Semiconductor spin noise spectroscopy

M. Oestreich
Institut fur Festkörperphysik, Leibniz Universität Hannover,
Appelstraße 2, D-30167 Hannover, Germany

Semiconductor spin noise spectroscopy (SNS) has emerged as a unique experimental tool that utilizes spin fluctuations to provide profound insight into undisturbed spin dynamics in doped semiconductors and semiconductor nanostructures. The technique maps ever present stochastic spin polarization of free and localized carriers at thermal equilibrium via the Faraday effect onto the light polarization of an off-resonant probe laser and was transferred from atom optics to semiconductor physics in 2005 [1]. The inimitable advantage of spin noise spectroscopy to all other probes of semiconductor spin dynamics lies in the fact that in principle no energy has to be dissipated in the sample, i.e., SNS exclusively yields the intrinsic, undisturbed spin dynamics and promises optical non-demolition spin measurements for prospective solid state based optical spin quantum information devices [2]. SNS is especially suitable for small electron ensembles as the relative noise increases with decreasing number of electrons. In this lecture, we first introduce the basic principles of SNS and the difference in spin noise of donor bound and of delocalized conduction band electrons. We continue the introduction by discussing the spectral shape of spin noise and prospects of spin noise as a quantum interface between light and matter. In the main part, we give in-

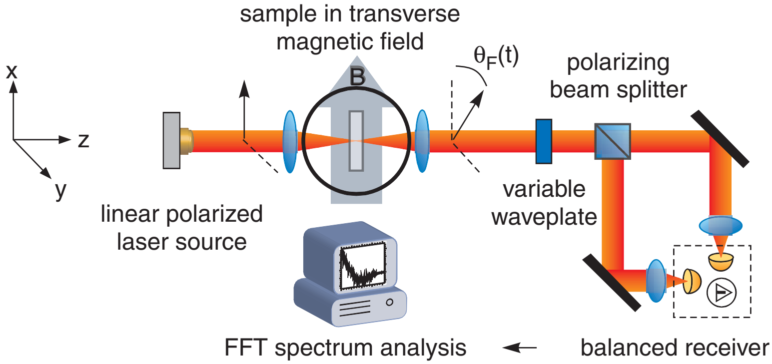

Рис. 1. Basic experimental setup for SNS. Linearly polarized light is transmitted through the sample. The Faraday rotation of the probe light induced by a stochastic spin polarization is measured via an optical polarization bridge. The signal is analyzed in the frequency domain via FFT spectrum analysis.

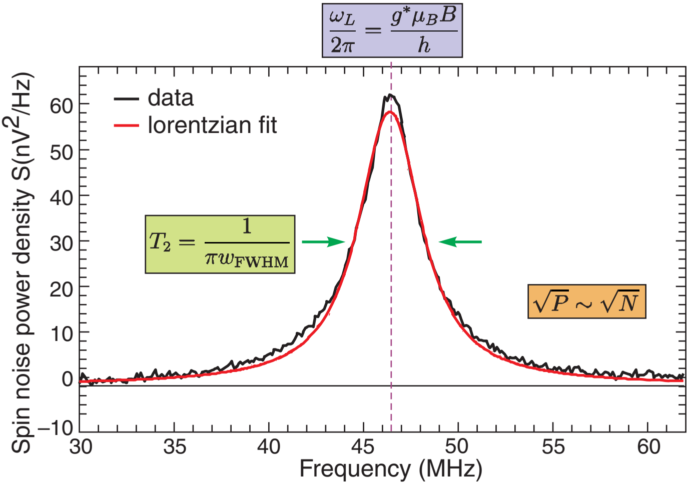

Рис. 2. Typical spin noise spectrum after subtraction of the shot noise background.

depth insight into the experimental aspects of SNS and summarize the most important previous [3–6] and current experiments employing SNS. The lecture ends by discussing possible applications of SNS.

The results presented in this lecture were obtained in collaboration with Georg Müller, Michael Römer, Fabian Berski, Hendrik Kuhn, Jan-Gerrit Lonnemann, Ramin Dahbashi and Jens Hübner.

Литература

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