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3	<b>ELGRA Membership</b>
4	Become an ELGRA member and strengthen our community! The following annual fees apply.
8	
10	<b>Students: free</b>
11	<b>Regular member 50 euro</b>
12	<b>Corporate member 600 euro</b>
13	<b>For further information please visit the ELGRA web site at <a href="http://www.elgra.org">www.elgra.org</a></b>
14	
14	<b>27th ELGRA Symposium &amp; General Assembly</b>
15	The Symposium is scheduled to take place in Lisbon, Portugal from the 1st-4th September 2021. With many interesting sights to visit and an attractive style of life for visitors, this is the ideal place to meet, generate fruitful discussions, start new collaborations, and elaborate bright ideas about microgravity research. Please visit our website for the latest updates.
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# PRESIDENT'S WORD

## Dear ELGRA members,

2020 has been a very challenging year that probably most of us like to soon forget. If we were asked to derive one positive outcome of the pandemics it could possibly be the higher recognition in our society of science as a main driver to improve the wellbeing of all of us.

Nevertheless, I hope that as soon as possible in 2021 we will leave tough times aside and will be able to focus more on positive personal and professional challenges.

I am glad to introduce you the second issue of our ELGRA Magazine, which in 2019 substituted the ELGRA Newsletter. In the Magazine we summarize the main activities carried out by ELGRA in the last two years, and we present information and announcements on future events.

In this issue we wanted to read your contributions about how you addressed the exceptional situation in 2020. It is nice to see that many colleagues managed to move forward their projects despite the difficulties.

In September 2019, the 26th ELGRA Biennial Symposium and General Assembly was organized jointly with the 14th International Conference on Two-phase Systems for Space and Ground Applications (ITTW-14) in Granada (Spain). Nearly 200 delegates attended from Europe, America and Asia. Aside from the usual technical session, we had special sessions to celebrate ELGRA's 40th anniversary: the President's panel with the participation of former ELGRA Presidents, and an international panel with members of the American Society for Gravitational and Space Research (ASGSR). During the symposium the organizers were proud to hand over the ELGRA Medals 2019 to Prof. Valentina Shevtsova and Prof. Javier Medina.

A new Management Committee was elected in the General Assembly in Granada. Inside this Magazine we present you the new members. Two members left the committee. I want to thank Kurt Kemmerle, who acted as treasurer for many years, for his accurate work and wise advices in the committee. Many thanks also to Carole Leguy for her enthusiastic and brilliant contribution during her position at the committee.

The ELGRA/ESA Gravity-Related Research Summer School co-organized with ESA Academy reached its 5th edition in June 2020. The school has been improving its format every year, with a big step last year, changing from a one-week on-site structure to a two-weeks on-line one, which will most probably repeat in 2021. When the on-site meetings will be possible again, an interesting option could be a two-weeks summer school with on-site and on-line activities.

Our collaboration with ESA Education Office student programmes (Spin, Drop, Fly and Orbit your Thesis!) successfully continued and consolidated. We look forward to new opportunities of collaboration with ESA Education.

In this issue we also bring you an update on SELGRA activities and provide you with information on our corporate members, including highlights from Ace2space, Swedish Space Corporation and Airbus. In addition, we introduce you to our partners around the globe: American Society for Gravitational and Space Research (ASGSR) and the Japan Society of Microgravity, which are societies with similar goals as ELGRA, and The Sub-orbital Applications Researchers Group in the USA, which promotes suborbital research.

Talking about suborbital, last year we launched the first ELGRA goes Suborbital! call, in which an

experiment from a Portuguese team was selected to fly in a SSC suborbital flight. We recently launched the second call for proposals, this time to fly an experiment onboard Blue Origin's New Shepard suborbital vehicle. Moreover, the second edition of the ELGRA Research Prize was also launched recently.

I recently signed on behalf of ELGRA an open letter to ESA Director General on the concern of the European scientific community about ESA's policy in Physical Sciences. The letter, which requests to keep the current programmes of academic research in Physical Sciences, is an initiative of European scientists involved in Topical Teams and MAP projects under the SciSpacE programme of ESA and ELGRA members.

Finally, you might wonder what is going to happen with the 2021 ELGRA Symposium and General Assembly. We pre-selected a venue in Lisbon and sent you a Save the date! message. The symposium will only take place on-site if it can be fully safe to similar levels as in past editions. If this is not assured, an alternative plan will be activated, which can consist on an on-line symposium or a postponement until 2022. We will let you know as soon as possible. Nevertheless, the ELGRA General Assembly will be carried out in 2021, either on-site or on-line.

I would like to thank Phil Carvil for the edition of this Magazine, and all the colleagues who contributed to it.

I wish you a healthy and peaceful year, hoping that your research goals for the year have gotten off to a great start.

All the best,

**Ricard González-Cinca**  
ELGRA President



[www.elgra.org](http://www.elgra.org)

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# A year in review: 2020 members reflect on their past year

**2020 has been** a challenging year, coupled with the inability to meet colleagues as we would normally at events, here we provide updates from our community.

## **John Z Kiss, University of North Carolina**

My job has not changed at all during the pandemic—I am the Dean of the College of Arts & Sciences with about 500 faculty and staff members. At the end of the last academic year, functions such as writing annual reviews and budget planning were the same as always. What really had changed is my daily routine—I work from home most days! We have been using Zoom to communicate and to schedule meetings large and small. I have taken over one room and my wife Helen is working remotely in another room. One additional challenge is that my research lab was closed for some time, so my students had to work remotely, and I met with them via Zoom. They had done well in that they worked on analyses of the large amount of data that they had previously generated. Fortunately, now with some limitations, our lab is open again.

## **Natacha Callens, ESA Academy**

When we were all sent home mid-March due to Covid-19 pandemic, I naively thought it would be a story of a few weeks but then quickly realised that this unique situation would last for several months. At personal level, my family adapted very well. We made a lot of activities together and really enjoyed it. It brought us even closer together! At work level it was more challenging, we were supposed to deliver more than 10 on-site

training sessions by end of 2020 and had to cancel all the upcoming ones. Nevertheless the ESA Academy's Training and Learning Programme team was very reactive and worked hard, with colleagues inside and outside ESA, to adapt several training sessions and offer them online, including the ESA-ELGRA Gravity-Related Research Summer School. It was worth it! Feedback is excellent. Up to now around 220 University students have participated and ESA Education Office will continue to offer online training opportunities in the coming months!

## **Jérémy Rabineau, SELGRA President**

Just like the whole society, the academic world suffered a lot during this year of pandemic: universities closed, and online teaching became the rule, highlighting even more the digital gap. When scientific conferences got canceled, there was no choice but to cancel SELGRA's conference grants too. However, challenging times also bring us the most empowering lessons, and we took this opportunity to diversify our activities. We strengthened bonds with our American counterpart and built new partnerships from scratch. With everyone getting more and more used to online meetings, the three webinars that we organized in 2020 were very successful. This year proved us that our community was strong enough to remain united through the distance.

## **Philip Carvil, ELGRA Vice President**

It has been an interesting year for certain. Like many the move to 'online' has been advantageous in

some regards allowing even greater connectivity, particularly internationally to fuel new collaborations. However, I do find it has made 'leaving the office' harder. I have been pleased to work on several projects this year including helping win two research grants for new science and technology projects in the coming year. In ELGRA, I was delighted to support the ESA & ELGRA teams with the delivery of our 6th joint ESA-ELGRA Gravity-Related Research Summer School, despite the circumstances, the students were able to interact and learn in the online format which was great. On a personal note I have enjoyed spending time rediscovering the joy of home cooking and now make fresh bread each week (after many failed attempts in March/April). I am thoroughly looking forward to attending conferences again in person and hearing from many of you when we meet again.

