Number 25, September 2007

Bulletin of the European Low Gravity Research Association

Editorial Team of Volume 25:

Dr. Monica Monici

ASAcampus
ASA Research Division
Dept. Clinical Phyisiopathology
University of Florence
50139 – Florence, Italy

& her group in the Section
of Medical Physics

ELGRA - registered in Munich, 22 November 1979, under the number 9702

COVER: Graphic design by S. Marchese on a Meteosat photograph kindly supplied by ESA-ESOC. The Pisa Tower and the Spacecraft represent the evolution of microgravity research from Galileo's first experiments in free fall (1590) to those in the future.

I do not feel obliged to believe that the same God who has endowed us with sense, reason, and intellect has intended us to forgo their use.

GALILEO GALILEI

More about ELGRA:
www.elgra.org

ELGRA MANAGEMENT COMMITTEE
Elected on September 22nd, 2005

Prof. Dr. Daniel Beysens
CEA-ESEME, ESPCI,
10, rue Vauquelin,
75231 Paris Cedex 9, France

President
Phone: +33-(0)-1 40 79 5806
Fax: +33-(0)-1 40 79 4523
email: daniel.beysens@espci.fr
Web: http://www-drfmc.cea.fr/SBT/ESEME/

Dr. Ing. Jack J.W.A. van Loon
DESC (Dutch Experiment Support Center)
ACTA - Vrije Universiteit, Dept. of Oral Cell Biology
van der Boechorststraat 7, 1081BT
Amsterdam, The Netherlands

Vice-president
Phone: +31 (0)20 444 8686 / 8664
Fax: +31 20 4448683
Mobile phone: +31 (0)6 53700944
E-mail: j.vanloon@vumc.nl
Web Site: http://www.desc.med.vu.nl

Dr. Thodoris D. Karapantsios
Department of Chemistry
Aristotle University Univiversity
Box 116
541 24 Thessaloniki, Greece

General Secretary
Phone: +30 2310 99 7772
Fax: +30 2310 99 7759
E-mail: karapant@chem.auth.gr
http://users.auth.gr/~karapant

Dr. Kurt Kemmerle
Kayser-Threde GmbH
Treasurer of ELGRA
Kayser-Threde GmbH
Wolfratshauserstr. 48
D-81379 München, Germany

Treasurer
Phone: ++ 49(0)89 72495 210
Fax: ++ 49(0)89 72495 215
E-mail: kurt.kemmerle@kayser-threde.com

Dr. Valérie Legué
UMR UHP-INRA 1136 IaM "Interactions arbres-microorganismes"
Faculté des Sciences
BP 239 54506 Vandoeuvre les Nancy, France

Member
Phone: + 33(0)3 83 68 42 32
Fax +33(0)3 83 90 32 77
Email: legue@scbiol.uhp-nancy.fr

Prof. Dr. Hendrik Kuhlmann
Institute of Fluid Dynamics and Heat Transfer
Technical University of Vienna
Resselgasse 3 / 1 / 2
A-1040, Vienna, Austria

Member
Phone: +43 (1) 58801-32212
Fax: +43 (1) 58801 32298
Email: hk@post.fluid.tuwien.ac.at
Web: http://www.fluid.tuwien.ac.at/

Prof. Dr. F. Strollo
Endocrine Unit, I..N.R.C.A.
Via Cassia, 1167
I – 00189 Rome, Italy

Member
Phone: +39.06.3034.2653
Fax: +39.06.30342534
E-mail: strofe@flashnet.it

Dr. Monica Monici
ASAcampus, ASA Research Division,
c/o Sect. Medical Physics,
Dept. of Clinical Physiopathology
University of Florence
Viale Pieraccini, 6 , Florence , 50139 -Italy

Member
Tel.: +39 055 4271217
Fax: +39 055 4271413
E-mail: monica.monici@unifi.it
Web: http://www3.unifi.it/dpfisc

ELGRA Corporate Members

(in the sequence of joining ELGRA)

ASTRIUM GmbH SPACE TRANSPORTATION
Germany

OHB-System AG
Germany

SWEDISH SPACE CORPORATION (SSC)-Esrange
Sweden

HTS AG
Switzerland

KAYSER-THREDE GmbH
Germany

ZARM Drop Tower Operation and Service Company
Germany

THE PRESIDENT'S PAGE

Dear ELGRA Members and attendants of the ELGRA 2007 Symposium,

It is with great pleasure that I welcome you at our Biennial Symposium (and General Assembly) in one of the most attractive cities in the world, Florence (Italy). The local organizing committee, led by Dr. Monica Monici, is doing an extraordinary job to make this Symposium the most successful and enjoyable.

This Symposium is held jointly with the Italian Association for Aeronautical and Space Medicine at the Institute of Aeronautical Military Sciences and we will have joint sessions with them. Five plenary lectures are planned. Due to the large number of attendants, parallel sessions had also to be organized. The social activities include many exciting events, as e.g. training with the aeromedical evacuation helicopter and a gala dinner in the court of the Palazzo del Bargello with a baroque concert.

During this meeting, ELGRA will award the winners of the Undergraduate Student competition in 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 science and one team for Physical Science) will be voted by the audience attending their presentations.

This meeting is also an opportunity to reward our most illustrious and distinguished members. The ELGRA medals will be given this year to Dr. Jan Vreeburg, for his outstanding results in Microgravity Fluid Dynamics (liquid slosh) and to Prof. Gérard Perbal, for his exceptional work in Plant Physiology in Microgravity (lentil gravitropism).

A major concern of the community is the new program ELIPS 3 that will be elaborated for the Conference of Ministries in 2008. A round table about the perspectives of low gravity research in Europe is organized with three representative of ESA. We expect a large audience and participation to this special event.

The Biennial ELGRA Symposium is the time of the ELGRA General Assembly and the renewal of the Bureau. Because I am finishing my second and last term as President, 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.

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

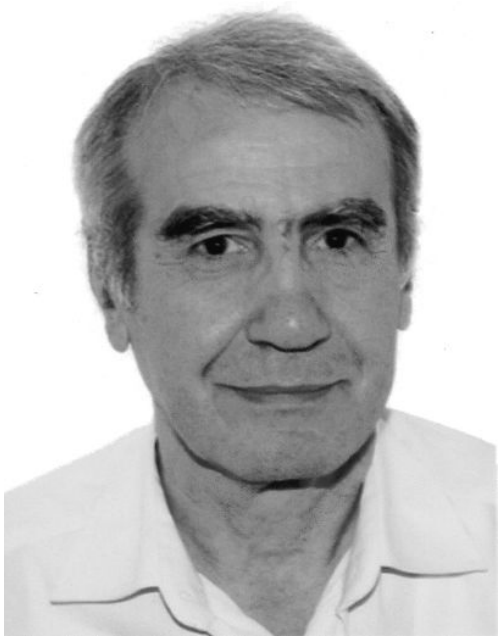
I wish you a very enjoyable stay in Florence and ELGRA 2007 bennial Symposium!

D. Beysens
President of ELGRA

ELGRA MEDAL

PROF. GERALD PERBAL

Laboratoire de Cytologie et Morphogenèse Végétale, Site d'Ivry
Université Pierre et Marie Curie
Le raphael, Case 150, 4 Place jussieu, 75252 Paris Cedex 05.



FROM ROOTS TO GRAVI-1: TWENTY FIVE YEARS FOR UNDERSTANDING HOW PLANTS SENSE GRAVITY.

Plant organs are able to sense gravity by the means of specialized cells called statocytes. In roots, which are the most sensitive organs, the statocytes are located in their tip (the root cap). In the 70's, when I started to work on gravitropism at the University Pierre and Marie Curie, it was known that statocytes contain voluminous amyloplasts (statoliths) that sediment under the influence of gravity. However, the role of these organelles in gravisensing was strongly disputed. In 1974, I attended a session of a meeting on gravitropism in Würzburg, where I presented results that supported the involvement of statoliths in the perception of gravity.

This meeting had a strong impact on my research, since at that time the Council of Europe was looking for people interested in performing experiments in Space. It was the way I entered the Space Science.

Our first experiment (ROOTS) was carried out in the Biorack Facility (ESA) in the frame of the Spacelab D1 mission (1985). We had a very efficient help from CNES which developed a very fine hardware to grow lentil seedlings and to chemically fix them at the end of the experiment. The results obtained were surprising since we observed that in microgravity the statoliths were located at one pole of the statocyte and not distributed at random as it was expected. The goal of the following experiment (Spacelab IML-1 mission, 1992) was to determine the threshold stimulation time at 1g (created by centrifugation). It was estimated at 25s.

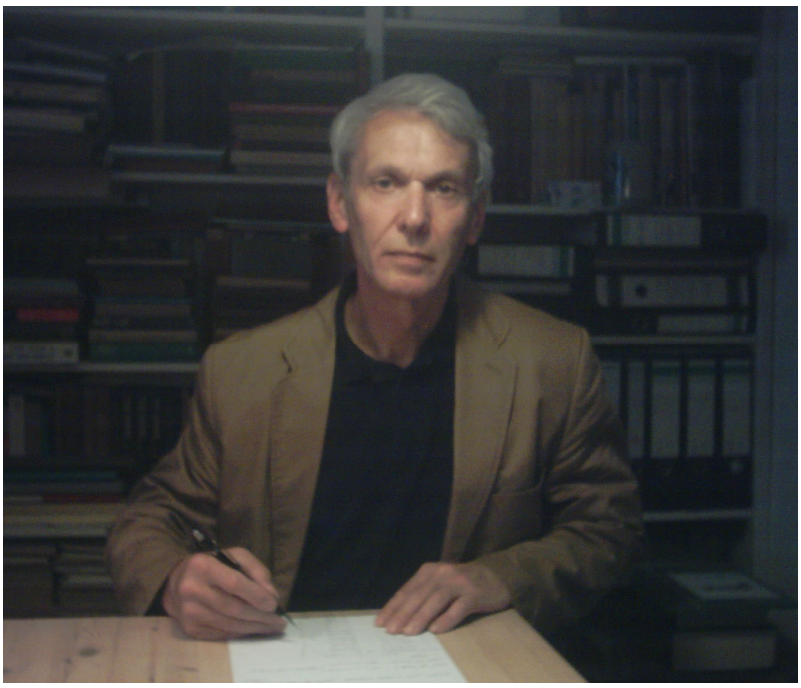
We also demonstrated that cell cycle was modified in microgravity and the following experiment dealt more with root growth and cell cycle under various gravitational stresses. The results obtained indicated that the first cell cycle was slower in microgravity (Spacelab IML-2 mission, 1994).

In the frame of the SMM/03 and SMM/06 missions (1996, 1997), we proved that the statoliths are attached on actin filaments by motor proteins (myosin) that make these organelles move in one preferential direction in microgravity.

The analysis of gravisensitivity with clinostats incited us to compare gravisensitivity of lentil roots grown in microgravity or on a 1g centrifuge (SMM05 mission, 1997). It was found that the latter were less sensitive than the former. We showed that this was due to the fact that the statoliths are not distributed in the same way in both cases (microgravity or 1g centrifuge). All these studies led us to propose a mode of gravity sensing by plants in which elements of the cytoskeleton and stretch activated ion channels are involved (Perbal and Driss-Ecole, 2003). The last experiment (GRAVI-1) which has been carried out (in ISS with the EMCS facility, 2007) dealt with the threshold acceleration that is perceived by roots. It was estimated at 3.8×10^{-4} g which is very low. Space experiments were certainly the most exiting and fruitful part of my academic activities.

DR. JAN VREEBURG

National Aerospace Laboratory, NLR, ASSP
PB 90502, 1006 BM, Amsterdam
E-mail: vreeburg@nlr.nl



LIQUID DYNAMICS FROM SPACELAB TO SLOSHSAT

The European participation in manned spaceflight had a strong impact on research in the natural sciences. Preparation for Spacelab required many decisions on organization, funding and allocation of resources. Lessons were learned from results obtained in precursors like Skylab or in unmanned programs such as TEXUS. Difficulties originate from the differences in science funding rules between ESA member states. ESA with scientists from the major disciplines instituted Working Groups that acted as consultant bodies. In formal contacts the users were represented by the Investigators' Working Group, organized according to major experiment facilities and chaired by the project scientist. European experiment hardware has been realized by aerospace industry by methods that are different from the traditional development of an instrument in a university laboratory. Validation of instrument performance in microgravity requires special techniques. The training of Payload Specialists to perform research in the Fluid Physics Module included theory and laboratory work. Duties for public relations were less than today. The ESA approach with multi-user facilities and Payload Specialists differs from NASA's practice to launch an investigator with a singular experiment. Delays in planned flight opportunities frustrate participation by industrial scientists. Unmanned spacecraft are preferable for certain types of research and lead to development of telescience. The dynamics of spacecraft with partially filled tankage benefit from conditions that conserve system momentum. The momentum of the rigid part of a spacecraft can be tracked accurately. Observation of liquid behaviour in a spacecraft tank is a challenging problem. A validated model of liquid effects on spacecraft manoeuvres makes servicing missions more efficient and less costly. Damping of liquid motion is not fully understood; experiments in space may provide fundamental contributions.

2007 Biennial International Symposium of ELGRA
European Low Gravity Research Association

jointly with

XX NATIONAL MEETING OF THE ITALIAN ASSOCIATION FOR AERONAUTICAL AND SPACE MEDICINE

Florence, 4 - 7 September 2007
Institute of Aeronautical Military Sciences

UNDER THE AUSPICES OF:
Italian Space Agency
National Institute for Cardiovascular Research
Faculty of Medicine and Surgery, University of Florence
Florence Municipality

ACKNOWLEDGEMENTS

The ELGRA Management Committee is very grateful to Prof. Felice Strollo, Prof. Antonio Conti, Prof. Franco Fusi, Prof. Fabrizio Ledda and Prof. Riccardo Pratesi for their contribution to the local organization of this meeting.

General Information

Venue
The conference site, the Institute of Military Aeronautical Sciences (IMAS) in the Cascine Park in Florence, was built by the famous architect Raffaello Fagnoni in the years 1937-38. From an architectonic point of view, it is considered one of the most beautiful examples of "functionalism".

Scientific/Organizing Committee
(ELGRA Management Committee)

Dr. Daniel Beysens	President
Dr. Jack van Loon	Vice-President
Prof. Felice Strollo	Vice-President
Dr. Thodoris Karapantsios	Gen. Secretary
Dr. Kurt Kemmerle	Treasurer
Prof. Hendrik Kuhlmann	Member
Dr. Valérie Legué	Member
Dr. Monica Monici	Member

Local Organizer
Dr. Monica Monici

Organizing Secretariat
Dr. Giovanni Romano
Dr. Venere Basile
Mr. Pasquale Imperiale

ABOUT THE CONFERENCE SITE

Florence, cradle of history, art and culture

Florence's origins date back to the Etruscan era. The name Florentia, "destined to flower", date back to the Romans. From the 13th century, with the prevalence of the Guelfs in the dispute between Guelfs and Ghibellines, loyal to the Pope and to the Emperor respectively, Florence enjoyed a long period of prosperity and magnificence. Great importance was given to the arts. The architectural beauties, which make Florence such a unique city, began to be built. Culture was in great ferment. The first work in the vernacular language (precursor of the italian language) appeared and then brought about the works of Dante, Petrarca, Boccaccio. Then, the Medici dynasty took over. Lorenzo il Magnifico brought the Humanist Age to Florence, together with the wonderful architecture by Brunelleschi. After Lorenzo il Magnifico's death (1492), the city oscillated between Republican agitation and Medici revenge, while geniuses such as Michelangelo and Leonardo Da Vinci became famous names in art. In the 18th and 19th centuries Florence was the capital of the Grand Duchy of Tuscany, and then of the Kingdom of Italy.

Now, Florence is one of the most atmospheric and pleasant cities in Italy. It retains a strong resemblance to the small late-medieval centre that contributed so much to the cultural and political development of Europe. With its striking buildings, formidable galleries, treasure-crammed churches, russet rooftops and lofty domes, Florence has a picturesque and elegant appearance.

The Venue

PROGRAMME

Monday, September 3rd

17:00 - 20:00 **Registration**

Tuesday, September 4th

8:30 - 9:00 **Registration**

9:00 - 9:20 **Welcome and Opening of the Works**

9:20 - 10:00 **Physical Sciences Plenary Lecture**
Chairperson: Rath H.J.

INTERFACIAL PROPERTIES OF LIQUID-LIQUID SYSTEMS, EMULSIONS AND NANOPARTICLE DISPERSIONS
Liggieri Libero, Ravera Francesca, Santini Eva, Passerone Alberto, Ferrari Michele, Antoni Mickael, Clausse Danièle, Loglio Giuseppe, Miller Reinhard

HALL A

10:00 – 11:00 **Session: Physical Sciences (Two-Phase Flow)**
Chairperson: Shevtsova V.

DILUTE EMULSION CHARACTERIZATION IN FASES EXPERIMENTS
Rozières Murielle, Antoni Mickaël, Krägel Jurgen, Liggieri Libero, Miller Reinhard, Sanfeld Annie

BOILING CRISIS AND EVAPORATION AT THE TRIPLE CONTACT LINE
Nikolayev Vadim, Chatain Denis, Beysens Daniel, Garrabos Yves

DIGITAL HOLOGRAPHIC MICROSCOPY FOR THREE-DIMENSIONAL STUDY OF PHOSPHOLIPID VESICLES IN A SHEAR FLOW UNDER MICROGRAVITY CONDITIONS
Callens N., Dubois F., Mader M.-A., Minetti C., Misbah C., Podgorski T., Queeckers P., Yourassowsky C.

HALL B

10:00 – 11:00 **Session: Life Sciences (Plant Biology 1)**
Chairpersons: Kordyum E. & Perbal G.

SEED GERMINATION AND SEEDLING GROWTH UNDER SIMULATED MICROGRAVITY CAUSES ALTERATIONS IN PLANT CELL PROLIFERATION AND RIBOSOME BIOGENESIS
Matía Isabel, van Loon Jack, Carnero-Díaz Eugénie, Marco Roberto, Medina Francisco Javier

CLINOSTATE AND HYPERFUGE EFFECTS ON PINUS PINEA SEEDS DURING GERMINATION PROCESS
Ranaldi Francesco, Giachetti Eugenio, Pippia Proto, Vanni Paolo

REPEATED MICROGRAVITY INCIDENTS INDUCE REPEATED BURSTS OF SUPEROXIDE ANION RADICALS IN ROOTS
Mancuso Stefano, Mugnai Sergio, Azzarello Elisa, Masi Elisa, Pandolfi Camilla, Hlavacka Andrej, Voigt Boris, Baluska Frantisek, Volkmann Dieter

11:00 - 11:20 ***Coffee Break***

HALL A

11:20 - 13:20 **Session: Physical Sciences (Material Properties)**
Chairperson: Liggieri L.

MEASUREMENT OF SORET COEFFICIENT IN LIQUIDS
Mialdun A., Shevtsova V.

BASIC PRINCIPES OF NON-CONTACT THERMOPHYSICAL PROPERTY MEASUREMENTS IN REDUCED GRAVITY UNSING INDUCTIVE LEVITATION
Schetelat Pascal, Bojarevics Valdis, Pericleous Koulis, Etay Jacqueline

Xrmon A NEW X-RAY FACILITY FOR METALLURGICAL EXPERIMENTS
Holm P., Houltz Y., Andersson P., Löfgren O., Löth K., Lockowandt C.

SURFACE TENSION AND VISCOSITY OF COMMERCIAL TI-ALLOYS: MEASUREMENTS BY THE OSCILLATING DROP METHOD ON BOARD PARABOLIC FLIGHTS
Wunderlich Rainer, Higuchi Kensuke, Schneider Stephan and Fecht Hans-Jörg

TERMOMAGNETIC CONVECTION AS A TOOL OF HEAT AND MASS TRANSFER CONTROL IN NANOSIZE MATERIALS UNDER MICROGRAVITY
Bozhko Alexandra, Putin Gennady

INFLUENCE OF SAMPLE SIZE ON THE VISCOSITY MEASUREMENT OF MOLTEN METALS WITH AN ELECTROSTATIC LEVITATION METHOD
Koike Noriyuki, Ishikawa Takehiko, Paradis Paul-François, Tomioka Hiroshi, Watanabe Yuki, Yoda Shinichi, Motegi Tetuichi

HALL B

11:20 - 13:20 **Session: Life Sciences (Plant Biology 2)**
Chairpersons: Medina F.J. & Vanni P.

AUXIN ACTIVATED GENES ARE INVOLVED IN THE SENESCENCE INDUCED BY SPACE ENVIRONMENT IN ARABIDOPSIS
Fortunati A., Tassone P. and Migliaccio F.

ALTERATIONS IN THE EXPRESSION OF TRANSCRIPTION FACTORS IN *ARABIDOPSIS THALIANA* CELL CULTURES DURING SOUNDING ROCKET µ*G*
Babbick Maren, Barjaktarovic Zarko, Hampp Rüdiger

CYTOSKELETON REARRANGEMENTS IN THE DISTAL ELONGATION ZONE OF ARABIDOPSIS ROOT UNDER CLINOROTATION
Shevchenko Galina, Kalinina Iana, Kordyum Elizabeth

SPATIAL ORGANIZATION OF CYTOSKELETON IN ARABIDOPSIS ROOTS UNDER CLINOROTATION
Kalinina Iana, Shevchenko Galina, Kordyum Elizabeth

PREPARING ULOCLADIUM CULTURES FOR STUDIES IN MICROGRAVITY CONDITIONS
Gomoiu Ioana, Sarantopoulou Evangelia, Kolia Zoe

MOLECULAR ANALYSIS OF GRAVITAXIS IN *EUGLENA GRACILIS*
Lebert Michael, Donat-Peter Häder

13:20 - 14:40 ***Lunch***

14:40 - 16:00 **Student contest**
Chairperson: Karapantsios T.

CAN FACILITATION INCREASE THE h-REFLEX IN MICRO-G ?
Betzler Felix, Schlabs Thomas, Wagenseil Boris, Gewies Marcel, Abels Wiltrud, Schulz Juliane, Dr. Kowoll Rainer, Prof. Dr. Gunga H.C.

ACHROMATIC AND CHROMATIC PERCEPTION IN MICROGRAVITY
Cromos experiment in the ESA student parabolic flight campaign
Schlacht Irene Lia, Birke Henrik, Brambillasca Stefano, Dianiska Balázs

SINGING GRAVITATION DETECTOR
Dujardin Bertrand and Vanpeteghem Jonathan

EXPERIMENTAL STUDIES ON THE AGGREGATION PROPERTIES OF DUST IN PLANET-FORMING REGIONS
Heißelmann Daniel

ANALYSIS OF FERROFLUIDS EXPOSED TO MAGNETIC FIELDS IN MICRO-GRAVITY
Krause Elisabeth, Verweyen Alice, Endesfelder Ulrike, Angsmann Anne, Bürgel Sebastian

VISCOUS FINGERING IN MICROGRAVITY
Andalsvik Yngvild Linnea, Storhaug Gunhild, Olluri Kosovare, Skaugen Arvid, Lindem Torfinn, Løvoll Grunde, Måløy Knut Jørgen

16:00 – 16:40 **ELGRA-AIMAS Plenary Lecture**
Chairperson: Monici M.

SPACEFLIGHT AFFECTS IMMUNE CELLS
Cogoli-Greuter Marianne, Cogoli Augusto

17:30 ***Visit to the Galileo Tribune and Anatomical Waxes at the "Specola" Museum***

21:00 ***Gala Dinner at the Institute of Aeronautical Military Sciences***

Wednesday, September 5th

HALL A

9:00 - 10:20 **Session: Physical Sciences (Capillary Flow)**
Chairperson: Zebib A.

NON-GRAVITATIONAL FLUID TRANSPORT IN AQUEOUS FOAMS: CAPILLARY AND SHEAR EFFECTS
Saint-Jalmes Arnaud, Marze Sebastien, Langevin Dominique

BREAK-UP OF BUBBLES AND DROPS UNDER MODULATED GRAVITY
Yoshikawa Harunori, Zoueshtiagh Farzam, Caps Hervé, Kurowski Pascal, Petitjeans Philippe

EXPERIMENTAL AND NUMERICAL STUDY OF BUBBLES BEHAVIOUR
Suñol F., Pino R., Maldonado O., González-Cinca R.

EXPERIMENTAL AND NUMERICAL STUDIES OF STABILITY LIMITS OF STEADY OPEN CAPILLARY CHANNEL FLOWS
Haake D., Rosendahl U., Grah A., Klatte J., Dreyer M.E.

HALL B

9:00 - 10:20 **Session: Life Sciences (Cell biology and Cardiovascular System)**
Chairpersons: Cogoli M. & Masini M.A.

EFFECTS OF MICROGRAVITY ON CARDIAC HOMEOSTASIS: THE ROLE OF STEM CELLS
Forte Giancarlo, Carotenuto Felicia, Pagliari Stefania, Romano Roberta, Cossa Paolo, Pagliari Francesca, Fiaccavento Roberta, Minieri Marilena, Zava Stefania, Rizzo Angela, Berra, Bruno Di Nardo Paolo

EFFECT OF HYPERGRAVITY ON ENDOTHELIAL CELL FUNCTIONS AND GENE EXPRESSION
Morbidelli Lucia, Marziliano Nicola, Basile Venere, Pezzatini Silvia, Romano Giovanni, Conti Antonio, Monici Monica

ADAPTATION OF VASCULAR MYOCYTES TO MICROGRAVITY BY THE DECREASE OF RYANODINE RECEPTOR SUBTYPE 1 EXPRESSION.
Morel Jean-Luc, Dabertrand Fabrice, Gasset Gilbert, Chaput Didier

HSP70, AN IMPORTANT PLAYER IN PRIMARY ENDOTHELIAL CELL RESPONSE TO SIMULATED MICROGRAVITY
Maier Jeanette A.M.

10:20 - 10:40 ***Coffee Break***

10:40 - 11:20 **ELGRA-AIMAS Plenary Lecture**
Chairperson: Caldarera C.M.

DRUGS IN SPACE
Vernikos Joan

HALL A

11:20-13:20 **Session: Physical Sciences (Vibration)**
Chairperson: Evesque P.

VIBRATION-MODIFIED PHASE SEPARATION OF SUPER CRITICAL CO_2 IN MAXUS 7 SOUNDING ROCKET AND H_2 UNDER MAGNETIC GRAVITY COMPENSATION
Beysens D., Garrabos Y., Chatain D., Evesque P.

STABILITY OF RIMMING FLOW UNDER VIBRATION
Kozlov Victor, Polezhaev Denis

DYNAMICS OF GASEOUS BUBBLES IN OSCILLATING LIQUID
Lyubimova T.P., Cherepanova A.A.

COMPLEX G-JITTERS. SUPERPOSITION AND SOLID SEGREGATION
Ruiz X.

VIBRATION EFFECT ON THERMOCAPILLARY DRIFT OF A BUBBLE
Lyubimov D.V., Lyubimova T.P., Soldatova L.S.

THE THERMOLAB PROJECT – THERMOPHYSICAL PROPERTIES OF INDUSTRIAL ALLOYS IN THE LIQUID PHASE FOR CASTING AND SOLIDIFICATION MODELLING
Fecht Hans-Jörg, Battezzati Livio, Egry Ivan, Étay Jacqueline, Matsushita Taishi, Novakovic Rada, Ricci Enrica, Schmidt-Hohagen Frank, Seetharaman Seshadri, Wunderlich Rainer

HALL B

11:20-13:20 **Session: Life Sciences (Neurosciences)**
Chairperson: Marco R. & Borisova T.

DIFFERENTIAL RESPONSE OF LIMBIC SYSTEM TO MICROGRAVITY AND HYPERGRAVITY: HYPOTHALAMUS VS. HIPPOCAMPUS
Kumei Yasuhiro, Zeredo Jorge, Kimoto Mari, Ikeda Tohru, and Toda Kazuo

G-INDUCED NEAR-LOSS OF CONSCIOUSNESS SHOWS ENLARGED Ca2+ INDEPENDENT RELEASE OF GLUTAMATE FROM SYNAPTOSOMES.
Borisova Tatiana, Krisanova Natalia

THE ROLL-INDUCED VESTIBULOOCULAR REFLEX IN SALAMANDER TADPOLES AFTER THE SOYUZ FLIGHT TMA8/TMA7 TO ISS
Horn Eberhard, Frippiat Jean-Pol

WALKING ACTIVITY OF ADULT CRICKETS DURING PARABOLIC FLIGHT
Martin Gabriel, Simmet Dana, Horn Eberhard

EFFECT OF RPM ROTATION ON INTRACELLULAR/EXTRACELLULAR CALCIUM CONTROL IN ASTROCYTES
Masini M.A., Strollo F., Ricci F., Prato P., Uva B.

BIOREACTOR TRANSIENT EXPOSURE ACTIVATES SPECIFIC NEUROTROPHIC PATHWAYS IN CORTICAL NEURONS.
Zimmitti Vincenzo, Benedetti Elisabetta, Sebastiani Pierluigi, Di Loreto Silvia

13:20 - 14:20 ***Lunch***

14:20 – 15:00 **Physical Sciences Plenary Lecture**
Chairperson: Kuhlmann H.

CURRENT TRENDS ON THE MECHANICS OF GRANULAR MATTER EXCITED BY VIBRATIONS IN MICROGRAVITY .
Evesque P.

HALL A

15:00 - 16:40 **Session: Physical Sciences (Body Forces)**
Chairperson: Dittus H. J.

DROPLET OSCILLATIONS IN HIGH GRADIENT MAGNETIC FIELD
Bojarevics V., Pericleous K.

GEOFLOW: THE ISS EXPERIMENT AND 3D NUMERICAL SIMULATION ON THERMAL CONVECTION IN SPHERICAL SHELLS
Futterer Birgit, von Larcher Thomas, Egbers Christoph

MAGNETIC COMPENSATION OF GRAVITY AND CENTRIFUGAL FORCE
Lorin Clément, Mailfert Alain

MAGNETIC LEVITATION: STUDIES OF FLUID AND GRANULAR DYNAMICS IN ALTERED GRAVITY
Hill R.J.A., López-Alcaraz P., Catherall A. T., Sánchez P., Swift M. R., King P. J.

MAGNETIC COMPENSATION OF GRAVITY: EXPERIMENTS WITH OXYGEN
Pichavant G., Cariteau B., Chatain D., Nikolayev V., Beysens D.

HALL B

15:00 - 15:40 **Session: Life Sciences I (Cell Biology and Immune System)**
Chairpersons: Strollo F. & Monici M.

MOTILITY OF MONOCYTES AND THEIR INTERACTION WITH T-LYMPHOCYTES IN LOW GRAVITY
Cogoli-Greuter Marianne, Galleri Grazia, Pani Giuseppe, Saba Angela, Pippia Proto, Meloni Maria Antonia

HYPERGRAVITY EFFECTS ON DENDRITIC CELL AND VASCULAR WALL INTERACTIONS
Bellik L., Parenti A., Ledda F., Basile V., Romano G., Fusi F., Monici M.

15:40 - 16:40 **Session: Life Sciences II (Gene Expression Profile)**
Chairpersons: Strollo F. & Monici M.

GENETIC SIGNATURES DURING PHYSIOLOGICAL ADAPTATION:
Sundaresan A. DuMond James, Singh Kamaleshwar, Pellis N.R.

GENE EXPRESSION PROFILING IN CHONDROCYTES UNDERGOING HYPERGRAVITY STIMULI
Marziliano Nicola, Basile Venere, Romano Giovanni, Arbustini Eloisa, Monici Monica

IS THERE A GROUP OF GENES IN ANIMALS THAT RESPOND TO / IS CONTROLLED BY GRAVITY?
Marco Roberto, Laván David, Leandro Luis J., Benguría Alberto, Medina F. Javier, van Loon Jack

17:30 ***Welcome of the Authorities "Salone dei Cinquecento", Palazzo Vecchio***

Thursday, September 6th

HALL A

9:00 - 10:20 **Session: Physical Sciences (Physics)**
Chairperson: Ruiz X.

A CASE STUDY FOR THE FLUID SCIENCE LABORATORY ON THE INTERNATIONAL SPACE STATION: NEW EXPERIMENTS ON CHARGE TRANSPORTATION IN LIQUIDS
Dell'Aversana P., Piccolo C.

EXPERIMENTAL CONSIDERATIONS REALISATION OF ULTRACOLD QUANTUM GASES IN MICROGRAVITY
Bongs Kai, Brinkmann Wiebke, Dittus Hansjörg, Ertmer Wolfgang, Göklü Ertan, Johannsen Greta, Kajari Endre, Könemann Thorben, Lämmerzahl Claus, Lewoczko-Adamczyk Wojciech, Nandi Gerrit, Peters Achim, Rasel Ernst M., Reichel Jakob, Schleich Wolfgang P., Schiemangk Max, Sengstock Klaus, Steinmetz Tilo, Vogel Anika, Walser Reinhold, Wildfang Sven and van Zoest Tim

EXPERIMENTAL CHARACTERIZATION OF A MICROBUBBLE INJECTOR
Arias S., Ruiz X., Ramírez-Piscina L., Casademunt J., González-Cinca R.

STABILITY LIMITS OF UNSTEADY CAPILLARY FLOW
Grah Aleksander, Rosendahl Uwe, Haake Dennis, Klatte Jörg, Dreyer Michael E.

HALL B

9:00 - 10:20 **Session: Life Sciences (Space Technology and Facilities 1)**
Chairpersons: Sundaresan A. & Hemmersbach R.

A MODULAR STANDARDISED SYSTEM TO SUPPORT TISSUE ENGINEERING EXPERIMENT IN BMTC

Kern P., Cornier J., Kemmerle K., Wagner S., Jones D.

DIAMAGNETIC LEVITATION EFFECT ON BACTERIAL GROWTH
Dijkstra C., Larkin O., Hill R.J.A., Anthony P., Davey M.R., Rees C., Smart K., Power J.B., Lowe K.C., Eaves L.

BIOREACTORS FOR TISSUE ENGINEERING SCAFFOLDS AND EX VIVO TISSUES
Jones D.B., Noble B., Vico L., VanderSloten J., Martin I., Richards G.

MECHANOMICS IN SPACE – A NEARLY LOST OPPORTUNITY
van Loon Jack J.W.A.

10:20 – 10:40 ***Coffee Break***

10:40 – 11:20 **ELGRA - AIMAS Plenary Lecture**
Chairperson: Carboni M.

ENVIRONMENTAL FACTORS IN SPACE MEDICINE
Lobascio Cesare

HALL A

11:20 - 13:20 **Session: Physical Sciences (Surface-Tension-Driven Flow)**
Chairperson: Lyubimova T. P.

ROLE OF HEATING SUBSTRATE GEOMETRY IN THE DYNAMICS OF EVAPORATING DROPLETS
Girard Fabien, Antoni Mickaël, Faure Sylvain and Steinchen-Sanfeld Annie

ORIGIN OF AXIALLY RUNNING WAVES IN LIQUID BRIDGES
Melnikov D., Shevtsova V.

NON-ISOTHERMAL MULTIPLE BUBBLE GROWTH OVER MINIATURE HEATERS
Divinis Nikolaos, Karapantsios Thodoris D., Kostoglou Margaritis and Bontozoglou Vasilis

DYNAMIC FREE SURFACE DEFORMATIONS DUE TO THERMOCONVECTIVE FLOWS
Shevtsova V.M, Mialdun A., Ferrera C., Cabezas M. G., Montanero J. M.

SOLUTOCAPILLARY CONVECTION IN SPHERICAL SHELLS
Subramanian Pravin, Zebib Abdelfattah

EXPERIMENTAL CONSIDERATIONS OF SOLUTOCAPILLARY FLOW INITIATION ON BUBBLE/DROP INTERFACE IN THE PRESENCE OF A SOLUBLE SURFACTANT
Kostarev Konstantin, Zuev Andrew, Viviani Antonio

HALL B

11:20 - 13:20 **Session: Life Sciences (Space Technology and Facilities 2)**
Chairpersons: Kemmerle K. & van Loon J.

REDUCED GRAVITY TESTING AND RESEARCH CAPABILITIES AT QUEENSLAND UNIVERSITY OF TECHNOLOGY'S NEW 2.0 SECOND DROP TOWER
Steinberg Ted

SUPPORT OF ISS LIFE SCIENCES EXPERIMENTS BEFORE COLUMBUS
Schuber Marianne, Seibt Dieter, Esser Paul

INVESTIGATING GRAVITY, RADIATION AND MAGNETISM IMPACT ON BIOLOGICAL STRUCTURES AND PROCESSES IN THE LUNAR LANDER PAYLOAD ASTROHAB - PREPARATION FOR THE EXPLORATION OF MOON AND MARS
Dünne Matthias, Slenzka Klaus

RESEARCH IN MARS-GRAVITY,MOON-GRAVITY AND WEIGHTLESS FLIGHTS
Viberti Carlo

ANIMAL RESEARCH IN SPACE USING MICE AS A MODEL
Falcetti G., Tenconi C., Cancedda R., Berckmans D.

CLINOSTATS AND CENTRIFUGES – PREREQUISITE FOR AND SUPPORT OF BIOLOGICAL EXPERIMENTS IN MICROGRAVITY
Hemmersbach Ruth, Ullrich Oliver, von der Wiesche Melanie, Hauslage Jens, Buess Gerhard

13:20 – 14:20 ***Lunch***

14:20 – 15:20 **Poster Session I**

GROUND EXPERIMENTS UNDER MODELED MICROGRAVITY CONDITIONS
Tenconi C., Freddi M., Pippia P., Rizzo A.M.

ROTARAD AND SCORE EXPERIMENTS ON FOTON M3 MISSION
Falcetti G., Freddi M., Ricci C., Bradamante S.

EFFECTS OF SPACE FLIGHT ON INTERACTION BETWEEN HUMAN T-LYMPHOCYTES AND MONOCYTES
Galleri Grazia, Meloni Maria Antonia, Saba Angela, Pani Giuseppe, Pippia Proto, Cogoli-Greuter Marianne

CORTICAL MICROTUBULE ORGANIZATION IS ALTERED IN THE DISTAL ELONGATION ZONE OF BRASSICA RAPA ROOTS UNDER CLINOROTATION
Kalinina Iana

HYPERGRAVITY INDUCES QUANTITATIVE CHANGES IN ARABIDOPSIS THALIANA PROTEOME
Vlieghe Celine, Rossignol Michel, Gasset Gilbert, Grat Sabine, Eche Brigitte, Ranjeva Raoul, Graziana Annick

THE LEVEL OF HEAT SHOCK PROTEINS HSP70 AND HSP90 IN PEA SEEDLINGS IN RESPONSE TO ALTERED GRAVITY
Kozeko Lyudmyla, Kordyum Elizabeth

MITOTIC ACTIVITY OF PEA ROOT APICAL MERISTEM UNDER CLINOROTATION.
Artemenko Olga

C.ELEGANS AS A DISCOVERY TOOL TO INVESTIGATE SPACE FLIGHT-INDUCED STRESS RESPONSES
Ventura Natascia, Testi Roberto

DISTRIBUTION OF CALCIUM IONS IN CELLS OF THE ROOT DISTAL ELONGATION ZONE IN THE CONTROL AND UNDER CLINOROTATION
Sobol Margarita, Kordyum Elizabeth

THE LIFE AND PHYSICAL SCIENCE LABORATORY FACILITY (LPS) AT ESA'S EUROPEAN SPACE RESEARCH AND TECHNOLOGY CENTRE
Krause Jutta, van Loon Jack J.W.A., Schiller Peter, Dowson Alan

VIBRATIONAL LIFT FORCES ACTING THE BODIES IN VISCOUS LIQUID IN THE VICINITY OF CAVITY WALL
Ivanova Alevtina, Kozlov Victor, Kuzaev Aidar

INVESTIGATION OF NANOPARTICLES AT FLUID INTERFACES IN THE FRAMEWORK OF "FASES" MAP PROJECT
Liggieri Libero, Ravera Francesca, Santini Eva, Ferrari Michele, Loglio Giuseppe, Miller Reinhard, Kraegel Jürgen, Grigoriev Dmitri

PROPERTIES OF WATER-PARAFFIN OIL EMULSIONS STABILISED BY SPAN-80 AND OF THE CORRESPONDING LIQUID-LIQUID INTERFACES INVESTIGATED IN THE FRAMEWORK OF THE MAP-FASES PROGRAMME
Liggieri Libero, Ferrari Michele, Ravera Francesca, Santini Eva, Antoni Mickael, Sacca Linda, Clausse Daniele

DYNAMICS AND STATISTICS OF A MICROBUBBLE JET IN MICROGRAVITY
Bitlloch Pau, Ruiz Xavier, González-Cinca Ricard, Ramírez-Piscina Laureano, Casademunt Jaume

DYNAMICS OF ROTATING TWO-LIQUID SYSTEM UNDER TRANSVERSAL VIBRATION
Ivanova Alevtina, Kozlov Nick, Salnikova Anastasia, Stambouli Moncef

CONVECTIVE AUTO-OSCILLATIONS NEAR A DROP-LIQUID INTERFACE IN A HORIZONTAL RECTANGULAR CHANNEL
Birikh Rudolph, Rudakov Rudolph, Viviani Antonio

ON THE USE OF CALORIMETRY FOR FOLLOWING IN MICROGRAVITY CONDITIONS THE EVOLUTION OF WATER IN OIL EMULSIONS
Clausse Danièle, Sacca Linda, Drelich Audrey, Gomez François, Pezron Isabelle, Liggieri Libero

NUCLEATE BOILING ON A SINGLE SITE: CONTACT ANGLE ANALYSIS FOR A GROWING VAPOUR BUBBLE
Serret Damien, Guignard Stephan, Tadrist Lounès

SHEAR CELLS AND REDUCED GRAVITY ENVIRONMENTS
Ruiz X., Pallares J., Grau F.X.

DEVELOPMENT OF MAGNETIC LEVITATION AS A GROUND-BASED SIMULATION OF ALTERED GRAVITY
Larkin O., Dijkstra C., Hill R.J.A., Anthony P., Davey M.R., Rees C., Smart K., Power J. B., Lowe K.C., Eaves L.

PROPERTY DETERMINATION OF LIQUID METALS BY ELECTROSTATIC LEVITATION AT HIGH TEMPERATURES
Paradis Paul-François, Ishikawa Takehiko, Koike Noriyuki, Yoda Shinichi

FACILITY FOR ADSORPTION AND SURFACE TENSION STUDIES ON BOARD OF THE INTERNATIONAL SPACE STATION (FASTER): DESIGN, FEATURES, TECHNICAL SPECIFICATIONS, INTERFACIAL SYSTEMS AND APPLICATIONS
Simoncini M., Campioni V., Liggieri L., Ravera F., Ferrari M., Passerone A., Miller R., Makievski A.V., Krägel J., Loglio G., Pandolfini P., Del Gaudio L.

DIAMOND SYNTHESIS IN MICROGRAVITY ENVIRONMENT WITH SOUNDING ROCKET "S-520-24"
Hirai Takayuki, Takagi Yoshiki, Inatomi Yuko, Abe Yoshiyuki, Usuba Syu, Suzuki Masaaki, Mori Shinsuke, Suda Yoshihisa, Shimizu Osamu, Kino Hitoshi, Kanno Yoshinori, Kato Yoshitaka, Shimada Shouhei, Hiraga Shinji, Yamazaki Ko, Yagi Katsunori, Yonekyu Naoyuki

WATERHAMMER EFFECT IN MICROGRAVITY ENVIRONMENT
Monzón A., Elvira R., Fernández-Cabrera J., Riesgo I.

CAN PHOTOMECHANICAL STRESS COUNTERACT THE EFFECT OF MICROGRAVITY ON THE CELLS PRODUCING ECM?
Basile Venere, Romano Giovanni, Fusi Franco, Monici Monica

COMMUNAL NESTING AS A STRATEGY TO IMPROVE MOTHER-INFANT RELATIONSHIP IN DEVELOPING MICE UNDER ALTERED GRAVITATIONAL ENVIRONMENT
Santucci D., Trincia V., Nicolas Gaia, Francia N. and Alleva E.

FASTER FACILITY ON BOARD OF THE INTERNATIONAL SPACE STATION: A MULTI-USER, HIGH MODULARITY CAPILLARY TENSIOMETER BUILT USING SPACE QUALIFIED TECHNOLOGICAL EXPERIENCE
Mazzoni T., Simoncini M., Campioni V., Soldani M., Ceccherini M., Leggieri L., Miller R., Loglio G., Pandolfini P.

SPATIAL HIGH-SPEED IMAGING OF FLUIDS AND RAPID PHYSICAL PROCESSES. Frozen Reality® Space Project
Florian Maier, Mirko Izzo, Benjamin Holfeld, Salvatore Dinardo

15:20 – 17:20 Workshop on Human Centrifuge

Chairpersons: van Loon J. & Strollo F.

THE HUMAN CENTRIFUGE
van Loon Jack J.W.A.

THE HUMAN CENTRIFUGE: THE PAST AND THE FUTURE
Trivelloni Pierandrea

HUMAN POWERED CENTRIFUGES ON THE MOON OR MARS
di Prampero Pietro Enrico

PRELIMINARY EXPERIENCE WITH THE ESA SHORT ARM HUMAN CENTRIFUGE
Wuyts Floris

HUMAN CENTRIFUGE FOR STUDYING NEUROBEHAVIOURAL PLASTICITY
Santucci Daniela

HYPERGRAVITY IN THE AREA OF SPORT'S MEDICINE AND REHABILITATION MEDICINE
Saggini R., Savoia V., Saggini A.

SHORT TERM AND LONGTERM MICROGRAVITY AND HYPERGRAVITY EFFECTS ON UPPER LIMB MUSCLES
Zolesi V. and Pastacaldi P.

16:40 – 17:00 ***Coffee Break***

17:20 – 19:00 **ELGRA General Assembly**

20:30 ***Social Dinner in the court of the Palazzo del Bargello***
Renaissance - Baroque Concert

Friday, September 7th

9:00 – 9:40 **ELGRA – AIMAS Plenary Lecture**
Chairperson: Cogoli-Greuter Marianne

RATIONALE AND PERSPECTIVES FOR MOON AND MARS EXPLORATION
Foing B.H.

9:40 – 11:10 **Round table: Perspectives of low gravity research in Europe**
Chairpersons: Beysens D. & van Loon J.

Contributions by
Minster O. (Physical Sciences)
Sunblad P. (Life Sciences)
Istasse E. (Missions)

11:10 – 11:30 ***Coffee Break***

11:30 – 12:20 ***Training with A.M. helicopter Aeromedical Evacuation***

HALL A

12:20 - 13:20 **Session: Physical Sciences (Solidification)**
Chairperson: Fecht H. G.

ARRAY DYNAMICS IN DENDRITIC SOLIDIFICATION WITH A CONCAVE INTERFACE: IN SITU CHARACTERIZATION ON TRANSPARENT MODEL ALLOYS
Bergeon N., Weiss C., Mangelinck-Noel N., Billia B., Zhou B.H.

