Universität Münster

Aktuelle Fragen der Nanophysik

Montag, 29.01.2024 um 15:15 Uhr
R87, Wilhelm-Klemm-Str. 10

Nonreciprocal Magneto-Acoustic Waves in Piezoelectric/Ferromagnetic Hybrids

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Surface acoustic waves (SAW) have made their way into both technology and research over the last few decades. These "nano earthquakes" are easily excited and detected on piezoelectric crystals and have many different applications, most notably for RF signal processing in telecommunications. Surface acoustic waves are in general propagating reciprocally, which means that SAW propagation does not change under inversion of the propagation direction and limits the usage of SAWs for reciprocal devices.

Resonant magnetoelastic coupling of SAWs with spin waves (SWs) is the basis for an energy-efficient approach towards SW manipulation [1]. In addition, magnetoelastic interaction affects the properties of the SAW, which in turn can be used to devise new types of microwave devices. Since SWs are known to show a pronounced nonreciprocal behavior, SAW-SW coupling is a straightforward approach to obtain nonreciprocal transmission of SAWs.

In this talk, I will give a brief introduction in the resonant coupling between SAWs and SWs which is modeled by magnetoacoustic driving fields [2]. The symmetry of the SAW-SW coupling depends crucially on the mode of the SAW [3]. Large nonreciprocal transmission of SAWs is demonstrated in magnetic systems with a nonreciprocal dispersion relation $f(+k) \neq f(-k)$, such as in ferromagnetic/heavy metal bilayers with the interfacial Dzyaloshinskii-Moriya interaction [4] and synthetic antiferromagnets composed of two ferromagnetic layers separated by a thin nonmagnetic spacer layer [5]. Because of the large tunability of the SW dispersion of synthetic antiferromagnets, the nonreciprocal transmission of the SAWs can be optimized to be very large (>100 dB) and to show a wide-band-like behavior.

References:

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