Universität Münster

Aktuelle Fragen der Nanophysik

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Spin straintronics driven by surface acoustic waves

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The term "straintronics" refers to a field of research in which strain-induced physical effects are used to manipulate optoelectronic properties in solids. Of particular interest for applications is the dynamic strain of surface acoustic waves (SAWs). These are elastic vibrations that propagate along the surface of a solid, with wavelengths reaching down to the submicron range. Due to their efficient piezoelectric generation and detection, and their frequencies of up to several GHz, SAWs are ideally suited for controlling a wide range of electronic excitations [1].

In this talk, I will discuss the use of SAWs for the efficient manipulation of two different types of magnetic systems. In the first case, I will report on SAW-driven transitions between the spin sublevels of silicon vacancy centers in 4H-SiC [2-4]. The dynamic strain of the SAW allows the selective excitation of microwave forbidden spin transitions even at room temperature. Moreover, the simultaneous excitation of ground and excited state spin transitions leads to novel physical phenomena such as coherent trapping of the spin polarization [3]. In the second case, I will discuss the non-reciprocal coupling of SAWs to spin waves in a hybrid structure consisting of an epitaxial ferromagnetic thin film (Fe_3Si) on a GaAs substrate, where the energy transfer from the acoustic to the magnetic system results in SAW attenuation [5]. The coupling efficiency depends on the relative chirality of the SAW and the spin wave, which is determined by the angle between the magnetization and the SAW wave vector. These two examples illustrate the great potential of SAWs for controlling magnetic states in low-dimensional systems, a property that can be used to develop new-generation devices for information, sensing and energy-saving technologies [6, 7].

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[5] A. Hernández-Mínguez *et al.*, Phys. Rev. Appl. **13**, 044018 (2020)
[6] A. A. Bukharaev *et al.*, Phys.-Usp. **61**, 1175 (2018)
[7] W.-G. Yang and H. Schmidt, Appl. Phys. Rev. **8**, 021304 (2021)