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| **Summer Placement Project Proposal** |
| Supervisor(s): Dr Thorsten Hesjedal  Nominees in case of absence: Dr Yulin Chen, Mr Shilei Zhang  Duration of Placement: 12 weeks  Date restrictions: none |
| **Section 1: Project description:**  Project title: **Magnetic Skyrmions**  The project aims at studying thin film magnetic Skyrmions close to room temperature. The student will join our team which involves researchers from Oxford, Diamond, ISIS, and the TU Munich.  Ordering in magnetic systems is commonly governed by the type of the dominant magnetic interaction. For example, in the Heisenberg exchange picture, ferromagnetic (all moments are parallel) and antiferromagnetic (adjacent moments are antiparallel) order is found. Anisotropic exchange (Dzyaloshinsky-Moriya interaction), on the other hand, induces magnetic spirals. However, frustration emerges when several microscopic interaction mechanisms coexist, and consequently compete with each other, which enriches the physics of the system and is a very active field of research at the moment.  One popular system that is modulated by frustration are chiral magnets, in which magnetic Skyrmions were very recently discovered. Magnetic Skyrmions were found to be topologically stable, vortex-like magnetization states that form periodic, three-fold symmetric lattices (periodicities ~3-30 nm). They are observed in non-centrosymmetric crystals when certain fluctuations are present. The Skyrmion state is elegantly described by topological models. Skyrmion systems are promising candidates for next-generation memory as the vortex state is ultra-stable compared with the conventional memory relying on uniform magnetisation patterns. Most interestingly, the Skyrmion state can be simply manipulated with current densities that are 5-6 orders of magnitude smaller than the ones needed for conventional spin torque transfer schemes.  The goal of this project is to synthesize and explore room temperature Skyrmion thin films and nanomaterials, which can be used as advanced non-volatile memory. Our strategy relies foremost on materials synthesis by molecular beam epitaxy (MBE), UHV sputtering and chemical vapour deposition (CVD). So far, we have successfully grown MnSi, doped MnSi, and Fe0.5Co0.5Si thin films by CVD and MBE.  This exploratory materials synthesis project uses two cutting-edge MBE systems, a CVD and a UHV sputtering system. The work will be carried out in Oxford’s Thin Film Quantum Materials Laboratory in the RCaH (http://www.rc-harwell.ac.uk/) at the Rutherford Appleton Laboratory. Training will be provided for learning to operate the growth tools, as well as a SQUID magnetometer, x-ray diffraction and reflectometry (XRD/XRR) setups, and scanning probe microscopy (AFM/MFM). |
| **Section 4: Special requirements (skills and experience required):**  Required skills: high motivation, practical lab experience (hands-on), strong interest in materials and magnetism.    Desired skills: ultra-high vacuum technology, thin films and thin film growth, electron microscopy, scanning probe microscopy. |