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Séminaire AXE 1 - Sciences et Matériaux Quantiques

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Photoluminescence and electroluminescence control of 2D semiconductors coupled to nanophotonic structures

Nanophotonic cavities, such as plasmonic lattices (periodic arrays of metal nanoparticles), have been used to modify the photoluminescence (PL) properties of emitters like fluorescent molecules, leading to the generation of coherent light through lasing or Bose–Einstein condensation [1, 2]. While most previous work has relied on optical excitation of the gain material, electrically driven and controlled active materials are desirable for on-chip integration. Two-dimensional (2D) semiconducting materials, particularly monolayers of transition metal dichalcogenides (TMDs), offer a direct optical bandgap and excitons with high binding energies, making them promising candidates for light-emitting optoelectronic devices. In this talk, I will discuss the control of PL and electroluminescence (EL) properties of 2D semiconductors by incorporating them into plasmonic and photonic crystal cavities, as well as into waveguides [3]. To further control light emission from TMDs, we exploit electrostatic doping [4]. Additionally, we investigate lasing of interlayer excitons in TMD heterostructures coupled to 1D and 2D photonic crystal cavities. We demonstrate tunability of interlayer exciton emission via an applied electric field, providing a pathway for dynamic control of lasing. Our results pave the way for novel on-chip optoelectronic devices, such as integrated light sources and optical modulators.

References

[1] T. K. Hakala*, A. J. Moilanen*, A. I. Väkeväinen, R. Guo, J-P. Martikainen, K. S. Daskalakis, H. T. Rekola, A. Julku, and P. Törmä, Nat. Phys. **14**, 739–744 (2018)
[2] A. J. Moilanen, K. S. Daskalakis, J. M. Taskinen, and P. Törmä, Phys. Rev. Lett. **127**, 255301 (2021)
[3] R. Khelifa*, S. Shan*, A. J. Moilanen, T. Taniguchi, K. Watanabe, and L. Novotny, ACS Photonics **10**, 5, 1328–1333 (2023)
[4] A. J. Moilanen, M. Cavigelli, T. Taniguchi, K. Watanabe, and L. Novotny, ACS Nano (2025)