newsletter

NEWSLETTER OF THE EUROPEAN LOW GRAVITY RESEARCH ASSOCIATION

elgra

NUMBER 5, DECEMBER 2006

President's page

Dear ELGRA Members,

It is with great pleasure that I take the opportunity of the publication of our Newsletter to give you a number of information regarding ELGRA and our passion: research in space and weightlessness.

You have already received or will receive soon the Proceedings of the last ELGRA Symposium in Santorini (Greece). This is a special edition of Microgravity Science and Technology that reports the status of our present research with the guest editors Marianne Cogoli, Thodoris Karapantsios and myself.

Please write on your notebooks that ELGRA will hold its next biannual symposium – the 19th since its foundation – between the 4th and 9th September 2007 in the magnificent city of Florence. This symposium will be hold jointly with the 19th meeting of the Italian Association for Aerospace Medicine, authorizing a large audience. Prof. Monica Monici is the local organizer of the meeting and we thank her very much for undertaking this heavy task.

We expect large student participation and will do our best to subsidize their venue. In addition, we organize a contest for the best student studies in both Physical and Life Sciences as in our previous Symposia. The winners, in addition to receiving a special ELGRA award, will expose their work in front of the ELFRA audience in a general session.

The Symposium gives us the opportunity to award the ELGRA medals. Every two years, ELGRA honours two of our more esteemed members in Life and Physical Sciences for their outstanding contribution in the field of Microgravity sciences.

It is also the time where the new Bureau of the Association will be elected, during the general Assembly. I would like to remind you that the volunteers interested in contributing to our Association can contact me directly (daniel.beysens@espci.fr). It is indeed the role of the current bureau to propose for the election of the members a number of new volunteers who want to serve in the future Bureau.

ELGRA represents its members and is an active Organization in a number of international scientific meetings as the International Symposium on Physical Sciences in Space (22-26 october 2007 in Nara, Japan) and the joint meeting of the International Society for Gravitational Physiology-American Society for Gravitational and Space Biology, ESA, the French Space Agency CNES and ELGRA, in Angers on 22-28 June 2008.

The future research using the microgravity and space environment looks promising since the recent Atlantis shuttle flight was a success. The Columbus module is still scheduled for launch in autumn 2007. Let us hope that this date will be the right one.

We have good reasons to be optimistic and I expect you in Florence to make our Symposium a great success!

Yours sincerely,

Daniel Beysens
President of ELGRA

INSIDE

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Can vibrations in fluids play the role of an artificial gravity?

Daniel Beysens

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The conditions of weightlessness in space complicate and make hazardous the management of fluids in satellites and spacecrafts as well as the survival of human beings and, more generally, of living systems. A means to improve the management of fluids and that of life support systems would be to create an "artificial" gravity. Classically, an artificial gravity can be produced in space in several ways. A centrifugal force, created by spinning the spacecraft or space station, can be used. However, large Coriolis forces are also present and everything would fall in curves instead of straight lines. One can also linearly accelerate the spaceships, but this cannot be continued over long periods because of the enormous energy costs. Less known would be to produce a uniform force field as coming from a magnetic field gradient, but here also the cost in energy is very high. (However, this solution can be advantageously used to compensate gravity on Earth [1].

If we narrow our focus to fluid systems and to some extent to living organisms, vibrations provide another possible means of reproducing some of the effects of gravity. First of all, large amplitude (with respect to the system size), low frequency (with respect to the system time response) vibration gives a periodic acceleration – and then a periodic artificial gravity – to any entity (Fig. 1a-b).

At small amplitude and high frequency, the situation is more complex and, at the same time, more interesting (Fig. 1c). In addition to local vibrations of the fluid, average flows are created. These flows are of inertial origin; they are connected to the nonlinear response of the fluid to the vibration and are initiated because of the existence of density inhomogeneities. The vibration induces, in general, mean flows perpendicularly to the vibration direction. A well-known example is the steady Bernoulli pressure difference that originates in the difference in velocity of gas and liquid and moves the interface perpendicularly to the vibration direction.

In some sense, high frequency vibrations can thus recreate some features of the effects of gravity. However, it is clear that the vibration and buoyancy induced flows have different origins. Can this simple and rather naive view be extrapolated to condensation and evaporation?
These are quite essential and basic processes involving significant heat and mass exchanges and are very non-linear and non-equilibrium phenomena.

The phase transition is concerned at the fundamental level with (i) the nucleation of individual drops or bubbles, not influenced by gravity or vibration flows and (ii) subsequent growth, where drop-drop or bubble-bubble coalescence (fusion) have to be taken into account. Here convective flows really matter. Under the Earth's gravitational field, buoyancy that directs bubbles upwards and droplets downwards makes them fuse very quickly, within a kinetics determined by gravity- induced flows. Eventually, after a furious burst of coalescence, the gas- liquid phase separation ends with the gas phase upwards and the liquid phase downwards, separated by a flat meniscus.

In space, the phase transition kinetics is only driven by the haphazard and slower process of collision between droplets or bubbles. Depending on the mean distance between drops or bubbles as determined by the volume fraction of the minority gas or liquid phase, the collision can be due to two processes [2]: (1)

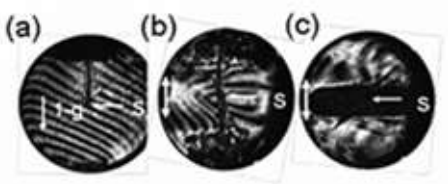

Fig. 1. (a) Supercritical fluid CO2 heated on ground by a point source (a thermistor S). It results in the convection of the less dense hot fluid parallel to gravity and an accumulation of hot fluid at the top, with a hot- cold interface perpendicular to gravity. The same phenomenon under vibration (double arrow) and in space conditions (Mir station) can give, according to the conditions, either (b) a similar convection pattern but symmetrical with respect to the direction of vibration or (c) a convection perpendicular to the vibration direction.

For drops or bubbles sufficiently far apart from each other (volume fraction < 30 %), the collisions are due to Brownian motion (Fig. 3a), with the diameter D of bubbles or drops growing as D ~ t1/ 3 . Here is the time. The evolution is very slow. (2) For volume fraction > 30 %, the drops or bubbles are sufficiently close together as the hydrodynamic attraction caused by the flow during coalescence is able to push neighbouring drops close enough to provoke coalescence, thus inducing a kind of chain reaction of drop or bubble fusions. The pattern then looks interconnected (Fig. 2a), with a typical wavelength Lm that increases with time. The dynamics is at present limited by the flow resulting from coalescence; growth is linear with time, Lm ~ t.

In any case, the kinetics of phase separation, whether limited by Brownian collisions or hydrodynamic interactions, is much slower than when gravity flows stimulate coalescence.

In order to investigate under space-like conditions the effect of vibration on evaporation or condensation, experiments have been carried out in sounding rockets (MiniTexus5, Maxus5 and 7) and on ground in a magnetic set- up that creates "artificial" weightlessness in hydrogen [1]. Then "artificial" gravity is added back in, this time in the form of high-frequency (< 50Hz), low- amplitude (< 500 µm) vibrations.

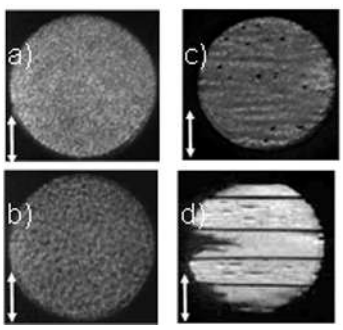

Fig. 2. Phase separation under vibration (double arrow, typically 20 Hz frequency and 300 µm amplitude) for volume fraction > 30%. (a) Very early times. The evolution is the same as if there were no vibrations. (b) Faster evolution obtained later as caused by the shear flow between the domains. This acceleration is followed by the deformation of the gas-liquid interfaces (c) that grow faster in the direction perpendicular to vibration, eventually forming alternate bands of gas and liquid (d). (Sample: (a)-(c): H2, 3mm diameter, 3 mm thickness; (d): CO2, 10 mm diameter, 5 mm thickness).

