Spin and charge noise in single quantum dots

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The sensitivity of optically detected spin noise has reached the ultimate limit of single charges and enables the measurement of spin and charge fluctuations in individual, self-organized (InGa)As quantum dots (QDs).[1,2] The fluctuations differ strongly for quasi-equilibrium and strong non-resonant conditions and thereby reveal the relevant underlying physical mechanisms of decharging and recharging of optically driven QDs. Such optically induced charging mechanisms in single semiconductor QDs are not only interesting from the fundamental point of view but also important in view of QD devices like single photon sources and solid-state spin-photon interfaces.

Up to now, spin noise spectroscopy (SNS) on single QDs has been limited to low magnetic fields and included only the Auger process as an optically induced charge transfer channel of a localized hole out of the QD. We now extend SNS on single QDs to high magnetic fields and include the photoeffect as a two-way charge transfer channel. The extension to high magnetic fields is interesting since the typical approximation of the regression analysis of separable spin and charge noise partially breaks down which has a significant influence on the evaluation of the experimental data.

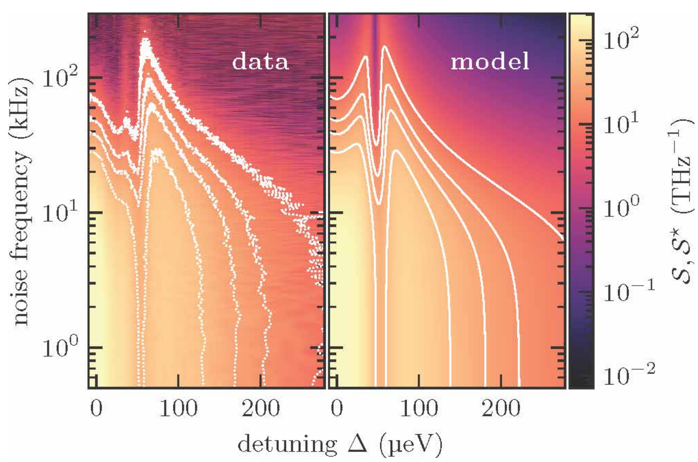

Fig. 1: *Kerr rotation noise of a single (InGa)As quantum dot reveals the dominant charge transfer mechanism between the quantum dot and its surrounding. The depicted detuning dependence of the power spectral density at a magnetic field of 750 mT proves that the photoeffect dominates over the Auger effect if the magnetic field induced Zeemann splitting is much larger than the trion linewidth.*

The comparison of experiment and theory shows that detuning dependent measurements are able to distinguish between the Auger effect and the photoeffect as charge transfer mechanisms. In fact, the Auger effect is in our QDs at high magnetic fields much less efficient than the photoeffect and thus can be neglected in good approximation.

References:

[1] R. Dahbashi, et al., *Phys. Rev. Lett.* **112**, 156601 (2014).
[2] J. Wiegand, et al., *Phys. Rev. B* **97**, 081403 (2018).