GRAVITY EFFECTS BEYOND FLUID FLOW IN ALLOY SOLIDIFICATION
Nguyen-Thi H., Jung H., Reinhart G., Mangelinck-Noel N., Billia B., Buffet A., Hartwig J., Baruchel J., Schenk T., Gastaldi J.

A NEW PARADIGM OF CRYSTALLIZATION ARISING FROM NON-STANDARD NUCLEATION PATHWAYS
Vasileios Basios, Lutsko Jim, Nicolis Gregoire

HALL B

12:20 - 13:20 **Session: Life Sciences (Space flight analogues and radiation)**
Chairpersons: Santucci D. & Wuyts F.

RISK ASSESSMENT OF SPACE RADIATION BASED ON MUTATION DATA
Kiefer Juergen

MODELLED MICROGRAVITY DOWN-REGULATES EXPRESSION OF *STAPHYLOCOCCUS AUREUS* VIRULENCE DETERMINANTS
Rosado Helena, Doyle Marie, Hinds Jason, Taylor Peter W.

HORMONAL CHANGES OBSERVED DURING VALDOLTRA (SLOVENIA) BED REST STUDY
Strollo F., Magni P., Biolo G., Masini M.A., Pisot R., Mekjavic I.B., Broccoli M., Morè M., Uva B.M., Celotti F.

13:20 – 14:20 ***Lunch***

14:20 – 15:20 **Poster Sessions II**
Prosecution of poster discussion (see Poster Session I on Thursday 6th)

15:20 – 16:30 **ELGRA Medals (Lectures and ceremony)**
Chairperson: Beysens D.

FROM ROOTS TO GRAVI-1: TWENTY FIVE YEARS FOR UNDERSTANDING HOW PLANTS SENSE GRAVITY.
Perbal Gerald

LIQUID DYNAMICS FROM SPACELAB TO SLOSHSAT
Vreeburg Jan P.B.

16:30 **Conclusion**

ABSTRACTS

Invited Lectures

(Plenary Lectures)

INTERFACIAL PROPERTIES OF LIQUID-LIQUID SYSTEMS, EMULSIONS AND NANOPARTICLE DISPERSIONS

Libero Liggieri[1], Francesca Ravera[1], Eva Santini[1], Alberto Passerone[1], Michele Ferrari[1], Mickael Antoni[2], Danièle Clausse[3], Giuseppe Loglio[4], Reinhard Miller[5]

1.CNR-Istituto per l'Energetica e le Interfasi, via De Marini 6, 16149 Genova, Italy, l.liggieri@ge.ieni.cnr.it; 2.Univ. "Paul Cezanne" Aix-Marseille, Centre St. Jerome, Marseille, France; 3.Dép. de Genie Chimique, Université de Tecnologie de Compiegne, France; 4.Dip. Chimica Organica, Università di Firenze, Italy; 5.Max-Planck Institut fuer Kolloid und Grenzflaechenforschung, Germany

The interfacial properties of liquid-liquid systems have a fundamental role in different natural phenomena, scientific fields and technological applications.

In particular they are at the basis of the mechanical behaviour of multiphase flows and of disperse systems, such as emulsions and foams. Indeed, interfacial tension (IT) is concerned with the capability of "producing" new interface, while dilational visco-elasticity, that is the response of IT to area perturbations, is more concerned with the stability of the "produced" interface.

Interfacial properties can be properly tuned by the utilisation of surfactant molecules, which are in fact widely utilised in emulsions and foams technology. These molecules, even in small amount, are able to adsorb at the interface, decreasing interfacial tension and modifying the dilational response. Today, also micro/nanoparticles, segregating at the interfaces, are utilised as additives to control stabilisation. In spite of that, a complete picture of the relationship between interfacial properties and collective properties of emulsions is still missing.

Owing to the suppression of buoyancy and to the possibility of obtaining purely diffusive conditions, microgravity offers a unique opportunity to investigate the properties of interfacial surfactant/particle layers and the droplet interaction and dynamics in emulsions.

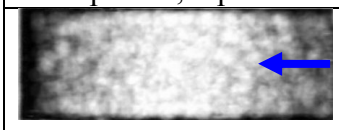
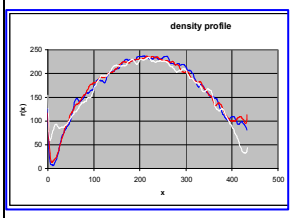
The lecture will provide an overview of the subject together with a summary of the results of previous microgravity investigations, of ground studies and future studies planned onboard the ISS, in the framework of the MAP-FASES programme.

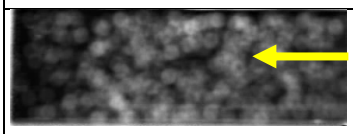
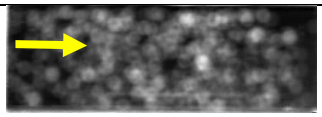
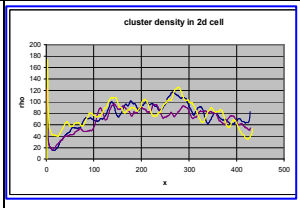
CURRENT TRENDS ON THE MECHANICS OF GRANULAR MATTER EXCITED BY VIBRATIONS IN MICROGRAVITY

P. Evesque
Laboratoire MSSMat, Ecole Centrale de Paris, UMR 8579 CNRS, 92295 Châtenay-Malabry Cedex; E-mail: pierre.evesque@ecp.fr

The dynamics of a collection of grains in a cell which is submitted to a harmonic vibration [a cos(ωt)] has been studied in micro-gravity condition during different flights including a series of parabolic flights in different CNES-ESA campaigns (2001-2006), the MiniTexus5 (1998), Maxus5 (2003) & Maxus 7 (2006) ESA rocket flights launched from Esrange and a satellite mission SJ8 (2008. Both cells were filled with 3 layers of monodisperse grains (ball diameter d=1mm) when the cells are at rest with their length parallel to vertical (gravity). One of the cell was 2d (10*27mm²) and the other one 3d (10*10*27mm^3). Video recording has been performed and used to analyse the distributions of grains.
In Fig. 1, averaging of photos has been performed to determine the local density of grains at two different phases of vibration (φ=π/2 and –π/2). The profile is mainly regular with a maximum density at the centre and with two lateral wings. Also, the central part of the profile does not evolve noticeably with the phase, while the most eccentric part of lateral wings do in opposite phase. This is true for both the 2d cell and the 3d one. This evolution modified slightly the centre of mass of the cluster. The slow motion in the wings and the depletion which exists there prove that the cell moves faster that the typical agitation speed of grains, which demonstrate in turn the supersonic kind of excitation. We note also the similarity of the 2d and 3d distributions.

Fig. 1: Maxus 7 (25Hz, 1.4mm): Density distribution in a granular gas, averaged over 90 photos; top: 3d cell filled with 3 layers; bottom 2d cell filled with 3 arrays of grains

<table>
<tr>
<td> 
3d cell moving backward (towards left). Sum over 90 photos at the same phase</td>
<td> 
3d cell moving forward (towards right). Sum over 90 photos at the same phase</td>
<td rowspan="2"> 

density of cluster profile in the direction of vibration. Red and blue: cell moving towards left; white: cell moving towards right.</td>
</tr>
<tr>
<td> 
2d cell moving backward (towards left). Sum over 90 photos at the same phase.</td>
<td> 
2d cell moving forward (towards right). Sum over 90 photos at the same phase</td>
<td> 

density profile in 2d cell,. Blue & pink: cell moving towards left; yellow: cell moving towards right .</td>
</tr>
</table>

I want to thank CNES, CNSA and ESA for funding and launching. D. Beysens, Y Garrabos, M. Hou, C. Lecoutre, F. Palencia, M. Leconte, are greatfully thanked as my coworkers.

ELGRA News, vol. 25, September 2007

SPACEFLIGHT AFFECTS IMMUNE CELLS

Marianne Cogoli-Greuter, Augusto Cogoli
Zero-g LifeTec GmbH, Technopark, CH-8005 Zurich, Switzerland; marianne.cogoli@zeroglifetec.ethz.ch

Since the first flight of humans into space it is known that space flight conditions affect the immune system; one observation was - and still is - a weakening of the reactivity of immune cells after flight. Based on this observation one of us (A.C.) proposed an experiment for Spacelab 1 in order to study the in-vitro activation of human T-lymphocytes under microgravity conditions. This investigation enabled us to reproduce some of the events occurring during an infection and thus was a good model for the study of the immune system as well as cell differentiation. In this experiment, flown in 1983, we discovered that mitogenic T cell activation is nearly completely depressed in microgravity. This unexpected result was followed by extended investigations in space and on the ground conducted in our and other laboratories in Europe and in the US. In fact low gravity permits to study important and still not fully understood mechanisms of lymphocyte activation from a new perspective. Each new experiment answered some questions and gave rise to new questions. The advent of new technologies in the last twenty years has permitted to clarify some important aspects of such mechanisms. Today we know that some of the signal transduction pathways are markedly disturbed in microgravity. Step by step we are approaching our goal to explain how gravity can directly interfere with crucial events occurring at the cellular level.
During the last 30 years the influence of space flight conditions on the immune system of astronauts and cosmonauts has been studied extensively, but still there is no clear explanation on the reason of the observed changes. From our results with immune cells in culture we cannot deduce on what is going on in the complex and dynamic system of a human being. So far alterations in the immune system of space travellers have not hindered them to go into space. However, as very long-term multi-year missions are envisaged, the potential for space flight induced alterations of the immune system might have major impact on crew health and success of the mission.

Our achievements are the result of the invaluable team work of scientists in Switzerland, Italy, Germany, Russia and US, of European, US and Russian astronauts as well as of personnel of ESA, NASA, DLR, IBPM in Moscow and of European aerospace industries.

DRUGS IN SPACE

J. Vernikos
Formerly Director NASA Life Sciences Division – Washington DC, USA

It is essential that astronauts respond in a predictable manner when administered a pharmacological agent in space. In the low gravity environment a different bioavailability parameter is expected when an oral dosage is administered due to a different tablet disintegration time.
In addition to the altered drug bioavailability, there significant variability in pharmacokinetic parameters and pharmacodynamic responses are also expected during long duration space missions.
Variable pharmacokinetic and pharmacodynamic parameters such as drug metabolism, drug binding and ultimately drug clearance might be found in space. Therapeutic concentrations of many drugs must be achieved and maintained in order to cure the disease or control symptoms. It has been challenging so far to design appropriate studies to adequately predict the pharmacokinetic parameters of common medications in microgravity but now such pieces of information are necessary to optimize drug therapy for space flight and to ensure the safety of long duration space travel.
Moreover, as space flight may be associated with vomiting and/or altered gastrointestinal function.
We all expect a large variability in drug concentrations with tablet disintegration at 1-g of with respect to 0-G, so that probably oral liquid dosing formulations will provide a more predictable drug level during space flight.

ENVIRONMENTAL FACTORS IN SPACE MEDICINE

Cesare Lobascio
Thales Alenia Space Italia; cesare.lobascio@thalesaleniaspace.com

Human exploration always requires the provision of Environmental Control & Life Support (ECLS) functions, ranging from atmosphere pressure, composition and contamination control to water and waste management. In general, the harsher the environmental conditions expected during a mission, and the farther the source of resupply, the more complex and demanding will be the system providing those functions. Ensuring a comfortable and productive human life in outer space pushes ECLS Systems to extreme design and development challenges. Absence of breathable air, extreme temperatures, modified gravity conditions, ionizing radiation are "normal" characteristics of the earth orbit and planetary environments.

The astronauts and equipment now on board the International Space Station (ISS) rely on physico-chemical ECLSS, demanding significant provision of resources from Earth. The lessons learned on ISS in terms of physico-chemical ECLS are extremely valuable. The future, however, is more challenging: for space missions it is necessary to minimize the mass at launch and the number of launches. This requires that all systems be lightweight; ECLSS should minimize resupply mass, by a maximum recycling of the resources available on board or in the planetary base. As a logical consequence, future ECLSS for long-duration missions will be more regenerative and biological, involving plants and micro-organisms, and aiming at the closure of oxygen, water and carbon loops. Deeper support to Extra Vehicular Activity (EVA) on the surface of planets will be necessary, with its implications on environmental pressure selection, airlock and suits design, etc.

RATIONALE AND PERSPECTIVES FOR MOON AND MARS EXPLORATION

B.H. Foing
ESA & ILEWG – ESTEC – Noordwjik – The Netherlands

We discuss the different rationale for Moon exploration. This starts with areas of scientific investigations: clues on the formation and evolution of rocky planets, accretion and bombardment in the inner solar system, comparative planetology processes (tectonic, volcanic, impact cratering, volatile delivery), records astrobiology, survival of organics; past, present and future life. The rationale includes also the advancement of instrumentation: Remote sensing miniaturised instruments; Surface geophysical and geochemistry package; Instrument deployment and robotic arm, nano-rover, sampling, drilling; Sample finder and collector. There are technologies in robotic and human exploration that are a drive for the creativity and economical competitivity of our industries: Mecha-electronics-sensors; Tele control, telepresence, virtual reality; Regional mobility rover; Autonomy and Navigation; Artificially intelligent robots, Complex systems, Man-Machine interface and performances. Moon-Mars Exploration can inspire solutions to global Earth sustained development: In-Situ Utilisation of resources; Establishment of permanent robotic infrastructures, Environmental protection aspects; Life sciences laboratories; Support to human exploration. We also report on the IAA Cosmic Study on Next Steps In Exploring Deep Space, and ongoing IAA Cosmic Studies, ILEWG/IMEWG ongoing activities, and we finally discuss possible roadmaps for robotic and human exploration, starting with the Moon-Mars missions for the coming decade, and building effectively on joint technology developments.

SCIENTIFIC SESSIONS:

Tuesday, 4th September 2007
HALL A, 10:00 – 11:00

Physical Sciences
Two-Phase Flow

DILUTE EMULSION CHARACTERIZATION IN FASES EXPERIMENTS

Murielle Rozières[1], Mickaël Antoni[1], Jurgen Krägel[2], Libero Liggieri[3], Reinhard Miller[2], Annie Sanfeld[1]

[1] UMR-CNRS 6171 - Université Paul CEZANNE - Aix-Marseille III - BP. 531, Av. Escadrille Normandie-Niemen, 13397 Marseille Cedex 20, France. [2]MPI KGF, Am Mühlenberg 1, 14476 Potsdam-Golm, Germany; [3]CNR-IENI, Via de Marini 6, 16149 Genova, Italy.

Despite their longstanding use, much remains to be understood about the mechanisms that rule aging of binary dispersed systems like emulsions. We report about optical tomography microscopy (OTM) ground measurements for dilute transparent emulsions that will be studied in the forthcoming ITEM-S ISS-FSL-FASES experiments but under microgravity conditions. When droplets of an emulsion aggregate in complex structures, ordinary optics becomes too restrictive. OTM has the advantage here to overcome these limitations and to allow the description of dilute emulsions bulk characteristics since inspection far inside the samples is possible. Beside droplet size distribution, this technique allows the determination of the location of the centre of each droplet evolving in the scanned emulsion volume. From the time evolution of the centre coordinates of each droplet it is possible to estimate the components of its velocity. As a result both position and velocity of the emulsion droplets in the visited scanned volume can be evaluated and used for further studies. Gravity remains one of the main drawbacks for a precise investigation of non isodense emulsions on earth. Beside transparency, another important constraint is indeed to consider not too rapidly evolving emulsions regarding to the characteristic times of the OTM equipment. In this context forthcoming FASES microgravity experiments will allow a full investigation of the aging dynamics even for non isodense emulsions.

BOILING CRISIS AND EVAPORATION AT THE TRIPLE CONTACT LINE

Vadim Nikolayev[1,2], Denis Chatain[1], Daniel Beysens[1,2], Yves Garrabos[3]
[1]ESEME/SBT/CEA-Grenoble, 17 rue des Martyrs, 38054 Grenoble Cedex 9 France ; [2]CEA-ESEME, PMMH, ESPCI, 10 rue Vauquelin, 75231 Paris Cedex 05 France; [3]CNRS-ESEME, Institut de Chimie de la Matière Condensée de Bordeaux, 87, Avenue du Dr. Schweitzer, 33608 Pessac Cedex, France

This communication deals with the experimental and numerical studies of boiling. The experiments have been performed near the critical point (33°K) of H_2 and under reduced gravity. The installation of magnetic gravity compensation at CEA-Grenoble [1] has been used. The purpose of the experiment is to verify the validity of two theories of the boiling crisis: Zuber's vapor column instability model and the vapor recoil model [1]. The critical heat flux (CHF) at which the boiling crisis occurs has been obtained as a function of the system pressure. While the predictions of the both mentioned models are similar far from the critical point they have been predicted to be very different in its vicinity. The obtained experimental data [2] have shown the validity of the vapor recoil model.
New simulations of the single bubble growth will be presented. The CHF can be obtained from such simulations as a threshold between two regimes of bubble growth. The first regime corresponds to the usual bubble growth and departure from the heater under the influence of gravity. The second regime is the bubble spreading under the influence of the vapor recoil. The obtained CHF dependencies on gravity and various system parameters will be discussed. A careful analysis of the hydrodynamics and heat transfer in the vicinity of the triple contact line is crucial to assess correctly the CHF. Influence of main physical effects occurring in this important region will be addressed.

1. Nikolayev, V., Beysens, D., Garrabos, Y., Chatain, D., Lecoutre C. Bubble spreading during the boiling crisis: modeling and experimenting in microgravity, Microgravity Science and Technology, Vol. 18, pp. 34-37 2006.
2. Nikolayev, V.S., Chatain, D., Garrabos, Y., Beysens. D. Experimental evidence of the vapor recoil mechanism in the boiling crisis, Physical Review Letters, Vol. 97, p. 184503, 2006.

DIGITAL HOLOGRAPHIC MICROSCOPY FOR THREE-DIMENSIONAL STUDY OF PHOSPHOLIPID VESICLES IN A SHEAR FLOW UNDER MICROGRAVITY CONDITIONS

N. Callens[1], F. Dubois[1], M.-A. Mader[2], C.Minetti[1], C. Misbah[2], T. Podgorski[2], P. Queeckers[1], C. Yourassowsky[1]

[1] Microgravity Research Center, Université Libre de Bruxelles, 50 Av. F. Roosevelt, CP 165/62, 1050 Brussels, Belgium ; [2] Laboratoire de Spectrométrie Physique, Université J. Fourier, UMR5588 - 38, Saint Martin d'Hères, 38402, France. email: frdubois@ulb.ac.be, phone: +32 2 650 42 83

The ESA project BIOMICS (BIOMImetic and Cellular Systems) is dedicated to the study of phospholipid vesicle suspensions under shear flow. The objective of the project is the development of an experiment which will take part in the MASER 11 sounding rocket payload foreseen for 2008. In this experiment, various suspensions of giant phospholipid vesicles will be shear successively in a Couette shear flow cell at different shear rates. A Digital Holographic Microscope, working in transmission with a partial spatial coherent source, will provide a 3D visualisation of the system. The preliminary experiments made during two parabolic flight campaigns (the 56th ESA campaign and the 59th CNES campaign) are presented as well as the important post-processing work needed to obtain information on the size, the shape, the 3D position, and an estimation of the mean velocity of each flowing vesicle[1,2]. As the dynamics of single isolated vesicles is now quite well understood[3], the goal is to study the collective motion of several samples submitted to different shear flows under microgravity conditions and compare their dynamics to the ones observed under gravity conditions where sedimentation screens the effect of hydrodynamic lift forces pushing vesicles away from the walls. The long term objectives of this study include a detailed understanding of the circulatory system and the rheology of deformable objects with potential new therapeutic means to prevent diseases.

1. Dubois, F., Callens N., Yourassowsky, C., Hoyos, M., Kurowski, P., Monnom, 0., "Digital holographic microscopy with reduced spatial coherence for 3D particle flow visualization and velocimetry", Applied Optics, Vol. 45, No. 5, pp. 864-871, 2006.

2. Dubois, F., Schockaert, C., Callens, N., Yourassowsky, C., "Focus plane detection criteria in digital holography microscopy by amplitude analysis", OPTICS EXPRESS, Vol. 14, No. 13, pp. 5895-5908, 2006.

3. Mader, M.-A., Vitkova, V., Abkarian, M., Viallat, A., Podgorski T., "Dynamics of viscous vesicles in shear flow", The European Physical Journal E - Soft Matter, Vol. 19, No. 4, pp.389–397, 2006.

SCIENTIFIC SESSIONS:

Tuesday, 4th September 2007
HALL B, 10:00 – 11:00

Life Sciences
Plant Biology I

SEED GERMINATION AND SEEDLING GROWTH UNDER SIMULATED MICROGRAVITY CAUSES ALTERATIONS IN PLANT CELL PROLIFERATION AND RIBOSOME BIOGENESIS

Isabel Matía[1], Jack van Loon[2], Eugénie Carnero-Díaz[3], Roberto Marco[4], Francisco Javier Medina[1]*

[1]Centro de Investigaciones Biológicas (CSIC), Ramiro de Maeztu 9, E-28040 Madrid, Spain.; *mailto:fjmedina@cib.csic.es; [2]DESC, ACTA-Free University, Amsterdam, The Netherlands; [3]CEMP, Université Pierre et Marie Curie, Paris, France [4]Departamento de Bioquímica-IIB "Alberto Sols", Universidad Autónoma de Madrid-CSIC, Madrid, Spain

The survival of terrestrial organisms in conditions different from those of the Earth is one of the main objectives mobilizing the current space exploration initiatives, such as the ISS or the projects for exploring Mars. The study of the modifications induced by altered gravity in functions of plant cells is a valuable tool to achieve this objective. The system "cell proliferation-ribosome biogenesis" is advantageous for these studies, since these functions are essential for the cell and organism survival, they are inter-related and they respond in a detectable form to external alterations, such as the absence of gravity, which can be either found in the space environment, or artificially induced by specific devices [1, 2]. An early experiment on these topics, called "Root", was carried out in the ISS in the course of the "Cervantes Mission". It consisted of *Arabidopsis* seed germination and growth in space for 4 days and seedling fixation for analysis of root meristematic cells by structural and morpho-metric study of the root and of the nucleolus, and the quantitative immunocytochemical study of the expression of the nucleolar protein nucleolin. The results showed alterations in the cell proliferation and in ribosome biogenesis, suggesting that, in weightlessness, cell proliferation is enhanced, but not cell growth [3]. For testing this preliminary conclusion, *Arabidopsis* seedlings in which the expression of the cyclin gene *CYCB1,* a cell cycle regulator, was linked to the reporter gene GUS [4] were grown in a Random Positioning Machine, a device known to accurately simulate microgravity [5]. Samples were taken at 2, 4 and 8 days after germination and subjected to the same analyses previously performed in the ISS experiment, plus the estimation of the expression of the cyclin gene. Our results confirm our previous interpretations, showing that cells divide more in absence of gravity than in control ground gravity, but the cell cycle appears deeply altered as early as 2 days after germination. Furthermore, higher proliferation is not accompanied by an increase in ribosome synthesis, as is the rule on Earth, but the functional markers of this process appear depleted in microgravity-grown samples. Therefore, the alteration of the gravitational environmental conditions results in a considerable stress for the plant.

1. Mayer, C., Grummt, I. Cellular stress and nucleolar function. Cell Cycle 4, 1036-1038, 2005.
2. González-Camacho, F., Medina, F.J. The nucleolar structure and the activity of nucleolin-like protein NopA100 during cell cycle in proliferating plant cells. Histochem.Cell Biol.125,139-153, 2006
3. Matía, I. et al. Nucleolar structure and proliferation activity of Arabidopsis root cells from seedlings germinated on the International Space Station. Adv. Space Res. 36, 1244-1253, 2005.
4. Ferreira, P. et al. Three discrete classes of Arabidopsis cyclins are expressed during different intervals of the cell cycle. Proc. Natl. Acad. Sci. USA 91, 11313-11317, 1994.
5. Kraft, T.F.B. et al. Plastid position in Arabidopsis columella cells is similar in microgravity and on a random-position machine. Planta 211, 415-422, 2000.

CLINOSTATE AND HYPERFUGE EFFECTS ON PINUS PINEA SEEDS DURING GERMINATION PROCESS

Francesco Ranaldi, Eugenio Giachetti, Proto Pippia, Paolo Vanni
Dipartimento di Scienze Biochimiche, Laboratorio di Chimica Medica, Università di Firenze, Firenze, Italy.
Viale Pieraccini, 6 – 50139 Firenze, Italy

Our previous studies performed on *Pinus pinea* seeds, subjected to a hyper-gravitational stress (1000 X g for 64 hours at 4°C) before the beginning of the germination, shown a delay of the germination and a decrease of the enzymatic activities of the isocitrate lyase and other correlated enzymes (1). Now we propose a new study in which *Pinus pinea* seeds were subjected to two different gravitational stress during the whole time of germination (21 days): a moderate hyper-gravitational stress (20 x g) and a hypo-gravitational one (about 10^{-3} x g).
We estimated the activities of the most representative enzymes of the main metabolic pathways (isocitrate lyase for glyoxylate cycle, 3hydroxyacilCoA dehydrogenase for fatty acids metabolism, glucose 6-phosphate dehydrogenase for shunt of pentose phosphates, isocitrate dehydrogenase for Krebs Cycle, pyruvate kinase for glycolyse) in treated seeds with respect to the control ones (1 x g), at different days during the whole germination process.
Some of these enzymes showed interesting variations of their activity levels.
The hypo-gravity condition and the hyper-gravity one brought to opposite results.

1. Ranaldi, F., Giachetti, E., Vanni, P., "Gravitational stress on germinating Pinus pinea seeds" C.R. Soc. Biol. Accademie des Sciences de l'Institut de France, Vol. 326, pp. 553-564, 2003.

REPEATED MICROGRAVITY INCIDENTS INDUCE REPEATED BURSTS OF SUPEROXIDE ANION RADICALS IN ROOTS

Stefano Mancuso[1], Sergio Mugnai[1], Elisa Azzarello[1], Elisa Masi[1], Camilla Pandolfi, [1] Andrej Hlavacka[1], Boris Voigt[1], Frantisek Baluska[2], Dieter Volkmann[2]
1 LINV, University of Firenze, Viale delle idee 30, Sesto Fiorentino (FI) – Italy; 2 IZMB, University of Bonn, Kirschallee 1, Bonn, Germany

Plant cells are exquisitely mechano-sensitive. Besides light, gravity is the most important physical factor shaping the plant body. Moreover, penetrating plant pathogens are exerting mechanical pressure on plant cells and ability to perceive sensitively mechanical signals may be important for rapid mounting of defence responses. The most well understood is induction of the oxidative burst with pathogen-derived elicitors. Whereas early studies focused almost exclusively on production of reactive oxygen species (ROS) from the plant defense perspective of attacking pathogens, more recent studies revealed another perspective. Both in animals and plants, but not yeast, ROS emerge as an important signalling molecules acting as second messenger. In plants, several recent studies documented signaling roles of ROS in cell death, stress adaptation, stomata movements, root hair tip growth, as well as auxin and abscisic acid signaling.
Here we have investigated effects of hypergravity and microgravity repeatedly imposed on roots of maize during parabolic flight experiment. In the first campaign, we have monitored production of superoxide anion radical (O_2^-) along surfaces of intact plant root apices. In the second campaign, we have monitored O_2^- in the whole chamber in which five isolated roots were placed. Both these different approaches resulted in the same surprising results. Not the hypergravity, but the microgravity induced all the time immediate oxidative bursts. As this activation can be repeated many times and the hypergravity which is imposed in-between does not inteferes with the microgravity-induced burst of superoxide anion radicals, our data strongly suggest that the sensing mechanism is specific only for the microgravity and that the receptor NADPH oxidase(s) can be rapidly resetted back to the sensing modus.

Monitoring of the root apices with the non-invasive oxygen sensitive electrode in the first campaign showed that the microgravity sensing via NADPH oxidases activity is specific for cells located in the root apex, including the root cap, meristem and transition zone and that cells of the root elongation region do not respond to the microgravity. Our future studies will aim in the identification of those cells which accomplish the microgravity-induced burst of superoxide anion radicals and of the identity of NADPH oxidases which underly this one of the fastest response to microgravity ever recorded in plants.

SCIENTIFIC SESSIONS:

Tuesday, 4th September 2007
HALL A, 11:20 – 13:20

Physical Sciences
Material Properties

MEASUREMENT OF SORET COEFFICIENT IN LIQUIDS

Mialdun A.*, Shevtsova V.
MRC, CP-165/62, Université Libre de Bruxelles, 50, av. F.D.Roosevelt, B-1050 Brussels, Belgium
*Corresponding author e-mail: amialdun@ulb.ac.be

Nowadays Earth sciences inspire new wave of interest to studying thermodiffusion separation in liquid mixtures. For that an improvement of Soret coefficient measuring techniques is required either to achieve better reliability and accuracy of measurement or to make it more rapid.

A new measurement method is proposed and validated by authors. Unlike previously used techniques that are typically based on spot measurements (sometimes even invasive), the proposed one is contactless and gives information on 2D distribution of components over volume of thermodiffusion cell. The method is based on interferometry and modern techniques of digital processing of interferograms. It gives several important advantages, as for example ability to observe concentration profile throughout the entire thermo/diffusion path, which allows studying transient regime of Soret separation. Another important feature of the method is that it gives clear evidence of convective motion in the cell (if it presents). It lets either to reject measurements disturbed by unwanted convection or, in contrary, to study convective influence on Soret separation. Namely for the last purpose the method was initially developed.

Using the developed technique the thermodiffusion coefficients were measured for number of mixtures in systems of water-isopropanol and water-ethanol. For the last system, that is common test system de-facto, good quantitative agreement with previous data was obtained.

BASIC PRINCIPES OF NON-CONTACT THERMOPHYSICAL PROPERTY MEASUREMENTS IN REDUCED GRAVITY UNSING INDUCTIVE LEVITATION

Pascal Schetelat*, Valdis Bojarevics, Koulis Pericleous**, Jacqueline Etay***
*CNRS-SIMAP-EPM ENSEEG BP75 38402 St Martin d'Heres Cedex FRANCE; **University of Greenwich, School of Mathematics, 30 Park Row, London SE10 9LS, UK

Electromagnetic levitation of electrically conductive droplets by alternating magnetic fields is a technique used to measure the physical properties of liquid metallic alloys such as surface tension, viscosity, heat capacity and thermal diffusivity. Experiments are conducted in microgravity, to reduce electromagnetic stirring and shaping of the droplet. Surface tension and viscosity measurements are deduced from the record of the time-dependent behaviour of a point of the free surface, heat capacity and thermal conductivity are determined by modulated calorimetry and from the record of the polar temperature. Then, those signals are analyzed by the use of analytical models. Our purpose is to check the various assumptions on which those models are build by the use of adapted numerical codes. Particularly, we emphasize the fluid flow effects on the measurement precision, by comparing expected and calculated properties values. We determinate the critical values of initial droplet distortion or magnetic field intensity which can lead to an overestimation of the value of viscosity. We also calculate the limit on thermal conductivity measure. We note the strong robustness of measurements of surface tension and heat capacity.

XRMON A NEW X-RAY FACILITY FOR METALLURGICAL EXPERIMENTS

P. Holm, Y. Houltz, P. Andersson, O. Löfgren, K. Löth, C. Lockowandt
Swedish Space Corporation, P.O. Box 4207, SE-171 04 Solna, Sweden, E-mail: per.holm@ssc.se tel: +46 8 627 62 00, fax: +46 8 98 70 69

The XRMON (X-ray monitoring) metal foam experiment module, developed by the Swedish Space Corporation, is using an in-situ X-ray diagnostic system. The purpose of the experiment is to, by X-ray, monitor and analyse the foaming process of an Aluminium alloy in absence of gravity induced drainage in a thermally controlled furnace.
The investigator is Dr Francesco Garcia-Moreno HMI, Berlin, Germany. The experiment module is under development under a contract from European Space Agency, ESA and will fly on a parabolic flight 2007 as a preparatory step before the microgravity rocket flight on Maser 11 in spring 2008.
The experiment module contains an experiment furnace system, in which the Al sample is melted. The sample contains particles with hydrogen, blowing agents, which generates the foaming process. The furnace temperature is controlled during the heating, foaming and stabilisation process. The furnace is cooled by a forced air-flow in order to solidify the sample before the end of microgravity. High requirements on image contrast and resolution pose special demands i.e. X-ray transparency on the selection of materials and technologies in the furnace.
The diagnostic X-ray system consists of a microfocus X-ray source (tungsten anode), a CMOS high-resolution digital x-ray detector and an image acquisition computer. Images acquired during the microgravity phase will be stored on a fast solid state memory on board. The X-ray system is based on a commercial X-ray system that have been adapted and qualified for flight on a microgravity rocket. It will be the first X-ray system flying on in space on a microgravity rocket. The system can be adapted and used for a multitude of metallurgical experiments requiring in-situ observation of the process in the samples. The existing system has the following specification:

- Tube power range: 20-100 kV, 0-250 µA.
- Sensor in CMOS technology with 50 µm res.
- Resolution of sample in shadow view is 12 µm.
- Sensor size 120x120 mm
- Image frequency: up to 2 frames/sec

For radiation protection reasons, a layer of lead covers the system and fulfils the requirements for radiation protection in all test situations until flight. A new in-house developed mechanical damping system is verified to radically reduce high frequency vibrations at a sounding rocket flight.

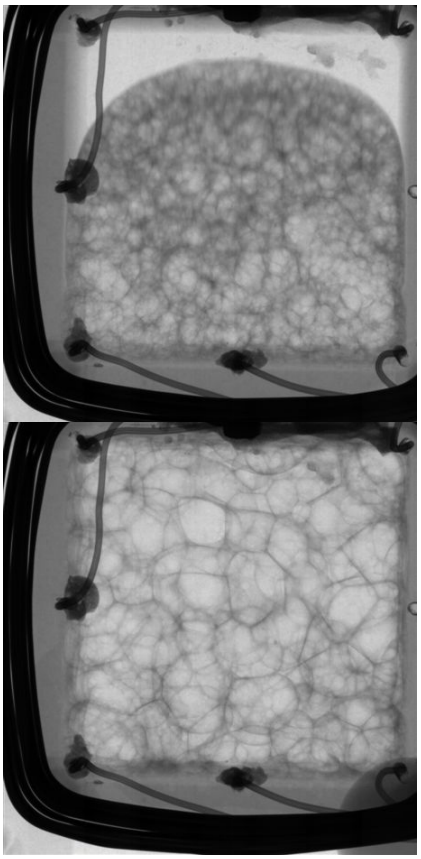


Figure 1 and 2: X-ray images of Al foam during expansion and coarsening.

SURFACE TENSION AND VISCOSITY OF COMMERCIAL TI-ALLOYS: MEASUREMENTS BY THE OSCILLATING DROP METHOD ON BOARD PARABOLIC FLIGHTS

Rainer Wunderlich[1], Kensuke Higuchi[2], Stephan Schneider[3], Hans-Jörg Fecht[1,2]
[1]University of Ulm, Institute for Micro- and Nanomaterials, Ulm, Germany; [2]Gakushuin University, Department of Physics, Mejiro, Tokyo, Japan; [3]German Aerospace Center, DLR, Microgravity User Support Center, Cologne, Germany; [4] Forschungszentrum Karlsruhe, Institute of Nanotechnology, Karlsruhe, Germany.

The surface tension and the viscosity are two important thermophysical properties in casting simulations relevant to fluid flow, form filling, and defect prediction such as microporosity. Their measurement is, however, complicated by the presence of container reactions when handling metallic liquids over an extended period of time as required, for example, in the oscillating cup or sessile drop methods. This holds in particular for Ti -alloys with liquidus temperatures ranging from 1700°C for the Ti6Al4V alloy and its variants to 1570°C for the γ-TiAl alloys. Thus, reliable values of the surface tension and the viscosity are often not available. Within the ESA ThermoLab project, measurements of the surface tension and viscosity have been performed in an electromagnetic levitation device by the oscillating drop method on board parabolic flights. Parabolic flights provide about 20 seconds of reduced gravity. It was demonstrated that this time is sufficient to melt, heat into the liquid phase, excite surface oscillations, and cool to solidification of many metallic alloys of technological interest. A review of the development of processing techniques in parbolic flights and data analysis for surface tension and viscosity measurements will be given. Results will be demonstrated for the Ti6Al4V and γ-TiAl alloys suggested by the industrial partners of the ThermoLab project.

TERMOMAGNETIC CONVECTION AS A TOOL OF HEAT AND MASS TRANSFER CONTROL IN NANOSIZE MATERIALS UNDER MICROGRAVITY

Alexandra Bozhko, Gennady Putin
Department of Physics, Perm State University, Bukirev Str. 15, 614990 Perm, Russia; +7 3422 396642, bozhko@psu.ru

Magnetothermal mechanism of convection allows the creation of a virtually arbitrary, controllable body force distribution in nonconducting nanosize materials, like protein solutions [1,2] and other forms of colloids [3]. It may be also fruitfully used as a simple test method of oxygen content in the air [4] inside spacecrafts. However, on the Earth magnetic forces for ordinary fluids exerted by a typical magnet are too insignificant, that is why colloids of monodomain particles (ferrofluid) with thousand times higher magnetic susceptibility are very convenient for ground-based modeling of magnetoconvection. One should note that the study of thermal and concentration ferrofluid magnetoconvection, as well as the measurements of the translation diffusion coefficient and thermal diffusion ratio, are complicated at laboratory conditions due to ubiquitous gravity sedimentation effects. Therefore, the investigations of pure magnetoconvection and the transport factors measurings would be very useful under microgravity. On the other hand, the ground-base preparation may include the more integrated tasks, including ferrofluid convection over a gravitational sedimentation of magnetic particles and their aggregates. The research described in this publication was made possible in part by Russian Foundation for Basic Research (grant 07-08-96039) and Award PE-009-0 CRDF.

1. De Lucas, L.J., Tillotson, B.J., "Diamagnetic control of convection during crystal growth", Joint 12th European and the 6th Russian Symp. on Phys. Sc. in Microgravity, St. Petersburg, Russia, June 15-21, 1997.
2. Ramachandran, N., Leslie, F. W., "Using magnetic fields to control convection during protein crystallization – analysis and validation studies", J. Crystal Growth, Vol. 274, pp. 297-306, 2005.
3. Odenbach, S., "Microgravity experiments on thermomagnetic convection in magnetic fluids", J. Magn. Magn. Mater., Vol. 149, pp.155-157, 1995.
4. Ageikin, D.I., "Definition of heat emission by magnetothermal convection", Proceedings USSR Academy of Sciences, Vol. 74 (2), pp. 229-232, 1950.

INFLUENCE OF SAMPLE SIZE ON THE VISCOSITY MEASUREMENT OF MOLTEN METALS WITH AN ELECTROSTATIC LEVITATION METHOD

Noriyuki Koike[1], Takehiko Ishikawa[2], Paul-François Paradis[2], Hiroshi Tomioka[3], Yuki Watanabe[3], Shinichi Yoda[2], Tetuichi Motegi[1]

[1]Chiba Institute of Technology, 2-17-1 Tsudanuma, Narashino, Chiba 275-0016, Japan; [2]Japan Aerospace Exploration Agency, 2-1-1 Sengen, Thukuba, Ibaraki 305-8505, Japan; [3]Advanced Engineering Services Co. Ltd., 1-6-1 Takezono, Tsukuba, Ibaraki 305-0032, Japan.

Corresponding author's TEL: +81-29-868-3817, FAX : +81-29-868-3956, E-mail : koike.noriyuki@jaxa.jp

The materials are handled in their liquid phase, in such industrial processes as casting, welding, and crystal growth (i.e. Czochralski method, Bridgeman method, etc.).
Therefore, for quantitative grasp of those processes, viscosity of liquid phase becomes necessary. However, due to their high melting temperatures and risk of contamination from the container wall, measured viscosity of liquid refractory metals are very scare.
The electrostatic levitation system and non-contact viscosity measurement technique (oscillating drop method) has overcame the contamination problems associated with the conventional high temperature processing and allowed accurate determination of the viscosity of molten refractory metals[1].
When the viscosity of liquid materials are measured by the oscillation drop method [2], it is assumed that no external field is present and that the oscillation is damped only by the viscosity of the sample. In the real experiments, some external forces are applied to the sample to levitate and maintain the sample position on the ground. In case of the electrostatic levitation, huge electric fields and a high speed feedback control are necessary to levitate a sample in 1-G.. Until now, the effect of the electric field on the viscosity measurement has not been verified. In this study, viscosity measurements with different sample sizes were conducted using a ground based electrostatic levitator to investigate the effects. The experimental results clearly showed that an additional damping effect, associated with the levitating electrical field, became more significant as the sample became larger. The experimental result and necessity of microgravity condition will be discussed.

1. Ishikawa, T., Paradis, P. –F., Itami, T., Yoda, S. Measurement Science and Technology, Vol. 16, pp. 443-451, 2005.
2. Rhim, W. -K., K. Ohsaka, P. -F. Paradis; Rev. Sci. Instrum. Vol. 70, pp. 2996, 1999.

SCIENTIFIC SESSIONS:

Tuesday, 4th September 2007
HALL B, 11:20 – 13:20

Life Sciences
Plant Biology II

AUXIN ACTIVATD GENES ARE INVOLVED IN THE SENESCENCE INDUCED BY SPACE ENVIRONMENT IN ARABIDOPSIS

A.Fortunati, P. Tassone, F. Migliaccio
Institute of Environmental Biology and Forestry (IBAF), Consiglio Nazionale delle Ricerche; 00016 Monterotondo (Roma) Italy.

Even though senescence is a physiological process in plants, it can also be induced by situations of stress such as heat, cold, drought, or stress consequent to growth in space. An environment deprived of gravity, subject to bombardment by high energy particles. To know more about the effect of space on senescence, we submitted Arabidopsis plants to irradiation by high energy neutrons, followed by the analysis of the expression of key genes in the process. In particular, our study was directed to determine, by quantitative Real-time PCR, the involvement of some of the auxin (IAA) activated genes in the induction of senescence after irradiation. The genes so far studied were from the *ARFs* and *IAAs* families, the carriers of auxin *AUX1* and *EIR1*, and the heat shock factor *AtRHA1*, a gene isolated in our laboratory. The results showed that all the considered *ARFs* (*ARF1, ARF2, ARF7, ARF19*) and *IAA*s (*IAA3, IAA7*), as well as *Atrha1* increase the expression after neutron irradiation in the wild-type plant, whereas in the mutant *Aux1*, deprived of a carrier for the influx of auxin some genes did not show increase of expression. These were *ARF3, ARF19, IAA7*. Three genes that were already shown to be involved in significant morphogenetic processes, such as lateral root development and organ symmetry. The role of auxin in the control of senescence is discussed in the presentation.

ALTERATIONS IN THE EXPRESSION OF TRANSCRIPTION FACTORS IN *ARABIDOPSIS THALIANA* CELL CULTURES DURING SOUNDING ROCKET μ*G*

Maren Babbick, Zarko Barjaktarovic, Rüdiger Hampp
University of Tübingen, Physiological Ecology of Plants, Auf der Morgenstelle 1, D-72076 Tübingen, Germany;
Email: ruediger.hampp@uni-tuebingen.de

Gravity is an important environmental factor that controls plant growth and development. Studies have shown that the perception of gravity is not only a property of specialized cells, but can also be performed by undifferentiated cultured cells. We thus used cell cultures of *Arabidopsis thaliana* (cv. Columbia) in order to screen for early alterations in gene expression as a response to altered gravitational fields. Genes of interest were selected from a larger group, the expression of which was altered under hypergravity (microarray study; Martzivanou and Hampp, Physiol. Plant. 118, 221-231, 2003). For studies regarding responses to short-term exposure to altered gravity, we especially looked for genes, the products of which control the expression of other genes (transcriptions factors, TFs) and which are thus at the beginning of signal transduction chains. These comprise genes belonging the TF families WRKY, MADS-box, MYB, and AP2/EREB. In addition, we included a gene that controls auxin-mediated responses (*IAA 19*) and a gene coding for phosphoinositol-4-kinase (part of phospholipid-dependent signalling). Transcriptional changes of these genes were studied within a time frame of up to 12 min of exposure to microgravity as part of a sounding rocket experiment (MAXUS 7). Most gene products exhibited significant changes in abundance as determined in 2-min-intervals. According to the time-dependent changes in amount, three groups could be distinguished. A comparison with other types of exposure (clinorotation (2D and random positioning machine: RPM), hypergravity (8*g*), magnetograviphoresis) showed some homologies in transcript behaviour between MAXUS μ*g*, RPM, and magnetophoresis. The MAXUS data appear very encouraging with respect to the possibility to identify steps of gravity-related signal transduction.

CYTOSKELETON REARRANGEMENTS IN THE DISTAL ELONGATION ZONE OF ARABIDOPSIS ROOT UNDER CLINOROTATION

Galina Shevchenko, Iana Kalinina, Elizabeth Kordyum
Cell Biology Department, Institute of Botany, 2, Tereshchenkivska St., 01004, Kiev, Ukraine; Tel. /fax +38(044) 272-32-36, E-mail: olga-s@mail.kar.net

We investigated the impact of clinorotation (2 rpm) on Arabidopsis thaliana seedlings transfected with ABD2, which decorates the actin microfilaments. The idea was to find out whether changes of cytoskeleton arrangement affect the cell growth rate in the distal elongation zone (DEZ) of seedling root. Drug analysis (cytochalasin D and oryzalin) was applied in order to distinguish the role of separate cytoskeleton elements in growth coordination in the DEZ. Our preliminary results have shown that there was no obvious discrepancies in the arrangement of actin microfilaments between control and clinorotated samples. Microfilaments formed distinct network from bundles of various density. Cytochalasin treatment results in damage of actin network. There was no evident disruption of microfilaments but their bundles were sparse and not so prominent. Use of oryzalin (tubulin inhibitor) also made the network of microfilaments thinner and sparse. In contrast to cytochalasin treatment, some spots appeared in DEZ cells after application of oryzalin. They were distributed randomly in the epidermis and cortex cells of root.
The same type of spots were found in clinorotated roots. Their quantity does not differ from the control samples. Measurements of cell parameters in the DEZ after application of inhibitors did not show any significant difference in cell sizes between control and clinorotated seedlings. Although, under clinorotation the cell parameters in oryzalin treated roots were more variable. It is suggested that tubulin cytoskeleton is able to influence the arrangement of actin cytoskeleton in the DEZ of root. Therefore, it is suggested that interrelated organization of microfilaments and microtubules promotes the growth stability in root cells under clinorotation.