Typical evolution is shown in Fig. 2 for the minority phase volume fraction larger than 30 % and Fig. 3 for volume fraction lower than 30%. Some general features are the same for both interconnected and bubble (drop) patterns. There are no effects when the domain size is very small, as the viscous interaction maintains a uniform velocity field despite the density difference. In other words, the domain size is still smaller than the viscous boundary layer [3]. Later, as bubbles / drops grow, a faster evolution is observed with layering of domains perpendicular to the vibration direction.

Returning to the initial question: can high frequency, low amplitude vibrations be used in space as an artificial gravity? The answer is "yes… but" since it depends on the very phenomenon involved. When one deals with thermal convection, interface localisation and even – as mostly reported here – phase separation, vibration can indeed induce mean flows that closely resemble buoyancy. In this sense vibration can really serve as an artificial gravity.

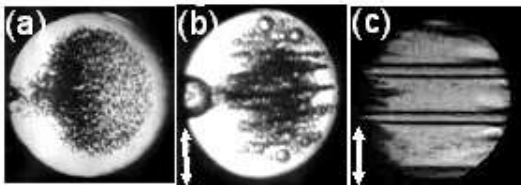

Fig. 3. Phase separation under vibration (double arrow, typically 40 Hz frequency and 300 µm amplitude) for volume fraction < 30%. (a) (a) Very early times. The evolution is the same as if there were no vibrations. (b) Later. The bubbles start to "feel" the vibration. As the hydrodynamics of two vibrated inclusions result in repulsion between inclusions in the vibration direction and attraction in the direction perpendicular to vibration [4] the bubbles / drops organise themselves in periodic, parallel layers where bubble coalescence is increased -thus increasing the growth rate. (Sample: (a)-(b): H2, 3mm diameter, 3 mm thickness; (c): CO2, 10 mm diameter, 5 mm thickness)

As a matter of fact, small amplitude and high frequency vibration was recently used as a possible countermeasure for microgravity for astronauts [5]. Such studies show that vibrating an astronaut's legs and feet helped to prevent muscle decay or bone decalcification, due to the stress induced by vibrations. Effects of vibration on single cells will be addressed in the next paper. Many thanks to Denis Chatain for his outstanding support, and Pierre Evesque, Yves Garrabos and Vadim Nikolayev for essential advice and never- ending encouragement. ESA and CNES are gratefully acknowledged for their support.

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Further reading

Phase separation under vibration:

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Response of bone cells to high-frequency, low-amplitude translational vibration stress.

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Bone loss in space is likely resulting from an exceptional form of disuse [1, 2]. Microgravity provides a mechanical environment, where the loss of gravity might play a significant role on affecting the way bone cells sense stress. It is possible that the mechanosensitivity of bone cells is directly modulated by microgravity. In bone, mechanical loading is likely transferred to the bone cells by strain- induced fluid flow through the lacuno- canalicular system [1]. We have shown earlier that bone cell activation by fluid shear stress (upto 9 Hz), is linearly rate dependent [3]. One study showed that low magnitude (< 10 microstrains) high-frequency (10-100 Hz) mechanical loading restored anabolic activity on rats, which were previously subjected to disuse by hind limb suspension [4]. Aside from the effect of loading magnitude, high frequencies seem to be stimulatory to bone cells. We plan to test some of these hypotheses in future spaceflight studies. However, low-amplitude, high- frequency vibration stress might stimulate bone cells, since this stress regime stimulates an anabolic response in bone despite disuse [4]. Furthermore, vibration stress during launch might affect bone cell response to stress. NO production is an essential step for mechanical loading- induced bone formation in vivo [5]. Thus NO production in response to mechanical vibration is a meaningful parameter for measuring bone cell activation Prostaglandins are generated by the release of arachidonic acid from phospholipids in the cell membrane, followed by conversion of arachidonic acid into prostaglandin G2 and subsequently H2. Prostaglandin H2 is further isomerized to the biological active prostanoids, prostaglandin E2 (PGE2). The in vivo acute prostaglandin production by loading-stimulated bone cells seems to be more important than the sustained prostaglandin release. Thus, we studied the nitric oxide (NO) and prostaglandin E2 (PGE2) production of MC3T3- E1 osteoblast-like cells in response to vibration stress at frequencies 5 Hz, 30 Hz, and 100 Hz, at different amplitudes.

Methods

Bone cell culture: MC3T3- E1 cells were cultured to near confluency in α-MEM (Gibco, Paisley, UK) with 10% fetal bovine serum (FBS) Vibration stress treatment: Cells were plated in 24- wells plates, at 4x104 cells/cm2, in CO2- independent medium (Gibco) with 2% FBS, and incubated for 5 min in the presence of mechanical vibration at 5, 30, and 100 Hz, and varying amplitudes (Table 1). Vibration stress was implemented on attached cells by sinusoidal displacement of the 24-wells plate along the cells' plane of attachment using a voltage controlled linear actuator. Conditioned medium was sampled after the 5 min of vibration stress treatment to measure accumulated NO in medium produced by MC3T3- E1 cells. The conditioned medium was sampled after 30 min post-incubation subsequent to the 5 min vibration stress treatmet to measure accumulated PGE2 in the medium.

Table 1. Data of applied vibration stress

Regime	5 Hz	30 Hz	100 Hz
Amplitude (mm)	5	4.5	0.75
Peak acceleration rate (km/s^3)	0.15	30.1	186

Peak acceleration rate = amplitude x frequency^3 x $(2\pi)^3$

Statistics: Results were analyzed by the Wilcoxon rank sum test of the S- Plus 2000 package

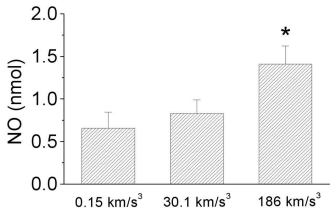

Fig. 1. NO production by MC3T3- E1 cells in response to vibration stress in relation to increasing peak acceleration rate. Values are mean ± SEM. * p < 0. 05.

Results

In rapid response (after 5 min) to treatment with vibration stress, the NO released was highest at 100 Hz compared to the response at 5 Hz and 30 Hz (fig. 1; table 1). The response to vibration stress correlated with increasing peak acceleration rate (fig. 1). However, the PGE2 released in response to vibration stress decreased with increasing frequency (fig. 2).

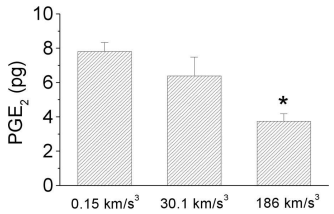

Fig. 2. Prostaglandin E2 production by MC3T3- E1 cells in response to vibration stress in relation to increasing peak velocity. Values are mean ± SEM. * p < 0.05.

Discussion

NO production by bone cells was significantly higher at 100 Hz compared to the response at 5 and 30 Hz of vibration stress. PGE2 production by bone cells was however, much lower at 100 Hz compared to the response at 5 and 30 Hz. This implies that the bone cell response to vibration stress is highly dependent on the applied frequency of loading regardless of the applied amplitude. Furthermore, NO and PGE2 might have opposing roles in vivo in driving the adaptation of bone to mechanical stress.This supports our earlier finding that bone cell response is linear to the applied fluid shear stress rate [3]. Interestingly, bone cells do respond to high frequency vibration stress (100 Hz) although fluid shear stresses in vivo involve lower frequencies [3]. Nuclear oscillation as response to high- frequency translational stress: Vibration stress was induced by oscillating the plate along the horizontal axis using a voltage controlled linear actuator at a wide range of frequencies and amplitudes. We take a minimalist approach to understand how the cells are possibly receiving stress by translational oscillation. We consider the nucleus to be spherical and embedded in the viscoelastic medium of the cell body. The source of mechanical stimulus is then attributed to the possible motion of the cellular nucleus inside the cell. Based on the Generalized Stokes-Einstein relation we estimated the displacement of the nucleus in the cell xn(ω), modeled as a rigid sphere compared to the cytoplasm, as proportional to the applied force F (where ω = 2 xπx frequency):

$$x_n(\omega) \propto \frac{F(\omega)}{R_n G(\omega)}$$

The acting force is due to the mass of the nucleus ρnVn (with density ρn and volume Vn) and radius Rn, considering a relative acceleration of the nucleus with respect to the cell body. In this approximation, we neglect the time dependence of the shear modulus G, so, G(ω) →Go. The time dependence is important for a complete description of the viscoelastic response of a cell to stress. However, since the elastic response is in-phase with the applied translational vibration stress, the viscous response was neglected.
Here, we approximate the elastic modulus to be constant Go. The peak rate of acceleration by the plate is related to the rate of acceleration ran by the nucleus at ω:

$$ra_n(\omega) \propto \left(\frac{\rho_n' V_n}{R_n G_o}\right) x_o \omega^3$$

where ρn' is the density difference between the cell nucleus and the surrounding cytoplasm.

