Technology 21 (2009) 107-111.
[9] J. Carrera, X. Ruiz, L. Ramírez-Piscina, J. Casademunt and M. Dreyer, Generation of a monodisperse

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MICROPARTICLES FOR PROBING THE PLASMA SHEATH DURING HYPERGRAVITY CONDITIONS IN A CENTRIFUGE

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In the region between a conducting solid surface and a quasi-neutral plasma, electric space charge fields build up due to the difference in mobility between electrons and the much heavier ions. This region is called the “plasma sheath”. As it is for many applications very important to understand the structure of the plasma sheath, many researchers have proposed sheath models [1-3]. Electrical fields in the sheath have been measured and reported in the literature [4]. Those measurements were based on Stark splitting and Stark shift. Another method to investigate the sheath region is based on temporally resolved probe measurements [5]. These probe measurements are far from ideal as they influence the local electric field themselves. We present a novel diagnostic tool to obtain the electric field and potential profile within the plasma sheath by means of microparticles inserted in a plasma under hypergravity conditions in a centrifuge. Once microparticles are inserted into the plasma, they become highly negatively charged and will be confined at a certain position in the sheath due to equilibrium between several forces. The dominant forces appear to be the electrostatic force and the gravitational force, which are equal in size when the particles are in their equilibrium position. Measuring the equilibrium position and solving the force balance on the particles give the value of the electric field at the position of the particles. Increasing the apparent gravity with the centrifuge changes the position of the particles, and, as the charge on the particle is assumed as being constant, the electric field at the new position can be calculated. As it is possible to vary the apparent gravity over a wide range, the electric field and the potential profile can be scanned over the whole sheath thickness. The experiments are carried out in a Plexiglas cubic (20x20x20 cm) vacuum vessel containing a capacitively coupled low pressure (20-100 Pa) argon RF discharge. The 13.56 MHz RF input power of ~10 Watt is applied to the lower of two parallel plate electrodes. Al_2O_3 microparticles with a radius of 2.5 μm are illuminated by an expanded 532 nm laser beam, and their position above the powered RF electrode is measured on-flight by a CCD camera. The whole setup is mounted on the end of one of the arms of the centrifuge. The used centrifuge is extensively described in Ref. [6]. The apparent gravity ranges from 1-10 times normal gravity (g). First measurements show a linearly decreasing particle position with increasing apparent gravity (see figure 1). Calculations from these data show that the electric field is linear in the sheath region as well. The experimental results show good agreement with the commonly accepted sheath model, predicting a linear electric field in the plasma sheath. In figure 2 the electric field determined by our experimental method is plotted together with values calculated from such a sheath model. These first measurements prove that this novel diagnostic tool allows us to measure the sheath electric field accurately.

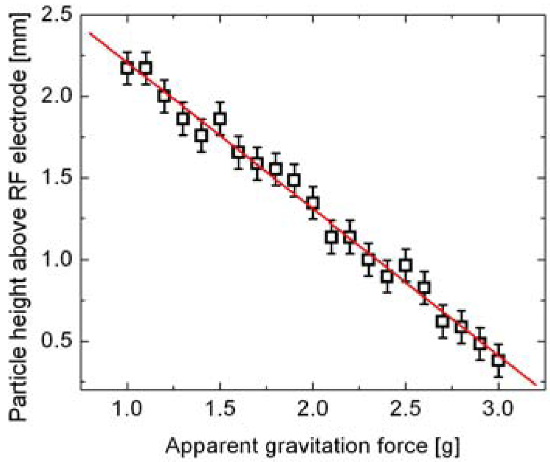

Figure 1: Particle height above the powered electrode as function of the apparent force, showing a linear behaviour.

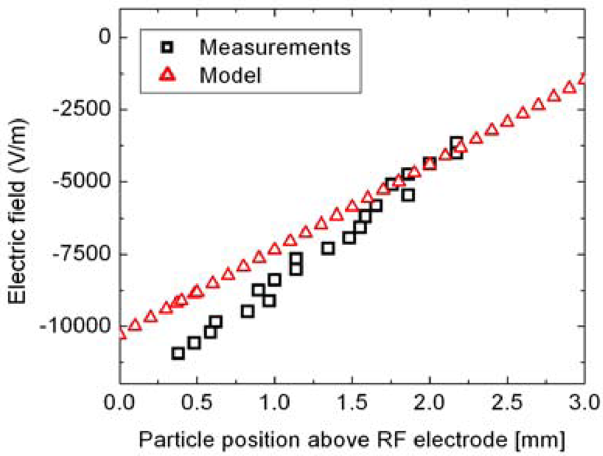

Figure 2: Electric field as function of the position above the powered electrode determined experimentally with microparticles in plasma under hypergravity conditions, compared with values predicted by the generally used sheath model.

