

## Tuning the interlayer coupling of van der waals heterostructures with hydrostatic pressure.

M2

### Detailed subject

The Grenoble High Magnetic Field Laboratory (LNCMI-G, CNRS), is a French large scale facility enabling researchers to perform experiments in the highest possible continuous magnetic field.

2D materials are a class of material extracted from 3D lamellar materials and offering a new playground for optoelectronics as well as for fundamental physics. This family includes today metallic compounds like graphene, semiconductors like transition metal dichalcogenides, charge density wave materials as well as superconductors. In the last years, the possibility of stacking different 2D materials on top of one another to form van der Waals heterostructures has emerged. When two 2D semiconductors are assembled, new types of excitations - interlayer excitons - for which the photocreated electron and hole are located in different layers, become possible. They are characterized by long lifetime in the ns range and they exhibit the peculiar valley properties inherited from monolayers.

We propose to assemble two monolayers of semiconducting 2D materials and to investigate their optical properties, in particular interlayer excitons, in extreme environments. The van der Waals heterostructure will be placed at low temperature to limit thermal broadening, and the interlayer coupling will be tuned with high pressures in a diamond anvil cell. The modifications of the interlayer coupling and of the resulting band structure will be traced in the emission properties (intensity, energy, FWHM) as well as in fundamental parameters such as the exciton g-factor and effective mass, extracted from magneto-optical experiments.

### Publications linked to the theme

A. Delhomme et al. 2020 2D Mater. 7 041002

M.R. Molas et al. 2019 Phys. Rev. Lett. 123 096803

S. Shree et al., 2020 arXiv:2006.16872

### Background and skills expected :

Candidates should be highly motivated by experimental physics, be interested in condensed matter physics and possibly have some experience with low temperature environments or clean room facilities.

### Key words:

2D materials, van der waals heterostructures, interlayer excitons, high pressure, magnetic fields

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