Optical pumping of carrier and nuclear spins in quantum dots

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The mesoscopic spin system formed by about 10 000 nuclear spins in a semiconductor quantum dot offers a unique setting for the study of many-body spin physics in the condensed matter. The dynamics of this system and its coupling to electron spins is fundamentally different from its bulk counter-part as well as that of atoms due to increased fluctuations that result from reduced dimensions. In recent years, the interest in studying quantum dot nuclear spin systems and their coupling to confined electron spins has been fuelled by the fascinating nonlinear (quantum-) dynamics of the coupled electron-nuclear spin system and its implication for possible applications of such systems in quantum information processing.

In this talk, we review experimental work performed over the last decades in studying this mesoscopic, coupled electron-nuclear spin system and discuss how optical addressing of electron spins can be exploited to manipulate and read-out quantum dot nuclei. We conclude by speculating how this recently gained understanding of the quantum dot nuclear spin system could in the future enable experimental observation of quantum mechanical signatures or possible collective behaviour of mesoscopic nuclear spin ensembles.

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