## **Michael Kringer, Team AIMIS-FYT**

For us as a student team, 2020 was a special year. On the one hand, we had the pandemic with all its restrictions, and on the other hand, we were selected to participate in the FlyYourThesis!2020 programme to conduct experiments on our 3D-printing process during parabolic flights. Thus, between lockdowns, we had the challenge to bring our experiment from draft to flight readiness. This was not always easy, as the university was closed and only granted restricted access in the meantime. After high infection rates in France during September, the campaign was moved at short-term from Bordeaux, France, to Paderborn, Germany, where it was

carried out under extraordinary Covid-19 measures. This allowed us to successfully test our 3D printing process under 0g.

## **Willian Abraham da Silveira, Queen's University Belfast**

I have been involved on Space Biology research for the last 4 years, but 2020 was the year where I became more established on the field. I had the honour to be the first-author of the paper that made the cover of CELL in November where we describe the development of a mitochondrial dysfunction and its related consequences on mice and Astronauts at the ISS. As quoted by CNN, the work was part of "largest set of data about space biology to date", and the only of the set of 30 original research to be in CELL itself. In this year I co-founded and became the co-head for Multi-Omics and System Biology of the Space Omics Topical Team Funded by ESA, with the objective to increase the use of Omics technologies for the European Space Biology Community. 2020 was indeed an eventful year.

## **Christos Tsagkaris, University of Crete, Faculty of Medicine, Heraklion, Greece**

Distance is a challenge, but not a dead-end: Our joint space mission started in April 2019, when Ana Sofia Mota from Portugal, Andrea Camera from Italy and I attended the ESA Human Space Physiology Training Course. Our virtual collaboration skyrocketed in 2020. In February 2020, we delivered a presentation about 3D printing in Space in the Beyond Science Initiative Conference. In September 2020, we shared our vision of Space Medicine in a webinar

organized by the Circle of Sustainable Europe and the European Student Think Tank during the opening ceremony of the NASA Space Apps Challenge in the Netherlands. Distance is a challenge, but not a dead-end.

## **Antoni Perez-Poch, UPC-BarcelonaTech, Spain**

Our recent line of research on Human reproduction in space, a joint venture between UPC BarcelonaTech and Institute Dexeus (Spain), studied the possibility of establishing a human sperm bank outside Earth. In 2019 we reported first results on microgravity effects on frozen human sperm samples. However, our parabolic flights based in Barcelona (Spain) had to be cancelled due to the confinement, but we indeed continued analysing data and planning the next steps. We have resumed these parabolic flights after summer 2020, and we certainly look forward to report on these experiments at the upcoming Elgra symposium. We have also just launched the Barcelona ZeroG Challenge 2021 for students, providing a parabolic flight opportunity to experiment aimed at young researchers, and we expect to actually fly the winning experiment in Fall 2021, conditions permitting (please find here information: <http://window2theuniverse.org>). We just should not let the pandemic stop our activities.

## Lab Updates in 2020

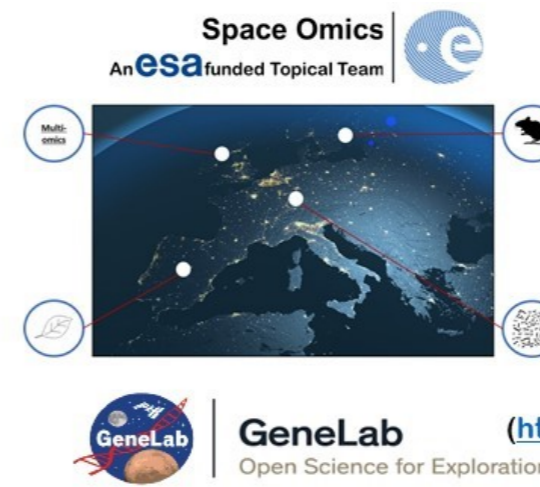
### **Javier Medina** PCNP Micro-g Lab, CIB Margarita Salas – CSIC, Madrid, Spain

Plants under Microgravity in Times of Pandemic: Covid-19 pandemic has constituted a new environment for our Lab, requiring a quick adaptive process without any previous “memory” of a similar scenario in the history of our Team. This represented a similar challenge as plants experience when they are confronted with spaceflight. First, mandatory tele-work; then, when the conditions somehow relaxed, a combination of in situ presence in the lab for some members, permanent homework for others, and mixed model for the rest. Our International projects involving ground-based facilities suffered the most, affected from drastic travel restrictions.

Nevertheless, we are proud of having succeeded in our adaptation to online resources. We have submitted and/or published a total of 11 papers in 2020! The results of our “Seedling Growth” spaceflight experiments are being successfully exploited, taking full advantage of the GeneLab/ISSOP platforms. We have participated in advisory committees to ESA, and in International conferences, such as ASGSR, and even produced outreach activities. Last, but not least, the two Co-PIs of “Seedling Growth”, Drs. Kiss and Medina, have been awarded with the COSPAR Medal for International Cooperation.

### **Raúl Herranz**, PCNPmicrogravity Lab Centro de Investigaciones Biológicas Margarita Salas (CSIC, Madrid SPAIN)

Due to the COVID-19 situation, @PCNPmicroGlab in Spain (CSIC, Madrid, Head Javier Medina) we have chosen to boost our transcriptome datamining efforts in the context of international collaboration, focused on the overall transcriptional effects of suboptimal spaceflight environments. I have gathered the group of European participants in GENELAB AWG (NASA related) to coordinate the Space Omics Topical Team (ESA funded, Madrigal et al. 2020) in parallel to the brand new consortium International Standards for Space Omics Processing (ISSOP, Rutter et al. 2020, <https://issop.space/space-omics-topical-team/>). These achievements of the European Space Biology Community have been announced in the Special 25th November 2020 issue @CellPress “The Biology of Spaceflight” <https://www.cell.com/c/the-biology-of-spaceflight>, including the covers of Cell (Silveira et al. 2020), Cell Reports and iScience journals, the latest highlighting the importance of our Seedling Growth Ground Reference experiment to find new molecular mechanisms to improve plant growth out of Earth (Manzano et al. 2020).



More information is available at Cell Systems (<https://authors.elsevier.com/a/1c8878YyDfcea2>) or contact our coordinator/points of contact for the Genelab Analysis Working Group

## Research updates in 2020

### **Olga Artemenko & Elizabeth Kordyum, Institute of Botany, National Academy of Sciences of Ukraine, Kyiv, Ukraine**

Laurdan generalized polarization changes in pea root plasmalemma under clinorotation

Plasmalemma is considered as the most sensitive to microgravity due to its heterogeneity based on the presence of lipid rafts – functional micro-domains till 200 nm, sterol- and sphingolipid-enriched, highly dynamic in vivo and responsible for many vitally important cell processes. We studied the plasmalemma in pea root intact cells using Laurdan, which is a fluorescent probe sensitive to local lipid packing, with a confocal laser microscope ( $\lambda = 435$  nm and 580 nm). Pea seedlings grew in stationary conditions and under slow horizontal clinorotation in darkness during 3 and 6 days. Generalized polarization (GP) fluctuations in the plasmalemma of root cells were different in control and under clinorotation, especially on the sixth day (from -0,04 to +0,5). GP value raising can indicate an increase in lipid rafts moving in a more fluid background phase under clinorotation.