References

1. Godyak V A and Stemberg N 1990 *Phys. Rev.* A **42** 2299

2. Bornig K 1992 *Appl. Phys. Lett.* **60** 1553

3. Edelberg E A and Aydil E S 1999 *J. Appl. Phys.* **86** 4799

4. Booth JP, Derouard J, Fadlallah M, Cabaret L and Pinard J 1996 *Optics Communications* **132** 363-370

5. Yamada H, Murphree D L 1971 *Physics of Fluids* **14** Issue: 6 1120

6. Flikweert A J, Nimalasuriya T, Kroesen G M W, Stoffels W W 2007 Plasma Sources Sci. Technol. 16 606-613

GRAVITY DEPENDED BEHAVIOUR OF GRANULAR MATTER IN DROP-TOWER EXPERIMENTS AND CREATION OF DIFFERENT GRAVITY LEVELS BY PARABOLIC FLIGHTS WITH AN UNMANNED AIR VEHICLE

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The behaviour of granular material for different gravity levels is of interest to gain an understanding of the surface of small bodies in the solar system. A set of experiments was performed in the drop tower Bremen. Dropping creates weightlessness and the desired acceleration for the experiment of 0.3, 0.1, 0.03 and 0.01 g0 (with g0 being the gravitational acceleration of the earth) was created as centrifugal acceleration by mounting the experimental set-up on a centrifuge. The centrifuge has a diameter of 0.6 m and rotates at a well-defined speed. Two different types of sand and spherical basalt and glass grains were filled in an evacuated quasi-2d hourglass. The experiment was recorded with a high-speed camera that records 231 images per second with a resolution of 1024x1024 8-bit black-and-white pixels. Due to the high recording rate, it was possible to track the trajectory of individual basalt grains. The flow velocity and the total depth of the flow layer was determined. A software motion detector (see Fig. 1) identifies the depth of the flow layer for all used particles.

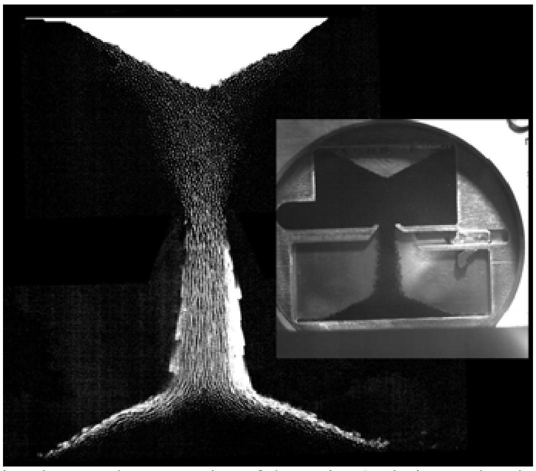

Fig. 1 The motion detector detects motion of the grains (main image, basalt spheres at 0.01 g0) from the recorded video (insert). Brightness of grains indicates speed, the white triangle at the top shows the area drained of grains to calculate the granular volume flow. Relevant angles are also measured from the processed image.

Friction angle in the lower chamber and repose angles in the upper chamber were evaluated. The volume flow through the hourglass was determined. It is perfectly constant over time and depends on the gravity level. According to theory the volume flow depends on the square root of gravity. We found an exponent of 0.6 for basalt and 0.7 and 0.8 for two different kinds of sand (see Fig. 2).

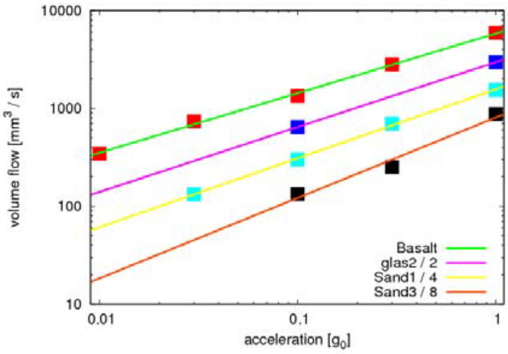

Fig. 2 Volume flow through the hourglass depending on gravity level and grain type. To increase readability some measurements are scaled to avoid overlapping.