SPATIAL ORGANIZATION OF CYTOSKELETON IN ARABIDOPSIS ROOTS UNDER CLINOROTATION

Iana Kalinina, Galina Shevchenko, Elizabeth Kordyum
Cell Biology Department, Institute of Botany NASU, 2, Tereschenkivska Str., 01004 Kiev, Ukraine; Tel. /fax +38(044) 272-32-36, yana.kalinina@mail.ru

To modulate some biological effect of microgravity on plant cytoskeleton we used clinorotation (2rpm). Microtubule (MT) function in Arabidopsis root cells has been studied using oryzalin, that targets tubulin and interferes with MT assembly. As MTs and actin microfilaments affect each others' distribution we also examined spatial organization of microfilaments. We used the stably transformed lines of Arabidopsis expressing GFP-MAP4 for visualization of MTs and Arabidopsis expressing GFP-fABD2 for visualization of microfilaments. Arabidopsis seedlings were clinorotated during 5 days and examined with a confocal microscope LSM 5 PASCAL (Carl Zeiss, Germany). The GFP-fABD2 labeled highly dense actin networks in meristem and distal elongation zone and less dense but more dynamic in elongation zone, but no visible differences between control and clinorotated seedlings were noted. The GFP-MAP4 stained fine cortical MT arrays, the endoplasmic microtubules were not so numerical and distinct. We report changes in the MT spatial configuration under clinorotation in epidermal and cortical cells in distal elongation zone, where numbers of discordant shorter MTs appeared. To see a dynamics of this realignment we applied 5μM/L oryzalin in control and clinorotated seedlings. Combined application of clinorotation and oryzalin during 5 days did not result in additive effects and evoked disruption of tubulin cytoskeleton. In control and after rapid oryzalin treatment, followed by clinorotation, MTs in meristem and in distal elongation zone are disappeared earlier then in mature zone. It is suggested that sensitivity to oryzalin is depended on the MT orientation which varied in the different growth zones of a root. It is revealed that disoriented MTs, which appeared in distal elongation zone under clinorotation, are hypersensitive to oryzalin. As far as oryzalin binds to tubulin dimers and blocks polymerization, a dynamic MT with high turnover should be more sensitive to inhibitor as compared to a stable MT with a low rate of dimer exchange. The increased oryzalin sensitivity of these MTs can be interpreted as consequence of the increasing in rate of MT dynamic turnover. It is assumed that the changes in the stability of the tubulin cytoskeleton may underlie the clinorotation-induced rearrangement of cortical MT arrays.

PREPARING ULOCLADIUM CULTURES FOR STUDIES IN MICROGRAVITY CONDITIONS

Ioana Gomoiu[x], Evangelia Sarantopoulou[xx], Zoe Kolia[xx]
x-Institute of Biology, 296,Splaiul Independentei,296, 6 Sector , Bucharest, Romania; xx- National Hellenic Research Foundation, TPCI, 48 Vassileos Constantinou Avenue, Athens11635,Greece.

Ulocladium chartarum is a black fungus isolated from mural painting of Stavropoleos church from Bucharest, Romania. It is one of microbiodetriogens of artefacts producing aesthetic and biochemical deteriorations. It will be a coloured fungus for studies in microgravity conditions in 2008. In normal conditions, on potatoes-dextrose agar, *Ulocladium chartarum* develops colonies with diameter of 42-45mm in 7 days, waved and diffuse edges. Sporulation is starting from the centre of colony and it is in the end at 9 days. Condiophores are septate, branched or simple. They are straight and flexuous with diameter of 40-50x5,0-7,0 µm, coloured in light brown, with smooth walls. Conidia can be solitary or part of a chain containing 2-10 spores. Their shape can be ovoid or ellipsoidal, size 18-38x11-20 µm, colour olivaceous-black; walls are verrucose. On Atomic Force Microscope were put in evidence rodlets which are involved in attachments of spores on nutrient medium or artefacts as a step of biological colonization and spores aggregation. During exposure of spores at laser illumination - 157 nm, if there is a single layer all of them are completely destroyed but in case of multi layers the outer layer act as a protection level of inner spores. In microgravity conditions we are expected to find random orientation of hyphae, conidiophores and spores. The shape and size of colonies in biocontainer placed in ISS for 10 days can be changed as a result of random orientation of hypahe. Branching of hyphae and conidiophore, spreading of spores, degree of sporulation and thickness of mycelium can be also affected.

1. Hader, D.P., "Gravitaxis in unicellular microorganisms", Adv Space Res, Vol.24, pp. 843-850, 1999.
2. Hatton,J.P. et al., "Kinetics of stipe gravitropism in the mushroom Coprinus cinereus under conditions of microgravity simulation", Microgravity Q.,Vol.4, pp. 101-106, 1994.
3. Mogami, Y., "Dynamic instability of biological system under natural and experimental gravity conditions", Biol Sci Space, Vol.15, pp. 198-199, 2001.
4 .Sarantopoulou, S., "Preventing biological activity of Ulocladium spores in artefacts using 157-nm laser", Appl.Phys.A., Vol. 83, pp. 663-668, 2006.
5. Yamashita, M., "Biology of size gravity",Vol.18, pp. 13-27, 2004.

MOLECULAR ANALYSIS OF GRAVITAXIS IN *EUGLENA GRACILIS*

Michael Lebert, Donat-Peter Häder
Plant Ecophysiology, University of Erlangen, Plant Ecophysiology, Staudtstr. 5, 91058 Erlangen, Germany
Phone: +49-9131-8528217, Fax: +49-9131-8528215, mlebert@biologie.uni-erlangen.de

The unicellular, photosynthetic flagellate *Euglena gracilis* uses several environmental hints to reach and stay in regions optimal for growth and reproduction. Gravity and light are the most important stimuli in this respect. For more than hundred years gravitaxis of *Euglena* (orientation in respect to the gravity vector) was an important subject of investigations of many scientists, but only in recent years new insights based on the biochemical and molecular analysis could be provided.

Currently two subjects are in the centre of interest in our laboratory. One is the genetical analysis of gravitaxis in *Euglena*. The other is the use of photosynthetic flagellates in Closed Bioregenerative Life-Support Systems (CBLSS). Gravitaxis in *Euglena* is based on a specific density difference between the cell body and the medium. The resulting force on the lower membrane results in an activation of mechano-sensitive ion-channels. Currently, RNAi-knock-down mutants for a specific, gravitaxis-related trp-type mechano-sensitive ion channel as well as a specific calmodulin knock-down strain are under close investigations. Preliminary results indicate that both proteins are directly involved in the gravitactic signal transduction chain of *Euglena.*

Life support systems involve the use of photosynthetic organisms to support animal compartments with oxygen. In the same time carbon dioxide as well as nitrogenous compounds are removed from the system by the single cells. The development of an autonomous system scheduled to be flown in a Fotton mission in September 2007 will be reported as well as the biological control experiment results.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL A, 9:00 – 10:20

Physical Sciences
Capillary Flow

NON-GRAVITATIONAL FLUID TRANSPORT IN AQUEOUS FOAMS: CAPILLARY AND SHEAR EFFECTS

Arnaud Saint-Jalmes (1), Sebastien Marze (2), Dominique Langevin (2)
(1)Groupe Matière Condensée et Matériaux, Université Rennes 1, Rennes, France; (2)Laboratoire de Physique des Solides, Université Paris-Sud, Orsay, France.

On ground, the liquid initially trapped inside an aqueous foam irreversibly flows downward due to gravity. But gravity is not the only driving force for fluid motion. More subtle mechanisms also induce fluid transports in foams, and these are also important for the macroscopic properties.
Here, we investigate the fluid motions induced by these other non-gravitational mechanisms: first, due to capillarity and then in response to macroscopic deformation. To study the capillarity-driven flows, we performed imbibition experiments under microgravity conditions (parabolic flights and Maxus rocket). Using optical and electrical tools, the capillary motion of the foam fluid and the local liquid fraction ε are monitored. Data are compared to classical drainage models: while at low ε, the drainage equation well predicts the permeability, it becomes finally better described by a model of non-deformed packed spheres at the highest ε. We also show that the interfacial mobility are less and less important as the liquid fraction increases. Secondly, we show that under non-homogeneous shear, a dynamic dilatancy effect occurs (studied by an acoustic method), which implies a liquid transport. As well, while slipping at solid surfaces, we show that liquid can be re-distributed between foam channels, films and nodes, in a region close to the lubrication layer at the surface. Here again the role of the interfacial mobility is investigated in these processes.These new results on the links between hydrodynamics, structure and rheology can also be useful for other soft, wet and elastic materials, like some plants or biological tissues, which share similar poroelastic properties with foams, and where both capillarity-induced and strain-induced fluid transport are present.

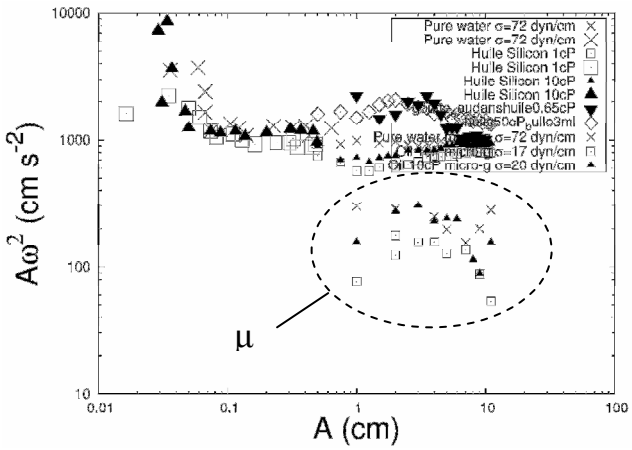
Saint-Jalmes, A., Marze, S., Ritacco, H., Langevin, D., Bail, S., Dubail, J., Roux, G., Guingot, L., Tosini, L., Sung, P., “Diffusive liquid transport in porous and elastic materials : the case of foams in microgravity”, Phys. Rev. Lett., Vol. 98, p. 058303, 2007.

BREAK-UP OF BUBBLES AND DROPS UNDER MODULATED GRAVITY

Harunori Yoshikawa[1], Farzam Zoueshtiagh[2], Hervé Caps[3], Pascal Kurowski[1], Philippe Petitjeans[1]

[1] Laboratoire de Physique et Mécanique des Milieux Hétérogènes (UMR 7636, ESPCI-CNRS-UP6-UP7), 10 rue Vauquelin, 75231 Paris Cedex 5 ; [2] Laboratoire de Mécanique de Lille (UMR 8107 CNRS), Bd Paul Langevin, 59655 Villeneuve d'Ascq, France ; [3] Group for Research and Applications in Statistical Physics (GRASP), Université de Liège, Institut de Physique B5, B-4000 Liège, Belgique

Dynamics of bubbles and drops in a vibrated surrounding fluid was studied experimentally under normal G and μG environments with a special interest in their break-up. The experimental cell has a dimension of 80x80x60 mm and is filled by a surrounding fluid (typically water or silicon oil) with a bubble or a drop (~3 ml of volume). It has been reported in Zoueshtiagh *et al.* (Eur. Phys. J. E, 2006) that such a bubble in water breaks up beyond a constant critical acceleration around 0.7G for a large vibration amplitude (A>1 mm, f<10 Hz) and that this break-up is followed by successive break-ups until the bubble size became sufficiently small against the vibration. Under μG, the bubble break-up also happens at a constant but a smaller acceleration (around 0.2G). Recently, we studied a small amplitude case (A>0.1 mm, f<100 Hz) and found a different behaviour of the break-up threshold. The critical acceleration was not constant and increased with decreasing the frequency. We also realised experiments on the Earth in the aim of examining viscosity effect and the case of a liquid drop. Stabilization by the viscosity and behaviours of the drop very different from those of a bubble were found. These results will be presented with corresponding experiments under μG during parabolic flights prearranged on March 2007.



Bubble break-up threshold for different viscosities under G and μG

EXPERIMENTAL AND NUMERICAL STUDY OF BUBBLES BEHAVIOUR

F. Suñol, R. Pino, O. Maldonado and R. González-Cinca
Departament de Física Aplicada, Universitat Politècnica de Catalunya, Av. Canal Olímpic s/n, 08860 Castelldefels (Barcelona), Spain

We present ground experiments and numerical simulations of air bubbles behaviour in a cavity full of water. In the experiments, bubbles of controlled size are generated at a controlled frequency by means of two microchannel injectors [1] situated face to face or yielding an angle up to 60º. A wide range of gas and liquid flow rates and injectors orientation angles have been explored. The dynamics of the bubble jets and their coalescence have been investigated.
Numerical simulations using CFD software Fluent have been carried out for 0g and 1g conditions. Validation of simulations for 1g with experimental data allows a more reliable numerical prediction of the behaviour of the system in microgravity conditions.

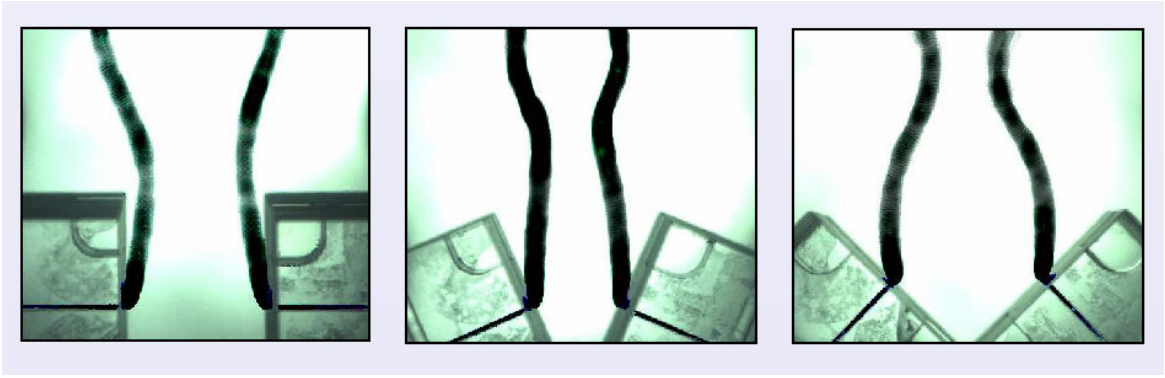


Fig. 1.- Air bubble paths generated at different relative orientation of the injectors.

1. Carrera, J., Ruiz, X., Ramírez-Piscina, L., Casademunt, J., Dreyer, M., "Generation of a Monodisperse Microbubble Jet in Microgravity", preprint, 2007.

EXPERIMENTAL AND NUMERICAL STUDIES OF STABILITY LIMITS OF STEADY OPEN CAPILLARY CHANNEL FLOWS

D. Haake, U. Rosendahl, A. Grah, J. Klatte and M.E. Dreyer
ZARM, University of Bremen, Germany, dhaake@zarm.uni-bremen.de

In this work forced liquid flows through open capillary channels are investigated experimentally and numerically under micro gravity conditions. The investigated capillary channel (a so called groove) consists of two parallel plates with a free surface at one side and a plate at the other side (see Figure 1). The liquid flows along the x -axis from the inlet to the outlet and forms a free surface at the open side between the plates. The flow is maintained by an external pump and the free surface deforms corresponding to the pressure along the flow path. In case of steady flow through the channel the capillary pressure of the free surface balances the differential pressure between the liquid and the surrounding constant pressure gas phase. Due to convective and viscous momentum transport the pressure along the flow path decreases and causes the free surface to bend inwards. The maximum and so called critical flow rate (Q_{crit}) is achieved when the free surface collapses and gas ingestion occurs at the channel outlet.

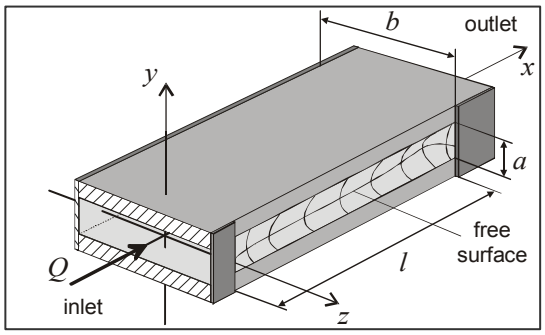


Fig. 1: Schematic drawing of the groove with width a , depth b and length l .

The describing characteristic numbers of the capillary channel flow are the OHNESORGE number Oh , the dimensionless channel length λ , the aspect ration L and the hydraulic diameter of the groove d_h . These characteristic numbers are defined as follows:

$$\mathrm{Oh} = \sqrt{\frac{\rho \nu^2}{\sigma d_h}}, \quad \lambda = \frac{\mathrm{Oh}\, l}{2 d_h}, \quad \mathrm{L} = \frac{b}{a} \quad \text{and} \quad d_h = \frac{4ab}{2b + a}$$

with the density ρ , the kinematic viscosity ν and the surface tension σ of the liquid.

We present experimental critical flow rates and surface contours for several capillary flow regimes in comparison to our theoretical model [1]. The experimental setup was developed to operate within a drop capsule of the Bremen drop tower and will also be introduced.

1. Rosendahl et al., “Choked flows in capillary channels: theory experiment and computations”, J. Fluid Mech., Vol. 518, pp. 187-214, 2004.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL B, 9:00 – 10:20

Life Sciences
Cell Biology and Cardiovascular System

EFFECTS OF MICROGRAVITY ON CARDIAC HOMEOSTASIS: THE ROLE OF STEM CELLS

Giancarlo Forte[1], Felicia Carotenuto[1], Stefania Pagliari[1], Roberta Romano[1], Paolo Cossa[1], Francesca Pagliari[1], Roberta Fiaccavento[1], Marilena Minieri[1], Stefania Zava[2], Angela Rizzo[2], Bruno Berra[2] and Paolo Di Nardo[1].

1) Laboratorio di Cardiologia Molecolare e Cellulare, Centro di Biomedicina Spaziale, Universita` di Roma "Tor Vergata"; 2) Istituto di Fisiologia Generale e Chimica Biologica "G. Esposito" - Università degli Studi Milano.

Cardiac homeostasis is the result of a fine-tuned balance between cell death and proliferation. In this perspective, major roles are played by cardiomyocites, highly specialized cells endowed with contractile function, cardiac fibroblasts, responsible for microenvironmental integrity and resident cardiac stem cells, which are likely to be putative precursors of all the differentiated cardiac cells. The activation of cell division and death is orchestrated by a complex array of bioactive substances produced within the myocardium and/or circulating in the blood stream. At present, scarce information is available on the effects that physical factors could induce on the activity of different myocardial cells. Indeed, the cardiovascular system has evolved under gravity conditions and several reports showed that exposition to conditions of altered gravity can affect cardiac silhouette and performance. Moreover, *in vitro* experiments on isolated cells demonstrated that behind the macroscopic evidence of deconditioning, a direct effect of microgravity on the single cells could be hidden. In the present study, a cardiomyocite line (HL1), cardiac fibroblasts (cfibro) and resident cardiac stem cells (CSC) were cultivated on clinostat to investigate the effects of microgravity on cardiac microenvironment. Our data show that important modifications are induced by microgravity on cardiac cells cytoskeletal organization, adhesive system and proliferative ability after 1, 24 and 72 hours. Moreover, the induction of apoptotic events was detected among the cardiomyocytes. Interestingly, when reconditioning conditions were applied by appropriate experimental procedures, only CSC showed the ability to recover cell proliferation. Altogether, our data suggest that deconditioning of cardiovascular system could be the result of a direct effect of microgravity on cardiac cells. This effect appears more severe on differentiated cells, while CSC seem able to restore cardiac homeostasis by massive proliferation and differentiation. In conclusion, we speculate that microgravity-induced cardiac deconditioning is due to cardiomyocyte and cardiac fibroblast death and that this phenomenon could be counteracted by CSC activation.

EFFECT OF HYPERGRAVITY ON ENDOTHELIAL CELL FUNCTIONS AND GENE EXPRESSION

Lucia Morbidelli[(1)] Nicola Marziliano[(2)], Venere Basile[(3)], Silvia Pezzatini[(1)], Giovanni Romano[(3)], Antonio Conti[(3)], Monica Monici[(4)],

[1]Section of Pharmacology, Dept. Molecular Biology, Univ.f Siena, Via A. Moro 2, 53100 Siena, Italy; [2]IRCCS, San Matteo Hospital, Piazzale Golgi 2, I-27100, Pavia, Italy; [3]Dept. of Clinical Physiopathology, Univ. Florence, V.le Pieraccini 6, I-50139 Florence, Italy; [4]ASACampus, Div. Ricerca di ASA, c/o Dept. of Clinical Physiopathology, Univ. Florence, V.le Pieraccini 6, I-50139 Florence, Italy.

It is well known that endothelial cells, which influence cardiovascular system functioning, are very sensitive to mechanical stimuli. It has been demonstrated that changes in inertial conditions (i.e. microgravity and hypergravity) can affect both phenotypic and genotypic expression in endothelial cells. In particular we have previously reported that hypogravity affects endothelial cell function by up-regulating apoptotic signals.

In this report we describe the effects of hypergravity on endothelial cells isolated from bovine aorta (BAEC). BAEC, cultured on glass slides coated with gelatine, were subjected to 5 periods of 10 minutes exposure at 10g (hyperfuge 3-18K, Sigma Laborzentrifugen) spaced by 10 minutes of recovery. Then, cell morphology and metabolism were analysed by autofluorescence techniques. The phenotypic expression of cytoskeleton constituents (β-actin, vimentin, tubulin), adhesion and survival signals (integrins, caspase-3), mediators of inflammation and angiogenesis (endothelial nitric oxide synthase - eNOS) and fibroblast growth factor-2 - FGF-2) was evaluated by immunocytochemistry. Microchip array technology was used to evaluate modifications in gene expression.

After hypergravity exposure, cell adhesion to the substratum did not change significantly. Related to this, integrin distribution remained the same as in control cells. The distribution of the cytoskeletal proteins beta actin, tubulin and vimentin changed, documenting cell activation. The expression of these markers changed accordingly. The expression and distribution of mediators of angiogenesis as FGF-2 and eNOS was not modified, while there was a reduction in the expression of genes controlling vasoconstriction and inflammation. Proapototic signals were downregulated, documenting in the whole that hypergravity exposure maintained endothelial cell survival and functions.

ADAPTATION OF VASCULAR MYOCYTES TO MICROGRAVITY BY THE DECREASE OF RYANODINE RECEPTOR SUBTYPE 1 EXPRESSION

Jean-Luc Morel[1], Fabrice Dabertrand[1], Gilbert Gasset[2], And Didier Chaput[3],
[1]Centre de Neurosciences Intégratives et Cognitive, UMR CNRS-Université Bordeaux 1-Université Bordeaux 2, Bâtiment B2, 33701 Talence Cedex France; [2]GSBMS, Faculté de Médecine de Rangueil, 133 route de Narbonne, 31062 Toulouse cedex – France; [3]Centre National d'Etudes Spatiales, DCT/SI/EM Bpi 2221, 18 avenue Edouard Belin 31401 Toulouse Cedex 9, France

In space, blood spreading is modified and induces the adaptation of the cardiovascular system. The main effect of microgravity on vascular function is the decrease of vascular tone leading to failure of orthostatic blood pressure after the spationaut return. Vascular contractility depends on Ca^{2+} signalling. Ryanodine receptor subtypes (RYR) are required in Ca^{2+} signalling implicated in vasoconstriction. In the hindlimb suspended rat, we have shown that a decrease of RYR expression was responsible for the lost of vascular tone. To know if the same result could be observed in cells cultured in microgravity, we used vascular cells cultured in MAMBA cassettes placed in KUBIK and boarded in taxi-flight to ISS. KUBIK has two compartments, one exposed to microgravity and the other on a centrifuge reproducing gravity. Cells were fixed either at the beginning (flight effects) or the end of the flight (adaptation to microgravity) and expression of RYR subtypes (RYR1-3) were measured by RT-PCR and immunostaining. We show that RYR1 and RYR3 were expressed in cultured cells. The expressions of RYR1 and RYR3 subtypes were similar in cells on the centrifuge or maintained in laboratory. A long exposure to microgravity decreased only the expression of RYR1 whereas the flight did not modify the expression of RYR1. In conclusion, we suggest that vascular myocytes can adapt their contractility to microgravity by a decrease of RYR1 that modifies the Ca^{2+} signalling. This work is the first evidence that microgravity during flight induces molecular adaptation of Ca^{2+} signalling in vascular myocytes.

HSP70, AN IMPORTANT PLAYER IN PRIMARY ENDOTHELIAL CELL RESPONSE TO SIMULATED MICROGRAVITY

Jeanette AM Maier
Department of Preclinical Sciences, School of Medicine, University of Milan, Via GB Grassi, 74, Milan I-20157, E-mail jeanette.maier@unimi.it

It has been demonstrated that simulated microgravity (μg) enhances human umbilical vein endothelial cell (HUVEC) growth by decreasing the amounts of interleukin 1α, a potent inhibitor of endothelial proliferation. Cell cycle distribution has been analyzed by cytofluorimetry in HUVEC cultured in μg for 96 h. While no relevant modulation of apoptosis occurs, μg significantly decreases the number of cells in G0/G1 and increases the cells in S phase. These data are confirmed by studies about the expression of regulatory proteins of the cell cycle. Indeed, by western analysis, controls show higher amounts of the cyclin kinase inhibitors p21 and p27 than cells exposed to μg. p21 and p27 determine growth arrest in the G0/G1 phase of the cell cycle. In addition, in μg the upregulation of cdc25B, a phosphatase that plays a role in promoting the progress through the G2 phase of the cell cycle, was observed.
μg also upregulates hsp70. A part from protecting endothelial cells from apoptosis, we anticipate that hsp70 may play a role in modulating cell growth. To assess this hypothesis, we have utilized siRNA against hsp70. We cultured HUVEC in μg for 96 h in the presence of the anti-hsp70 siRNA. As a control, siRNA against the green fluorescent protein was utilized. Interestingly, the knock-out of hsp70 inhibits μg-induced HUVEC proliferation and increases apoptosis.
We conclude that the upregulation of hsp70 is necessary for HUVEC adaptation to μg.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL A, 11:20 – 13:20

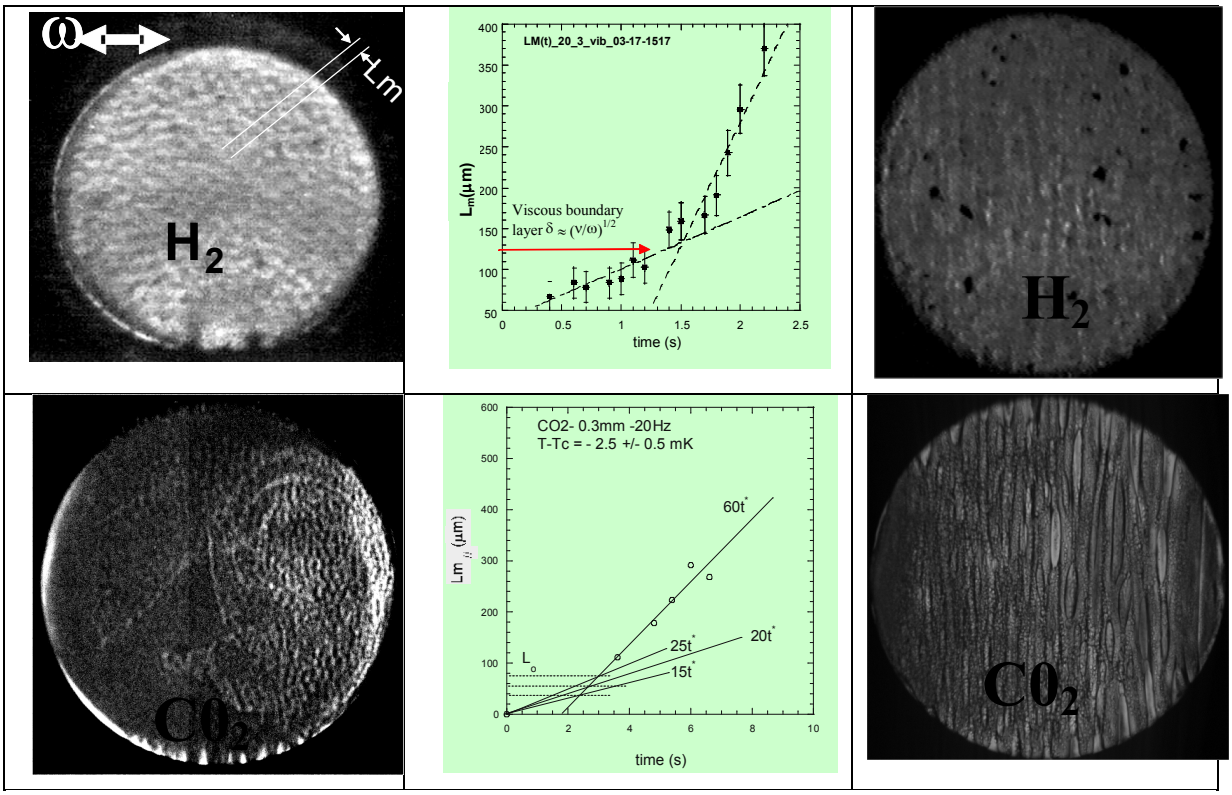
Physical Sciences
Vibration

VIBRATION-MODIFIED PHASE SEPARATION OF SUPER CRITICAL CO_2 IN MAXUS 7 SOUNDING ROCKET AND H_2 UNDER MAGNETIC GRAVITY COMPENSATION

D. Beysens[1,2*] , Y. Garrabos[3], D. Chatain[2], P. Evesque[4]

[1]ESEME, Physique et Mécanique des Milieux Hétérogènes, ESPCI et Universités Paris 6 et Paris 7, 10 rue Vauquelin, 75231 Paris Cedex 05; [2]ESEME, Service des Basses Températures, CEA-Grenoble, 38054 Grenoble Cedex 9; [3]ESEME, Institut de Chimie de la Matière Condensée de Bordeaux, CNRS, 87, Av. du Dr. A. Schweitzer, 33608 Pessac Cedex; [4]Laboratoire MSSMat, Ecole Centrale de Paris, UMR 8579 CNRS, 92295 Châtenay-Malabry Cedex; [*]Speaker. Email: daniel.beysens@espci.fr

The dynamics of a supercritical fluid that undergoes phase separation into gas and liquid phases were studied under harmonic vibration (amplitude 0.2 mm, frequency 20 Hz), close to a critical point and in the absence of gravity. The studies have been carried out with H_2 (critical temperature 33 K) on ground under magnetic compensation of gravity and CO_2 (critical temperature 301 K) in the sounding rocket Maxus 7 (flight 02/05/2006). For a volume fraction of the gas phase higher than 30 % where interconnected domains of gas and liquid nucleate and grow, remarkably coherent and complementary behaviours are observed in these two experiments: when the size of the gas/liquid domains exceeds the size of the viscous boundary layer, they acquire different speeds and one observes an acceleration of the growth due to the shear flow at the gas-liquid interface. This acceleration becomes anisotropic, favouring the growth of domains perpendicularly to the vibration direction (see figures below).



We gratefully acknowledge CNES and ESA for their support. C. Lecoutre, F. Palencia are thanked for their never ending support.

STABILITY OF RIMMING FLOW UNDER VIBRATION

Victor Kozlov[1], Denis Polezhaev[2]
[1]Laboratory of Hydrodynamic Stability, Institute of Continuous Media Mechanics, Russian Academy of Sciences, Acad. Korolev Str. 1, 614013, Perm, Russia. E-mail: kozlov@icmm.ru; [2]Department of Experimental Physics, Perm State Pedagogical University, Sibirskaya Av. 24, 614900, Perm, Russia. E-mail: polezhaev@pspu.ru

Vibrational dynamics of centrifuged liquid layer in a rotating cylinder subjected to transversal vibrations is experimentally investigated. Rotation velocity is high and the gravity does not play any role. Under the vibrations the liquid performs oscillations and it results in generation of average prograde or retrograde (in the cavity frame) liquid motion. In the resonance domain the azimuth inertial wave is excited on the free surface and it generates the liquid flow in the direction of wave propagation. The velocity of the azimuth vibrational flow could be of the same order of magnitude as the cavity one [1]. This flow corresponds to the acoustic streaming and is generated in the relatively thin Stokes boundary layers which are formed near the cavity wall by the progressive inertial wave. It is found [2] that at a critical value of Reynolds number the two-dimensional azimuth flow become unstable to the spatial periodic vortexes with axis parallel to streamlines. The 3D motion is caused by the instability of Stokes layer near the cavity wall. The dimensionless parameters governing the 2D flow instability are determined and the structure of vortical flow is studied in a wide range of dimensionless rotation frequency. The thresholds of 2D instability and the transition to the chaotic regime of flow are investigated.

The study demonstrates the unusual vibrational behaviour of liquid in rotating cavity under weightlessness.

The work was supported by Russian Foundation for Basic Research (Grant No. 06-01-00189).

1. Ivanova, A.A., Kozlov, V.G., Polezhaev, D.A., “Vibrational dynamics of a centrifuged fluid layer”, Fluid Dynamics, Vol. 40, No. 2, pp. 297–304, 2005.
2. Kozlov, V.G., Polezhaev, D.A., “Stability of vibrational flow in a centrifuged fluid layer”, Fluid Dynamics, submitted.

DYNAMICS OF GASEOUS BUBBLES IN OSCILLATING LIQUID

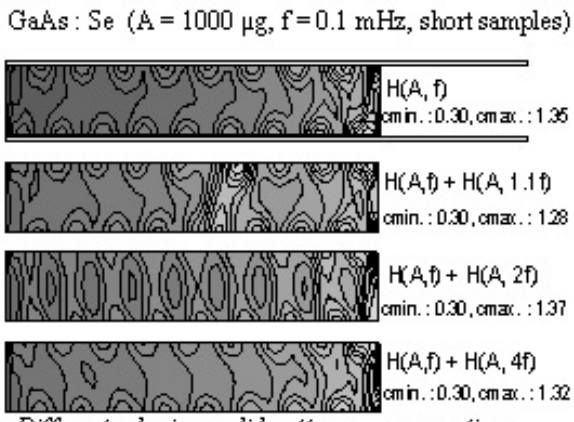
T.P. Lyubimova, A.A. Cherepanova
Institute of Continuous Media Mechanics UB RAS, Perm, Russia

Dynamics of a gaseous bubble suspended in a liquid in a rectangular container subjected to vibrations with linear polarization in zero gravity conditions is studied numerically by Level Set method. The bubble radius is ten times smaller than the container dimension. Initially the bubble is at rest and its centroid is located at a distance in two radii from one of container walls, parallel to which vibrations are applied. It is found that in the case of low viscous media the bubble is attracted to the nearest wall. With the increase of viscosity vibrational attraction becomes weaker and at some value of viscosity it changes to the repulsion of the bubble from the wall. Moreover, this effect becomes stronger with further growth of the viscosity. Dynamics of two similar gaseous bubbles located far from the cavity walls, in oscillating liquid is also investigated. The calculations made for the case of vibrations normal to the line connecting the bubble centers demonstrates that in this case the viscosity makes the same effect on the type of interaction between two bubbles as on the interaction of the bubble with the wall: at low viscosities the bubbles are attracted and with the growth of viscosity vibrational attraction changes to the repulsion. Under vibrations parallel to the line connecting the bubble centers the bubbles repulse each other in the case of low viscous fluids; with the growth of viscosity vibrational repulsion becomes weaker and at some viscosity value changes to the attraction.

COMPLEX G-JITTERS. SUPERPOSITION AND SOLID SEGREGATION

X. Ruiz
Institut d'Estudis Espacials de Catalunya, IEEC, Barcelona, Spain (also, Applied Physics Lab., Universitat Rovira i Virgili, URV, Tarragona, Spain).

To optimize the limited growth time available in low-gravity platforms a previous knowledge of the solid segregation impact generated by real g-jitters is extremely valuable. The literature provides information concerning this impact in the cases of elementary g-pulses [1, 2] and single frequency harmonic g-signals [3, 4], but, real g-jitters are more complex and because of the nonlinear nature of the segregation problem it is not enough to know what is the response for each one of the single frequencies of the Fourier decomposition. Superposition effects should also be carefully analyzed.
The aim of the present work is thus to revise these effects using additive, subtractive or mixed g-pulse trains as well as discrete superposition of plane polarized translational harmonic g-jitters of different amplitude, frequency and phase.



Different selenium solid patterns – segregation - generated by the superposition of two harmonic g-jitters of different frequencies.

The frequencies used in this last harmonic case has been very low, in the range of milliHertz because of growth processes are only sensitive to these values – for the moment, out of range of the available anti-vibratory mounts.

1. Ruiz, X., "Transient dynamics and directional solidification in space platforms", Ann. N.Y. Acad. Sci., Vol. 1077, 96 – 114, 2006.
2. Ruiz, X., "Single g-pulses and segregation in virtual Bridgman growth environments. A complementary two-dimensional approach", Microgravity Sci. Technol. XVIII-3/4, 51- 56, 2006.
3. Ruiz, X., "Solid segregation and translational deterministic g-jitters", Proceedings of the 57th International Astronautical Congress, Valencia, Spain. September 2006 (paper IAC-06-A2.P.8).
4. Ruiz, X., "Modelling of the influence of residual gravity on the segregation in directional solidification under microgravity", J. Crystal Growth, doi: 10.1016/j.jcrysgro.2006.11.330.

VIBRATION EFFECT ON THERMOCAPILLARY DRIFT OF A BUBBLE

D.V. Lyubimov, T.P. Lyubimova, L.S. Soldatova
Perm State University, 15, Bukireva Str., 614990, Perm, Russia; Institute of Continuous Media Mechanics UB RAS, 1, Koroleva Str., 614013 Perm, Russia

Behaviour of a gaseous bubble in a container of infinite extent filled with incompressible liquid is considered. Uniform temperature gradient is imposed at a large distance from the bubble. The surface tension is assumed to be a linear function of temperature. The system is subjected to the vibrations of linear polarization with the axis parallel to the temperature gradient. Vibration frequency is assumed to be such high that the Stokes layer thickness is small in comparison with the bubble radius. Vibration amplitude is small as compared to the bubble size. This allows efficient decomposition of the bubble motion into the fast and slow components. The spatial distribution of the pulsation velocity field and the asymptotics of time-average flow are found. It is shown that, although in the first order, under the action of vibrations, the gaseous bubble undergoes translational oscillations but does not change its shape, the average flow which substantially depends on the interface curvature is generated near the bubble. This means that this new mechanism of average flow generation differs from the Longuet-Higgins one, for which the interface deformability is important. The behaviour of gaseous bubble in a container of finite size, subjected to the vibrations of large enough intensity and high enough temperature gradient is studied numerically by Level Set method.

THE THERMOLAB PROJECT – THERMOPHYSICAL PROPERTIES OF INDUSTRIAL ALLOYS IN THE LIQUID PHASE FOR CASTING AND SOLIDIFICATION MODELLING

Hans-Jörg Fecht[1,2], Livio Battezzati[3], Ivan Egry[4], Jacqueline Étay[5], Taishi Matsushita[6] , Rada Novakovic[7], Enrica Ricci[7], Frank Schmidt-Hohagen[4], Seshadri Seetharaman[6], and Rainer Wunderlich[1]

[1]University of Ulm, Institute for Micro- and Nanomaterials, Ulm, Germany. [2]Forschungszentrum Karlsruhe, Institute of Nanotechnology, Karlsruhe, Germany. [3]Università di Torino, Torino, Italy. [4]DLR Cologne, Institute of Materials Physics in Space, Cologne, Germany. [5]CNRS-EPM, Grenoble, France. [6]Royal Institute of Technology KTH, Department of Materials Science and Engineering, Stockholm, Sweden. [7]IENI-CNR, Genova, Italy.

The numerical modelling of casting, solidification and microstructure formation is of increased importance in industrial production. While the numerical models are highly advanced, there is an increased need for reliable thermophysical property values which are needed as input values to these models. Due to the difficulty of handling metallic liquids over an extended time period as required for most thermoanalytical measurements, such values are often not available or fraught with error. The ThermoLab project is concerned with the measurement of such properties by combining conventional thermoanalytical methods with containerless processing techniques including measurements under reduced-gravity conditions in a containerless electromagnetic processing device on board parabolic flights. Properties investigated are the viscosity, surface tension, density, specific heat capacity, enthalpy and solidus- liquidus temperatures. The project works in close collaboration with an industrial project user group. Alloys of interest are Ni -based, Fe -based, Ti -based, and Cu -alloys. Moreover, the ThermoLab project pursues thermodynamic modelling of phase diagrams based on codes such as Thermocalc as well as modelling of the surface tension as a function of composition. An overview of the project will be given with emphasis on the interaction between the industrial user group, the alloy and property selection, and the experimental programme.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL B, 11:20 – 13:20

Life Sciences
Neurosciences

DIFFERENTIAL RESPONSE OF LIMBIC SYSTEM TO MICROGRAVITY AND HYPERGRAVITY: HYPOTHALAMUS VS. HIPPOCAMPUS

Yasuhiro Kumei[1)]*, Jorge Zeredo[2)], Mari Kimoto[3)], Tohru Ikeda[2)], and Kazuo Toda[2)]
[1)] Tokyo Medical and Dental University, Tokyo 113-8549, [2)] Nagasaki University, Nagasaki 852-8588, [3)] Japan Women's University, Tokyo 112-8681, Japan * Tel/Fax (+81-3-5803-4555) and E-mail (kumei.bch@tmd.ac.jp)

We examined the neuronal activities in the rat limbic system during microgravity and hypergravity exposure, using parabolic flights or light-blocked animal centrifuge. Male Wistar rats (10-week-old) were exposed to microgravity (less than 0.1 G) for 7 seconds and hypergravity (~1.4G) by parabolic flight. The firing spikes or excitatory postsynaptic field potential were recorded telemetrically through chronically implanted electrodes into the hippocampus (CA1), hypothalamus (arcuate nucleus), amygdala (basolateral), and dentate gyrus. Upon microgravity or hypergravity exposure, the firing frequency in the hypothalamus promptly increased three-times higher than the 1.0G basal level. No immediate response was observed in hippocampus, amygdala, or dentate gyrus. However, late response was observed in hippocampus 30 seconds after gravitational alteration. On the other hand, the efficiency of synaptic transmission was facilitated in hippocampus and amygdala during and after 2.0G hypergravity exposure by centrifugation. Data suggest that gravitational alteration may differentially modulate the neuronal activities in rat limbic system. The complicated neuronal networks including limbic system, autonomic nervous system, and vestibular function may underlie the stress-response mechanism to gravity change. Supported by Japan Space Forum and Grant-in-Aid from Ministry of Science, Education, and Culture of Japan.

G-INDUCED NEAR-LOSS OF CONSCIOUSNESS SHOWS ENLARGED Ca^{2+}-INDEPENDENT RELEASE OF GLUTAMATE FROM SYNAPTOSOMES

Borisova Tatiana & Krisanova Natalia
The Department of Neurochemistry, Palladin Institute of Biochemistry, NAS of Ukraine, 9 Leontovicha Street, Kiev, 01601,Ukraine; Tel:+38044 2343254; Fax:+38044 2796365; E-mail: tborisov@biochem.kiev.ua

G-induced losses of consciousness occur when G forces reduce cerebral blood volume, thereby lowering the amount of oxygen available to the cerebral tissue. The syndrome demonstrates sensory abnormalities, amnesia, confusion, disturbance in cognition and has been observed in centrifuge studies and reported in flight. L-Glutamate is now recognized as the major excitatory neurotransmitter and essentially mediates all the rapid communications in the CNS. Proper glutamate synaptic transmission is not only essential for basic neuronal communication but also is important for learning and memorizing, attention, control of mood, stress and anxiety. The release of L-[^{14}C]glutamate via Na^+-dependent glutamate transporters functioned in the reverse mode was investigated in cortical synaptosomes in G-induced near-loss of consciousness. 1 μM protonophore FCCP *per se* induced the release of 4.8±1.0% и 8.0±1.0 % of total accumulated synaptosomal label in control and G-loaded animals, respectively ($P \leq 0.05$). The high-KCl stimulated L-[^{14}C]glutamate release from synaptosomes preliminary treated with FCCP considerably increased from 27.0±2.2 % (control) to 35.0±2.3% in G-stress ($P \leq 0.05$). Transportable inhibitor of glutamate transporters-DL-threo-beta-hydroxyaspartate (DL-THA) induced heteroexchange of L-[^{14}C]glutamate from enlarged by FCCP cytosolic pool of the neurotransmitter. DL-THA-evoked release of L-[^{14}C]glutamate was also increased significantly for G-loaded animals. Combined application of KCl, DL-THA and FCCP unmasked dramatic changes in the activity of the glutamate transporters functioning in the reverse mode in G-induced near-loss of consciousness.

THE ROLL-INDUCED VESTIBULOOCULAR REFLEX IN SALAMANDER TADPOLES AFTER THE SOYUZ FLIGHT TMA8/TMA7 TO ISS

Eberhard Horn[1], Jean-Pol Frippiat[2]
[1]Gravitational Physiology, Ulm University, 89081 Ulm, Germany; eberhard.horn@uni-ulm.de; [2]Immunogénétique et Développement, Université Henri Poincaré, 54506 Vandoeuvre-lès-Nancy Cedex; Jean-Pol.Frippiat@scbiol.uhp-nancy.fr

Some features of developing animals such as the formation of muscle-nerve contacts, the differentiation of embryonic mesenchym to cartilage, or locomotor and sensorimotor behaviour revealed an age-dependent susceptibility to microgravity (µg). In *Xenopus laevis* and *Oreochromis mossambicus*, the roll-induced vestibuloocular reflex (rVOR) revealed this age-dependent sensitivity. The rVOR is mediated by the labyrinthine macula organ of the utricle; it responds to postural static changes and translatory accelerations of the body. In space, in the absence of gravity, the macula organ is, therefore, stimulated when young fish or tadpoles swim. All larvae in the *Xenopus* and *Oreochromis* spaceflight experiments experienced this macula stimulation because they (1) hatched 2 days after onset of µg, (2) swam in µg, and (3) developed vestibular functionality during their space flight. The development of the salamander *Pleurodeles waltl* is retarded with respect to *Xenopus*. In particular, development of the vestibular system starts 5 days after fertilization (dpf) with the appearance of the ear vesicle; the rVOR can be elicited 13 to 15 dpf for the first time. In the time frame of Soyuz Taxi Flights to ISS, *Pleurodeles* can be considered as an animal model to study effects of µg during space flight on the development of the rVOR in the absence not only of the gravitational stimulus but also in the absence of physiological excitation experience of the macular organ because the first physiological response, the rVOR, occurs 1 to 2 days after landing. - The respective rVOR experiment was performed as part of the experiment AMPHIBODY during the Brasilian Soyuz taxi flight TMA8 (landing in TMA7) in spring 2006. At launch, the 384 *Pleurodeles* embryos were 2 days old and had not yet reached the neurula stage. At landing, 84% had developed to tadpoles. Recordings of the rVOR were performed twice with each animal, the first between post-flight days 1 and 4, and the second 4 weeks later. The rVOR analysis and a comparison with former *Xenopus* tadpoles' data will be presented during the conference.

Supported by Deutsches Zentrum für Luft- und Raumfahrt, grant no. 50WB0323 to Horn.