### **Liudmyla Kozeko, M.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine, Kyiv, Ukraine**

Previously, we found that HSP90 and HSP70 chaperones stabilize a gravitropic response. In the absence of a gravitational stimulus, plant growth can be guided by light. To understand whether HSPs are involved in

phototropism, we evaluated the ‘pure’ phototropic response in loss-of-function Arabidopsis mutants for individual HSP90s and HSP70s. Seedlings grown in simulated microgravity (2-D clinostat) conditions with a point light source of low intensity had an etiolated phenotype and showed a clear photoresponse. Comparison of mutant and wild-type seedlings revealed the dependence of growth activity in organs on individual genes, and also showed the importance of HSP90 and HSP70 for maintaining a stable spatial orientation of the plastic response to light.



# 26TH ELGRA SYMPOSIUM

## Celebrating 40 years of ELGRA

The 26th ELGRA Biennial Symposium and General Assembly was organized jointly with the 14th International Conference on Two-phase systems for space and ground applications (ITTW-14). Chaired by Dr. Ricard González Cinca (ELGRA President, Technical University of Catalonia- BarcelonaTech, Spain) the symposium held a special place for ELGRA where the association also celebrated its 40th Anniversary.

Taking place from 24th-27th September (2019), in the beautiful city of Granada in Spain it was attended by nearly 200 international delegates including colleagues from Canada, China, Europe, Japan, Russia and USA. It was a pleasure to also

welcome so many of the past presidents of ELGRA (including Professor's Valentina Shevtsova, Jack Van Loon & Daniel Beysens) to speak at the symposium on a dedicated Presidents Panel reflecting on 40 years of the association. We were also joined by representatives from American Society for Gravitational and Space Research (ASGSR; Professors Alamelu Sundaresan and William Meyer) as part of ongoing work to strengthen international collaborations.

A diverse array of contributions were presented at the symposium, covering a large variety of topics. Within the Physical Science talks included advanced material processing and properties, heat transfer and high energy particles, soft or complex matter and combustion/Fire safety to name a few. Similarly within the Life Science sessions an array of topics were presented included Gravitropism responses in plants to space, cellular

and genetic responses to gravity and whole body Human Physiology experiments. Instrumentation and Outreach were also covered with presentations from national space agencies including the European Space Agency (ESA) on current educational opportunities. A poster session took place in the first day of the Symposium allowing delegates to network, discuss contributions with authors and form future collaborations.



It was our pleasure at the symposium to award the ELGRA medals for outstanding contribution to Physical and Life sciences to Professor Valentina Shevtsova and Professor Javier Medina respectively. Valentina, a pioneer of the Marangoni convection studies in deformed liquid bridges she is the Head of Group at the Microgravity Research Centre, Université Libre de Bruxelles (ULB), Belgium and has been a Principal investigator in 4 space experiments on the International Space Station (ISS). Javier is a Senior Researcher for the Spanish National Research Council (CSIC) on the cellular and molecular physiology of plants and has led three projects conducted at the International Space Station (ISS), namely "Root" (2003), the first European experiment on Plant Biology in the ISS, "Genara" (2010), and "Seedling Growth" (2011-2018), a joint NASA-ESA project.

beautiful city of Granada, resulted in a very nice atmosphere among the participants in the Symposium. Delegates were treated to a visit to the historic city of La Alhambra and dinner in the majestic palace of Carmen de Los Mártires.

The Symposium attracted a large number of early career researchers and students, including ten students supported by ELGRA, and five students supported by ESA as part of our on-going, fruitful collaboration with ESA. The impressive quality of the scientific presentations and discussions combined with both the convenient conference centre in the



# WHO ARE ELGRA'S NEW COMMITTEE MEMBERS?

During the 26th ELGRA Symposium in Granada, ELGRA members elected two new members to the management committee, Dr Elisa Ferre and Dr Thorben Könemann.



**Dr Elisa Raffaella Ferre**

Elisa Ferre is Cognitive Neuroscientist and a Senior Lecturer at Royal Holloway University of London. Her research investigates the interaction of signals from different sensory modalities, primarily between vestibular, visual and somatosensory inputs. Using a range of techniques from neuroscience, neurophysiology and experimental psychology, she has demonstrated that vestibular-multisensory interactions are crucial in several cognitive processes, including gravity processing. Her work is supported by project grants from the UK British Academy, UK Royal Society, UK Meniere's Society, Japan National Institute of Information and Communications Technology, European Low Gravity Research Association and European Space Agency.



**Dr Thorben Könemann**

Thorben Könemann is the Deputy Scientific Director of the ZARM Drop Tower Operation and Service Company (ZARM FAB mbH). ZARM FAB mbH is an integral part of ZARM, the Center of Applied Space Technology and Microgravity, and operates as well as maintains the Bremen Drop Tower. In his position, Thorben is responsible for the overall microgravity experiment operation. Together with ZARM's engineering team, he facilitates all drop tower experiments of the scientific users coming from a variety of research fields. He is also involved in both drop tower-related student programs, ESA Academy's Hands-on Program „Drop Your Thesis!“ and the United Nation Fellowship Program „DropTES“ (Drop Tower Experiment Series) supported by DLR Space Administration. Furthermore, Thorben contributes to many innovation and development projects, e.g. realizing a next-generation drop tower system, the GraviTower Bremen. During its General Assembly in 2019, he became the new Treasurer of ELGRA.



## ESA-ELGRA COLLABORATIONS: AN UPDATE ON OUR ON-GOING ACTIVITIES

For over 10 years the ESA Academy and ELGRA have enjoyed a fruitful collaboration. 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. 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 ELGRA knowledgeable in the field of research pertinent to the experiment. We have also enjoyed continuing to co-create the ESA-ELGRA gravity related research summer school which is soon approaching its 6th edition.

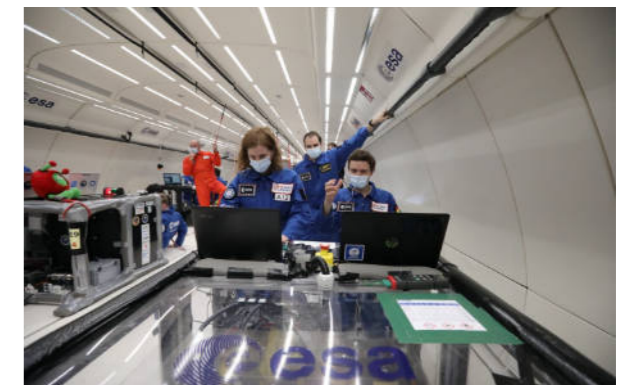
### How to run a parabolic flight campaign in the face of a pandemic?