Also a box filled with granular matter was mounded on the centrifuge. An avalanche occurred and was recorded with a PAL video camera. Width, steepest slope and time from launch until expiration as a function of gravity were determined for sand, basalt and glass grains (see Fig. 3). To gain easy access to different gravity levels, we developed the unmanned air vehicle ISAAC (see Fig. 4) suitable for small parabolic-flight experiments.

The experiment can be exposed to g-levels from 0 g0 to 5 g0 in any combination multiple times during the same flight. Duration depends on desired acceleration level, e.g. 16 seconds zero-gravity or 21 seconds at 0.38 g0 (Martian surface level). The aircraft has a mass of 24.9 kg (including 5 kg payload) and a wingspan of 2 m. It is powered by a jet engine with an exhaust speed of 450 m/s providing a thrust of 190 N which is sufficient for a flight speed of 100 m/s. The desired acceleration is achieved by an on-board closed-loop control system. The aircraft can legally be operated from any model aircraft field certified for 25 kg model aircraft.

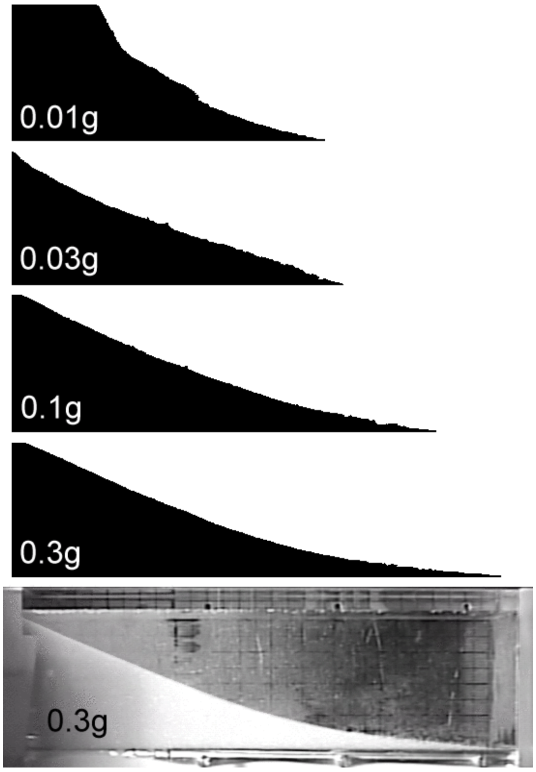

Fig. 3 Avalanche of glass grains at different levels of gravity. The first four images show binarized data, the last is shown as recorded by the PAL video camera.

Fig. 4 Our 24.9 kg UAV ISAAC during a test flight.

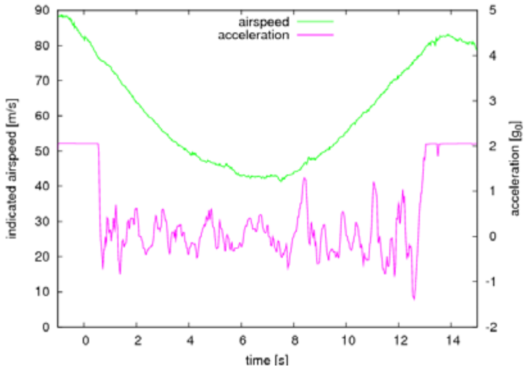

Fig. 5 Vertical acceleration and air-speed measured by ISAAC. The average acceleration is zero, reduction of temporary disturbances still offers some room for improvement. The precise air speed sensor allows analysis of localized weather effects.

