Nanocomposites and nanomaterials

The dynamics of a strongly bound magnetic vortex pair in an alternating magnetic field

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Individual magnetic vortexes and their corresponding pairs are of a great practical significance because they are candidates for use in future memory devices due to their size, speed and reliability. A single vortex can be present in one of four states depending on its chirality and vortex core polarity. Switching between states of the single vortex and the registration of them is well studied and there is a good understanding of the underlying mechanics.

Research of magnetic vortex pairs [1] has shown the possibility of registering the state of vortexes in a stack by measuring the magnetic tunnel junction current in an external alternating magnetic field. The resulting frequency responses show resonances corresponding to the modes present in the system of bound vortexes. However some of these cannot be explained since they are not excited by an external field, even though they have bigger responses when the excitation field is large.

In our study we have explored the dynamics of vortex pairs in states which display unexpected excitations. The research has shown that there is a parametric excitation of the non-excitable mode through the weak nonlinearity in individual demagnetisation potentials. We have shown that parametric excitation is only possible when the non-excitable mode is larger than some critical amplitude, which together with the results of better controlled experiments hints at particles in the stack having different parameters. We analytically demonstrated that the system has a set of very unusual frequency responses, where some frequencies have as many as five different solutions. The frequency responses can be explained by the interplay between the strong localised nonlinearity in the cores' interaction potential and the weakly nonlinear demagnetising potential.

1. *Cherepov S.S., Koop B.C., Galkin A. Yu., Khymyn R.S., Ivanov B.A., Worledge D.C., Korenivski V.* Core-Core Dynamics in Spin Vortex Pairs // Phys. Rev. Let.-2012.-**109.-**097204