IBS CINAP Seminar

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Probing the magnetism of single atoms with orbital sensitivity

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Abstract: Magnetic storage devices such as hard drives and magnetic tapes are massively used in conventional high-capacity storage units. The increasing data-storage needs motivate the research towards novel fundamental alternatives to achieve ever-larger bit density. Individual atoms adsorbed on a surface, with each atom being able to store a single bit of data, could potentially allow maximal storage density in a solid-state system. However, in order to store and process information, it is required to stabilize the electron spin of the magnetic atoms against thermal and quantum fluctuations.

In the first part of this talk, I will present the rapid evolution of this field and the sequence of advancements that led to the discovery of the first single atom magnet, namely a holmium atom on a magnesium oxide ultra-thin film. Using x-ray magnetic circular dichroism (XMCD), we found these atoms to be magnetically stable up to 40 K even in absence of an external magnetic field [1]. In addition, they can be read and written individually using a scanning tunneling microscope [2,3].

In the second part, I will present the most recent advances towards the understanding of their magnetic properties and the design of novel single atom magnets. We used XMCD to investigate the different transitions accessible in the soft x-rays range to probe the spin magnetic moments with orbital sensitivity and understand the magnetic level scheme of rare earth atoms on MgO/Ag(100). Finally, I will discuss the strategies to realize novel single atom magnets with enhanced structural and magnetic stability, as well as the first results obtained in this direction.

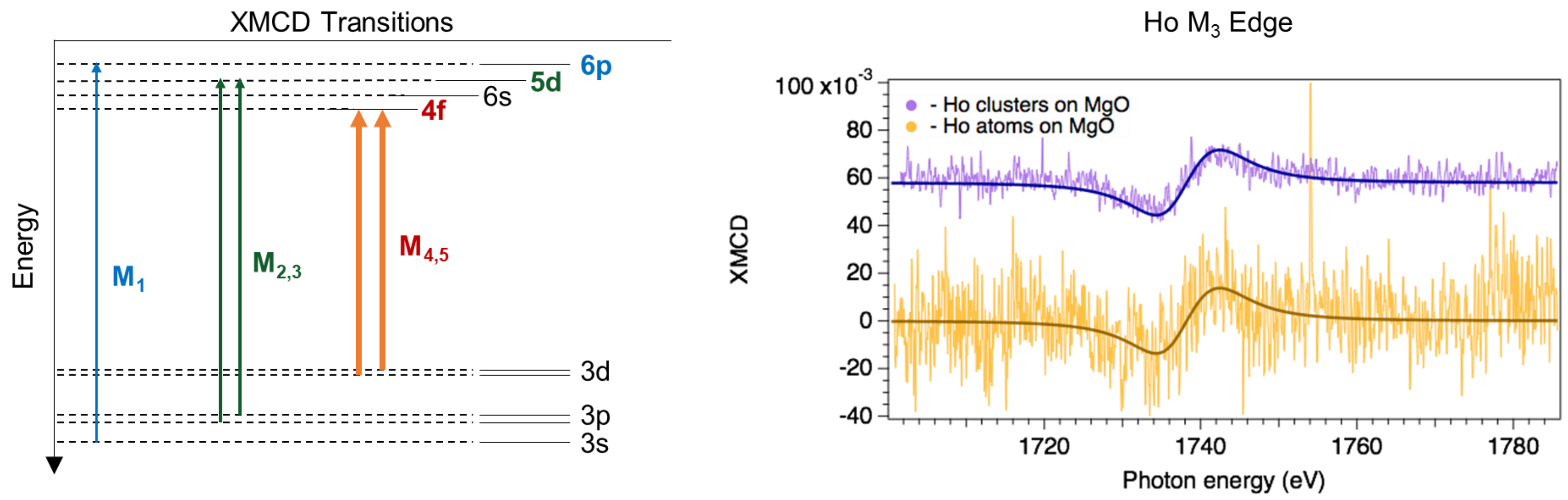

Figure 1: x-ray magnetic circular dichroism of single atoms with orbital sensitivity. Left: schematics of the soft-x-rays absorption transitions. Right: XMCD signal of the M3 edge acquired on 0.10 ML (clusters) on 0.03 ML (atoms) of Ho on MgO/Ag(100). Black lines show simulated transitions obtained from multiplet calculations.

Brief Bio:

Prof. Fabio Donati obtained B.Sc. (2004) & M.Sc. (2006) in Physics Engineering from Politecnico di Milano, Italy, and his PhD (2010) in Radiation Science and Technology also from Politecnico di Milano, Italy. Part of the research of his PhD thesis was done at the Max Plank Institute of Halle, Germany.

He carried out his post-doc activity at the Ecole Polytechnique Federale de Lausanne, Switzerland from 2011 to 2017 in the field of single atoms and molecules on surfaces using scanning tunneling microscopy and X-ray magnetic circular dichroism. Since 2017, he is a Research Fellow leading the Ensemble Measurements Group at the Center for Quantum Nano Science, Institute for Basic Science in Seoul. In 2019 he also became Assistant Professor of Department of Physics at Ewha Womans University.

In 2010 he obtained the Best talk presentation at the European Conference of Surface Science and more recently, he received the Max Auwärter award (2018) for “outstanding achievements in physics of surfaces and interfaces”. His personal research is focused on the investigation of magnetic and quantum coherence properties of novel quantum magnets at surfaces.