EFFECT OF SPACE CONDITIONS ON NEURONAL MORPHOLOGY

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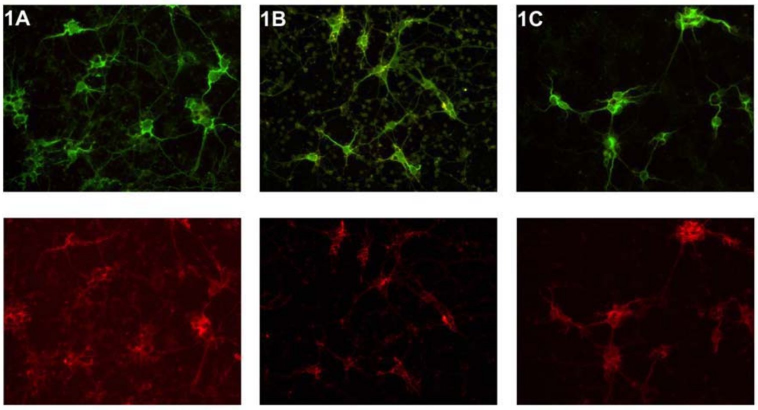
Due to the cosmic environment a space travel is known to induce various deleterious effects on astronauts (1;2). The aim of this work is to investigate the particular effects of space conditions on the mature neuronal network in order to evaluate the risk of long space missions (like aboard the International Space Station (ISS) or towards Mars or short sojourns in the Space Shuttle or Soyuz) on human behavior. In particular, exposure of neuron cells to cosmic environment during long journeys could compromise neuronal plasticity and connectivity. In this context, the impact of microgravity and cosmic radiations are currently investigated at the cellular and molecular levels in established neuronal network. To study cell motility and internal transport, as well as neuronal network defects we use fetal mouse primary cell cultures (cultivated for 5 days) and mouse embryonic stem cells differentiated into mature neurons. The determination of the gene profiles and metabolic pathways involved in such stresses will allow to evaluate the health risk for astronauts and to develop new appropriate strategies for the maintenance of high behavioural and cognitive performances. Our preliminary results with fluorescence techniques show morphological alterations after exposure of mature neurons to radiation (180 µGy/day corresponding to a one day exposure on the ISS) (3) or simulated microgravity (Random Positioning Machine, RPM Dutch Space). Further gene expression experiments will allow to understand the effect of space conditions at the molecular level and will help to develop new appropriate strategies for the maintenance of highly performant neuronal network to prevent behavioural and cognitive defects.

Acknowledgments: This research is currently supported by the "Master & Back programme" from the Sardinian Government (AF-DR-A2008-67).



Pictures acquired after fluorescence staining with Nikon fluorescence microscope (20x magnification) coupled with color CCD camera. They show fetal mouse neuronal cells cultured for 5 days in control conditions (1A) as well as after exposure to an equivalent of 50 times ISS radiation dose (1B), or 1h of microgravity in RPM (1C). Green fluorescence indicates MAP2 stained with anti-MAP2 rabbit antibody as primary and FITC labeled anti- Rabbit antibody as secondary. Red fluorescence shows actin filament stai ed with TRITC labeled phalloidin. Qualitative analysis underlines a morphological difference between our experimental points and control. Neuron cells exposed to radiations (50 times ISS dose) (1B) show shorter and larger neurites than controls (1A). Neuron cells exposed to 1h of simulated microgravity (RPM) (1C) show a greater accumulation of MAP2 in the soma. Furthermore, neurites appear shorter and thiner than controls (1A).

References

(1) Cogoli A., "Cell Biology And Biotechnology In Space", ISBN: 0444507353, 2002.

(2) Cucinotta FA, Durante M., "Cancer risk from exposure to galactic cosmic rays: implications for space exploration by human beings". Lancet Oncol. 7(5):431-5, 2006.

(3) Vanhavere F., Genicot J.L., O'Sullivan D., Zhou D., Spurny F., Jadrnickova I., Sawakuchi G.O., Yukihara, E.G. "DOsimetry of BIological EXperiments in Space (DOBIES) with luminescence (OSL and TL) and track etch detectors". Radiation Measurements 43(2):694-697, 2008.

STUDY OF THE VESTIBULAR PART OF THE INNER EAR SENSORY SYSTEM: IG VERSUS OG

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Team: The Supaeronauts

Experiment achieved in October 16th, 2008 during the CNES Parabolic Flight Campaign.

In order to control the position of our body in space, nature has given us a fascinating and very sophisticated organ, the inner ear. Inside the inner ear, the system in charge of equilibration is called vestibular system. Each inner ear consists of five biological sensors: three angular (the semicircular canals) and two linear (the otolith organs) accelerometers, which enable the body to detect angular and linear motion of the head.

