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**Spin noise spectroscopy from acoustic to GHz frequencies**

JENS HÜBNER, Institute for Solid State Physics, Leibniz University of Hannover, Appelstr. 2, 30167 Hannover, Germany

Performing perturbation free measurements on semiconductor quantum systems has long been banished to textbooks on quantum mechanics. The emergent technique of spin noise spectroscopy is challenging this restriction. Empowered only by the ever present intrinsic spin fluctuation dynamics in thermal equilibrium, spin noise spectroscopy is capable to directly deduce several physical properties of carriers spins in semiconductors from these fluctuations. Originating from spin noise measurements on alkali metal vapors in quantum optics [1] the method has become a powerful technique to unravel the intrinsic spin dynamics in semiconductors [2]. In this talk I will present the recent progress of spin noise spectroscopy and how it is used to monitor the spin dynamic in semiconductor quantum wells at thermal equilibrium and as a consequence thereof directly detect the spatial dynamics of the carriers being marked with their own spin on a microscopic scale [3]. Further I will present measurements of how the non-perturbative nature of spin noise spectroscopy gives valuable insight into the delicate dependence of the spin relaxation time of electrons on doping density and temperature in semiconductors n-doped in the vicinity of the metal-insulator transition where hyperfine and intra-band depolarization compete [4]. Also the measurement bandwidth can be extended to GHz frequencies by ultrafast optical probing [5] yielding in conjunction with depth resolved spin noise measurements insights into the origin of inhomogeneous spin dephasing effects at high magnetic fields [5]. Additionally I will present how spin noise spectroscopy can be employed to spatially depth resolve doping profiles with optical resolution [6] and give a summary on easy to implement techniques of spin noise spectroscopy at acoustic frequencies in alkali metal vapors.

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