WALKING ACTIVITY OF ADULT CRICKETS DURING PARABOLIC FLIGHT

Martin Gabriel, Dana Simmet, Eberhard Horn
Gravitational Physiology, Ulm University, Albert-Einstein-Allee11, 89081 Ulm, Germany; martin.gabriel@uni-ulm.de

Weight-loading due to gravity is an important principle in gravity perception in man and animals. Insects rely on several sensory systems in sensing gravity: (1) proprioceptors of the leg joints stimulated by dislocation of the whole body with respect to the legs which is common in most insect species, (2) proprioceptors stimulated by dislocations of parts of their body such as antennae or head which is common in ants, bees or flies [1], and (3) specialized sense organs such as the club-shaped sensillae on the cerci which is common in crickets and cockroaches [2]. We studied the impact of altered gravity on leg movements and walking activity in adult crickets (*Acheta domesticus*) during the 45th ESA Parabolic Flight Campaign (October 2006) in crickets with and without gravity input from the leg proprioceptors and cercal organs. The crickets were mounted on a holder, and could move a walking wheel. The type of mounting either eliminated the weight-loading (*fixed-mode*) or maintained it (*free-mode*). Activity was recorded by a light bridge that measured the movements of the walking wheel. We tested (1) crickets with intact proprioceptive and cercal system and (2) crickets after surgical elimination of the cercal system. Four sets of data were recorded from each animal during the various g-levels of the parabolas: (a) spontaneous and (b) induced walking in free-mode, and (c) spontaneous and (d) induced walking in fixed-mode condition. Walking was induced by air-puffs. - Both intact and lesioned crickets showed a higher running activity during hg- and 1g-periods following the µg-period compared to the respective hg- and 1g-periods preceding the µg-period. Air-puff stimulation augmented running activity of intact animals in both conditions; in lesioned animals only in the fixed mode. In addition to activity recordings, trajectories of the leg movements and changes in the angle of the leg's tibia and femur were determined by 100 Hz recordings. Preliminary observations will be reported.
Supported by Deutsches Zentrum für Luft- und Raumfahrt (DLR), grant no. 50WB0323

1. Horn, E., "Gravity" IN Comprehensive Insect Physiology, Biochemistry and Pharmacology, Vol. 6, Nervous System: Sensory, Kerkut, G.A., Gilbert, L.I. (eds.), Pergamon Press, Frankfurt, pp. 557-576, 1985.
2. Horn, E., Bischof, N., "Gravity reception in crickets: the influence of cercal and antennal afferences on the head position", J. Comp. Physiol. 150, pp. 93-98, 1983.

EFFECT OF RPM ROTATION ON INTRACELLULAR/EXTRACELLULAR CALCIUM CONTROL IN ASTROCYTES

M.A. Masini[1], F. Strollo[2], F. Ricci[3], P. Prato[1], and B. Uva[1]
[1]Dipartimento di Biologia, University of Genova, Italy, [2]Unita' Endocrinologia INCRA & Università di Roma "La Sapienza", Italy; [3]ENEA C.R. Casaccia Roma Italy.

Calcium balance is carefully regulated by means of extrusion channels, buffering proteins and intracellular organelles. Modeled microgravity causes severe damages to the cells. Aim of the present study was to verify if the addition of divalent ions to the culture medium protects the cells and a period of rest may restore, calcium balance in C_6 cell line from rat astroglioma. The glial cells were submitted to 3D RPM clinorotation for different length of times (1h to 24h) with or without addition of calcium ions to the culture medium. After clinorotation, the cultures were kept for different length of time (1h to 24h) in a rest condition. The results were examined by immunohistochemistry using Ab to α-tubulin, Ab to Ca^{2+}ATPase, Ab to proteins of inner mitochondria cristae, Ab to caspase 7 executioner, Ab to HSP, Ab to integrins. Cytosolic calcium concentration was visualized by FURA-2 fluorescent method. After rest, the cells in culture were again well organized, the microtubule arrays were normal; the Ca^{2+}ATPase was again normally expressed. The addition of calcium to the culture medium protected the microtubules during 3D RPM rotation and during the rest periods. Ca^{2+}ATPase immunostaining diminished after 1h of clinorotation but was again strong after a prolonged rest or by addition of calcium ions to the culture medium.

BIOREACTOR TRANSIENT EXPOSURE ACTIVATES SPECIFIC NEUROTROPHIC PATHWAYS IN CORTICAL NEURONS

Vincenzo Zimmitti, Elisabetta Benedetti, Pierluigi Sebastiani e Silvia Di Loreto
ITOI – CNR p.Le Collemaggio, 67100 L'Aquila, Italy – Tel. +390862414275; Fax +390862410758; email: s.diloreto@itoi.cnr.it

During CNS development, environmental stimuli regulate connection formation, therefore, altered gravity forces might influence neuroplasticity and can provoke changes in biochemical mechanisms. In this contest, a pivotal role is to be ascribed to neurotrophins, particularly to nerve growth factor (NGF) and brain derived neurotrophic factor (BDNF). A suspension of dissociated cortical cells from rat embryos were exposed to 24h of microgravity (rotary wall vessel bioreactor, RWV) before plating in a normal adherent culture system. Expression and transductional signalling pathways of NGF and BDNF were assessed at the end of maturational process (7-8 days in vitro). RWV pre-exsposition did not induce changes in NGF expression and its high affinity receptor TrkA. On the contrary both BDNF expression and its high affinity receptor TrkB were strongly activated inducing Erk-5 activation and, in turn, MEF2C over-expression and activation. Moreover, RVW pre-exposition did not induce changes in a different BDNF transduction pathway involving Erk-1/2 activation. According to our previous and present results, demonstrating an increased viability activation of pre-exposed neurons with respect to the control, we pustulate that relatively short microgravitational stimuli, applied to neural cells in the developmental stage, exert a long time activation of specific neurotrophic pathways.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL A, 15:00 – 16:40

Physical Sciences
Body Forces

DROPLET OSCILLATIONS IN HIGH GRADIENT MAGNETIC FIELD

V. Bojarevics and K. Pericleous
University of Greenwich, School of Computational and Mathematical Sciences, London SE10 9LS, UK
V.Bojarevics@gre.ac.uk

In the presence of high intensity and gradient magnetic field the volumetric force on diamagnetic material, like water, permits to achieve conditions very similar to the microgravity in the terrestrial laboratory conditions. In principle, this gives a posibility to determine material properties of liquid samples without any contact to walls even for electrically non-conducting materials in difference to the more familiar AC field levitation method [1]. Experimental observations of the diamagnetic levitated samples are available, e.g. [2], but there is little theoretical understanding of this process. The volumetric force distribution in the oscillating droplet is time dependent and the total force on the sample is modulated with the motion of liquid boundary in the high gradient magnetic field. We present a non-linear spectral numerical model for this surface tension controlled fluid flow, the magnetic field and temperature in the levitated droplet [3]. The slow damping of the oscillations is completely controlled by the laminar viscosity, and the temperature time variation is also determined by the laminar liquid thermophysical properties.

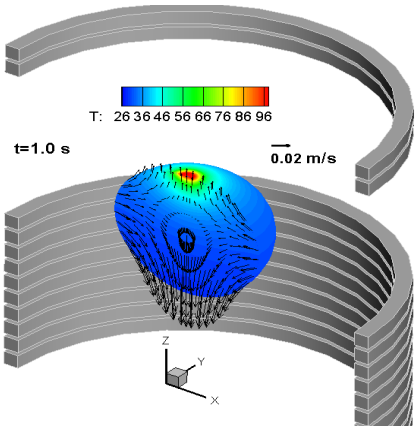


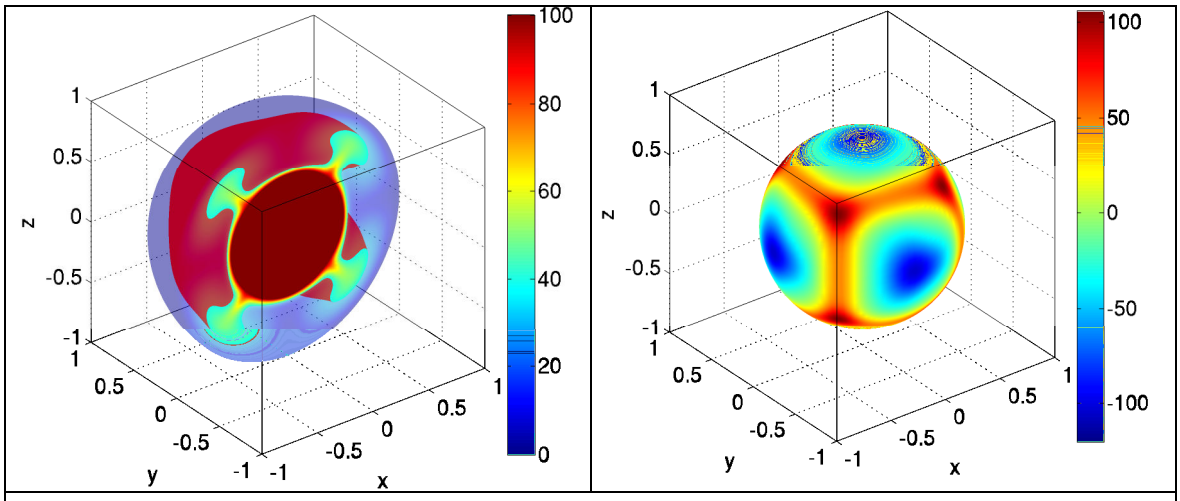
Figure. Velocity field and temperature in half-section of the 8mm diameter water droplet levitated in quasi-weightless conditions due to the magnetic field from the DC current in the coil.

1. Egry I., "Thermophysical Property Measurements on Electromagnetically Levitated Samples", Proc. Electromagnetic Processing of Materials 4th Int.Conf., Lyon, pp. 295-300, 2003.
2. Ikezoe Y., Hirota N., Nakgawa J., Kitazawa K., "Making Water Levitate", Nature, Vol.393), pp. 749750, 1998.
3. Bojarevics V., Pericleous K.. "Modelling Electromagnetically Levitated Liquid Droplet Oscillations", ISIJ International, Vol. 43, N 6, pp. 890-898, 2003.

GEOFLOW: THE ISS EXPERIMENT AND 3D NUMERICAL SIMULATION ON THERMAL CONVECTION IN SPHERICAL SHELLS

Birgit Futterer, Thomas von Larcher, Christoph Egbers
Brandenburg University of Technology Cottbus, Department of Aerodynamics and Fluid Mechanics, Siemens-Halske-Ring 14, 03046 Cottbus, Germany

Research on thermal convection in spherical shells is a fundamental model in geophysical fluid dynamics. Instabilities provide details for understanding large scale geophysical motions as convective transport phenomena in the Earth´s liquid outer core.
We want to face this hydrodynamical problem within an experiment on thermal convection in rotating spherical shells influenced by a central force field. This experiment will take place at International Space Station in European Columbus Modul inside Fluid Science Laboratory (FSL). The special experiment container is called 'GeoFlow'. Central force field is produced using effect of a dielectrophoretic force by impressing an alternating high voltage on the inner sphere. Optical measurement methods as Wollaston shearing interferometry will be used to determine the temperature fields and flow patterns.
Numerical and theoretical studies of spherical Rayleigh-Bénard problem under a central dielectrophoretic force in microgravity environment are accomplished for a wide range of radius ratio, Prandtl, Rayleigh and Taylor number.



Steady state convection in rotating spherical shells (η=0.5, Pr=64.64, Ra=2E04, Ta=2E02): animation of temperature field (left) and radial velocity component (right).

For testing the FSL environment and 'GeoFlow' framework a laboratory experiment is designed and constructed including set-up of optical measurement techniques. In principle it has the same proportion as the original GeoFlow experiment.

MAGNETIC COMPENSATION OF GRAVITY AND CENTRIFUGAL FORCE

Clément Lorin, Alain Mailfert
Laboratoire Environnement et Minéralurgie, UMR 7569, Institut National Polytechnique de Lorraine, 15 rue du Doyen Roubault, 54 501 Vandoeuvre Lès Nancy, France

Since 1991[1] magnetic fields are used in order to levitate on Earth diamagnetic and paramagnetic fluids. Several theoretical and practical works have been done on magnetic compensation of gravity[2,3]. These previous studies demonstrate the impossibility to obtain an homogeneous and perfect compensation[4]. The inhomogeneity is described by vector **ε**. The magnetic force is theoretically calculated in a 2D-cylindrical domain with a horizontal axis.
First, it is shown that a quadrupole distribution of magnetic fields generates a force linearly decreasing as the cylinder radius. So, in true weightlessness conditions (space flying) a paramagnetic fluid exposed to a quadrupole magnetic field has a similar behaviour compared to the one exposed to a centrifugal force due to a rotational motion.
Secondly the magnetic counterbalance of gravity is studied in the same 2D domain. The behaviour of paramagnetic compounds submitted to a rotational motion in weightlessness conditions (space flying) can be fulfilled by a static ground based magnetic apparatus. Liquid oxygen is used for example.
To conclude, the impact of the same magnetic field distribution on diamagnetic fluids is observed inside a cylinder in rotational motion. Values of parameters can be found in order to cancel the sum of all forces exerted on the diamagnetic fluid. The fluid is also in ground based experiments in true weightlessness conditions. These special values of parameters allowing to reach a perfect gravity compensation are determined for liquid hydrogen.

1. Beaugnon, E., Tournier, R., “Levitation of organic materials”, Nature, Vol. 349, pp. 470, 1991.
2. Wunenberg, R., Chatain, D., Garrabos, Y., Beysens, D., “Magnetic compensation of gravity forces in (-p) hydrogen near critical point: Applications to weightless conditions”, Physical Review E, Vol. 62, pp. 469-476, 2000.
3. Quettier, L., Félice, H., Mailfert, A., Chatain, D., Beysens, D., “Magnetic compensation of gravity forces in liquid/gas mixtures : surpassing intrinsic limitations of a superconducting magnet by using ferromagnetic inserts”, The European Physical Journal Applied Physics, Vol. 32, pp.167-175, 2005.
4. Quettier, L., “Contribution méthodologique à la conception de systèmes supraconducteurs de lévitation magnétique” , Thesis INPL, 2003.

MAGNETIC LEVITATION: STUDIES OF FLUID AND GRANULAR DYNAMICS IN ALTERED GRAVITY

R. J. A. Hill, P. López-Alcaraz, A. T. Catherall, P. Sánchez, M. R. Swift, P. J. King, L. Eaves
School of Physics and Astronomy, University of Nottingham, Nottingham NG7 2RD, UK

In this paper, we will describe our recent work in which we use a superconducting magnet with a closed-cycle cryogenic system to carry out experiments on the dynamics of magnetically levitated fluids and granular systems. Diamagnetic materials, such as liquid water, are repelled from magnetic fields with a force proportional to the magnetic field strength and the magnetic field gradient. Ordinarily, the diamagnetic force is extremely weak, but within the bore of our magnet, the repulsion can be large enough to support the weight of a water droplet so that it levitates with no other mechanism of support. Since the magnetic force acts at the molecular level, we can regard the droplet as being in a weightless environment analogous to the environment in orbit, where the weight of the object is balanced by the magnetic force instead of the centrifugal force. We will describe recent experiments we have undertaken to investigate the dynamics of magnetically levitated water droplets, which complement the work of the Grenoble group [1]. We will also describe experiments on the separation of binary granular mixtures vibrated within the magnet bore [2]. The separation is driven by the difference between the effective gravity experienced by each component, due to their differing magnetic susceptibility. This work is supported by the Basic Technology Research Scheme of Research Councils, UK.

1. Beaugnon, E., Fabregue, D., Billy, D., Nappa, J., Tournier, R, "Dynamics of magnetically levitated droplets," Physica B, Vol. 294-295, pp.715, 2001.
2. Catherall, A.T., López-Alcaraz, P., Sánchez, P., Swift, M.R., King, P.J., "Separation of binary mixtures under vibration and differential magnetic levitation force," Phys. Rev. E , Vol. 71, pp. 21303, 2005.

MAGNETIC COMPENSATION OF GRAVITY: EXPERIMENTS WITH OXYGEN

G. Pichavant[(1)], B. Cariteau[(1)], D. Chatain[(1)], V. Nikolayev[(1,2)], D. Beysens[(1,2)]
(1) ESEME, Service des Basses Températures, DRFMC, CEA-Grenoble, 17 rue des Martyrs, F-38054 Grenoble cedex 09 ; (2) ESEME, ESPCI-PMMH, 10 rue Vauquelin, F-75015 Paris cedex 05

In the last past years, the interest in heat and mass transfers under microgravity conditions emerged with the development of a new Ariane launcher engine that can be reignited in space. In that context, we have developed a magnetic setup providing gravity compensation in liquid oxygen. In the influence zone of a magnetic field gradient, oxygen, by its paramagnetic property, is subjected to a volume force that can exactly compensate its weight. The setup involves a superconducting coil that delivers 1.5 T at 4.2 K and leads to a residual gravity level below 0.01 g for a few cubic centimeter volume. This volume is much larger than in our previous experiments with hydrogen where the compensation was only possible in a few cubic millimeter volume.
The possibility of a steady microgravity environment that can be sustained for a long time is the main advantage of such a system. Therefore, this setup is a unique tool, well adapted for studying boiling heat transfer which is characterized by long transients.
A first experimental cell designed for boiling heat transfer in liquid oxygen was successfully tested. Some experimental results will be presented.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL B, 15:00 – 15:40

Life Sciences I
Cell Biology and Immune System

MOTILITY OF MONOCYTES AND THEIR INTERACTION WITH T-LYMPHOCYTES IN LOW GRAVITY

Marianne Cogoli-Greuter, Grazia Galleri[*], Giuseppe Pani[*], Angela Saba[*], Proto Pippia[*], Maria Antonia Meloni[*]

Zero-g Life Tec GmbH, Technopark, CH-8005 Zurich, Switzerland; [*]Dipartimento di Scienze Fisiologiche, Biochimiche e Cellulari, Universita di Sassari, Via Muroni 25, I-07100 Sassari, Italy

Earlier experiments have shown that gravity changes affect important cellular functions in human lymphocytes; in particular a dramatic depression of the mitogenic in vitro activation was observed in space. The mechanism of T-cell activation is very complex. The hypothesis of experiment MIA (Motion and InterAct) flown in Kubik BIO#1 is, that a reduced interaction between T lymphocytes and monocytes might be one of the reasons for the observed depression of the in vitro activation. Cell motility and a continuous rearrangement of the cytoskeletal network within the cell are essential for cell-cell contacts. The goal of experiment MIA was to determine in space the ability of adherent monocytes to migrate (Motion), as well as to interact with T-cells (Interact). In the "Motion" experiment monocytes (J111 cells) were incubated on a colloid gold substrate attached to a cover slide. Migrating cells removed the colloid gold, leaving a track recording cell motility. Control experiments were performed simultaneously. Postfligth, the migration tracks and the cytoskeletal structures of tubulin, F-actin and Vinculin were analysed. A severe reduction of the motility of the J-111 cells and changes in the structures of actin, tubulin and Vinculin were observed. Similar results have been found in modeled low gravity. The results of experiment "Interact" will be presented in a poster.

HYPERGRAVITY EFFECTS ON DENDRITIC CELL AND VASCULAR WALL INTERACTIONS

L. Bellik[(1)], A. Parenti[(1)], F. Ledda[(1)], V. Basile[(2)], G. Romano[(2)], F. Fusi[(2)], M. Monici[(3)]
[1]Department of Pharmacology, University of Florence; [2]Department of Clinical Physiopathology, University of Florence; [3]ASAcampus, ASA Research Division, Department of Clinical Physiopathology, University of Florence

Dendritic cells (DCs), the most potent antigen-presenting cells inducing specific immune responses, are involved in the pathogenesis of atherosclerosis. In this inflammatory disease, DCs increase in number being particularly abundant in the shoulder regions of plaques (1). Since the exposure to altered gravitational conditions results in a significant impairment of the immune function, the aim of this study was to investigate the effects of hypergravity on the function of DCs and their interactions with the vascular wall cells. Monocytes from peripheral blood mononuclear cells were sorted by CD14+ magnetic beads selection, cultured for 6 days in medium supplemented with GM-CSF and IL-4 followed by further maturation stimuli (2). DC phenotype, assessed by flow cytometry, showed a high expression of the specific DC markers CD80, CD86, HLA-DR and CD83. The DCs obtained were then exposed to hypergravitational stimuli and their phenotype, cytoskeleton, ability to activate lymphocytes and interaction with vascular wall cells were investigated. The findings showed that the exposure to hypergravity conditions resulted in a significant impairment of DC cytoskeletal organization without affecting the expression of DC markers. Moreover an increased DC adhesion to human vascular smooth muscle cells as well as a change in their ability to activate lymphocytes were observed.

1. Bobryshev, Y.V., Lord, R.S., "Co-accumulation of dendritic cells and natural killer T cells within rupture-prone regions in human atherosclerotic plaques", J Histochem Cytochem, Vol.53, pp. 781-5, 2005.
2. Bellik, L., Gerlini, G., Parenti. A., Ledda, F., Pimpinelli, N., Neri, B., Pantalone, D., "Role of conventional treatments on circulating and monocyte-derived dendritic cells in colorectal cancer", Clin Immunol, Vol. 121, pp. 74-80, 2006.

SCIENTIFIC SESSIONS:

Wednesday, 5th September 2007
HALL B, 15:40 – 16:40

Life Sciences II
Gene Expression Profile

GENETIC SIGNATURES DURING PHYSIOLOGICAL ADAPTATION

A. Sundaresan[1] James DuMond[1], Kamaleshwar Singh[1], N.R.Pellis[2]
[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

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. Cardiovascular biomarker expression placental induced growth factor (PIGf) and stress response gene expression (HSP 90) also presented an aberrant response in analog microgravity. 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

GENE EXPRESSION PROFILING IN CHONDROCYTES UNDERGOING HYPERGRAVITATIONAL STRESS

Nicola Marziliano[1], Venere Basile[2], Giovanni Romano[2], Eloisa Arbustini[1], Monica Monici[3]

1) Fundation IRCCS Policlinico San Matteo, Pavia, Piazzale Golgi 1/2, I-27100 Pavia; 2) Dept. of Clinical Physiopathology, University of Florence, V.le Pieraccini 6, I-50139 Florence; 3) ASAcampus, ASA Research Division, Dept. of Clinical Physiopathology, University of Florence, V.le Pieraccini 6, I-50139 Florence

The evidence that joint loading is needed for the homeostasis of articular cartilage has emerged from both in vivo and in vitro studies. Mechanical forces are effective in inducing chondrocyte differentiation and production of extracellular matrix (ECM) molecules but, in spite of extensive studies, the optimal loading conditions for cartilage homeostasis and stimulation of chondrocyte function are still unknown. Studies carried out in altered gravitational conditions represent an useful tool for approaching this problem.

Here we describe the results of a study on the behaviour of human chondrocytes in monolayer cultures exposed to discontinuous hypergravitational stress.

Hypergravity conditions were modeled in a thermostated centrifuge (3-18K, Sigma Zentrifugen), alternating with recovery periods.

Following important changes in phenotypic expression of differentiation markers and ECM molecules observed also in previous studies, here we investigated in particular the genetic signature of chondrocytes in response to the loading. Briefly, total RNA was recovered from cell cultures either in the hypergravity and resting conditions, converted to cDNA and probed with TaqMan assays for each of the studied genes; results were subsequently analysed within the Panther database platform (www.pantherdb.org) in order to trace a biological signature of the hypergravity condition.

Results demonstrated that several pathways were under/up regulated in the hypergravity/resting conditions.

IS THERE A GROUP OF GENES IN ANIMALS THAT RESPOND TO/IS CONTROLLED BY GRAVITY?

Marco Roberto[1], Laván David[1], Leandro Luis J.[1], Benguría Alberto[2], Medina F. Javier[3], van Loon Jack[4]

[1]Departamento de Bioquímica (UAM) e IIB (UAM-CSIC) Facultad de Medicina, Universidad Autónoma de Madrid, Spain. [2]Centro Nacional de Biotecnología (CSIC), Cantoblanco, Madrid, Spain. [3]Centro de investigaciones Biológicas, CSIC, Madrid, Spain. [4]Dutch Experiment Support Center, DESC @ OCB-ACTA-Vrije Universiteit, Amsterdam, The Netherlands.

Experiments performed during the last few years in real and simulated gravity using Drosophila development as the target process for the detection of potential effects on gene expression and microarray analysis as the analytical tool, has allowed detecting that under these conditions there is an important genomic response. We have initially focused on a particular phase of development, namely, pupal development, *i.e.,* the process by which the larvae after being surrounded by a thick envelope, the pupal case, starts an important developmental process by which the final imago body is build almost from scratch using different groups of cells that were laid apart during embryogenesis and integrating the cues left behind by the larval body parts. The process occurs inside this ellipsoid in the absence of any obvious external movement. Thus, when the organism is subjected to gravity simulation equipment, for example, using rotating motions to neutralize the gravity vector, the pupa will remain in its place without changing position and counteracting the external movements. Here we will analyze the groups of genes that are modified by these treatments, both in the International Space Station (Cervantes Mission) and in the Random Position Machine (RPM) as ground based low-gravity simulation equipment. To avoid some of the constraints of the Soyuz taxi-flights, we had to subject the pupae as soon as being formed to a transportation step during which they were maintained at 14ºC. By this approach, that previously had been shown to be fully compatible with a normal development but at a slower pace, we could subject to a real microgravity environment the pupae during three days before fixing them. A replica experiment in the RPM included also this cold transportation step. In addition, two additional experiments were performed, one in the RPM without this cold transportation step and one in the Midicar centrifuge at 10 g also without the cold transportation step. The results of the microarray analysis of different biological replicas in these four experimental conditions plus the corresponding controls samples with and without cold transportation step will be discussed in the presentation. The main conclusion is that there is a very high correlation between the gene expression profile changes in simulated (RPM) and real (ISS) gravity. In addition, the synergic effect of the exposure to a relative low temperature, fully compatible with survival, on the microgravity-induced changes will be discussed. In the absence of this synergic process it is possible to detect a smaller but clear effect on gene expression of the simulated microgravity on the pupal development. There is again a correlation among the response of these fewer genes in the RPM, independently of whether they were exposed or not to this cold treatment. Interestingly, the 10g treatment leaves the pupae almost unchanged in term of the gene expression profile. Using gene ontology meta-analysis and quantitative real-time PCR, we conclude that there is a core group of microgravity responding genes. Unfortunately, the majority of these genes belongs to the group of genes which have so far resisted identification. (Supported by the grant ESP2006-13600-C02-01).

SCIENTIFIC SESSIONS:

Thursday, 6th September 2007
HALL A, 9:00 – 10:20

Physical Sciences
Physics

ELGRA News, vol. 25, September 2007

A CASE STUDY FOR THE FLUID SCIENCE LABORATORY ON THE INTERNATIONAL SPACE STATION: NEW EXPERIMENTS ON CHARGE TRANSPORTATION IN LIQUIDS

P. Dell'Aversana, C. Piccolo
MARS Center (Via E. Gianturco, 31. 80131 – Napoli, Italy); dellaversana@marscenter.it, piccolo@marscenter.it

The fluid physics experiments to be performed on board the International Space Station will be executed mostly by means of the Fluid Science Module (FSL), the dedicated ESA facility.
MARS is the Facility Responsible Centre (FRC) for FSL. Since February 2005, MARS hosts the Science Reference Module of FSL and, since February 2007, ESA handed over to MARS also the Engineering Model of FSL.
The Centre is open to European scientists who want to exploit and familiarize with the diagnostics capabilities of FSL before to design their own fluid physics experiments and during the subsequent development phases.
In order to assist present and future FSL users, some case-study experiments have been devised and performed with the available FSL models, to achieve a deep feeling about the performance of its optical diagnostics.

Following this preliminary phase, the authors have conceived a new experiment that takes advantage of the FSL diagnostics. The experiment is devoted to investigate the behaviour of electric charges within an insulating liquid, under the combined action of an external electric field and of liquid flows. The experiment can yield the application of the investigated charge transportation mechanisms in different fields such as, e.g., novel electrophoresis techniques.

EXPERIMENTAL CONSIDERATIONS REALISATION OF ULTRACOLD QUANTUM GASES IN MICROGRAVITY

Kai Bongs[4], Wiebke Brinkmann[1], Hansjörg Dittus[1], Wolfgang Ertmer[2], Ertan Göklü[1], Greta Johannsen[4], Endre Kajari[5], Thorben Könemann[1], Claus Lämmerzahl[1], Wojciech Lewoczko-Adamczyk[3], Gerrit Nandi[5], Achim Peters[3], Ernst M. Rasel[2], Jakob Reichel[6], Wolfgang P. Schleich[5], Max Schiemangk[3], Klaus Sengstock[4], Tilo Steinmetz[6], Anika Vogel[4], Reinhold Walser[5], Sven Wildfang[4], Tim van Zoest[2]

1 ZARM - University of Bremen, Am Fallturm, 28359 Bremen, Germany; 2 Institute of Quantum Optics - Leibniz University of Hanover, Welfengarten 1, 30167 Hannover, Germany; 3 Institute of Physics - Humboldt-University of Berlin, Hausvogteiplatz 5-7, 10117 Berlin, Germany; 4 Institute of Laser-Physics - University of Hamburg, Luruper Chaussee 149, 22761 Hamburg, Germany; 5 Institute of Quantum Physics - University of Ulm, Albert-Einstein-Allee 11, 89069 Ulm, Germany; 6 Laboratoire Kastler Brossel de l'E.N.S., 24 rue Lhomond, 75231 Paris Cedex 05, France

Trapping and cooling of neutral atoms has become an important tool for a very active field in modern physics in the last decades as documented by the Nobel prizes in 1997 and 2001 and several thousand publications per year. Owing to unique control and precise measurement possibilities of intrinsic and extrinsic parameters, ultracold atomic gases open new frontiers and relate to many different fields of physics. An outstanding example is the use of cold atoms in atom interferometers for high precision atom clocks, gravitational or rotational sensors. In this respect cold atoms in microgravity promise even higher precision as the time of unperturbed evolution between measurements on the system can be arbitrarily extended.

Furthermore the realisation of quantum degenerate gases in microgravity would open perspectives to significantly shift boundaries in physics, e.g. realise unprecedented low temperatures. Motivated by these prospects several initiatives around the world (e.g. PHARAO, ACES, RACE and initiatives at JPL and Stanford) have been started pursuing mobile and ruggedised cold atom experiments, which might be used in space applications. The first optical molasses experiments under weightlessness conditions during parabolic flights have been recently reported by the PHARAO/ACES project as a precursor to an atomic clock setup on the international space station.

We will present the results of the first realisation of a magneto-optical trap (MOT) in microgravity based on a small, light, rigid and portable setup optimized for cooling and trapping neutral ^{87}Rb atoms in microgravity conditions at the drop tower in Bremen [1]. This project is performed within the ATKAT ("atom catapult", [2]) collaboration as part of the QUANTUS ("quantum systems in weightlessness", [3]) project pursuing a Bose-Einstein condensate (BEC) in weightlessness at the drop tower.

1. ZARM - Center of Applied Space Technology and Microgravity, http://www.zarm.uni-bremen.de/
2. Bongs, K., et al., "Realisation of a magneto-optical trap in microgravity", submitted to Journal of Modern Optics, 2007
3. Vogel, A., et. al., "Bose–Einstein condensates in microgravity", Appl. Phys. B. 84, 664-671, 2006

EXPERIMENTAL CHARACTERIZATION OF A MICROBUBBLE INJECTOR

S. Arias[a], X. Ruiz[d,e], L. Ramírez-Piscina[b,e], J. Casademunt[c,e] and R. González-Cinca[b]

[a] Escola Politécnica Superior de Castelldefels, Universitat Politècnica de Catalunya, Av. del Canal Olímpic, s/n, Campus Baix Llobregat, E-08860 Castelledefels (Spain). [b] Departament de Física Aplicada, Universitat Politècnica de Catalunya, Jordi Girona 1-3, Campus Nord, Mòdul B4, E-08034 Barcelona (Spain). [c] Departament d'Estructura i Constituents de la Matèria, Facultat de Física, Universitat de Barcelona, Diagonal 647, E-08028 Barcelona (Spain). [d] Departament de Física Aplicada, Universitat Rovira i Virgili, Marcel i Domingo s/n, Campus Sant Pere Sescelades, E-43005 Tarragona (Spain). [e] Institut d'Estudis Espacials de Catalunya, Gran Capità, 2-4, E-80034 Barcelona (Spain)

We have performed a systematic characterization of a novel microchannel bubble injector in conditions relevant to microgravity operation. Bubbles are generated injecting a slug flow created in a capillary T-junction, as seen in Fig. 1. The procedure is robust to changes in gravity level [1]. We address questions regarding the performance under different working regimes. In particular we span a large range of parameters such as gas and liquid injection rates, and capillary diameters. The injection performance in different conditions is characterized by measuring bubble injection frequency and bubble size distribution. Limits of operation performance regarding the control of bubble sizes are evaluated. We compare quantitative results with theoretical scaling laws expected in different regimes.

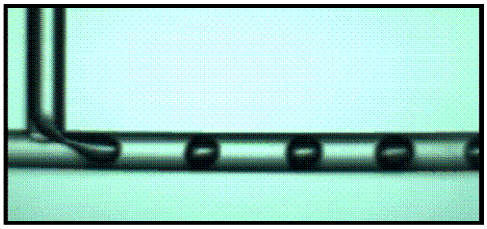


Fig. 1.- Slug flow generated at the T-junction

1. J. Carrera, X. Ruiz, L. Ramírez-Piscina, J. Casademunt, M. Dreyer, "Generation of a Monodisperse Microbubble Jet in Microgravity", preprint, 2007.

STABILITY LIMITS OF UNSTEADY CAPILLARY FLOW

Aleksander Grah, Uwe Rosendahl, Dennis Haake, Jörg Klatte, Michael E. Dreyer
ZARM (Center of Applied Space Technology and Microgravity), University of Bremen, Am Fallturm, D-28359 Bremen, Germany, grah@zarm.uni-bremen.de, Tel.: +49 421 218 8685

We will present numerical studies on capillary channel flow, based on results of a sounding rocket experiment (TEXUS 41, ESRANGE, Sweden, 2005). The aim of the experiment is to determine the shape of the free surface and the maximum flow rate. The maximum flow rate is achieved when the free surface collapses (Rosendahl et al., J. Fluid Mech. (2004), vol. 518, pp. 187214). The experimental set-up is shown in Figure 1. The flow through the channel is established by a gear pump. The capillary channel is shown in Figure 2. Pressure effects force the surfaces to bend inwards. The displaced liquid oscillates along stream line **b** in Figure 1.

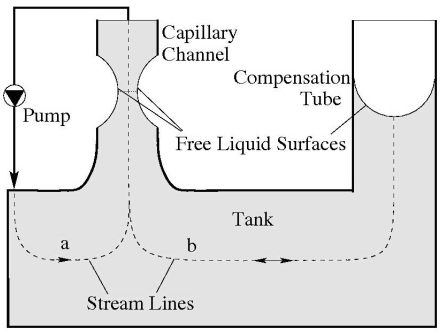


Figura 2: Capillary channel with two free surfaces

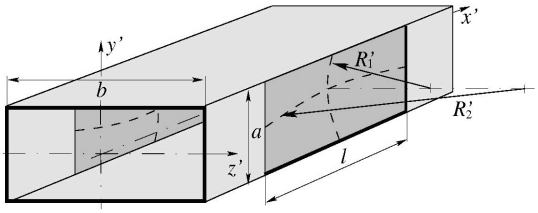


Figura 1: Set-up with the capillary channel

The transient model is based on the momentum equation, the continuity equation, the Gauss-Laplace equation and geometrical conditions. Figure 3 shows the evaluated oscillation of the surface and the experimental results; Q is the experimental flow rate. The comparison shows good agreement. The pump dynamic is defined as a flow rate increase over time $\delta=\Delta Q/\Delta t$. In the case of maximum flow rate "choking" occurs and the surfaces collapse. This effect is related to the Speed Index S_{ca}, which reaches at a critical point S_{ca}=1, in analogy to the Mach Number. For steady flow rates that causes immediate surface collapse. For unsteady flow temporarily overcritical but stable flow can be achieved. As a new stability criterion we define a Dynamic Index D which is a function of the local capillary pressure and local velocity. The free liquid surface collapses at D=1. The result of this studies is a dynamic diagram (Figure 4) with the area of choking and the limit of stable flow.

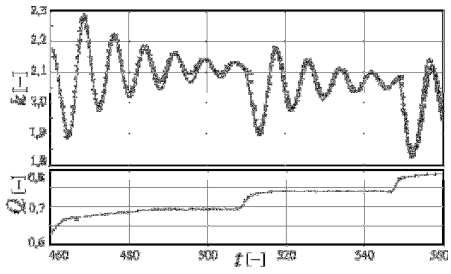


Figura 3: Evaluated (-) and experimental (...) surface oscillation

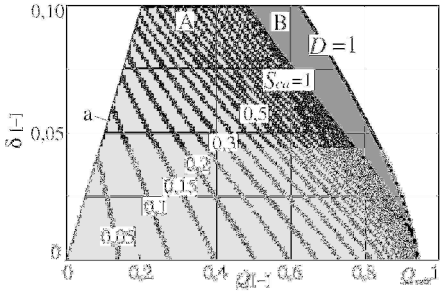


Figure 4: Dynamic diagram; choking: S_{ca}=1, collapse: D=1.

SCIENTIFIC SESSIONS:

Thursday, 6th September 2007
HALL B, 9:00 – 10:20

Life Sciences
Space Technology and Facilities I

A MODULAR STANDARDISED SYSTEM TO SUPPORT TISSUE ENGINEERING EXPERIMENT IN BMTC

P. Kern[1], J. Cornier[2], K. Kemmerle[2], S. Wagner[3], D. Jones[4]
[1] Astrium GmbH, Space Transportation, Friedrichshafen, D.; [2] Kayser-Threde GmbH, München, D.; [3] InVitro System & Services GmbH, Göttingen, D.; [4] CytoScience SA, Fontaines, CH

A large number of cultivation experiments are currently performed worldwide on a research level. Their objectives range from basic research to first steps on "spare-part production". To do so each group normally uses its own equipment and different procedures. This makes it difficult to compare the results and to define a suitable platform for such experiments to be performed in space in the future.
To overcome this deficiency ESA initiated the BMTC (Biotechnology Mammalian Tissue Cultivation Facility) program to prepare a well defined platform for tissue engineering as a space experiments. Currently the BMTC is focusing on bone and cartilage cultivation.
The BMTC is dedicated to support tissue cultivation principles under controlled and standardised conditions.
The basis is a modular and standardised set of subsystems, which provide reproducible conditions for such experiments. These subsystems are to be tested and optimised on ground and shall be used later in the flight experiments. This approach ensures that the results of the future space experiments can be well compared with the terrestrial experiments.
The set of modular standardised subsystems consist of:

- Experiment Chamber Module (ECM) which provides a medium buffer, the medium circulation loop, the gas exchanger, continuous supply of fresh medium, collection of used medium, interfaces to take samples for external analysis, in-situ sensors for pO_2- and pH-monitoring.
- Experiment specific reactors
  - For 2D- and flat 3D-cultures with flow induced shear stress stimulation
  - Real 3-D cultivation with uni-axial stimulation by the ZETOS device
- A roller pump supporting several ECMs in parallel with the same medium perfusion flow
- A device for the active medium supply of cartilage samples during perfusion by the pump
- High degree of experiment automation
  - to ensure the proper execution of the experiment protocol and to avoid handling errors
  - automation of the complete experiment life cycle
    - maintain experiment protocol also during long weekends
  - individual transport of an experiment unit to a workstation e.g.
    - for observation by fluorescence microscopy
    - for the application of a mechanical uni-axial loading profile as stimulus using the ZETOS
    - active collection of medium or tissue samples

Infrastructure for environmental control (temperature, gas composition, humidity) will be provided.
An internet link will allow remote monitoring and interaction as parameter modification or timeline changes.
The paper will present the different subsystems in detail. Additionally technical performance characteristics will be provided, which are critical for successful experimentation.

DIAMAGNETIC LEVITATION EFFECT ON BACTERIAL GROWTH

C. Dijkstra[a], O. Larkin[a,c], R.J.A. Hill[d], P. Anthony[a], M.R. Davey[a], C. Rees[b], K. Smart[b], J.B. Power[a], K.C. Lowe[c], L. Eaves[d]

[a]Plant Sciences Division, [b]Division of Food Sciences, School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD, UK; [c]School of Biology, [d]School of Physics & Astronomy, University of Nottingham, University Park, Nottingham NG7 2RD, UK

Earth-based simulations of the environment in space provide a means to acquire information about the development of micro-organisms in altered gravity. Magnetic levitation is based on the principle that water and other diamagnetic materials experience a repulsive force when placed in a strong magnetic field. In the present investigation, we use a superconducting magnet with a closed-circuit cryogenic system to levitate bacterial cells for extended periods of time. As the levitation force acts at the molecular level, cells experience conditions similar to those of weightlessness in space. By varying the magnetic field strength, it is possible to investigate the influence of different effective gravities ($0g \leq g^* \leq 2g$) on bacteria. Exposure to $0g^*$ for 16 h increased the bacterial growth more than 2-fold, consistent with data reported for experiments in space. Bacteria were unaffected by the magnetic field alone. Experiments have been performed to identify the mechanisms responsible for the observed changes. Studies with *Escherichia coli* expressing green fluorescent protein showed that cell sedimentation was prevented at $0g^*$, which increased oxygen availability. This was confirmed by studies of anaerobic conditions and *E. coli arc*$^-$ mutants, which are incapable of anaerobic respiration. Direct effects of diamagnetic levitation on cells are being investigated by assessing changes in gene expression.

BIOREACTORS FOR TISSUE ENGINEERING SCAFFOLDS AND EX VIVO TISSUES

DB Jones[1], B Noble[2], L Vico[3], J VanderSloten[4], I Martin[5], G Richards[6]

1) Dept. Experimental Orthopaedics and Biomechanics, Phillipps University, Marburg, Germany; 2) Musculoskeletal Tissue Engineering Collaboration, University of Edinburgh Medical School, Edinburgh, UK; 3) INSERM U890, Université Jean Monnet, F-42023 St Etienne, France; 4) Katholieke Universiteit Leuven, Div. of Biomechanics and Engineering Design, Celestijnenlaan 300C, PB 02419, room 04.214 3001 Heverlee, Belgium; 5) University Hospital Basel, Institute for Surgical Research and Hospital Management, Basel, Switzerland; 6) AO Research Institute, AO Foundation, Davos, Switzerland.

Although many bioreactors have been described, very few can apply the specific mechanical forces that are needed to stimulate or maintain tissue fitness and very few can also measure the mechanical properties of the tissue. The mechanical properties of the tissue, such as stiffness, elasticity, breaking strength etc is for several tissues such as bone, cartilage, tendon, muscle, the most significant property. Other tissues such as the lungs, hair, blood vessels etc also have specific mechanical properties necessary for their proper function, while organs such as the brain, spleen, glands etc do not seem to need specific mechanical properties as such. Hence many organs and tissues of the body are defined by their mechanical properties.

Over the last 10 years the Zetos group has been designing and working with a bone bioreactor called Zetos (1). This device is used to investigate the role of mechanical forces on bone and several investigations have been published that show that in vivo–like responses to mechanical loading are reproduced (2,3,4,5), justifying its use as a model system for many bone related investigations. One of the many investigations was into the role of high frequency. Any desired waveform can be applied such as those typical of walking, running and jumping. An in built FFT filter was used to cut frequencies lower than 30Hz and only apply frequencies above 30Hz (controls were the normal signal and the low frequency signal). The results showed that the high frequency components alone can significantly stimulate bone formation. These results were the basis of the forthcoming Freqbone experiment on a Photon flight in the next year, coordinated by the Leuven group.

However if it is desired to apply physiological forces to other tissues than bone, such as cartilage, tendon and muscle, these require much higher expansions of the actuator (of up to 1600μm) and also apply motions other than compression. Stretching can also be required.

Hence a new mechanical design using different actuators and a new electronics design using real time positive feedback and new sensors has been carried out which results in a radically different concept of the bioreactor. As for the original bone Zetos, the devices are designed to also gain precise information on several mechanical properties, stiffness, visco-elasticity, etc.

Cartilage is one of the major targets for tissue engineering. Presently little is known precisely about the mechanical properties of cartilage. It is known that the stiffness is dependant on the frequency of loading. The visco-elastic properties are also very complex. Hence an extremely fast (0.4MHz and upwards) feedback of the position sensor and force sensor are required to control the loading and the mechanical properties sensing. The Zetos for cartilage, Zetos C or *Chondros,* is being implemented for the BMTC project by CytoScience SA Switzerland.

This project has been supported by the European Space Agency Microgravity Applications programme, several awards of the AO foundation Davos and The Robert Mathys Foundation. David Jones is a currently also a director of CytoScience SA of Fontaines Switzerland.

1. Jones, D.B., Broeckmann, E., Pohl, T,.. Smith, E.L. “Development of a mechanical testing and loading system for trabecular bone studies for long term culture”, European Cells and Materials, Vol. 5, pp.48-60, 2003.

2. Clarke, M.C.H, Savill, J.,. Jones, D.B, Noble, B., Brown S.B. "Compartmentalised progenitor cell apoptosis generates functional platelets committed to caspase-independent death", JCB, Vol. 160, pp. 577-587, 2003.
3. Davies, C.M, Jones, D.B., Stoddart, M.J., Koller, K., Smith, E., Archer, C.W., Richards, R.G., "Mechanically loaded ex vivo bone culture system 'Zetos': Systems and culture preparation", Eur Cell Mater, Vol. 11, pp. 57-75, 2006.
4. Mann, V., Huber, C., Kogianni, G., Jones, D., Noble, B,."The influence of mechanical stimulation on osteocyte apoptosis and bone viability in human trabecular bone", J Musculoskelet Neuronal Interact; Vol. 6(4), pp.408-417, 2006.
5. David, V., Martin, A., Lafage-Proust, M.H., Malaval, L., Peyroche, S., Jones, D.B., Vico, L., Guignandon, A., "Mechanical loading down regulates PPARγ in bone marrow stromal cells and favours osteoblastogenesis at the expense of adipogenesis", Endocrinology, Vol. 148(5), pp. 2553-2562, 2007.

MECHANOMICS IN SPACE - A NEARLY-LOST OPPORTUNITY

Jack J.W.A. van Loon
Dutch Experiment Support Center, ACTA, Dept Oral Cell Biology, Vrije Universitiet, Amsterdam, The Netherlands. E-mail: j.vanloon@vumc.nl. Web: http://www.desc.med.vu.nl/ Tel: +31204448686/+31653700944

The European Columbus module will, hopefully, be launched soon as a valuable contribution to the International Space Station, ISS. It will provide some tools for cell biologists helping to understand how cells respond to mechanical forces such as gravity. Sensing gravity by 'non-professional' cells still puzzles many of us. Are the effects direct or indirect, and if they were direct, what would be the sensing organelle or mechanism within a cell. These questions in 'gravisensing' are not much different from questions in general mechanosensing or cell mechanomics. What are the mechanical properties of a cell; are there differences in mechanical properties, especially with respect to gravity, between cell types and if so why.
With relatively novel techniques such as optical and magnetic tweezer, atomic force microscopy but also computer modelling a whole field of research has been opened up. A similar approach should also be applied for micro-gravity related research but non such facilities have been built nor scheduled for ISS.
In this paper we will address the current techniques used in mechanosensing in regular, ground based research and stress some points in how a cell could sense the relatively insignificant force of gravity and why such instruments should be made available on the ISS.