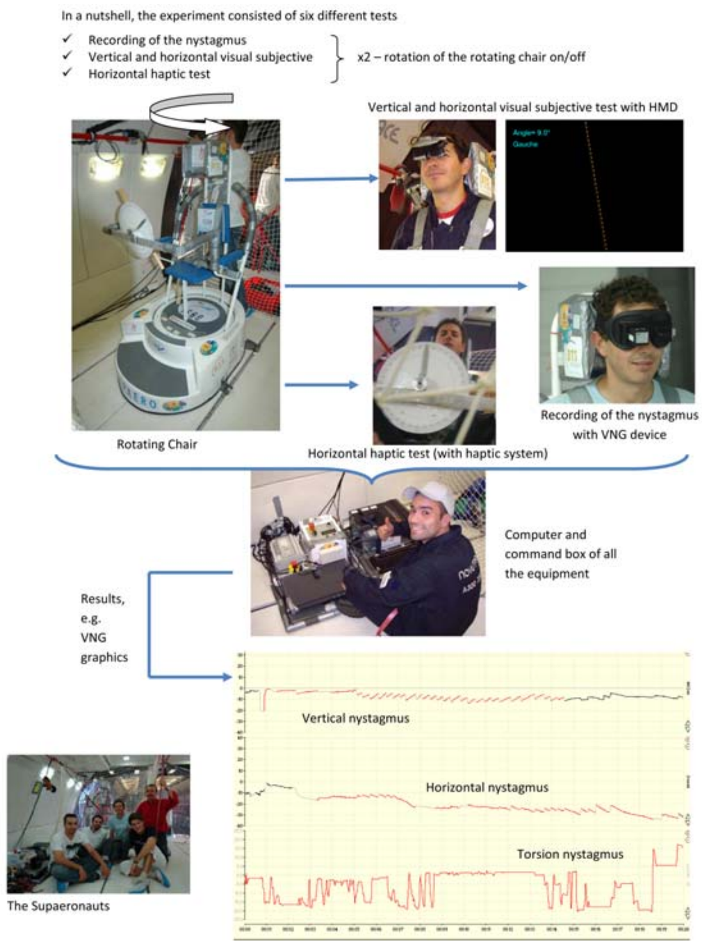
The goal of our experiment was to study the behavior of this sensory system under microgravity condition, and then to make a comparison with the same experiments performed on Earth. The Zero-G environment is very interesting for the gravity component, which continuously acts on the otolith organs, vanishes for about 20s. Our motivation was to understand how the vestibular system works in weightlessness - a fundamental issue for astronauts - as it is the key organ for spatial orientation.

Our experiment was first and foremost a student project. If our results are currently being analyzed by the physician we worked with, the results may not be as reliable as expected, as we had to do the tests on a Zero-G-trained CNES employee, whose inner ears turned out to be not medically sane, although he did not have any real equilibration problem. Therefore, the tests should be reproduced on several sane people and for a longer time - as we only flew 30 parabolas - to have better and more reliable results.

In order to achieve our goal, we designed an experimental protocol so as to test primarily the lateral semicircular canals and the otolith organs. This protocol consisted of two kinds of experiments. First, we recorded the nystagmus of the subject, i.e. the ocular reflex that reflects the stimulation of the vestibular system, under various stimulations. Then, we tested the subject perception of both horizontality and verticality.

In order to generate and control the stimulation of the subject we used a rotating chair, which is a common device used either for the rehabilitation of patient with equilibration related disease or for vestibular diagnosis. Basically, the subject is strapped on this chair while an operator controls the commanded rotational motions around the vertical axis. The ocular reflex of the subject was recorded by using a common medical device as well, called Video-Nystagmography (VNG) system which tracks the movement of the pupils. To measure both the vertical and horizontal perception of the subject we used a Head Mounted Display (HMD) device in which we projected a luminous tilted bar in a dark environment so as to avoid any other visual references. Then, the subject had to ask an operator to rotate the bar until he sees the projection as either vertical or horizontal. Finally, we also tested the horizontal perception of the subject by using a haptic (related to the perception of the body) bar mounted in front of a protractor - which basically looks like handlebars. The tilt angle was measured thanks to cameras.

To achieve this experiment, we collaborated with physicians, private companies and several medical institutions. It notably involved several sponsors who provided all the equipment: Integral Design (rotating chair), Colin ORL (VNG device + PC), Immersion (HMD), BTS Industrie (accelerometers) that we would like to thank again. We also want to mention the huge support of our university, SUPAERO, and of the hospital of Lamalou, without which we could not have made it.



DESIGN OF A MULTIBUBBLE SONOLUMINESCENCE EXPERIMENT FOR A MICROGRAVITY PLATFORM

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Co-authors: Eloi Cortés Catalan, Eduardo M. Fortes Galera
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Sonoluminescence (SL), consisting in the emission of light by an oscillating bubble which collapses under a high frequency sound wave was accidentally discovered in 1934. In order to produce SL, acoustic cavitation starting at nuclei inside the liquid (gas bubbles, solid particles containing small amounts of gas, or trapped gas at the walls of the recipient) is needed. When a standing sound wave is applied, a sinusoidal variation on the ambient pressure is imposed. When the pressure amplitude decreases to negative values, tiny bubbles are excited and start to grow. SL starts when a bubble is trapped by a standing wave, imposing the stable oscillation of the bubble, which usually increases its initial radius (see Figure 1).

