

Physics Department

Colloquia Speakers 2025/26

Prof Tomas Jungwirth (University of Nottingham & Institute of Physics of the Czech Academy of Science)

Altermagnetism: Unconventional spin-ordered phase of matter

Friday 14 November 2025

The research beyond conventional magnetism, which led to the recent discovery of altermagnetism [1-5], was largely motivated by the field of spintronics. From an applied perspective, spintronics is a modern branch of integrated-circuit technologies currently undergoing a transition from niche to mass production, in particular thanks to embedded non-volatile memories complementing semiconductors on advance-node processor chips. The functionality of present spintronic memories is based on the magnetization in conventional ferromagnets which generates well separated and conserved spin-up and spin-down channels in the electronic structure. Simultaneously, however, the magnetization sets physical limits on the spatial, temporal and energy scalability of the spintronic technology. In the talk we will show that altermagnetism opens a prospect of removing these limits by combining well separated and conserved spin-up and spin-down channels with no net magnetization. Altermagnetism enables this extraordinary combination of properties thanks to the unconventional nature of the magnetic ordering whose symmetry is reminiscent of unconventional superfluidity.

References

- [1] L. Smejkal, J. Sinova, T. Jungwirth, Phys. Rev. X 12, 031042 (2022).
- [2] L. Smejkal, J. Sinova, T. Jungwirth, Phys. Rev. X (Perspective) 12, 040501 (2022).
- [3] J. Krempasky, T. Jungwirth et al., Nature 626, 517 (2024).
- [4] O. J. Amin, T. Jungwirth et al., Nature 636, 348 (2024).
- [5] A. Cho, Science 386, 1211 (2024).

Prof Nial Tanvir (University of Leicester)

Probing the distant universe with gamma-ray bursts

Friday 28 November 2025

Long-duration GRBs are the most luminous sources known and can be detected to large distances and hence early times in the Universe. Produced by the deaths of massive stars, they pinpoint star formation over the span of cosmic history, while spectroscopy of their bright

afterglows provides detailed information about their environments, in some cases for galaxies too faint to see with our most powerful telescopes. I will review lessons learnt to date from studies of high redshift GRBs and their hosts, including evidence for a puzzlingly low escape fraction of ionizing radiation, and compare to the results from high-redshift galaxy studies with HST and JWST.

Prof George Malliaras (University of Cambridge)

Materials and Devices for Bioelectronic Medicine

Friday 13 February 2026

Bioelectronic medicine provides a new means of addressing disease via the electrical stimulation of tissues: Deep brain stimulation, for example, has shown exceptional promise in the treatment of neurological and neuropsychiatric disorders, while stimulation of peripheral nerves is being explored to treat autoimmune disorders. To bring these technologies to patients at scale, however, significant challenges remain to be addressed. Key among these is our ability to establish stable and efficient interfaces between electronics and the human body. I will show how this can be achieved using materials with mixed ionic-electronic conductivity. I will discuss devices engineered from these materials to communicate with the body and evolve with it.

Prof Alessia Pasquazi (Loughborough University)

Laser cavity solitons in microcombs: dynamics, robustness, and perspectives

Friday 13 March 2026

Optical frequency combs in microresonators, or microcombs, are coherent optical sources composed of equally spaced spectral lines generated by Kerr nonlinearity. The discovery of dissipative temporal cavity solitons marked a turning point, enabling broadband, smooth comb spectra ideally suited for metrology and precision timing.

We demonstrated that localized pulses can self-organize when a nonlinear microresonator is nested within a fibre laser loop, leading to the formation of laser cavity solitons. This architecture merges the robustness of laser cavities with the compactness of microresonators, providing an intrinsic route for the creation, stabilization, and control of solitary waves in integrated photonic platforms.

Our recent work has shown that these solitons can spontaneously emerge, persist, and self-recover even after strong perturbations, highlighting their dissipative resilience and topological protection mechanisms. In particular, the interplay between fast Kerr dynamics and slow nonlinearities—such as gain saturation and thermal feedback—governs a topological bifurcation structure that locks the soliton's repetition rate and phase.