Acknowledgements:
This work is supported by NWO-ALW-SRON grant MG-057.

SCIENTIFIC SESSIONS:

Thursday, 6th September 2007
HALL A, 11:20 – 13:20

Physical Sciences
Surface – Tension – Driven Flow

ROLE OF HEATING SUBSTRATE GEOMETRY IN THE DYNAMICS OF EVAPORATING DROPLETS

Fabien Girard[a], Mickaël Antoni[a], Sylvain Faure[b] and Annie Steinchen-Sanfeld[a]
[a]Laboratoire de Thermodynamique et de Modélisation des Milieux hors Equilibre, UMR-CNRS 6171, Université Paul Cézanne Aix-Marseille BP 451, F-13397, Marseille cedex 20 (France); [b]CEA-Marcoule, Laboratoire des Procédés Avancés de Décontamination, DTCD/SPDE/LPAD, Bât. 222, F-30207 Bagnols/Cèze Cedex (France)

Evaporating systems have for long interested both the academic and industrial community. Specific properties like hydrodynamical instabilities, coexisting vapor-fluid phases and the role of interfaces have been investigated and used in various fields of industrial applications (paintings, cooling systems, printers and photocopiers, etc). The complete understanding of evaporation phenomena still motivates important scientific activity. One important objective is, for example, to allow substrate characterization from measured evaporation rates or contact angle dynamics.

We propose to investigate numerically the properties of water evaporating droplets on a heating substrate [1]. These droplets are assumed to be sessile and axi-symmetric for the duration of the evaporation process. The dynamics is described through the usual hydrodynamic equations and the coupling between the droplet and surrounding air is determined by the water diffusivity in air, the rate of humidity and the local vapor pressure.

We compare the numerical outputs with experimental data [2, 3] and show a relative good agreement. We investigate the influence of the heating substrate on evaporation dynamics [4] and describe the evolution of the Marangoni velocity field on the free interface [5]. We also present results about the role of humidity rate. We finally discuss the influence of the size of the heating substrate on droplet evaporation dynamics.

1. Hu, H., Larson, R. G., "Analysis of the microfluid flow in an evaporating sessile droplet", Langmuir, Vol. 21, pp. 3963-3971, 2005.
2. Crafton, E.F., Black, W.Z., "Heat transfer and evaporation rates of small liquid droplets on heated horizontal surfaces", Int. J. Heat Mass Transfer, Vol. 47, pp. 1187-1200, 2004.
3. Sefiane, K., "The coupling between evaporation and adsorbed surfactant accumulation and its effect on the wetting and spreading behaviour of volatile drops on a hot surface", J. Petrol. Sci. Eng., Vol. 51, pp. 238-252, 2006.
4. Girard, F., Antoni, M.I., Faure, S., Steinchen, A., "Numerical study of the evaporating dynamics of a sessile waterdroplet", Microgravity Sci. Technol. Vol. 18, pp. 42-46, 2006.
5. Girard, F. et al., Langmuir, (in press).

ORIGIN OF AXIALLY RUNNING WAVES IN LIQUID BRIDGES

Melnikov* D., Shevtsova V.
MRC, CP-165/62, Université Libre de Bruxelles, 50, av. F.D.Roosevelt, B-1050 Brussels**,** Belgium**;**
*Corresponding author e-mail: dmelniko@ulb.ac.be

Thermo-convective flow is analyzed in a cylindrical liquid zone held between two parallel rods at different temperatures (called liquid bridge). Three-dimensional Navier-Stokes equations in Boussinesq approximation are solved numerically by finite volume method. 1cSt silicone oil, with rather large Prandtl number, Pr = 14, is chosen as test liquid. The simulations are done under normal gravity conditions and for relatively large aspect ratio *height/radius = 1.8*. Convective motion starts in the liquid bridge as soon as tiny temperature difference is applied between horizontal rods. This 2D axisymmetric flow becomes oscillatory (in case of large Pr numbers) at a critical value of the imposed temperature difference. As a rule, at the threshold of instability the flow pattern with azimuthal wave number $m \neq 0$ is observed.

The existence of axial wave with $m=0$ was under discussions during last years. For the chosen set of parameters, we have found that instability begins as an axially running wave with $m=0$. Study of temporal behavior has confirmed that it is a hydrothermal wave propagating from cold side to the hot side. The wave amplitude is larger near the free surface. The system has to fulfill at least two conditions for being able to generate this type of the waves: (a) liquid bridge should be long enough for the wave to have space to propagate; (b) the system should have physical properties enabling generating rather strong wave on the cold side. The constrains imposed by rigid walls are severe: the disturbances should die out at the walls. It is one of the reasons why this type of waves was never observed before in numerical calculations.

NON-ISOTHERMAL MULTIPLE BUBBLE GROWTH OVER MINIATURE HEATERS

Nikolaos Divinis[a,b], Thodoris D. Karapantsios[a*], Margaritis Kostoglou[a] andVasilis Bontozoglou[b]

[a] Dept. of Chemistry, Aristotle University, Univ. Box 116, 541 24 Thessaloniki, Greece. [b] Dept. of Mechanical Engng., University of Thessaly, Pedion Areos, 38 334 Volos, Greece. *Speaker

Non-isothermal degassing refers to gas bubbles growing over heated surfaces that are submerged in subcooled liquids. In such cases, the liquid layers adjacent to hot surfaces become superheated causing local desorption of dissolved gases while the liquid far afield remains at low temperatures. Buoyancy effects on gas bubbles and natural convection of hot liquid layers prohibited the thorough investigation of non-isothermal degassing under terrestrial conditions and only recent microgravity data allows serious progress to be made.

This work investigates the simultaneous growth of several bubbles over the surface of miniature heaters at low gravity conditions. CO_2 is used as the desorbing gas and water and n-heptane as the test liquids. It is found that simultaneous bubbles do not grow at exactly the same rate and calculations show that this corresponds to slightly different bubble temperatures. Moreover, simultaneous bubbles exhibit smaller growth rates than single bubbles at similar conditions, a strong indication that they compete for dissolved CO_2. As bubbles expand into the surrounding cold liquid, the heater's temperature gradually decreases in a fashion indicating the inception of Marangoni convection. Simultaneous bubbles detach due to g-jitters but following different ways in the two liquids. However, they always detach synchronously and at smaller sizes than single bubbles do. The intense destabilization of contact lines occurring at the higher heater temperatures required to create multiple bubbles is deemed responsible for this.

DYNAMIC FREE SURFACE DEFORMATIONS DUE TO THERMOCONVECTIVE FLOWS

Shevtsova[1]* V.M, Mialdun[1] A., Ferrera[2] C., Cabezas[2] M. G., Montanero[2] J. M.
[1]MRC, CP-165/62, Université Libre de Bruxelles, 50, av. F.D.Roosevelt, B-1050 Brussels, Belgium; [2]Departamento de Electronica e Ingenieria Electromecànica, Universidad de Extremadura, E-06071 Badajoz, Spain. *Corresponding author e-mail: vshev@ulb.ac.be

Dynamic free surface deformations induced by buoyant and thermocapillary convection in liquid bridges of *5 cSt* silicone oil are studied experimentally and numerically. The experiments are performed in ground conditions and static deformation is unavoidable. Convective motion starts in the liquid bridge as soon as tiny temperature difference is applied and initially leads to a stationary dynamic deformation of the free surface. Oscillatory motion starts at a critical value of imposed temperature difference and causes oscillations of the interface. The final supercritical shape of the free surface is a result of the static shape with superimposed subcritical stationary and supercritical oscillatory dynamic deformations.
The initial static bridge shape and flow-induced free surface motions of sub-micron size are accurately determined by digital image processing. The significant result of this study is that the static deformation is about ~500μm, while the subcritical dynamic surface deformation is at least 10 times smaller, e.g. ~ 50 μm. The amplitude of the oscillations was experimentally determined by optical imaging. The maximal amplitude of oscillations was observed near the hot wall and its magnitude is about ~1-2μm. Temperature oscillations inside the liquid bridge were also recorded by five thermocouples. The amplitude and fundamental frequency of temperature oscillations were compared with the corresponding values of interface oscillations. Examination of free surface deformations reveals the same dynamics as obtained from the more disturbing temperature measurements.

SOLUTOCAPILLARY CONVECTION IN SPHERICAL SHELLS

Pravin Subramanian, Abdelfattah Zebib
Mechanical and Aerospace Engineering, Rutgers University, Piscataway, NJ 08854 U.S.A.

Hollow spherical shells used as laser targets in inertial confinement fusion (ICF) experiments are made by microencapsulation. In one phase of manufacturing, the spherical shells contain a solvent (fluorobenzene, FB) and a solute (polystyrene, PAMS) in a water-FB environment. As the solvent evaporates it leaves behind the desired hardened plastic spherical shells, 1-2 mm in diameter. Perfect sphericity is demanded for efficient fusion ignition. It is proposed that Marangoni instabilities driven by surface tension dependence on the FB concentration (c) might be the source of observed surface roughness (buoyant forces are negligible in this micro-scale problem). Here we model this drying process, investigate conditions for incipient instabilities, and compute nonlinear axisymmetric and three-dimensional convection. The inner radius of the shell is taken stress-free and impermeable. At the receding outer radius $r_2(t)$ the FB evaporates with an assumed constant mass transfer coefficient. The non-dimensional equations along with the nonlinear boundary conditions are solved through a coordinate transformation, a second-order finite volume approach and Crank-Nicholson time marching. We first consider the diffusive state and determine $r_2(t)$ and $c(r,t)$. Instability of the diffusive-state is then considered in the limit of small Capillary number (Ca), which is a measure of the deviation of surface tension from its average value and thus the magnitude of surface deviation from sphericity. To leading order, the outer interface recedes in a convective state as it does in the diffusive state. Linear stability analysis assuming viscosity dependence on c and normal mode decomposition in surface harmonics leads to a partial differential system in (r,t) with time-dependent coefficients. We have performed frozen-time, quasi-steady-state calculations to determine the critical Reynolds number and degree of surface harmonics (linear convection is independent of the azimuthal wavenumber). We have also calculated maximum growth rates of perturbations by solving the initial boundary value problem with random initial conditions. We compute nonlinear, time-dependent, infinite Schmidt number convection by a second order accurate finite volume technique. Preferred supercritical patterns are investigated in the relevant parameters space and with various initial conditions. Companion O(Ca) surface deformations are determined and our results compared with available experiments.

* Supported by NSF Grant # CTS-0211612

EXPERIMENTAL CONSIDERATIONS OF SOLUTOCAPILLARY FLOW INITIATION ON BUBBLE/DROP INTERFACE IN THE PRESENCE OF A SOLUBLE SURFACTANT

Konstantin Kostarev[1], Andrew Zuev[1], Antonio Viviani[2]

[1]Laboratory of Hydrodynamic Stability, Institute of Continuous Media Mechanics, UB Russian Academy of Sciences, Acad. Korolev Str. 1, 614013 Perm, Russia. E-mail: vab@icmm.ru. [2]Dipartimento di Ingegneria Aerospaziale e Meccanica, Seconda Università di Napoli, via Roma 29, I-81031 Aversa, Italy. E-mail: antonio.viviani@unina2.it

Experimental investigation of the solutocapillary convective motion near the interface of air bubbles and drops of insoluble fluids placed in a liquid with a vertical surfactant concentration gradient [1] has shown its essential difference from thermocapillary convection. In the thermal case one can observe a non-threshold development of a stationary flow at arbitrary small temperature gradients on the interface. In the concentration case, by contrast, there occur well-defined oscillatory regimes. These differences are caused by extremely long characteristic times of the surfactant diffusion. Moreover the mechanism of the surfactant emergence (adsorption) at the phase interface differs from the mechanism of the boundary temperature formation. Investigation of the flow structures and concentration fields near the bubble in a long horizontal channel [2] revealed a delay in the onset of the Marangoni flow with respect to the moment, at which the surfactant flux comes into contact with the free surface of the bubble. Such a delay can be caused by formation of a new surface phase of the surfactant. This work is intended to investigate experimentally the conditions for initiation of solutocapillary flow at the interface, the effect of its delay, and to define critical surfactant concentration difference (diffusion Marangoni numbers) responsible for its generation depending on various factors. This will enable us to estimate the actual role of adsorption and to construct an adequate theoretical model for description of mass transfer along the interface.

The work was supported by Russian Foundation for Basic Research (Grant No. 06-01-00221).

1. Kostarev, K.G., Zuev, A.L., Viviani, A., "Thermal and concentrational Marangoni convection at liquid/air bubble interface", ASME J., Vol. 73, No. 1, pp. 66-71, 2006.

2. Birikh, R.V., Zuev, A.L., Kostarev, K.G., Rudakov, R.N., "Convective Self-Oscillations near an Air-Bubble Surface in a Horizontal Rectangular Channel", Fluid Dynamics, Vol. 41, No. 4, pp. 514-520, 2006.

SCIENTIFIC SESSIONS:

Thursday, 6th September 2007
HALL B, 11:20 – 13:20

Life Sciences
Space Technology and Facilities II

REDUCED GRAVITY TESTING AND RESEARCH CAPABILITIES AT QUEENSLAND UNIVERSITY OF TECHNOLOGY'S NEW 2.0 SECOND DROP TOWER

Ted Steinberg
Associate Professor, Director, Phenomena in Microgravity Laboratory,School of Engineering Systems, Queensland University of Technology. Bribane, QLD, Australia. t.steinberg@qut.edu.au

Reduced gravity experimentation is important to many research groups working in various fields investigating both fundamental and applied aspects of diverse physical phenomena. Very few terrestrial or extra-terrestrial experimental facilities are currently available that allow researchers access to reduced gravity environments. The Queensland University of Technology's has recently (2006) decommissioned its 1.9 second drop tower adapted for operation within an unused lift well of a building and has fabricated a purpose built, stand alone 2.0 second drop tower specifically to accommodate reduced gravity experimentation. The specifications and operational procedures of this new research facility are presented. Information concerning current and future areas of research is also presented and discussed. These research areas include: 1) cellular biology, 2) fluid dynamics and multiphase flow**,** 3) nanomaterial production including silica sol-gels and carbon nanotubes, and 4) heterogeneous combustion with a focus on bulk metallic materials burning in oxygen enriched atmospheres performed in collaboration with NASA and industry partners. Opportunities will also be discussed regarding both collaborative research and the provision of reduced gravity test services.

SUPPORT OF ISS LIFE SCIENCES EXPERIMENTS BEFORE COLUMBUS

Marianne Schuber, Dieter Seibt, Paul Esser
MUSC at German Aerospace Center DLR, Linder Hoehe 23b, D-51147 Cologne**;** Marianne.Schuber@dlr.de

This paper is summarizing all activities related to the ESA ISS Interim Utilisation programme comprising two SOYUZ missions and the ASTROLAB mission for which the Microgravity User Support Center (MUSC) at DLR was nominated by ESA as the Responsible Center for the KUBIK Facility (FRC). The BIO#1 mission took place in spring 2006 and was followed by the BIO#2 mission in autumn 2006. In total, 9 biology experiments from different subdisciplines could be performed.
The different fields of support for the scientific groups from France, Netherlands, Italy, Russia, Switzerland and Belgium for the 2 SOYUZ flights will be described for the SOYUZ mission preparation and mission operations:

- support of the scientists in experiment preparation and documentation,
- enhancement of the scientific laboratory infrastructure in Baikonour,
- performance of an integrated Experiment Sequence Test (EST) before the flight,
- mission operations from the MUSC control rooms including information to the PIs and
- interaction with the ESA Control Center Munich and the Russian interface in Moscow.

These activities will be detailed in the frame of KUBIK BIO#1, BIO#2 and the Astrolab missions in 2006.

INVESTIGATING GRAVITY, RADIATION AND MAGNETISM IMPACT ON BIOLOGICAL STRUCTURES AND PROCESSES IN THE LUNAR LANDER PAYLOAD ASTROHAB - PREPARATION FOR THE EXPLORATION OF MOON AND MARS

Matthias Dünne, Klaus Slenzka
OHB-System AG, Universitätsallee 27-29, 28359 Bremen, Germany. Phone: ++49 421 2020716; Fax: ++49 421 2020610; duenne@ohb-system.de, slenzka@ohb-system.de

Exploration of life to the mars is one of the main goals of the scientific and public community at the moment. But living of humans in extreme environments requires knowing more about the impact of different environmental conditions (mainly gravity, magnetism and radiation) on biological structures and processes in larger time scales. Sustainable closed ecological life support systems (CELSS) are needed also, which increases the importance of such research additionally.
OHB-System, Bremen, Germany, is currently analysing in the Mona Lisa Initiative of German Space Agency DLR a first pre-cursor-lander-mission to the moon to push the preparation of longer journeys to moon and mars significantly. Working together with scientists of several research disciplines, a broad spectra of relevant aspects are covered.
AstroHab will be the autonomous biological payload for this first pre-cursor-mission, allowing investigations as mentioned above. AstroHab will consist mainly of a biosolar energy supply unit, an experiment bioreactor as well as of a sensor unit, which will monitor the environmental conditions at the landing site as well as further experiment conditions in the bioreactors.
An overview of AstroHab and the status of current R&D activities will be given.

RESEARCH IN MARS-GRAVITY,MOON-GRAVITY AND WEIGHTLESS FLIGHTS

Carlo Viberti
President, C.O.S.M.O. SpaceLand Cultural Association, via Rivalta 9 Grugliasco (Torino) Italy

Manned space programs have demonstrated the major role played by gravity in several natural processes and human pathologies. This is the reason for the success of the low-g research and educational flights which SpaceLand carries out since the year 2000, taking off from the NASA Space Shuttle Landing Facility since Nov. 5th 2005. Such SpaceLand campaigns, in synergy with Florida and NASA institutes, provide users with a flexible "flying laboratory" for research, development, test and qualification activities in weightlessness as well as in conditions simulating the gravitational fields on Moon and Mars. The 2007 SpaceLand campaigns are focused to best define and implement a systematic science & technology transfer, especially for: 1) accelerated growth and proliferation of adult stem cells and macro-molecular crystals 2) development of telemedicine & biomedical garments 3) hand-free ICT tools and robotic systems. Attention is also paid to the benefits of developing systems, hardware and methodologies to help both astronauts and, on ground, people affected by temporary or permanent mobility problems: in particular, studies are carried out on the analogies between operational difficulties and pathologies experienced by space crews and similar problems of mobility on the ground affecting old people, bed-resting individuals, children and/or individual with physical disabilities during their daily life on the ground.

ANIMAL RESEARCH IN SPACE USING MICE AS A MODEL

G. Falcetti [1], C. Tenconi [1], R. Cancedda [2], D. Berckmans [3]
[1] Alcatel Alenia Space – Italy (Milan plant). [2] Universita' di Genova and Istituto Nazionale sul Cancro – Genoa (Italy).[3] Katholieke Universiteit Leuven (Belgium)

Mice are valid models to perform research in space. They are used to study microgravity and radiation effects on their physiology and behaviour during long-term missions. As a result, many experiments with mice have been proposed by worldwide scientific community. The use of mice for research in space is important also because: A) many different strains (inbred, transgenic and outbreds) are available from breeding companies and research labs; B) their reduced mass (from 25 to 40 grams) permits to use a significant number of animals and the acquisition of more data with better statistics; C) less food, water and oxygen needed/animal; D) due to the different life spans of the two species, results based on few months observation are comparable to results based on many year observation in human. Alcatel Alenia Space – Italy (Milan plant) is involved in several programs aimed at developing equipment able to support scientific experimentation in space with mice. In particular: 1) MDS (Mice Drawer System), funded by ASI, which individually houses 6 mice for up to 100 days on board the ISS, 2) MISS (Mice on ISS), funded by ESA, aimed at identifying a design concept of a equipment that can house up to 32 mice for 3 months on board the ISS, 3) MIS (Mice In Space), also funded by ESA, is adapting the MISS design concept to an accommodation on board the Russian FOTON satellite, 4) Life Support Technology for MIS identifies technologies able to sustain mice housing for a period of 35 days on board the unmanned FOTON satellite. Services and performances provided by each equipment are presented.

CLINOSTATS AND CENTRIFUGES – PREREQUISITE FOR AND SUPPORT OF BIOLOGICAL EXPERIMENTS IN MICROGRAVITY

Ruth Hemmersbach[1], Oliver Ullrich[2], Melanie von der Wiesche[1], Jens Hauslage[1], Gerhard Buess[1]

[1]DLR-Institute of Aerospace Medicine, Biomedical Science Support Center, Köln, Germany. [2]Otto von Guericke University, Institute of Immunology, Magdeburg, Germany

In order to vary the influence of the unique stimulus gravity, different experimental and technical approaches have been developed. Our working group provides access to experimental platforms which enable the alteration of the gravity stimulus on ground. The status of functional weightlessness for small biological systems can be achieved by different types of fast-rotating clinostats**.** Currently we have developed a portable clinostat allowing parallel operation of ten sample containments (pipettes), deflating and thus chemical fixation of the samples during the experimental run**.** Correspondingly, various centrifuge devices – such as NIZEMI, the slow rotating centrifuge microscope - complete our experimental scenario.

Recent scientific results on lymphocytes demonstrate the efficiency of the applied tools (fast-rotating clinostat, centrifuge) as a prerequisite for space experiments (in this case the 8th DLR, 9th DLR and 45th ESA Parabolic Flight Campaigns 2006). During this project, we investigated the gravisensitivity of molecular mechanisms of lymphocyte activation and function by fast-rotating clinostat and hypergravity experiments. We identified several initial molecular responses to simulated microgravity such as an enhanced and sustained MAPK activation, and activation of cell cycle-regulatory and DNA-damage-associated proteins. After longer exposure to simulated microgravity up to 15min, most initial alterations returned to normal levels, but some parameter remained constantly altered, such as expression of p21 and p27 proteins. These experiments allowed us to verify specific gravisensitive alterations in flight experiments afterwards and furthermore to address the underlying molecular mechanism.

Thus, ground-based experimental platforms are an important tool for the identification of gravisensitive processes and for the preparation of experiments in real microgravity.

SCIENTIFIC SESSIONS:

Friday, 7th September 2007
HALL A, 12:20 –13:20

Physical Sciences
Solidification

ARRAY DYNAMICS IN DENDRITIC SOLIDIFICATION WITH A CONCAVE INTERFACE: IN SITU CHARACTERIZATION ON TRANSPARENT MODEL ALLOYS

N. Bergeon[1], C. Weiss[1], N. Mangelinck-Noel[1], B. Billia[1], B.H. Zhou[1,2]
[1] L2MP, UMR CNRS 6137, Université Paul Cézanne – Aix-Marseille III, Marseille, France. [2] NMLC, CAS, Beijing, China

Solidification microstructure controls materials properties. On Earth, convection precludes precise characterization of microstructure formation in the dynamical growth process on bulk samples [1]. We are thus preparing experiments under low gravity on ISS that will observe in situ and in real time the spatio-temporal evolution of the solid-liquid interface morphology on bulk samples of transparent succinonitrile-based alloys that freeze like metals. These experiments will be carried out using the Directional Solidification Insert in the DECLIC facility of CNES. Due to the higher thermal conductivity of glass crucible, the latent heat generated upon solidification is preferentially evacuated through the wall, which drives fluid flow and renders the interface concave and microstructure dynamics peculiar. The formation of the dendritic columnar microstructure, which includes the mushy zone, is central in casting and should be clarified [2]. Observation along the growth direction using oriented <100>-single crystals allow the characterisation of array dynamics from initial transient to steady-state. Interface concavity makes dendrites switching from vertical to horizontal growth, following the change in the temperature gradient orientation, which imposes unsual constraints on the dendrite array. In particular, a birth / elimination mechanism takes place in dendrite drifting (Fig. 1), that will be detailed.

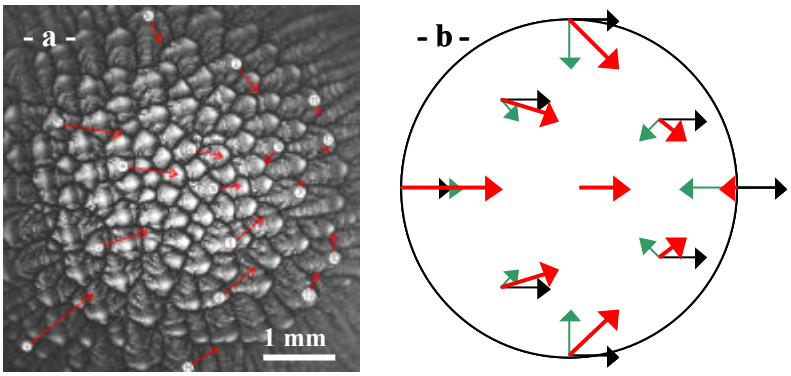


Figure 1. Top view (a) and sketch (b) of the drift (red arrows) of almost vertical dendrites, sum of the concavity/temperature-gradient drift (green arrows) and the <100>-misfit drift (black arrows). Succinonitrile – 0.1 wt% camphor , V = 20 µm/s, G = 17 K/cm.

1. Bergeon, N., Trivedi, R., Billia, B., Echebarria, B., Karma, A., Liu, S., Weiss, C., "Necessity of investigating microstructure formation during directional solidification of transparent alloys in 3D", Adv. Space Res., Vol. 36, pp. 80-85, 2005.
2. Billia, B., Fecht, H.J., "Microstructure and control in advanced casting processes", in "A World without Gravity", Fitton, B., Battrick, B. Eds, ESA SP 1251, pp. 186-210, 2001.

GRAVITY EFFECTS BEYOND FLUID FLOW IN ALLOY SOLIDIFICATION

H. Nguyen-Thi[1], H. Jung[1], G. Reinhart[1], N. Mangelinck-Noel[1], B. Billia[1], A. Buffet[2], J. Hartwig[2], J. Baruchel[2], T. Schenk[3], J. Gastaldi[4]

[1] L2MP, UMR CNRS 6137, Université Paul Cézanne, Marseille, France, [2] ESRF, Grenoble, France, [3] LPM-UMR CNRS 7556, Ecole des Mines, Nancy, France, [4] CRMCN, UPR CNRS 7251, Marseille, France

Improving the monitoring of the solidification microstructure is the object of the CETSOL MAP of ESA. This is a major endeavour in materials processing as columnar microstructure means anisotropic properties whereas equiaxed microstructure results in homogeneous behaviour. Beyond driving fluid flow in the melt, Earth gravity causes other phenomena which are less recognized or documented. After a review of the experimental technique and procedures, our recent results from in situ and real-time synchrotron X-ray imaging (radiography and white-beam topography) of alloy directional solidification at ESRF will be presented. First, due to the density difference between melt and solid, every dendrite in the array is submitted to mechanical forces. On Al – based alloys, growth-induced bending moments break down the topographic Laue images into pieces (Fig. 1a), in particular revealing dynamical deformation of the dendrite trunk like a cantilever beam articulated at sidearm inceptions on Al – 7 wt% Si. With time, disorientating gets more uniform, with reconnection of images showing the elastic character of the deformation. Second, the sedimentation of grains and fragments is analyzed, which happens to enhance deformation (Fig. 1b-d). Such limitation of the perfection of the dendritic array may be critical for the utilization range of high-tech castings, such as single crystal turbine blades.

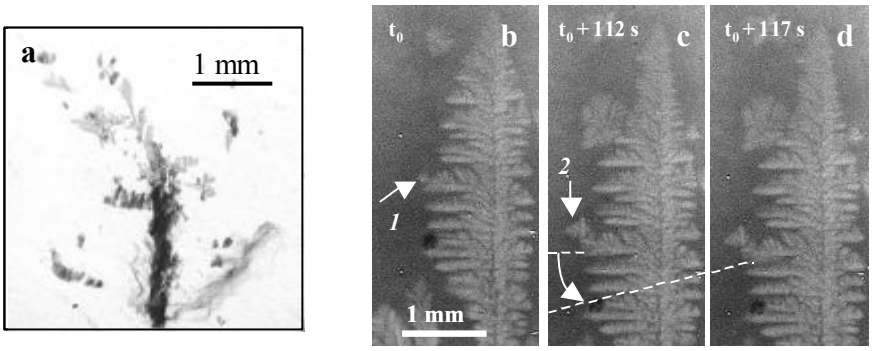


Figure 1. – a) Synchrotron topograph showing an image of the dendritic columnar microstructure broken into pieces. Al – 3.5 wt% Ni, V = 1 µm/s, G ≈ 30 K/cm. – b-d) Synchrotron radiograph showing the bending of a secondary dendrite arm due to the sedimentation of equiaxed grains 1 et 2 at its tip. Refined Al-3.5 wt% pds Ni, V = 4 µm/s, G = 23 K/cm.

A NEW PARADIGM OF CRYSTALLIZATION ARISING FROM NON-STANDARD NUCLEATION PATHWAYS

Vasileios Basios, Jim Lutsko, Gregoire Nicolis
CeNoLi-ULB, Interdisciplinary Center for Nonlinear Phenomena & Complex Systems, C.P. 231, Université Libre de Bruxelles, B-1050 Brussels, Belgium.

There is increasing evidence that large classes of colloid materials crystallize via a non-standard nucleation mechanism involving intermediate metastable phases.
In this presentation recent work by the authors on the microscopic derivation of the phase diagram and free energy barriers in the nucleation of protein crystals, and on the kinetics of growth of solid particles in the post-nucleation regime is reviewed.
The extent to which combined structural and density fluctuations may give rise to favorable crystallization pathways in the two order-parameter phase-diagram, where the intermediate fluid phase exerts its enhancing action, is assessed and the connection with experiments in microgravity experiments at ISS (PROMISS-2 & NANOSLAB-2) is discussed.

1. James F. Lutsko and Gregoire Nicolis, "Theoretical evidence of a Dense-Fluid precursor to crystallization", Phys. Rev. Lett. Vol. 96, 046102 (2006).
2. James F. Lutsko, "First principles derivation of Ginzburg-Landau free energy models for crystalline systems", Physica A Vol. 366, 229, (2006).
3. V. Basios, "Self-organization and nonequilibrium aggregation phenomena in colloidal matter: why microgravity matters", Int. J. of Bifurcation and Chaos, Vol. 16, No. 6, 1689-1700 (2006)

SCIENTIFIC SESSIONS:

Friday, 7th September 2007
HALL B, 12:20 – 13:20

Life Sciences
Space Flights Analogues and Radiation

RISK ASSESSMENT OF SPACE RADIATION BASED ON MUTATION DATA

Juergen Kiefer
University of Giessen, Germany, Am Dornacker 4, D-35435 Wettenberg. E-mail: juergen.kiefer@strz.uni-giessen.de; Tel. +49-6406-1587

Radiation still poses one of the most important risks for human space activities, particularly for long term missions. As the radiation field is quite unique, consisting of very energetic charged particles which are not found in the terrestrial environment risk assessment has to rely on laboratory experiments. Because of the close link between carcinogenesis and mutation induction mutation data may be helpful for risk assessment. Mutation induction by heavy charged particles at the HPRT-locus in V79 Chinese hamster cells is reviewed. There is no unique dependence of mutation induction cross sections on LET or any other physical parameter. There is, however, a general trend showing an increase up to about 100 keV/μm and an indication of a saturation with higher values. An empirical expression is given approximating the data which may be useful for practical purposes. On its bases it is suggested that the ICRP formula for the quality factor overestimates the risk for very heavy particles. This may have implications for the assessment of iron ions in space

MODELLED MICROGRAVITY DOWN-REGULATES EXPRESSION OF *STAPHYLOCOCCUS AUREUS* VIRULENCE DETERMINANTS

Helena Rosado, Marie Doyle, Jason Hinds, Peter W. Taylor
Microbiology Group, School of Pharmacy, University of London, 29-39 Brunswick Square, London WC1N 1AX and Bacterial Microarray Group, St George's, University of London, Cranmer Terrace, London SW17 0RE, UK.

Microbiological monitoring of air and surfaces within the ISS indicated that bacteria of the genus *Staphylococcus* are found with high frequency. *Staphylococcus aureus*, an opportunistic pathogen with the capacity to cause severe debilitating infection, constitutes a significant proportion of these isolates. Ground-based studies of *Salmonella enterica* have provided evidence that bacterial virulence is increased under the influence of simulated microgravity[1]. These studies, and others linking space flight to reduced immune competence[2], provide clear evidence that extended missions may be compromised by increased risk of infection. We have therefore initiated studies to determine the effect of simulated microgravity on antibiotic resistance and expression of virulence determinants by clinical isolates of *S. aureus*. When cultured under microgravity conditions in the High Aspect Ratio Vessel, three isolates of *S. aureus* showed a reduced capacity to secrete haemolysins and other protein virulence determinants compared to 1g controls. Determination of global gene expression using DNA microarrays identified a trend towards down-regulation of the staphylococcal genome under the influence of microgravity. Simulated microgravity appears, therefore, to reduce the intrinsic virulence of the staphylococcal phenotype.

1. Nickerson, C.A., Ott, C.M., Wilson, J.W., Ramamurthy, R., Pierson, D.L. "Microbial responses to microgravity and other low-shear environments" Microbiol. Molec. Biol. Review Vol. 68, pp. 345-361, 2004.
2. Sonnenfeld, G., Shearer, W.T., "Immune function during space flight" Nutrition, Vol. 18, pp. 899-903, 2002.

HORMONAL CHANGES OBSERVED DURING VALDOLTRA (SLOVENIA) BED REST STUDY

F. Strollo[1], P. Magni[2], G. Biolo[3], M.A. Masini[4], R. Pisot[5], I.B. Mekjavic[6], M. Broccoli[1], M. Morè[1], B.M. Uva[4] and F. Celotti[2]

[1]Endocrinology and Metabolism Unit - Rome INRCA-IRCCS, Italy; [2]Institute of Endocrinology, Milan University - Italy; [3]Clinical Medicine Institute, Cattinara Hospital, Trieste University, Italy; [4]Biology Dept, Genoa University, Italy; [5]Faculty of Education Primorska University, Koper, Slovenia; [6]Dept of Automation, Biocybernetics and Robotics, Jozef Stefan Institute, Ljubljana, Slovenia

During the last decade we showed reversibly defective androgen production in male astronauts during the D2 mission and others did so in male rodents, apparently due to peripheral rather than hypothalamic-pituitary-mediated mechanisms. More recently our group also showed that leptin - an adipose tissue derived peptide increasing during 7-week modeled microgravity experiments (bed rest, BR) - enzymatically inhibits testosterone production.

The aim of the present study was to assess whether bed rest might affect the secretion of metabolism-regulating hormones as a possible underlying mechanism for impaired testicular function in man.

Leptin, insulin, adiponectin and ghrelin were measured on morning blood samples drawn from 10 male volunteers - whose free food intake was constantly monitored - before and at the end of a 35 day BR performed in Valdoltra Hospital (Slovenia).

Leptin levels roughly doubled and ghrelin decreased by about 20% ($p<0.02$ for both), while adiponectin did not change significantly, No correlations were found between leptin and ghrelin absolute levels or percent variation figures, while adiponectin negatively correlated with leptin ($p<0,05$).

Interestingly enough, a sharp increase was shown in a newly identified index of insulin resistance, namely the leptin to adiponectin ratio ($p<0,01$).

Our results point to an activation of lipolytic pathways through enhanced leptin secretion and to a reduction in insulin sensitivity. Another interesting finding is the observed decrease in appetite regulating mechanisms through blunted ghrelin release. As a consequence of that, other factors modulating the above mentioned adaptive changes deserve further investigation, including androgens and melatonin. Due to that we are waiting for the possibility to assay androgens on spare plasma in order for them to be attributed a reliable percent contribution to the whole mechanism.

POSTER SESSION

GROUND EXPERIMENTS UNDER MODELED MICROGRAVITY CONDITIONS

C. Tenconi [1], M. Freddi [1], P. Pippia [2], A.M. Rizzo [3]
1 Alcatel Alenia Space – Italy (Milan plant); 2 Institute of Physiological, Biochemistry and Cellular Sciences, University of Sassari (Italy); 3 Institute of General Physiology and Biochemistry, University of Milan (Italy)

The execution of ground experiments to perform an early verification and preparation of in-orbit experiments is more and more important. The Random Positioning Machine (RPM) is suitable to simulate microgravity conditions and allows performing a high number of on-ground experiments, either to prove or to extend observations made during spaceflights or to develop and prepare new spaceflight experiments. The simulation of microgravity conditions by means of the continuous random change of orientation of samples relative to the gravity's vector can generate effects comparable to those induced by true microgravity when the changes are faster than the sample's response time to gravity [1)]. Thus, slow responsive living samples are excellent candidates to be studied on RPM (Model RPM-5/0999 made by Fokker Space B.V.). Either the LSS on RPM (Life Support System on RPM) or the MHOR (Mouse Habitat On RPM) are systems with a high level of automatism, conceived to be accommodated on the RPM for mid-duration term experiments (maximum 20 days) with no need of human interaction. The LSS is more addressed to small aquatic organisms breeding, while the MHOR system is provided with two single cages for mice housing. Both systems provide the services necessary to guarantee animals well-being throughout the whole experiment duration. Scientific and technical details of both experiments are presented.

1. Huijser, R.H., "Desktop RPM: New Small Size Microgravity Simulator for the Bioscience Laboratory", Fokker Space B.V.

ROTARAD AND SCORE EXPERIMENTS ON FOTON M3 MISSION

G. Falcetti [1], M. Freddi [1], C. Ricci [2], S. Bradamante [3]
1 Alcatel Alenia Space – Italy (Milan plant); 2 Dipartimento di Biologia – University of Milan (Italy); 3 CNR - ISTM, Istituto Scienze e Tecnologie Molecolari c/o University of Milan (Italy)

The Russian FOTON satellite is more and more considered a valid alternative to the ISS for the execution of experiments under microgravity conditions. With respect to experiments running on board the ISS, the unmanned FOTON environment requires the Hardware to be fully autonomous during the whole mission. The next FOTON M3 mission, scheduled for launch on 14 September 2007 from Baikonur Cosmodrome, will carry several experiments in life and physical sciences and will spend 12 days on-orbit. Experiments will be exposed to microgravity, and in some cases, to the harsh environment of open space. Alcatel Alenia Space – Italy (Milan plant) is developing the hardware able to support the following two experiments: 1) ROTARAD (P.I. Prof. C. Ricci) which consists of three sets of 12 Chambers each, mounted on the Biopan-6 bottom plate. Each set permits to expose animal samples (dehydrated Rotifers, Nematodes and Tardigrades) to a specific radiation range. 2) SCORE (P.I. Prof. S. Bradamante) which consists of two sets of 2 variable volume Cultivation Chambers each accommodated inside an autonomous BIOKON container. Each set permits to verify the effects of microgravity on the cellular response in the yeast *S. cerevisiae* grown in aerobic conditions. Scientific and technical details of both experiments are presented.

EFFECTS OF SPACE FLIGHT ON INTERACTION BETWEEN HUMAN T-LYMPHOCYTES AND MONOCYTES

Grazia Galleri, Maria Antonia Meloni, Angela Saba, Giuseppe Pani, Proto Pippia, *Marianne Cogoli-Greuter

Dipartimento di Scienze Fisiologiche, Biochimiche e Cellulari, Università di Sassari, Via Muroni 25, I-07100 Sassari, Italy. * Zero-g Life Tec GmbH, Technopark, CH-8005 Zurich, Switzerland

Weightlessness is known to influence various cellular processes. Activation of lymphocytes is severely reduced and the expression of surface adhesion molecules on cultured cells is affected. Cell-to-cell interactions, mediated by adhesion molecules with the involvement of membrane receptors, play an important role and are involved in signal transduction. In the experiment "Interact" on board the ISS (Kubik BIO#1 mission) we studied the effects of low gravity on the interaction of human T lymphocytes with monocytes. This to test the hypothesis that a reduced interaction of the leukocyte integrin LFA-1 on lymphocytes with its ligand ICAM-1 on monocytes might be one of the reasons for the observed loss of the *in vitro* activation of human lymphocytes. In flight, Jurkat and J-111 cells were co-cultured and fixed at two different times after activation. Postfligth, the samples were analysed for cap formation of the adhesion proteins LFA-1 and ICAM-1 and their interaction, by fluorescence microscopy. Our results suggest that LFA-1/ICAM-1 interactions occur in space and are dependent on activation time but show differences in number, arrangement and fluorescence intensity. LFA-1 and ICAM-1 adhesion proteins seem to be sensitive to low gravity, without being altered their interaction; therefore reduced lymphocytes activation has to be investigated on downstream molecules of signal transduction pathway.

CORTICAL MICROTUBULE ORGANIZATION IS ALTERED IN THE DISTAL ELONGATION ZONE OF BRASSICA RAPA ROOTS UNDER CLINOROTATION

Iana Kalinina
Cell Biology Department, Institute of Botany NASU, 2, Tereschenkivska Str., 01004 Kiev, Ukraine; Tel. /fax +38(044) 272-32-36, yana.kalinina@mail.ru

Spaceflight experiment showed that microtubule self-organization *in vitro* is gravity-dependent [1]. If it is the same *in vivo* it would be an explanation for the gravity dependence of living systems at a cellular level. To determine whether the tubulin cytoskeleton is participating in gravisensitivity of cells, which are not specialized to perceive gravity stimulus, we made immunofluorescence labeling of microtubules with anti-α-tubulin antibodies (Sigma, USA) and measured cell length in the different growth zones in roots of 5-day old *Brassica rapa* in control and under clinorotation, that was used to simulate biological effect of microgravity. Confocal microscopy (LSM 5 Passcal, Zeiss) investigation showed no differences in the spatial organization of endoplasmic microtubules and in nucleus topography in control and under clinorotation. Cortical microtubules in root epidermal and cortical cells undergo the series of changes of their pattern according to the developmental stages of cells during their differentiation. The alterations in cortical microtubule orientation under clinorotation were revealed only in the distal elongation zone. In the distal elongation zone of control roots, cortical microtubule arrays were organized transversely to the axis of root growth. Under clinorotation, cortical microtubules looked more randomly organized then in control. Simultaneously with preservation of transversal pattern a number of disordered single microtubules were observed. Cell shape depends on the ordering of dynamic cortical microtubules. In the root cortical microtubules ordering the transition from the isodiametric cellular growth distinctive for the distal elongation zone to the anisotropic cellular growth in elongation zone via providing spatial information for cellulose microfibril synthesis. Measurement of root cells in the different growth zones demonstrated the significant decrease in cell length only in the central elongation zone of clinorotated seedlings. It is suggested that the declining in anisotropic growth is connected with microtubule disorientation under clinorotation.

1. Papaseit, C., Pochon N., Tabony J., “Microtubule self-organization is gravity-dependent”, PNAS, Vol. 97, pp. 8364-8368, 2000.

HYPERGRAVITY INDUCES QUANTITATIVE CHANGES IN ARABIDOPSIS THALIANA PROTEOME

Celine Vlieghe, Michel Rossignol, Gilbert Gasset*, Sabine Grat, Brigitte Eche*, Raoul Ranjeva, Annick Graziana

Pôle de Biotechnologie Végétale, UMR 5546, 24 chemin de Borderouge, BP 42617 Auzeville, 31326 Castanet Tolosan Cedex, France; *Groupement Scientifique en Biologie et Médecine Spatiales, Université Paul Sabatier, 133 route de Narbonne, 31062 Toulouse, France; graziana@scsv.ups-tlse.fr

Different gravitational contexts are known to impact on plant development. These changes are expected to involve a remodelling of protein composition. To address the question of relative changes in the quantities of individual proteins we have taken advantage of the ^{15}N-metabolic labeling to evaluate changes in *Arabidopsis* root proteome following different gravitational conditions. We confirm that ^{15}N metabolic labelling of proteins is possible and efficient in *Arabidopsis* plants. Relative quantification of ^{14}N versus ^{15}N mass spectrometry signals reflects the relative abundance of ^{14}N and ^{15}N proteins in the sample analysed. Basically, no qualitative change was recorded in either case. However, the isotopic ratio of individual proteins was significally modified showing remodelling of the proteome. Different classes, especially root specific peroxidases, components of ribosomal proteins and cell wall proteins were selectively increased or decreased under 5*g*.

Supported by the French Space Agency, CNES.

THE LEVEL OF HEAT SHOCK PROTEINS HSP70 AND HSP90 IN PEA SEEDLINGS IN RESPONSE TO ALTERED GRAVITY

Lyudmyla Kozeko, Elizabeth Kordyum
Department of Cell Biology and Anatomy, Institute of Botany NA S of Ukraine, Tereshchenkivska str. 2, 01004 Kyiv, Ukraine, kozeko@voliacable.com

Exposure to altered gravitational environment (both microgravity and hypergravity) induces significant changes in cell ultrastructure and gene expression in plants. A lot of environmental disruptions result in activation of synthesis of heat shock proteins (HSPs) being a substantial part of adaptive processes. This study evaluated the effects of varied accelerations (from μg to 14g) on the stress protein level. 5-d-old etiolated pea seedlings were exposed to simulated microgravity condition on a horizontal clinostat (2rpm) and centrifuge-induced hypergravity (from 3g to 14g) for 15 min and 1 h. The Hsp70 and Hsp90 levels in the seedlings after hypo- and hypergravity exposure were analyzed by Western blot. Some temporary increasing in the HSPs level was determined in the clinorotated seedlings. Changes in the Hsp70 and Hsp90 level after exposures to hypergravity conditions were more significant and depended on g-number and time of exposure. The analysis of recovery periods up to 24 h after hypergravity conditions is currently in progress. Obtained data suggest that the changes in the Hsps level can reflect intensity of adaptive processes to the changes in gravitational forces.

MITOTIC ACTIVITY OF PEA ROOT APICAL MERISTEM UNDER CLINOROTATION

Artemenko Olga
Department of Cell Biology and Anatomy, Institute of Botany NAS of Ukraine, 01601, Kyiv, Tereschenkovska Str., 2. e-mail: oartyomenko@yahoo.com

Determination of proliferative system sensitivity to clinorotation effect showed the decrease of mitotic activity in the root meristematic cells of two-day pea seedlings under slow horizontal clinorotation compared control. Dynamic of mitotic activity under clinorotation looks like control one. Curve of mitosis recur all peaks and decreases of control variant, but with lower index. Decrease of mitotic activity can take place due to mitosis acceleration or proliferative pool decrease, that happen because of presynthetic phase duration increase.

By clinorotation effect study on the process of mitotic activity induction, it was shown undulating mitotic activity increase that is typical for first, particularly timed mitotic cycle. Cell division kinetics under clinorotation is similar to control, but mitotic index was lower than control. Further researches on later stages (61, 72 and 96 hours) was shown saving of tendency to increase of mitotic activity under clinorotation effect.

As a results of our investigations of mitotic activity in two-day seedlings and during induction of germination, it was shown that by clinorotation effect abrupt prohibition of mitotic activity does not happen.

