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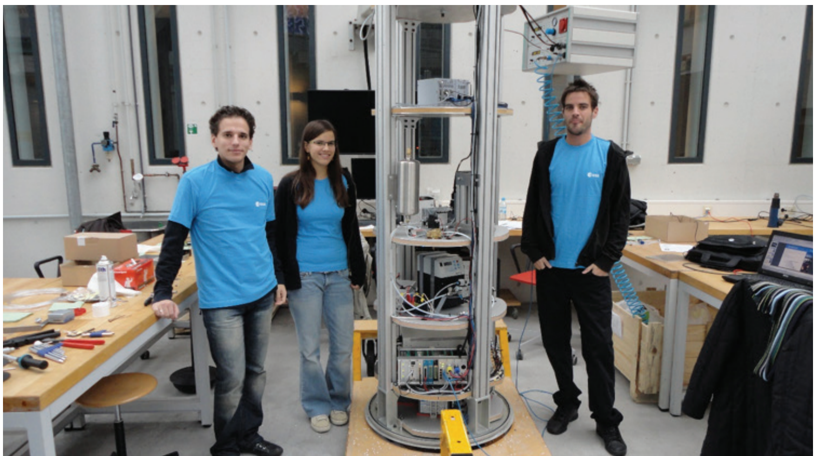

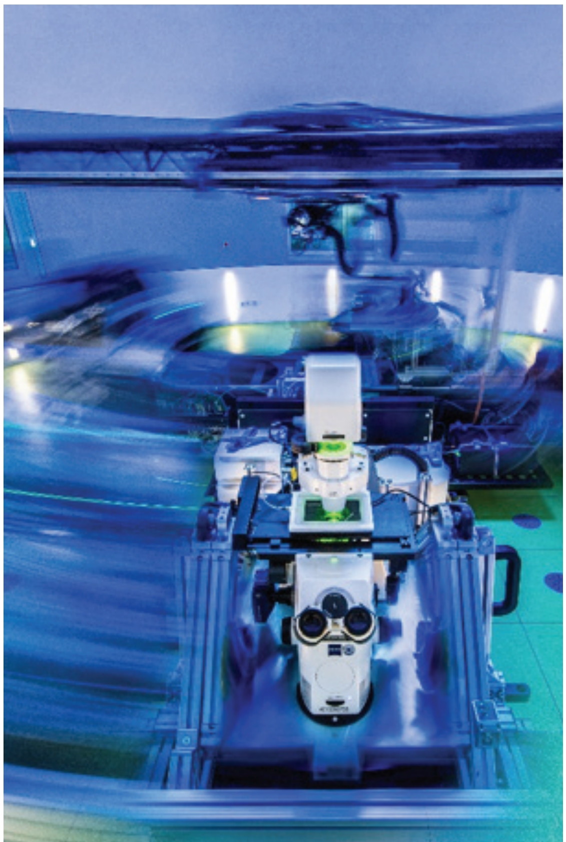

ELGRA Membership

Become an ELGRA member and strengthen our community! The following annual fees apply.

Students	**free**
Regular member	**50 euro**
Supporting member	**600 euro**

For further information and to download the application form, please visit the ELGRA web site at www.elgra.org.

The 26th edition of the ELGRA Symposium and General Assembly will be held jointly with the 14th International Conference on Two Phase Systems for Space and Ground Applications (ITTW-2019) and the annual meetings of the following European Space Agency Topical Teams:

- Diffusion in Non-Metallic Mixtures.
- Geophysical Fluid Flow Simulation.
- Marangoni Instabilities in Systems with Cylindrical Symmetry.
- Non-Equilibrium Phenomena in Soft Matter and Complex Fluids.
- Personalised Medicine Approaches for Space Exploration.
- Space And Ageing.
- Space Grains.
- Thermophysical Properties.
- Wound Healing (Tissue Healing in Space: Techniques for Promoting and Monitoring Tissue Repair and Regeneration).

The Symposium will take place at the Barceló Granada Congress Hotel in Granada (Spain) from 24th to 27th September 2019. Granada is a charming city in the southern region of Andalusia, with many interesting sights to visit and an attractive style of life for visitors. The venue is located close to the city center and offers excellent facilities for conferences. This is the ideal place to meet, generate fruitful discussions, start new collaborations, and elaborate bright ideas about microgravity research that will make our community even more successful.

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www.elgra.org

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PRESIDENT'S WORD

Dear ELGRA members,

2019 is a special year for those interested in Space Exploration in general, and in particular, for the ELGRA community. This year we celebrate the 50th anniversary of Neil Armstrong's (and humanity's) first steps on the moon, a milestone of the Apollo programme. Ten years after such a memorable event, a group of scientists (Prof. F. Bonde-Petersen from Denmark, Dr. Y. Malméjac from France, Prof. L.G. Napolitano from Italy, Dr. J.F. Padday from the UK, Dr. Stott from the UK, Prof. H. Weiss from Germany, and Dr. H.S. Wolff from the UK) made their own steps to form an association. Its purpose, to foster cooperation between European scientists involved in low gravity research and to provide ground-based expert advisory service for low gravity experiments. ELGRA was created on June 18, 1979. The ELGRA Management Committee (MC) aims to celebrate both these events, including through the new ELGRA Magazine. The write-ups included from some of our former ELGRA Presidents will undoubtedly provide us with interesting information on the history of our organization.

In fact, this Magazine is by itself a novelty. We moved from our printed Newsletter to an electronic Magazine with many advantages. Among others, it includes hyperlinks, has an improved design, can be stored on your computer, and ELGRA's economy likes it.

In the first issue of our new ELGRA Magazine, we summarize the main activities carried out by ELGRA in the last two years. In addition, we present information and announcements on future events.

In October 2017, the 25th ELGRA Biennial Symposium and General Assembly took place in the conference center of Juan-les-Pins (France) jointly with the 7th International Symposium on Physical Sciences in Space. This symposium was co-organized by ELGRA and ESA. Although ELGRA and ESA are different organizations in many aspects, they share some common goals. The success of the symposium shows that we can reach these goals by working together. It is in the aim of the ELGRA MC to continue the collaboration with ESA in future opportunities. During the symposium the organizers were proud to hand over the ELGRA Medals 2017 to Prof. Jack van Loon and Prof. Hendrick Kuhlmann.

A new MC was elected in the General Assembly in Juan-les-Pins. Although almost half of the committee members (3 out of 7) are new, they have perfectly integrated in the dynamics of a committee of this kind, contributing to different tasks. Inside this Magazine we present you the new members.

The ELGRA/ESA Gravity-Related Research Summer School co-organized with ESA Academy reached its 3rd edition in June 2018, with an increase of the number of selected students from the previous editions. In the 2018 edition, 30 students were introduced into physical and life science research in microgravity and hypergravity. Some of these students have already started developing their careers in gravity-related research, whilst others have explored other opportunities. The most important outcome of the school is the fact that many students will acquire an understanding on our research topic, which is very difficult to get in a regular university course. In addition, according to the survey to the school attendees at the end of the course, the level of satisfaction of students with the school is very high. This is another example of an excellent outcome of an ELGRA-ESA collaboration, which is possible thanks to the valuable participation of the ELGRA speakers.

Our collaboration with ESA Education Office on the students programmes which make use of microgravity and hypergravity platforms has successfully continued. The new programmes Spin your Thesis! Human Edition and Orbit your Thesis! were launched in 2018, offering student teams additional opportunities to carry out their experiments.

In the framework of our 40th anniversary celebration, the "Gravity Spotlight Team" grant was launched with the aim at fostering multi- and interdisciplinary projects by providing opportunities including workshops, working groups or forums. Inside you will find more information about it.

The 2019 ELGRA Symposium and General Assembly will take place at the Barceló Granada Congress Hotel in Granada (Spain) from 24th to 27th September. Granada is a charming city in the southern region of Andalusia, with many interesting sights to visit and an attractive style of life for visitors. This venue is the ideal place for us to meet, generate fruitful discussions, and elaborate new ideas about gravity research that will make our association and research community even more successful. I am looking forward to seeing you there.

In this Magazine we also remember our colleague Prof. Jean-Claude Legros who recently passed away after a pioneering career in microgravity research full of scientific achievements.

I would like to thank Carole Leguy for the edition of this Magazine and all the colleagues who contributed to it.

I wish you a Happy 40th ELGRA anniversary hoping that your research goals for the year have gotten off to a great start.

All the best,

Ricard González-Cinca
ELGRA President

ELGRA IS 40 YEARS OLD, FORMER PRESIDENTS REMEMBER.

Augusto Cogoli, President 1986-89 and Marianne Cogoli, President 1999-2003: 40 years of microgravity research in cell biology

Spacelab 1 crew training with the incubator at the ETHZ in 1979
From left Wubbo Ockels, A. Cogoli, Ulf Merbold Mike Lampton, Owen Garriott, Bob Parker, Byron Lichtenberg, Claude Nicollier

In July 1969 we both followed with great excitement the landing of Apollo 11 and the first steps of the astronauts on the moon.

A few years later Augusto presented a proposal for his first lymphocyte experiment in space upon a call of ESA. On a morning while traveling to work we discovered in the daily newspaper an article on a swiss experiment selected for Spacelab-1; but no name was mentioned. A few hours later we had the confirmation that it was Augusto's experiment. And so, we entered the world of microgravity research. In 1997 he founded the Space Biology Group at the ETH in Zürich.

Very soon this new and special research community expressed the need for an association. Augusto still remembers that long train trip to Grenoble in June 1979 where, with a simple ceremony, ELGRA came to life.

The beginning of microgravity research was not easy. A complex task was to satisfy the needs of different disciplines like fluid and material sciences on one side and biology and medicine on the other. Moreover we had to compete with the traditional and strong Space Science for the resources and research platforms provided by ESA.

The advent of several Spacelab missions, of Russian biosatellites and sounding rockets and later also the International Space Station permitted to establish microgravity research as an important scientific and technological discipline. The use of ground-based facilities like clinostats and free-fall machines were useful in preparing experiments in space and in predicting possible effects of real microgravity in space.

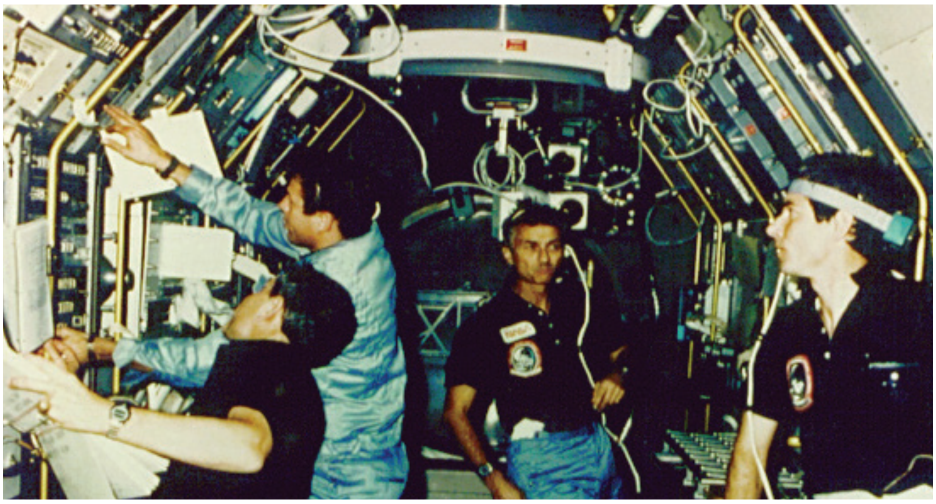
A major achievement of ELGRA was that since its beginning it provided an invaluable opportunity to establish interdisciplinary and international collaborations and by giving advice to ESA and national Agencies in shaping the research programs.

Incubator installed in Spacelab rack; beside the culture block syringes containing either activator, marker and fixative are placed.

Another important activity consisted of the organizing scientific meetings and Summer schools where young scientists and students were guided to approach and appreciate microgravity research.

Hundreds of papers in international high-impact journals from all disciplines fostered by ELGRA testify the success of the members of our association. Focussing on our own contribution in Space Biology we would like to mention our work in cell biology. Our first experiment was conducted on Spacelab 1 in 1983. We were able to demonstrate that single cells in culture are sensitive to changes in the gravitational environment. In particular human T lymphocytes, a population of white blood cells, responsible for immunity against infections, could not respond to activation agents in microgravity. The findings, published in Science, had a large resonance in the scientific community and several researchers worldwide were inspired to study the phenomenon. Thank to intense collaborations with colleagues in the USA, Russia, Italy and Japan we were able to confirm the data on several following space missions (about 30 experiments performed on different shuttle missions and sounding rockets and finally in Kubik BIO#1 on ISS in 2006) and to study at molecular level the origins of the effects.

In the last 40 years space biology has evolved from "try-and-see" experiments to sophisticated basic and applied research with well-based hypotheses as well as studies on the use of low gravity in biological applications. To perform an experiment in space is quite different than in the earth laboratory. Scientists need special hardware and have to follow special requirements. Further there is the need for a proper control to find out if the effects observed in space are really due to microgravity. To fulfil the requirements of many scientists ESA built a multiuser facility for biological experiments in microgravity – BIORACK. This facility contained 2 incubators, one for 22°C and the other for 37°C, 1-g control centrifuges, a microscope, a glovebox and a cooler/freezer unit. Researchers were supported by the Biorack-team, a group of scientists and engineers from ESA. This team was responsible for all aspects of the performance of the different experiments and a real help to the scientists. Biorack has been flown for several times in the space shuttle or in shuttle to Mir missions. Many biological experiments have been flown in this unique facility and a whole series of new and in part unexpected results were obtained.



Incubator installed in Spacelab during Spacelab-1 mission (red arrow)

In 2000 ESA decided to set up a network of 9 User Support and Operation Centers (USOC) distributed all over Europe for all disciplines of microgravity research. To our great astonishment one of these center was assigned to our Space Biology Group in Zürich - we named it BIOTESC „Biotechnology Space Support Center". At the beginning, BIOTESC was Facility Support Center (FSC) for Biolab located at MUSC, the German USOC. Later it became a Facility Responsible Center for Kubik, but still functions also as FSC for Biolab. Kubik, located on the Space Station, is a versatile facility for the performance of biological experiments containing an incubator and 1-g centrifuge. The samples must be returned to earth before having any result. Biolab is a more complex facility and allows to get certain data already during a mission. BIOTESC supports scientists in the set-up and performance of their experiments – like the BIORACK team at earlier time. BIOTESC can give advices to astronauts and scientists can directly follow their experiment.

After our retirement we have handed over the Space Biology group to Marcel Egli. In January 2013 he transfered the Space Biology group and BIOTESC from Zürich to the Lucerne University. It is now located in Hergiswil.

