“Condensates and Caustics for the Curious: a Magnon Extravaganza”

On the afternoon of Monday 30th April there will be a special seminar featuring two of the world’s foremost experts in magnon and spin-wave dynamics: Prof. Burkard Hillebrands (Technical University of Kaiserslautern, Germany) and Prof. Andrei Slavin (University of Oakland, Michigan). All members of the department are warmly invited to attend. The speakers and their talks will be introduced by Dr Alexy Karenowska at 2.15pm (abstracts attached) and the session will conclude at 4.15pm.

Bose-Einstein Condensate of Magnons and Evaporative Cooling of a Magnon Gas

It has been established that unlike the Bose-Einstein condensation of real particles, the formation of BECs of light quasi-particles such as magnons and spatially-confined photons does not require low temperatures since the quasi-particle densities required for the condensates to form can be produced via external pumping. Here we demonstrate that the effective temperature in the spectral region where a BEC of quasi-particles is formed can reach surprisingly high values (~30,000 K), and strikingly unexpected transitional dynamics of an externally pumped BEC of interacting quasi-particles can be observed. For example, our experiments demonstrate a dramatic jump in the density of the condensed magnons immediately after the pumping which seeds the condensate is switched off. This surprising behaviour finds explanation in the fact that the thermalization processes which underpin the formation of the condensate apply only over a very narrow region of the lowest energy states of the quasi-particle gas where it is strongly overheated (T > 30,000 K) by the pumping process. As a result of nonlinear magnon-magnon scattering, a magnon may gain additional energy and leave the thermalized region, thus reducing the average energy of the remaining magnons. This mechanism is similar to the well-known process of evaporative cooling in real atomic gases, but is much more pronounced due to its low value of “cutoff” energy. A simple analytical model of such cooling of a quasi-equilibrium magnon gas, which will be presented in the talk, gives a good quantitative account of the experimentally observed phenomena.

Prof Burkard Hillebrands, Technical University Kaiserslautern, Germany

Non-Diffractive Sub-Wavelength Wave Beams in a Medium with Externally Controlled Anisotropy

We predict and experimentally demonstrate that in a medium with externally induced anisotropy a wave source of a sufficiently small size can excite practically non-diffractive wave beams with stable sub-wavelength transverse aperture. The direction of the beam propagation is controlled by rotating the induced anisotropy axis. Non-diffractive wave beam propagation, reflection, and scattering, as well as beam steering have been directly observed by optically probing dipolar spin waves in yttrium iron garnet films, where the uniaxial anisotropy was created by an in-plane bias magnetic field.

Prof Andrei Slavin, Oakland University, USA