INSTITUT DE PHYSIQUE ET CHIMIE DES MATERIAUX DE STRASBOURG

23, rue du Loess, 67034 STRASBOURG Cedex 2

Mini-symposium '2D materials and thermodynamics'

QMat & AXE 1 – Sciences et Matériaux Quantiques

Vendredi 29 Novembre 2024 | 09:00 | Auditorium de l'IPCMS

09h00-09h30: Iann Gerber (LPCNO Toulouse)

Theoretical exploration of exciton-exciton interactions in 2H-transition metal dichalcogenide bilayers

09h30-10h00: Vincent Jacques (L2C, Montpellier)

Quantum sensing with spin defects in hexagonal boron nitride

10h00-10h30: Coffee break

10h30-11h00: Clément Faugeras (LNCMI, Grenoble)

Magneto-Raman scattering of a frustrated van der Waals magnet

11h00-11h30: Cyriaque Genet (ISIS, Strasbourg)

Taming a Maxwell's demon for experimental stochastic resetting

Iann Gerber

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Theoretical exploration of exciton-exciton interactions in 2H-transition metal dichalcogenide bilayers

The fundamental properties of an exciton are determined by the spin, valley, energy, and spatial wavefunctions of the Coulomb-bound electron and hole. In van der Waals materials, these attributes can be widely engineered through layer stacking configuration to create highly tunable interlayer excitons with static out-of-plane electric dipoles, at the expense of the strength of the oscillating in-plane dipole responsible for light-matter coupling. Here we show that interlayer excitons in bilayer 2H-MoX_2 (X=S,Se) systems can exhibit electric- field-driven coupling with the ground (1s) and excited states (2s) of the intralayer A excitons [1]. We can also demonstrate, theoretically as well as experimentally, that the hybrid states of these distinct exciton species provide strong oscillator strength, large permanent dipoles and high energy tunability [2]. Thanks to GW+BSE calculations, we can address the origin of these couplings in the intimate nature of those excitations [1,3].

[1] S. Feung et al, Nature Commun. **15**, 4377 (2024)
[2] N. Leisgang et al, Nature Nanotechnol. **15**, 901 (2020)
[3] L. Sponfeldner et al, Phys. Rev. Lett. **129**, 107401 (2022)

Vincent Jacques

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Quantum sensing with spin defects in hexagonal boron nitride

Quantum sensors based on optically-active spin defects in semiconductors have found a broad variety of applications, in both basic and applied science, due to their unprecedented combination of sensitivity, spatial resolution and ability to operate under a wide range of experimental conditions. While the most prominent example is undoubtedly the nitrogen-vacancy (NV) center in diamond, the exploration of alternative spin defects and host materials remains an active field of research worldwide. In this context, the negatively-charged boron vacancy (VB) center in hexagonal boron nitride (hBN) is currently attracting a growing interest for the development of quantum sensing and imaging technologies on a two-dimensional (2D) material platform. This point defect, which can be readily created by various irradiation methods, has a spin triplet ground level whose electron spin resonance frequencies can be measured optically under ambient conditions and strongly depends on external perturbations. In this talk, I will describe our recent research work aimed at developing quantum sensing foils based on VB centers in hBN.

Clément Faugeras

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Magneto-Raman scattering of a frustrated van der Waals magnet

Magnetic frustration, the impossibility to simultaneously satisfy all nearest neighbours magnetic exchange interactions, leads to very rich magnetic phase diagrams comprising highly-degenerate magnetic ground states and complex spin orders. Varying temperature, magnetic field or hydrostatic pressure, one can navigate through these exotic magnetic phases. CrOCl belongs to this class of frustrated van der Waals magnets and presents magnetic order with very large magnetic cells that profundly modify its magnetic and phonon excitation spectra. In this talk, I will show our recent results on magneto-Raman scattering of bulk and thin layers of CrOCl and tentatively identify the different magnetic phases evidenced in its optical response.

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Taming a Maxwell's demon for experimental stochastic resetting

A diffusive process that is reset to its origin at random times, so-called stochastic resetting, is an ubiquitous expedient in many natural systems. Recent developments of experimental information thermodynamics renew the way to address the non-equilibrium nature of stochastic resetting. This approach brings out a Maxwell's demon surprisingly docile and ready to be tamed.