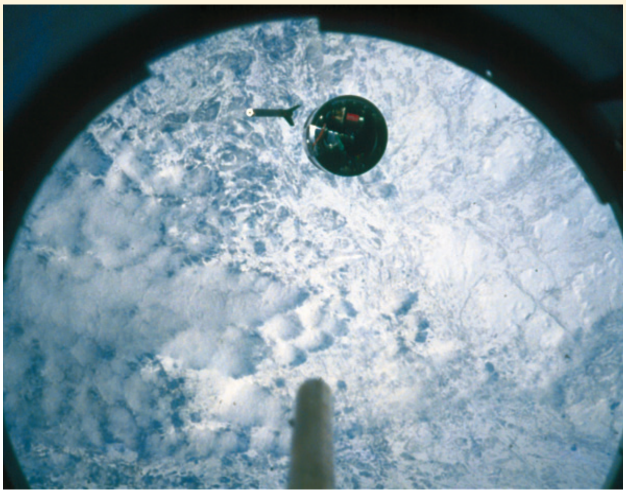
We were proud to share our and others ideas, data and achievements within the ELGRA community and we wish to our association the same success we experienced in the past 40 years. We are also proud that we have both had the honour of being President of ELGRA.

Jan P.B. Vreeburg, ELGRA president from 1989 until 1993

The introduction of ELGRA occurred at the 3rd European Symposium on Materials Science in Space in 1979 (Grenoble). It was a logical step in the further development of the user community that had been organized by ESA and national authorities in anticipation of the use of Spacelab and other carriers. Dedicated groups prepared experiments in ground laboratories, sounding rockets and space vehicles, and used gained experiences for consultation on space experiment facilities under development by industry. Many investigators were or had been members of ESA's Materials (and Fluid) Science Working Group, Life Sciences Working Group, one of the various expert groups or similar national teams. They became the first ELGRA members.

ELGRA provided a forum for the presentation of research activities and experiment proposals and so fulfilled its major objective: the promotion of cooperation between different groups. Other objectives were education (summer schools), contacts with similar organizations outside Europe (Japan, US) and be the public voice of the microgravity community on space policy issues. These objectives have not changed much over the years but there has been a shift of interest towards life science disciplines.

Among the investigations with microgravity relevance possibly the oldest can be characterized as 'unsupported system'. A good example from the 19th century is the analysis of the falling cat landing on its feet, whose maneuver is copied by astronauts floating in weightlessness to show (off) that they can turn around without external contact. In the same category is the study of slosh dynamics (a Wikipedia lemma) that seeks to determine the interaction between the motion of a rigid tank and its (partial) liquid fill. As such the problem has been studied from the beginning of rocketry (e.g. for the V-2 guidance system) and space operations. National Aerospace Laboratory NLR and partners have prepared experiments in this field from basic investigations in the Fluid Physics Module (Spacelab) to the Wet Satellite Model launched with the Maser V sounding rocket, to the dedicated Sloshsat spacecraft in 2005. The investigations had a fundamental aspect also since they might clarify the unexplained strong damping of liquid oscillations in containers in microgravity.



View of the Wet Satellite Model experiment just after its release from the MASER V sounding rocket (1992 Apr 9, Swedish Space Corporation).

Together with the experimental program a Computational Fluid Dynamics (CFD) package has been developed at Groningen University (RUG). It was special for its capability to handle large deformations of a free liquid surface, accounting also for surface tension effects. CFD became a developed discipline during the 70's and 80's of the previous century, made possible by the advancing processing capability of the computer. An objective of the experiments has been validation of the CFD package, another to support the development of a simple slosh model for inclusion in spacecraft motion control algorithms. This slosh model was to be refined from comparisons with predicted spacecraft motions by the validated CFD package. Industry developed CFD programs for slosh problems, under contract with ESA.

Flow in liquid with a curved free surface in a moving tank can be predicted accurately only with CFD. If the tank motion is imposed, as during excitation in the Fluid Physics Module, the problem is much less complicated than for an unsupported tank. In a coordinate system fixed to the tank its motion becomes a force field in the liquid flow equations and can be highly variable. The motion of the tank, supposing its inertia tensor is known, gives precise data of the force and torque that is exerted by the liquid. These data are predicted also by the CFD package and so form a basis for validation. The shape of the liquid is predicted as well and should be compared with visual observations.

At this time, relevant research is performed in the free-floating SPHERES facility of ISS. The investigators are from the US and, in addition to partially filled tank experiments, study multiple unsupported systems, as in formation flying and during (energy) transfer. The investigations have various applications within the defence but also in the civil domain, for example to develop controls for manoeuvring inspection spacecraft. These are often liquid fuelled and so have to deal with liquid slosh problems. Formation flying allows replacing a big spacecraft by a myriad of small ones.

Manuel G. Velarde (1997-1999): My relation with ELGRA

Preliminaries and service to the ELGRA community

I do not remember when I joined ELGRA and for how long I was one of its members. What I do remember is that I started participating in space related activities as peer reviewer and member of panels for ESA in the eighties of past century. Then I became member of its MAC (1994-97) and that led me to ELGRA. Consequences of this involvement was, on the one hand, the activities I did as service to the ELGRA community and, on the other hand, the orientation of part of my scientific research. I participated at an ELGRA Symposium in Madrid in 1983 and secured its realization at UNED (Spanish Open University) quarters where I was Professor. In 1993 I organized at Universidad Complutense Madrid an ESA sponsored Symposium on interfacial phenomena on Earth and in space. Under the presidency of Prof Y. Malmejac, in 1994 I organized the ELGRA biennial conference and General Assembly that took place at U. POLITECNICA MADRID. Besides regular scientific presentations we had a special session open to the lay audience at ATENEO of Madrid (where I had a Chair sponsored by the BBV Foundation) with participation of several ELGRA scientists and ESA astronaut C. Nicollier. I was the promoter of the ELGRA Medal securing its materialization by Spanish artist D. Blanco. At the closing session of the mentioned biennial meeting (with participation of ELGRA President and the then candidate-astronaut P. Duque, later an experienced astronaut and at present Minister of Research and Universities of Spain) two medals were offered to the late Prof. I. Da Riva and to Dr J. Padday, respectively, for their outstanding and seminal research activities and service to ELGRA (a violin recital was given in memory of the former). I participated in several other ELGRA biennial meetings of which I remember one in Roma (1999) and another in Santorini (2005) where I delivered results of my research. In 1997 I was co-chairman of the St.Petersburg-Kiji ship conference on Physical Sciences in Microgravity conference, sponsored by ESA, ELGRA, NASA and the Soviet Space Agency. At various times I participated representing ESA and/or ELGRA at NASA-ESA-Soviet Space Agency-USSR Academy of Sciences meetings: Ottawa (1982, COSPAR), Boulder (1988, Workshop at the Center for Low-Gravity Fluid Mechanics), Moscow (1989, Institute for Problems in Mechanics, International Conference Plenary speaker "Interfacial phenomena: Oscillations and Chaos. Interfacial turbulence"), and Orlando (1999, Presidential welcome address at ISGP on behalf of ELGRA). Further, along the years I have organized several international conferences: in 1986 on Physicochemical Hydrodynamics (La Rabida; an ELGRA management meeting took place there; proceedings published by Plenum Press), in 1992 an IUPAP Teaching Modern Physics Conference (Badajoz, with the presence of ESA and ELGRA representatives, and Cuban cosmonaut A. Tamayo and Director General of UNESCO Prof. F. Mayor; proceedings published by World Scientific). In 1998, sponsored by ESA and ELGRA, I organized in Madrid an IUPAP satellite workshop on interfacial phenomena. In 2000, I codirected a school on interfacial phenomena at CISM (Udine; lecture notes published by Springer) followed by several other workshops and schools in Spain (lecture notes published by World Scientific) and Morocco (with additional EPS sponsorship). I contributed two chapters (Fluids and transport phenomena, Critical phenomena) in the ELGRA "yellow" book European Low-gravity Physical Sciences in Retrospect and in Prospect (1995), a natural follow-up of the seminal document Challenges & Prospectives of Microgravity Research in Space (1981, ESA BR-05) by ELGRA founders Y. Malmejac, A. Bewersdorff, I. Da Riva and L. Napolitano. In 1998 at the 2nd European Symposium on the Utilization of the International Space Station (ESTEC), I coauthored with J. J. Favier a summary evaluation report on "Physical Sciences and Applications" contributions, ESA SP 433, pp. 663-664. In 2001, I reported on "Achievements and prospects of research in physical sciences in space" at the First International Symposium on Microgravity Research & Applications in Physical Sciences & Biotechnology, ESA SP-454, pp. 27-28. Finally, I was ELGRA Vice-President (1995-97) and President (1997-99).

Collaborative research following ELGRA aims

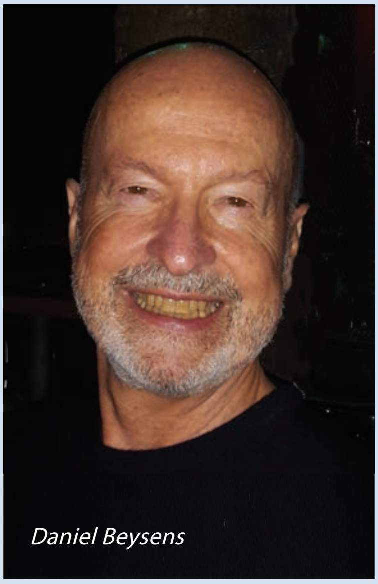
Largely motivated by my ESA and ELGRA related duties I was involved in the study of fluid physics and, in particular, interfacial phenomena. Major results achieved were: an in-depth study of the Benard-Marangoni (buoyancy-thermocapillary) convection (evolution of patterns and role of pattern defects and their influence on transport), clarification of the interplay of buoyancy with the Soret efeffect and double diffusion processes, elucidation of significant features of transverse (capillary-gravity) and longitudinal (dispersionless, alien to gravity) interfacial waves, and the prediction and subsequent experimental verification of interfacial solitons (which I called "dissipative solitons") all such waves driven by the Marangoni effect, predictions about the cooperation or competition between gravity and Marangoni forces in falling liquid films, predictions about selfpropulsion of drops and bubbles (as traveling reactors or payload carriers) driven by the Marangoni effect and g-jitter –today in fashion due to the development of microfluidics, and a thorough study of the role of "surface forces" (Van der Waals and other Derjaguin-Casimir-DLVO forces) in wetting and spreading processes mostly in the absence of gravity. This activity led to numerous publications in scientific journals as well as chapters in ESA and ELGRA related books: Fluid Sciences and Materials Science in Space. A European Perspective, Springer, 1987 (edited by H. Walter), Low-Gravity Fluid Dynamics and Transport Phenomena, AIAA, 1990 (edited by J. N. Koster and R. Sani) and Physics of Fluids in Microgravity, Taylor & Francis, 2001 (edited by R. Monti). Besides, I coauthored five full monographs: Nonlinear Dynamics of Surface-Tension-Driven Instabilities, Wiley, 2001 (with P. Colinet and J. C. Legros), Interfacial Phenomena and Convection, Chapman & Hall, 2002 (with A. A. Nepomnyashchy and P. Colinet), Liquid Interfacial Systems. Oscillations and Instability, M. Dekker, 2003 (with R. V. Birikh, V. A. Briskman and J. C. Legros), Wetting and Spreading Dynamics, Taylor & Francis, 2007, 2019-2nd ed. to appear (with V. M. Starov and C. J. Radke) and Falling Liquid Films, Springer, 2012 (with S. Kalliadasis, C. Ruyer-Quil and B. Scheid). These books based on research tuned to the ELGRA aims illustrate how fruitful has been the collaboration between scientists based in Spain, Belgium, France, Germany, former Soviet Union now Russia, the UK and the USA.

M. G. Velarde i Emeritus Professor
IP-UCM (www.ucm.es/info/fluidos)

Daniel Beysens: President of ELGRA 2003-2007

The first time I met ELGRA, it was in Madrid in 1983. ELGRA was only 4 years old, but yet very active. I remember the intense discussions at the General meetings but it was always possible to find solutions because the members had an extraordinary level of both professionalism and mutual confidence. ESA through its representatives and never ending human and financial support was present from the beginning as a positive force to make ELGRA a strong and representative Association of European scientists. But what has made up to now, in my view, the greatest originality and importance of ELGRA is the ability to join in the same Society scientists from both physical and life sciences having in common their enthusiasm for space and microgravity environment. More than collaborating on specific common actions, life and physical scientists have indeed to face the same questions and address the same problems: how to deal and use space weightlessness, vacuum, radiation of an extra-terrestrial environment. And last but not least, both communities have to deal with the same Direction of Human Spaceflight at ESA.

MAXUS 5 rocket experiment in April 2003 (Esrange, Sweden)



Daniel Beysens

This creates a community and strengthen the professional and personal relationships between the members, who can influence in all Europe 'countries the policy of their government in favor of space related projects.

More than fostering the actions for the access to space – and this was a major step initiated in the first years of the new millennium - ELGRA has also a strong commitment for promoting microgravity (and more generally various gravity conditions) among the young scientists and students through support, organization of competition, educational programs. ELGRA also promotes the use of alternate means such as drop towers, parabolic flights, magnetic and electric fields, density matching systems, bed rest/head-down-tilt, clinostats to provide an alternative to extra-terrestrial environment. In support and/or in addition of the weightless studies, acceleration can be provided by vibrations and centrifuges.

I believe that the future of ELGRA is firstly to continue the way initiated 40 years ago by the founding fathers: foster close relationship between life and physical scientists in Europe, promote low gravity among the young generations and stimulate the governments and government agencies. 40 years is the maturity age. ELGRA should however remain inventive and look into the future to challenge itself.

Prof. Daniel Beysens, ESPCI Paris

Jack van Loon, 2007–2011: An overview about the past developments of gravity science over the last 40 years

Jack van loon monitoring crew operations of his 'BONES' experiment in the Experiment Monitoring Area (EMA) at the Kennedy Space Center (KSC) in Florida during the STS-42 / IML-1 flight launched 22 Jan. 1992.

As for quite some young human beings, space, the solar system and space flight where subjects that appealed to one's imagination. Especially when, as a young boy from 8 years, you are watching TV showing people walking and jumping on the surface of our Moon.

So I was very happy to enroll in a project at the Free University in Amsterdam in 1986 where the PI of this study, Paul Veldhuijzen, had received a grant to explore the impact of micro-gravity on the development of embryonic mouse bone rudiments in vitro. I was hired first as technician and later as the PhD student whose task was to prepare for this complex Space Shuttle experiment. The study was planned to be performed during the first International Microgravity Laboratory mission, IML-1 [1], initially targeted for a May 1987 launch. However, due to the tragic Challenger accident on 28 January 1986, the IML-1 mission was delayed for nearly 6 years till 22 January 1992.

