Department of Physics
Condensed Matter Physics
Clarendon Laboratory, Parks Road, Oxford OX1 3PU

UNIVERSITY OF OXFORD

CONDENSED MATTER PHYSICS SEMINAR

Thursday 15 October at 14:30
Simpkins Lee Seminar Room, Department of Physics
(https://maps.app.goo.gl/WjG71uLF2D48n85B6)

Ultrafast Control of Spins, Waves and Interactions in Magnetic Materials

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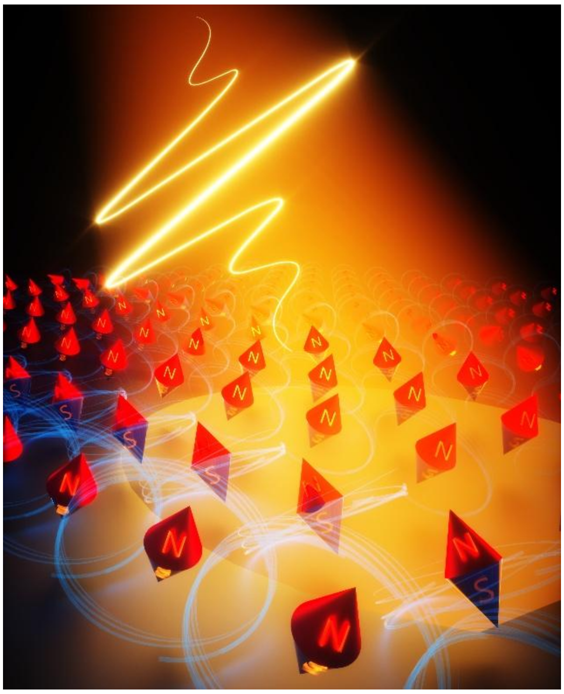

Ultrafast control of magnetisation by light offers a promising route toward energy-efficient information technologies operating on intrinsic magnetic timescales. By engineering the temporal, spectral and polarisation properties of ultrashort light pulses, one can launch the precessional motion of spins, manipulate the magnetic phases and drive the magnetic order far from equilibrium. My research pursues “on-demand” control of magnetism, based on selective perturbing microscopic interaction parameters, which can be used to transform materials into a desired magnetic state.

I will first discuss the potential of intense THz-radiation to switch spins in magnetic materials [1-3]. When the strength of the THz field is enhanced with the help of custom-made plasmonic antennas, we achieved switching between stable antiferromagnetic states. In this way the magnetic recording at THz clock rates is made feasible.

Then I will show that strong ultrafast driving of infrared active phonons in magnetic materials can also provide a new route to control magnetic properties by triggering coherent magnon oscillations or even inducing a transient magnetic phase not accessible by adiabatic changes of ambient conditions [4].

Finally, I will demonstrate that ultrafast excitation does not only switch magnetisation, but also generates the microscopic waves of spin motion inside a magnet, quanta of which are called magnons. The trick to generating magnons at the nanoscale is in the high photon energy of the light pulse. The magnetic material under study exhibited extremely strong absorption of ultraviolet light, which localized the excitation to a very thin region of only a few tens of nanometres from the interface, allowing coherent magnons with 10-nm wavelengths to be generated and controlled [5-7].

[1] S. Baierl, et al. Nature Photonics 10, 715 (2016).
[2] S. Schlauderer, et al. Nature 569, 383 (2019).
[3] R. Leenders, et al. Phys. Rev. Lett. 135, 246703 (2025).
[4] D. Afanasiev, et al. Nature Materials 20, 607 (2021).
[5] J. Hortensius, et al. Nature Physics 17, 1001 (2021).
[6] R. Leenders, et al. Nature 630, 335 (2024).
[7] V. Radovskaia, et al. Nature Physics 22, 728 (2026).

Host: Dr Hariom Jani