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Comment on "Mapping of localized spin-wave excitations by near-field Brillouin light scattering" [Appl. Phys. Lett. 97, 152502 (2010)]

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The authors reported in their letter[1] some outstanding experimental results of spin excitations in nano-particles investigated by near-field Brillouin scattering. They conclude from their observations that existing theories—in particular micromagnetic simulations—do not correctly describe the behavior of the spin modes. Since excellent agreement has been reported between spin-wave mode frequencies obtained from Brillouin scattering experiments and those obtained from micromagnetic-based simulations,[2–4] it is somewhat surprising that the simulations should fail for the particles investigated in Ref. 1. In the literature, there is also evidence of various kinds and degrees of mode localization when exchange competes with dipolar interactions.[5,6] When dipolar long-range interactions are taken into account, the eigenmodes can be seen as the superposition of plane waves, leading to different localizations and in particular to the appearence of bulk-dead modes.

We have simulated the normal modes of the particles used in Ref. 1, with the dynamical matrix method;[7] the results are shown in Fig. 1 for different values of the applied field. In addition to the lowest frequency non-localized mode (1-BA),[3] several localized modes are present. Large particles exhibit modes with oscillations along the field direction;[8] for such modes, we use the label n-BA-loc, with n the number of nodes. While the profile of the pure end-mode, i.e., 0-BA-loc, has its maximum at the edge with the amplitude monotonously decreasing toward the interior of the ellipse, as correctly described by the authors, the localized modes with $n > 0$, not considered by them, do not have this characteristic: see inset of Fig. 1.

Based on Fig. 1, we believe that the assumption that the mode they observe is "the" localized spin mode is not correct. Instead, we believe that the mode detected in the experiment at $H > 700$ Oe is a combinations (due to non-linear excitation conditions of the experiment) of several n-BA-loc modes, with $n > 0$. In this picture, the sharp peaks of the n-BA-loc modes are smoothed in the experimental measurements, thanks to the superposition of modes with different nodal lines. Finally, at 350 Oe, the measured profile and frequency suggest that the mode seen in the experiment may be well due to the 1-BA mode. The observed change in mode profile at 350 Oe is substantiated by the frequency behavior shown in

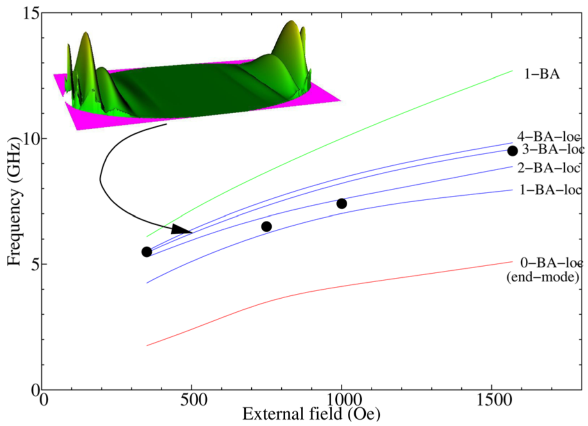

FIG. 1. (Color online) Frequencies of selected spin modes calculated as a function of the applied field with a cell size 10 nm (lines), plotted together with the experimental points of the commented letter (dots). The inset shows the magnetization profile ($|m_z|$) of the 3-BA-loc mode at 500 Oe.

Fig. 3(b) of Ref. 1, where it can be observed that the frequency of the low-field point does not lie on the same curve as the high-field points.

In summary, before concluding that micromagnetic-based simulations of spin wave modes in nano-particles are unreliable, we believe that it is necessary to await either the simulation of large particles using small cell sizes or for more exhaustive experiments reaching lower frequencies on particles of varying size. The comparison of calculations with experiment would greatly benefit if the authors were to provide the field dependence of all the modes detected in their experiment (in order to achieve a proper assignment).

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