Later that same year, on 29 December, we had the opportunity to also fly an experiment on the Russian Bion-10 mission [2] that was launched form Plesetsk. The preparation were done in Moscow where ESA had built a dedicated mobile laboratory to prepare for the various biological experiments. So one winter working in Florida at +25°C while the other winter in that same year working in Moscow at -25°C.

For a young enthusiastic scientist these times were a real venture. The experience was not only in the actual lab work but also with the social elements associated to space flight experiments. One of these was that you travel a bit more than usual for a PhD student. We attended these so called Investigator Working Group (IWG) meetings for the IML-1 mission. In these multi day meetings the status of the mission was presented and discussed, from the agencies point of view, from the launcher / orbiter points of view and especially from the science from the full mission. It was from these IWG meetings that I started to develop some knowledge regarding gravity related physical phenomena and the experiments performed in that field. During lunch and dinner discussions the various physical researchers happily explained their experiments in laymen's terms to a simple cell biologist in spe. The same the happened the other way around. These IWG were quite common for Shuttle Spacelab [3] missions. We also had them for our IML-2 and later Shuttle to Mir Missions with Spacehab.

In the current ISS era we do not have these IWGs anymore. With that we also have far less opportunities to be exposed to (micro-) gravity related research from other disciplines. Maybe a cell biologist might run into an animal or human researcher but seldom into e.g. a fluid physicist.

Also, at the time of Spacelab the science teams themselves informed and instructed the crew about the background and in-flight procedures of their experiments. Accept for maybe human physiological studies, this contact between science groups and crew is also far less, if at all present, for current spaceflight studies. This makes the present involvement in spaceflight studies a bit less exciting (says the old man!). With current flights you are more and more becoming only a small part of a much larger system. I also have the feeling and see evidence that the focus and role of the science in current spaceflight activities is far less than it was at the time I started to work in this field. There is no facility scientist with a pivotal role in the preparation and execution of the experiments anymore. I think this will decrease even more with the increasing liberalization of space flight. This is for sure a good evolvement of our research area but is does take away some of the grandeur of spaceflight research.

The science we performed in our first studies was from a kind of explorative nature. It was known from Salyut [5], Skylab [6] and Mir [7] missions that cosmonauts and astronauts loose bone while in space. Such findings were confirmed by animal studies. However, since spaceflight also is a highly stressful activity, it could be that these reduced bone structures were related to higher levels of cortisol. In our in vitro study [8] we could show that indeed bone tissue itself, so without systemic factors, can adapt to a lower (gravity) mechanical load environment. On top of that we were one of the first who showed that not only bone forming cells (osteoblasts) are reduced in spaceflight but that also the activity of bone resorbing cells (osteoclasts) is increased.

The initial experiments were performed in the very successful ESA Biorack facility. Other biological 'pilot studies' were performed in these IML missions such as systematic studies on plant gravitropism, bacterial and Drosophila growth that formed the basis for nowadays studies.

The Biorack was one of the first facilities that systematically applied to use of an on-board centrifuge. This provided a 1g control and was later also used for part-time 1g exposures for even partial g studies.

Paul Veldhuijzen (left) and Jack van loon awaiting for their bone samples return after Shuttle STS-42 / IML-1 had retuned on Kennedy Space Center in Florida, USA, 30 Jan. 1992

The use of centrifuges dominated the rest of my career in space and gravity related research. I built ny own very small centrifuge for in vitro bone studies. Later we developed the MidiCAR and the ESA Large Diameter Centrifuge (LDC). I hope we are also to make the next step toward chronic hypergravity for humans using the Human Hypergravity Habitat, H3. I am pleased to see that the role and importance of centrifuges and hypergravity has increased over the last couple of decades.

Dr. Jack van Loon, VU Amsterdam

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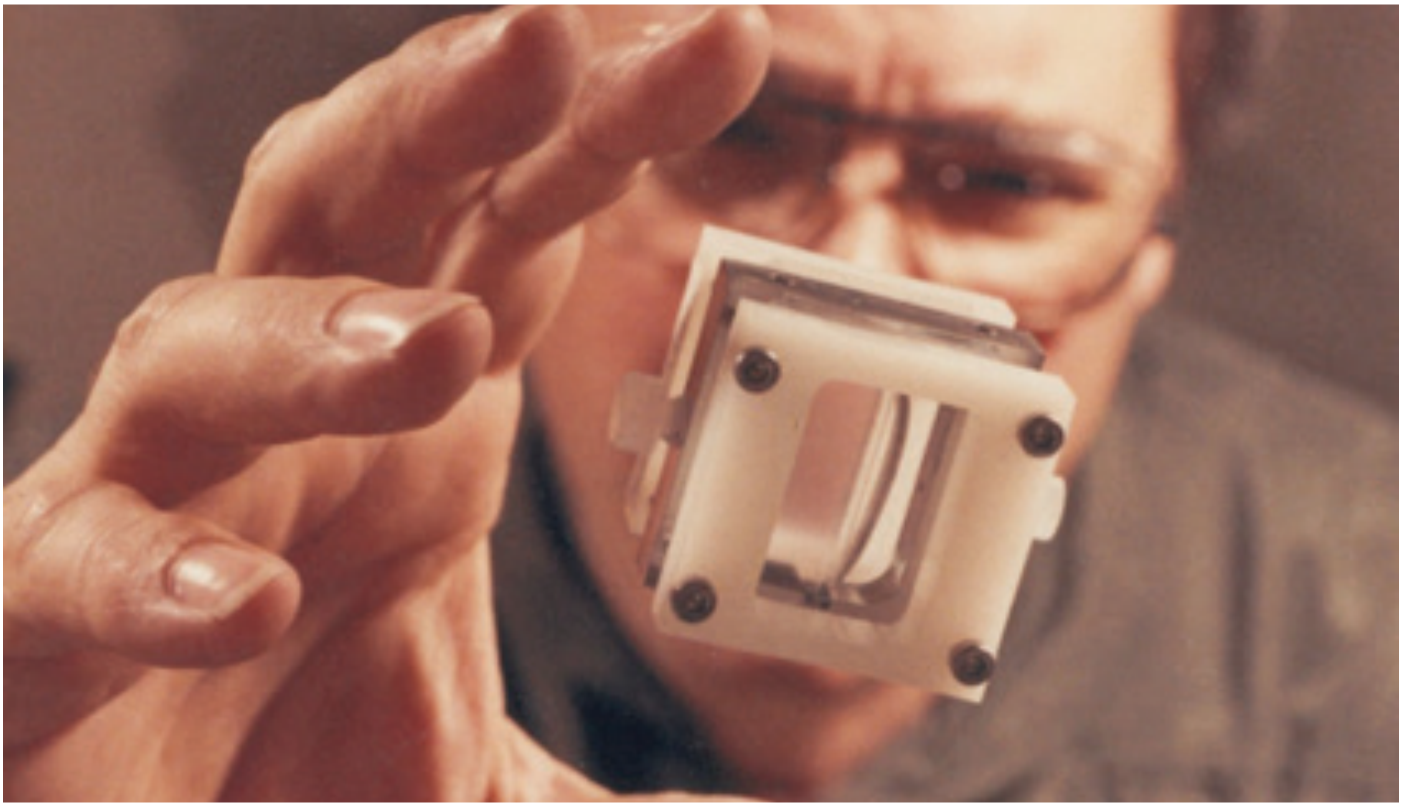
Valentina Shevtsova, 2011-2015: 40 years of ELGRA across space missions and microgravity platforms



Parabolic flight experiment in fluid science (J.C. Legros , ~1985)

Although gravity is the most obvious force in the universe for human perception, for many centuries people had not been able to conduct experiments aimed at its better understanding. The launch of the Skylab (US) and Salut (Russia) stations in the early 1970-ies had initiated a new era in access to space for microgravity science. Inspired by new provocative results, the scientists who participated in the first experiments forty years ago created the ELGRA Society.

The golden age for microgravity research in Europe was opened by the D-1 and D-2 scientific space missions. The D-1 Spacelab mission (1983), funded and directed by Germany, carried the NASA/ESA Spacelab module into orbit with 76 scientific experiments on board, and was declared a success. The D-2 mission (STS-55, April 1993) further augmented the microgravity research programme initiated by D-1. The flight was involving 88 experiments from eleven different nations. The experiments ranged from biological sciences to simple earth observations. Another milestone to mention is the ESA mission EURECA (European Retrievable Carrier) flying to space in 1993 with 15 experiments onboard. This platform provided exceptionally low microgravity level and was one of the few space vehicles that returned to the Earth unharmed. These missions led to a substantial growth of the ELGRA community.

Back in those days, just as much as now, parabolic flight experiments were used for preparation of larger space missions. However, the safety requirements were very different, as can be seen on the photos – scientists were at times conducting experiments on their lap, whereas now the cell has to be put in a container with double or triple walls, firmly fixed inside the rack. Another significant difference is that in earlier times researchers directly contributed to the design of facilities for large missions, while nowadays they only need to provide the scientific requirements to a dedicated industry via ESA.

Parabolic flight experiment in fluid science (J.C. Legros , ~1985)

The next major step of microgravity science begins with the International Space Station, commissioned in 2008-2009, in particular with the preparation of experiments for the ISS. The gap between large-scale missions and the ISS had been filled with experiments in Drop Towers, Parabolic flights, Sounded rockets and Foton satellites, and scientists were eagerly anticipating to see their experiments carried out onboard the ISS. This is when the ELGRA society had reached a peak in its membership.

It is worth noting that the space station provides the only place to study long-term physical effects in the absence of gravity. In particular, the series of diffusion controlled experiments, such as the IVIDIL (Influence of VIbration on DIffusion in Liquids) and the four DCMIX experiments (Diffusion Coefficients MIXtures) have been conducted in the frame of the ESA programme. In the course of these experiments, scientists have been obtaining reliable benchmark results on diffusion and thermodiffusion, highly valuable for validation and calibration of present and future ground-based measurements.

In the beginning of the ISS operation phase, an essential number of the planned experiments had been delayed due to revision of facilities. The slow pace in the development of experimental activity had frustrated scientists, considering that the preparatory work strongly relied on graduate students, who by then had completed their thesis. The ELGRA society had gradually started shrinking.

With time, the public awareness about the ISS has been raising the interest of the younger generation for space. Keeping up to date, in 2013 the members of the ELGRA management committee have suggested creating a branch at the student level for all gravity-related research in Europe, i.e. SELGRA (Student ELGRA). Since then, more and more students have been joining the ELGRA community, and their number keeps steadily growing.

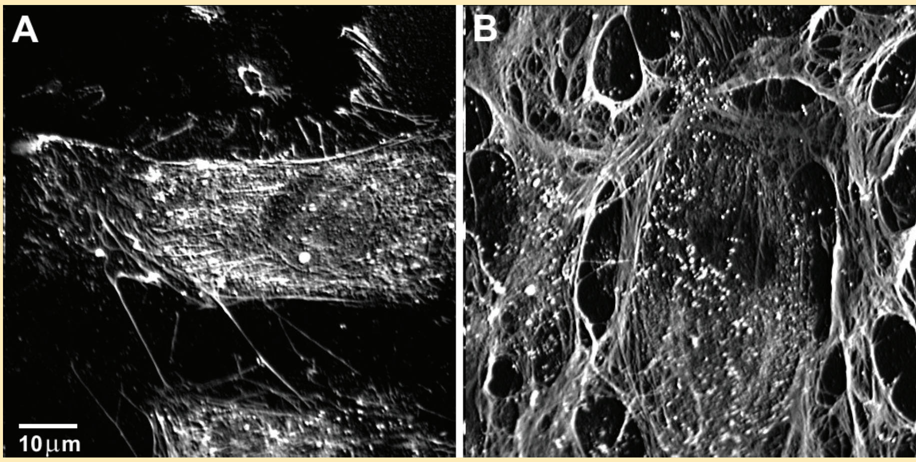
Looking forward to exciting Moon and Mars missions, we have the firm belief that ELGRA will know a further dynamic development and continue to attract new young talent.

Valentina Shevtsova: Microgravity Research Center, University of Brussels

Monica Monici, 2015-2017: 40 years of space-biology, physiology and medicine.

The importance of mechanical factors in biological processes has been known for a long time: Galileo Galilei already had guessed that mechanical factors play a key role in the development of the skeleton. With the beginning of manned space flights, it became immediately clear that the exposure to unloading conditions has a profound influence on human physiology. Since then, biological studies have also begun to understand the molecular and cellular mechanisms underlying the alterations induced by the space environment on human physiology. One of the outstanding problems is to understand how a single cell can "perceive" gravitational changes.

For more than three decades, most studies have focused on the alterations of the immune, circulatory, musculoskeletal and neurovestibular systems, whose importance was immediately evident, with effects that persist even after returning to Earth and require a recovery period. These studies have provided a lot of information on the pathways involved in the above alterations and have allowed to identify some countermeasures that, subsequently, have also been applied on Earth for some specific pathological conditions, such as osteoporosis. With the progress of the studies it has been observed that gravitational changes (hyper- and microgravity) can affect a variety of biological processes and have a more or less important impact on many functions of plants and animals. This generated a series of questions, for now without



Fibronectin (FN) production in endothelial cell cultures at 1xg (A) and exposed to modeled microgravity (RPM, 72 h) (B). The exposure to unloading conditions induces an increase in the protein production. The picture shows a tight network of FN fibrils in which the cells are trapped. The alteration in fibronectin production and assembly can affect tissue repair mechanisms. Courtesy Microgravity Sci. Technol. (2011) 23:391–401. DOI 10.1007/s12217-011-9259-4.

definite answers, on the consequences that long-term missions could have on the health of astronauts.

New space exploration programs, with the future perspective of manned interplanetary missions and long stays on space bases, have opened up completely new scenarios for space research in the fields of biology, human physiology and medicine. It has become urgent and important to understand the long-term effects of the exposure to microgravity on: endocrine system and metabolism, central and peripheral nervous systems, connective tissue and the extracellular matrix, human microbiota and the microbiome-immune system interaction, just to give only some examples of topics on which, to date, we know too little.

Pharmacological aspects must necessarily be addressed. It is known that astronauts use drugs quite frequently. The most used are medicines against motion sikness, sleep-inducing drugs, anti-inflammatories and painkillers to manage back pain and similar diseases. It has been observed that, in some cases, the effects of these drugs are different from those known in the use on Earth. For some drugs, higher doses are required in space to achieve the same effects as on Earth. Since the space environment causes important changes in human physiology, it is understandable that the processes involved in pharmacokinetics and pharmacodynamics are also altered, compared to how we know them on Earth. Therefore, studies on pharmacokinetics and pharmacodynamics in space, at least for the most important classes of drugs, are absolutely needed. Moreover, also for patients exposed to the space environment, efforts should be made to administer a personalized therapy, taking into account the condition and characteristics of the patient.