C.ELEGANS AS A DISCOVERY TOOL TO INVESTIGATE SPACE FLIGHT-INDUCED STRESS RESPONSES

Natascia Ventura and Roberto Testi
Laboratory of Signal Transduction, Department of Experimental Medicine, University of Rome "Tor Vergata"

Space flight induces a variety of stress responses, mostly due to microgravity and UV exposure, that may cause long-term tissue damage, generally mimicking conditions associated to accelerated aging. The nematode *C. elegans* has been extensively used as a model system to study age-related changes and the genetics of stress responses at the organismal level. We established a model in *C. elegans* in which, by RNAi titrating the level of expression of a single nuclear gene (frataxin, coding for a mitochondrial protein involved in iron metabolism), we can modulate worm lifespan and resistance to stress, ranging from enhanced stress resistance and extended lifespan (by mild frataxin suppression) to overwhelming stress sensitivity and reduced lifespan (by severe frataxin suppression). We could correlate the increased resistance to stress and longevity to mild mitochondrial dysfunction and to the induction of protective pathways mediated by antioxidant and DNA repair genes. Our model will be useful to test whether mild michondrial dysfunction will also protect *C. elegans* against metabolic stress induced by microgravity and against UV-induced DNA damage.

DISTRIBUTION OF CALCIUM IONS IN CELLS OF THE ROOT DISTAL ELONGATION ZONE IN THE CONTROL AND UNDER CLINOROTATION

Margarita Sobol, Elizabeth Kordyum
Department of Cell Biology and Anatomy, Institute of Botany of NASU, Tereschenkivska St., 2, 01004, Kyiv, Ukraine, tel./fax: +380442723236, e-mail: margaret_sobol@yahoo.com

Modern ideas concern a multifunctional role of calcium ions in the plant cell vital activity and in the responses to various environmental signals, altered gravity included. The obtained experimental data on modifications in the distribution and the concentration of Ca^{2+} in the cells of unicellular and multicellular organisms under the influence of altered gravity (Hilaire et al., 1995, Kordyum, 2003) are the reasonable evidence to suggest that microgravity belongs to factors affecting the calcium messenger system, and open the new approaches to a study of the calcium-dependent and gravity-dependent processes in a cell. We investigated the cells in *Beta vulgaris* root distal elongation zone (DEZ) participating in a gravitropic reaction (Ishikawa, Evans, 1995). Cells of this zone accomplish a developmental transition recently from cytoplasmically driven expansion to vacuome driven elongation (Baluska et al., 1990). Dry seeds wrapped in a moist filter paper were germinated in the stationary conditions and on the slow horizontal clinostat (2 rpm) in darkness. Three-day-old seedlings were incubated in the calcium-specific fluorescent dye fluo-4 (Molecular Probes, USA) for 25 min in darkness in the stationary conditions and under clinorotation. Observations were carried out with a confocal microscope LSM 5 Pascal (Carl Zeiss, Germany) at the excitation wavelength 494 nm and emission wavelength 516 nm. Among clinorotated seedlings, we distinguished seedlings grown upward and downward, and studied them separately. The cells of an epidermis and cortex first-third layers in the DEZ of a length ~ 380 μm (at ~760 μm from the root apex) were scanned thirdly on both sides of a root. Data on the calcium ion distribution and quantification in cells were obtained using software "Pascal". An intensity of fluorescence correlates directly with the cytosolic Ca^{2+} concentration at the corresponding emission wavelength (Ng, McAinsh, 2003). We showed that calcium ions in the presence of specific fluorescent indicator were brightly fluorescent in green color in the cells. In the control, a fluorescence intensity of calcium ions in DEZ cells was 181,25±0,82 rel.units. Under clinorotation, a fluorescence intensity was 228,84±0,63 rel.units for seedlings grown upward and 222,95±0,74 rel.units for seedlings grown downward. Thus, the Ca^{2+} fluorescence intensity was 1.3 times higher in roots of seedlings grown upward and 1.2 times in seedlings grown downward as compared to the control. It is of interest to note that seedlings grown upward exhibited the significantly increased Ca^{2+} fluorescence intensity as regard to seedlings grown downward under clinorotation. Our results coincide with the earlier data on an increase in the calcium ion concentration in different plant cells in microgravity and under clinorotation (Kordyum, Guikema, 1998). Obtained data are discussed basing on the specific physiological properties of DEZ cells, and Ca^{2+} involvement in cytoskeleton polymerization.

THE LIFE AND PHYSICAL SCIENCE LABORATORY FACILITY (LPS) AT ESA'S EUROPEAN SPACE RESEARCH AND TECHNOLOGY CENTRE

Jutta Krause*, Jack J.W.A. van Loon, Peter Schiller*, Alan Dowson***
*ESA-ESTEC, TEC-MMG, Noordwijk, The Netherlands; ** Dutch Experiment Support Centre, DESC, OCB-ACTA, Free University -Amsterdam, The Netherlands.

After a building period of about 7 months and the following first equipment integration phase, the Life and Physical Science Laboratory (LPS) started operation in March 2007 by hosting the science verification test campaign for the ESA FOTON M3 experiments. The second equipment integration phase is envisaged to be completed towards the mid of 2007. The set of facilities will then be completed with the installation of the Large Diameter Centrifuge Facility.
The purpose of this new facility is to offer academia and industry the environment to perform verification activities which are beyond standard test capabilities. Further this facility is equipped to host science verification and flight sequence tests as well as biological and long term functional testing of flight-instruments and ground reference-models. Another task of the LPS is to offer the expertise and the facilities to perform assessments and experimental verifications of instrument design concepts.

(For J. van Loon this work is support through the NWO-ALW grant MG-057 via the Netherlands Institute for Space Research, SRON.)

VIBRATIONAL LIFT FORCES ACTING THE BODIES IN VISCOUS LIQUID IN THE VICINITY OF CAVITY WALL

Alevtina Ivanova[1], Victor Kozlov[2], Aidar Kuzaev[1]
[1]Department of Experimental Physics, Perm State Pedagogical University, Sibirskaya Av. 24, 614900, Perm, Russia. E-mail: A.Ivanova@pspu.ac.ru; [2]Laboratory of Hydrodynamic Stability, Institute of Continuous Media Mechanics, Russian Academy of Sciences, Acad. Korolev Str. 1, 614013, Perm, Russia. E-mail: kozlov@icmm.ru

Mean force acting on a solid spherical (cylindrical) body near the boundary of the cavity filled with liquid and subject to translational or rotational vibrations is investigated experimentally. The aim is detailed investigation of a new type of vibrational interaction – the repulsion of the body from the wall [1]. The liquid viscosity plays the defining role in this case. The repulsion manifests itself in a wide range of dimensionless frequencies but only at short distance between the oscillating body and the wall, when it is comparable with the Stokes-layer thickness. The effect is strong enough and can provide the levitation of the solid in the gravity field near the cavity bottom but decays with the distance. Outside the distance of viscous interaction (double thickness of the Stokes boundary layer) the repulsion is replaced by well known attraction force. The experiments carried out with inclusions of different densities have shown that the amplitude of the body oscillation with respect to the liquid plays the essential role in generation of lift force. The dependence of vibrational lift force on the distance is determined. The threshold of transition of the body in the suspended state in the gravity field is found. This investigated effect is of special interest for the management of hydrodynamic systems with solid inclusions under the low gravity conditions.
The work was supported by Grant of President of Russian Federation (No. MK-5059.2007.1).

1. Ivanova, A.A., Kozlov, V.G., Kuzaev, A.F., “Vibrational lift force acting on a body in a fluid near a solid surface”, Doklady Physics, Vol. 50, No. 6, pp. 311–314, 2005.

INVESTIGATION OF NANOPARTICLES AT FLUID INTERFACES IN THE FRAMEWORK OF "FASES" MAP PROJECT

Libero Liggieri[1], Francesca Ravera[1], Eva Santini[1], Michele Ferrari[1], Giuseppe Loglio[2], Reinhard Miller[3], Jürgen Kraegel[3], Dmitri Grigoriev[3]

1. CNR-Istituto per l'Energetica e le Interfasi, via De Marini 6, 16149 Genova, Italy; l.liggieri@ge.ieni.cnr.it; 2. Dip. Chimica Organica, Università di Firenze, Italy; 3. Max-Planck Institut fuer Kolloid und Grenzflaechenforschung, Germany

Solid particles of micro/nanometric dimension are often used as stabilizer additives in emulsion and foam technology. Understanding how the properties of the fluid interfaces are modified by these surfactant/particle structures is an important and still open scientific and technological target which is also one of the objectives of the FASES (Fundamental and Applied Study on Emulsion Stability) project in the framework of which this study has been performed.

In this work some results obtained on the interfacial properties of nanometric colloidal silica dispersions in the presence of a cationic surfactant are presented.

The equilibrium and dynamic interfacial tensions of these systems as a function of the surfactant and particle concentration were measured by using a Capillary Pressure Tensiometer.

The same tensiometer was used to investigate the interfacial rheology of the same systems by measuring the dilational visco-elasticity against the area perturbation frequency according to the oscillating drop methodology.

The analysis of these results together with the estimation of the surfactant adsorption on the silica particles allowed to evidence the key mechanisms determining the observed kinetic and equilibrium features. In particular, it was pointed out that, besides the surfactant adsorption on the silica particles, an important role is played by the Brownian transport of particles from the bulk to the interface and by the internal reorganisation of the mixed particle-surfactant interfacial layer.

PROPERTIES OF WATER-PARAFFIN OIL EMULSIONS STABILISED BY SPAN-80 AND OF THE CORRESPONDING LIQUID-LIQUID INTERFACES INVESTIGATED IN THE FRAMEWORK OF THE MAP-FASES PROGRAMME

Libero Liggieri[1], Michele Ferrari[1], Francesca Ravera[1], Eva Santini[1], Mickael Antoni[2], Linda Sacca[3], Daniele Clausse[3]

1. CNR-Istituto per l'Energetica e le Interfasi, via De Marini 6, 16149 Genova, Italy; l.liggieri@ge.ieni.cnr.it; 2. Univ. "Paul Cezanne" Aix-Marseille, Centre St. Jerome, Marseille, France; 3. Dép. de Genie Chimique, Université de Tecnologie de Compiegne, France

The research project FASES (Fundamental and Applied Studies in Emulsion Stability) is aimed at the investigation of the relation between emulsion stability and properties of the corresponding liquid-liquid adsorption layer. In particular the interfacial dilational properties are believed to play an important role in the stabilisation of liquid films and, as a consequence, of emulsions. The existing correlations are however non trivial. The modelling of these relations requires a systematic investigation of the parameters influencing the dilational properties and the emulsion stability.

Here a ground study on water-in- paraffin oil emulsions, stabilised by Span80 surfactant is reported. The study is propedeutic to the preparation and interpretation of microgravity experiments planned in the FSL-Experiment Container FASES onboard the ISS.

Interfacial dilational properties have been measured by means of different tensiometric methods and surface rheometers, while the emulsion properties have been investigated by microscopy and Differential Scan Calorimetry. All methods have also been developed or improved in the framework of the FASES programme.

The results show how some observed features of the emulsion can be correlated to the measured dilational visco-elasticities of the Span80 adsorption layer.

DYNAMICS AND STATISTICS OF A MICROBUBBLE JET IN MICROGRAVITY

Pau Bitlloch[1], Xavier Ruiz[2,3], Ricard González-Cinca[4], Laureano Ramírez-Piscina[3,4], Jaume Casademunt[1,3]

[1] Departament d'Estructura i Constituents de la Matèria, Universitat de Barcelona; [2] Departament de Física Aplicada, Universitat Rovira i Virgili; [3] Institut d'Estudis Espacials de Catalunya; [4] Departament de Física Aplicada, Universitat Politècnica de Catalunya

We present a numerical study of the collective dynamics of a bubble suspension in a turbulent jet under microgravity conditions, based on a recently introduced stochastic model of bubble dispersion. In the framework of a k-epsilon model of the flow, bubble motion is decomposed into a passive component advected by the mean flow, and a diffusive random walk with an effective diffusion coefficient which depends on the local properties of the turbulent flow [1]. The has been satisfactorily tested with data from Drop Tower experiments conducted at ZARM (Bremen), where a novel system of gas injection was recently introduced [2]. This injector, based on the creation of a slug flow at a capillary T-junction prior to injection, is gravity insensitive and generates a jet carrying a monodisperse bubble suspension with a prescribed size. Our model predicts the probability distribution of bubbles in the jet generated by this procedure. From the corresponding simulation of bubble stochastic trajectories, we also study expected rate of bubble coalescence in the jet, which is typically very low. Finally some lines of possible improvement of the model are also explored, such as the effect on the overall cavity flow of the lower effective density of regions with bubbles. Our numerical analysis is adapted to the geometry and parameter ranges of a projected series of Parabolic Flight experiments to be conducted in the near future.

1. Bitlloch, P., Carrera, J., Ruiz, X., González-Cinca, R., Ramírez-Piscina, L., Casademunt, J., "Numerical Study of the Generation and Dispersion of a Bubble Jet in Microgravity", Proceedings IAF, 2006.
2. Carrera, J., Ruiz, X., Ramírez-Piscina, L., Casademunt, J., Dreyer, M., "Generation of a Monodisperse Microbubble Jet in Microgravity", Preprint 2006.

DYNAMICS OF ROTATING TWO-LIQUID SYSTEM UNDER TRANSVERSAL VIBRATION

Alevtina Ivanova[1], Nick Kozlov[1], Anastasia Salnikova[1], Moncef Stambouli[2]
[1]Department of Experimental Physics, Perm State Pedagogical University, Sibirskaya Av. 24, 614900, Perm, Russia. E-mail: A.Ivanova@pspu.ac.ru; [2]Laboratoire de Genie des Procedes et Materiaux, Ecole Centrale Paris, Grande Voie des Vignes, France. E-mail: stambouli@lgpm.ecp.fr

The behaviour of multiphase systems (two immiscible liquids; suspension – liquid) in the horizontal rotating cylinder under the action of transversal vibrations is experimentally investigated. Fast rotation when the gravity role is negligible is considered. The system is in a centrifuged state, thus the phase of lower density settles down on the axis of rotation as a column. It is revealed that at the certain frequencies of vibration the resonant oscillations of the system could be excited. One can see the 2D azimuth waves propagating along the interface. Depending on the relative vibration frequency the waves can be leading or lagging behind the cavity; in turn they generate the leading or lagging azimuth liquids flow. The velocity of liquids in the cavity frame at a resonance achieves the value comparable with the velocity of the cavity rotation. The intensity and the structure of vibrational streams as well as the shape of the interface are investigated versus the vibrational and rotational parameters. Various kinds of instability of the interface are found out: when the column of low density phase takes the form of a polyhedron, or shares on axisymmetrical segments periodic along the axis.

Researches testify the high efficiency of application of rotation and vibrations for the management of mass transfer in multiphase hydrodynamic systems under the conditions of low gravity.

The work was supported by Russian Foundation for Basic Research (Grant No. 06-01-00189).

CONVECTIVE AUTO-OSCILLATIONS NEAR A DROP-LIQUID INTERFACE IN A HORIZONTAL RECTANGULAR CHANNEL

Rudolph Birikh[1], Rudolph Rudakov[1], Antonio Viviani[2]
[1]Department of Theoretical Physics, Perm State Pedagogical University, Sibirskaya Str. 24, 614900 Perm, Russia. E-mail birikh@pspu.ac.ru; [2]Dipartimento di Ingegneria Aerospaziale e Meccanica, Seconda Università di Napoli, via Roma 29, I-81031 Aversa, Italy. E-mail: antonio.viviani@unina2.it.

The concentration convection in an isothermal liquid near a drop (or an air bubble) clamped between the vertical walls of a horizontal channel is studied numerically within the framework of two simple mathematical models: with and without the surface phase at the drop-liquid interface formed by adsorption/desorption process. In the initial state, on the drop surface there is no surfactant concentration gradient. In the gravity field, the action of the horizontal light-component surfactant gradient creates a weak convective flow, and a fairly high surfactant concentration reaches the drop surface. A surface tension gradient develops along the interface, and Marangoni-driven convection sets in. The intense Marangoni-driven convection cuts off a zone near the drop from the buoyancy-driven motion and smoothes out the surfactant concentration in this zone. As a result of this, the Marangoni-driven convection is damped and the buoyancy-driven motion encompasses the entire region again. Due to this interaction between the buoyancy-driven motion and the Marangoni-driven convection, an auto-oscillation regime develops. Similar auto-oscillation regime has been experimentally investigated in [1, 2]. In our numeric experiments it was possible to observe more then 20 spikes of Marangoni-driven convection. The surfactant distributions obtained numerically in different oscillation phases agree well the experimental data.
The work received financial support from the Russian Foundation for Basic Research (Grant No. 06-01-00221).

1. Kostarev, K.G., Zuev, A.L., Viviani, A., "Oscillatory Marangoni convection around the air bubble in a vertical surfactant stratification", J. Comptes Rendus Mecanique, Vol. 332, No. 1, pp. 1-7, 2004.
2. Birikh, R.V., Zuev, A.L., Kostarev, K.G., Rudakov, R.N., "Convective Self-Oscillations near an Air-Bubble Surface in a Horizontal Rectangular Channel", Fluid Dynamics, Vol. 41, No. 4, pp. 514-520, 2006.

ON THE USE OF CALORIMETRY FOR FOLLOWING IN MICROGRAVITY CONDITIONS THE EVOLUTION OF WATER IN OIL EMULSIONS

Danièle Clausse[*1], Linda Sacca[1], Audrey Drelich [1,] François Gomez[1], Isabelle Pezron[1], Libero Liggieri [2]

[1]Laboratoire CNRS – UMR 6067, Département de Génie des Procédés, Université de Technologie de Compiègne, BP 20529-60205 Compiègne – France- *Daniele.Clausse@utc.fr; [2]istituto per l'Energetica e le interfasi –CNR – sezione di Genova- via De Marini 6- 16149 Genova - Italy

To study the evolution of water in oil emulsions in microgravity conditions, a technique based on the correlation existing between the freezing temperature of water and the way it is dispersed has been set up [1]. Freezing is evidenced through the energy released thanks to a differential scanning calorimeter (DSC) that has been specially built by industrials for being used in space. Experiments on ground with commercial DSC have shown that a totally dispersed water as micro-sized droplets is freezing around – 40°C due to under cooling phenomena. The total amount of energy released is given by the area of the freezing signal. Should the water not being totally dispersed as microsized droplets, freezing signals at higher temperatures could be observed [2]. Melting is always observed without delay at 0°C whatever are the freezing temperatures as far as Laplace pressure inside the droplets can be neglected (radii larger than 0.1μm). For determining the percentage of water present in the emulsion as micro-sized droplets, the ratios of the area of the signal at -40°C and the total area of the various freezing signals are determined. DSC tests performed on emulsions samples taken from the mother emulsions and kept at ambient temperature allow to follow the emulsion evolution versus time, during repeated freezing-melting cycles, after emulsion heating and during mass transfers in emulsions stabilized either by surfactants or particles.

The European Space Agency is gratefully acknowledged for the financial support of the MAP Project FASES (Fundamental and Applied Studies in Emulsion Stability, ESA O-99-52).

1. Clausse, D., Gomez, F., Dalmazzone, C., Noik, C., "A method for the characterization of emulsions, thermogranulometry: application to water-in-crude oil emulsions", J. Colloid Interface Sci., Vol., 287, pp. 694-703, 2005.
2. Clausse, D., Gomez, F., Pezron, I., Komunjer, L., Dalmazzone, C., "Morphology characterization of emulsions by differential scanning calorimetry", Adv. Colloid Interface Sci., Vol. 117, pp. 59-74, 2005.

NUCLEATE BOILING ON A SINGLE SITE: CONTACT ANGLE ANALYSIS FOR A GROWING VAPOUR BUBBLE

Damien Serret*, Stephan Guignard, Lounès Tadrist
Institut Universitaire des Systèmes Thermiques Industriels; 5 rue Enrico Fermi 13453MARSEILLE – France
* Corresponding author: damien.serret@polytech.univ-mrs.fr

This study aims to get a better understanding of the heat and mass transfer of a nucleate bubble. The ultimate goal is to get new data on heat transfer between the wall and the fluid when boiling occurs on a single nucleation site configuration. An experimental set-up is carried out to investigate the phase change on a single vapour bubble. In this paper, we focus on the morphological description of the bubble (interface curvature, contact angle and velocity of the contact line…) as well as the temperature field around the bubble using interferometry method.
To avoid the mirage effect due to the superheated liquid in the vicinity of the wall, we design a two dimensional boiling cell (700µm of thickness). To have a better control of the bubble behaviour (growth and detachment), the nucleation site is situated at the bottom of the upper heated wall. Three thermocouples control the sub cooling level of liquid and a camera records the video. Each picture is treated with a special algorithm developed in the frame of this study. We obtain the bubble curvature from the apex to contact line.
The first results concern the influence of the sub cooling level of liquid. If we suppose that the radius increases as a power function of time ($R(t)=t^n$), the exponent varies from 0.3 to 0.45 when the sub cooling level varies from 20 to 30°C. During the growing step, larger is the sub cooling level on the top of the bubble, larger is the condensation.
The second part of this work is dedicated to the measurement of temporal evolution of the contact angle during nucleation. The detection method shows a variation of the angle from 40° (when the top of the bubble reach to the outside of the nucleation site) to a limit value of 120° (when the depinned bubble have only a horizontal growth). This contact angle variation inheres in the contact line dynamic.

SHEAR CELLS AND REDUCED GRAVITY ENVIRONMENTS

X. Ruiz[1] , J. Pallares[2], F. X. Grau[2]
(1) Institut d'Estudis Espacials de Catalunya, IEEC, Barcelona, Spain (also, Applied Physics Lab., Universitat Rovira i Virgili, URV, Tarragona. Spain). (2) Mechanical. Engineering. Dept., Universitat Rovira i Virgili, URV, Tarragona. Spain.

Shear-cells and reduced gravity environments seemed to be, since the nineties, a good combination to perform highly accurate measurements of diffusion coefficients in low Prandtl number fluid systems such as doped semiconductors or dilute liquid alloys. But experimental results are not as precise as it could be expected because of the existence of disturbing factors acting together in real environments. These factors are based on the interaction between the concentration gradients and the residual μg vector - particularly important is, in this case, the impact of the g-jitter on the experimental results -, and also on the interaction between the concentration gradients and the natural convection generated by the unavoidable existence of thermal gradients at high temperatures [1]. Another disturbing mechanism, related with the shear flow generated by the relative movement of the cell segments during the joining and separation periods, has also been discussed in the literature [2, 3].

The present work, numerically solving the corresponding 2D transport equations by using a structured finite volume method and accurately controlling gravity conditions will analyze the impact of the above-mentioned potential factors on the diffusion coefficient measurements using as unique quantitative indicator the percentage of error, %D(t) [3].

1. Barat, C., Garandet, J.P., "The effect of natural convection in liquid phase mass transport coefficient measurements: the case of thermosolutal convection", Int. J. Heat Mass Transfer, Vol. 39, 2177 –2182, 1996.
2. Yang, B.J., Smith, R.W., "Numerical modeling of transport in a liquid diffusion couple shear cell", J. Phys.: Condensed Matter. Vol. 15, 3855 - 3865, 2003.
3. Ruiz, X., Pallares, J., Grau, F.X., "On the space diffusion coefficient measurements", Proc. of the 57th International Astronautical Congress, Valencia, Spain. September 2006 (paper IAC-06-A2.2.1).

DEVELOPMENT OF MAGNETIC LEVITATION AS A GROUND-BASED SIMULATION OF ALTERED GRAVITY

O. Larkin[a,c], C. Dijkstra[c], R.J.A. Hill[b], P. Anthony[c], M.R. Davey[c], C. Rees[d], K. Smart[d], J. B. Power[c], K. C. Lowe[a], L. Eaves[b]

[a]School of Biology, [b]School of Physics & Astronomy, University of Nottingham, University Park, Nottingham NG7 2RD, UK; [c]Plant Sciences Division, [d]Division of Food Sciences, School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD, UK

The physiological adaptations of living organisms to microgravity conditions are relevant to future space exploration. However, space studies are often limited in scope, costly and present technical difficulties, making Earth-based simulations desirable. We use a novel, superconducting magnet with a closed-cycle liquid helium cooling system to create a magnetic field gradient large enough that the weight of an object composed mostly of water can be balanced by diamagnetic repulsion. Since the repulsive force acts at the molecular level, comparisons can be made with the weightless environment experienced in space. We have constructed and modelled theoretically a system to allow the study of biological material under this condition. The 5 cm diameter magnet bore allows observation of the behaviour of biological systems at room temperature. The facility is equipped with hardware to contain samples in specific locations, typically at effective gravities equivalent to 0*g*, 1*g* and 2*g*, with cameras and associated optics to monitor samples *in situ*. Temperature control is achieved using air flow, controlled by probes within the bore. The temperature of samples is monitored using thermocouples and recorded. Temperature stability can be maintained to ± 0.1°C. By altering the field, different effective gravity conditions permit experimentation to identify thresholds of the effects of reduced gravity.

ELGRA News, vol. 25, September 2007

PROPERTY DETERMINATION OF LIQUID METALS BY ELECTROSTATIC LEVITATION AT HIGH TEMPERATURES

Paul-François Paradis,[1,3] Takehiko Ishikawa,[1] Noriyuki Koike,[2] and Shinichi Yoda[1]
[1]Japan Aerospace Exploration Agency, 2-1-1 Sengen, Tsukuba, Ibaraki 305-8505, Japan; [2]Chiba Institute of Technology, 2-47-1 Tsudanuma, Narashino, Chiba, 275-0016 Japan; [3]Corresponding author: Tel: +81 298-68-3791, Fax: +81 298-68-3956, E-mail: paradis.paulfrancois@jaxa.jp

Understanding the nature and behavior of liquid metals requires accurate values of their physical properties. For example, density is needed to optimize metallurgical processes, to model planetary core, and to describe the radial distribution function. Surface tension is also a vital quantity in refining processes, as is viscosity, since it helps to evaluate diffusion and to quantify the rise of bubbles and inclusions in melts. However, maintaining samples of matter in their liquid phases, in particular under supercooled conditions, is a great challenge when dealing with refractory metals. This is mainly due to their high melting temperatures (e.g., 3695 K for W), their high vapor pressure, the risk of melt contamination with a support, or simply to the fact that sometimes there are no suitable crucibles. Electrostatic levitation, laser heating in vacuum, and non-contact characterization techniques circumvented these difficulties and allowed the determination of the properties of several metals in their liquid state, above their melting temperature as well as in their supercooled phase. In this paper, the levitation furnace, the experimental procedures, and the non-contact characterization techniques developed by the Japan Aerospace Exploration Agency are first briefly introduced and typical data are presented.

FACILITY FOR ADSORPTION AND SURFACE TENSION STUDIES ON BOARD OF THE INTERNATIONAL SPACE STATION (FASTER): DESIGN, FEATURES, TECHNICAL SPECIFICATIONS, INTERFACIAL SYSTEMS AND APPLICATIONS

M. Simoncini [a], V. Campioni [a], L. Liggieri [b], F. Ravera [b], M. Ferrari [b], A. Passerone [b], R. Miller [c], A.V. Makievski [c], J. Krägel [c], G. Loglio [d], P. Pandolfini [d], L. Del Gaudio [e]

[a] Galileo Avionica SpA-BU Space & Electro Optics, Campi Bisenzio, Firenze (Italy); [b] CNR - Istituto per l'Energetica e le Interfasi, IENI, U.T. Genova, Genova (Italy); [c] Max-Planck Institut für Kolloid- und Grenzflächenforschung, Potsdam/Golm (Germany); [d] Dipartimento di Chimica Organica, Università di Firenze, Sesto Fiorentino, Firenze (Italy); [e] ENI S.p.A. - E&P Division, TEOP, S. Donato Milanese, Milano (Italy).

FASTER is a Capillary Pressure Tensiometer designed for scientific research on liquid interfaces in a microgravity environment. The FASTER instrument is specifically constructed to operate in the International Space Station. It consists of two main systems, contained in one EDR Locker and one ISIS Drawer (Facility Controller and Experiment Unit).

FASTER measures dynamic surface tension and rheological parameters related to the adsorption of surfactant molecules, to the adsorption of polymers or proteins, as well as to the attachment of nanoparticles at fluid/fluid interfaces, in response to a variety of functional forms of interfacial area disturbances.

FASTER experiments cover a wide range of controlled temperatures and emulsifying-agent concentrations. FASTER apparatus includes several main features, as follows: i) generation of drops in water/oil solution; ii) fluid temperature measurement and control; iii) drop oscillations generation; iv) radius measurement by digital-image real-time data processing; v) real-time drop dimension control and stabilisation; vi) piezo-element displacement and fluid pressure measurement; vii) controlled surfactant injections by two different surfactant systems; viii) tele-metered scientific data together with video compressed digital images and uncompressed images of drop profiles; ix) possibility to operate on new fluid cells for the study of "thin film" systems; x) provide maximum flexibility with respect to re-configuration for new experiments.

Applications embrace oil-technology operations, pharmaceuticals/food production, environmental control and various industrial processes utilising foams, emulsions and other liquid dispersions.

The presentation illustrates technical details, adopted interfacial liquid/liquid systems and preliminary on-ground test experiments. Funding by the European Space Agency (ESA) is acknowledged.

DIAMOND SYNTHESIS IN MICROGRAVITY ENVIRONMENT WITH SOUNDING ROCKET "S-520-24"

[1]Takayuki Hirai, [2]Yoshiki Takagi, [3]Yuko Inatomi, [4]Yoshiyuki Abe, [4]Syu Usuba, [5]Masaaki Suzuki, [5]Shinsuke Mori, [6]Yoshihisa Suda, [6]Osamu Shimizu, [6]Hitoshi Kino, [1]Yoshinori Kanno, [2]Yoshitaka Kato, [2]Shouhei Shimada, [2]Shinji Hiraga, [2]Ko Yamazaki, [2]Katsunori Yagi & [2]Naoyuki Yonekyu

[1]University of Yamanashi, 4-4-37 Takeda, Kofu, Yamanashi 400-8510, Japan; [2]Teikyo University of Science & Technology, 2525 Yatsusawa, Uenohara, Yamanashi 409-1093, Japan; [3]Japan Aerospace Exploration Agency (JAXA), 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan; [4]National Institute of Advanced Industrial Science and Technology (AIST), Central 2, 1-1-1 Umezono, Tsukuba, Ibaraki 305-8586, Japan; [5]Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro, Tokyo 152-8550, Japan; [6]MITSUBISHI PENCIL CO.,LTD. 5-23-37 Higashioi, Shinagawa, Tokyo 140-8537, Japan. [1]Takayuki Hirai Tel.: +81-55-220-8511; E-mail address: g06dhl06@ccn.yamanashi.ac.jp; [2]Yoshiki Takagi Tel.: +81-554-63-6851; E-mail address: takagi@ntu.ac.jp

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 crystals in microgravity environment with modulation of fluid environment more than natural gravity. This experimental project was designed to clarify the mechanism of high quality diamond synthesis in microgravity environment.
We use graphite rod as solid carbon source, the reaction chamber completely closed and hydrogen for reaction gas. Reaction chamber and other equipments will set up in the sounding rocket top as shown in Fig.1.
To synthesize diamonds in low-gravity environment, thermal convection of synthetic gas will be repressed, and the growth rate mechanism of diamond synthesis will be clarified. We will present key points of this work in the presentation.

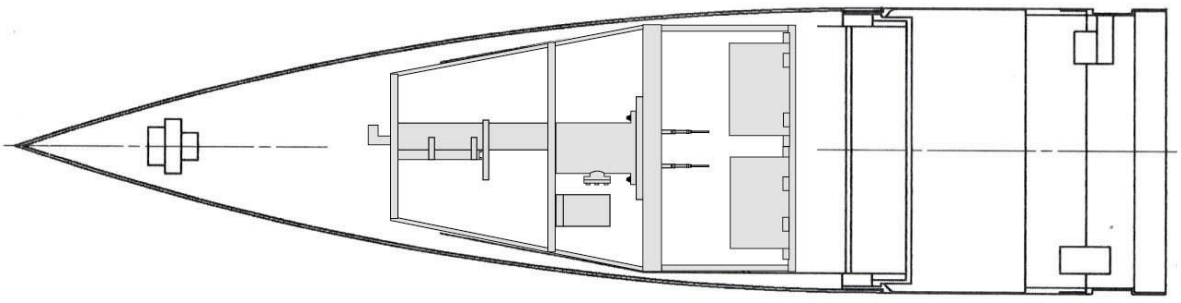


Fig. 1 Experimental apparatus of diamond synthesis in the sounding rocket top

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

WATERHAMMER EFFECT IN MICROGRAVITY ENVIRONMENT

A.Monzón, R.Elvira, J.Fernández-Cabrera and I.Riesgo
Escuela Universitaria de Ingeniería Técnica Aeronáutica, Universidad Politécnica de Madrid, Plaza de Cardenal Cisneros Nº3, Madrid, Spain

This research is on a fluid mechanics phenomenon called Waterhammer Effect in microgravity conditions. It makes a comparison between several flow rates. Usually hydraulic installations are working on stationary conditions but there are some cases in which transient phenomena appear by an external action. One example is a fluid moving through a pipe and it is suddenly stopped by a quick-closing valve. It causes an over-pressure in the near field of the valve that causes stresses into the pipe as well and could break and may jeopardize the performance of devices in the installation. This experiment was performed both in microgravity and gravity conditions to determinate how critical is in this weightlessness environment and to establish a baseline of hardness trying to be a kick-off point in space engineering pipes development. In order to obtained weightlessness it was used a parabolic flight carried out by an Airbus A300 Zero G operated by Novespace and sponsorized by European Space Agency (ESA) and CNES. It had been done sixty parabolas with approximately 30 seconds of weightlessness on each one. In qualitative terms water hammer intensity on microgravity is less than on gravity conditions as it has had been predicted in the initial hypothesis through CFD analysis. These results open a new research line in order to develop pipes with less thickness and weight and consequently decrease the cost associated to the space operations.

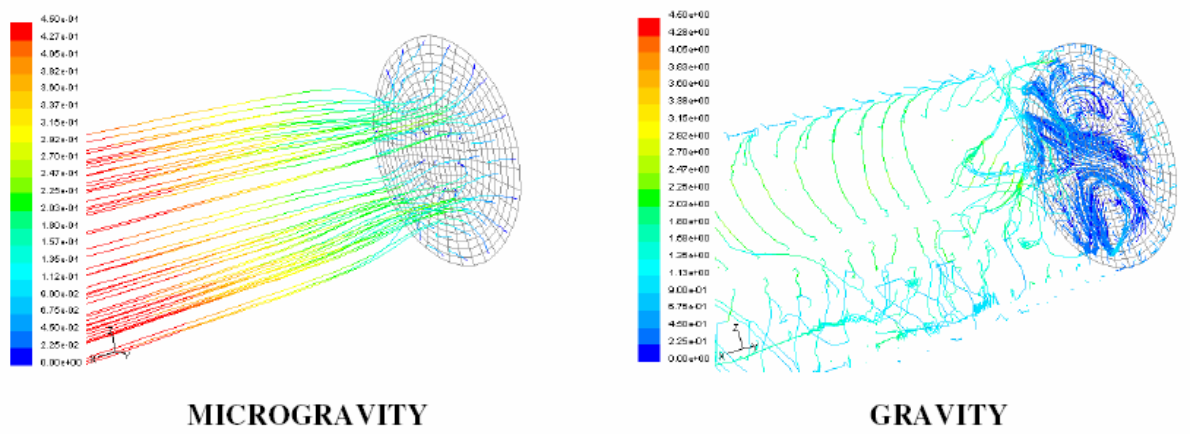


Figure 1. Water Hammer Effect in Microgravity (symmetric flow) and Gravity conditions (non symmetric flow). Path lines colored by velocity magnitude in m/s

1. Parmakian, J., "Waterhammer analysis", Dover publications, 1963.
2. Allievi, L., "Theory of Waterhammer", translated by E. E. Halmos, printed by Riccardo Garoni, Rome, Italy, 1925.
3. Allievi, L., "Air Chambers for Discharge Pipes", Transactions ASME, Vol. 59, Paper Hyd-59-7, November 1937.

CAN PHOTOMECHANICAL STRESS COUNTERACT THE EFFECT OF MICROGRAVITY ON THE CELLS PRODUCING ECM?

Basile Venere[1], Romano Giovanni[1], Fusi Franco[1], Monici Monica[2]
[1]Dept. of Clinical Physiopathology, Univ. Florence, V.le Pieraccini 6, I-50139 Florence, Italy; [2]ASACampus, Div. Ricerca di ASA, c/o Dept. of Clinical Physiopathology, Univ. Florence, V.le Pieraccini 6, I-50139 Florence, Italy.

Mechanical stress is an important factor for tissue homeostasis. Connective tissue, muscle, bone and cartilage are particularly responsive to mechanical and gravitational stress. Rather than to oppose a passive resistance, these tissues dynamically interact with mechanical and gravitational stimuli, modifying their mechanical properties through the continuous modification of their composition.
It has been widely demonstrated that unloading conditions have a negative effect on these tissues, with loss of mass and impairment of mechanical properties. On the contrary, proper mechanical solicitations improve tissue function. Besides the well known effect of increasing bone mass trough osteoblast stimulation and osteoclast inhibition, mechanical stress increases the production of extracellular matrix (ECM) components by chondrocytes and fibroblasts. Although various loading conditions have been extensively investigated, the optimal loading conditions required for an optimal tissue homeostasis are still unknown. The studies comparing the effects of different mechanical stresses, investigating different ranges of intensity and frequence of the solicitations, exploring new modalities for supplying mechanical stimuli are essential to increase our knowledge on this subject and to counteract the effect of unloading both in space flight and in clinics.
Here we describe the effect of photomechanical stress, supplied by a Nd:YAG laser, on extracellular matrix production by chondrocytes and fibroblasts, and compare it with the effect produced by hyergravity conditions.
Cell morphology and structure, ECM production, cell adhesion, cell energy metabolism have been studied in human chondrocytes and fibroblasts by using immunocytochemistry, fluorescence and autofluorescence microscopy, 3D imaging. The results show that photomechanical stress induce cytoskeleton remodelling, redistribution of membrane integrins, increase in production of ECM molecules, changes in cell energy metabolism. The effects are similar to those observed in the same cells exposed to cyclic exposure to hypergravational stress (10g).

COMMUNAL NESTING AS A STRATEGY TO IMPROVE MOTHER-INFANT RELATIONSHIP IN DEVELOPING MICE UNDER ALTERED GRAVITATIONAL ENVIRONMENT

D. Santucci, V. Trincia, Gaia, Nicolas, N. Francia and E. Alleva
Section of Behavioural Neurosciences, Dept of Cellular Biology and Neurosciences, Istituto Superiore di Sanità, Viale Regina Elena, 299, I-00161 Rome, Italy

Exposure to altered gravitational environment, especially during critical ontogenetic phases, may affect neurobehavioural development in mammals and space agencies indicate a strong need for studies of mammalian reproduction and development in space. 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.
We are beginning to explore the "communal nesting" paradigm to both improve mother-siblings interaction and counteract alterations in maternal repertoire particularly vulnerable to changes in the gravitational environment.
Female house mice often nest communally, and within these communal nests females appear to indiscriminately nurse all pups which are provided with a highly parental caring environment.
We carried out detailed behavioural observations during the first two postpartum weeks in communal nests with 3 dams delivering 3, 5, or 7 days from one each other.
Maternal behaviour was affected by both order of delivery (1^{st}, 2^{nd}, or $3^{rd)}$ and temporal distances within deliveries. 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.

FASTER FACILITY ON BOARD OF THE INTERNATIONAL SPACE STATION: A MULTI-USER, HIGH MODULARITY CAPILLARY TENSIOMETER BUILT USING SPACE QUALIFIED TECHNOLOGICAL EXPERIENCE

T. Mazzoni [a], M. Simoncini [a], V. Campioni [a], M. Soldani [a], M. Ceccherini [a], L. Liggieri [b], R. Miller [c], G. Loglio [d], P. Pandolfini [d]

[a] Galileo Avionica SpA-BU Space & Electro Optics, Campi Bisenzio, Firenze (Italy); [b] CNR - Istituto per l'Energetica e le Interfasi, IENI, U.T. Genova, Genova (Italy); [c] Max-Planck Institut für Kolloid- und Grenzflächenforschung, Potsdam/Golm (Germany); [d] Dipartimento di Chimica Organica, Università di Firenze, Sesto Fiorentino, Firenze (Italy).

The FASTER Facility is one of the ESA facilities developed within the frame of ELIPS, the European Programme for Life and Physical Sciences and Applications utilising the International Space Station (ISS). FASTER is the continuation of the FAST Facility, itself an evolution of sounding rocket experiments, that has been successfully flown on STS-95 and on STS-107. The Facility is a semi-autonomous multi-user facility supporting experiments which have been proposed by an international team of investigators from Italy, Germany, Greece, Spain, Bulgaria, France and Ukraine. FASTER is a space-borne surface rheology tensiometer, a high flexibility instrument which allows the observation of surface tension phenomena and the measurement of rheological parameters in response to different kinds of stimuli. The dynamic characteristics of the interface between two fluids are studied, when exposed to different controlled temperatures and with various controlled concentration amounts of two different surfactants. The FASTER Facility, in its flight configuration, is composed by two main subsystems, the Experiment Unit and the Facility Controller. The FC is dedicated to the control electronics and provides power, control, data acquisition, processing and data transmission to ground. Functional subsystems of the FC are a DC/DC converter, a Single Board Computer, an Image acquisition system, a data acquisition sequencer, an actuators control/driver system and a piezo control/driver system. The EU hosts two Experiment Cells (EC1 and EC2), which constitute the experimental 'core' of the Facility, where the fluid interface is created in shape of a droplet and excited with different kinds of stimuli. In addition, the FASTER Facility has been architecturally designed in such a way to be compatible with the future implementation of new surface tension experiments types and different Experiment Cells. The FASTER Facility foreseen accommodation is within the European Drawer Rack (EDR) of the Columbus Laboratory of the International Space Station, where the FASTER Experiment Unit (EU) will fit into an EDR locker, and the FASTER Facility Controller (FC) will be inserted into an EDR ISIS drawer.

SPATIAL HIGH-SPEED IMAGING OF FLUIDS AND RAPID PHYSICAL PROCESSES

Frozen Reality® Space Project

Florian Maier[1], Mirko Izzo[2], Benjamin Holfeld[3], Salvatore Dinardo[4]

1) University of Ilmenau, Germany, Prof. Schade, Ahornstr. 5, D-82205 Gilching, fm@frozen-reality.de, phone: +49-8105-379610; 2) Seconda Universita di Napoli, Italy, Prof. Viviani, via Volturno 18, Scafati - SA, CAP 84018, izzogen@libero.it, phone: +39-3478445542; 3) University of Würzburg, Germany, Prof. Ossau and Prof. Umbach, Heidemühlweg 41, 01324 Dresden, benjamin.holfeld@gmail.com, phone: +49-351-2679144; 4) Seconda Universita di Napoli, Italy, Prof. Viviani, Via Alcide De Gasperi NÂ°36, IT-Cardito (Napoli), salvatore_dinardo@katamail.com, phone +39-0818314429.

Short Summary:

The Frozen Reality Space Project focused mainly on spatial recording of rapid physical processes in weightlessness (Zero G) by using the "Frozen Reality" technique. Collisions of projectiles with liquids or solar panels in Zero G that are too rapid to be visible to the naked eye were photographically "frozen" during a parabolic flight. Computer calculations produce a video visualization of a continuous movement around the frozen experiment from an angle of 0° to 100°.

Abstract:

On Earth and in space there are physical and chemical processes that are not perceptible or observable to the human eye due to their speed and chaotic three dimensional dynamics. A patented method of photographic visualization called "Frozen Reality" enables more precise analysis and evaluation of these processes. They can be photographically stopped at one moment and examined in three dimensions using existing software tools. The object photographed is essentially suspended in space and time and can be viewed from any angle. In order to achieve this, the physical experiment is imaged with ten high-resolution digital cameras arranged in a semicircle in a dark container. A flash is triggered by sensors so that all cameras are exposed at the same designated time. Using these 10 images, a computer program renders images at any angle from 0° to 100°.

This new technique was used for experiments under weightlessness and to demonstrate its utility for space research. In a microgravity environment the behavior of both liquids and granular matter changes. Examples of fast processes in space that are not easily visible include: small ice chunks colliding with a solar panel of a satellite and the resulting floating fractures, quickly flowing liquids and bubbles in water pump systems, and the movement of fuel in a spacecraft reacting due to rocket ignition. Fifteen experiments in Plexiglas cylinders were planned and performed using the "Frozen Reality" technique. In addition to the high-resolution spatial pan shot, a time resolved video was recorded with a high-speed camera. In the first experiments a projectile was shot into a liquid. In contrast to an impact under gravity, it created a long water tube and a large air bubble in the impact area (due to surface tension). Another experiment examined the impact of a metal projectile on a solar panel. The recordings showed the directions in which the fragments float after the impact. With "Frozen Reality", these processes can now be analyzed and quantified in detail. The spatial views and high-speed recordings obtained can also be used to demonstrate basic physics to the layman (principles such as surface tension, conservation of momentum, dynamics of fracture, behavior of granular matter, dust, etc. can be visualized). Further experiments with "Frozen Reality" under Zero G with fine sand or small asteroids will be beneficial to current and future academic research, .It has been demonstrated successfully during this Parabolic Flight project that the "Frozen Reality" technique can contribute to research in physics and space flight under the condition of weightlessness.

For further information and videos about the Frozen Reality Space Project, please visit
www.frozen-reality.de/parabolic/

Fig.1: "Frozen Reality" experiment setup. Ten cameras are directed to an exchangeable experiment cylinder. A projectile will be automatically accelerated with a spring

Fig.2: Water floating in a water repellent coated plexiglas cylinder.

