Keynote Speakers

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Short Biography

Lisa Michez holds a PhD from Leeds University. In 2005, she joined Aix Marseille Université and the CINaM lab where she was appointed as a professor in 2022. She has a 20 years expertise in Si- and Ge-based thin films and nanotructures, from their elaboration by molecular beam epitaxy to their in-depth structural and magnetic characterization. Her current research focuses on determining and tailoring the structure of functional materials in thin films, at the atomic level, to predict and control their physical properties, with a particular emphasis on altermagnetism and chiral antiferromagnetism for potential applications in spintronics. She co-leads the Department of Nanomaterials and heads the 'Spintronics & Epitaxy' team at CINaM.

Title of Oral Presentation

Altermagnets: new opportunities for spintronics

Keywords : spintronics, magnetic materials, altermagnets, epitaxial growth

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Abstract of Oral Presentation

Spintronics currently relies heavily on ferromagnetic materials, which serve as sources of spin-polarized currents or spin analyzers due to their strong spin-dependent properties. However, the rapidity and scalability of ferromagnetic-based spintronic devices have reached their limits. Antiferromagnetic systems offer a promising alternative, with very fast dynamics and zero net magnetization, but they typically do not generate spin currents. Recently, a third magnetic class has emerged, combining the advantages of both worlds: altermagnets exhibit zero net magnetization together with the desired strong spin-dependent phenomena, merits previously deemed as principally incompatible. This unique combination positions altermagnets as compelling candidates for the next generation of spintronic devices.

Over one hundreds of materials have been predicted altermagnetic. Up to date, only four of them have experimentally been demonstrated altermagnetic: RuO_2, Mn_5Si_3, MnTe and CrSb by order of discovery. Among these materials, Mn_5Si_3 presents incomparable advantages. First, it is composed of light elements with weak spin-orbit coupling, making it possible to unequivocally link its altermagnetic character to the intrinsic, non-relativistic specific arrangement of the staggered magnetic moments with respect to its crystalline symmetries. Then, its magnetic structure is extremely sensitive to small changes in the crystal structure, offering a variety of magnetic behaviors: non-collinear and collinear antiferromagnet [1], and d-wave altermagnets [2]. Epitaxy is therefore a powerful tool to explore this model system, disentangle the various contributions driving the altermagnetic properties and explore spin-dependent phenomena.

In this context, we report routes to grow epitaxial Mn_5Si_3 thin films 'under strain' using molecular beam epitaxy [3]. The altermagnetic nature of Mn_5Si_3 is evidenced by several key signatures: a strong anomalous Hall effect in the absence of a magnetic field and magnetization [2, 3], variant-dependent anisotropic behavior [4, 5], a significant Nernst effect despite the lack of magnetization [6], and a clear influence of crystallinity [3], all supported by theoretical predictions [2]. They are all consistent with the stabilization via epitaxy of a specific crystal and spin structure [5]. The control and optimization of the altermagnetic properties by epitaxy therefore represent a new and promising avenue in the field of spintronics, offering distinct opportunities for advancing both fundamental physics and technological applications.

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