Among fluid phenomena this transduction of sound into light is unique in that the energy enters the fluid at low energy and long wavelengths and it results to visible photons. A very high sound energy is concentrated, but only a small fraction of this energy ends up as visual photons. We present the experimental setup and procedure to carry out a set of experiments focused on the study of the effects of instabilities into a multibubble sonoluminescence (MBSL) system under controlled conditions. By means of an acoustic wave generation system connected to a flask containing water, a multibubble sonoluminesceing field will be initially generated, which presumably produces a different light intensity level in microgravity than in normal gravity. Later on, instabilities in the MBSL phenomenon will be induced through water and bubble jets injected into the system. We expect that liquid circulation and size and number of bubbles in the jets may influence the MBSL process inside the flask. The experimental setup is designed in order to be able to change the main parameters of the acoustic wave generation system (frequency and amplitude of the acoustic wave) and the injection system (liquid and gas flow rates). The flow rates used in the injection system fully determine the number and size of injected bubbles. The experiment is also designed to output information on the MBSL intensity. The data obtained will be compared to the results of a single bubble SL in microgravity experiment [1], MBSL experiment on ground [2], effects of injection of fluid flow on MBSL in normal gravity [3] and our ground testing. The experimental setup is composed by three main systems, which are the acoustic wave generation (creation of cavitation bubbles and bubble trapping), the flow injection system (which is controlled by liquid and gas flow rates) and finally the data acquisition system.

The acoustic wave generation system is composed by two PZT, fed by the function generator, to produce the sonoluminescence phenomenon. The flow injection system consists of two circuits, one of liquid and another of gas, joined by a T-junction. Finally, the data acquisition system consists of a hydrophone detecting the cavitation, a Photomultiplier Tube (PMT) capturing the SL intensity, the flask itself and a laptop monitoring the whole experimental setup (see Fig. 2) We expect that the influence of the input flow will either enhance SL intensity, making cavitation bubbles not to coalesce and start clustering because the flow breaks them up, or weaken it by making the instabilities of the bubbles increase. The benefits of flow circulation could be to prevent the shield effect and make bubbles stay at the pressure antinodes.

[1]. Thomas J. Matula. Single-bubble sonoluminescence in microgravity. Ultrasonics 38 (2000) 559–565.
[2]. G.J. Posakony, L.R. Greenwood, S. Ahmed. Stable multibubble sonoluminescence bubble patterns. Ultrasonics 44 (2006) e445–e449
[3]. Shin-ichi Hatanaka, Hideto Mitome, Kyuichi Yasui, Shigeo Hayashi. Multibubble sonoluminescence enhancement by fluid flow. Ultrasonics 44 (2006) 435–438.
[4]. S. Arias, X. Ruiz, J. Casademunt, L.Ramírez-Piscina, R. González-Cinca. Experimental study of a microchannel bubble injector for microgravity applications. Microgravity Sci. Technol (2009) 21:107-111

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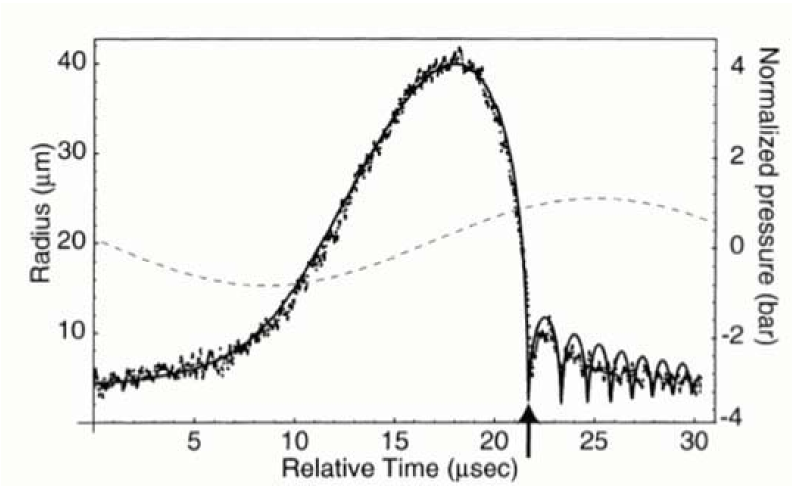

Figure 1: The nonlinear, radial response of a bubble in normal gravity subject to an oscillating acoustic pressure field of 0.14 MPa. The heavy line is the calculated bubble radius, the dashed line is the normalized acoustic drive pressure. The arrow indicates where, in the hydrodynamic motion of the bubble, the light flash occurs. Extracted from [1].