In normal circumstances, a parabolic flight campaign requires a

tremendous amount of planning and coordination. Bringing 12 to 14 experiments to a state of completion whilst meeting strict safety requirements for flying in Novespace's AirZeroG A310 is no simple task, not to mention the logistics of bringing hundreds of scientists in Bordeaux, France. This year's Fly Your Thesis! and other ESA parabolic flight campaigns however, were heavily affected by the Covid-19 pandemic. National quarantine regulations meant that the campaigns could no longer occur in France in the latter part of the year, so in the space of three weeks, Novespace secured a suitable airport in Germany, Paderborn-Lippstadt, to host the campaigns. The number of people allowed on site was restricted to the bare minimum and teams had to arrive in Germany from abroad with negative Covid-19 PCR test results to fulfill local quarantine regulations. During the actual campaign, mandatory twice daily temperature monitoring, salivary tests as well as nasopharyngeal tests were performed regularly on all participants who also wore masks

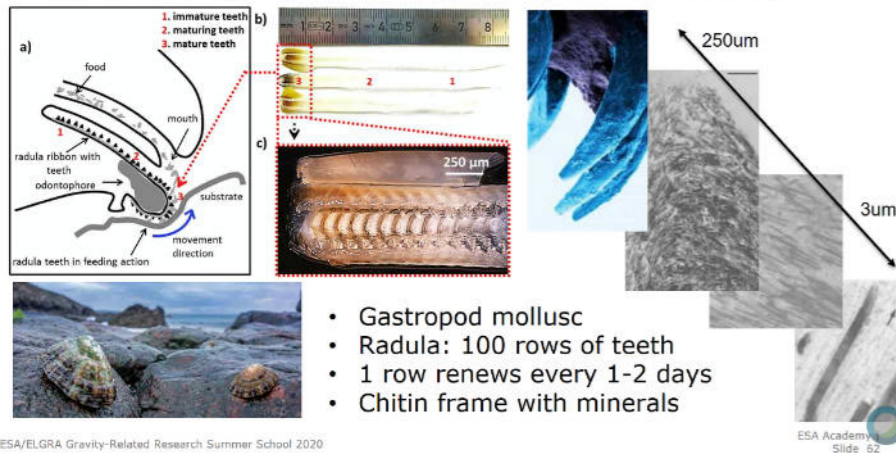
and maintained social distancing in the specially accommodated airport hangar.

Despite all these rather imposing changes to the campaigns, they were deemed to be extremely successful, with all teams obtaining the data they set out to acquire. The hard work of



Novespace, ESA and the scientists and the willingness to work together to make the campaign a successful one paid off, but this is not to say that everyone hopes that next year the aircraft will take off from Bordeaux once again!

## Topic background – Phenomenon of Study



- Gastropod mollusc
- Radula: 100 rows of teeth
- 1 row renews every 1-2 days
- Chitin frame with minerals

ESA/ELGRA Gravity-Related Research Summer School 2020

ESA Academy | Slide 18

<https://www.esa.int/>

## ESA - ELGRA Gravity-Related Research Summer School 2020

Running from 22 June to 3 July 2020, this 10-day Summer School was the fifth annual edition, but the first to be held entirely online, in response to limitations imposed by the COVID-19 pandemic. Participating were 30 university students from 11 different ESA Member States. Lectures were delivered by ESA and ELGRA experts from across Europe, introducing students to current research performed under altered gravity conditions, and the impact of gravity-related research.

**“This was an invaluable experience for someone looking forward to discovering ESA and space exploration,”** said a Spanish student from Imperial College London (UK). **“I was delighted to meet students and experts coming from a huge range of scientific backgrounds. The mix of multidisciplinary sessions made the Summer School really enjoyable and inspiring. I would definitely recommend this Summer School to any student interested in cutting-edge science.”**

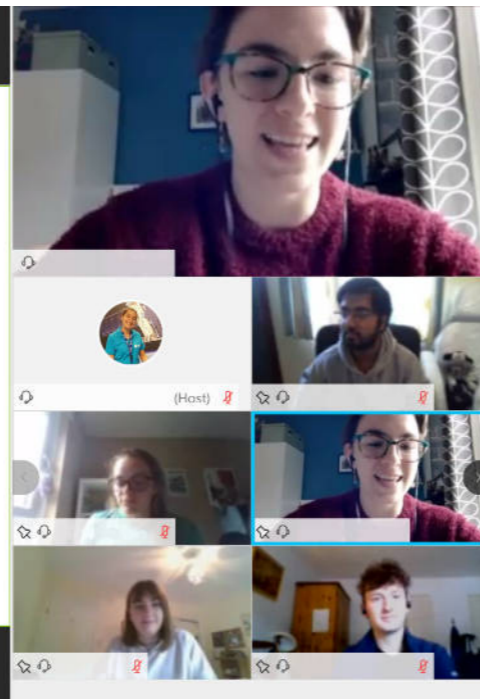
The Summer School's first week saw students gain a solid grounding in the various aspects of gravity-related research. They began by investigating different platforms used to perform innovative gravity-related experiments, such as centrifuges, drop towers, parabolic flights, and the International Space Station. They were then told about the many opportunities ESA Education Office offers university students to perform their own gravity-related research including the Spin, Drop, Fly and Orbit your

thesis programmes. The first day concluded with an overview of team project activities: students were divided into small groups and, with the support and guidance of the experts, were challenged to devise their own idea for a gravity-related experiment or technology demonstration.

Day two continued at the same rapid pace. Participants of previous editions of ESA Education's Hands-On programmes shared their experiences and lessons learned with the students, giving top tips and valuable insight. Further lectures focussed on gravity machines and animal models, complex fluids in microgravity, and space motion sickness. The third day saw the students learn about cell modulation due to altered gravity, and how microbes can support human life in space.

The fourth day centred on technical aspects of gravity-related research, from artificial gravity to technology demonstrations in microgravity followed by time for project development. At the end of the week each team presented the current status of their project development, and had the opportunity to identify what they considered to be the most critical aspects.

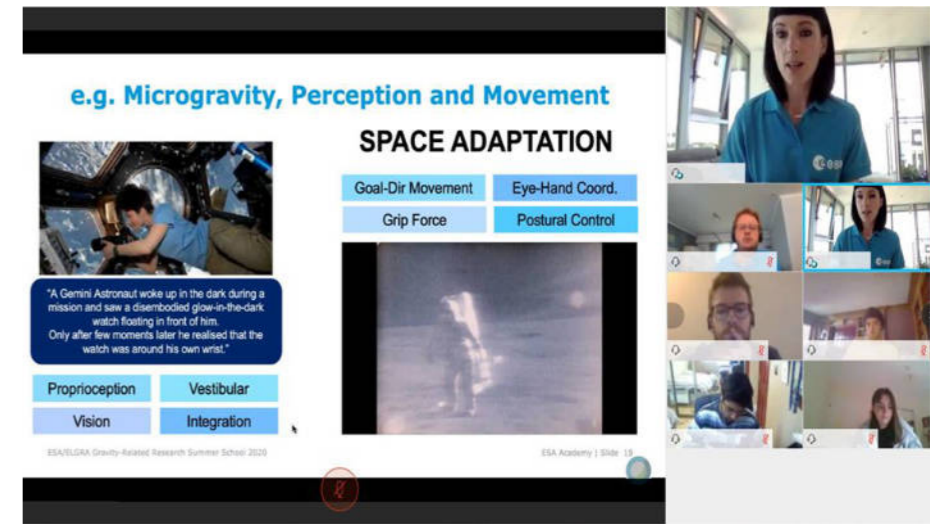
The second week kicked-off with a workshop dedicated to project management, specifically designed to help students with organising the development of their project. While they continued their team work for the rest of the day, experts were on-hand to assist with any issues the teams were experiencing. The next day attendees enjoyed a workshop about systems engineering, which proved particularly useful in the development of their projects. Then came a real treat: former ESA astronaut Reinhold



Ewald shared his experiences with the students!

A British student from the University of Strathclyde commented on just how much they had learnt: **“I thoroughly enjoyed interacting with ESA and ELGRA experts over the two weeks and have gained invaluable knowledge and experience. Although online, the environment was welcoming and it was easy to interact and get to know the other students. I highly recommend it to anyone thinking of applying!”**

The final days were devoted to the team projects, before participants presented their final plans to a panel of ESA and ELGRA experts. The students were questioned on the scientific relevance of their experiment, their choice of platform, and the feasibility of their study, which led to many fruitful scientific discussions.



