Simulated time-resolved response of parametric spin wave excitations in YIG disks

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Parametric excitation using RF fields allows populating individual spin wave modes in magnetic microstructures. In the context of unconventional computing, it is important to understand how an excited mode can influence the generation of another and whether transients and history play an important role. We examined this question in simulation for 1-μm diameter YIG disks [Fig. 1.a)] at 300 K, whereby we investigated the transient mode population dynamics computed with the MuMax3 [1] by projecting the magnetization dynamics onto eigenmode profiles computed by numerical computations of magnetization modes [2] [Fig. 1.b)]. The figure shows the main features for modes, $k = 8, 13$, with frequencies of $f_8 = 2.813$ GHz and $f_{13} = 2.980$ GHz, respectively. Fig. 1.c) shows the evolution of the mode populations when the system is driven at $f_A = 2f_8$ and $f_B = 2f_{13}$ separately, where for the former $k = 8$ dominates while for the latter $k = 13, 14$ are excited equally. When these driving frequencies are combined using the toggle sequence in Fig. 1.d), we see from the mode spectrogram that the order of the frequency toggle has a strong bearing on the overall dynamics. We observe mode inhibition, suppression and transitions as the sequence evolves depending on the frequency at play, which differs markedly from the case of single frequency excitation. Such noncommutativity could be promising for information processing. This work is supported by the EU Horizon2020 Framework Programme under contract no. 899646 (k-Net).

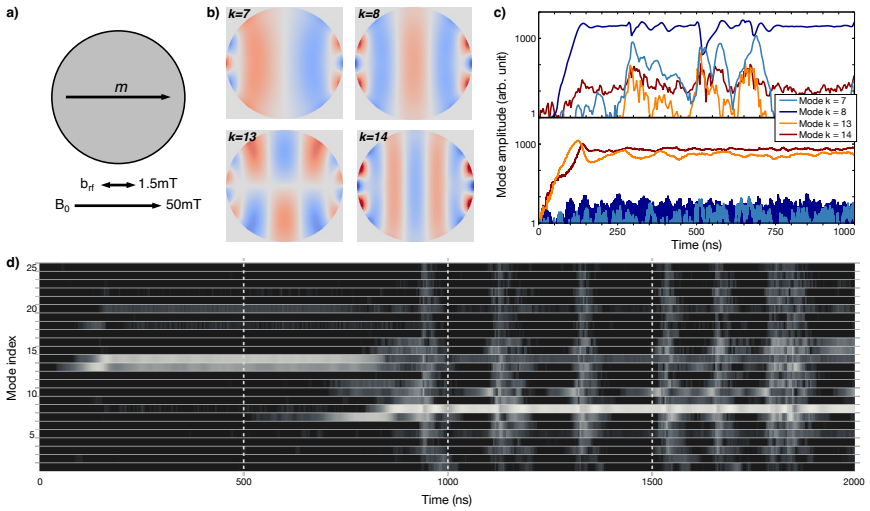

Figure 1: a) Geometry. b) Eigenmode profiles. c) Mode population versus time under a driving frequency of $f_A = 2 \times 2.813$ GHz (top) and $f_B = 2 \times 2.980$ GHz (bottom). d) Populations of the first 25 modes under the pulse sequence f_A, $f_A + f_B$, f_B, $f_B + f_A$, where the duration of each pulse is 500 ns.

References

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