Exploring 2D magnetic semiconductors, through magneto-optical coupling

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Recent advances in understanding magneto-optical coupling in layered magnetic semiconductors, with a particular focus on CrSBr and its halogen-alloyed derivatives will be discussed. Owing to the strong interplay between magnetic order and excitonic response, CrSBr provides a unique platform for optically probing both intrinsic and externally induced magnetic phenomena in low-dimensional systems.

I will present how the geometry and configuration of CrSBr flakes can locally influence magnetic order and modify the critical magnetic field associated with magnetic phase transitions. By combining optical spectroscopy with magnetic-field-dependent measurements performed in EMFL facilities, we demonstrate that factors such as local geometry on the surface of a substrate can lead to pronounced variations in the magneto-optical response.

Additionally, I will discuss the effects of chlorine alloying in CrSBr1−xClx, where controlled halogen substitution enables continuous tuning of both magnetic and optical properties. We show that chlorine incorporation modifies the excitonic landscape, magnetic anisotropy, and magnetic saturation fields as well as the exciton spatial character, providing a route toward engineering magneto-optical coupling in van der Waals magnetic semiconductors. These results highlight alloying and structural engineering as powerful tools for tailoring light-matter interactions in 2D magnetic materials.