Another field of medicine that needs to be totally reconsidered is that of emergency surgery and trauma care on board space vehicles. Although the feasibility of a number of procedures and equipments for trauma care and basic surgery in space has been evaluated, the current management of traumatic events and surgical emergency on board space vehicles and the ISS requires patient stabilization and rapid return to Earth. This procedure could be inadequate in interplanetary missions because medical evacuation times to Earth might become too long.Comprehensive methodologies to guide the crew members remotely have been developed, but they are appropriate for low Earth orbit and lunar missions (< 5sec delay in communication) In missions beyond LEO, the communication lag would render useless to guide the crew actions remotely. Therefore, the future planning procedure for medical care in space should incorporate space surgery and trauma care concepts. Critical aspects in surviving a trauma or a surgery are wound/suture behavior and healing. A recent report on the "state of the art" in space surgery included wound healing and sutures among the critical aspect which need to be further investigated and ESA created a TT on this topic.

Finally, on the wave of the interplanetary space exploration journeys, suggestive hypotheses, such as the hibernation of the crew members, have been advanced. Until very recently, these were science-fiction screenplays, but today a dedicated ESA TT is studying the topic.

Prof. Monica Monici,
University of Florence

Miguel Ferreira, president of SELGRA: Microgravity research in 40 years

During the next 40 years, we foresee an exponential development of the Gravity-related research field, fuelled by technological advancements and an increased societal interest in Space. Progress will be made both in terms of scientific research and improvement of the platforms used to perform ground-based and low-Earth orbit research. These two aspects are interdependent as progress in scientific research greatly benefits from technological advances and improved platforms, especially in terms of quality of microgravity simulation, duration, cost, and versatility.

In the upcoming decades, we expect to observe a gradual decrease of the cost of the gravity-related studies and an increased availability of access to Space. The International Space Station and the ESA Columbus Module will continue to serve Space science and Gravity-related research for a few more years, until their retirement around 2024. From then onwards, we expect the development of novel low-Earth orbit architectures, which can be smaller and more flexible than the ISS, as the DLR Orbital Hub Base Platform. We also foresee an increasing interest for new commercial platforms, such as suborbital reusable launch vehicles and small satellite launchers (e.g. Nano/CubeSats). Santa Maria, in Azores, may soon become a base for launching small satellites, which could potentially increase the scientific and technological research in microgravity.

Certainly, Gravity-related research will continue to promote a better life on Earth. New insights on how to treat cardiovascular or musculoskeletal diseases, advances in manufacturing, and a better understanding of fundamental physical phenomena are just a few examples. Perhaps, we will even see a Moon Village and the first Humans being sent to Mars.


Farther, together, three miniature satellites or CubeSats
Copyright: ESA/NASA-A. Gerst

Finally, we need to remember that the future will only be bright with new and creative minds and collaborative work. The future of Gravity-related research depends on our community, particularly on the efforts of current students that will be active professionals during the next 40 years. It is therefore necessary develop new initiatives, and strengthen the relationships between European countries, governmental, industrial, and academic institutions. This is what we, SELGRA, hope for the future.

Miguel Ferreira
President of SELGRA (Student-ELGRA)

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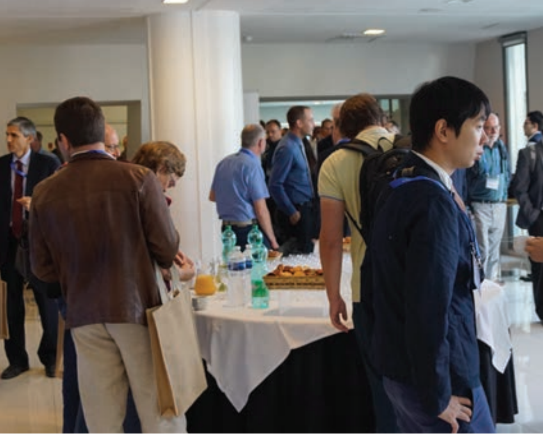


THE ELGRA-ISPS SYMPOSIUM

The 25th ELGRA Biennial Symposium and General Assembly was organized jointly with the 7th International Symposium on Physical Sciences in Space (ISPS-7). The conference took place from October 2 to 6, 2017 in Juan-les-Pins (France) and it was attended by 178 participants across Europe, U.S., Japan, and China. Dr. Astrid Orr (ESA), Dr. Monica Monici (ELGRA President, University of Florence, Italy), and Dr. Ricard González-Cinca (member of the ELGRA Management Committee, Technical University of Catalonia-BarcelonaTech, Spain) chaired the symposium.

Interesting contributions ranged from Physical Science to Life Science, covering a large variety of topics and stimulating discussion. Physical Sciences contributions covered advanced material processing and properties, two-phase flow and heat transfer, ultra-precise cold atom sensors, quantum information, and high energy particles, soft or complex matter, and combustion/Fire safety.

Life Science sessions included Biology and Human Physiology.

Instrumentation and Outreach were also covered in separated sessions. The symposium hosted a round table plenary session focusing on interdisciplinary Physical-Life Science questions. A poster session took place in the first day of the Symposium and included 39 poster presentations. The ELGRA medals were awarded to Prof. Jack van Loon for his outstanding work in space biology and physiology and for the development of the ESA-ESTEC-based Large Diameter Centrifuge, and to Prof. Hendrik Kuhlmann for his highly recognized work on hydrodynamic instabilities, vortex dynamics, thermocapillary flows and nonlinear dynamics.
The Symposium attracted a large number of early career researchers and students, including five student supported by ELGRA, and five students supported by ESA.
The impressive quality of the scientific presentations and discussions combined with both the convenient conference center in the beautiful city of Juan-les-Pins and the lovely weather, resulted in a very nice atmosphere among the participants in the Symposium.
The successful co-organization of the Symposium between ELGRA and ESA stimulated the interest in organising of future joint events.

WHO ARE ELGRA'S NEW COMMITTEE MEMBERS?

During the ELGRA-ISPS Symposium in Juan Les Pins, ELGRA members elected three new members to the management committee, Prof. Dr. Marcel Egli, Dr. Eric Falcon and Dr. Philip Carvil.

Prof. Dr. Marcel Egli

Marcel Egli is leading the Institute of Medical Engineering at the Lucerne University of Applied Sciences and Arts which combines the Centre of Competence in Bioscience and Medical Engineering, the Space Biology Group, and the User Support and Operational Centre "BIOTESC" that serves the European Space Agency ESA. He graduated from the University of Berne with a degree in biology. Thereafter, he spent several years as a postdoctoral fellow at the University of Melbourne and at the Florida State University. Later on, the appointment to lead the Space Biology Group at ETH Zurich brought him back to Switzerland. A few years later, the Space Biology Group was moved from Zurich to Lucerne, where the Institute of Medical Engineering was founded. Marcel Egli has published numerous scientific articles in the fields of neuro-endocrinology and space biology. His current research interests include the cellular mechanisms of mechanosensation, induced by mechanical unloading (e.g. weightlessness).

Dr. Eric Falcon

Eric Falcon is senior scientist at CNRS and works on nonlinear physics at University Paris Diderot. He received his Ph.D. at Ecole Normale Supérieure (ENS) Lyon in 1997, followed by Postdoctoral Fellowships at ENS Paris. He was appointed as CNRS scientist in 1999 at ENS Lyon. Eric Falcon serves notably as General Secretary of French committee for physics (CFP) of French Academy of Sciences. He received the CNRS Bronze Medal in 2001, Branly Prize in 2004, PRE Milestone-Paper from APS in 2016, and CNRS Scientific Excellence Rewards in 2014 and 2018. His current research concern fundamental studies in nonlinear physics including experiments on wave turbulence, fluid dynamics, granular media, and ferrofluid. Eric Falcon is strongly involved in low-gravity research as President of expert group in physics of the French Space Agency (CNES), coordinator of the Space Grains ESA Topical Team, co-PI of the ISS VIP-GRAN ESA instrument for the study of granular media, and co-PI of the ISS FLUIDICS CNES instrument for fluid dynamics studies. He also performed low-gravity experiments in Mini-Texus (1999), Maxus 5 (2004), and dozen or so parabolic flight campaigns.

Dr. Philip Carvil

Philip Carvil is a Human Physiologist. He graduated from Kings College London, and his PhD was funded by the European Space Agency's (ESA) NPI Program which evaluated whether the ESA's SkinSuit could be used to support the spine in space. The SkinSuit has currently flown as part of two ESA ISS missions.

He is employed by the UK research council – STFC (Science and Technology Facilities Council) as the HealthTec Cluster Development Manager for the Daresbury Campus located in North West England. He is also the co-coordinator of the UK's Space Life and Biomedical Sciences Association and a trustee for the charity 'Pride in STEM'.

IN FOCUS
NEW CHALLENGES FOR HUMAN EXPLORATION?

ESA Astronaut Alexander Gerst in Cologne after second spaceflight

Research under altered gravity conditions at the interface of life sciences and technology

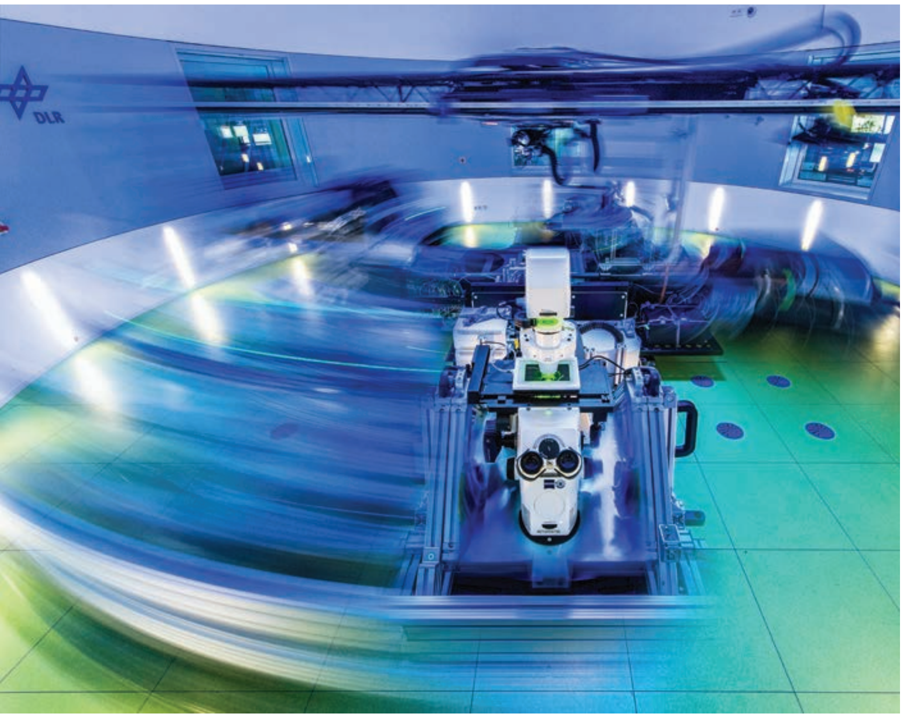
The Institute of Aerospace Medicine serves as interface between life sciences including biology, medicine, and psychology and advanced technology at the German Aerospace Center (DLR). The research is conducted in close collaboration with leading national and international research institutions. The long-standing experience of the Institute in caring for astronauts provides a solid foundation guiding our research efforts. Systematic ground-based studies in gravitational biology as well as radiation- and astro-biology are performed in the space and planetary simulation facilities of the Institute and are complemented by successful investigations in space and thus under real microgravity conditions over many years.

Biomedical research in space translated to applications on Earth

In space, human beings are exposed to extreme environmental stresses affecting wellbeing and performance. Microgravity, radiation and isolation are important in that regard and individually or collectively affect the human body. During prolonged space missions, these challenges jeopardize crew health as well as the success of the mission. We seek to elucidate the underlying mechanisms. Based on the mechanistic research, we develop diagnostic tests predicting psychological and medical risks and targeted medical and psychological countermeasures.

Many of the psychological and physiological challenges experienced in space are also relevant for human beings on Earth. For example, in the absence of sufficient countermeasures, space travel replicates many of the physiological changes associated with ageing including loss of musculoskeletal function, cardiopulmonary fitness, coordination, and ocular health among others. Increased radiation exposure promotes cellular senescence and premature ageing. Opacification of the eye lens a so called cataract is a prime example. Radiation damage to epithelial cells maintaining ocular lens fibers promotes cataract formation. The condition is commonly observed at an older age in people on Earth. The potential for radiation exposure during spaceflight to induce tumor formation, cardiovascular disease, and damage to critical structures in the central nervous system is an area that needs to be addressed. Indeed, excess radiation exposure is one of the important and unresolved challenges of long-term missions in outer space. The repair mechanisms maintaining cell integrity after radiation exposure also mitigate damage elicited through other environmental challenges, making this research relevant for terrestrial medicine.

Space travel perturbs circadian rhythms and sleep, which in addition to affecting health may limit human performance and promote critical errors. Insufficient duration and poor quality of sleep are also recognized as an increasing health risk on Earth. Indeed, epidemiological studies on Earth showed that short sleep duration is an important risk factor for cardiovascular and metabolic diseases.



Translation from cells to humans and back to cells

Our medical research in human beings is complemented by studies at the cellular level. For example, we conduct detailed investigations delineating cellular responses to altered gravity, to radiation, and to both combined. We believe that cellular and molecular understanding will give rise to novel preventive measures for space and for terrestrial medicine. An important component of this endeavor is development of new methodologies to investigate cellular responses to simulated microgravity and hypergravity conditions. In particular, we are interested in how mechanical forces are sensed, transduced, and integrated at the cellular level. In addition to providing insight in fundamental biology, the research is relevant for human physiology and medicine. Indeed, cellular mechanotransduction affects cardiovascular and musculoskeletal structure and function among others. For example, mechanosensitive ion channels are crucial for the function of the human baroreflex, which is indispensible in maintaining blood pressure.

The need for unique scientific models on Earth

Our Institute has longstanding experience conducting research under space conditions. For example, we investigate cardiovascular and musculoskeletal function in astronauts and in cosmonauts on the Internationals Space Station. The biological research involves experiments in real microgravity on the International Space Station, on satellites, research rockets, parabolic flights and in drop towers. However, the availability of astronauts and cosmonauts for biomedical and psychological research projects is limited. Therefore, biomedical research in space and in aeronautics has to be complemented by sophisticated simulations on Earth.