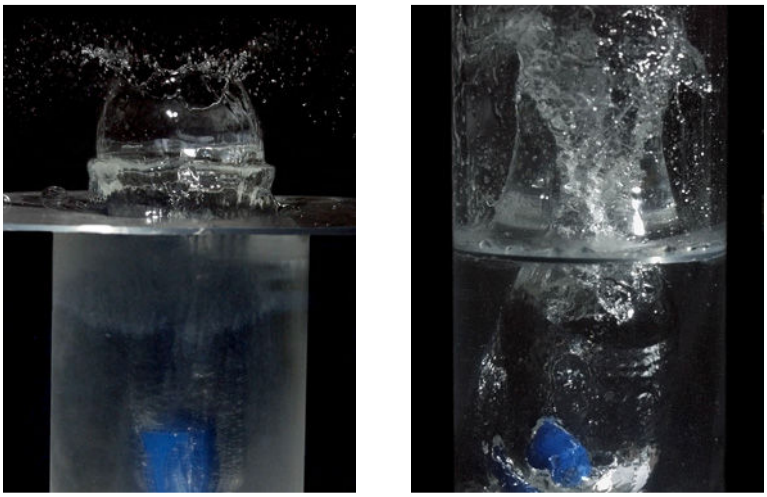


Fig.3: Impact of a projectile in water with force of gravity (left) and in weightlessness (right)

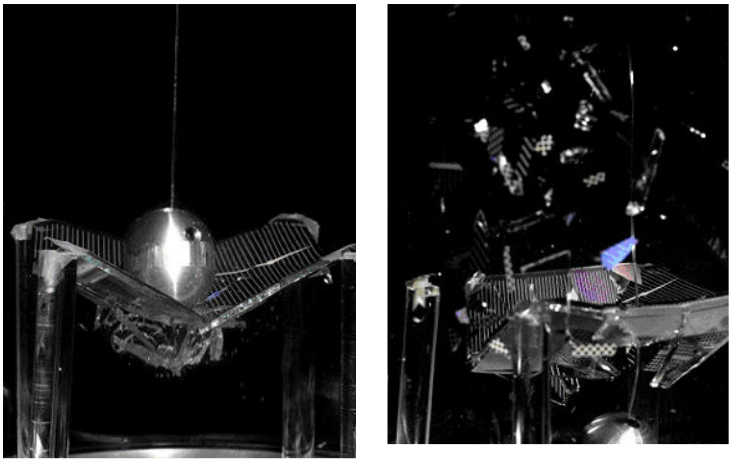


Fig.4: Impact of a metal projectile in a solar panel with force of gravity (left), and in weightlessness (right)

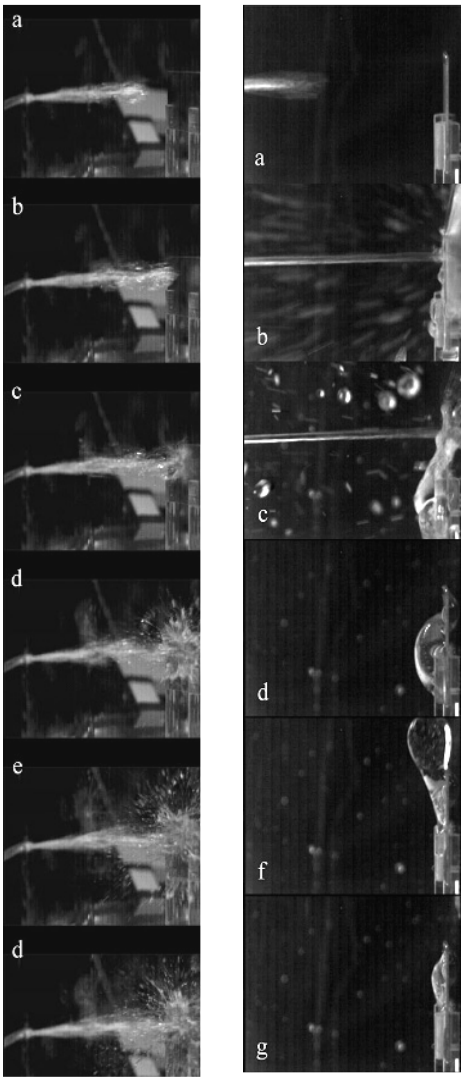


Fig.5: Water beam on a metal plate with force of gravity (left), and in weigtlessness (right)

Please have a look at the videos of the experiments on:
www.frozen-reality.de/parabolic/fluids.htm and www.frozen-reality.de/parabolic/impact.htm

STUDENT CONTEST

CAN FACILITATION INCREASE THE H-REFLEX IN MICRO-G?

Felix Betzler, Thomas Schlabs, Boris Wagenseil, Marcel Gewies, Wiltrud Abels, Juliane Schulz, Dr. Rainer Kowoll †, Prof. Dr. H.C. Gunga
Center for Space Medicine Berlin (ZWMB) c/o Department of Physiology, Charité – Universitaetsmedizin Berlin, Felix.betzler@gmail.com, Tel. 0049 176 24318538

BACKROUND:
It is important to understand the sensory, motor and perceptual factors that influence man's ability to adapt to different gravitational forces. Experiments performed on Space Shuttle, Skylab and MIR revealed that changes in a person's neurovestibular system occur during middle- and long-term exposure to weightlessness – changes related to the inner ear, equilibrium and awareness of body or limb orientation. When returning to Earth an astronaut's microgravity-adapted neurovestibular system must re-adjust to the gravity environment.
Several studies on the HOFFMANN-reflex (H-reflex) conducted during parabolic flights have shown an increased reflex response under short-time micro-gravity (micro-g) conditions. The mechanisms on this effect still remain uncertain. In our neurophysiologic study we examined the influence of short-time (about 20s) micro-g conditions (+GZ = 10^{-2}g) on the HOFFMANN-reflex of the triceps-surae muscle while a technique called facilitation was applied. This facilitation is commonly known as the JENDRASSIK- mannoeuvre (JM, see fig. 1). The objectives of our study were 1) to ascertain that the micro-G environment alone leads to an increased reflex response of the conditioned triceps-surae muscle, and 2) to find out whether facilitation performed during micro-G results in a further amplification of the reflex response.
METHODS:
Our study was conducted during the 9th Student Parabolic Flight Campaign of the European Space Agency in Bordeaux from 6th till 15th of September 2006. We tested 4 subjects on two flight days and performed measurements in three different gravitational conditions (+ GZ = 10^{-2}g; +GZ = 1g; +GZ = 1,8g). To elicit the H-reflex we stimulated the Ia fibers of the tibialis nerve and measured the reflex response of the soleus muscle by deflecting an electromyogram (EMG). The amplitude of the EMG was a measure of the strength of the H-reflex (see fig. 2 and fig. 3).
RESULTS:
Valid data has been collected from three subjects. We found a significant increase of the reflex-response in micro-g on two subjects, a decrease on one subject. Facilitation leads to a further amplification but the elevating effect in micro-g (+GZ = 10^{-2}g) is weaker than in normo-G (+GZ = 1g). Thus, reflex response in general can not be increased endlessly, and therefore the JM effect declines through micro-g (which itself has an increasing influence on reflex response already). Furthermore there occurred an unexpected, not yet explainable phenomenon in the normo-G phase of the flight: the reflex-response was declined while JM was applied.

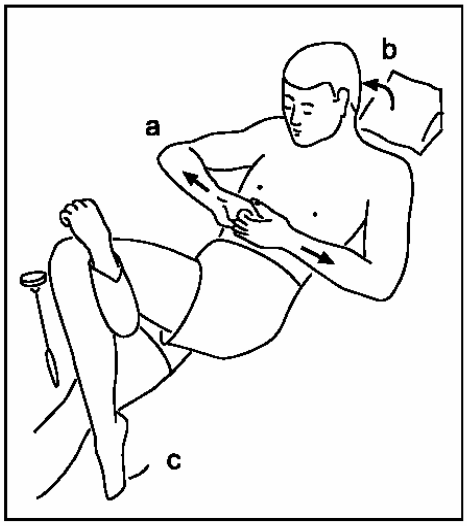


Fig. 1: *the Jendrassik-Manouevre. Before setting the stimulus, the subject interdigitates his hands in front of the chest and pull them apart with maximum force, but not let go.*

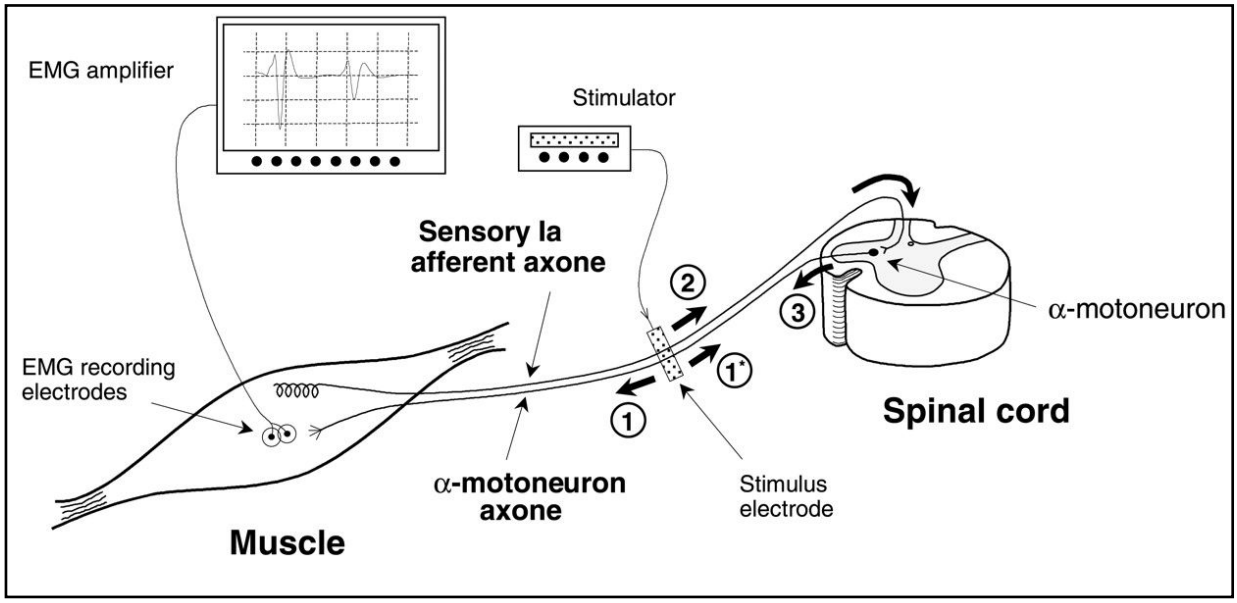


Fig. 2*: Elicitation of the H-reflex*

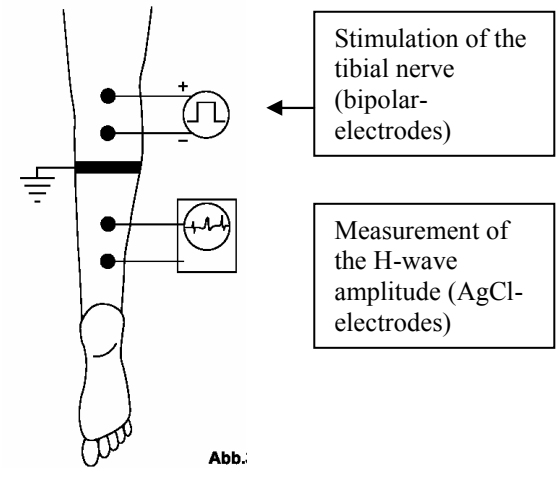
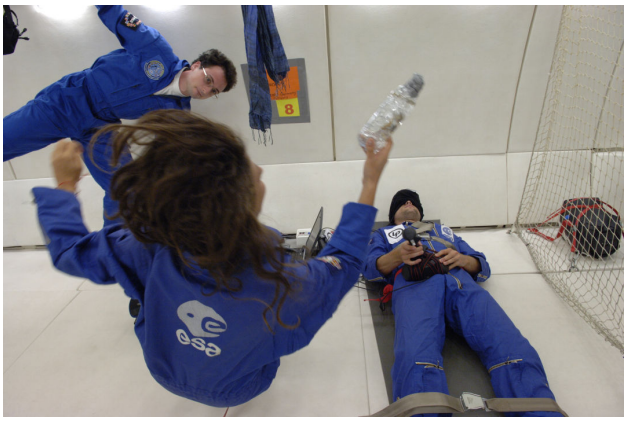


Fig. 3*: Experiment setup*

ACHROMATIC AND CHROMATIC PERCEPTION IN MICROGRAVITY
Cromos experiment in the ESA student parabolic flight campaign

Irene Lia Schlacht[1], Henrik Birke[2], Stefano Brambillasca[3], [4]Balázs Dianiska
[1]Technische Universität Berlin, Irene.Schlacht@gmail.com, 0049.(0)162.1869681, [2]Aerospace Ingenieur, TU-Berlin, henrik.birke@dlr.de, 0049.(0)1631521108, [3]Dipartimento di Ingegneria Aerospaziale Politecnico di Milano, stefano@bicar.it, 0039-029252028), [4]Department of Astrophysic, Budapest University, dianiska@szofi.elte.hu, 0036-12760054)

The European Space Agency (ESA) gives the opportunity every year to 15 groups of European students to perform experiments in zero gravity, by carrying out parabolic flights with a specially designed Airbus A300. The flights are carried out in Mergignac, France near Bordeaux at the base of Novespace, a French Aerospace company.



In the last Student Parabolic Flight Campaign (September 2006), we, for the first time, had the opportunity to carry out an experiment related to "Space Design" on the change of "visual perception" in microgravity sub-orbital conditions. In this presentation two aspects of our involvement of the campaign are presented: the experience of the parabolic flight, and the experiment results.

Fig. 1: Cromos group during the microgravity condition.

SUMMARY
The experiment on "Achromatic and Chromatic perception in microgravity" was carried out by the team CROMOS of the Milan Polytechnic University, the Berlin Technische Universität, with the collaboration of students from the Eotvos University of Science in Budapest.
After one and a half year of intense search and organization the 6 students of the CROMOS group in September 2006 were able to test and verify the difference of color perception between earthly 1g and 0g flight microgravity conditions, the study was based on the search in the '60 by the Soviet scholar Kitayev and the Americans White and after by Wise & Wise. During the flight, also the student group collected data to improve the experiment methodology, with the aim to conduct it with a larger number of subjects under parabolic flight condition and, consequentially, to make it suitable to apply it to the International Space Station (ISS) facilities.
The search results are applicable to increase the habitat space design, considering the fall-out to everyday products with an ergonomic point of view as on board scientific activity (as in chemical analysis based on chromatic reaction).
The experiment in the student parabolic flight campaign and its results were important achievements for the group, but not the only one.
The first successful achievement was to win the support of ESA to perform the experiment. Another important achievement was to be able to experience the opportunities of the free floating area in microgravity condition.
It is important to emphasize that to win the campaign the students have to learn much about marketing management, in order to achieve the support for the materials and the costs from

companies and institutions, but also about intercultural communications, as the group may be multinational as in our case (German, Hungarian and Italian graduate and undergraduate students), and also about safety, physiology, physics and mechanics of the parabolic flight.
A factor of organization and skills is also to be able to fully experience the free floating area using also the free parabolas to perform short trials for the feasibility of further experiments it also for. In this view the Cromos group tried in one free parabola a gymnastics/choreographic trial suggested by the "CSAM (Centro Studi per le Attività Motorie) of the Turin University accomplished by two subjects selected following the anthropometric concept of maximum body difference (roughly 5^{th} female and 95^{th} male European stature percentile). Experience the free floating area was for every of the student something hard to believe, that takes part not only of the personal formation but on the dreams forever.

ABOUT THE FIRST AUTHOR

Irene Lia Schlacht is the CROMOS project leader and organizer, with more than 16 publications and attending various international conferences related Outer Space Environment, she can be considered as a candidate expert in the field of visual ergonomics design of this subject. She is also involved in search for context of gymnastic and anthropometrics posture studies in parabolic flight and microgravity facilities.

AKNOWLEDGEMENTS

This work have been carried out by the CROMOS group, supervised by Prof. Melchiorre Masali of the University of Turin (Dipartimento di Biologia Animale e dell'Uomo, melchiorre.masali@gmail.com, 0039.3355947901); Irene Lia Schlacht (leader and project designer), Stefano Brambillasca (test programming) and Henrik Birke (review coordinator), with the collaboration of Gabriele Rotondi, Miklos Vincze, Balazs Dianiska, Varhegyi Zsolt and the help of many experts.
The CROMOS group of experiment is supported by: Prof. C. Cardani, AIDAA; Prof. A. E. Finzi, Aerospace Engineering Department of Milan Polytechnic University; Ing. E. Gaia, Arch. G.Musso and Doct. M.Ferrino, Thales Alenia Space Italy; Journalist of Design Alessandra Fanelli; Prof. Dina Riccó, Politecnico di Milano Design Faculty; Prof. Giulio Bertagna, B&B Color Design, J.O. Meile, Aerospace Medic of Lugano; Ing Johannes Bernd, DLR. The experiment research proceeding is possible thanks to the facilities of the Human Machine Department in the Technical University of Berlin, coordinated by Prof. Matthias Rötting. The experiment presentation at the ELGRA 2007 is possible thanks to the support of the Elgra´s organisation. Last but not least thanks to all the people and organisations that collaborated or will be involved in the project. Development and other publication are presented online inside the Extreme Design group context: www.extreme-design.eu.

- Mahnke, F., Color, Environment and Human Response. New York: Van Nostrand Reinhold: USA, 1996
- Bretania, G., Vivere nello spazio abitato, Laboratorio Colore, Politecnico di Milano, Milan, Italy. Mimeography, 2003.
- Durao, M.J., Colour in space architecture AIAA 2002-6107, Houston, Texas: USA, 2002
- NASA, The Human Factors of Colors in Environmental Design: A Critical Review (Contractor Report 177498) Barbara K. Wise, James A. Wise, Department of Psychology, University of Washington, Seattle, Washington. (Prepared for Ames Research Center under Contract NCC22-404), 1988.
- Foto Geo http://www.geo.de/GEO/technik/51452.html?t=img&p=3
- Articolo Ansa: Al lavoro a 0 G anche Designer di astronavi http://www.ansa.it/opencms /export/main/notizie/rubriche/approfondimenti/visualizza_new.html_1993868506.html
- Cromos Video
http://www.le-plaisir.org/cromos/2006_CROMOS_high.mov
http://www.le-plaisir.org/cromos/2006_CROMOS_low.wmv

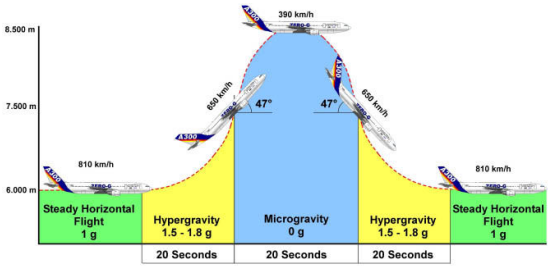


Fig. 2: ZERO-G A300 Airbus maneuver to achieve microgravity conditions.

Fig. 3: CROMOS team, 13.9.2006 after the experiment, Bordeaux 14.9.2006.

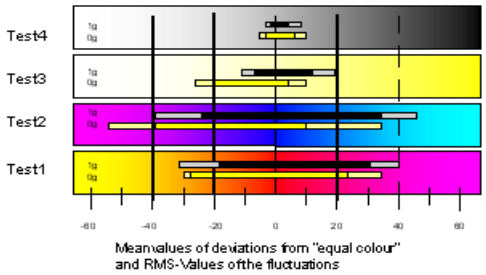


Fig. 4: Cromos Result: Mean values of deviations from "equal color" and RMS-Values of the fluctuations

SINGING GRAVITATION DETECTOR

Bertrand Dujardin[1], Jonathan Vanpeteghem[2]
[1]Katholieke Universiteit Leuven, Faculty of Eng., Kasteelpark Arenberg 1, B-3001 Leuven (Heverlee), duji.bertrand@gmail.com, +32 499990636; [2]Hogeschool West-Vlaanderen, Department PIH, Graaf Karel De Goedelaan 5, B-8500 Kortrijk, jonathan_314@hotmail.com, +32 494143470.

This paper describes a gravitation detector which measures gravity via a visible and an audible scope. The experiment contains a rotating recipient filled with water, in which a pipe is placed (Fig.1). When rotating the recipient around its symmetry axis (which will be the pipe) at 180 rpm the fluid surface will pass different stadia (Fig. 2) which can be calculated.
We captured the shape of this fluid surface with a camera, and recorded the sound produced by the pipe in which we generated a standing wave by blowing air over it (Fig. 1: ventilator).
From the resulting 160,000 color video frames, we extracted the grayscale equivalent frames and applied a noise reduction and edge enhancement algorithm. By means of edge detection we obtained up to 100 unique points per frame of the fluids surface. These points are the basis for solving a least squares system that gives the equation representing a parabolic shape of the fluid, from which we derive the gravitational data (Fig. 3, 4 & 5).
To the audio we applied the Cooley-Tukey algorithm to obtain the strongest tone present in the spectrum of the experiment. Via the pipe dimensions and a constraint of the present fluid we derive an equation for the shape of the fluid. This gives us a second gravity measurement.
By comparing our data with the reference data, recorded during the flights by Novespace, we can conclude that the singing gravitation detector closely matches the reference data (Fig. 6).

Linear Algebra and its Applications (Third Edition),
Pearson International Education, David C. Lay, 2006 (English)
Aanvullingen bij Toegepaste Algebra, Pearson Custom Publishing,
Joos Vandewalle en Ronald Cools, 2007 (Dutch)
An Introduction To Digital Image Processing, Internet, Frédéric Patin, 2003, http://www.yov408.com/imageproc/ImageProc.pdf (English)

Plots, schematics and photos

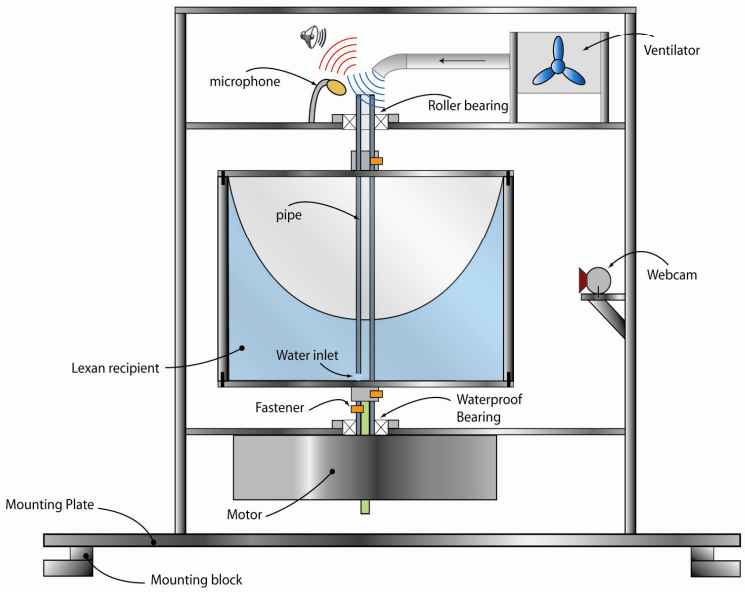


Fig. 1: Schematic representation of the experiment rack

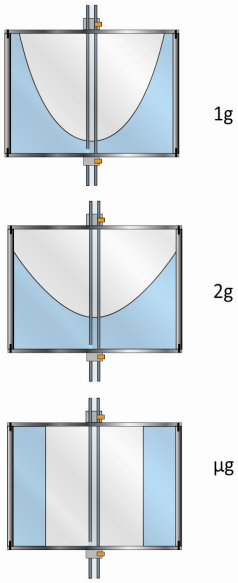


Fig. 2: Different gravity stadia

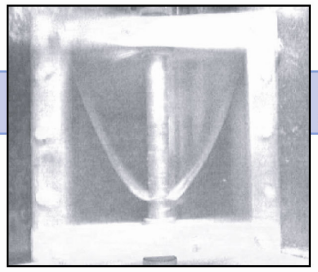


Fig. 3: RAW data

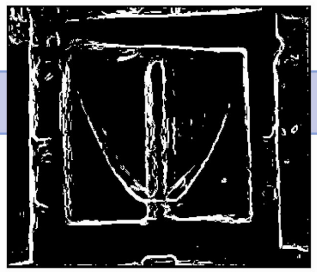


Fig. 4: Denoise & edge detection

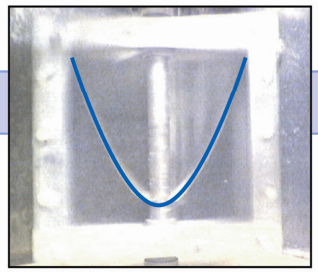


Fig. 5: Parabola & data

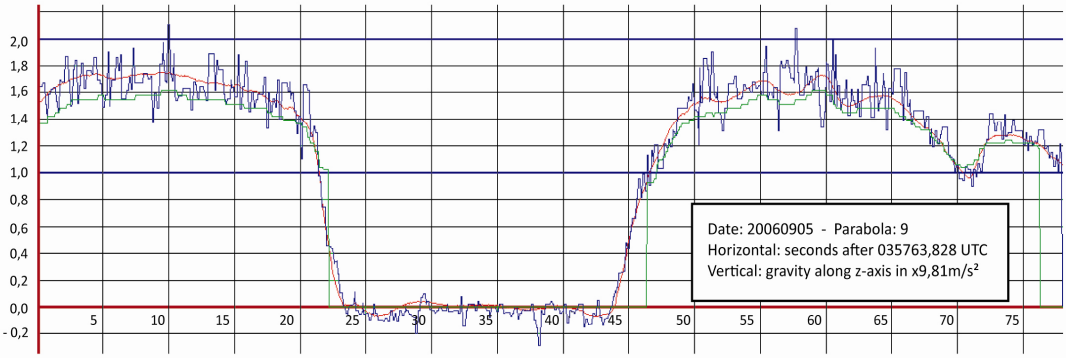


Fig. 6. Experiment results
- Red: ref data from Novespace
- Green: Audio data
- Blue: Visual data

EXPERIMENTAL STUDIES ON THE AGGREGATION PROPERTIES OF DUST IN PLANET-FORMING REGIONS

Daniel Heißelmann
Institute for Geophysics and Extraterrestrial Physics, Technical University at Braunschweig, Germany, email: d.heisselmann@tu-bs.de, phone: +49531-3915246

To investigate the initial stage of planet formation, we built a setup for collision experiments with millimetre-sized, highly porous and well characterised dust aggregates[1,2]. The experiments, which were successfully conducted at ambient temperature during ESA's 45th Parabolic Flight Campaign, were the first in a series of at least three parabolic flight campaigns. The recent experiments probed the sticking and collision behaviour of dust aggregates (composed of 1.5 µm-sized monodisperse SiO_2 grains) from which planetesimals and cometary nuclei are considered to have formed[3,4]. In the parabolic flights, pairs of fragile dust aggregates were collided under microgravity conditions at relative velocities between ~20 cm/s and ~40 cm/s. Additionally, fragile aggregates were impacted on a dusty target screen, simulating protoplanetary collisions with larger bodies. The collision events happened at random impact angles and were recorded with a high-speed, high-resolution digital camera. The majority of both the particle-target (Fig. 1) and aggregate-aggregate collisions (Fig. 2) showed a quasi-elastic rebounding behaviour. Whereas ~10% of the particle-target collisions resulted in sticking (of sub-millimetre-sized fragments only), the other key effect in ~10% of the aggregate-aggregate collisions was fragmentation. The measured coefficient of restitution for the bouncing collisions (Fig. 3) indicates that the residual translational energy is ~5% of the primal energy of the aggregates' motion for central collisions and increases with increasing impact parameter. During future Parabolic Flight Campaigns, the experimental work will be extended to collisions of dust aggregates at lower temperatures (80-220 K) and of solid ice particles and icy aggregates at cryogenic temperatures (below ~140 K) corresponding to the conditions found in the outer solar nebula at 5-30 AU.

1. Blum, J. and Schräpler, R., "Structure and Mechanical Properties of High-Porosity Macroscopic Agglomerates Formed by Random Ballistic Deposition", PRL, Vol. 93, pp. 115503-1 – 115503-4, 2004.
2. Blum, J., Schräpler, R., Davidsson, B.J.R. and Trigo-Rodríguez, J.M., "The Physics of Protoplanetesimal Dust Agglomerates. I. Mechanical Properties and Relations of Primitive Bodies in the Solar System", The Astrophysical Journal, Vol. 652, pp. 1768-1781, 2006.
3. Weidenschilling, S.J. and Cuzzi, J.N., "Formation of Planetesimals in the Solar Nebula", In: Protostars and Planets III, pp. 1031-1060, 1993.
4. Weidenschilling, S.J., "The Origin of Comets in the Solar Nebula: A Unified Model", Icarus, Vol. 127, pp. 290-306, 1997.

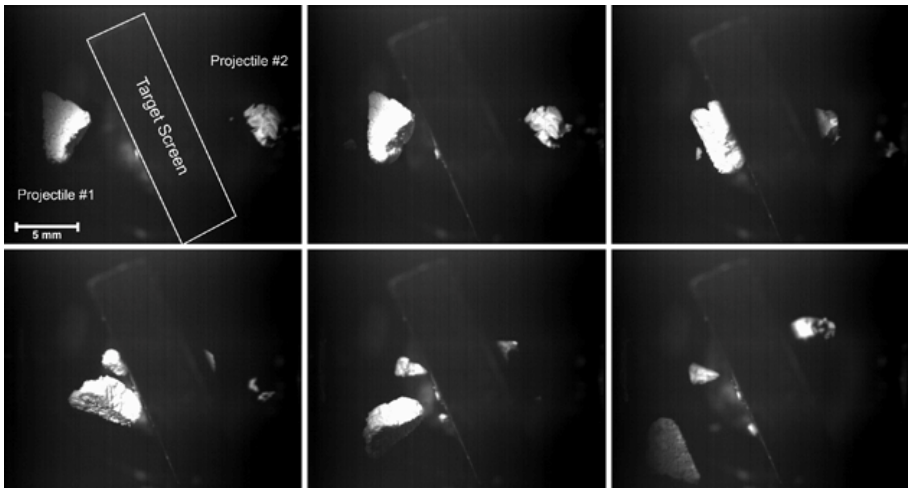


Fig. 1: Collisions of dust aggregates at room temperature, recorded during the 45th ESA PFC. Example of a collision of a high–porosity dust aggregate with a dust target. The collision velocity is ~20 cm/s.

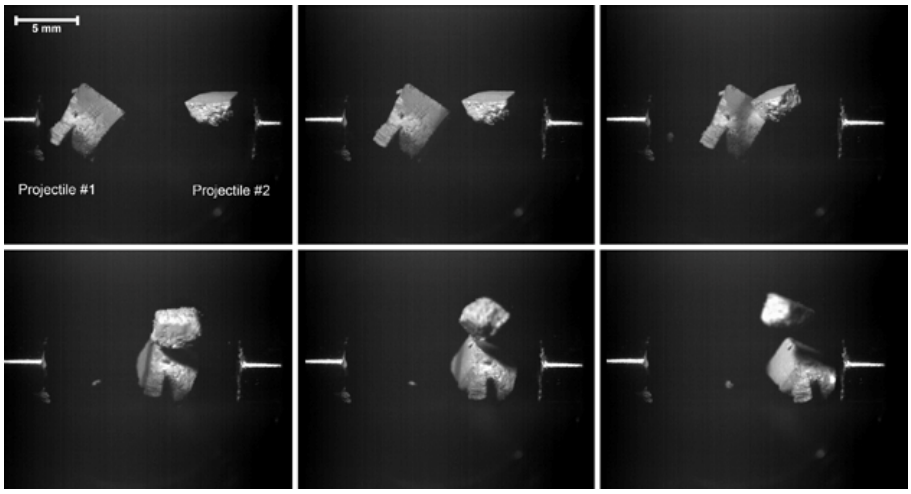


Fig. 2: Collisions of dust aggregates at room temperature, recorded during the 45th ESA PFC. Example of a collision between two high–porosity dust aggregates. The collision velocity is ~40 cm/s.

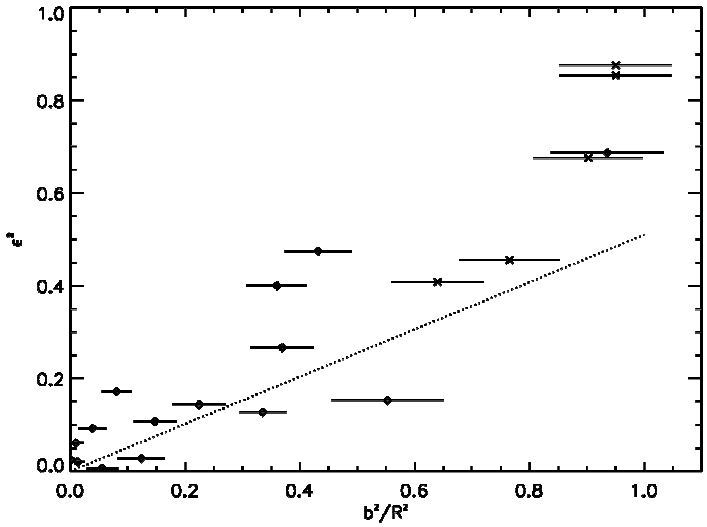


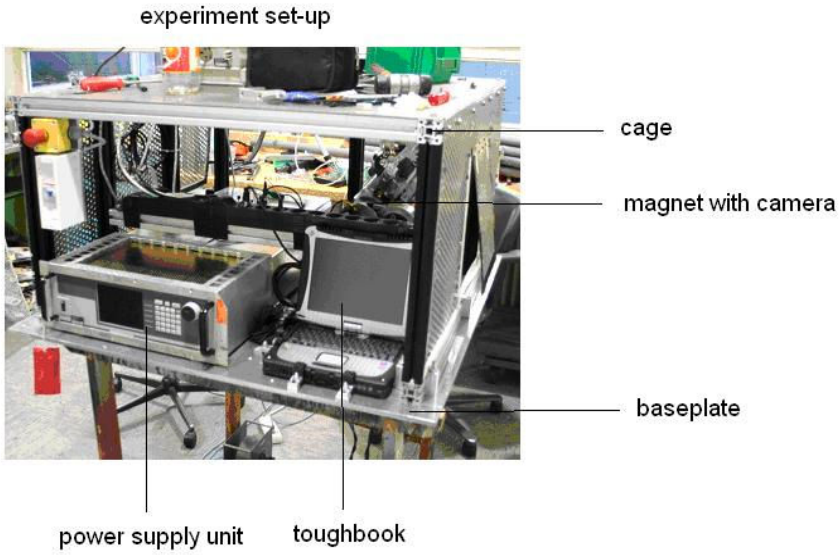
Fig. 3: Squared coefficient of restitution ε^2 vs. squared normalised impact parameters b^2/R^2 for aggregate-aggregate collisions at relative velocities of 20-40 cm/s. For central collisions ~5% of the energy is conserved.

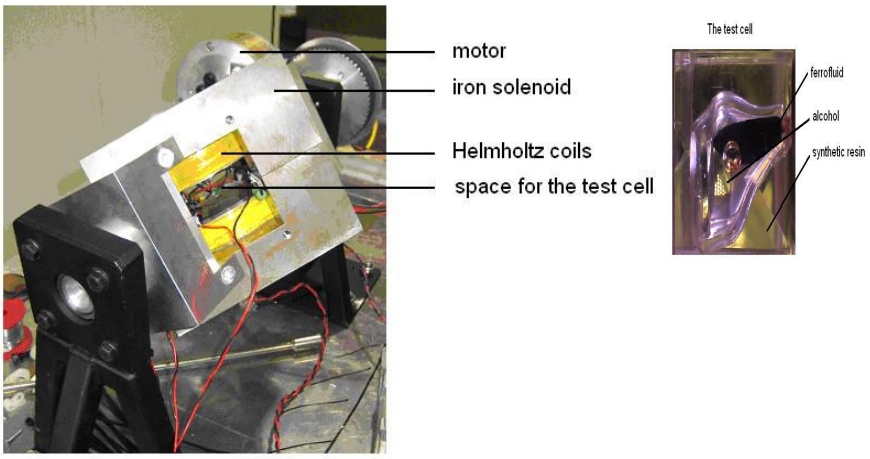
ANALYSIS OF FERROFLUIDS EXPOSED TO MAGNETIC FIELDS IN MICRO-GRAVITY

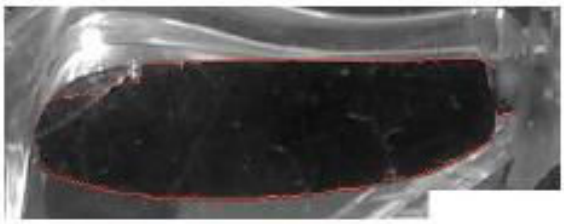
Elisabeth Krause[1], Alice Verweyen[1], Ulrike Endesfelder[1], Anne Angsmann[1], Sebastian Bürgel[2]
[1] University of Bonn, Germany; [2] ETH Zürich, Switzerland; Corrsponding author: Alice Verweyen, email: averweyen@gmx.de, phone: 0049-228-2999600

We present an analysis of ferrofluid observations in micro-gravity that were recorded during the 8th ESA Student Parabolic Flight Campaign in July 2005.
The objective of our experiment is to analyze the flow of a ferrofluid that is exposed to different magnetic fields in an otherwise force free environment. This is realized by placing a glass containment filled with ferrofluid between two Helmholtz coils, which produce well-controlled magnetic fields, and recording the flow of the ferrofluid with two video cameras.
During every parabola, the airplane, and thus the axes of our experiment setup inside the plane, rotate in space around the plane's y axis; this causes shear forces and friction. We decided to switch off these distortions in order to observe the free motion of the ferrofluid by using a so-called ESP (Electronic Stability Programme). Usually, this piece of equipment is used in cars to prevent sliding in bends. The experiment is mounted on an axis in y-direction of the airplane. The ESP is attached to the magnet's rotation axis, and provides a signal proportional to the magnet's rotation velocity. This signal triggers a servomotor such that the ESP - and thus the whole magnet - is kept on a stable axis. The rest of the base plate is occupied by a programmable power supply unit for the generation of the magnetic fields and a notebook that controls the power supply.
We want to understand the flow of ferrofluids in the absence of gravity, in this environment the energy density of the ferrofluid is given by the difference of surface energy density and energy density of the magnetization of the ferrofluid. Only few observations of ferrofluids in micro-gravity hve been published, thus we decided to start with covering a broad parameter range during flight 1, and to study the most promising points to more detail during flight 2.
The overall question is how the shape of the ferrofluid varies with the strengths of the applied field; in this context we are especially interested in the following transition points: the minimum field strengths for Rosensweig instabilities to occur, and the saturated magnetization of the ferrofluids.
A first inspection of the data after flight 1 showed that, in absence of gravity, the magnetization of the ferrofluid saturates much earlier than expected from ground tests. Therefore we had to repeat a number of field configurations from flight 1 at smaller field strengths during flight 2.
Additionally, we tried to measure the magnetization of the ferrofluid as function field strengths using a reverse field method. The ferrofluid is magnetized at a constant field level, and the magnetic field is switched off. The field is reversed and the field strength at which the magnetized, and thus elongated ferrofluid, is demagnetized (and thus loses its shape) is measured. Threfore, the magnetization of the ferrofluid can be calculated.
A first analysis shows that the experiment worked well and produced data of good quality for a physical analysis. The ESP-sensor provides an easy way to implement position control, that can be recommended to other groups with acceleration sensitive experiments. In this report, we compare the measurements in micro-gravity with ground based tests. Our analysis shows that approximations similar to those describing ferrofluid in 1-g environment hold in micro-gravity. Due to the increased wavelength of these surface perturbations, in reduced gravity we do not observe Rosensweig instabilities during the 0-g phase of the flight. We obtained 3-D

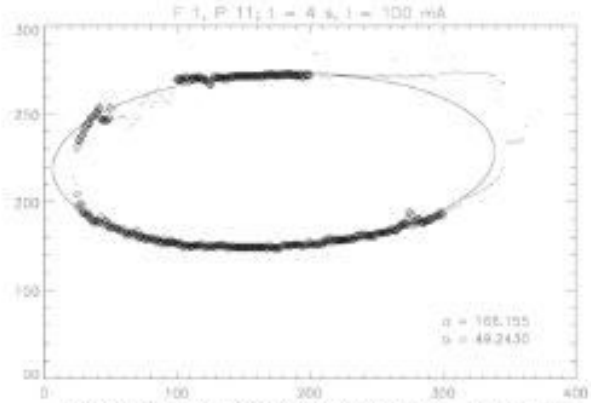
models of the ferrofluid motion from the recorded projections, and describe the goals of the forthcoming analysis of these data.







On cleaned images the largest continuous black area is selected and the boundary coordinates are extracted. Boundary points that are near to a wall of the containment or directly next to a masked pixel (scratches, light reflexes), are flagged as bad points, as these do not necessarily resemble well the shape of the ferrofluid.



projection of the ferrofluid surface at B = 40 Gauss

VISCOUS FINGERING IN MICROGRAVITY

Yngvild Linnea Andalsvik, Gunhild Storhaug, Kosovare Olluri, Arvid Skaugen, Torfinn Lindem, Grunde Løvoll, Knut Jørgen Måløy
Department of Physics, University of Oslo. Postboks 1048 Blindern, 0316 Oslo. y.l.andalsvik@fys.uio.no, Phone nr.: +4748211733; gunhild.storhaug@fys.uio.no Phone nr.: +4792620997

Viscous fingering effects arise when a low viscous fluid is injected into a high viscous fluid. The injected air forms a finger-like structure spreading non-isotropically in the porous media. The understanding of viscous fingering is important for oil recovery, when gas is injected into a reservoir to expel more oil. In addition, it is an interesting phenomenon in itself, as a simple system that generates complex and fractal patterns. The gravitational force will set up a pressure gradient causing fragmentation of the air cluster due to buoyancy. Performing the experiments in the microgravity phase of a parabolic flight is one way to reduce the gravitational effects sufficiently. Such experiments were performed by a team of four students during ESA Student Parabolic Flight Campaign 2006. The experimental set-up consisted of cylinders filled with a granular media and a viscous fluid with matching index of refraction. Liquid was withdrawn from one end of the cylinders causing air to flow in through a vent at the other end. The matching refraction index allowed observation of the air transportation.

Figure 1: Microgravity. When liquid was withdrawn from the cylinder in microgravity it resulted in fractal fingers of air spreading upwards through the porous medium. The mirror image is showing the back side of the cylinder, giving an additional viewing angle.

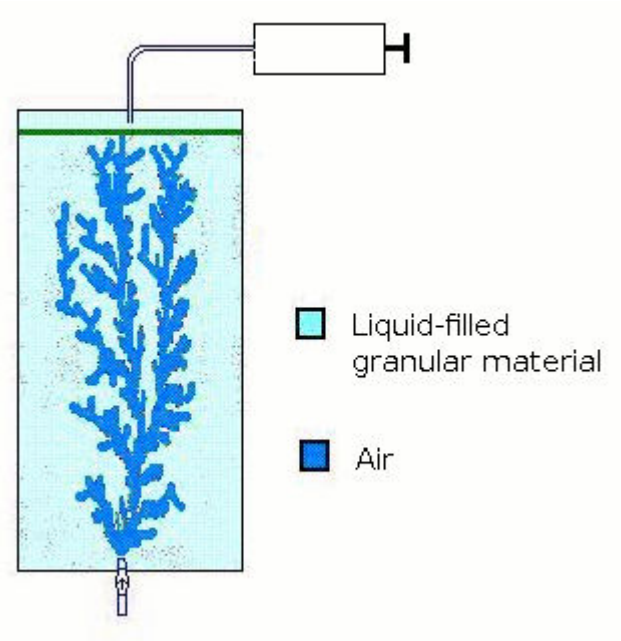


Figure 2: Experimental setup. It consisted of a glass cylinder filled with Plexiglas granules and liquid dibutylphthalat. Because the dibutylphthalat and the granules had similar index of refraction, it was possible to observe the air transportation inside the cylinder. When the syringe piston was pulled, liquid was withdrawn causing air to flow into the cylinder. A one way went at the bottom of the cylinder provided the air.

Workshop on Human Centrifuge

THE HUMAN CENTRIFUGE

Jack J.W.A. van Loon
Dutch Experiment Support Center, ACTA, Dept Oral Cell Biology, Vrije Universitiet, Amsterdam, The Netherlands. E-mail: j.vanloon@vumc.nl. Web: http://www.desc.med.vu.nl/ Tel: +31204448686 /+31653700944

Life on Earth has been developed at unit gravity, 9.81 m/s^2 but how would nature have evolved on a larger planet, i.e. larger than Earth? We are able to address this question simply by studies using centrifuges. In the past decades numerous experiments have been performed on cells (see e.g. Beams et al. 1987), plants (see e.g. Hemmersbach et al. 1999) and animals (see e.g. van Loon et al. 2005) grown for longer durations, even multi generations, under hypergravity conditions. Based on these studies we have gained interesting insides in the physiological process of these systems. Animals and plants adapt themselves to this new high-g environment. Information on mammalian adaptations to hyper-g is interesting or maybe even vital for human space flight programs. We know from long duration studies that various structures like muscles, bones, neuro-vestibular, or the cardio-vascular system is affected in numerous animals. However, humans have never been exposed to a hyper-g environment for long durations. Human studies are mostly in the order of hours and weeks at most. The current work on human centrifuges are all focused on short arm systems to apply artificial gravity in relation to long duration space missions in ISS or to Mars.
In this paper I want to address the possible usefulness of a human centrifuge on Earth. In such a centrifuge a group of humans may be exposed to hypergravity for, in principle, an unlimited period of time. The inputs from a survey under scientists working in gravitational physiology, but also other disciplines, will be discussed.

Acknowledgements:
For this paper I want to thank all persons that somehow contributed by providing input and discussions on 'The Human Centrifuge'. This work is supported by NWO-ALW-SRON grant MG-057.

- Beams, H.W., Kessel R.G. "Development of centrifuges and their use in the study of living cells", Int. Rev. Cytol., Vol. 100, pp. 15-48, 1987.
- Hemmersbach, R., Volkmann, D., Hader, D.P., "Graviorientation in protists and plants", J. Plant Physiol. Vol. 154, pp. 1-15, 1999.
- van Loon Jack J.W.A, Tanck, E., van Nieuwenhoven, Frans A., Snoeckx, Luc H.E.H., de Jong, Herman A.A., Wubbels, René J., "A brief overview of animal hypergravity studies", J. Gravit. Physiol, Vol. 12, pp. 5-10, 2005.

THE HUMAN CENTRIFUGE: THE PAST AND THE FUTURE

Pierandrea Trivelloni,
M.D., Lt Col, ITAF, MC, SFS; Chief, Biodynamics Group, Flight Experimental Center, Aerospace Medicine Department – Pratica di Mare AFB, Rome (Italy); email: trivelloni@iol.it; tel: +39.069129.2718; fax: +39.069129.2075

In the late '70s Leverett and Burton published their original paper on human consequences of high and sustained G exposures in aviation environment, about 30 years later the first citation in MedLine about human centrifuge.
At the beginning, human centrifuges for aviation and space medicine purposes were quite simple but powerful devices, performing only +G accelerations.
Lately, the new, supermaneuvreble aircraft design and development required higher and sustained acceleration to be generated by the devices. At the same time, a new physiological training approach was designed: not only a simple G-onset and G-load demonstration, to make aircrew aware of individual tolerance and confident in AGSM (anti-G straining maneuver), but also a full operational simulation in DFS, to allow trainees to deal with the whole potential threats in an advanced agile aircraft.
Along this time, several research have been conducted to identify human systems failures and/or time constrains in human exposures to the high-G environment. At present, several systems are involved in, or impaired by hypergravity: musculoskeletal, respiratory, cardiovascular, neurological, visual, vestibular, according to the acceleration axis and magnitude. Mobility limitations, ventilation/perfusion mismatch, baroreflex response and dysrhythmias, N-LOC/G-LOC syndromes, contrast sensitivity, Coriolis phenomenon and clear motion sickness are well known and today can be counteracted by the use of protective equipments, physiological and educational methods (AGSM, flight currency, physical and physiological training).
However, all these results are related to short-arm centrifuge (< 20 ft) tests. The usual devices for aviation medicine research and development are no longer than that. But this arm length is the main cause of the most common complain reported by aircrew, motion sickness occurring during the acceleration offset: the shorter the arm is, the worst the sickness is.
As far as it is known, the longest arm centrifuge is located in GCTC at Star City (Russia): 18 mt length device, specifically designed for space mission training. Another interesting facility in Pensacola, at the NAMRL: it is a rotating room, performing up to 2 +G.
The actual aeromedical standpoint in high and sustained acceleration is based on rapid to very rapid onset (6 to 12-15 G/sec), very high G-load (9 +Gz), push-pull effect and short duration exposure (30 sec., up to 90-120 in "simulated aerial maneuver"). Many researches are in progress at the moment to push the envelope of both the 4th generation aircrafts and the DFS, to allow aircrew to deal with the G-forces in a "carefree" mode, protected by automatic or self regulating equipments, to optimize individual readiness and, therefore, organizational effectiveness, by saving psychological and physiological resources for operational human performance in flight.