Limitations: In this study we have not considered in detail the implications and differences of the physical effects of varying stress stimulations on bone cell deformation. It is likely that the response of bone cells to stress by fluid flow or by mechanical vibration, are closely related. The high dependency of the amount of NO and PGE2 released on the applied frequency of stress, implies a fundamental role of dynamic loading on the physiological response of bone cells to stress.

Our results imply that vibration stress provide a mechanical stimulation that directly affects bone cells. The application of vibration stress provides a promising technique for maintaining bone health under the extreme condition of unloading by microgravity environment. In such an environment of low gravitation, it has been proposed that small amplitude and high frequency vibration is able to reproduce interesting phenomena in fluids as might be observed in the presence of gravity. In general, vibration could introduce mean flows in fluid systems reproducing similar effects as in conditions under gravitation. Here we show the possibility that vibration induces intracellular mechanical stimulation that induces the production of specific signalling molecules regulating bone metabolism. Thus, vibration as a direct mechanical stimulus to cells effectively introduces an artificial gravity environment for cells that might counteract the effects of loss of loading under microgravity conditions.

ELGRA 2005 Biennial Symposium and General Assembly

Acknowledgements

R. G. Bacabac was supported by the Space Research Organization of the Netherlands (SRON) grant MG- 055, and J. J. W. A. van Loon by SRON grants MG- 055 and MG- 057.

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ELGRA 2005 Biennial Symposium

The ELGRA 2005 Biennial Symposium took place in the idyllic island of Santorini, Greece, on September 21 to 23, 2005. The meeting was in the successful tradition of previous ELGRA meetings in bringing together world class scientists working in the microgravity field. The meeting was an excellent opportunity for the presentation of recent research investigations on gravity dependent phenomena in physical, material and life sciences. Contributions on both experimental and theoretical topics delineated the current state-of- the art on various aspects of space research. Papers on experiments using ISS facilities, sounding rockets, parabolic aircraft flights, drop towers and centrifuges were presented. Ground based investigations and the development of new diagnostic methods contributed also to a substantial program. Invited papers were presented as plenary or keynote lectures whereas a global poster session covering both Physical and Life sciences was a special event of the meeting.

The large number of participants required the organization of three parallel sessions on every day of the program. However, the ELGRA spirit to foster cross- discipline interactions was maintained through several common events and plenary sessions. A few Euro-Japanese sessions were organized in collaboration with the Japanese Society of Microgravity Application (JASMA) mostly in the field of material sciences where several Japanese colleagues gave lectures or presented posters. Participants from the USA and Australia made also significant contributions. During the meeting, two undergraduate student teams that have won the ELGRA2005 Student Contest (R. Rocha, V. Botello and J. Pais in Physical science: gas jet study and P. Zervoulakos and R. Otchwemahin in Life science: vibration training) were awarded with an honor certificate in a special student plenary session. Furthermore, two distinguished senior members of ELGRA were honored with the ELGRA medal: Prof. Dr. Ing. habil. J. Straub for his outstanding results in Critical Point and Boiling Phenomena, and Dr. A. Cogoli for his exceptional work in Biology, Immunology and Technology. Traditionally, a central moment of this ELGRA gathering was the ELGRA General Assembly and the election of the new Management Committee for the period 2005- 2007. Prof. Daniel Beysens was re- elected as president for the new Bureau after a fruitful previous administration.

Thodoris Karapantsios

ELGRA 2005 General Assembly

Minutes

The 2005 ELGRA General Assembly starts on September 20th, 2005 at 18:30 in the P.M.Nomikos Conference Center,Fira,Santorini Island (Greece).

Agenda

1 Opening by the president /Adoption of the agenda
2 Approval of the minutes of the previous General Assembly
3 President's report
4 Treasurer's report
5 Auditor's report
6 Discharge of the treasurer
7 Acceptance of new members
8 Rules related to Membership
9 Election of two Auditors
10 Election of management Committee Members
11 Any other business

1. Opening by the President /Adoption of the Agenda

The ELGRA President, Danièl Beysens, opens the Assembly.

37 members are present, plus several guests.

Upon request of the President the Assembly adopts the above Agenda.

2. Approval of the minutes of the previous General Assembly

The minutes of the previous General Assembly, held in Munich on April 3rd, 2003, are unanimously approved by the Assembly.

3. President's report

The President reports about the status of the Association and about the work performed during the last term with the MC.

3.1 Communications to the members

Members have been contacted several times via e- mail to spread and request informations. Updated informations were also available on the ELGRA web site.

E-mails with the President Words have been sent at least twice a year. Finally the ELGRA Newsletter n. 4 has been published during this term.

ELGRA 2005 Biennial Symposium and General Assembly

3.2 Meetings of Management Committee

During the last 2- years term the MC met 5 times. The main discussions and consequent actions were concerned with the following activities.

- The implementation of the decisions of the last general assembly concerning the changes of the Statutes and of the Membership.
- The discussion and actuation of the ELGRA policy, such as, Association development/ addresses, fostering of the ELGRA role in respect of the members and of the microgravity community, consultancy and lobbing activity, services to the members.
- The organisation of the 2005 ELGRA Biennial Meeting and of the General Assembly in Santorini, with the joint session ELGRA- JASMA.
- The early organisation of the 2007 Biennial meeting in Firenze and of the ESA- ASGSB- SRON meeting of 2008 in Holland.
- The actuation of the ELGRA education policy, with the organisation of student contest;
- The publication of the Elgra Newsletter.
- The ordinary management of the association (membership maintenance, finances, etc.).

3.3 Promotion/ Defence of the microgravity activity and of the ELGRA community.

The President, assisted by the MC, has been involved in different ordinary and extraordinary activities concerning relations with subjects external to the association and finalised to the promotion of the microgravity research and of the ELGRA community.

- The relations with EU, ESA, ESSC- ESF, with participation to the preparation of green- white books on EU space research, meetings with the ESA Director and EU representatives.
- The representative of the ELGRA microgravity user community vs. ESA in 8 LPSAC and in other ESA meetings.
- The defence of the Sounding rocket program vs. ESA member states.
- The reports at the French Academy of Science.
- The participation to the process of definition of the ESA ELIPS2 programme.
- The joint chair at the meeting ISPS/ Spacebound 2004 Conference in Toronto.
- The preparation of some alert letters.
- The setting of relations with JASMA.

3.4 Elgra Meeting 2007

The president announces the Elgra Biennial meeting 2007, which will be held in Firenze in spring 2007 and jointly organised with the Italian Association of Aerospace Medicine. Monica Monici has been appointed by the MC for the local organisation.

4. Treasurer report/ 5. Auditor report / 6. Discharge of the treasurer

The Treasurer, K. Kemmerle, reports on the financial status of the Association and shows the balance of the period April 2003- August 2005 (see attachment).

5. The Auditors Report

The auditors, H. Dittus and E. Brinkmann, states the correct financial administration of the Association by the Treasurer during the period April 2003- August 2005.

The Assembly unanimously accepts the financial report and discharges the Treasurer.

7. Acceptance of new members

The status of the membership is presented and the new members are unanimously accepted by the Assembly.

8. Rules related to Membership

The GA approves by majority the following deliberations.

8.1 Members readmission

The re- admission of members who have suspended the payment of their membership fees and want to join again the association will be decided case by case by the GA.

8.2 Student's Membership

Student's Membership is granted only to undergraduate students, who remain members for two years or till the acquisition of a PhD.

9. Election of the Auditors

Hans Dittus and Petra Rettberg are elected as Auditors for the new term.