Our Institute developed internationally unique expertise and research infrastructure for human studies under highly controlled environmental conditions. In our research facility :envihab, the name is derived from environment and habitat, highly standardized simulations of environmental factors in human beings can be achieved. The environmental conditions covered by our research include atmosphere composition and pressure, gravitation, noise, light, radiation, nutrition, and the microbiome.

Bedrest studies in the head-down position – one of the workhorses in space medicine – are conducted in collaboration with international space agencies. The model produces fluid shifts in the body towards the head resembling changes observed in weightlessness. Much like astronauts, participants experience reductions in muscle and bone mass and physical performance. Through the head-down bedrest model, countermeasures such as artificial gravity provided in our human centrifuge can be tested on Earth before they are applied during space travel.

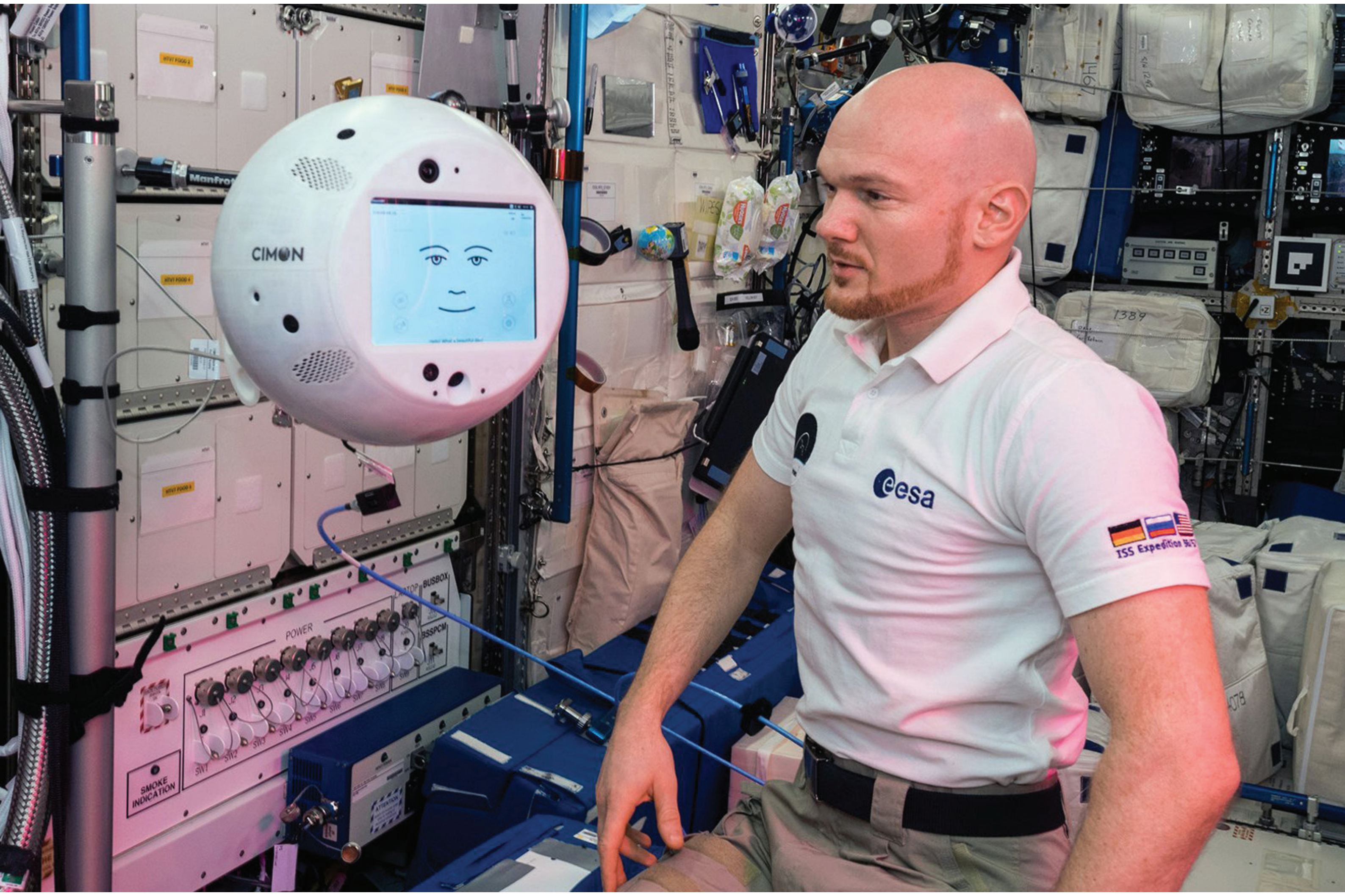
The :envihab is also equipped to conduct sophisticated isolation experiments. Perhaps, crews more or less resilient to withstand isolation can be prospectively identified. Technology might aid in maintaining individual and crew function in the face of prolonged isolation during missions in outer space.

Finally, :envihab hosts ESA astronauts directly after their return from the International Space Station to Earth.

Prof. Jens Jordan, director of the Institute of Aerospace Medicine, DLR, Cologne, Germany

MyoCardioGen climbing wall at the DLR
Copyright: Ralf Dujmovits

INDUSTRIE HIGHLIGHT



CIMON crew assistant with the astronaut Alexander Gerst.

Airbus

The department Payloads and Life Support Systems of Airbus Defence and Space GmbH in Friedrichshafen has a long-standing experience of in the development and operation of scientific payloads for microgravity experiments. Airbus Defence and Space has participated in payload developments as prime contractor and system engineer in all relevant technical domains and science fields like materials science, life science and fundamental physics, both for the space shuttle and the ISS. The following major facilities have been developed in the last decade in cooperation with partners from all over Europe:

- BIOLAB, MSL, MELFI, EMCS, and EML as rack type payloads
- The external payload ACES
- The technology experiment CIMON as crew assistant

Especially, CIMON as technology experiment inside the ISS has generated a lot of public awareness and interest in the last month and is considered as pioneering experiment for artificial intelligence in space applications.

Airbus DS was additionally responsible for the development of the life support systems of Spacelab, for the Columbus-Module, ATV, MPLM, and for ACLS on ISS. Furthermore, Airbus has led numerous ESA TRP and GSP studies as preparation for the development of flight facilities.

Christian Stenzel, Airbus Defence and Space GmbH,
Immenstaad, Germany

AIRBUS

The GraviTower Bremen Prototype

Today's and future scientific research programs ask for high quality microgravity conditions of 10-6 g on ground (earthbased) combined with high repetition rates of 100 fights per day or more. Accordingly, a new type of drop tower, the GraviTower Bremen, (GTB), has been suggested and is currently under development. As a first stage of development, a GTB-Prototype (GTB-Pro) is designed which uses an active rope drive to accelerate (initial acceleration of up to 4 g) a slider / drag shield and an experiment therein on a vertical parabola. During the free fall phase, the experiment is decoupled from the slider by a selfacting Release-Caging-Mechanism (RCM). The prototype will provide 2.5 s of microgravity for experiments of up to 500 kg for at least 100 times per day.

Based on extensive simulations aiming at an optimization of the whole system we developed a hydraulic rope drive system with minimized vibrational amplitude and low number of eigenfrequencies. The RCM achieves a very fast (≤ 0.1 s) self-acting release of the experiment from the slider by making use of the dynamics of the hydraulic rope drive. Furthermore, passive hydraulic stop dampers in the RCM build a passive and self-acting recoupling mechanism. This system is optimized for a fast decoupling to compensate for the time limitation posed by the chosen drive technology.

The systems and safety architecture of the GTB-Pro aims for a high performance level (PL d) by consequent use of automated safety monitoring to enable direct operation by scientists to a great extend. Also for this purpose the graphical user interface (GUI) is designed strictly sequential starting with selftests of each subsystem and is continuously monitored by mutual automated safety structures applicated in three independent PLC´s. Furthermore direct access to the experiment inside the GTB-Pro between flights and while recharging the hydraulic drive is made possible allowing to change samples and data carriers.

Currently the hydraulic drive of the GTB-Pro is mounted and first tests of the drive will start in mid 2019. The _tower_ rail guiding system will be mounted parallel in mid 2019 and first tests of the complete setup will start late 2019. First test flights with experiments should take place in early 2020. The requirements and design guidelines for the experiments are very similar to those for experiments in the Bremen Drop Tower. We kindly ask all potential and interested experimenters to contact us for further details of experiment operation in the GTB-Pro.

Andreas Gierse,
ZARM Drop Tower Operation and Service Company
c/o University Bremen

CENTER OF
APPLIED SPACE TECHNOLOGY
AND MICROGRAVITY

Sounding rockets accessible and affordable for everyone

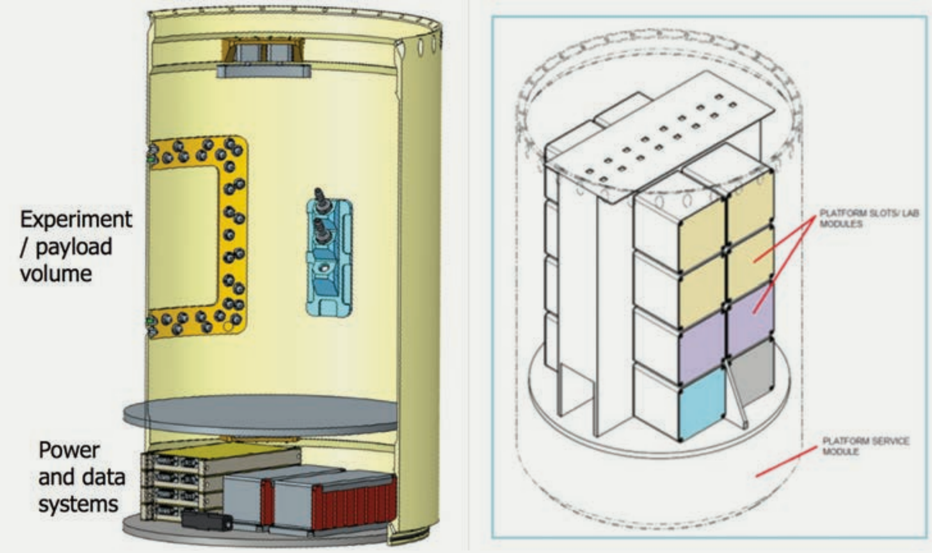
Sounding rocket missions have in the past decades generally been used by Space Agencies or large organisations that fly experiments, being the single user of the platform. The cost for launch ("flight ticket") of the experiments often exclude research organisations with small or single experiments – and small budgets – from using sounding rockets for performing experiments. With a ride-share concept accessible for everyone, the user books the required space in the payload and pays a flight ticket price that is proportional to the booked space and mass. The availability and cost of sounding rocket flight becomes affordable also for users not filling up a whole payload. SSC re-introduced in 2017 the concept shared payload with accommodation of several customers; agencies, academia and commercial on the same mission, with the objective that the flight opportunity should be available for everyone. The interface to the payload is straight-forward and easy to adapt to any specific experiment requirements. The shared-ride flight concept offers frequent flight opportunities for small to large experiments. The specific platform in this case is the MASER microgravity sounding rocket that accommodates up to 300 kg of experiments in the 430 mm diameter payload experiencing 6 minutes of microgravity, with residual accelerations as low as 10-6 g.

In order to expand flight opportunities for the community, SSC has made an announcement of MASER flight opportunity every 18 months, with next launch in June 2019 (fully booked) and the following in November 2020 (space available).

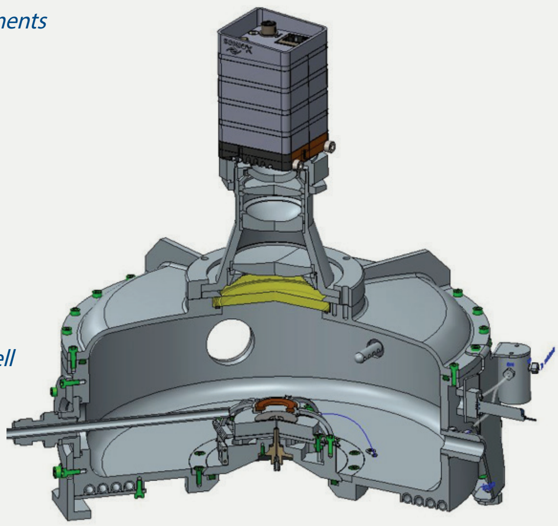
MASER microgravity sounding rocket programme is run by SSC, Sweden since 1992 with launches from Esrange Space Center in northern Sweden and ground impact in a restricted vast area. Experiments are recovered within hours after the flight. In combination with the microgravity experiments, the platform can accommodate mechanisms for releasing free-flying bodies for very high altitude drop tests (300 km), which extends the share-ride concept to many other research and technology disciplines. MASER is the only available commercial sounding rocket offering high quality microgravity levels for 6 minutes. It is also the only commercial sounding rocket available with such a long successful record of accomplishment.

Christin Lockowandt

MASER 14 the next shared ride mission



A typical larger experiment compartment to the left and typical payload compartments for smaller experiments to the right.



Main ARLES experiment cell

The SSC sounding rocket mission MASER 14 is scheduled for launch in June 2019 from Esrange Space Center in northern Sweden. The rocket will carry a mixed payload consisting of four experiments of three customers sharing the payload capacity and cost; two ESA scientific experiments developed under ESA contract; ARLES and XRMON-GF2, one Surface Tension Tank (STT) experiment of Space Solutions in Korea and the JAXA/DLR experiment DUST.

The ARLES experiment, developed under ESA contract, (science coordinator Pr. D Brutin, IUSTI Université Aix-Marseille) intends to study evaporating drops of pure fluids, which contain a low concentration of nanoparticles, under the influence of an electric field. The scientific objectives are directed towards study of the flow motion and the flow instabilities occurring in the drop, at the droplet interface and in the vapour phase. They also deal with the pattern formation on the substrate after the evaporation of the volatile phase, as well as the eventual heat transfer enhancement.

The XRMON-GF2 experiment, developed under ESA contract, (science team coordinator Pr. H Nguyen-Thi IM2NP, Université Aix-Marseille) aims at studying the directional solidification (columnar and equiaxed dendritic growth in purely diffusive environments) of an Al-Cu system by in-situ real-time X-ray radiography. Special attention will be put on the aspect of nucleation, segregation and impingement. The XRMON program contains a series of in-situ radiography experiments on metallurgical processes related to solidification phenomena under microgravity and terrestrial conditions. A number of experiments have already been carried out on sounding rockets in the frame of this program; XRMON-Metal Foam on MASER 11; XRMON-Diffusion on MAXUS 8 and 9; XRMON-Gradient Furnace on MASER 12; XRMON-Solidification on MASER 13, as well as parabolic flight campaigns with Metal Foams, Gradient Furnace and Solidification experiments. There are also plans to implement an XRMON facility on ISS in a near future.

