Carl von Ossietzky
Universität
Oldenburg

Institut für Physik

Physical Colloquium

„Tunable Quantum Confinement of Excitons in 2D Materials“

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Monday, 28.10.2024, 2.15 p.m.
Room No. W02 1-148

I will present several recent developments and insights into the electronic and excitonic properties of 2D van der Waals materials from our group. I will particularly focus on a novel approach to create electrically controlled quantum confinement of neutral excitons in 2D semiconductors. Achieving fully tunable quantum confinement of optically active excitons has been a long-standing goal in solid-state photonics. Most existing approaches to confine excitons rely on material modulation, which suffers from poor control over the energy and position of trapping potentials. This has severely impeded the engineering of large-scale quantum photonic systems.

I will present an approach that achieves exciton confinement by combining gate-defined in-plane electric fields to create a lateral p–i–n junction. The inherent interactions between excitons and free charges induce a local potential minimum for excitons. This scheme to create quantum confinement for excitons is enabled by several key properties of 2D van der Waals materials, such as the large exciton binding energy leading to a small exciton Bohr radius, having electrical gates in close proximity to the optically active layer, and the ability to electrostatically dope the same layer with both electrons and holes.

By choosing the appropriate layout of the gates, I will present exciton confinement to 1D and 0D, where the latter realizes an electrically defined quantum dot for bosonic excitons, with the nonlinear response arising from exciton–exciton interactions.

Host: Prof. Dr. Christian Schneider