10. Election of management Committee Members

The election is done, according to the current procedure by secret ballot in three turns: first the election of the president, then of the two vice-Presidents and the General Secretary, and finally the election of the MC members, including the Treasurer. The results of each turn are communicated before starting a new turn.

According to the new Statutes approved during the 2003 General Assembly, only one vice- President is elected. Moreover, as from the deliberations of the last MC meeting, the MC members have been reduced to 5, including the Treasurer.

According to the above procedure the following Officers and MC members have been elected:

President:	Danièl Beysens	(34votes)
vice- President:	Jack van Loon	(37votes)
General Secretary:	Thodoris Karapantsios	(37votes)
Members:	Valerie Legué	(35votes)
	Monica Monici	(36votes)
	Felice Strollo	(35votes)
	Hendrik Kuhlmann	(36votes)
	Kurt Kemmerle (Treasurer)	(35 votes)

11. Any other business

11.1 Underlining ELGRA e- mails

Due to the large amount of spam mails most members receive, it is recommended to use a standardised heading/ subject line to allow for a prompt recognition of ELGRA e- mails.

11.2 ELGRA journals

The possibility for ELGRA to produce or to associate to a scientific journal is briefly discussed, in particular with reference to the contacts undertaken with The Microgravity Science and Technology Journal. The commercial proposal of that Journal for devote part of its space to ELGRA are evaluated too onerous for the financial status of ELGRA.

The discussion did not arrive to a definite conclusion and the MC is asked to continue it during the next term.

The President closes the Assembly at 20: 00

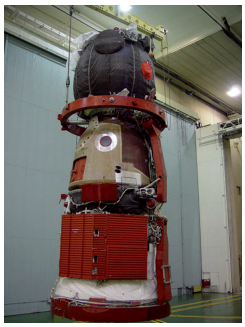
ELGRA 2005 General Assembly

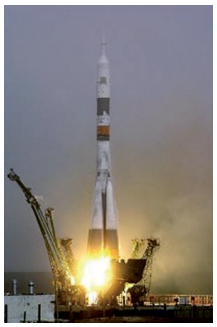
ELGRA 2007 Biennial Symposium and General Assembly, Florence, Italy, 4-7 Sept. 2007.

Local organizer: Dr. Monica Monici (monica.monici@inoa.it) of the Centre of Excellence in Optronics, Univ. of Florence. Venue is the Institute of Military Aeronautical Sciences (IMAS) in the Cascine Park in Florence.

As in past ELGRA Symposia the meeting is intended as a forum for scientific and technical research in microgravity. Topics are in life and physical sciences, material sciences, fluid physics, cell, animal, plant and human physiology and biotechnology.
Sufficient time will be reserved for discussions on the present status and the perspectives of microgravity research in view of the scheduled launch of the European Columbus module around that time, access to the International Space Station as well as other flight opportunities such as Soyuz and sounding rockets.

Go to the ELGRA web site for additional information and registration; see also pag.14,15.





Congress on European Soyuz Missions to the International Space Station, Toledo June 27 till June 30, 2006

150 Space scientists and engineers participated in this meeting where the results of the six missions have been presented. They covered Science, Technology and Education. In science, more than 60 experiments in Biology, Human Physiology and Physical Sciences were presented. So far more experiments have been carried out during these Soyuz missions as compared to the ISS increments.

Two main conclusions emerged:

1. The experiments supported the critical effect of the Space Environment on different organisms and materials, makes it absolutely necessary to maintain an active program of Basic Research in Space before a real exploration of other celestial bodies can even be initiated.
2. The Soyuz Missions will remain a major mode to access the ISS during the remaining life of the Station Thus, it is important to optimize the use of these missions. The availability of Ground Support Equipment in the USOCs to increase the ground experimentation in parallel or as preparatory for future Space experiments was found quite mandatory.

Pedro Duque in his summary presentation indicated that the presence of five astronauts, three European (Claudie Haigneré, Pedro Duque and André Kuipers) and two non- European (Chiaki Mukai, JAXA and Donald Thomas, NASA) in the meeting allows everybody to gain much more insights on the work done and the way it can be improved in future missions.

A dedicated issue of Microgravity Science and Technology Journal will be published as a result of the Conference.

Roberto Marco, Javier Medina

Some Research Opportunities

ESA- MARS-500: Call for science / technology proposal for 500 day isolation study. Russian-ESA cooperation expected late 2006-early 2007.
ESF : European Science Foundation: http://www.esf.org (Grants, Calls & Applications)
INTAS: International Association for the Promotion of Co-operation with Scientists from the New Independent States (NIS) of the Former Soviet Union (http://www.intas.be/)
No new general Announcements for Opportunities are to be expected from ESA within the next year or more due to the limited current flight opportunities and backlog of already accepted proposals.
EU: FP6-Infrastructures: Access to ISS especially for non-ESA member states from the EU. Go to CORSIS site: www.cordis.lu Project: The international space Station: a Unique REsearch infrastructure. Start date: 2006-01-01, duration 48 months.
National Agencies: Call at national levels. See respective agencies.

French- Russian colloquium "40 years of space COOPERATION: The roots of the future"

17- 18 October 2006 – Roskosmos – Moscow (Russia)

In order to celebrate 40 years of uninterrupted and unique in Europe relationships of excellence, the French space agency CNES, the Russian space agency Roskosmos and the French embassy in Moscow organized a commemorative and prospective workshop on this strategic collaboration.

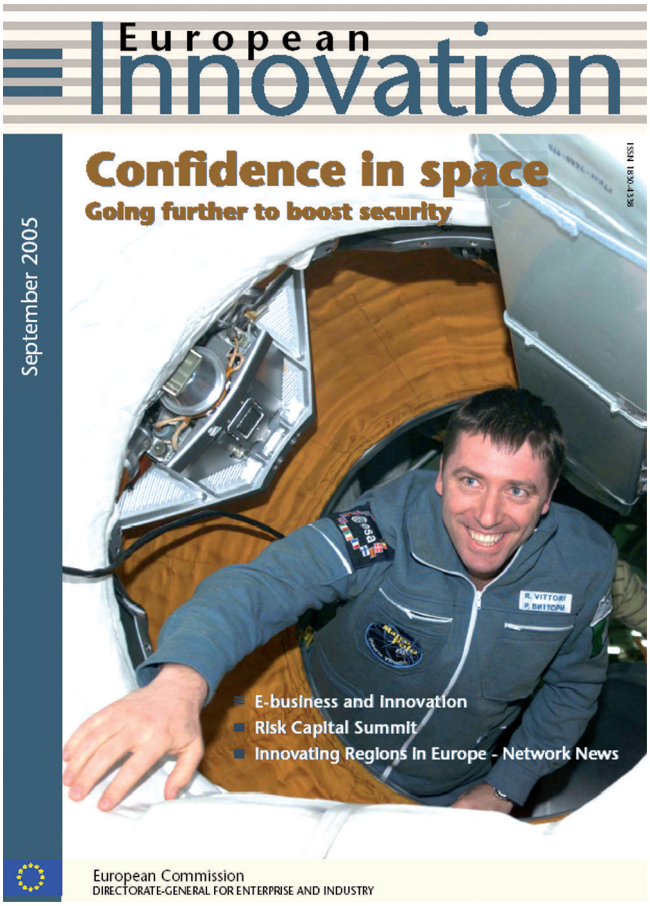
Witnesses and actors of these great common missions have recalled their common adventures and expressed their vision of common future projects in several round tables (the ELGRA President was among the contributors). An impressive number of cosmonauts witnessed the celebration: J. L. Chrétien, L. Eyharts, C., J.- P. Haigneré, M. Togninifrom the French side and V. Afanassiev, S. Avdeev, A. Ivachenkov, A. Kalei, V. Korzun, I. Oussatchev, A. Poleschuk, A. serebrov, A. Solovyev, V. Tsibliev, A. Volkov from the Russian side.

During a reception at the French embassy in Moscow, the French ambassador decorated of the famous "ordre du mérite" decoration A. Kotovskaïa and Taïa Tabakova, both well- known in our community to have trained and taken care of all the cosmonauts on MIR and the ISS from the very beginning of space exploration (including the dog Laïka!).