**“The ESA/ELGRA summer school was something far beyond my expectations,”** concluded a Portuguese student from the University of Lisbon. **“More than a great place to learn and meet cool people. It is a place to make dreams come true. Thank you.”**

## An example of recent Student led Research as part of ESA's Spin your Thesis

### The effect of hypergravity in intestinal permeability of nanoformulations and molecules

Cláudia Azevedo<sup>1,2,3,#,\*</sup>, Maria Helena Macedo<sup>1,2,3,#</sup>, Andreia Almeida<sup>1,2,3,#</sup>, Soraia Pinto<sup>1,2,3,#</sup>, Jack J. W. A. van Loon<sup>4,5</sup>, Alan Dowson<sup>5</sup>, Bruno Sarmiento<sup>1,2,6</sup>

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<sup>3</sup> Instituto de Ciências Biomédicas Abel Salazar, Universidade do Porto, Portugal

<sup>4</sup> Department of Oral and Maxillofacial Surgery/Oral Pathology, VU-University Medical Center, Amsterdam, The Netherlands

<sup>5</sup> ESTEC, TEC-MMG-Lab, European Space Agency (ESA), Noordwijk, The Netherlands

<sup>6</sup> CESPU, Instituto de Investigação e Formação Avançada em Ciências e Tecnologias da Saúde, Gandra, Portugal

#Equal contribution

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### Abstract

Through the program “Spin Your Thesis”, in collaboration with the European Space Research and Technology Centre, it was studied the effect of hypergravity in the intestinal permeability, using the large diameter centrifuge. According to the literature, mechanical forces, as hypergravity, can interfere with cellular integrity and absorption. However, there are no studies describing the influence of hypergravity in the intestinal permeability. Here, it was shown that the cellular metabolic activity and integrity was maintained after exposure to different gravity levels. Expression of important drug transporters and tight junctions' proteins were evaluated to understand possible influence on permeability outcomes. Also, different transport mechanisms were evaluated using different nanoformulations and molecules. Besides helping with the understanding of what happens to astronauts and pilots, a good correlation with cellular permeability studies in hypergravity might be important when developing new therapeutic nanoformulations. This study supports the potential of simulated hypergravity to be used in oral delivery of biopharmaceuticals.



## INDUSTRY HIGHLIGHT

**ELGRA is delighted** to be supported by several industry members, representing skills, services and facilities which can support our members with research and innovation as well as broadening network opportunities. This currently includes the Airbus Defence and Space GmbH, OHB System AG, Olympia Space GmbH & Co. KG (Representative of Blue Origin), Royal Netherlands Aerospace Center (NLR), Swedish Space Corporation & ZARM FAB mbH. In this section we feature the latest updates from some of these members.

### ace2space – serving a low gravity niche market

Royal Netherlands Aerospace Center (NLR) and Delft University of Technology offer flexibility to customers in combination with accurate and affordable low gravity flights to perform experiments.

When it comes to low gravity flight services in Europe, most people in the community will immediately mention Novespace's Air Zero-g facility in France. This renowned flight facility has hosted many experiments over the years in their large Airbus aircraft. A truly impressive service provider. In comparison, ace2space has a more modest appearance. Our aircraft is relatively small, as is our

flight organization. Yet, these two characteristics turn out to provide a base for serving a niche market in low gravity flight operations. Before looking into this niche market in more detail, first let me introduce ace2space.

ace2space is the name under which Royal Netherlands Aerospace Centre (NLR) and Delft University of Technology (DUT) perform low gravity flight services. NLR and DUT already operated together a flight test facility, when in 2019 they both decided to combine their efforts and experience in the low gravity field. To mark this co-operation, the name ace2space was launched.

The aircraft used for parabolic flight is a Cessna Citation II research aircraft. It is a twin-engine, business-



type aircraft, which is relatively small when compared to large airline type aircraft. The aircraft has several features that improve the quality of the parabolic manoeuvres, which will be addressed below.

A 2016 survey among a great number of people in the field revealed that there is an interest in more flexible and affordable

parabolic flight services.

The term flexible contains many aspects. Firstly, it refers to a short time between request and flight, something ace2space can offer because of their compact organization that can be directly contacted. ace2space does not assess the scientific content as a condition for a parabolic flight, but scientists from Royal NLR and Delft



University can offer support when needed. Secondly, the term flexible refers to the ability to abort a flight when needed, e.g. when the experiment setup inadvertently fails or first results show that another approach should be followed. As ace2space flies with one customer at a time, it is easy to return to base and save valuable time and money whenever needed. Other aspects of flexibility range from the ability to fly a customer defined number of parabolas, easy rescheduling of flights when needed, to such practical things as the ability to park the aircraft in a limited hangar space at customer's premises/nearby airport, all of which can be offered by ace2space.

The earlier referred term affordable obviously means a low price per parabola, which ace2space can offer because of the low operating cost of the relatively small aircraft. However, many of the flexibility aspects mentioned above contribute to low cost as well.

In a nutshell, if flexible and affordable low gravity flight services are required for not-too-large experiment set-ups,

ace2space is the way to go.

ace2space has given much attention to the low gravity performance by developing means to provide flight guidance to the pilots. Flight guidance can be displayed on Augmented Reality Glasses as well as on a display in the cockpit. With these means, 15 second parabolas with an accuracy of about 0.01g can be reached. Also Moon (0.17g) and Mars (0.38g) parabolas, or any other g-target between 0 and 1g, can be flown. Finally, the relatively small size of the aircraft makes sure that the experiment in the cabin is always very close to the center of gravity, which further adds to the high quality of the gravity condition.

To comfortably host our customers in the aircraft, several standard cabin layouts have been certified and are available for use. These layouts consist of all kinds of combinations of seat arrangements, instrumentation boxes and experiment tables. A minimum seat arrangement is ideal for free floating experiments. A maximum seat arrangement (8 seats in the cabin) can host a Flying Classroom environment, in which each seat is equipped with a personal instrumentation system displaying real-time primary flight data via a wireless connection.

With this unique flight facility, ace2space hopes to contribute to the low gravity research community by filling up a niche in the total spectrum of services.

**Marcel Verbeek**

**ace2space**

[info@ace2space.nl](mailto:info@ace2space.nl)



## Swedish Space Consortium

**From hyper- to microgravity – Sounding rockets as a tool for research and tech-demonstration**

**For more than 50 years**, sounding rockets have been providing the perfect environment for microgravity and atmospheric research. Numerous missions have been building the bridge between the short duration and the very long duration platforms by enabling 2-15 minutes of undisturbed  $\mu$ g for scientists from all over the world.

**Sounding rocket ride share with SubOrbital Express**

For many years, most sounding rocket missions were entirely agency founded and nearly the only way of entering the flight opportunities was through the National and International Space Agencies. Scientists and customers with limitations in budgets were easily excluded from the research under microgravity conditions.

Since 2019, SSC has eased up the access to sounding rocket microgravity missions by introducing the ride share concept SubOrbital Express. It facilitates the entire payload capacity of 300kg per flight on a flight ticket approach, meaning the customer pays only for the fraction of the required payload mass and the necessary services. A frequent flight schedule of



approximately 18 month offers a fast and reliable access to high quality long duration microgravity environment. The transparent pricing model helps to find the best flight and service option for each application and standardised systems are the building blocks for cost efficient solutions tailored to the scientific and technical needs.

### Moon and Mars gravity missions

While in the past, the focus of sounding rocket missions was determined by microgravity research, nowadays, in the outlook of humankind returning to the moon and reaching out for mars, a strong demand on qualification and test platforms for technical and scientific validation of processes and technologies is inevitable. The SubOrbital Express concept fills into the demand with dedicated Mars and Moon gravity missions providing experimenting time in the order of 2 to 6 minutes.

