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Laser induced magnetization dynamics in antiferromagnetically coupled ferromagnetic thin films

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Combining magnetic thin films such that two ferromagnetic layers couple antiferromagnetically via a non-magnetic spacer layer lead to the discovery of new physical properties, such as the giant magnetoresistance effect [1], that are not present in bulk materials. In addition, the magnetization dynamics in these multilayer films are modified by the interlayer coupling [2]. Such systems are proposed to support a nonreciprocal spin-wave dispersion and achieve the unidirectional propagation of spin waves [3]. As a first step to ascertain the spin-wave nonreciprocity in such systems, we have measured the uniform precessional dynamics in a series of antiferromagnetically coupled CoFeB/Ru/CoFeB trilayer films using time-resolved magneto-optical Kerr effect (TRMOKE). We have observed both the acoustic and optical modes, together with a transient mode that is caused by laser induced decoupling between the two ferromagnetic layers. In order to quantitatively explain our observation, we calculated the precessional dynamics expected in our trilayer films based on the Landau-Lifshitz equation. We found, in agreement with the experimental observation, three different field regions where the frequency relation between the three modes are qualitatively different. Such distinct responses are the results of the competition between the interlayer coupling and Zeeman energy.

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[1] G Binasch, P Grünberg, et al. Phys. Rev. B 39.7 4828 (1989)
[2] Z Zhang, et al. Phys. Rev. B 50,6094 (1994)
[3] K Di, et al. Sci. Rep. 5 10153 (2015)

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