The objective of the STT experiment is to study the drainage of a liquid from a pressurized tank equipped with a liquid surface tension and capillary system designed to collect the liquid at the outlet of the tank. This experiment is related to the development of future launchers.

The objective of the DUST experiment (Hokkaido University and Braunschweig University) is elucidation of formation processes of carbonaceous dust. The scientific goal is to determine the most important physical properties controlling dust production and observe and measure during formation and agglomeration of dust grains in microgravity. This experiment is related to particle formation in interstellar space.

MASER programme is run by SSC and has provided for 13 successful flights from Esrange Space Center with 6-8 minutes of high-quality microgravity, with residual accelerations as low as 10-6 g. The MASER payload can accommodates multiple experiments of high complexity and offers – with its high speed telemetry system – real-time digital video monitoring as well as ground command capabilities during the flight of the scientific experiments.

With the 2015 ALAT/CNES Cryofénix mission, SSC introduced provision of low gravity levels to experiments, in this case 1.75 mg and 7 mg, by applying thrusts of 7 N and 28 N.

Christian Lockowandt,
Swedish Space Corporation

Research under Microgravity Conditions at OHB

Cosmonaut Sergey Sergey Prokopyev on International Space Station, operating PK-4 in EPM (credit NASA)

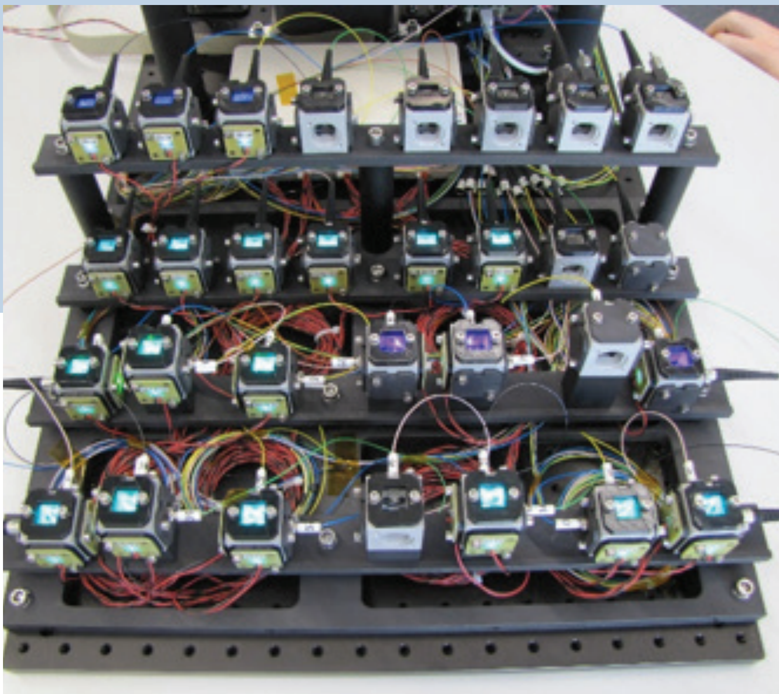
OHB System AG is one of the three leading space companies in Europe. It belongs to listed high-tech group OHB SE, where around 2,700 specialists and system engineers work on key European space programs. With two sites in Bremen and Oberpfaffenhofen near Munich, OHB System AG specializes in high-tech solutions for space. These include small and mid-sized satellites for Earth observation, navigation, telecommunication, science and space exploration as well as systems for human space flight, aerial reconnaissance and process control systems.

Despite being a Large System Integrator (LSI), from the very early beginning developing, manufacturing and qualifying experiments, instruments and facilities for scientific research under microgravity conditions have been core activities of OHB - both in Bremen and in Oberpfaffenhofen (formerly Kayser-Threde GmbH), either in the frame of human spaceflight (MIR and ISS), on unmanned capsules (e.g. FOTON, BION), or on sounding rockets (TEXUS and MAXUS).

OHB has gained key experience and competencies in the development, qualification and operation of ISS facilities, subsystems and experiments. In several completed and ongoing projects, OHB was entrusted with the development of ISS payloads and experiments including the data and power systems, the implementation and qualification of instruments and sensors as well as fluidic, optical systems and mechanisms, the flight and ground segment software, the functional and environmental testing and finally the successful handling of the applicable safety and acceptance processes. Prominent examples for ISS payload and experiment developments are the complex plasma experiments (i.e. the three “Plasma Kristall” facilities PKE, PK-3 Plus, and PK-4, as well as Ekoplasma) and VIPGRAN in the area of fundamental physics, ThermoLab, Skin-B and Myotones experiments in the area of human physiology, BIOPAN, EXPOSE and SPECTROModule as precursor of the ESA new Exobiology facilities in the area of exobiology, WAICO and Biolab Experiment Batch 3 in the area of life sciences, and finally ANITA 1&2 trace gas monitors, MELT and IMPERIAL 3D printing prototypes and the Flywheel exercise device in the area of technology demonstrators. In all of these areas OHB typically works in close cooperation with the scientists, and covers a wide range of activities and “sizes”: from small equipment which is brought into orbit in within less than one year, to large research facilities like Plasma Kristall-4 (PK-4) and ISS infrastructure elements like the European Physiology Module (EPM).

Armin Stettner, OHB System AG

For more information on OHB System AG, please refer to https://www.ohb-system.de, or feel free to contact us: pr@ohb.de



Cosmonaut Sergey Sergey Prokopyev on International Space Station, operating PK-4 in EPM (credit NASA)

OPPORTUNITIES

ELGRA Prize 2017

Among its activities to promote scientific research under various gravity conditions in Europe, ELGRA has given the ELGRA RESEACH PRIZE to two young scientists who were in their first 5 years after the completion of their Phd.

In 2017, Dr Elisa R. Ferrè from the Department of Psychology at the Royal Holloway University of London (UK), as well as Dr. Christian Liemersdorf, together with Timo Frett, from the Institute of Aerospace Medicine at the German Aerospace Center (DLR) in Cologne (Germany) have each received 5.000 € to support over a period of 2-years their research in the field of Micrograyity science.

Dr. Christian Liemersdorf and Time Frett have used the ELGRA funding to "investigate the role of hypergravity on the synaptic activity of sensory neurons, under different hypergravity conditions" and are analysing to results that are looking promising.

Thanks to ELGRA support, Dr. Ferrè has been able to pursue her research on "Vestibular alterations in voluntary action under conditions typical of spaceflight" which so far led to two peer-reviewed published articles showing the effects of altered gravity on human brain and cognition ("Getting ready for Mars: How the brain perceives new simulated gravitational environments." QJEP, 2019; "Gravity modulates behaviour control strategy." EBR, 2019). The research supported by ELGRA has been also presented to international conferences and had attracted media interest.

We are wishing a successful further development of their research and in their respective scientific career.

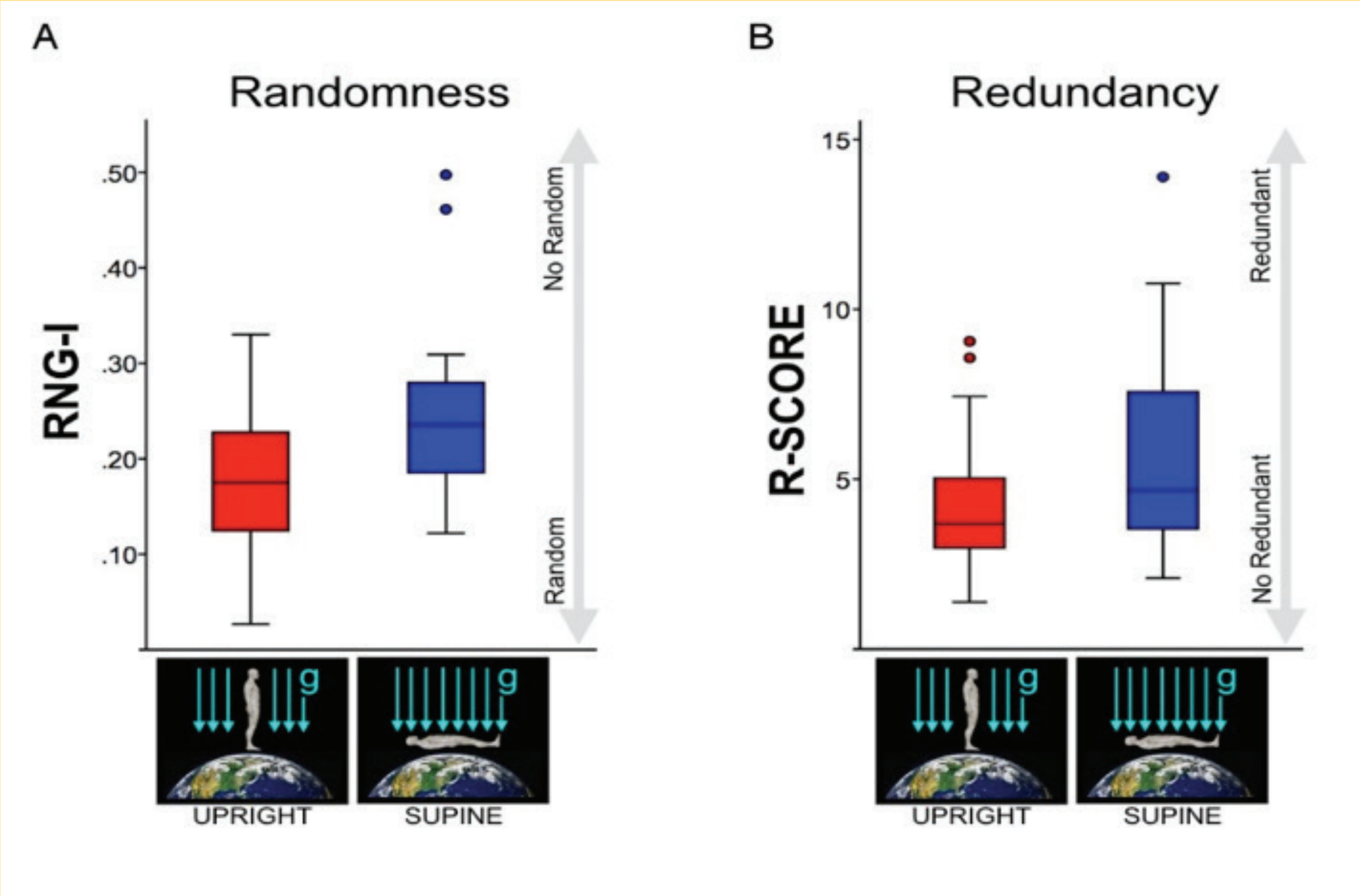
Bellow you can read a summary of the two laureates' first year report.

Vestibular alterations in behavioural control strategy under conditions typical of spaceflight.

Human behaviour is a trade-off between exploitation of familiar choices and exploration of new ones. There is nowhere more important to make the right decision than in outer space. During spaceflight, astronauts are in an extremely challenging environment in which decisions must be made quickly and efficiently. To ensure crew well-being and mission success, understanding how cognition is affected by gravity is vital.

To investigate whether vestibular-gravitational signals could influence the balance between routine and novel behaviour, we used a random number generation paradigm in which participants were asked to generate sequences of numbers as randomly as possible. Random number generation involves both suppressing stereotyped responses and generating non-stereotyped responses, and it can be considered a proxy for flexible and adaptive cognition. We manipulated how the vestibular organs sense gravity by changing the body's orientation to the gravitational vector. Thus, participants completed the random number generation task while either upright or lying supine on a 3D human inversion table.

In the former condition, the body and vestibular organs are congruent with the direction of gravity, while in the latter they are orthogonal.



Thus, this is an efficient lab-manipulation which allows us to reliably mimic vestibular-gravitational alterations, avoiding other non-specific physiological changes.

The experimental protocol was approved by the local research ethics committee of Royal Holloway, University of London, and the study was completed in line with the Declaration of Helsinki. Written informed consent was obtained from the participants before commencing the experiment. Twenty-five participants completed the study. The random number generation task requires participants to generate a sequence of 20 consecutive digits. Participants were instructed to name digits ranging from 1-9 as randomly as possible. Participants performed three sequences while upright and three while supine in a counterbalanced order.

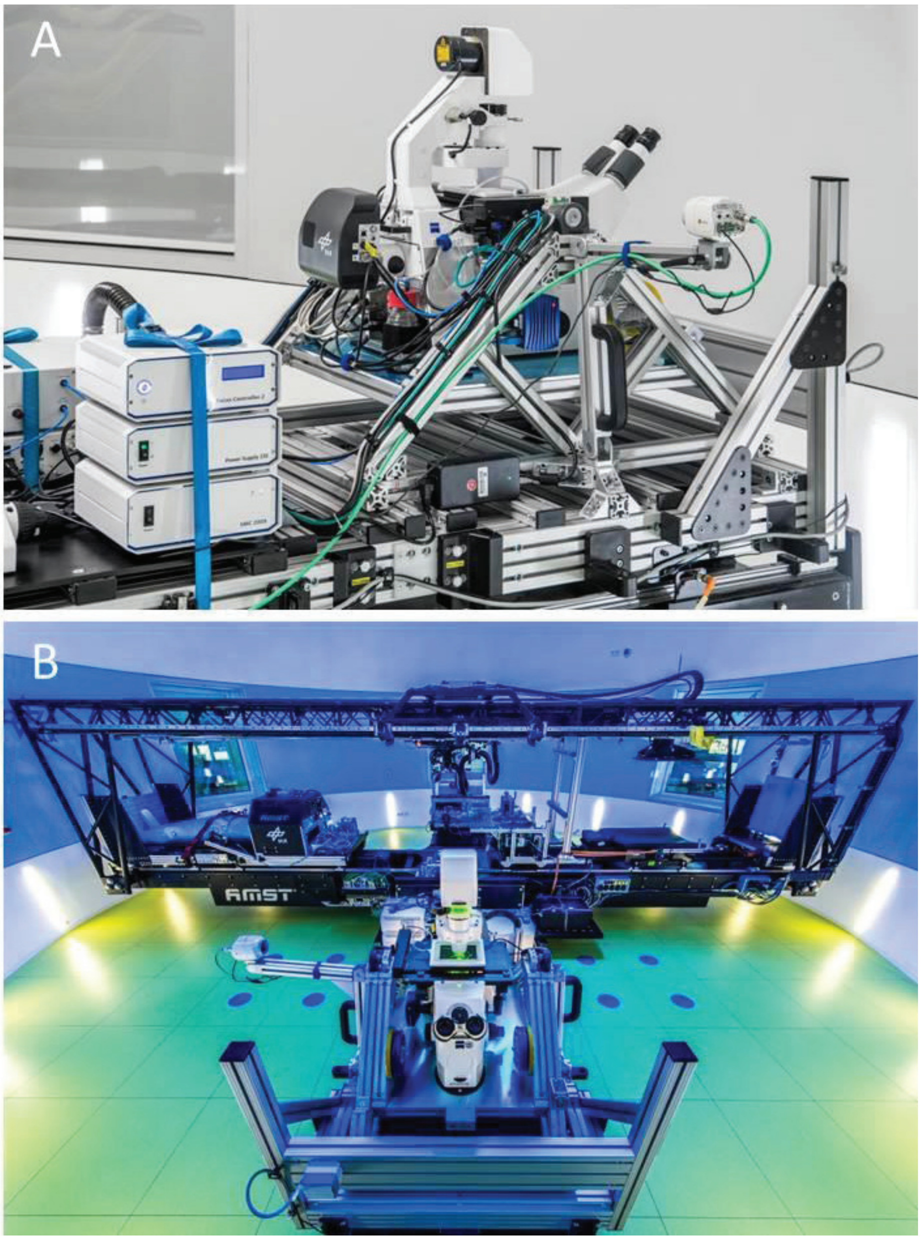
The quality of randomness generated was analysed through calculation of the Random Number Generation Index (RNG-I). The RNG-I assesses the degree of equiprobability of pairs of consecutive responses. Thus stereotyped behaviour is indicated by higher values of RNG-I. The Redundancy Score (R Score) was also applied to estimate the sampling bias by identifying the deviations from the equiprobability of response alternatives. Low R Score values correspond to novel behaviour or exploration, and high values to routine behaviour or exploitation.