### SubOrbital Express 3 – MASER 15

The next ride share mission already started filling up with numerous experiments. The experiments CHIP and ARLES-II have been selected by ESA as part of the CORA (Continuous

Open Research Announcement) of the E3P program SciSpace in 2020. The planned launch date is in June 2022 on microgravity mission from Esrange Space Center in northern Sweden.

### CHIP – Charges In Planet Formation

The CHIP experiment is being development by SSC under ESA contract (Principle Investigator Dr. J. Teiser and Prof. G. Wurm, University Duisburg-Essen) is investigating the influence of the charges of particles in the agglomeration processes in planet formation. Numerous successful drop tower tests and parabolic flight experiments lead to the need of longer undisturbed experimenting time. Basalt beads on  $\mu\text{m}$  scale are charged by forced collision during the agitation process before flight. Under microgravity, the particles may form clusters and the while the charge distribution can be measured.

### ARLES II

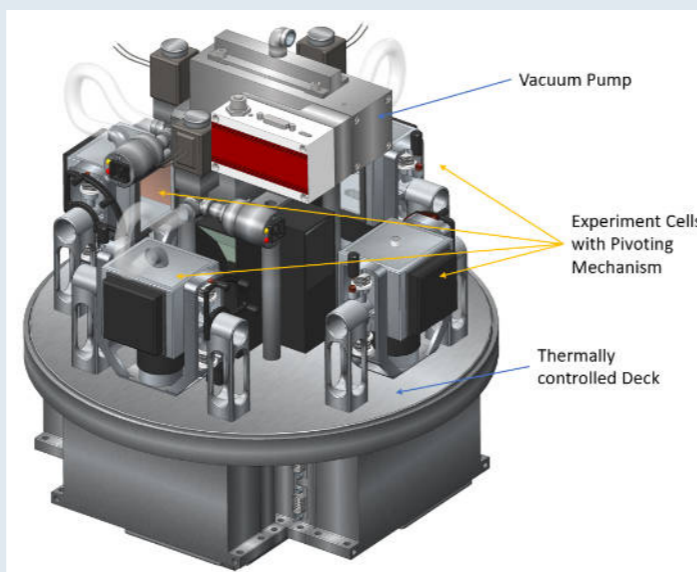
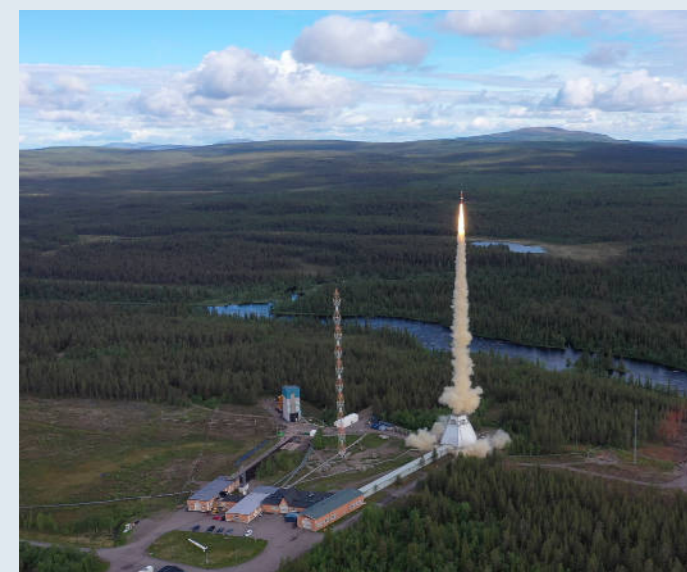
The ARLES experiment was developed by SSC under ESA contract (Principle Investigator Prof. D Brutin, Université Aix-Marseille) and successfully performed on SubOrbital Express 1 – MASER 14 in

summer2019. The resulting data created new scientific questions, which are to be investigated in an additional experiment. After a thorough refurbishment and some minor technical updates by SSC, the experiment will be ready for flight again. The scientific goal is the better understanding of evaporation processes of liquids under  $\mu\text{g}$  conditions by studying the flow motion and flow instabilities.

### Stefan Krämer

### Program Manager SubOrbital Express

### Swedish Space Corporation



# AIRBUS

### TEXUS / MAXUS Sounding Rocket Program

In December 1977 the first TEXUS launch was successfully performed from the Esrange Space Center in Sweden with the German Space Agency DLR as customer. It marked the beginning of the successful Sounding Rocket Program for research under microgravity conditions at Airbus. Until the end of 2020 a total of 6 Mini-TEXUS, 56 TEXUS and 10 MAXUS missions were flown for DLR and the European Space Agency ESA. Airbus Defence & Space in Bremen, Germany as prime contractor is responsible for the program with support of our partners OHB, DLR-Moraba and SSC-Esrange.

TEXUS flights are using the Brazilian two-stage VSB-30 rocket motor procured via DLR-Moraba delivering ca. 6 minutes of microgravity better than 10-4 g at a peak altitude of ca.

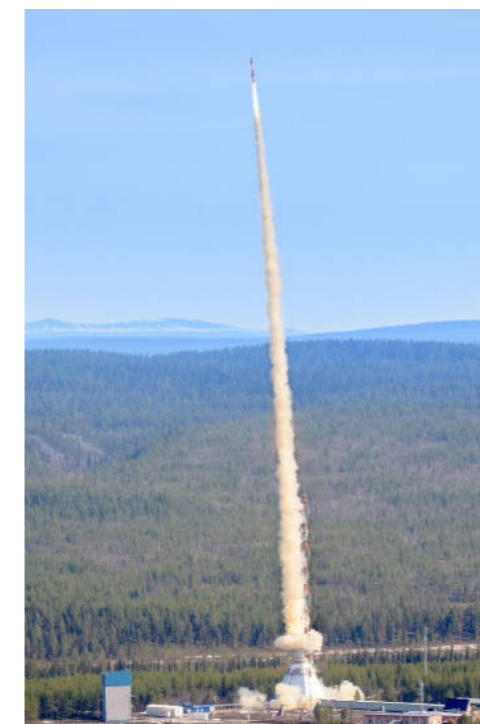


Figure 1: TEXUS 55 launch from Esrange in May 2018

250 km (see figure 2). After the suborbital flight the payload module will be recovered quickly (ca. 2 hours) after flight

offering the opportunity for a quick examination of the scientific samples as well as later re-flights of the experiment modules.

A representative TEXUS payload is shown in figure 3. It consists of typically 3-4 scientific experiment modules plus the Service Systems which is provided by OHB for flight and re-entry / landing control. TEXUS scientific disciplines include e.g. material, biological or fluid science as well as space technology demonstration / qualification.

During experiment modules preparation Airbus is closely working with the scientists for the design and test of the experiment modules to ensure maximum scientific output.

The TEXUS payload system uses a commercial state-of-the-art TPC/IP based avionic system providing multi-mission modularity allowing to fly TEXUS systems also on parabolic flight tests as well as drop tower test campaigns.

Upcoming missions are TEXUS 57 in late 2021 as well as TEXUS 58 and 59 planned for 2022 with in total 10 scientific experiment modules. The customers are both agencies, ESA and DLR. Flight implementation in recent years has changed from the procurement of full missions by the agencies to an industrial service offering flight opportunities for the science modules, then integrated in an optimum way by industry in missions. This increases technical and programmatic flexibility for the customers.

Since more than 40 years the sounding rocket program has

demonstrated its extraordinary benefit for the microgravity research community due to its inherent quick and cost-efficient nature, supported by a stable and highly experienced program!

