“High-field spectroscopy in 2D materials”

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Optical spectroscopy in high magnetic fields has historically played an essential role in determining the fundamental properties of excitons (mass, size, binding energy (E_B) etc.). In conventional bulk semiconductors such as GaAs, or CuO_2, magnetic fields ~ 10T are sufficient to achieve the regime where cyclotron energies exceed E_B. In marked contrast, in the family of monolayer semiconductors such as MoS_2, WSe_2 or 2D perovskites, masses are heavier and E_B is huge, requiring magnetic fields of order 100 T to reach this regime [1,2,3].

In this talk, I will review our recent progress on magneto optical spectroscopy of laterally small and atomically thin materials in DC and pulsed magnetic fields up to ~70 T with an emphasis on the spin-valley physics of neutral excitons.

In monolayer semiconductors at charge neutrality, high field magneto-absorption spectroscopy revealed the diamagnetic shifts of the exciton Rydberg states (*ns*) [2,3], which allowed the first direct experimental measure of the excitons reduced mass and binding energy. Surprisingly, utilizing nominally the same samples but now investigating the photoluminescence, we observe the emergence of a new excitonic peak from the neutral A:1s exciton in WSe_2, which we discuss in the framework of the theoretically predicted linear dispersing exciton branch originating from exchange interactions [4].

In 2D Ruddlesden-Popper perovskites, spin-orbit coupling effects may lead to the lifting of the degeneracy of the exciton dispersion, leading to an exciton branch called the Rashba-exciton [5]. We discuss our recent high field magneto-absorption spectroscopy on high quality hBN encapsulated (BA)MAPI in this framework, taking into account the exciton fine structure as determined from two-photon spectroscopy and time resolved Kerr spectroscopy.

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