Orientation of the body with respect to gravity had a significant effect on RNG-I scores, with a higher RNG-I score for the supine, gravity incongruent, relative to upright, gravity congruent, condition (Fig.1). This indicated that randomness was decreased when participants were supine compared to when they were upright. This may therefore correspond to decreased exploration when the body is no longer aligned with the direction of gravity. No significant effect of body orientation was found on R score.

Exposure to non-terrestrial gravity environments leads to several changes in the human body. Surprisingly, the role of gravity on the balance between exploitation and exploration has not yet been investigated. Given the technical and communication limitations in space environments, knowing the consequences of altered gravitational signals on how people take decisions is essential. Here we show that people were less prone to generating random behaviours while supine relative to upright. Thus, our results suggest that online gravitational signals shape the balance between exploitation and exploration, in favour of more stereotyped and routine responses. The balance between novel behaviour and routine behaviour is fundamental to successfully interact with the external environment. The organism's nervous system must respond to unusual gravitational information in ways that increase survival chances of the organism. A simple adaptive response is, for instance, to avoid risks. Thus, gravitational inputs may influence behavioural control strategies.

Dr. Elisa R. Ferrè,
Royal Holloway University of London

Live-cell Imaging of Neuronal Activity hangesunder Altered Gravity Conditions



Calcium-Imaging has been sucessfully implemented on a live-imaging microscope under hypergravity generated by a Short Arm Centrifuge.

To perceive our environment, the brain uses the sensory nervous system to receive and extensively process external inputs. Different senses (e.g. sight, hearing or touch) are used to transduce information from the physical world into neurological signals. The ability of the human brain to form a robust perception of its surroundings by merging highly variable sensory inputs (e.g. from the eyes, the ears) is called multisensory integration. Extreme environments, however, like altered gravity conditions, i.e. micro- or hypergravity, can lead to an incorrect multisensory integration. Such consequences can be seen in microgravity, for example in the space adaptation syndrome during early stages of space flight and even in hypergravity environments resulting in fatal misjudgments causing airplane crashes.

In order to investigate the role of gravity on the activity of sensory neurons, we propose the measurement of neuronal activity by live-cell imaging under different hypergravity conditions. Therefore we implemented a state of the art live-cell imaging microscope on the Short Arm Human Centrifuge (DLR, cologne). The microscope was mounted on a swing to ensure a perpendicular orientation of the resulting gravity vector on the cells. Several tests runs at 2g showed good feasibility of the remotely controlled microscope. Resulting vibrations from the centrifugation was in the range of approx. 1 µm, which is negligible. Thus, we were able to achieve high-resolution images at fast time intervals of measurements.

Neuronal activity of primary astrocytes from mice could be shown in hypergravity at 2g. Calcium imaging was used to measure neuronal activity of the axon (see figure 1). Long-term adaptation processes were investigated by measuring the migration behavior of astrocytes. Under hypergravity conditions an approx. 10% decrease of the migration rate was observed in 24h increments in cells exposed to 2g compared to cells grown at normal 1g conditions. These results are important measurements for future ex vivo or in vivo studies to investigate the effects of hypergravity on gliar scar formation in neuronal regeneration processes.

For future studies, a longer exposure and imaging time of app. 24h would be the primary aim.

Timo Frett and
Dr. Christian Liemersdorf,
German Aerospace Center

Students from Fly Your Thesis 2009.

ESA ACADEMY STUDENT OPPORTUNITIES

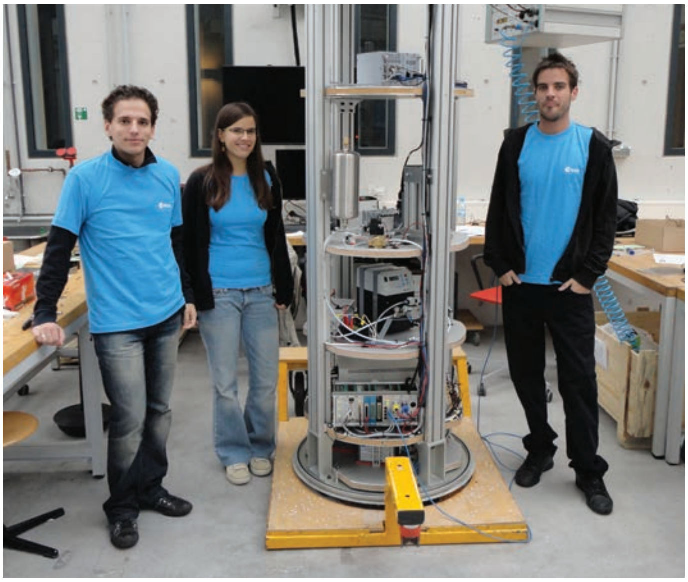
Ten years of fruitful collaboration between ESA Academy and ELGRA

2019 marks an important milestone between ESA Academy and ELGRA as it represents 10 years of fruitful collaboration between the organisations. ELGRA has continued to provide essential feedback and inputs during the selection processes of the teams for ESA Academy programmes and as with all ESA Academy hands-on programmes related to gravity research, successfully selected student teams have the option to be mentored by scientists from the European Low Gravity Research Association knowledgeable in the field of research pertinent to the experiment. Every year, between 6 and 10 teams are selected for the various programmes, Spin Your Thesis!, Drop Your Thesis!, Fly Your Thesis! Spin Your Thesis! Human Edition and Orbit Your Thesis! and every year many teams reap the benefit of the experience of ELGRA researchers who perform experiments in microgravity.

Two new student programmes from ESA Academy: Spin Your Thesis! Human edition and Orbit Your Thesis!

In 2018, ESA Academy initiated two new programmes which run sequentially, Spin Your Thesis! Human Edition (even years) and Orbit Your Thesis! (odd years).

The Spin Your Thesis! Human Edition (SYT-HE) programme offers university students (bachelor, master and PhD level) the opportunity to perform non-invasive experiments investigating human physiological responses to exercises employed on the International Space Station when performed in 1Gz (upright) and in simulated Gz on a human centrifuge.
A combination of artificial gravity provided by a human centrifuge and exercise has been proposed as way to mitigate the physiological de-conditioning associated with microgravity and thereby support human health during long-term space missions. Researchers need to define what kind of exercise should be part of a new training protocol during centrifugation.
In 2018, ESA Education teamed up with the DLR (German Aerospace Center) Institute of Aerospace Medicine to use their unique Short Arm (3.8 m radius) Human Centrifuge in Cologne (Germany), upon which participants performed a range of exercises whilst being spun. :envihab is located next door to the European Astronaut Centre (EAC), the home of European Space Agency astronauts.
The Spin your Thesis! Human Edition programme therefore provides to university students the unique opportunity to perform experimental research on the Short Arm Human Centrifuge, usually only accessible to professionals. Like all other ESA Academy programmes, the students proposals received are scrutinized and assessed by a Selection Board, comprised of ESA Education, ELGRA, ESA EAC and DLR experts knowledgeable in the field of human research.
Once selected, teams are asked to develop and conduct their experiment within approximately 6 months; including a 2-day workshop at the facilities to define the protocol. Once ethical committee permission has been received the student teams are granted the opportunity to access the human-rated centrifuge for 7 days (2 dry run and 5 test days). After the campaign is over, the results are processed and documented.
The Orbit Your Thesis! programme (OYT) offers university students (Master and PhD level) the unique opportunity to think up, design, build, test and operate their experiment on the International Space Station for a period of up to 4 months! For this programme, ESA Academy teamed up in 2019 with Space Applications Services' (Space Apps) "ICE Cubes" platform which is present on ESA's Columbus module. The experiments can take on a variety of shapes and sizes so long as they comply with the basic requirements from Space Apps.



BubJet team (Drop Your Thesis! 2010).

Spin Kings team Spin Your Thesis! Human Edition

Like all other ESA Academy programmes, teams are selected through a competitive announcement of opportunity which remains open for several months prior to being shortlisted during a selection workshop. Selected teams then attend a Gravity-Related Experiments Training Workshop at ESA Academy's Training and Learning Facility in ESEC-Galaxia (Redu Belgium). Here the teams from all programmes (Spin, Drop, Fly) meet each other, learn about project, team, risk management, system engineering and importantly meet face to face for 6 hours with the engineers of the facility, in this case from Space Applications Services. This initial week sets the team off in the right directions with all the right tools to design their experiment and start prototyping the hardware. ESA and Space Applications Services manifest the payload on a launcher at a specified date and the team work frantically for one year to achieve this deadline. It's long and hard work, but not many can say that they built an experiment that went to the International Space Station. If you are interested in participating in the next Spin your Thesis! Human Edition or Orbit Your Thesis! iterations, please check regularly the ESA Academy pages (www.esa.int/Education/ESA_Academy)

SOUNDING ROCKETS. ESA

Sounding Rockets – Now in ESA's Continuously Open Research Announcement, CORA

The easiest, fastest and most accessible way to fly a microgravity experiments within ESA´s programs is to apply to the Continuously Open Research Announcement, CORA. As the title indicates proposals can be submitted any time and should not be very extensive and ESA has a typical review time of 2 months. So far CORA has included drop towers and parabolic flight, excellent platforms for performing microgravity experiments but only giving up to 25 seconds of microgravity. Since the end of 2018, Sounding Rockets have been added to CORA giving up to 13 minutes of microgravity. As ESA is announcing:

"To further enhance and promote ESA's strong non-ISS research programme, ESA's Continuously Open Research Announcement scheme has been expanded to offer dedicated opportunities for research on ESA's non-ISS research platforms."

"Sounding rockets are a unique mission platform for providing truly excellent levels of microgravity, with very low residual acceleration (~10-5 g), for studying phenomena with a longer timescales (typically 3 to 13 minutes) than ground or airplane platforms. Physical science and biology science experiments can be conducted on board this platform. Sounding Rockets constitute a completely independent European access to microgravity conditions and have significantly contributed to microgravity science research, resulting in many publications in scientific journals. Sounding rockets are currently the only accessible microgravity platform for experiments, which are difficult to execute in human environments for safety reasons (e.g.: hazardous materials)."

More information and proposal template can be found here:

https://www.esa.int/Our_Activities/Human_Spaceflight/Research/Research_Announcements

http://esamultimedia.esa.int/docs/HRE/SR/ESA-CORA-SR_final.pdf

http://esamultimedia.esa.int/docs/HRE/SR/ESA-CORA-SR_submission_template.docx

Students posing with their certificates of participation under the brand-new ESA Education Training Centre logo. Credits: ESA

ESA/ELGRA GRAVITY-RELATED RESEARCH SUMMER SCHOOL 2018 AT THE NEW ESA EDUCATION TRAINING CENTRE

For its third edition, the collaborative ESA/ELGRA Gravity-Related Research Summer School took place from 25 to 29 June 2018 at the brand-new ESA Education Training Centre located in ESEC-Galaxia, in Belgium.

Thirty university students from 15 different ESA Member States and Canada, participated in the event. A Dutch student from the Erasmus University College was particularly impressed: "The inspirational lectures given by enthusiastic experts from various scientific fields greatly contributed to a clearer understanding of the multiple possibilities for interdisciplinary gravity-related research. The staff and fellow students were so lovely as well and made the summer school an experience to treasure for a lifetime!"

Nineteen ELGRA and ESA experts from across Europe were on-hand to offer tuition, guidance, and a wealth of experience to the participating students. "I have participated in the Summer School as lecturer for the three editions of the event" reported Dr. Javier Medina , ELGRA expert on Plant Biology at the CIB-CSIC in Madrid. "My experience has been extremely rewarding. At the beginning, I was afraid of the difficulties in reaching a group of students coming from such different disciplines: physicists, engineers, only a few biologists... with a talk actually containing much plant cell biology. However, the result exceeded my expectations, due to the curiosity and interest of the audience in knowing every aspect of microgravity and space research. I felt happily overwhelmed by the amount of questions and comments from the students that my talk had raised. Many thanks to the organizers for such this exciting initiative."

The summer school combined lectures and hands-on experience. Participating students gained a foundation of understanding about the interest and benefits of performing scientific research at different g levels. Students were also challenged by asking them to work in groups to generate their own research ideas for an experiment in altered gravity conditions. The team of ESA and ELGRA experts were available to facilitate, stimulate and monitor students' progresses. On the final day, students presented their projects to a panel of experts. The students proposed a highly diversified set of projects, including testing the ability of bees to pollinate in micrograv-ity, examining the solidification of thermoplastics in microgravity, and investigating the motility of immune cells in hypergravity.

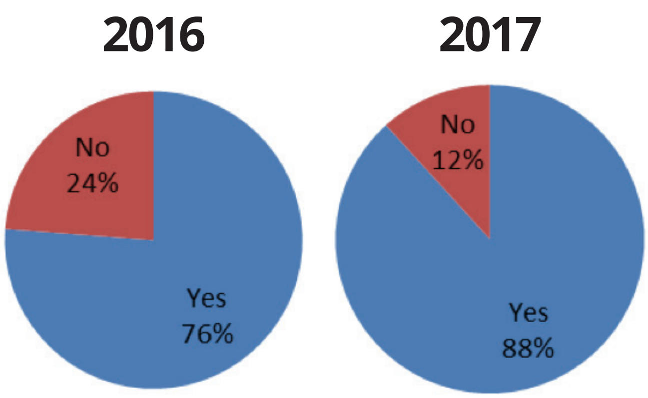
Upon completion of the Summer School students received a certifi-cate of participation and a course transcript, allowing them to claim ECTS credit(s) from their respective universities.