Daniel Beysens

ELGRA is co- organizing a broad international meeting on life sciences in Angers (France) 22- 28 June 2008. Other organizing entities are the ISGP (International Society for Gravitational Physiology), the ASGSB (American Society for Gravitational and Space Biology), CNES (French Space Agency) and ESA. It is the second time ELGRA is participating with ASGSB. The first combined meeting was in Montreal in 2000. The meeting is hosted by dr. J- M. Custaud, Medical Faculty, University Angers.

Jack van Loon



The EU-ESA 'High-Level Space Policy Group'

ESA and the European Union are for years now working on a common strategy for space related policy. One of the main subjects is the new Galileo GPS system but also issues as space science, the International Space Station and relations with Russia and China are discussed. One of the main documents related to the EU-ESA policy relationship is the so called 'White Paper'. In November 2003, the European Community and ESA signed a Framework Agreement on future co-operation and the joint development of a comprehensive European Space Policy. The two organisations have forged a close working relationship in recent years, due to the important role of Space in maintaining Europe's political and economic strength. The Agreement officially entered into force on 28 May 2004. An important element of the Agreement entails the convening of an EC/ESA 'High-Level Space Policy Group', co-chaired by the European Commission and ESA at Director General level and gathering representatives from EU and ESA Member States. The Group's stated goal is to reach a common understanding on the implementation of European Space Policy, in particular the preparation of the future European Space Programme. The Group's launch represents the first concrete action taken under the EC/ESA Framework Agreement Activities covering our ELGRA research area were addressed in the White Paper. As a recommended action regarding the role of the International Space Station it was stated "consistent with the outcome of the previous recommendation, the European Union with ESA to assess and ensure the availability of core capabilities and know-how in Europe which are indispensable for the preparation of human spaceflights activities and exploration. Continue the exploitation of the ISS as a common infrastructure, were possible, also in the context of the 6th Framework Programme. Another recommendation is "supporting ISS utilisation and fostering technology transfer to non-space applications

High Level Space Policy Group item cont'd.

Since this White Paper discussions on the European level have advanced. However, in a recent draft document as produced by the 'High-Level Space Policy Group' no mention whatsoever is made regarding our field of research and application. The paragraph in the draft text that comes most close to this says: "Current space exploration programmes, in Europe and elsewhere, intend to extend the human presence, in a real or virtual way, through missions to the Moon and to Mars or through automatic missions in direction to objects of the solar system. Complementary to, and in close co-operation with respective activities undertaken by ESA and other interested national agencies in this domain, the FP7 Space work programme will support research aimed at improving the capability to access planets surfaces, to move, to select and collect and finally return samples to Earth in the frame of space exploration activities." The exploitation of the largest research facility ever build, the ISS, is not mentioned. (This is very surprising while it seems that there is a clear interest in space and microgravity research as might be seen from the cover of a publication by the European Commission Directorate-General for Enterprise and Industry publication "European Innovation" of September 2005. We see the Italian-ESA astronaut Roberto Vittori during his visit to the ISS.)

Recently ELGRA has taken action towards the 'High-Level Space Policy Group' in addressing the problem that science for and in microgravity is not mentioned in this draft document. A letter was send to the EU representatives as well as to representatives from more than 30 countries participating in this Policy Group in the hope to draw their attention to our activities. The letter send can be found on our web site under 'Announcements'.

ELGRA as the main society for gravity related research within Europe intends to continue these activities in order to serve our members. See for additional information on EU space policy and activities: http://europa.eu.int/comm/space/index_en.html

Jack van Loon, Dec. 2006

European space life and physical sciences score very well.

In a recent bibliometric study conducted by the Center for Science and Technology Studies (CWTS), Leiden University, The Netherlands in contract for ESA-ESTEC it was shown that European scientists in the field of space physical (SPS) and life sciences (SLS) publish very well. The output of papers in peer-reviewed journal has increased steadily

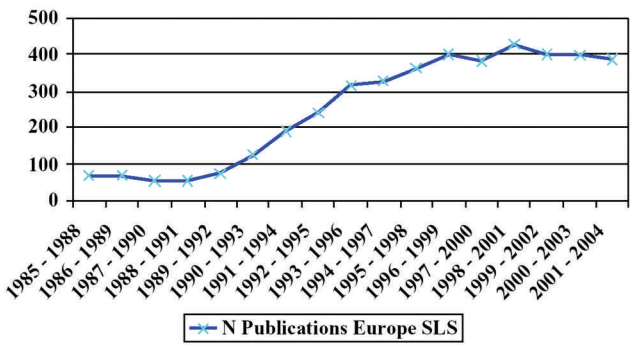


Figure 1: Publication output in Space Life Sciences of ESA/Europe increases strongly during 1990s

European space life and physical sciences score contn'd

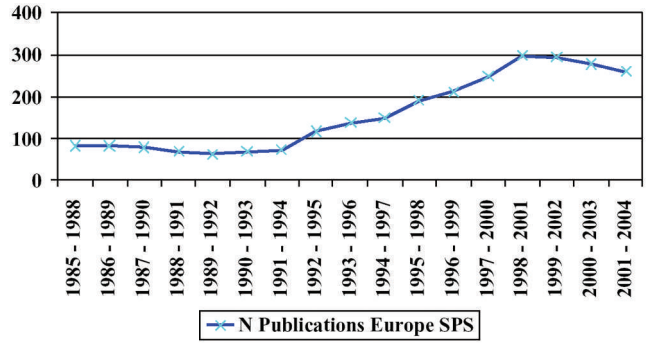


Figure 2: Publication output of ESA/Europe in Space Physical Sciences strongly up during 1990s/early 2000s.

The number of European papers is slightly below that from the United States and considerately higher than in Japan, Russia, Canada and remaining areas. See Fig.3.

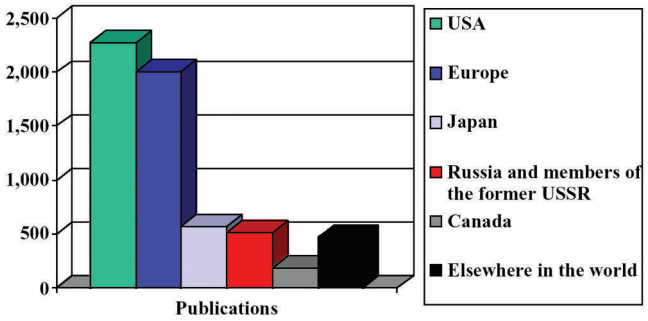


Figure 3: Output of ESA/Europe is close to that of USA in SLPS.

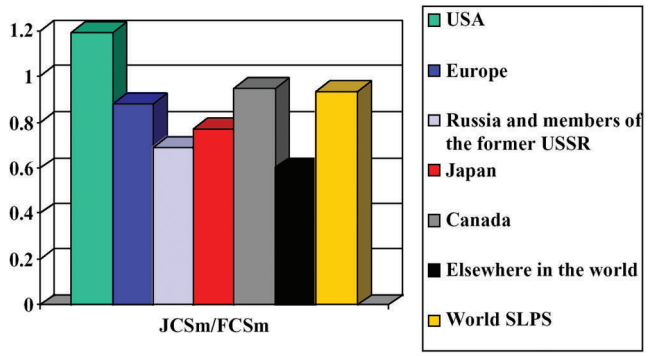
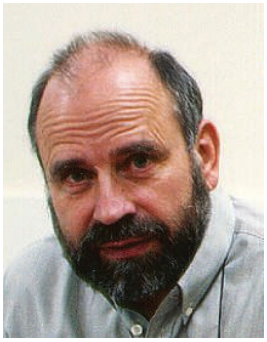


Figure 4 ESA/Europe publishes in journals of near ground-based impact level.

The average impact level of the journals in which our science papers are published have no or only slightly smaller impact level as compared to those for the general 'ground-based' papers. (Fig.4) Taken together these general figures we might conclude that the field of Space Physical and Life Sciences is doing very well. We are in very close competition with our US colleagues. Taken into account the investments ESA and the individual European national governments make for space and gravity related research we might conclude that Europe is leading in this field.
J. van Loon, Dec. 2006.

