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HAMBURG PRIZE FOR THEORETICAL PHYSICS AWARDED TO QUANTUM RESEARCHER

Matthias Troyer Honored for his Work on Quantum Many-Body Systems

Hamburg, April 29, 2019. This year's Hamburg Prize for Theoretical Physics will be presented to Austrian Matthias Troyer, a professor at ETH Zurich and quantum computing researcher at software company Microsoft. He is receiving the prize for his contributions to the development of quantum Monte Carlo algorithms. Using random numbers, these algorithms can predict how tiny particles will interact within quantum mechanical many-body systems such as atoms and molecules. As a result, Troyer is playing a key role in basic research and the ongoing development of quantum computers and superconductive materials. He is one of just a handful of leading international researchers in this field. The Joachim Herz Stiftung awards the prize in conjunction with the Wolfgang Pauli Centre (WPC) at the University of Hamburg, DESY, and the Cluster of Excellence "CUI: Advanced Imaging of Matter" at the University of Hamburg.

The Hamburg Prize for Theoretical Physics is worth €137,036 in total – a figure that plays on Sommerfeld's fine-structure constant. As such, it is one of the most valuable German prizes for physics. Troyer is the tenth winner of the prize, which will be presented on November 13, 2019, at a symposium at Planetarium Hamburg.

"In Professor Troyer, we are honoring a scientist whose work connects myriad areas of physics and computer science. On account of his current research in the field of quantum computing, he partners with universities and companies in the US and around the world. He has also set up an open-source platform in order to share his knowledge. By awarding the prize to Professor Troyer, we also wish to recognize this contribution to collaborative research," explained Dr. Nina Lemmens, Member of the Executive Board of the Joachim Herz Stiftung.

IMPETUS FOR CUTTING-EDGE RESEARCH IN HAMBURG

The prize not only comes with a grant, but also entails research placements in Hamburg that will see Troyer give talks and work closely with doctoral candidates, postdocs, and other colleagues. "We are delighted that the winner's areas of expertise once again cover an exciting and relevant field of research, which is increasingly coming to the fore at the Wolfgang Pauli Centre and in Hamburg in general. Therefore, Professor Troyer's stays in Hamburg will resonate well beyond working groups in the discipline of theoretical physics. For example, our colleagues at the new European XFEL facility are very interested in collaborating with him," said Professor Volker Schomerus, chairman of the judging panel for the prize, a lead scientist at DESY, and spokesman for the Wolfgang Pauli Centre. The Centre, which was founded in 2013, pools research activities in theoretical physics, including the work of the two current Clusters of Excellence – "Advanced Imaging of Matter" and "Quantum Universe" – which form part of the Hamburg Excellence Initiative. In the 100th anniversary year of the University of Hamburg and the year of its bid to become a University of Excellence, the spotlight is being shone on theoretical physics within the city.

"I feel honored that the judges have decided to recognize my work with the Hamburg Prize for Theoretical Physics. I can't wait to start sharing ideas with my colleagues at DESY and the University of Hamburg, both in the physics faculty and related institutes such as computer science," remarked Troyer.

ABOUT MATTHIAS TROYER

Troyer studied physics at Johannes Kepler University Linz and ETH Zurich, obtaining his doctorate at the latter in 1994. As a postdoc, he worked as a Fellow of the Japan Society for the Promotion of Science at the University of Tokyo and, starting in 1998, as an Associate Professor at ETH Zurich. Since 2005, he has been Full Professor for Computational Physics at the Institute for Theoretical Physics at ETH Zurich. He also became a Principal Researcher at Microsoft Quantum in the United States in 2017. Troyer has been a Fellow of the American Physical Society since 2010 and a Trustee of the Aspen Center for Physics since 2014. He was awarded the Aneesur Rahman Prize in 2016.

ABOUT MATTHIAS TROYER'S WORK: SIMULATING QUANTUM SYSTEMS WITH QUANTUM COMPUTERS

The behavior of a vast array of systems can be studied using computer simulations; examples include the ways in which physical systems behave, diseases spread, and traffic flows arise within public transportation networks. The term "Monte Carlo simulation" is used when the simulation is based on random numbers.

Computer simulations are also used to study systems that hinge on the properties of minute particles, known as "quantum particles." In order to understand these quantum many-body systems, it is important to consider the unique behavior of individual quanta. After all, quanta boast special properties: they can be in more than one place at once and depend on the state of all other quanta. Physicists need the help of exceptionally powerful computers to determine the state of quantum many-body systems, which requires close cooperation between physics and computer science.

Troyer works at the interface between computer science and theoretical physics. He has developed new computer algorithms that enable him to understand the behavior of many highly interactive quantum systems. He has carried out research on subjects such as quantum magnets, superfluid crystals, atomic gases, and exotic materials such as graphene. His studies of quantum many-body systems led to his work with quantum computers, which researchers hope will deliver far higher computing power than conventional computers.

Instead of standard bits, quantum computers use quantum bits ("qubits" for short). These result in computing capacity that can be best compared with that of massively parallel computing systems. For many years, companies and researchers alike have been striving to build better and better quantum computers. Potential applications of quantum computers include faster calculation and optimization of transport volumes as well as medical imaging techniques. It is also hoped that they will drive forward basic research into quantum particles.

A **photo** of Matthias Troyer **for media use** can be downloaded from www.joachim-herz-stiftung.de/pressefotos.