

# Preface

*The 33rd International Symposium on Rarefied Gas Dynamics (RGD33)* was held in Göttingen, Germany, from July 15 to 19, 2024. Since the first meeting in Nice in 1958, venues have changed every two years across countries and continents. This marked only the third time the RGD symposium was held in Germany, returning to Göttingen exactly 50 years after it was first hosted there.

Rarefied gas dynamics is a branch of physics mainly concerned with the study of gas flows in which processes at the molecular level play a role. With its diverse applications ranging from astrophysics to micro-flows, it continues to raise challenging questions that require a multidisciplinary effort of mathematicians, physicists, chemists, computer scientists and engineers.

Still under the impression of the fading COVID-19 pandemic, the RGD33 symposium was deliberately planned as a purely face-to-face event in order to promote direct scientific exchange and strengthen the professional community. The response was overwhelmingly positive. With 243 participants from 30 countries, the attendance exceeded expectations. However, for the first time in its history, the symposium was severely affected by sanctions imposed on Russian universities and research institutions as well as numerous other organizations embargoed by the USA and the European Union. Nevertheless, we remain committed to global scientific cooperation, as we are convinced that it also plays an important role in strengthening civil society against authoritarianism worldwide.

A total of 176 papers were presented in three parallel tracks. In addition, 49 posters were presented and put up for discussion in a dedicated session. The organizers took care to include a balance of contributions from mathematics, natural sciences and engineering in order to promote interdisciplinary exchange. Among the topics discussed during RGD33 were:

- Boltzmann and Related Equations,
- Granular Flows,
- Gas-Surface Interactions,
- Quasi-Classical Trajectory Simulation,
- Moment Methods,

Electric Propulsion Simulation,  
Machine Learning,  
Air-breathing Electric Propulsion Simulation,  
Spectroscopy,  
Micro- and Nanoscale Flows,  
Plasma Simulation,  
Multi-scale Simulations,  
CFD for Rarefied Flows,  
Modern DSMC,  
Fluid Interfaces,  
Multi-scale Simulation Methods,  
Particle-based Methods,  
High-speed/High-enthalpy Flows,  
Flows in Vacuum Systems,  
Planetary Science and Exploration,  
Jets and Plumes,  
Thermochemically Non-equilibrium Flows,  
Kinetic Methods,  
Plasma Experiments.

Four plenary lectures were delivered at the symposium: the Graeme Bird Lecture was given by Alejandro Garcia. Richard Morgan delivered the Lloyd Thomas Lecture, and Vincent Giovangigli spoke in the Harold Grad Lecture. In addition to the three traditional plenary lectures, the Irving Langmuir Lecture was delivered by Anne Bourdon. The lecture was introduced for this symposium to strengthen connections with the related field of plasma research. Incidentally, Irving Langmuir, earned his PhD in Göttingen. In addition to the four outstanding scientists mentioned above, eight other researchers were invited to highlight their recent work: Alina Alexeenko, Christos Tantos, Eunji Jun, Hossein Gorji, Milana Čolić, Zhenning Cai, Tetsuro Tsuji and Philip Varghese.

The *Proceedings of the 33rd International Symposium on Rarefied Gas Dynamics* comprises of 69 full papers that were accepted for inclusion after having been evaluated by at least two independent professional peers.

The organizers thank the Deutsche Forschungsgemeinschaft (DFG) and the DLR Institute for Aerodynamics and Flow Technology for their generous support. We are also grateful to the many members of our community that served as reviewers and session chairs, as well as for the enthusiastic support we received from our DLR colleagues during all the phases of the symposium. In particular, we are indebted to the DLR Event Management Service (Petra Naoum and Rebecca Bartkowski) for smoothly managing the logistics. Last but not least, we thank the members of the International Advisory Committee, who continue to dedicate their time and effort to

ensure the venerable *International Symposium on Rarefied Gas Dynamics* remains at the scientific forefront of the field.

Göttingen, Germany  
Aachen, Germany  
Aachen, Germany

Martin Grabe  
Georgii Oblapenko  
Manuel Torrilhon