- Leverett, S,D,, Burton, R.R., "Physiological effect of high, sustained +Gz forces on man", Life Sci Space Res, Vol. 17, pp. 171-85, 1979.
- Gillingham, K.K., "G-tolerance standard for aircrew training and selection", Aviat Space Environ Med, Vol. 58, pp. 1024-26,1987.
- Albery, W.B., "Martin ET. Development of space motion sickness in a ground-based human centrifuge", Acta Astronaut, Vol. 38, pp. 721-31, 1996.

- Convertino, V.A., "Mechanisms of blood pressure regulation that differ in men repeatedly exposed to high-Gacceleration", Am J Physiol Regul Integr Comp Physiol, Vol. 280, pp. R947-58, 2001.
- Soeda, K., Dizio, P., Lackner, J.R., "Balance in a rotating artificial gravity environment", Exp Brain Res, Vol. 148, pp. 266-71, 2003.

HUMAN POWERED CENTRIFUGES ON THE MOON OR MARS

Pietro Enrico di Prampero
Dipartimento di Scienze e Tecnologie biomediche, Università di Udine, Italy. e-mail: pprampero@makek.dstb.uniud.it.Tel: +39-0432-494330

Cycling on appropriately constructed tracks may help maintaining physical fitness and cardiovascular conditioning of crews living in permanently manned bases on the Moon or Mars. Indeed, cycling along a curved path induces a centrifugal acceleration vector (a_c):

$$a_c = s^2/R \qquad 1)$$

where *s* is the ground speed and R the radius of curvature of the cyclist's path. Since a_c is applied horizontally outwards, the vectorial sum of ac and the constant acceleration of gravity lies in the plane which includes the centre of mass of the system and the points of contact between wheels and terrain. So, the resulting vector (g') can be calculated by simple geometry as:

$$g' = \sqrt{(g_M^2 + a_c^2)} \qquad 2)$$

where g_M (= 1.62 m s^{-2} or 3.72 m s^{-2}) is the acceleration of gravity on the surface of the Moon or Mars. So, a cyclist riding a bicycle on a circular track generates a force acting in the head to feet direction which depends on the radius of the track and on the ground speed, and which can be expected to mimic the effects of gravity. For *s* ranging from 10 to 20 m s^{-1} (36 to 72 km h^{-1}) and R from 50 to 100 m, it can be calculated that g' ranges from 0.19 to 0.83 of the Earth gravity on the Moon and from 0.43 to 0.90 on Mars. This state of affairs is presumed to counteract, on the one side muscle atrophy, on the other cardiovascular deconditioning that may result from long duration permanence in low gravity bases.
It goes without saying that, for the above described tracks to be operational on the Moon or on Mars, they must be enclosed in appropriate structures within which the air is maintained at a predetermined pressure and temperature. The speeds necessary to achieve sufficiently large values of the vector simulating gravity (g') can be achieved without surpassing the subjects' maximal O_2 consumption only if the air pressure and temperature in the track tunnel are maintained at about 250 mm Hg (33.3 kPa) and 20° C. Thus, the gas contained in the "track tunnel" should be appropriately enriched in O_2, so as to bring its inspiratory fraction to about 0.50. Finally the angles of g' with the vertical, in the range of speed and radiuses mentioned above will vary from 10° to 78.6°, thus showing that the curved parts of the track should be appropriately constructed. Alternatively, to avoid complex construction procedures, a circular rail of the appropriate dimensions could be constructed a few metres above the ground. In this case, the bicycle could be suspended to the rail by means of two wheels, one of which connected, and set in motion, by the pedals via a regular transmission system. The overall structure, rail and hanging bicycle should be enclosed in a "tube" wherein the atmospheric conditions are kept as mentioned above. This system will also have the advantage of freeing the upper limbs of the cyclist for providing, if needed, additional propelling power, via a second transmission system.

Prampero P.E.(di). Cycling on Earth, in space, on the Moon. Eur. J. Appl. Physiol. 82:345-360, 2000.

PRELIMINARY EXPERIENCE WITH THE ESA SHORT ARM HUMAN CENTRIFUGE

Floris Wuyts
Antwerp University Research center for Equilibrium and Aerospace (AUREA). University of Antwerp, Belgium. Groenenborgerlaan 171, 2020 Antwerp, Belgium Floris.Wuyts@ua.ac.be; tel.: +32.486.63.75.50

The ESA short arm human centrifuge (SAHC - constructed by Verhaert Space (BE)) was evaluated during its 8 months commissioning phase in AUREA, before being definitely placed at MEDES in Toulouse (FR). It contains 2 bed nacelles and 2 chairs that are radial oriented. When lying supine on the horizontally oriented bed, the heart was typically situated at 1.05 m from the center of rotation. The bed nacelles were tested in positions from 0 to 45 degrees. Depending on each subject, rotations were set at ~ 24, 29 and 32 rpm to obtain respectively 0.7Gz (radial oriented), 1Gz and 1.2 Gz at heart level. This yielded at the head center values of approximately 0.47, 0.66 and 0.80 Gz and at the feet 1.5, 2.2 and 2.6 Gz respectively. By means of a canopy placed over the upper part of the body, a dark environment was obtained for the subjects. Subjects were equipped with a head set with microphone and head phones to communicate with the operator in the control room. IRB approval was obtained and Informed Consent signed by the subjects. Electrocardiogram, respiration and continuous blood pressure were recorded from 7 healthy male control subjects. A series of 3 imposed and controlled breathing protocols (6, 9 and 15 breaths per minute for 9 breaths) for 180s, was repeated 5 times during 3 different g-load conditions (0.7, 1 and 1.2 Gz). In between, a one minute break was inserted for lower limb exercises. Control measurements in erect and supine position were obtained. The response of the Autonomic Nervous System (ANS) to the orthostatic challenge induced by the different g-loads was assessed through the analysis of heart rate variability (HRV). Hereto, a short-term time domain algorithm [1] was used to compute the amplitude of the respiratory sinus arrhythmia (RSA) which is the high frequency component of HRV and a well recognized marker of vagal control. Our results show that the g-load induced blood pooling induced increased HR (sympathetic activation) and decreased RSA amplitude (vagal withdrawal). As such, the response of the ANS to the orthostatic challenge can be monitored by means of RSA analysis during short (<180s) controlled breathing protocols. The Gz-gradient is an important factor of orthostatic challenge, since at a moderate 1.2 Gz at the heart, yet 2.6 Gz at the feet, HR was significantly increased. This study demonstrates the usefulness of the ESA-SAHC as a model for the adaptation of cardiovascular control to different G-load gradients.
Additionally shows this preliminary study that the ESA SAHC is a very powerful instrument to study different human physiological functions as a response to artificial gravity with a special emphasis on the gravity gradients.
This research was supported by the PRODEX program managed by the European Space Agency in collaboration with the Belgian Federal Science Policy Office.

[1]. Migeotte et al. Am J Physiol – Heart Circ Physiol, 284, H1995-06,2003.

HUMAN CENTRIFUGE FOR STUDYING NEUROBEHAVIOURAL PLASTICITY

Daniela Santucci
Section of Behavioural Neurosciences, Dept of Cellular Biology and Neurosciences, Istituto Superiore di Sanità, Viale Regina Elena, 299, I-00161 Rome, Italy

A number of data on the plasticity of the nervous system have been obtained from experiments where subjects underwent sensorial deprivation during critical developmental periods. Alteration in gravity environment offers an important opportunity for studying neurobiological phenomena and their underlying mechanisms. Human centrifuge has been extensively used to explore artificial gravity as a way to counter the physiologic effects of extended weightlessness for future space exploration. The possibility to perform long term experiment on a long radius centrifuge maintaining the vertical position offer an important opportunity for studying plastic processes in terms of adaptive response to a changing environment.

In particular, we have been working since decades studying the role of polypeptide growth factors (especially NGF and BDNF) which are known to be involved in several neurodegenerative disorders, such as Alzheimer's disease, and which may operate through multiple paths to ultimately regulate physiological homeostasis and behavioural coping. More recently, we found an increase in NGF levels both in plasma and in some brain areas, such as the frontal cortex, hippocampus and hypothalamus, of mice exposed to rotation-induced hypergravity as well as changes in salivary NGF levels in an astronaut during a short term space-flight.

Short- and long-term human centrifuge studies thus represent a possibility for gaining further insight on the role of neurotrophins and specifically of NGF in the physiopathological manifestation of stress and in pathologies associated to nervous and immune system disregulations also for the prevention and treatment of neurodegenerative diseases.

HYPERGRAVITY IN THE AREA OF SPORT'S MEDICINE AND REHABILITATION MEDICINE

Saggini R., Savoia V., * Saggini A.
B.A.M.S. Department University " G. d'Annunzio" Chieti – Italy; *University "La Sapienza "Rome - Italy

It is well-known that the modifications of the gravitational impact over the body can cause modifications over the body system, and in particular over the tissue's constituents.
In hypergravity-related contexts it has now become evident that the body fluids appear to have a downward motion, and how modifications of the homeostasis of the circulatory system and of the fascial and musculoskeletal system occur (Yang Y, Akima H, 2005; Katayama K, 2004). It is also clear that tissue's components can undergo strains that may be positive for certain tissues and negative for other tissues.
For a large centrifuge able to determine hypergravity strains of 2g, 3g, etc., it is possible to identify a series of applications within the area of physical medicine, sport's medicine and rehabilitation medicine – all of them using physical exercise – that can determine the following:

1. increased performance and resistance in athletes;
2. improvement of demineralisation conditions in patients with osteoporosis;
3. improvement of muscular trophism in hypothrofic subjects with increased dynamic antigravity modality;
4. reduction of overuse pain typical of various pathological conditions, including rheumatic subjects.

SHORT TERM AND LONG TERM MICROGRAVITY AND HYPERGRAVITY EFFECTS ON UPPER LIMB MUSCLES

V. Zolesi and P.Pastacaldi
Kayser Italia, Livorno, Italy Azienda Ospedaliera Universitaria Pisana, Pisa, Italy

It is known that altered gravity conditions have an important effect on bones and muscles.
Studies on upper limb with different astronauts as test subjects have been conducted both during taxi flights (short term) and ISS increments, measuring the Maximum Voluntary Contraction (MVC) and other parameters.
Short term effects seem to be more related to psychological and temporary response to gravity changes, while long term indicate loss of performances up to 30% of MVC in six months.
The experimental facility HPA (Hand Posture Analyser) and the protocol CHIRO (Crew Health In Reduced Operability) is a promising tool for the investigation of muscle atrophy and rehabilitation.

Round table
Perspectives of low gravity research in Europe

Minster O., Sunblad P. and Istasse E.
explain the European Space Agency strategy
and the next missions.
A general discussion follows the presentation.

LIST OF PARTICIPANTS

Abe Yoshiyuki
Space Technology Group, AIST
Umezono 1-1-1
305-8568, Tsukuba
Japan
Phone: +81-29-861-5749
E-mail: y.abe@aist.go.jp

Anansah Edem
Research Department, ABA
BOX OD 342, Odorkor- Accra-Ghana
23321, Accra
Ghana
Phone: 233242283428
E-mail: anansah@yahoo.com

Arias S.
Escola Politécnica Superior de Castelldefels
Universitat Politècnica de Catalunya, Av. del Canal Olímpic, s/n
Campus Baix Llobregat,
E-08860, Castelledefels
Spain
E-mail: santiarias78@hotmail.com

Artemenko Olga
Dept. Cell Biology and Anatomy
Institute of Botany, NASU
Tereschenkivska Str., 2
01601, Kyiv
Ukraine
Phone: +380442723236
E-mail: oartyomenko@yahoo.com

Avorsey Frank
Research Department, ABA
BOX OD 342, Odorkor- Accra-Ghana
23321, Accra
Ghana
Phone: 233242283428
E-mail: anansah@yahoo.com

Balázs Dianiska
Department of Astrophysic, Budapest University
dianiska@szofi.elte.hu
Phone: 0036-12760054

Basile Venere
Department of Clinical Physiopathology
University of Florence
Viale Pieraccini 6
I-50134, Florence
Italy
Phone: +39 055 4271216
E-mail: venere.basile@unifi.it

Basios Vasileios
Interdisciplinary Center for Nonlinear Phenomena & Complex Systems
Université Libre de Bruxelles
CP 231, Blvd du triomphe, Campus Plaine
B-1050, Brussels
Belgium
Phone: +322-650.55.39
E-mail: vbasios@ulb.ac.be

Bellik Lydia
Department of Pharmacology
University of Florence
Viale Pieraccini 6
I-50134, Florence
Italy
E-mail: lydia.bellik@unifi.it

Bergeon Nathalie
L2MP Laboratory, CNRS
University Paul Cezanne-Aix Marseille III
Faculte des Sciences de St Jerome
Case 142
13397, Marseille, Cedex 20
France
Phone: +33(0)491 28 86 73
E-mail: nathalie.bergeon@L2MP.fr

Betzler Felix
Center for Space Medicine Berlin
(ZWMB) c/o Department of Physiology
Charité – Universitaetsmedizin Berlin,
Felix.betzler@gmail.com
Phone: 0049 176 24318538

Beysens Daniel
ESEME-PMMH, CEA-ESPCI
rue Vauquelin, 10
75231, Paris, Cedex 05
France

Phone: + 33 1 40 79 58 06
E-mail: daniel.beysens@espci.fr

Birikh Rudolph
Dept. Theoretical Physics
Voldemarovich
Perm State Pedagogical University
Sibirskaya Str. 24,
614900, Perm
Russia
Phone: +7 3422386364
E-mail: birikh@pspu.ac.ru

Bitlloch Pau
Departament d'Estructura i Constituents de la Matèria
Universitat de Barcelona
E-mail: belegruth@gmail.com

Bojarevics V.
University of Greenwich
School of Computational and Mathematical Sciences
London SE10 9LS
UK
E-mail: V.Bojarevics@gre.ac.uk

Borisova Tatiana
Dept. Neurochemistry
Palladin Institute of Biochemistry NASU
Leontovicha str, 9
01601, Kiev
Ukraine
Phone: +380442343254
E-mail: tborisov@biochem.kiev.ua

Bozhko Alexandra
Department of Physics
Perm State University
Bukirev Str. 15
614990, Perm
Russia
Phone: +7 3422 396642
E-mail: bozhko@psu.ru

Caldarera Claudio Marcello
Dept. of Biochemistry «G. Moruzzi» via Irnerio 48, 40126 Bologna, Italy
Phone: +39 051 2091205
E-mail: claudio.caldarera@unibo.it

Callens Natacha
Microgravity Research Center
Université Libre de Bruxelles
Service de Chimie-Physique E.P.
CP 165/62
Avenue F.D. Roosevelt, 50
1050, Brussels
Belgium
Phone: 00322650 (2982)
E-mail: natacha.callens@ulb.ac.be

Carboni Manlio
Corpo Sanitario Aeronautico
Viale Piero Gobetti 2a, Roma
Phone: +39 06 4986 5661
E-mail: carbonimn@aeronautica.difesa.it

Casademunt Jaume
Dept. E.C.M
Physics Faculty
University of Barcelona
Avenida Diagonal 647
08028, Barcelona
Spain
Phone: +34934021188
E-mail: iaume.casademunt@ub.edu

Clausse Danièle
Dept. Génie des Procédés
Université de Technologie de Compiègne
BP 20529
60205, Compiègne
France
Phone: 33 3 44 23 44 39
E-mail: daniele.clausse@utc.fr

Cogoli Marianne
Zero-g LifeTec GmbH
Technoparkstrasse 273
8005, Zürich
Switzerland
Phone: +41446337755
E-mail:
marianne.cogoli@zeroglifetec.ethz.ch

Dell'Aversana Pasquale
MARS Center
Via E. Gianturco, 31.
80131, Napoli

Italy
E-mail: dellaversana@marscenter.it

Dijkstra Camelia
School of Biosciences
University of Nottingham
Plant Sciences Building
Sutton Bonington Campus
LE12 5RD, Loughborough
United Kingdom
Phone: 00447958651500
E-mail:camelia.dijkstra@nottingham.ac.uk

Di Nardo Paolo
Laboratorio di Cardiologia Molecolare e Cellulare, Centro di Biomedicina Spaziale
University of Rome "Tor Vergata"
Via Montpellier, 1, 00133 - Roma
Phone: +39 06.72594215
E-mail: Dinardo@med.uniroma2.it

Di Prampero Pietro Emilio
Dept. Of Biomedical Sciences
University of Udine
Via Gervasutta, 48, 33100, Udine, Italy
E-mail: fisioud@dstb.uniud.it

Dittus Hansjörg
Centre of Applied Space Technology and Microgravity
University Bremen
Am Fallturm
28359, Bremen, Germany
Phone: ++49.421.2183604
E-mail: dittus@zarm.uni-bremen.de

Dubois Frank
Microgravity Research centre CP 165-62
Université Libre de Bruxelles
Av. Roosevelt 50
1050, Bruxelles, Belgium
Phone: +32 2 650 42 83
E-mail: frdubois@ulb.ac.be

Dujardin Bertrand
Katholieke Universiteit Leuven, Faculty of Engineering
Kasteelpark Arenberg 1, B-3001 Leuven (Heverlee)
Phone: +32 499990636
E-mail: duji.bertrand@gmail.com

Dünne Matthias
OHB-System AG
Universitätsallee 27-29
28359, Bremen, Germany.
Phone: ++49 421 2020716
E-mail: duenne@ohb-system.de

Egbers Christoph
Lehrstuhl Aerodynamik und Strömungslehre
BTU Cottbus
Siemens-Halske-Ring 14
03046, Cottbus, Deutschland
Phone: 0355694868
E-mail: egbers@tu-cottbus.de

Endesfelder Ulrike
University of Bonn, Germany

Evesque Pierre
Lab MSSMat
CNRS Ecole Centrale Paris
grande voie des vignes
92295, Chatenay-Malabry
France
Phone: 33 1 41 13 12 18
E-mail: pierre.evesque@ecp.fr

Falcetti Giancarlo
Alcatel Alenia Space
Milan, Italy
E-mail: Giancarlo.Falcetti@aleniaspazio.it

Fecht Hans-Jörg
Institute of Micro and Nanomaterials
Ulm University
Albert-Einstein-Allee 47
89081, Ulm, Germany
Phone: +49 731 50 (25490)
E-mail: hans.fecht@uni-ulm.de

Foing Bernad H.
ESA & ILEWG – ESTEC
Noordwjik
The Netherlands
Email: bernard.foing@esa.int

Forte Giancarlo
Laboratorio di Cardiologia Molecolare e Cellulare, Centro di Biomedicina Spaziale
University of Rome "Tor Vergata"
Via Montpellier, 1, 00133 - Roma
Phone: +39 06.72594215
E-mail: giaforte@gmail.com

Fortunati Alessio
Institute of Environmental Biology and Forestry (IBAF)
Consiglio Nazionale delle Ricerche
00016, Monterotondo, Roma
Italy

Futterer Birgit
Department of Aerodynamics and Fluid Mechanics
Brandenburg University of Technology Cottbus
Siemens-Halske-Ring 14
03046, Cottbus, Germany
E-mail: futterer@TU-Cottbus.de

Gabriel Martin
Gravitational Physiology
Ulm University
Albert-Einstein-Allee11
89081, Ulm
Germany
E-mail: martin.gabriel@uni-ulm.de

Galleri Grazia
Dipartimento di Scienze Fisiologiche, Biochimiche e Cellulari
Università di Sassari
Via Muroni 25, I-07100, Sassari
Italy

Gasset Gilbert
Dept 31
Université Paul-Sabatier/GSBMS Toulouse
Faculté de Médecine Rangueil
133 route de Narbonne bat A2
31062 cedex, Toulouse
France
Phone: 33 (0)5 62 88 90 89
E-mail: gasset@cict.fr

Gomoiu Ioana
Dept of Microbiology
Institute of Biology
296, Splaiul Independentei, 6 Sector
060031, Bucharest
Romania
Phone: 0040744961213
E-mail: ioana.gomoiu@ibiol.ro

Grah Aleksander
ZARM
University of Bremen
Am Fallturm
28359, Bremen
Germany
Phone: +49 421 – 218 (8685)
E-mail: grah@zarm.uni-bremen.de

Graziana Annick
Dept. of Surface cellulaire et signalisation chez les végétaux
Université Paul Sabatier
UMR UPS/CNRS 5546
Pôle de Biotechnologie Végétale
BP 42617 Auzeville
31326, CASTANET Tolosan
France
Phone: 33562193536
E-mail: graziana@scsv.ups-tlse.fr

Haake Dennis
Center of applied space technology and microgravity
University of Bremen
Am Fallturm
28359, Bremen
Germany
Phone: +49-421 218-2353
E-mail: dhaake@zarm.uni-bremen.de

Harunori Yoshikawa
Laboratoire de Physique et Mécanique des Milieux Hétérogènes
(UMR 7636, ESPCI-CNRS-UP6-UP7)
10 rue Vauquelin
75231, Paris Cedex 5
France
E-mail: harunori@pmmh.espci.fr

Heißelmann Daniel
Institute for Geophysics and
Extraterrestrial Physics, Technical
University at Braunschweig, Germany,
email: d.heisselmann@tu-bs.de
Phone: +49531-3915246

Hemmersbach Ruth
German Aerospace Center, DLR
Institute of Aerospace Medicine
Linder Höhe
51147, Cologne
Germany
Phone: 0049-2203601-3094
E-mail: ruth.hemmersbach@dlr.de

Hill R.J.A.
School of Physics and Astronomy,
University of Nottingham
Nottingham NG7 2RD
UK
E-mail: Richard.Hill@nottingham.ac.uk

Hirai Takayuki
University of Yamanashi
4-4-37 Takeda,
Kofu Yamanashi 400-8510
Japan
Phone: +81-55-220-8511;
E-mail: g06dhl06@ccn.yamanashi.ac.jp

Holm P.
Swedish Space Corporation
P.O. Box 4207
SE-171 04, Solna
Sweden
Phone: +46 8 627 62 00
E-mail: per.holm@ssc.se

Horn Eberhard
Gravitational Physiology
Ulm University
89081 Ulm
Germany
E-mail: eberhard.horn@uni-ulm.de

Ivanova Alevtina
Department of Experimental Physics
Perm State Pedagogical University
Sibirskaya Av. 24
614900, Perm
Russia
Phone: 210-87-18 (07-342)
E-mail: A.Ivanova@pspu.ac.ru

Jaramillo Esther
RUAG Aerospace
Dept. Of Development
Windenholzstrasse 1
8304, Wallisellen
Switzerland
E-mail: esther. jaramillo@ruag.com

Jones D.B.
Dept. Experimental Orthopaedics and
Biomechanics
Phillipps University, Marburg
Germany

Kalinina Iana
Cell Biology Department
Institute of Botany
Tereshenkivska, 2
01004, Kiev
Ukraine
Phone: +380442723236
E-mail: yana.kalinina@mail.ru

Karapantsios Thodoris
Division of Chemical Technology
Department of Chemistry
Aristotle University of Thessaloniki
University Box 116,
541 24, Thessaloniki
Greece
Phone: 0030 2310 997772
E-mail: karapant@chem.auth.gr

Kemmerle Kurt
Low Gravity + Exploration Department
Kayser-Threde GmbH
Wolfratshauserstr. 48
81477, Muenchen
Germany
Phone: ++49 89 72495 (210)
E-mail: kurt.kemmerle@kayser-
threde.com

Kern Peter
Astrium GmbH, Space Transportation

Department: Life Sciences Technology
D-88039 Friedrichshafen, Germany
Phone: ++49 (7545)-8 (3146)
E-mail: Peter.Kern@astrium.eads.net

Kiechle B.
Congress, T&C
Adenauerlaaee 131
53113, Bonn
Germany
Phone: 0228-9104175
E-mail: b.kiechle@bonn-region.de

Kiefer Juergen
Strahlenzentrum
University Giessen
Am Dornacker 4
D-35435, Wettenberg
Germany
Phone: +49-6406-1587
E-mail: juergen.kiefer@strz.uni-giessen.de

Kofi Asare
Research Department, ABA
BOX OD 342, Odorkor- Accra-Ghana
23321, Accra
Ghana
Phone: 233242283428
E-mail: anansah@yahoo.com

Koike Noriyuki
Department of Engineering
Chiba Institute of technology
c/o Japan Aerospace Exploration Agency
2-1-1 Sengen,
305-8505, Tukuba
Japan
Phone: +81-29-868-3817
E-mail: koike.noriyuki@jaxa.jp

Kordyum Elizabeth
Department of Cell Biology and Anatomy
Institute of Botany, NAS of Ukraine
Tereshchenkivska str., 2
01004, Kyiv
Ukraine
Phone: +38 044 2723236
E-mail: cell@svitonline.com

Kostarev Konstantin
Laboratory of Hydrodynamic Stability,
Institute of Continuous Media Mechanics
UB Russian Academy of Sciences, Acad.
Korolev Str. 1, 614013 Perm, Russia
E-mail: vab@icmm.ru.

Kozeko Liudmyla
Department of Cell Biology and Anatomy
Institute of Botany, NAS of Ukraine
Tereshchenkivska str., 2
01004, Kyiv
Ukraine
Phone: +38 044 2723236
E-mail: kozeko@voliacable.com

Kozlov Victor
Laboratory of Hydrodynamic Stability
Institute of Continuous Media Mechanics,
Russian Academy of Sciences,
Acad. Korolev Str. 1,
614013, Perm
Russia
Phone: 237-84-14 (07-342)
E-mail: kozlov@icmm.ru

Krause Jutta
TEC-MMG, ESA-ESTEC
Keplerlaan 1
2201 AZ, Noordwijk
The Netherlands
Phone: 0031715656372
E-mail: jutta.krause@esa.int

Kuhlmann Hendrik
Inst. of Fluid Mechanics and Heat Transfer
Vienna University of Technology
Resselgasse 3
1040, Vienna
Austria
Phone: +43 1 58801 (32212)
E-mail: h.kuhlmann@tuwien.ac.at

Kumei Yasuhiro
Hard Tissue Engineering
Tokyo Medical and Dental University
1-5-45 Yushima, Bunkyo-ku
113-8549, Tokyo
Japan
Phone: 81-3-5803-4555

E-mail: kumei@nifty.com

Kurowski Pascal
ESPCI, PMMH
rue Vauquelin, 10
75005, Paris
France
Phone: 0140794497
E-mail: pascal@pmmh.espci.fr

Larkin Oliver
Division of Plant Sciences
University of Nottingham
School of Biosciences
University of Nottingham
Sutton Bonington Campus
LE12 5RD, Loughborough
UK
Phone: +44 (0) 7905168046
E-mail: sbxojl@nottingham.ac.uk

Lebert Michael
Department of Plant Ecophysiology
University of Erlangen
Staudtstrasse 5
91058, Erlangen
Germany
Phone: +49-9131-8528217
E-mail: mlebert@biologie.uni-erlangen.de

Liggieri Libero
Istituto per l'Energetica e le Interfasi
CNR- Genoa Department
via De Marini, 6
16149, Genova, Italy
Phone: +39 0106475 (722)
E-mail: l.liggieri@ge.ieni.cnr.it

Linnea Andalsvik Yngvild
Department of Physics, University of Oslo.
Postboks 1048 Blindern, 0316 Oslo
E-mail: y.l.andalsvik@fys.uio.no
Phone nr.: +4748211733

Lobascio Cesare
Thales Alenia Space Italia
E-mail:
cesare.lobascio@thalesaleniaspace.com

Loglio Giuseppe
Department of Organic Chemistry
University of Florence
Via della Lastruccia, 13
50019, Sesto Fiorentino (FI)
Italy
Phone: +39-055-4573487
E-mail: loglio@unifi.it

Lorin Clément
INPL - LEM
avenue de la Forêt de Haye, 2
54500, Vandoeuvre, France
Phone: 33(0)383595663
E-mail: clement.lorin@ensem.inpl-nancy.fr

Lyubimov Dmitriy V.
Theoretical Physics Department
Perm State University
Bukireva Str., 15
614990, Perm, Russia
Phone: 7 342 2396208
E-mail: lyubimov@psu.ru

Lyubimova Tatyana P.
Computational Fluid Dynamics Laboratory
Institute of Continuous Media Mechanics
UBRAS
Koroleva Str., 1, 614013, Perm, Russia
Phone: 7 342 2396646
E-mail: lubimova@psu.ru

Maier Florian
Institute for Media Technology
TU Ilmenau
Ahornstr. 5
82205, Gilching
Germany
Phone: +498105379610
E-mail: florian_maier@gmx.de

Maier Jeanette A.M.
Department of Preclinical Sciences
School of Medicine, University of Milan
Via GB Grassi, 74, Milan I-20157, Italy
E-mail jeanette.maier@unimi.it

Mailfert Alain
Laboratoire environnement minéralurgie
nancy University, INPL
ENSEM, 2 avenue de la forêt de Haye
54500, Vandoeuvre les Nancy
France
Phone: 03 83 59 56 80 (0033)
E-mail: alain.mailfert@ensem.inpl-nancy.fr

Mancuso Stefano
LINV - Horticulture
University of Florence
Viale delle idee 30
50019, Sesto Fiorentino (FI)
Phone: +390554574063
E-mail: stefano.mancuso@unifi.it

Marco Roberto
Department of Biochemistry
Universidad Autonoma de Madrid
C/ Arzobispo Morcillo, 4
28029, Madrid
Spain
Phone: 34-914975409
E-mail: roberto.marco@uam.es

Marthy Hans-Jürg
Department of Life Sciences
CNRS (retired)
Rue Colommier, 13
66730, Rabouillet
France
Phone: +33 468(0)97 74 31
E-mail: jurg.marthy@free.fr

Marziliano Nicola
Fundation IRCCS Policlinico San Matteo
Piazzale Golgi 1/2
I-27100 Pavia
Italy
E-mail: n.marziliano@smatteo.pv.it

Masini Mariangela
Department of Biology
University of Genova
Viale Benedetto XV n. 5
I-16132, Genova
Italy
E-mail: masini@unige.it

Matia Isabel
Centro de Investigaciones Biológicas
Ramiro de Maeztu 9
E-28040, Madrid
Spain
E-mail: imatia@cib.csic.es

Medina Francisco Javier
Centro de Investigaciones Biológicas
(CSIC), Ramiro de Maeztu 9, E-28040
Madrid, Spain
E-mail:fjmedina@cib.csic.es

Meloni Mariantonia
Dipartimento di Scienze Fisiologiche,
Biochimiche e Cellulari
University of Sassari
Via Muroni, 25
07100, Sassari
Italy
Phone_number: +39 329 1710215
E-mail: melonima@uniss.it

Melnikov Denis
Chem. Phys. E. Department
Microgravity Research Center
(MRC), CP-165/62
ULB 50, Av. F. D. Roosevelt,
B-1050, Bruxelles
Belgium
E-mail: dmelniko@ulb.ac.be

Mialdun Alexander
Chimie-physique E. P.
Universitè Libre de Bruxelles
CP-165/62, Av. F. D. Roosevelt,
B-1050, Bruxelles
E-mail: aliaksndr.mialdun@ulb.ac.be

Mickaël Antoni
UMR-CNRS 6171
Université Paul CEZANNE
Aix-Marseille III - BP. 531
Av. Escadrille Normandie-Niemen
13397 Marseille Cedex 20
France

Migliaccio Fernando
Institute of Agroenvironmental Biology
and Forestry (IBAF)
Consiglio Nazionale delle Ricerche
Via Salaria Km 29,300
00016, Monterotondo (Roma)
Italy
Phone: 06 90672535
E-mail: fernando.migliaccio@ibaf.cnr.it

Minetti Christophe
Microgravity Research Center
Université Libre de Bruxelles
Service de Chimie-Physique E.P.
CP 165/62
Avenue F.D. Roosevelt, 50
1050, Brussels
Belgium
Phone: 00322650 (6573)
E-mail: cminetti@ulb.ac.be

Misbah Chaouqi
Department of Physics
CNRS and Univ. J. Fourier Grenoble
140 rue de la physique BP 87
38402,Grenoble
France
Phone: 33476514876
E-mail: chaouqi.misbah@ujf-grenoble.fr

Monici Monica
ASAcampus, ASA Research Division
Dept. of Clinical Physiopathology
University of Florence
Viale Pieraccini, 6
I-50139, Florence
Italy
Phone: +39 055 4271217
E-mail: monica.monici@unifi.it

Monzón Vázquez Amalio
Student
Universidad Politécnica de Madrid
C\Virgen del Sagrario nº3, esc A - 1º Ctro
28027, Madrid
Spain
Phone: 0034645914093
E-mail: amalio.monzon@gmail.com

Morbidelli Lucia
Section of Pharmacology
Dept. Molecular Biology
University of Siena
Via A. Moro 2
53100, Siena
Italy
E-mail: morbidelli@unisi.it

Morel Jean-Luc
CNIC - centre de neurosciences
intégratives et cognitives
CNRS, CNIC UMR5228
Batiment B2, avenue des facultés
33405, Talence, France
Phone: 5 5757 1232 (33)
E-mail: jlucmorel.cnic@voila.fr

Nguyen-Thi H.
L2MP, UMR CNRS 6137
Université Paul Cézanne, Marseille, France

Nikolayev Vadim
PMMH-ESPCI
CEA-ESEME
Rue Vauquelin,10
75231 Cedex 05
75005, Paris, France
Phone: +33 1 40 79 58 26
E-mail: vadim.nikolayev@espci.fr

Paradis Paul-François
Japan Aerospace Exploration Agency
2-1-1 Sengen, Tsukuba
Ibaraki 305-8505
Japan
E-mail: paradis.paulfrancois@videotron.ca

Parenti Astrid
Department of Pharmacology
University of Florence
Viale Pieraccini 6
I-50134, Florence
Italy
Phone: 055 4271329
E-mail: astrid.parenti@unifi.it

Perbal Gerald
Laboratoire CEMV

Department of Plant Physiology
University Pierre and Marie CURIE
Site d'Ivry, Le Raphael, case 150
4, Place Jussieu - Cedex 05
75252, Paris
France
Phone: 33145466327
E-mail: perbal.gerald@wanadoo.fr

Pezzatini Silvia
Section of Pharmacology
Dept. Molecular Biology
University of Siena
Via A. Moro 2
53100, Siena
Italy
Phone: +39 0577 234443
E-mail: pezzatini@unisi.it

Pichavant Guillaume
ESEME, Service des Basses Températures
CEA Grenoble
rue des Martyrs, 17
Cedex 9
F-38054, Grenoble
France
Phone: +33 438789469
E-mail: guillaume.pichavant@cea.fr

Pravin Subramanian
Mechanical and Aerospace Engineering,
Rutgers University, Piscataway, NJ 08854
U.S.A.

Queeckers Patrick
Microgravity Research Center
Universite Libre de Bruxelles
Avenue Fr Roosevelt 50 CP 165-62
B-1050, Brussels
Belgium
Phone: +32 2 650 3171
E-mail: pqueeck@ulb.ac.be

Ranaldi Francesco
Dipartimento di Scienze Biochimiche,
Laboratorio di Chimica Medica, Università
di Firenze, Viale Pieraccini, 6 – 50139
Firenze
Italy

Rath Hans J.
Director General
ZARM, University of Bremen
Am Fallturm
28359, Bremen
Germany
Phone: 0049421218 (2752)
E-mail: rath@zarm.uni-bremen.de

Ricci Franco
ENEA C.R. Casaccia, Roma
Italy

Rizzo Angela Maria
Institute of General Physiology and
Biochemistry, University of Milan
Italy

Romano Giovanni
Department of Clinical Physiopathology
University of Florence
Viale Pieraccini 6
I-50134, Florence
Italy
Phone: +39 055 4271216
E-mail: giovanni.romano@unifi.it

Rosado Venâncio Helena Isabel
Department of Pharmaceutics
School of Pharmacy, University of London
Brunswick Square, 29/39
WC1N 1AX, London
United Kingdom
Phone: +44 (0)20 7753 5800 (4869)
E-mail: helena.rosado@pharmacy.ac.uk

Rüdiger Hampp
University of Tübingen
Physiological Ecology of Plants
Auf der Morgenstelle 1
D-72076, Tübingen,
Germany
E-mail: ruediger.hampp@uni-tuebingen.de

Ruiz Xavier
Applied Physics Lab.
Institut d'Estudis Espacials de Catalunya,
IEEC (also, Univ. Rovira i Virgili, URV).
Campus San Pere Sescelades

Marcel i Domingo s/n
E-43007, Tarragona
Spain
Phone: + 34 977 55 81 07
E-mail: josepxavier.ruiz@urv.cat

Saggini Raoul
Dipartimento di Scienze Mediche di Base ed Applicate
Facoltà di Scienze dell' Educazione Motoria
Via dei Vestini, 31, 66013, Chieti Scalo
Italy
Phone: 0871/ 587107
E-mail: saggini@unich.it

Saint-Jalmes Arnaud
Groupe Matiere Condensée et Matériaux
CNRS - Université Rennes 1
campus Beaulieu, batiment 11A
35042, Rennes
France
Phone: 33 (0)2 23 23 57 16
E-mail: arnaud.saint-jalmes@univ-rennes1.fr

Santucci Daniela
Department of Cell Biology and Neuroscience
Behavioural Neuroscience Section
Istituto Superiore di Sanità
Vialle regina Elena 299
I-00161, Roma
Italy
E-mail: santucci@iss.it

Schetelat Pascal
SIMAP-EPM
CNRS
ENSEEG BP75
38402, St Martin d'Hères Cedex
France
Phone: +33476825258
E-mail: pascal.schetelat@hmg.inpg.fr

Schlabs Thomas
Center for Space Medicine Berlin (ZWMB) c/o Department of Physiology
Charité – Universitaetsmedizin Berlin,
Phone: 0049 176 24318538

Schlacht Irene Lia
Technische Universität Berlin
Irene.Schlacht@gmail.com
Phone: 0049.(0)162.1869681

Schuber Marianne
MUSC/BSSC
German Aerospace Center DLR
Linder Hoehe 23b
D-51147, Cologne
Germany
Phone: +49-2203-601-(3523)
E-mail: marianne.schuber@dlr.de

Serret Damien
TCM – IUSTI
Rue Enrico Fermi, 5
13453, Marseille
France
Phone: +33 4 91 10 69 36
E-mail: damien.serret@polytech.univ-mrs.fr

Shevchenko Galina
Cell Biology and Anatomy Department
Institute of Botany
Tereshchenkivska St., 2
01004, Kiev
Ukraine
Phone: +380 44 272 32 36
E-mail: olga-s@mail.kar.net

Shevtsova Valentina M
University of Brussells
Chemical Physics, MRC
CP 165-62, Avenue Fr Roosevelt 50
B-1050, Brussels
Belgium
Phone: +3226503024
E-mail: vshev@ulb.ac.be

Simoncini Madine
Galileo Avionica SpA-BU Space & Electro Optics, Campi Bisenzio, Firenze
Italy

Sobol Margarita
Cell Biology and Anatomy Department
Institute of Botany of NAS of Ukraine
Tereschenkivska St., 2

01004, Kyiv
Ukraine
Phone: +380442723236
E-mail: margaret_sobol@yahoo.com

Steinberg Ted
Phenomena in Microgravity Laboratory
School of Engineering Systems
Queensland University of Technology
Bribane QLD
Australia
E-mail: t.steinberg@qut.edu.au

Storhaug Gunhild
Department of Physics, University of Oslo.
Postboks 1048 Blindern, 0316 Oslo
Norway
Phone: +4792620997
E-mail: gunhild.storhaug@fys.uio.no

Strollo Felice
Endocrine Unit, I..N.R.C.A.
Via Cassia, 1167
I – 00189 Rome, Italy
Phone: +39.06.3034.2653
E-mail: strofe@flashnet.it

Sundaresan Alamelu
Department of Biology
Texas Southern University/NASA
3100 Cleburne Avenue
77004, Houston
USA
Phone: 713-313-7926
E-mail: sundaresana@TSU.edu

Suñol F.
Departament de Física Aplicada,
Universitat Politècnica de Catalunya, Av.
Canal Olímpic s/n, 08860 Castelldefels
Barcelona
Spain

Talalaiev Oleksandr S.
Cell Biology and Anatomy Department
Institute of Botany of NAS of Ukraine
Tereschenkovskaya Str., 2
01601, Kyiv
Ukraine
Phone: +38 044 272 32 36
E-mail: atalalaev@yahoo.com

Taylor Peter W.
Microbiology Group
School of Pharmacy, University of London
29-39 Brunswick Square
WC1N 1AX, London
United Kingdom
Phone: +44 20 7753 5867
E-mail: peter.taylor@pharmacy.ac.uk

Tenconi Chiara
Alcatel Alenia Space – Italy (Milan plant).

Trivelloni Pierandrea
M.D., Lt Col, ITAF, MC, SFS; Chief,
Biodynamics Group, Flight Experimental
Center, Aerospace Medicine Department
Pratica di Mare AFB, Rome
Italy
Phone: +39.069129.2718
E-mail: trivelloni@iol.it

Uva Bianca Maria
Department of Biology
University of Genova
Viale Benedetto XV n. 5
I-16132, Genova
Italy
E-mail: uvab@unige.it

Vanpeteghem Jonathan
Hogeschool West-Vlaanderen, Department
PIH
Graaf Karel De Goedelaan 5, B-8500
Kortrijk
E-mail: jonathan_314@hotmail.com
Phone: +32 494143470

Vanni Paolo
Dept. of Biochemical Sciences,
Laboratorio di Chimica Medica, University
of Florence
Viale Pieraccini, 6 – 50139 Firenze
Italy

van Loon Jack
DESC @ OCB-ACTA
Free University Amsterdam
van der Boechorststraat 7

1081BT, Amsterdam
The Netherlands
Phone: +31204448686
E-mail: j.vanloon@vumc.nl

Ventura Natascia
Laboratory of Signal Transduction,
Department of Experimental Medicine,
University of Rome "Tor Vergata", Rome
Italy

Vernikos Joan
Formerly Director NASA Life Sciences
Division – Washington DC,
USA

Verweyen Alice
University of Bonn, Germany
Phone: +49-228-2999600
E-mail: averweyen@gmx.de

Viberti Carlo
President
Cultural Association C.O.S.M.O
SpaceLand
Rivalta Street, 9
10095, Grugliasco (TO)
Italy
Phone: +39 (0)11.234.14.635
E-mail: spaceland@spaceland.it

Viviani Antonio
Dipartimento di Ingegneria Aerospaziale e
Meccanica
Seconda Università di Napoli
via Roma 29
81031, Aversa
Italy
Phone: +39 081 5010247
E-mail: antonio.viviani@unina2.it

Vlieghe Celine
Pôle de Biotechnologie Végétale, UMR
5546, 24 chemin de Borderouge, BP 42617
Auzeville, 31326 Castanet Tolosan Cedex
France

Vreeburg Jan P.B.
National Aerospace Laboratory
NLR, ASSP
PB 90502
1006 BM, Amsterdam
E-mail: vreeburg@nlr.nl

Wunderlich Rainer
Institute of Micro and Nanomaterials
Ulm University
Albert-Einstein-Allee 47
89081, Ulm
Germany
Phone: +49 731 50 (26457)
E-mail: rainer.wunderlich@uni-ulm.de

Wuyts Florian
Antwerp University Research center for
Equilibrium and Aerospace (AUREA).
University of Antwerp, Belgium.
Groenenborgerlaan 171, 2020 Antwerp,
Belgium
Phone: +32.486.63.75.50
E-mail: Floris.Wuyts@ua.ac.be

Zebib Abdelfattah
Mechanical & Aerospace Engineering
Rutgers University
School of Engineering
98 Brett Road
08854, Piscataway, NJ
Phone: 1 732 445 3268
E-mail: zebib@rutgers.edu

Zimmitti Vincenzo
ITOI – CNR p.Le Collemaggio, 67100
L'Aquila,
Italy
Phone: +390862414275

Zolesi Valfredo
Kayser Italia, Livorno, Italy

Zuev Andrew L.
Laboratory of Hydrodynamic Stability
Institute of Continuous Media Mechanics,
Ural Branch of Russian Academy of
Sciences
Academician Korolev Str., 1
614013, Perm
Russia
Phone: +7 (342) 237 83 14
E-mail: zal@icmm.ru

BIENNIAL MEETING & GENERAL ASSEMBLY SPONSORS

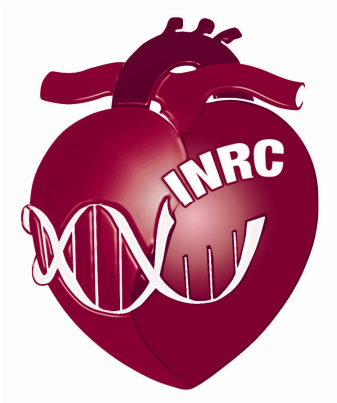
Galileo Avionica S.p.A

Ente Cassa di Risparmio di Firenze

Nikon Instruments S.p.a.

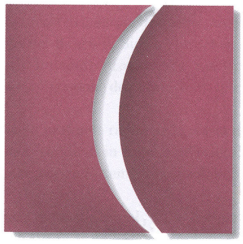
ASA srl

KAYSER ITALIA Srl



Consorzio Interuniversitario "Istituto nazionale per le ricerche cardiovascolari"

Banca Federico Del Vecchio S.p.A.



Banco di Sicilia

Banco di Sicilia S.p.A.

PARTICULAR REMARKS

ELGRA thanks

The European Space Agency for continuously supporting ELGRA activities and for sponsoring the Student Contest at the ELGRA Biennial Symposium 2007.

The Institute of Aeronautical Military Sciences for kindly hosting the ELGRA Biennial Symposium 2007, jointly with the XX national meeting of the Italian Association for Aeronautical and Space Medicine, and for the invaluable collaboration in the organization of the Symposium

The Italian Association for Aeronautical and Space Medicine for having organized the XX national meeting jointly with the ELGRA Biennial Symposium 2007, starting a collaboration destined to grow in the time for the common scientific interests of the two Societies