### Detlef Wilde, Airbus Defence & Space

Bremen, Germany

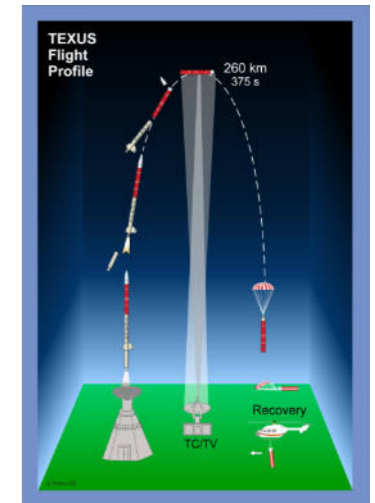


Figure 2: TEXUS flight profile

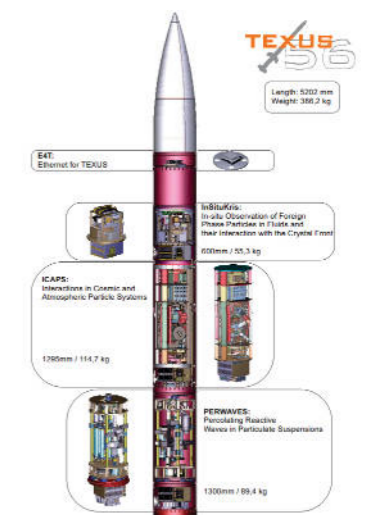


Figure 3: Typical TEXUS payload

# SELGRA UPDATE



**SELGRA is the** student chapter of the European Low Gravity Research Association aiming to be the point of reference for gravity-related students all over Europe. SELGRA works hard to organise and support outreach activities as well as to support its members to present and promote their research.

The new SELGRA committee was formed in 2019 in Granada and comprises of:-

- **President:** Jérémy Rabineau
- **Vice President:** David Przystupski
- **Immediate Past President:** Miguel Ferreira
- **Communications Officer:** Tânia Ribeiro
- **Committee Member:** Daniel Carvalho
- **Committee Member:** Agata Górska
- **ELGRA Member Committee Liaison:** Philip Carvil

2020 while challenging has not stopped SELGRA from growing and creating opportunities for students to engage with gravity related research and innovation. Below are some of the activities the association has been up to, to learn more you can follow us on twitter @StudentELGRA or visit our website at <https://sites.google.com/site/studentelgra/home>

## SELGRA Webinars

The popular SELGRA Webinar series, launched in 2019 has continued to be a key activity for the association in 2020 with several webinars available for students and others to view on our dedicated [youtube channel](#).

The SELGRA webinars cover a wide range of gravity-related research topics with Members able to watch

online talks given by international experts, ask questions and discuss the topics via text chat tools. Every two or three months, a SELGRA committee member will host the webinar. Each talk will have a duration of about 40 minutes followed by a 10 minutes Q&A session. Do you have a topic that you would like to be discussed? Send us an email to [selgra@elgra.org](mailto:selgra@elgra.org) and we will do our best to make it happen.

## Glide Your Experiment! Challenge

SELGRA has been working with LIDE in partnership to launch the "Glide Your Experiment! Challenge" to offer student teams the unique opportunity to fly their

experiments in altered gravity conditions on board a glider during parabolic flights. To read more click [here](#).

# A WORD FROM OUR INTERNATIONAL COLLEAGUES

## American Society for Gravitational and Space Research (ASGSR) in 2020



ASGSR, is a professional society serving the broad fields of biological and physical sciences in space. ASGSR seeks to foster research, education and professional development in the fields of gravitational life and physical sciences.

Both research topics related to advancing space exploration and the use of spaceflight for research or commerce in these topics related to life on Earth are of interest to ASGSR. Strong collegiate student involvement is enjoyed, as in ELGRA. ASGSR membership includes people from academia, government, and industry who pursue a common theme – how living organisms and physical systems respond to gravity (e.g. zero-gravity, low-gravity, hypergravity, etc.) In 2019 the society created a companion non-profit Science Technology Engineering Arts and Math (STEAM) Foundation to expand the opportunities for younger students to participate and learn about gravitational life and physical sciences research. ELGRA members may learn more about ASGSR and its Foundation at its web site, [asgsr.org](http://asgsr.org)

As part of annual ASGSR activities in support of science, the members who comprise the Governing Board and Officers meet with government leaders in Washington, DC. Here discussions are conducted to inform legislators and others on the value of conducting spaceflight research, the products of the scientists and their students, researchers' view of near- and long-term goals and needs in these fields, and similar. It is common for student members to participate in the government visits for it is found that their voices are welcomed and answering questions in this forum is a good lesson for future scientists.

ASGSR publishes the Gravitational and Space Research journal where papers on the topics of interest to ASGSR are welcomed. ELGRA members are eagerly invited to submit work to this journal or to benefit from papers already published. Substantial information for authors and others is available the web site <https://content.sciendo.com/view/journals/gsr/gsr-overview.xml?lang=en>

ASGSR thanks its staff and officers for the substantial work done to shift the recent annual ASGSR meeting to a highly successful on-line format on November 5 and 6, 2020. Conference attendance was strong and the keynote speaker was Dr. Jessica U. Meir, NASA astronaut and marine biologist. Plenary talks and technical talks are archived at <https://asgsr.org/2020meeting/>

**The next annual ASGSR meeting is scheduled for the autumn of 2021 in Baltimore, Maryland. ELGRA members are always welcomed participants at ASGSR meetings and are encouraged to join the conference in 2021. To keep up to date on meeting details visit <https://asgsr.org>**

## Introduction of the Japan Society of Microgravity Application

**Professor Osamu Fujita (Hokkaido University, President of JASMA)**  
<http://www.jasma.info/?lang=en>

### 1. Brief Description of JASMA

The Japan Society of Microgravity Application (JASMA) has been established in 1983 to provide a platform for academic exchange of microgravity science and technologies. JASMA covers fluid science, crystal growth, physical chemistry, material science, combustion, biological science etc. under microgravity or for space utilization. Its membership is about 200 mainly from academia, space agency, and industries in Japan.

### 2. Activities

JASMA's activities involve the organization of academic meetings including annual meeting and International conferences, publication of academic journal, and educational activities for young generations. JASMAC is an annual conference of JASMA and 32nd turn was held via online in Oct.4-7, 2020. 73 presentations were delivered under the coronavirus pandemic, while JASMAC would have around 100 presentations in regular year. As an advantage of online meeting in this year, we could have an invited international talk by Prof. Ricard Gonzalez-Cinca, President of ELGRA. JASMA also takes a role of organizer of international conference such as ISPS (International Symposium on Physical Science in Space) and AMS (Asian Microgravity Symposium). AMS is the biggest biannual symposium on microgravity science in Asia and JASMA is taking a leadership to maintain the symposium. IJMSA, International Journal of Microgravity Science and Application, is an academic journal published

by JASMA (<https://www.jstage.jst.go.jp/browse/ijmsa>). It is an open-access journal and four issues are released every year. The journal has an ESCI status and citation data for the journal are formally recorded in the database of Web of Science. JASMA sincerely welcome submission of papers from all over the world.



Mohri Poster session is an event to encourage students in the field of microgravity science. Dr. Mamoru Mohri is the first Japanese Astronaut who has carried out Space Mission called as FMPT in 1992 on STS-47. Dr. Mohri talks to individual students on their research in the poster session and encourage them for their research.

### 3. Summary and Future

JASMA works as a hub to enhance communication among members in the field of microgravity research and works as a hub to connect Japanese community with other international communities such as ELGRA. We are always happy to work together with you to enhance international collaboration and please feel free to contact us any time.

