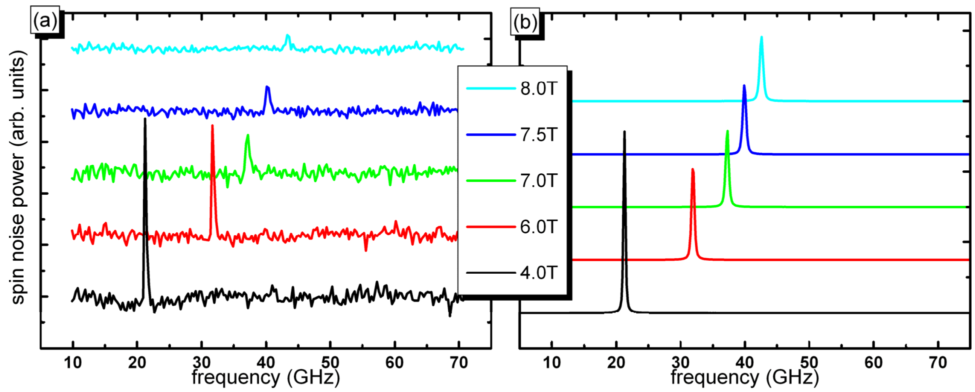

Fig. 4. (a) Experimental result of STUD-SNS. Shown is an excerpt of the measured spectral noise power density of n-doped bulk GaAs at low temperatures (4 K) for different transverse magnetic field strengths, i.e., Larmor frequencies. The difference frequency Δf is 39 kHz. The spin coherence time of $\tau_c \geq 1\,ns$ is determined by the spectral resolution of the setup and is in accordance with previously measured values of τ_c for this sample [3]. The measurement time for a single spectrum is 30 min. (b) Numerical simulations of the spin noise spectra. All spectra are vertically shifted for clarity.

4. Conclusion

We demonstrate for the first time the combination of the scanning temporal ultrafast delay technique with the quantum optical method of semiconductor spin noise spectroscopy. The effort of using two ultrafast oscillators is rewarded by an easy to implement background acquisition, yielding unambiguous signals not being affected by instabilities of the setup. As an archetypal and well understood model system we successfully applied STUD-SNS to measures the fast spin dynamics in moderately low doped GaAs. The high bandwidth of the presented STUD-SNS method is ideally suited for systems which intrinsically show a fast decay of spin coherence and are yet susceptible to optical excitation, like hole spin systems with a high degree of spin-orbit interaction [8]. An extension for measurements of extremely short spin lifetimes can be achieved by using two electronically phase-locked laser oscillators and only scanning the timespan comprising the relevant spin dynamics [17].

Acknowledgment

We acknowledge the financial support by the priority program "1285 – Semiconductor Spintronics" funded by the German Science Foundation (DFG), by the program "Quantum Repeaters on Semiconductor Basis" funded by the German Ministry of Education and Research (BMBF), the excellence cluster "QUEST" at the Leibniz University Hannover, and the school "Contacts for Nanosystems" funded by the Niedersachsen Institutes of Technology (NTH).

#182157 - $15.00 USD Received 19 Dec 2012; revised 4 Feb 2013; accepted 20 Feb 2013; published 1 Mar 2013