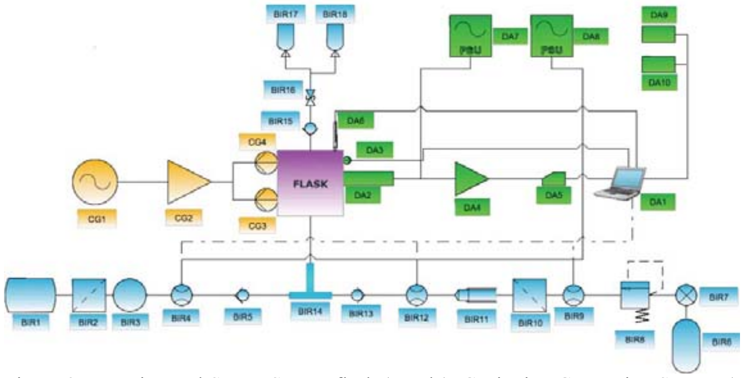

Figure 2: Experimental Setup: Square flask (purple), Cavitation Generation System (yellow) (CG3 and CG4: piezoceramic transducers); Data Acquisition System (green) (DA1: laptop, DA2: photomultiplier tube, DA3: piezoceramic hydrophone, DA6: thermometer, DA7: bench-top high voltage power supply, DA8: DC power supply, DA9 and DA10: accelerometers); Bubble Injection and Removal System (blue) (BIR3: water pump, BIR6: air bottle, BIR12: air mass flow meter, BIR14: T-Junction, BIR17 and BIR18: waste bags). More details on the gas and liquid injection system can be found in [4].

BUBBLES IN DIFFERENT LIQUIDS IN MICROGRAVITY AND OSCILLATING HIPERGRAVITY ENVIRONMENTS

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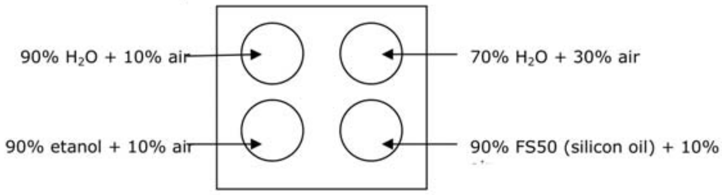
We present experimental results on the behaviour of two-phase fluids (liquid and gas) in microgravity and hipergravity conditions. Experiments were carried out in the ESA’s REXUS (Rocket Experiments for University Students) Campaign. The experiment test cell consisted on four small cylindrical cavities containing different liquids and portion gas fractions. Liquids and gas fraction used are shown in Fig. 1. With this distribution, we are able to compare results on the behaviour of bubbles with different volume fraction, viscosity and surface tension. The experimental set-up (Fig. 3) surrounding the test cell consisted on systems for control, power regulation and data acquisition (the camera, mirror and illumination). When REXUS-V went into the microgravity phase, the air of the cavities formed a bubble into the liquid. During the rocket launch the experiment just stayed on stand-by, and after 73 seconds (when the low gravity phase started) the camera started recording. We obtained a video of about 8 minutes, which allows studying the behaviour of the different bubbles in microgravity (Fig. 4) and also in hipergravity, when the changes on the acceleration caused interesting effects on the bubbles.

FIGURES

[1] Schematic drawing.



[2] Test Cell different views.

[3] Experimental Set-up.

[4] Bubbles formed in microgravity.

JET IMPINGEMENT IN DIFFERENT LIQUIDS

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An experimental setup for the study of impinging bubbly jets in microgravity has been recently designed [1]. An opposed-jet configuration with changeable orientation is used with the aim to identify the optimal position to achieve an efficient mixing process. The impact angle between jets can be changed from $\phi = 0^\circ$ (frontal collision) up to $\phi = 90^\circ$. The distance s between both jets can be changed from 0 mm up to 90 mm. Colliding jets are introduced into a test tank full of liquid (water, ethanol or silicon oil) by means of two bubble injectors [2]. The bubble generation method, insensitive to gravity level for low Bond numbers, is based on the creation of a flow inside a T-junction of capillary tubes of $d_C = 0.7$ mm of diameter. The bubble velocities at the injector outlet and generation frequencies can be controlled by means of the gas and liquid flow rates, Q_G and Q_L respectively. Individual bubble properties and coalescence events, as well as the whole jet structure are analyzed from the images recorded by a high speed camera at 1000 frames per second. The basic experiment operations (full control of the gas and liquid lines, illumination and camera) are remotely controlled by a computer, while the change of the impact angle and separation distances between jets have to be manually performed.