In this talk, I will discuss how these effects establish noise-quenched and topologically constrained states that extend the operational stability of microcombs toward fully free-running, metrology-grade sources. The discussion will integrate both experimental evidence and the

underlying mathematical model linking modal symmetry, topology, and soliton attractor dynamics.

References

- [1] H. Bao, et al. Laser Cavity-Soliton Microcombs. Nat. Photonics 13, 384 (2019).
- [2] M. Rowley, et al. Self-emergence of robust solitons in a microcavity. Nature 608, 303–309 (2022).
- [3] A. Cutrona, et al. Nonlocal bonding of a soliton and a blue-detuned state in a microcomb laser. Commun Phys 6, 259 (2023).

Prof Stefan Rotter (Vienna University of Technology)

Coherent perfect absorption, transmission and emission of light

Friday 27 March 2026

In my talk I will present three recent works focused on the perfect absorption, transmission and emission of radiation by interferometric wave engineering. In the first case, we demonstrate that even a weakly absorbing film can be turned into a “coherent perfect absorber” by building a degenerate cavity around it [1]. This special cavity perfectly couples incoming light fields with arbitrary wavefronts into the absorber – even for the case that light is a dynamically varying speckle pattern. In the second case, we demonstrate how to construct an anti-reflection structure for a complex scattering system like a disordered medium [2]. Similar to an anti-reflection coating for conventional eye-glasses, this structure leads to perfect transmission across a strongly scattering system by perfectly suppressing any back-scattering. As I will demonstrate in the last part of my talk, these effects have a topological origin, which can be used to engineer topologically protected thermal radiation [3].

References

- [1] Y. Slobodkin, G. Weinberg, H. Hörner, K. Pichler, S. Rotter, and O. Katz, Science 377, 995 (2022)
- [2] M. Horodynski, M. Kühmayer, C. Ferise, S. Rotter, and M. Davy, Nature 607, 281 (2022)
- [3] M. S. Ergoktas, A. Kecebas, K. Despotelis, S. Soleymani, G. Bakan, A. Kocabas, A. Principi, S. Rotter, S. K. Özdemir, and C. Kocabas, Science 384, 1122 (2024)

Prof Emma MacPherson (University of Warwick)

In vivo THz imaging: developing the Picobot

Friday 1 May 2026

Terahertz (10¹² Hz, THz) light is very sensitive to hydrogen bonds and, due to it also being non-ionising, researchers have been looking how to exploit this unique property for biomedical

applications for over 2 decades. The strong attenuation of THz light by water and therefore biological tissues means that in vivo THz imaging needs to be done in a reflection geometry. In this talk I will explain how THz imaging has evolved and how, in my latest project, Terabotics, I have been conducting the first in vivo studies of skin cancer patients in a hospital environment. Terabotics has enabled THz technology to be integrated with robotics to develop a robotically controlled THz probe, which we have called the “Picobot” (as THz light probes processes occurring at picosecond time scales). The Picobot has featured on BBC West Midlands News.

Prof Nader Engheta (University of Pennsylvania)

Near-Zero-Index Optics

Friday 8 May 2026

Materials are often used to manipulate and control photons. Metamaterials -- judiciously engineered material structures -- have enabled scientists and engineers to construct platforms with unconventional material parameters, providing exciting opportunities for optical and microwave devices and components. One major platform of metamaterials is the near-zero-index metamaterials. In such structures, the effective relative permittivity and/or relative permeability are designed to be near zero at operating frequencies, resulting in an effective refractive index close to zero. Consequently, in such epsilon-near-zero (ENZ), mu-near-zero (MNZ), and/or near-zero-index (NZI) structures, the wavelength is “stretched”, and therefore the phase distribution is effectively uniform throughout this volume. This leads to a variety of unique features in wave physics, including supercoupling, photonic doping, photonic surface states, electric levitation, extreme quantum optics, thermal beaming, and giant nonlinearity, just to name a few. In this talk, I will present an overview of the fundamental principles and the unique physics and engineering of wave interaction with near-zero-index structures. I will then discuss some of the applications of such platforms in photonics and microwave technologies. Possible future directions of research in this field will also be forecasted.