Moving Abrikosov vortex lattices generate sub-40 nm magnons

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Coherent spin waves are promising information carriers in magnonic devices for wave-based computing and quantum information technology [1]. Short-wavelength magnons are indispensable building blocks for magnonic nanodevices but are highly challenging to excite coherently. Previous efforts have combined magnetic nanogratings [2] or spin textures [3] with microwave induction to push the limit of the shortest wavelength down to about 50 nm. But it was not possible to go beyond this value in the past several years.

In the recent work [4], coherent excitation of exchange magnons has been demonstrated experimentally, with a wavelength down to 36 nm by driving fast-moving fluxons in a superconductor The successful generation of monochromatic magnons at a record short wavelength of 36 nm represents a milestone in coherent magnonics [5]. It provides an alternative means for coherent magnon excitation beyond conventional inductive microwave methods by leveraging magnetic flux quanta moving at a speed beyond 1 km/s.

[1] P. Pirro et al. Nat. Rev. Mater. 6, 1114 (2021).

[2] C. Liu et al. Nat. Commun. 9, 738 (2018).

[3] V. Sluka et al. Nat. Nanotechnol. 14, 328 (2019).

[4] O. Dobrovolskiy et al. Nat. Nanotechnol. https://doi.org/10.1038/s41565-025-02024-w, (2025).

[5] H. Yu, Nat. Nanotechnol. https://doi.org/10.1038/s41565-025-02023-x, (2025).

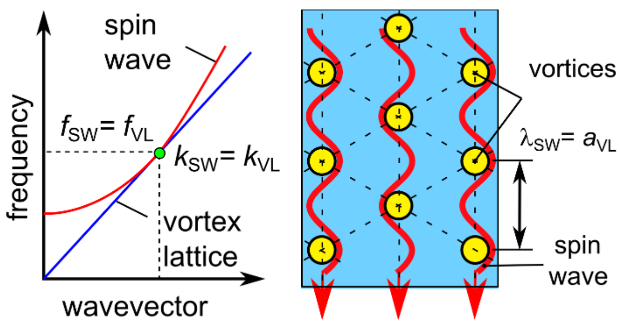

Fig. 1. The left panel shows the schematic dispersion relations of magnons (red parabola) and fluxons (blue straigh line). The magnons are excited by fast-moving fluxons when their frequency (energy) and wavevector (momentum) match. The right panel shows a schematic of the correspondence of the wavelength of the excited spin wave with the parameter of the vortex lattice. Experimentally, this regime is realized in [4] for vortices moving in a NbC superconductor film and magnons propagating in an adjacent CoFe magnonic conduit.