In Memoriam



Wolfgang Briegleb (1928-2006)

Wolfgang Briegleb died unexpectedly on September 16, 2006 - a pioneer in space biology. His name is associated with the fast-rotating clinostat and the slow-rotating centrifuge microscope NIZEMI.
Born on July 19, 1928, in Peilau, Silesia, Wolfgang Briegleb studied natural sciences at the University of Munich, Germany. In his thesis, he investigated the biology of the cave-dwelling Olm Proteus anguinus in its natural environment, the Postojna cave in Slovenia.

In 1962 he joined the Institute of Aerospace Medicine of the German Aerospace Centre (DLR), where he established and leaded up to his retirement in 1993 a division with a new topic – space biology. In 1965 he modified Muller's clinostat (dedicated for studies on altered gravity perception in humans) to the investigation of smaller objects. In Briegleb´s 2D clinostat the fast circular rotation about a horizontal axis compensates gravity, achieving functional weightlessness on Earth. His preferred research area became the gravity responses and gravity receptors of biological systems, such as beetles, frogs, toads, algae, nematodes, ciliates and especially the slime mould Physarum.
In order to observe the movements of cells and in cells during functional weightlessness, he integrated in 1971 a light microscope in clinostat. His favourites to demonstrate the quality of simulation were cells of the aquatic plant Elodea, in which heavy calcium oxalate crystals evenly distributed upon rotation (100 rpm) like in real microgravity. Wolfgang Briegleb loved puzzling about new experimental devices: results were e.g. a small light microscope for the German Spacelab mission D1, experiment-specific containers for several space missions, tilting light and stereo microscopes for 90° and 180° turns of objects. A further pioneering invention of Wolfgang Briegleb was the slow-rotating centrifuge microscope NIZEMI (Niedergeschwindigkeits-Zentrifugenmikroskop) providing accelerations between microgravity and 1 g in space and hypergravity on ground. The idea was realized in 1994 during the IML-2 mission, allowing the determination of gravisensitivity thresholds of different systems.
Wolfgang Briegleb could realize many of his ideas in space missions (sounding rockets (TEXUS) and space shuttles (IML-1 (1992), D-2 (1993), IML-2 (1994), STS-69 (1995)). He collaborated with numerous scientists from all over the world.
Over the years his clinostat principle received worldwide recognition, as data obtained in actual microgravity confirmed the high quality of the simulation. Today clinostats and the NIZEMI are common standard in preparatory and supporting experiments during space missions. They represent the basis of the life-science section of the DLR-User Support Centre MUSC (Biomedical Science Support Center) in Cologne.
Wolfgang Briegleb was among the very first ELGRA members. In 1982 he initiated the German space-related gravitational biology by convening meeting of potential users of space stations. In recognition of his achievements, Wolfgang Briegleb was awarded in 2001 the ELGRA-Medal.

Always curious and bursting with – sometimes quite unusual - ideas, he was able to relay his enthusiasm for his work to his c olleagues and friends. The ones who had the privilege to know him and to work with him will always remember many lively and fruitful discussions.

To compensate stress he practiced various sports. Since he loved the competition, he participated in marathons and up to this year in sailing competitions – almost winning one on the Rhine one week before his sudden death. He enjoyed constructing and flying gliders. With the age of 50 he resumed gliding – but the challenge was now the newly emerging sport of hang-gliding. For 28 years he was fascinated by soaring like an eagle. On September 16, 2006 Wolfgang Briegleb died at the age of 78 during hang-gliding, undoubtedly his favourite sport.

He is survived by his wife, a daughter and two grandchildren. With him a pioneer in space research has gone. We will miss him.

Ingrid Block and Ruth Hemmersbach, Cologne

Vibration training does not counteract decrease in plasma and stroke volumes after 14 days of 6 ° HDT bed rest.

Philipp Zervoulakos[1], Robin Otchwemah[1]

[1]Institute of Aerospace Medicine, German Aerospace Centre, Cologne, Germany. Corresponding author Philipp Zervoulakos Mail: philipp. zervoulakos@ dlr. de

Plasma volume (PV) and stroke volume (SV) are known to decrease after exposure to microgravity and to head- down- tilt bed rest (HDT). Physical exercise is a means of partially preventing cardiovascular deconditioning due to microgravity exposure. Application of vibration, a special type of exercise stimulus, is reckoned to increase the effectiveness of physical training. We investigated the impact of daily vibration training on plasma- and stroke volume following 14 days of HDT bed rest to test the hypothesis that vibration training prevents the deleterious effects of bed rest. Eight healthy male volunteers (26.38 years ± 4.90 SD, 179 cm ± 0.96 SD, 78.11 kg ± 9.54 SD) participated in a crossover designed study. The subjects were accommodated in the metabolic ward of the Institute for Aerospace Medicine, Cologne, Germany, where they completed two study phases, each one consisting of 4 days adaptation, 14 days HDT bed rest and 5 days of recovery. Vibration training was performed twice every day of HDT bed rest. Each workout was composed of 5 bouts of isometric exercise on a vibration platform in upright standing position with a defined knee angle of 30 ° paused by recovery periods of 1 minute. The applied vibration frequency was 20 Hz with amplitude of 2- 4 mm during one minute. In the control phase the course of the workout session was identical to the intervention phase, except for the absent vibration.

Cardiac output (CO) was assessed in the supine position by a foreign gas rebreathing method, which took place on the day before last of adaptation period, and on the first day after HDT bed rest. Stroke volumes were calculated by dividing cardiac output by the heart rates derived from the simultaneous ECG recordings. We also measured plasma volume on the last day of adaptation period and on the last day of bed rest by the Evan's Blue dye dilution technique. These measurements were performed only on four subjects under control conditions and on four subjects who performed the vibration protocol.

In addition, the course of haematocrit change was evaluated on all subjects under both conditions.

Figure 1. Experiment setup for cardiac output estimation by foreign gas rebreathing. Measurement in supine position.

Analysis of haematocrit values showed an increase (43.29 ± 3.54 SD to 44. 99 ± 2. 54 SD; p= 0.003) during the first 6 days of bed rest followed by a decrease achieving baseline values (43.29 ± 3.54 SD) at HDT- day 14. There were no differences across both study conditions (p= 0.719). The recovery period was characterised by a drop of haematocrit under baseline level (43.29 ± 3.54 SD to 39. 69 ± 2. 43 SD; p< 0. 001). The parallelism between the time courses of haematocrit across both conditions supports the notion that vibration was ineffective in counteracting the plasma volume changes induced by HDT bed- rest. The limited Evan's Blue plasma volume data further support this view. These determinations showed significant plasma volume reduction (p= 0.011) following HDT bed rest. The mean PV value obtained from the pooled data (control and vibration) before bed rest was 4310. 24 ml ± 341.90 SD. Plasma volume measurements performed after bed rest revealed a volume loss of 422. 83 ml ± 351.64 SD which comes up to a difference of 9. 7% ± 8.10 SD.

Statistical analysis of stroke volume values acquired before bed rest under both study conditions resulted in a good agreement (p= 0.786). A t- test for dependent samples revealed a decrease of stroke volume following HDT bed rest with a mean reduction of 17. 19 ml ± 7.16 SD (p< 0. 001), but no changes in heart rate values (p= 0.889).

In the light of these results, we conclude that the applied vibration workout fails to ameliorate reduction of both, plasma and stroke volumes caused by 14 days of head- down- tilt bed rest.

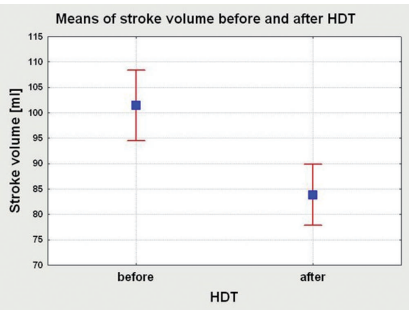


Figure 2. Decrease of stroke volumes after HDT bed rest in both, the intervention and control group with a mean reduction of 17.19 ml ± 7.16 SD (p< 0.001). Vertical bars denote 0.95 confidence intervals.

