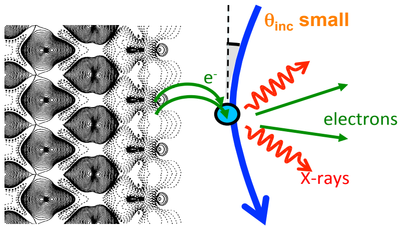
Ph.D. in

Investigation on the interaction between highly charged ions and surface magnetism



Interaction between a multicharged ion and a surface. In the collision, the ion can capture one or more electrons from different depths of the surface.

The purpose of this thesis is the characterization of the surface magnetization of samples by a grazing collision with highly charged ions. The x-ray emission that results from the collision depends on the alignment of the spins of the captured electrons by the ion. This can provide information on the presence or absence of magnetic domains. The detection of the presence of magnetic domains with highly charged ions represents an alternative to conventional methods used so far, such as the Kerr effect, x-ray dichroism, neutron scattering, etc. Differently from these methods, the interaction of the ions can be limited to the very first atomic layers of the sample only, allowing to probe magnetization at the surface. Past experiments based on the study of the electron emission and the use of relatively low charged ions demonstrated the possibility to detect the presence of magnetic domains via the ion–surface interaction and the detection of the associated Auger electron emission (Unipan et al., PRL 2006). This first detection has been however questioned (Busch et al. PRA 2008) due to a possible contamination of the samples.

To overcome Auger spectroscopy difficulties, we propose to study the ion–magnetised surface dynamics by x-ray spectroscopy of the radiative emission pathway. **A proof of principal experiment has been recently performed that demonstrates the sensitivity of x-ray emission to the ferro-/paramagnetic phase phases of a nickel sample surface** (the analysis is in progress). The proposed Ph.D. consists of continuing this stimulating new research topic. The following steps are: 1) to extend such a study to other materials like LaSrMnO (ferro-/paramagnetic transition) and FeRh (antiferro-/ferromagnetic transition), 2) to implement coincidence detection between the x rays and the ion charge state after the collision and 3) to implement high-resolution x-ray spectroscopy with a crystal diffractometer equipped with a new detector sensitive in position, energy and time (based on timepix3 technology). As long-term goal, magnetic properties of 2D materials and other more exotic magnetic materials will be investigated.

The Ph.D. will take place at our SIMPA facility, a platform equipped with its highly charged ion source and its low energy beam line, where a dedicated collision chamber is mounted. As the collision dynamics is very sensitive to the composition of the first layers of the sample, the surface is prepared and controlled in a dedicated ultra-high vacuum chamber before irradiation.

Techniques involved: The candidate will become familiar with the techniques of data analysis, X-ray and Auger spectroscopies. She/he will also learn the methods of production and transport of multicharged ion beams using an ECRIS (Electron Cyclotron Resonance Ion Source) on the Source of Multicharged Ions of Paris platform (SIMPA - INSP / LKB).

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