Ultrasensitive force measurements at the Quantum/Classical interface

**General Scope:** Optomechanical systems, which couples a light field to a nanomechanical oscillator, have demonstrated outstanding sensitivities for force measurements. Using a Silicon Carbide nanowire coupled to a focused laser beam we already demonstrated sensitivities in the atto-Newton ($10^{-18}$ N) range [1]. Moreover the vibrations of these wires consist in nearly degenerated and orthogonal modes which allows for vectorial sensing capabilities [1]. These amazing features, which have been employed to investigate their interaction to a single spin qubit [2], will be applied to design a new type of Magnetic Force Microscope (MFM) with a sensitivity increased by six orders of magnitudes compared to standard AFM/MFM probes and the ability to map the local magnetization vector. These capabilities will be crucial to prove the existence and reveal the fine structure of new exciting magnetic states at room temperature. Among those, the stable chiral structure of magnetic skyrmions [3] is very promising for future spintronics applications and will be the focus of this project.

**Research topic and facilities available:** The goal of this project is to detect, image and study the physics of magnetic skyrmions in thin ferromagnetic films of Platinum/Cobalt. The first task will be to set up a nanowire based MFM under vacuum, for which we have all the essential pieces and adapt and optimize new signal processing protocols to accelerate the acquisition time. This task will be followed by the functionalisation of nanowires with ferromagnetic nanoparticles. After preliminary characterisation of the instrument on calibrated nanostructures, measurements will be performed on individual magnetic skyrmions.

**Possible collaboration and networking:** The Micro and Nanomagnetism group (Néel Institute) will provide the magnetic nanoparticles as well as the thin films and magnetic dots hosting skyrmions.

**Possible extension as a PhD:** The internship can move on a PhD.

**Required skills:** The candidate must have good experimental skills and a good knowledge in optics. Prior experiment in magnetism is welcome.

**Starting date:** In 2019

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