We present on ground res lts on the role played by the impact angle and bubble velocities on the structure of the final jet. A systematic study for different gas and liquid flow rates has been carried out in liquids with different surface tension and viscosities. Current results will be compared with those obtained in a near future in low gravity conditions using two impinging bubbly jets.

In normal gravity, two distinct regions have been observed in bubbly jets. On the one hand, a bubbly cone emerging from the injector outlet in which inertial forces are dominant. On the other hand, a bubbly plume zone in which buoyancy compensates drag and the bubbles follow a nearly rectilinear path upwards. We define δ as the width of the bubbly cone (a schematic definition of δ is presented in Figure 1). In Figure 2, the variation of δ versus the distance from the injector for different values of the momentum flux J and the separation between jets s, is shown.

Bubble velocities at the jet centerline have been measured for different values of the momentum flux J. Obtained values collapse into a single curve, as expected by the theory, and are presented in Figure 3.

Bubble size have been measured for approximately 1000 bubbles. In Figure 4, the distribution of the measured bubble diameters dB is shown. Note that the y axis corresponds to the probability for a bubble to have a certain diameter dB. The obtained distribution has a significant tail at diameters $d_B \geq 2dC$ mainly due to coalescence events.

To conclude, we must note that the experiments have been carried out in different liquids, which will be presented at the conference. A qualitative comparison between our results and the experiments carried out by Carrera et al. [3] in microgravity conditions using a single bubbly jet is performed, and will also be presented at the conference.

1. F. Su˜nol, O. Maldonado, R. Pino and R. Gonz´alez-Cinca. Design of an experiment for the study of bubble jet interactions in microgravity. Microgravity Science and Technology, 21, Vol. 1, 99 (2009).
2. S. Arias, X. Ruiz, J. Casademunt, L. Ram´ırez-Piscina and R. Gonz´alez-Cinca. Experimental study of a microchannel bubble injector for microgravity applications. Microgravity Science and Technology, 21, Vol. 1, 107 (2009).
3. J. Carrera, X. Ruiz, L. Ram´ırez-Piscina, J. Casademunt and M. Dreyer. Generation of a monodisperse microbubble jet in microgravity. AIAA Journal, Vol. 46, No. 8, 2010 (2008).

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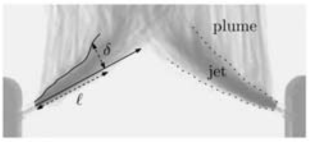

Figure 1: Time-average of 200 consecutive frames. Schematic definition of δ and ℓ. Distinction between the jet zone and the bubbly plume zone.

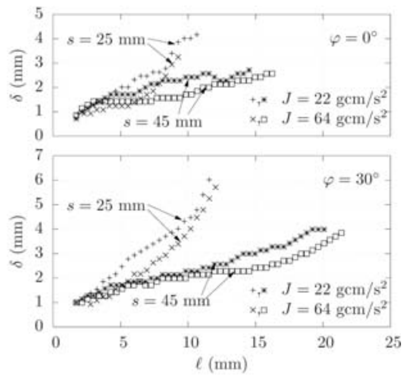

Figure 2: Variation of δ with the distance from the injector ℓ, for different values of separations s and momentum fluxes J, where

$$J = \frac{4}{\pi d_C^2}(\rho_L Q_L^2 + \rho_G Q_G^2).$$

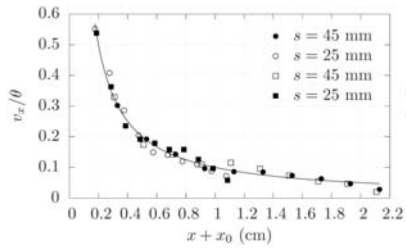

Figure 3: Bubble velocities at jet centerline, for different separations s between jets and momentum fluxes J. The solid curve correspond to

$$v_x = \frac{3}{8\pi\epsilon_0}\frac{J}{\rho_L}\left(\frac{1}{x+x_0}\right) = \theta(J)\left(\frac{1}{x+x_0}\right)$$

where ϵ_0 is the virtual kinematic viscosity, ρ_L is the liquid density, and J is the momentum flux.

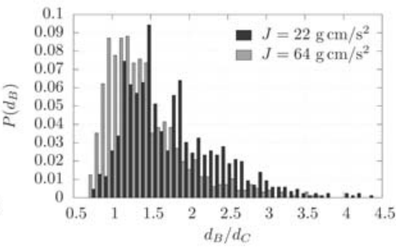

Figure 4: Histogram of bubble diameters, normalized by the capillary diameter d_C.

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