

## Malta Becomes the New Hub for the Inverse Problems Community

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Formally, an inverse problem is a mathematical framework that is used to obtain information about a physical object (cause) or theory (model) from observed measurements (effect). The solution to this problem is useful because it generally provides information about physical parameters that we cannot directly observe, and has been an important factor in the development of mathematics and science in the past 30 years. The approaches developed for inverse problems generally include numerical approximations, stability analysis, proofs of uniqueness and/or existence of the solution.

Inverse problems arise in many areas of mathematical physics and the realm of their applications is vast: medical imaging techniques, geophysical explorations, computer vision, astronomy, nondestructive testing, noninvasive evaluation, etc. Most of research is interdisciplinary and the community is constantly expanding.

More than 270 delegates coming from 36 countries and 200 universities and research institutions from across all continents attended the 9<sup>th</sup> International Conference “Inverse Problems: Modelling and Simulation” (IPMS 2018) which was organized by Prof. Cristiana Sebu (University of Malta, Malta) and was held in Malta in May 21–25, 2018, at the Paradise Bay Hotel.

The International Conference “Inverse Problems: Modelling and Simulation” (IPMS) is one of the main international forums in Applied Mathematics. Its main aims are to bring together all classical and new inverse problems areas from various international scientific schools, and to discuss new challenges of inverse problems in current interdisciplinary sciences. The conference is organized under the auspices of the leading international journals “Inverse Problems”, “Inverse Problems in Science and Engineering” and “Inverse and Ill-Posed Problems” and it has been held biennially since 2002 at the end of May. The main sponsor of the conference is The Eurasian Association on Inverse Problems (EAIP, <http://www.eurasianip.org/>). The previ-

ous IPMS Conferences were organized in Turkey in Fethiye (2002, 2004, 2006, 2008, 2014 and 2016) and in Antalya (2010 and 2012).

Prof. Cristiana Sebu from the Department of Mathematics, Faculty of Science, University of Malta, has been an active member of the International Programme Committee since 2008, and is now the Chair of the International Organizing Committee and one of the Co-Chairs of the IPMS Conferences.

The Opening Ceremony of the IPMS 2018 Conference (see Fig. 1) was moderated by Prof. Sebu. The opening speech was delivered by the Chair of the IPMS Conferences, Prof. Alemdar Hasanov Hasanoglu, and was followed by welcoming speeches by Prof. Godfrey Baldacchino, Pro-Rector for International Development & Quality Assurance of the University of Malta, and Prof. Charles Sammut, Dean of Faculty of Science of University of Malta. All speakers emphasized the fact that Malta is a safe and attractive place for organising the IPMS Conferences.

The Opening Ceremony was followed by the 2018 EAIP Awards Ceremony (see Figs. 2 and 3). The



**Figure 1:** The Opening Ceremony. Prof. Godfrey Baldacchino, Prof. Alemdar Hasanov Hasanoglu and Prof. Cristiana Sebu (from left to right).

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2018 EAIP awards were presented to Professors Vladimir G. Romanov (Novosibirsk State University, Russia) and Otmar Scherzer (University of Vienna, Austria) for their outstanding scientific contributions to the field of inverse problems and continuous efforts to foster cooperation between researchers of Eurasian countries. The 2018 EAIP Young Scientist Awardees were Dr Giovanni S. Alberti (University of Genoa, Italy), Dr Bernadette Hahn (University of Würzburg, Germany) and Dr Andrei Shurup, (Lomonosov Moscow State University, Russia) who are all young scientists of ages below 40 with particular merits in inverse problems analysis and its applications (see Figs. 4 and 5). Jubilee plaques were then presented to outstanding experts in inverse problems on the occasion of their birthdays: Prof. Vladimir Romanov (Novosibirsk State University, Russia) for his 80<sup>th</sup> birthday, Prof. Gen Nakamura (Hokkaido University, Japan) for his 70<sup>th</sup> birthday, and Prof. Willi Freeden (Technical University Kaiserslautern, Germany) for his 70<sup>th</sup> birthday. Prof. Sebu was also awarded a plaque for her distinguished contribution to the organisation of the IPMS 2018 Conference.



**Figure 2:** The 2018 EAIP Award.

The meeting offered a rich program covering a whole range of numerical and theoretical developments in inverse problems and regularization techniques with applications to wave phenomena, tomography, imaging, signal processing, finance, economy, life sciences, convex analysis, Maxwell's equations, mechanics and planetary science, inverse scattering, engineering, machine learning, etc. This included five plenary lectures, 26 minisymposia organized in four parallel sessions, two poster sessions and social events.

