

Speaker: Chiara Ciccarelli

University of Cambridge, UK

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Pumping spin out of antiferromagnets



BIO Chiara Ciccarelli is Professor of Physics at the Cavendish Laboratory, University of Cambridge. She completed her undergraduate and master studies at Tor Vergata University in Rome. After her PhD in Cambridge she held a Junior Research Fellowship at Gonville and Caius College. In 2017 she started her research group at the Cavendish Laboratory with a Winton Advanced Research Fellowship. She is a Royal Society University Research Fellow since October 2017. In 2023 she was nominated Wohlfarth Lecturer by the Institute of Physics in recognition of her "significant contributions to the understanding of magnetism" and has been awarded an ERC consolidator grant.

Within the field of spintronics, spin emission is a vital effect from both a fundamental and a technological point of view. For fundamental science, effects such as spin pumping allow us to study both the generation efficiency of spin currents and their transmission across interfaces.

Technologically, it is a basic requirement for spintronics that spin currents can be moved between different component parts of a circuit, including between different materials, magnetic and non-magnetic, to transfer spin information and generate torques that switch magnets.

Spin emission from ferromagnets has a long history and it is relatively well understood. Only in the last decade has attention turned to antiferromagnets, driven by the popularity of antiferromagnetic spintronics as a research topic. Despite their zero net magnetisation, antiferromagnets and compensated ferrimagnets have great potential as electrically and optically activated spin sources. The absence of stray fields means that such spin sources can be placed in close proximity to other magnetic elements without disturbing their state. Recent advances have shown that antiferromagnets and compensated ferrimagnets can emit spin current pulses with timescales down to the picosecond range and in the presence of small or zero external magnetic fields. These spin currents have been used in actual devices for inducing the switching of out-of-plane magnets.

In this tutorial, I will go over the fundamentals of spin-pumping in both ferromagnets and antiferromagnets and will review the different ways generating a spin current from a magnetically compensated material, describing the theoretical models for spin generation and the experimental techniques adopted for measuring the spin currents in different time regimes.

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