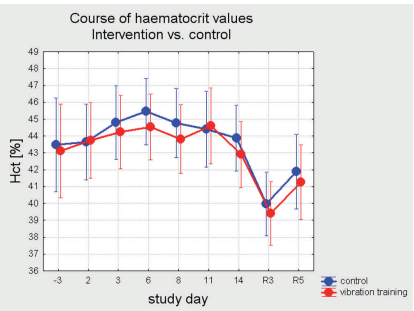


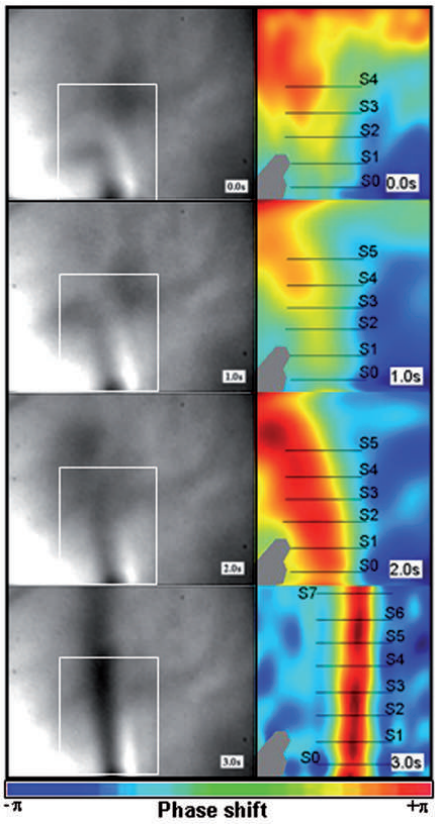
Figure 3. Course of haematocrit values. No difference across both study conditions (p= 0.719). Vertical bars denote 0.95 confidence intervals.

GAS JET STUDY IN MICROGRAVITY ENVIRONMENT

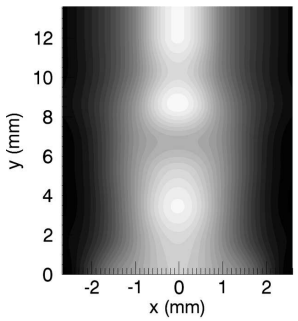
Rui Rocha, Vítor Botelho (Authors), José Pais (Co- author).

Contact: rui. mr@ clix. pt, Phone: +351 919225270 Physics Department, University of Porto, Rua do Campo Alegre, 687, 4169- 007 Porto, Portugal

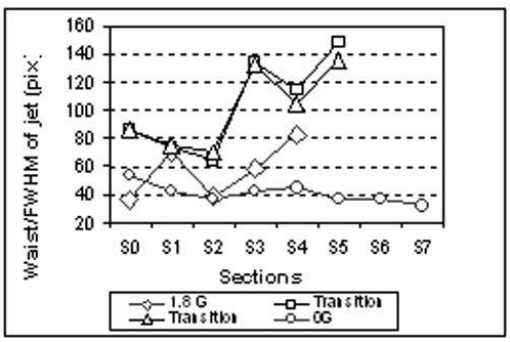
In the present work we have studied the flowing dynamics of a CO2 gas jet in a micro and macro gravity environment, produced by a conical nozzle and using both Mach- Zehnder interferometric and Schlieren imaging diagnostics recorded on two CCD (charge coupled device) cameras. Mach- Zehnder technique must be combined with a posterior numerical treatment of the raw data obtained, thus it cannot be used for real time monitoring of the gas jet. On the other hand, the Schlieren method allows real time visualization of the gas jet, which makes it ideal for monitoring and adjusting the jet parameters while performing the experiment. The selected diagnostic techniques have therefore a complementary character. The altered gravity environment was obtained on board of an A300 ZERO- G airplane performing 62 parabolic flights during the 7th Student Parabolic Flight Campaign (SPFC) from the European Space Agency (ESA), which took place in July 2004 at Bordeaux, France. During each parabola the gas jet experienced about 20 seconds of 1.8g (macrogravity), followed by 20 seconds of 0g (microgravity) returning to another 20 seconds of 1.8g. The optical diagnostics together with numerical analysis led to the time- dependent determination and characterization of the gas jet flow and its spatial structure. Our study of a CO2 gas flow near the laminar regime gave us the opportunity of simulating a small gas leak under microgravity. We observed considerable differences in the shape and height of the CO2 jet, as well as the gas jet dynamics, in distinct gravity environments. In particular, both the phase maps and the shadowgraphs appear to suggest the formation of higher density structures and surface ripples. Future investigations should be undertaken under stable microgravity conditions to better study the flowing dynamics.



The Mach Zehnder Interferometer and Schlieren images: A typical sequence of phase maps and Schlieren images, obtained from the Mach- Zehnder and Schlieren diagnostics respectfully in three distinctive situations: 1. 8G (macrogravity), the transition from 1.8G to 0G and during 0G (microgravity).



Reconstruction of the gas jet radial profile: Under microgravity, the waist of the jet does not vary much since the axial transport of the CO 2 gas from the centre to the outer regions is possibly dominated by axial diffusion



Variation of the waist of the gas jet at different heights for different gravity conditions: The waist of the jet under different gravity conditions has been reconstructed using the Abel transform to determine the refractive index radial distribution at different heights (s0 trough s7).

ELGRA medals for Augusto Cogoli and Johannes Straub

Abstracts from the lectures delivered by the two ELGRA Medal Awards

ELGRA president D. Beysens (l) and A. Cogoli (r)

HUMAN LYMPHOCYTES IN SPACE: 1975- 2005, THIRTY YEARS OF UPS AND DOWNS

Augusto Cogoli
Zero- g LifeTec GmbH, Technoparkstrasse 1, CH- 8005 Zurich, Switzerland

In late summer 1976 shortly after humans made their last excursions to the surface of the Moon, I found in the coffee room an unopened envelope addressed to the institute of Biochemistry of the ETH Zurich where I was working at that time. After five or six days in which the envelope lay neglected on a table I decided to open it. It was the invitation of ESA to submit experiment proposals to be flown in the first Spacelab mission. That was the beginning of my career as a “Space biologists”. What triggered my interest was the opportunity to expose living systems to environmental conditions not reproducible on Earth. The activation in- vitro of human lymphocytes 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 of cell differentiation. With the flight of our experiment in Spacelab 1 in 1983 my team 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. Recently we have also addressed the question if the scientific and technological knowledge acquired in space can be exploited for bioprocesses of medical and commercial importance. 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.

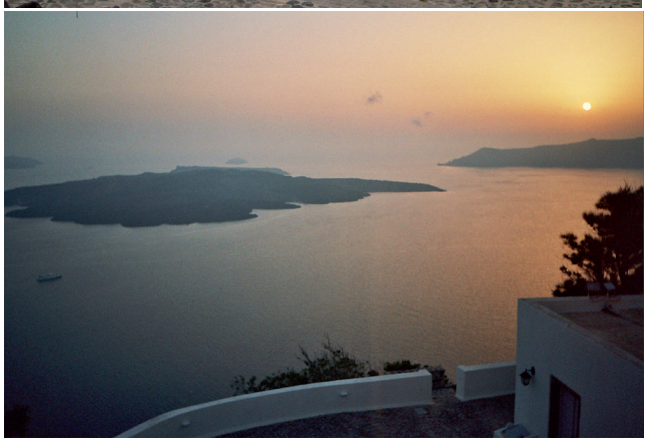
ELGRA president D. Beysens (l) and J. Straub (r)

PERSONAL MEMORY: 25 YEARS FLUID RESEARCH IN MICROGRAVITY

Johannes Straub
Retired from Lehrstuhl Thermodynamik, Technische Universität, Groebenzell,