"I truly enjoyed the ESA/ELGRA Gravity-Related Research Summer School" said an Italian student from the University of Bath. "It allowed me to meet passionate students across multiple disciplines who were all gazing towards the stars but also looking for ways to improve our lives here on Earth. Collaborating with them exposed our individual limitations but showed us that great scientific research can be developed by working in synergy. The school gave us great insights in current areas of research and the means to devel-op future experiments that can be carried on different platforms. I would highly recommend it to anyone who is interested in space and is aspiring to contribute to space exploration."

The interest that students have risen during the Summer School is often put into practise when some of the students, later on, apply for the ESA Academy's hand-on programmes such as the Spin, Drop, Orbit or Fly Your Thesis!. We are delighted to wel-come some of these young research-ers in ELGRA community.

Finally, we would like to sincerely thank all the ELGRA members who have contributed to the success of this wonderful adventure without whom the summer school would never been possible.

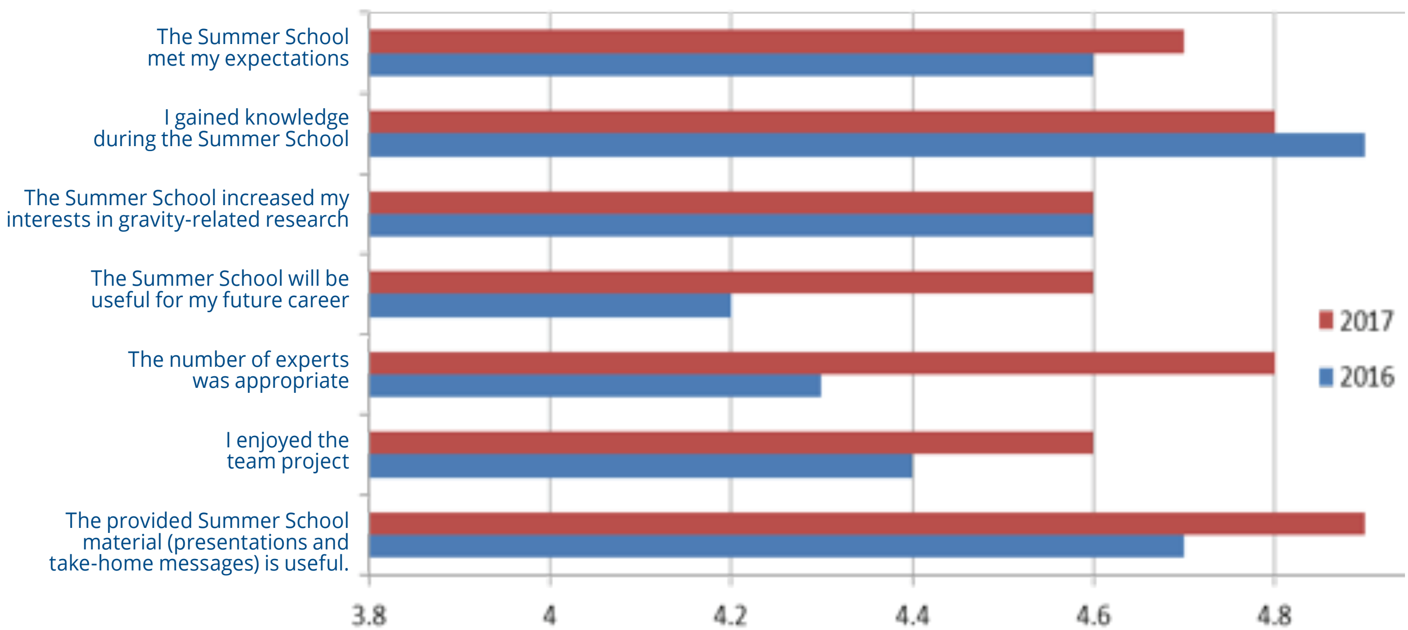
Natacha Callens,
Ricard González-Cinca,
Philip Carvil and
Carole leguy

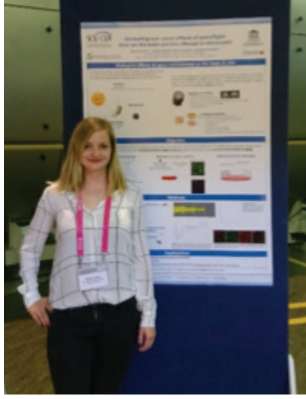


Results extracted from the feedback questionnaire answered by the students who participated in the two first editions of the Summer School. General impression:

To find more information about ESA Academy hands-on and training opportunities, please check the ESA Education website .

Call for applications for the fourth edition of the Summer School will be launched by ESA Education Office mid-March 2019. The Summer School will be organised from 24 to 28 June 2019.





SELGRA ACTIVITIES

Another year has passed, and SELGRA has continued to play an important role in supporting European students in the field of gravity-related sciences. We are happy to see our membership base grew more than 30% in 2018, with 144 students currently enrolled in our society. It was a busy year for SELGRA, as we were present in significant European meetings and events. As in previous years, we supported ELGRA at the ESA/ELGRA Gravity Related Research Summer School in Belgium. But this year we were also present at the ISGP & ESA Life Sciences Meeting, in which our Vice-President Jérémy Rabineau delivered a presentation about our society. Then, our committee member Luis Luque Alvarez represented SELGRA with a stand at the Space for Inspiration conference in Bilbao, Spain. Finally, our communications manager Tânia Ribeiro presented SELGRA in a European Space Talk in Porto, Portugal.

SELGRA Conference Grants

During the past year, we have awarded students from four different countries with travel grants to attend European conferences. This enabled SELGRA members to present their work in internationally-renowned stages and establish their professional network by connecting with academics, industry and other students.

The selected students in 2018 were:

- **Maria Gallagher** from Royal Holloway University of London, UK: Cognitive and Motor Functions of the Vestibular System conference in Marseille, France
- **Greta Lamers** from Ghent University, Belgium: ISGP & ESA Life Sciences Meeting 2018 conference in Noordwijk, The Netherlands
- **Daniela Melnik** from Otto-von-Guericke-University Magdeburg, Germany: ISGP & ESA Life Sciences Meeting 2018 conference in Noordwijk, The Netherlands
- **Álvaro Soria-Salinas** from Luleå University of Technology, Sweden: 69th International Astronautical Congress conference in Bremen, Germany

Here is what they had to say about their experience:

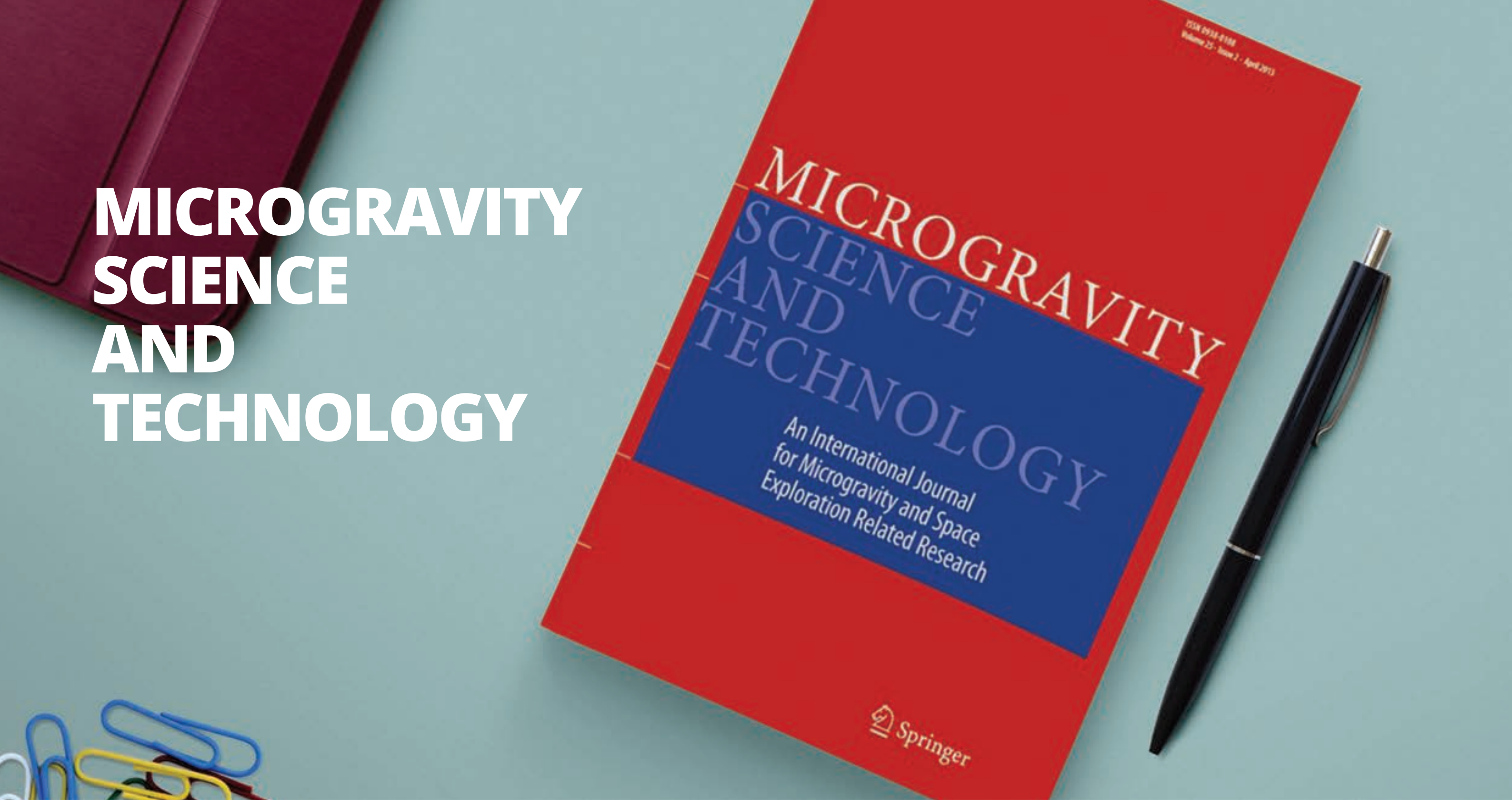
"Overall, my attendance to IAC 2018 was incredibly useful and rewarding from both personal and professional perspective. I had the opportunity to meet experts and space leaders from all over the World and to network with amazing student that share my passion and interest for the further development of the space sector. I want to thank to SELGRA for this great opportunity and I truly recommend to any student interested to apply in future events."

Álvaro Soria Salinas

"This conference gave me an amazing opportunity to network and discuss with experts, meet and befriend other PhD students in the field of space research and build the ground for potential collaborations. In addition, it gave me new insights, deepened and equipped me with knowledge, broadened my research interests, and inspired me to learn about and implement new techniques and skills that I can apply to my future lab work to get the best out of my PhD research."

Greta Lamers

MICROGRAVITY SCIENCE AND TECHNOLOGY



Microgravity Science and Technology (MST) is a peer-reviewed scientific journal concerned with all topics, experimental as well as theoretical, related to research carried out under conditions of altered gravity. The journal is published by Springer Nature Company.

To provide a thorough understanding of the scientific impact on future space research, Microgravity Science and Technology publishes a large variety of articles including regular Articles, Open Access Articles, Review Articles and the articles in the frame of Topical collections managed by Guest Editors.

The ELGRA society has been keeping a tight relationship with the journal for many years. Let me remind you, that as a member of ELGRA you have free access to the MST journal via the ELGRA website.

The development of the Journal keeps being on good track, with its reputation and its quality enjoying a worldwide recognition. The impact factor of the Journal, the total number of submitted publications and the number of accepted publications have all been steadily increasing over the last years, and the positive trend is set to continue.

The figures can be seen in the Editorial status summary below.

Valentina Shevtsova,
Editor-in-Chief of MST

SUBMISSIONS	2015	2016	2017	2018
Impact factor	0.725	1.188	1.357	
Quartiles (Engineering)	Q1	Q2	Q1	
Total submitted	102	63	130	153
Rejected	22	13	34	77
Average days to Final disposition Accept	145	1.188	1.357	1.357

IN MEMORY
OF OUR FRIEND AND COLLEAGUE
JEAN-CLAUDE LEGROS

In memory of our friend and colleague Jean-Claude Legros, who recently passed away, with the permission of his wife Valentina Shevtsova, a former ELGRA President, we report some paragraphs from a letter written by Dr. Lina De Parolis (Acting head of the Science Department, ESA-ESTEC-Directorate of Human Spaceflights and Exploration), who perfectly described the brilliant Intuitions and the intense activity that distinguished Jean-Claude's important contribution to space research in the field of physical sciences:

"Jean Claude Legros has been a pioneer in fluid physics research under microgravity conditions almost since the beginning of ESA's microgravity programs. He has flown his experiments on virtually all platforms available to ESA, from parabolic flights, sounding rockets, the Space Shuttle, Russian capsules to the International Space Station and contributed to the design of the facilities still used by the scientists today.

Over about three decades, Jean-Claude Legros has been one of the most prominent scientists, to whom ESA owns the success of several microgravity experiments not only in fluid physics and transport phenomena but also in many applicative fields of interest, such as thermal effects in crude oils. His work on free liquid surfaces and in particular his investigations into the Marangoni-Bérnard effect, are major achievements in microgravity research. His legacy will leave on in the many technical applications and patents, high efficiency capillary heat pipes and optical interferometers of different nature, as well as the creation of a successful company commercializing the results both for ground-based and space application.

Thanks to his knowledge, charismatic character and strong motivation, he has inspired and gathered around him a large number of talented scientists, not only at his own institute at the Université Libre de Bruxelles, but also at research institutes all over the world with whom he collaborated. Jean-Claude Legros will be sadly missed and fondly remembered."

Beyond the remarkable professional achievements, we also remember Jean-Claude's activity in favor of our scientific society: Jean-Claude was member of ELGRA since 1983, member of the ELGRA Management Committee from 1986 to 1990, General Secretary of ELGRA from 1991 to 1995. In the year 2011 he was awarded the ELGRA medal for his career and for the important contribution in the field of physical sciences in space.

GRANADA (SPAIN)
24-27 SEPTEMBER 2019

26TH ELGRA BIENNIAL SYMPOSIUM AND GENERAL ASSEMBLY

14TH INTERNATIONAL CONFERENCE ON TWO-PHASE SYSTEMS FOR SPACE AND GROUND APPLICATIONS

& ESA TOPICAL TEAMS MEETINGS