The five special keynote lectures were as follows:

- Dr Giovanni S. Alberti (University of Genoa, Italy): Mathematical analysis of ultrafast ultrasound imaging,
- Prof. Laurent Bourgeois (Laboratoire POEMS, Paris, France): On mixed formulations of quasi-



**Figure 3:** The 2018 EAIP Award Ceremony: Prof. Roman Novikov, Prof. Alemdar Hasanov Hasanoglu, Prof. Anreas Neubauer, Prof. Vladimir Romanov and Prof. Ian Boman (from left to right).



**Figure 4:** Young Scientist Award Ceremony: Prof. Otmar Scherzer, Prof. Alemdar Hasanov Hasanoglu, Dr Giovanni S. Alberti, Dr Andrei Shurup and Prof. Roman Novikov (from left to right).

reversibility and their application to inverse obstacle problems,

- Prof. Thorsten Hohage (University of Göttingen, Germany): Stability estimates and variational source conditions,
- Prof. Thomas Schuster (University of Saarland, Germany): Different views onto solving the non-



**Figure 5:** Young Scientist Award Ceremony: Prof. Alemdar Hasanov Hasanoglu, Prof. Otmar Scherzer, Dr Bernadette Hahn and Prof. Roman Novikov (from left to right).

linear problem of terahertz tomography,

- Prof. Masahiro Yamamoto (University of Tokyo, Japan): Mathematical analysis of inverse problems for coupling systems in fluid, viscoelastic dynamics.

A special issue of the *Inverse Problems in Science and Engineering* journal will be dedicated to this conference and will contain original research papers authored by the participants.

The IPMS 2018 meeting has proved to be highly beneficial, not only for the scientific exchanges between the participants, but also in terms of training opportunities for students and young researchers. Moreover, the conference also served to promote the research on inverse problems carried out at the University of Malta and to strengthen the reputation of the Department of Mathematics, the university, and the country in international fora.

The research on inverse problems at the University of Malta was revived since 2015 when Prof. Sebu joined the Department of Mathematics as Associate Professor in Biomathematics. Several students are currently pursuing postgraduate studies in inverse problems under Prof. Sebu's supervision: Nadia Vella (MPhil/PhD, Mathematics), Christopher Zerafa (MPhil/PhD, Geophysics) and Jeremy Curmi (MSc, Mathematics).

Apart from being the main driving force behind the organisation of the IPMS 2018 Conference, Prof. Sebu delivered an invited talk on “Deterministic methods for

conductivity imaging for skin and breast cancer detection”, and organised together with Dr Karel Van Bockstal (Ghent University, Belgium) and Prof. Liviu Marin, (University of Bucharest, Romania) the largest minisymposium of the conference, the minisymposium M21 Inverse Problems in Science and Engineering.

The minisymposium M21 Inverse Problems in Science and Engineering was aimed at bringing together well established scientists as well as young researchers working on inverse problems for partial differential equations to honour one of the experts in this field, Prof. Marian Slodička, on the occasion of his 60th birthday. The topics of the minisymposium ranged from the mathematical modelling and the theoretical analysis of inverse problems for partial differential equations where some parameters (right-hand side, kernel, diffusion coefficient, etc.), unknown boundary condition(s) or portion of the boundary are to be found, to the development of efficient numerical schemes and their practical implementations. The minisymposium featured 23 speakers from 21 international institutions: University of Cagliari (Italy), University of Lisbon (Portugal), Université Claude Bernard (France), Ghent University (Belgium), University of Caen-Normandie (France), University of Maryland (USA), Florida International University (USA), University of Goettingen (Germany), Goethe University Frankfurt (Germany), University of Oulu (Finland), Lodz University of Technology (Poland), Communication University of China (China), Clemson University (USA), University of Bucharest (Romania), Kocaeli University (Turkey), TU Dresden (Germany), University of Malta (Malta), K. N. Toosi University of Technology (Iran), University of Genoa (Italy), University of Utah (USA), and Military University of Technology (Poland).

Overall, the IPMS 2018 Conference in Malta was a great success both logistically and in terms of its contents: the perfect mix of cutting edge science, a very impactful attendee list and a spectacular location. Moreover, Malta proved to be the ideal venue for organising the future biennial IPMS Conferences, and has therefore become the hub for the international research community in inverse problems.

More details about the conference can be found on the conference website <http://www.ipms-conference.org/ipms2018/index.php>.