Droplet solitons in magnetic nanowires.

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The magnetic droplet is a localized excitation found in uniaxial ferromagnets where a polarized current provides sufficient spin transfer torque to counteract the inherent damping. This dissipative soliton was first predicted in 2010 [1] and experimentally verified a couple of years later using nanocontact spin torque oscillators (NC-STO) [2]. The droplet is created underneath the contact and consists of a reversed core where the spins precess at angles almost antiparallel to the initial state. Once formed, it can propagate away from the NC. It has been shown that this soliton is a necessary precursor to skyrmion injection in race track memories [3], but also that the boundaries of a confined geometry can attract a droplet and transform it to an edge mode or a quasi-1D droplet, depending on the distance from the NC to the edge [4]. The transport of droplets through a nanowire (NW) will thus be influenced by its width.

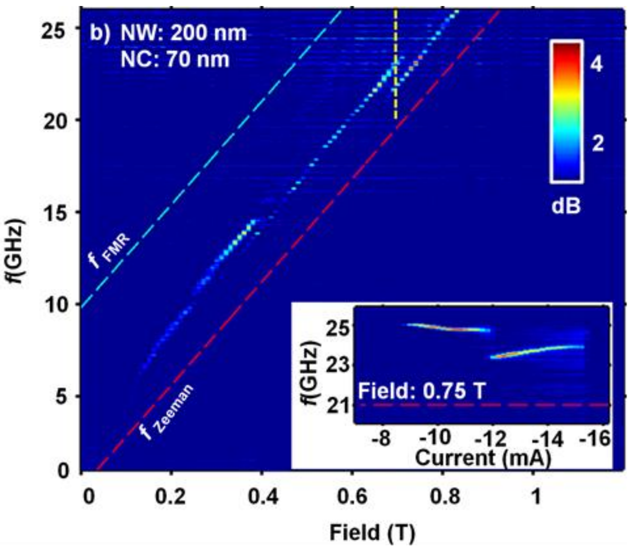

Figure 1. Power spectral density as a function of perpendicular field, at a constant current of -12 mA, for a 200 nm wide nanowire with a 70 nm NC. The inset shows the frequency versus current in a field of 0.75 T.

We have fabricated STO:s with nanocontacts placed on top of nanowires made of orthogonal spin valves. The magnetodynamics of a 200 nm wide nanowire is presented in Fig. 1. It reveals two distinct drops in the frequency - one at a field of about 0.4 T and a second at 0.75 T. The second reduction is highlighted in the inset of Fig. 1, which displays the current dependence at a constant field. A shift to a lower frequency is consistent with a larger footprint of the droplet and we identify the first enlargement as a conversion to an edge mode, while the second transition is attributed to the formation of a quasi-1D droplet. This conclusion is corroborated by micromagnetic simulations. Our results not only serve as an experimental verification of the theoretically predicted modes, but also open up a route for studies of droplets in nanostructures.

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