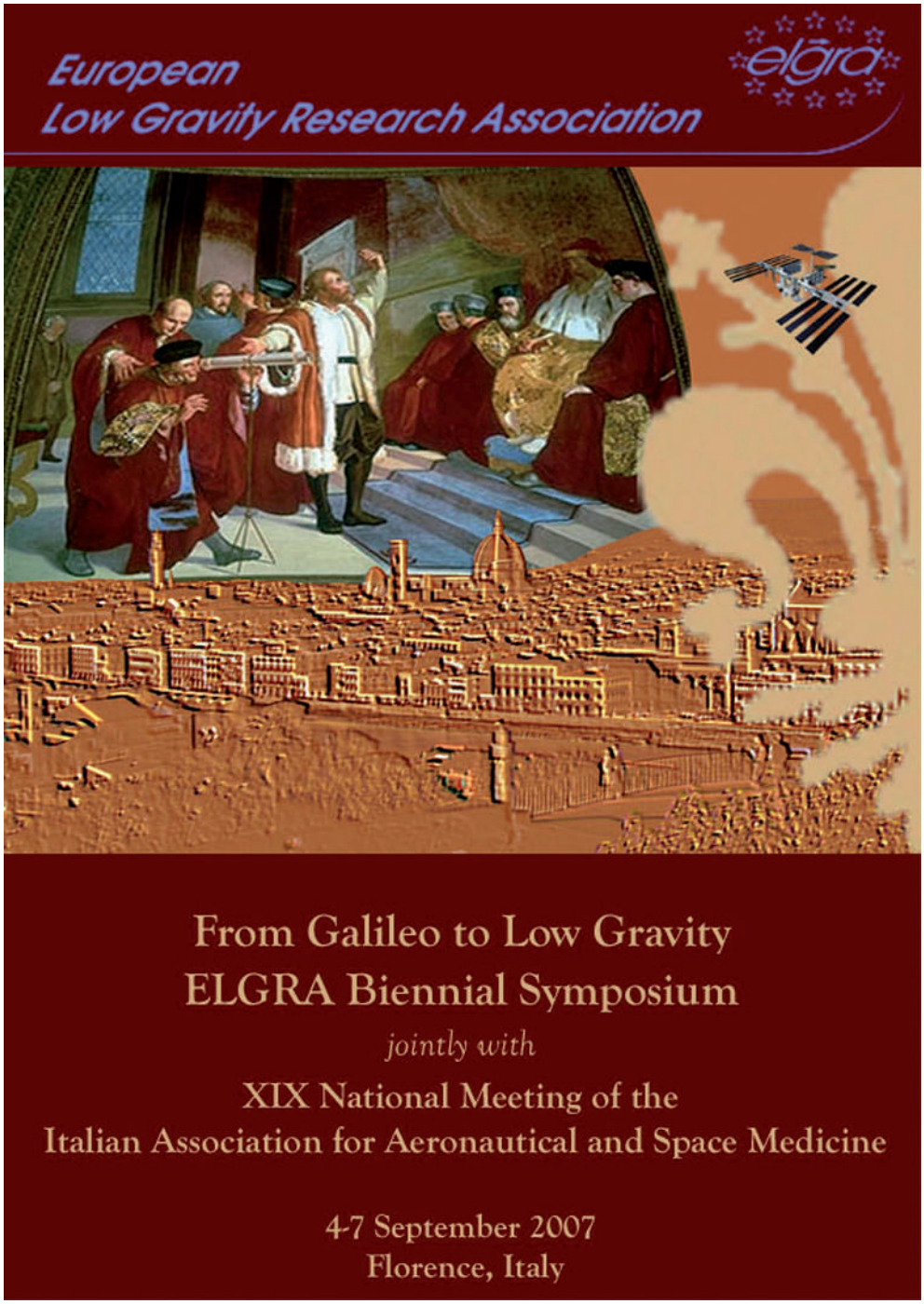
A short personal report will be presented about microgravity research in some fields of fluid physics. The author had the unique chance to be involved in microgravity experiments when this environment was opened to scientists. In thermodynamics and heat transfer the effects of gravity are well known. Fluids are most effected by gravitational forces which causes convection even at only small temperature differences. The buoyancy effect in fluids results in different densities caused by temperature or concentration. Great density differences appear if liquid and vapor act together in case of boiling and two phase flow. Many unknown phenomenon can be observed at the interaction of different phases which are not observable under the gravity influence on earth. Other phenomena occur due to the high compressibility of fluids at their critical point, known as critical phenomena. Not only that the high compressibility causes density stratification, but even by thermodynamic relations, other thermodynamic properties connected with the compressibility are effected by gravity and with that the fluids static and dynamic behavior.
At the presentation we will report about our experiments on critical phenomenon during the D1 and D2- mission, especially about the measurements of the isochoric heat capacity in the HPT with the new developed scanning radiation calorimeter. The experimental results confirm the prediction of the Renormalisation Group Theory with a critical exponent ? = 0.1105. During the same mission the identical facility could be used to prove the recent theory of the dynamic temperature propagation, called by our French colleagues "Piston Effect". Measurements are performed from 3 K below to 5 K above the critical temperature. The difference between the wall temperature and the temperatures directly measured in the fluid at various positions decrease to zero approaching the critical temperature. Experiments in Boiling started in 1980 with TEXUS, and are continued with aircraft KC135, and they finally culminate in three Space Shuttle missions. Boiling is influenced by many independent, and related parameters, therefore many experiments are necessary to understand the real physical nature of boiling. The general and most interesting result was that boiling can even be maintained in microgravity, this statement is still questioned by experts of boiling. In the lecture only a short presentation can be given about what we achieved up to now and what we may expect from future experiments.

Santorini Meeting



Some Forthcoming Events / Meetings:

- 45th Aerospace Sciences Meeting. m21st Microgravity Science and Space Processes Symposium. Reno, NV, USA. Jan 8-11, 2007
- 28th International Society for Gravitational Physiology (ISGP): 8-13 April 2007, San Antonio, USA
- STAIF-2007 (Space Technology & Applications International Forum) Albuquerque, NM, USA. Feb 11-15, 2007. http://www.unm.edu/~isnps
- IAA (International Academy of Astronautics), Humans in Space Symposium. Beijing, China. 20-24 May, 2007. http://www.iaaweb.org/
- ICES: 37th International Conference on Environmental Systems, July 9 - 12, 2007. Chicago, Illinois, USA. http://www.sae.org/events/ice/cfp.htm
- 58th IAF, Hyderabad, India between 24 - 28 September 2007
- ISPS: 22-26 October 2007 in Nara, Japan
- 10th ESA Life Sciences Meeting: 22-28 June 2008, combined with ELGRA, ISGP, ASGSB and CNES, Angers, France. See item in this NewsLetter
- 37th COSPAR 13 - 20 July 2008, Montreal, Canada



Fresco portraying Galileo Galilei which is showing his telescope to the Venice Senate; the outline of Florence and the fleur- de- lis (symbol of the city) with the space station.

Galileo Galilei (1564 – 1642) was an Italian scientist who formulated the basic law of falling bodies and, first of all, he realised that the rigidity of the skeleton of terrestrial animals is related to its load bearing function. He constructed a telescope with which he studied lunar craters, and discovered four moons revolving around Jupiter and espoused the Copernican cause.

ELGRA – European Low Gravity Research Association
2007 Biennial Symposium and General Assembly
Jointly with the
XX National Meeting of the Italian Association for Aeronautical and Space Medicine
September 4 th -7 th, 2007. Florence, Italy

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(ELGRA Management Committee)

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Local Organizing Committee

Dr. Monica Monici, Chair

Organizing Secretariat

Dr. Giovanni Romano, Assistant
Dr. Venere Basile, Assistant

Under the auspices of:

Faculty of Medicine, University of Florence
National Institute for Cardiovascular Research

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 architectonical point of view, it is considered one of the most beautiful examples of "functionalism".

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 13 th 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.

Social Program

The social program of the symposium will include the visit to the Galileo Tribune at the "La Specola" Museum, Institute and Museum of the History of Science.

Call for abstracts

Traditionally, the Elgra meeting is a forum for scientific and technological research in microgravity.
Abstracts in the fields of life, physical and material sciences, fluid physics, physiology, biotechnology and other are welcome.

Student Contest

For more info see **www. elgra. org**

Important deadlines

Submission of abstracts: March 31, 2007
Notification of acceptance: May 30, 2007
Early Registration: June 15, 2007

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ELGRA Membership Application

Membership	fee
Student Member	free
Regular Member	¤ 50,00
Supporting Member	¤ 600,00

For further information and to download the application form, please refer to the Elgra web site at **www.elgra.org**