# Press Release
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# Materials researcher Nicola Spaldin wins the Hamburg Prize for Theoretical Physics

**Hamburg, 30 June 2022. British scientist Nicola Spaldin is to receive the 2022 Hamburg Prize for Theoretical Physics. Currently serving as Professor of Materials Theory at ETH Zurich, Spaldin is a trailblazer in the development of a new class of materials known as multiferroics. These could facilitate ground-breaking microelectronics applications, such as the building of ultra-fast data repositories or supersensitive sensors. The prestigious award will be presented to Spaldin on 9 November 2022 in Hamburg and will be conferred jointly by the Joachim Herz Foundation, the Wolfgang Pauli Centre of DESY and Universität Hamburg, the Deutsches Elektronen-Synchrotron DESY and the Clusters of Excellence "CUI: Advanced Imaging of Matter" and "Quantum Universe" at Universität Hamburg.**

Multiferroics are materials that can be both permanently magnetised and electrically polarised. These physical properties almost never co-exist in nature. Nicola Spaldin's theoretical analyses have paved the way for the production of tailor-made ferromagnetic and ferroelectric crystals. This unusual combination could allow for the building of ultra-fast data repositories and supersensitive sensors. The versatile magnetoelectric materials also promise further ground-breaking applications: in computers, for example, by eliminating the need to physically separate the electrical processing of information in the processor and its magnetic storage on hard drives. This would ensure a higher processing power and lower power consumption, leading experts to hope that multiferroic materials could be useful in beyond-silicon microelectronic devices.

"This year, we are honouring Nicola Spaldin, a scientist whose work spanning over 20 years has been the impetus behind global multiferroics research. In presenting her with this award, we acknowledge her impressive pioneering achievements, but also her diverse range of activities in the

The Joachim Herz Foundation in Hamburg, Germany, promotes education, science, and research in economics and the natural sciences as well as the personal development of teens and young adults.

In these areas we also fund small, innovative third-party projects. Additional funding is granted to support research projects in the fields of medicine, law and engineering technology as well as projects promoting the exchange between Germany and the United States.

The Joachim Herz Foundation was founded in 2008 after the death of German entrepreneur Joachim Herz. It is one of the largest private foundations in Germany.

areas of international collaboration and teaching", says Sabine Kunst, Chairwoman of the Executive Board of the Joachim Herz Foundation.

The Hamburg Prize for Theoretical Physics has been honouring the work of internationally renowned researchers since 2010. Nicola Spaldin is the first woman to win the accolade since its inception. The prize is one of the highest-endowed scientific awards for physics in Germany, with prize money totalling 137,036 euros – this figure being an allusion to Sommerfeld's fine structure constant, which plays an important role in theoretical physics.

## Inspiring top-class research in Hamburg

The physics prize being awarded to Nicola Spaldin also includes a research residency in Hamburg. "Nicola Spaldin's leading expertise in the theory-based design of multifunctional materials is closely linked to the core research areas of our Science City Hamburg Bahrenfeld, e. g. in the working groups at Max Planck Institute for the Structure and Dynamics of Matter, the CFEL and the European XFEL. In addition, her ideas on the simulation of Higgs bosons or cosmic strings in novel materials also have the potential to form an exciting bridge into particle physics at DESY and Universität Hamburg. We are very much looking forward to working with her," says Volker Schomerus, leading scientist at DESY and spokesperson for the Wolfgang Pauli Centre.

## About Nicola Spaldin

Nicola Spaldin (born 1969) studied chemistry and geology at the University of Cambridge and showed an interest in the intersection between physics, chemistry and materials research from an early stage. After completing her PhD at the University of California/Berkeley in 1996, she worked as a postdoctoral researcher at Yale University/New Haven before serving as Assistant Professor and later Associate Professor at the University of California/Santa Barbara. She subsequently became a Full Professor at the same institution in 2006. She has been Professor of Materials Theory in the Department of Materials at ETH Zürich since 2011.

## Multiferroics: theoretical predictions and experimental breakthrough

In 1997, a colleague at Yale University made a casual comment to Nicola Spaldin during a coffee break that would come to consume her: it's a pity that there are no ferroelectric materials that also have ferromagnetic properties, i.e. that can also be magnetised. Using quantum theory and

computer models, she spent the next few years investigating the conditions that must be fulfilled in order for crystalline chemical compounds to be both electrically polarisable and magnetisable. In 2000, she published a ground-breaking article entitled “Why are there so few magnetic ferroelectrics?” The key finding of this work was the fact that ferromagnetism and ferroelectricity are not fundamentally incompatible. We simply need to arrange the right atoms in a suitable crystal structure to obtain these types of multiferroic materials.

With the aid of density functional theory – a numerical formalism used to calculate the electron states in complex many-particle systems, which Spaldin had to extend slightly for this work – she concluded that metal oxide compounds containing two specific metal atoms in addition to oxygen atoms could have both ferroelectric and ferromagnetic properties. Together with her collaborators, she began to create chemical compounds of this kind in the lab in order to test her predictions. The breakthrough came in 2003 in cooperation with the group of Ramamoorthy Ramesh at University of California/Berkeley: thin films of bismuth ferrite were grown in the laboratory and shown to be multiferroic. After the work was published in the journal “Science”, the number of publications on the topic skyrocketed. The material is now one of the most intensively researched multiferroics.

**Performance enhancement and optimisation**

Nicola Spaldin and her group at the ETH Zurich have been driving the development of this new material class since 2010. As the interaction between theory and experiment plays an important role in this process, she operates her own laboratory for the synthesis of multiferroics and benefits from access to supercomputers and physical measuring instruments for material characterisation at major Swiss research centres such as the Paul Scherrer Institute.

In addition to multiferroics, the British scientist is also interested in other innovative materials with exciting properties. She uses her expertise for the theoretical description of interactive many-particle systems to better understand how superconductors function, among other things. Her vision is to produce superconducting materials that no longer require costly cooling to conduct electricity without loss.

You can download a press photo of Nicola Spaldin at www.joachim-herz-stiftung.de/service/presse/pressefotos/.