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Spin and charge dynamics in zero-dimensional semiconductor systems

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Zero-dimensional semiconductors are promising platforms for quantum information, spin and photon-based quantum logic, and quantum light sources. However, despite the tremendous progress in the growth and manufacturing processes of such zero-dimensional systems, there are still several obstacles that limit their optimal use in quantum devices. One major obstacle is impurities in the surrounding solid-state matrix that lead to charge and spin noise. This noise is rather universal and will be discussed for two special cases in this talk.

First, we discuss the spin and hole burning dynamics of localised electrons in isotopically purified, phosphorous doped ^{28}Si. These phosphorous donors are auspicious candidates for efficient spin based quantum computing, as ^{28}Si has zero nuclear spin resulting in extremely long spin relaxation times of the donor bound electrons of up to tens of hours. What is more, the optically active phosphorous donor exciton transitions allow manipulation not only by electrical means but also optically. These transitions have a full width at half maximum of some tens of MHz and are currently the narrowest optical transitions of ensembles of bound excitons in any doped semiconductor. Even though the ^{28}Si comes from the Avogadro project, the transitions are not Fourier limited, show significant spectral shifts, and hole burning experiments yield spectral holes that are vanishing within seconds. We show that the underlying dynamics results from donor acceptor recombination, although the residual acceptor doping is extremely low.

Second, we discuss single semiconductor quantum dots which are promising candidates for single photon sources and spin-photon interfaces. However, their use is limited even in the most advanced structures by changes in the charge state of the quantum dot and its environment. We use time- resolved resonance fluorescence and spin noise spectroscopy measurements on a single charge- tunable GaAs quantum dot, shedding new light on the spectral shadows invoked by the complex impurity environment.

Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

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