## The Sub-orbital Applications Researchers Group in the USA during 2020

**Professor Steven H. Collicott, Chair**

**The Sub-orbital** Applications Researchers Group, or SARG, is a small group of volunteer researchers and educators, coordinated by the Commercial Spaceflight Federation (CSF) in the USA, who anticipate the benefits of low-cost frequent access to space on commercial re-

usable sub-orbital rockets for both automated and human-tended experiments. CSF is an industry organization in the USA with rocket companies, spaceports, and other allied industries as members. SARG membership can be viewed at the CSF website,

[www.commercialspaceflight.org](http://www.commercialspaceflight.org). Blue Origin and Virgin Galactic are already flying complete missions with automated payloads. Cost per payload is a small fraction of what it costs to fly on the older single-use sounding rockets; even a class of ten-year old students has already launched a small (2U-sized) original and successful firefly experiment to space and back.

SARG conducts advocacy activities with components of USA federal government. Annual meetings with NASA headquarters, National Space Council staff, and congressional committees and staff are common. Conversations cover topics such as increased affordability, the great breadth of fields of science that will benefit, how STEM educational payloads are inexpensive and comparable to other discretionary spending by schools, aerospace workforce development impacts, and similar. Many from SARG are pictured here in February 2020 after meeting with National Space Council staff, with the White House in the background. Advancing government-funded research into the human-tended sub-orbital arena is presently an important forward-looking topic for SARG.

SARG also plays a leading role in organizing and delivering the technical program for the Next-gen Sub-orbital Researchers Conference, or NSRC, working closely with the Convener, Dr. Alan Stern of the Southwest Research Institute. The seventh highly successful NSRC was held March 2-4, 2020 in Broomfield, Colorado in the USA. NSRCs are held on an irregular schedule as the sub-



orbital flight providers and scientific advances on such vehicles allow. Scheduling the eighth NSRC has not yet happened and, of course, the pandemic still impairs both the flight industry and the researchers. The seventh NSRC featured NASA Administrator Jim Bridenstine as Keynote Speaker and scientific contributions in at least physical sciences, biology, planetary science, atmospheric science, human factors, STEM education. Sub-orbital, balloon,

and other flight providers are prominent at NSRC both as exhibitors and in delivering informative sessions are researchers seeking to advance their research through flying with this new industry. NASA's Flight Opportunity Program has also been a major contributor in the seven NSRC to date. ELGRA members are encouraged to look for announcement of the eighth NSRC as the pandemic wanes. NSRC conveners invite ELGRA members to participate in future NSRCs to rapidly become active in this "new laboratory" of commercial re-usable sub-orbital space flight or to present their own sub-orbital research advances.



# OPPORTUNITIES

In 2020 we were pleased to launch several opportunities for ELGRA members including the ELGRA Research Prize 2020-2021, the 1st (with the Swedish Space Corporation's [SSC] sounding rockets) and 2nd (with Blue Origin's New Shepard suborbital rocket) ELGRA goes Sub-orbital call. We look forward to announcing the successes from these initiatives to you in 2021 as well as new opportunities for our members. Below are a few related highlights and other opportunities from our community. Remember to check the ELGRA website for the latest updates on ELGRA opportunities.

## Successful application to the 1st ELGRA goes Suborbital! Call

A special congratulations to our international team for their proposal "LAB ON PAPER AT MICRO G: Testing paper microfluidic biosensor". The team is made up of students and senior researchers from both Portugal and the United States of America. The aim of their experiment is to evaluate the feasibility of lab-on-paper devices as colorimetric rapid tests to assess human health in microgravity conditions. As a proof-of-concept, they propose a paper-based microfluidic design aimed to monitor glucose levels in space through a quantitative colorimetric response. It is a low-cost, disposable and rapid paper-based biosensor. If successful, these devices could revolutionize the facilitation of health monitoring in space.

Space diagnostic devices have multiple requirements: easy handling, easy interpretation, non-invasiveness, lightweight, satisfying mass and volume constraints, low-to-no power consumption, and usability in microgravity conditions. Many point-of-care biosensors used on Earth could fulfil all these criteria, except their analytical performance in microgravity is not usually evaluated. So far, diagnostic devices must be redesigned for space environment and often fail to comply with good features for spaceflight, namely: short shelf life, pre-analytical sample treatment, low accuracy, requirement of specific storage conditions, waste production and difficulty of interpretation. Thus, there is plenty of room to innovate in biosensors for space diagnostics and to satisfy current needs.

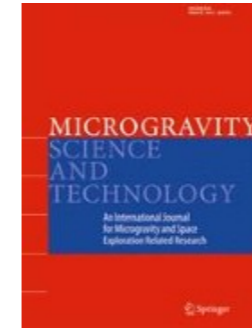
## Mentors sought for a unique program: Become part of a dynamic international community at Global Talent Mentoring!

Are you a scientist, mathematician, IT expert, or other specialist in science, technology, engineering, mathematics, and medical sciences (STEMM) and would like to support highly talented, motivated, young people by sharing your specialized knowledge and experience with them? Then join the community of mentors at Global Talent Mentoring!

Global Talent Mentoring is an online mentoring program led by Prof. Dr. Heidrun Stoeger and her research team at the University of Regensburg that fosters excellence in STEMM worldwide for exceptionally talented youth through evidence-based, long-term online mentoring. The mentees are truly outstanding, hardworking young talents in STEMM from around the world—and exceptionally motivated to pursue excellence in a specific STEMM domain. The mentors are scientists and other practicing STEMM experts working in the private and public sectors. The program is free of charge for participants and starts in March 2021. Global Talent Mentoring would be thrilled to welcome experts from ELGRA – European Low Gravity Research Association.

How can I become a mentor volunteer? Please submit the Mentor Volunteer Form at [www.globaltalentmentoring.org/mentor](http://www.globaltalentmentoring.org/mentor). For the last question ("How did you learn about us?" please select "ELGRA". For more information, please visit [www.globaltalentmentoring.org](http://www.globaltalentmentoring.org)

## Microgravity Science and Technology Journal (MST)



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.

*Professor Valentina Shevtsova, Editor-in-Chief of MST*



The Universitat Politècnica de Catalunya · BarcelonaTech (UPC), in collaboration with the Barcelona-Sabadell Aviation Club and Space Generation Advisory Council, organises the Barcelona ZeroG Challenge.

The competition is open to teams of up to four students worldwide aged between 18 and 35 who may submit scientific experiments that need to be conducted in microgravity. The team with the best proposal, endorsed by a mentor, will have the chance to conduct their experiment in parabolic flight in Barcelona, in addition to receiving a 2,500-euro grant. Projects will be assessed by independent experts from the European Space Agency (ESA). Gender balanced, international and multidisciplinary teams are encouraged. Teams may submit their CV, an endorsing letter from their mentor, and a two- or three-page proposal experiment to [barcelona.zerog@gmail.com](mailto:barcelona.zerog@gmail.com) before 30th June 2021.

The UPC, in collaboration with the Barcelona-Sabadell Aviation Club, has pioneered the development of parabolic flying for scientific experiments using single-engine aerobatic aircraft leading to up to 8.5 seconds of microgravity. Please read the Experiment Requirements here

<https://www.upc.edu/en/press-room/news/the-barcelona-zero-g-challenge-gives-university-students-the-opportunity-to-design-an-experiment-to-be-conducted-in-zero-gravity>





27th

ELGRA BIENNIAL SYMPOSIUM  
& GENERAL ASSEMBLY

save  
the date!

SEPTEMBER 1-4, 2021  
Lisbon, Portugal

