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SUPPLEMENTARY INFORMATION

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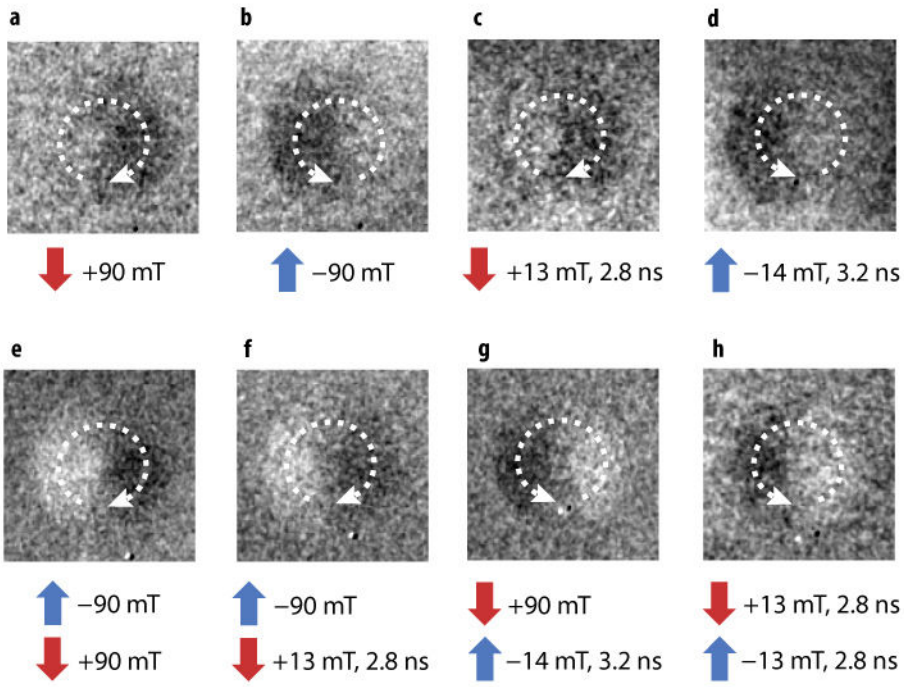
Dynamic switching of the spin circulation in tapered magnetic nanodisks



Supplementary Figure 1 – Reproducible switching of the spin circulation.
a-d, MTXM images of a magnetic vortex in a 960/20 disk in remanence after applying the indicated static magnetic field or a field pulse. The images are divided by a reference image taken at saturation. **e-h**, Resulting circulations after applying different combinations of static fields and field pulses (the stimulus indicated at the top first, the bottom one second) which yield the same final state. The images of the final state are divided by a reference image containing the opposite spin circulation of the preceding state.

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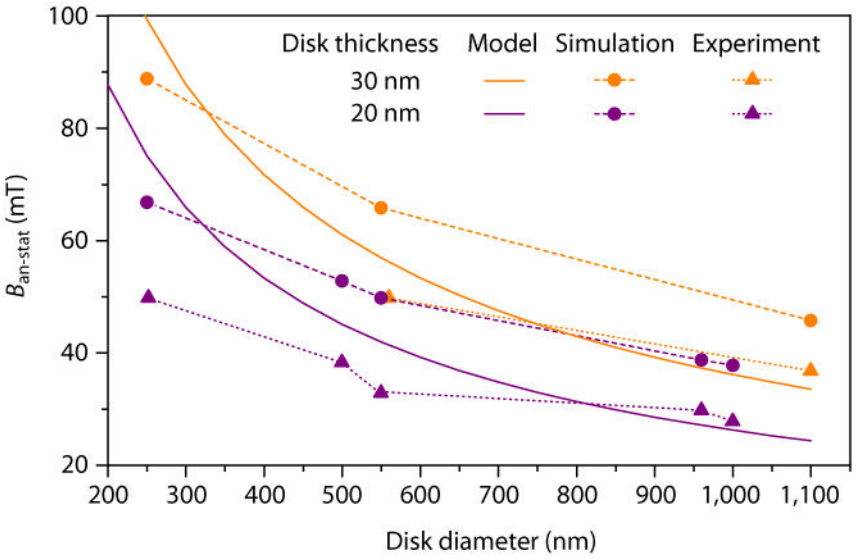
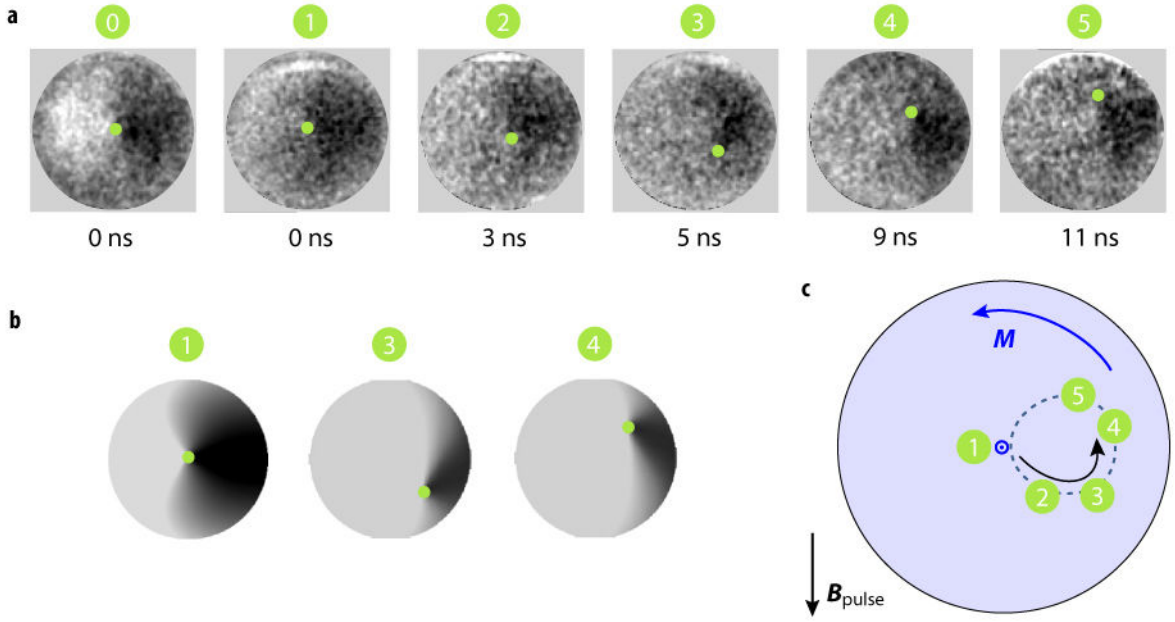


Supplementary Figure 2 – Static annihilation fields of vortices in nanodisks with different geometry.
Static vortex annihilation fields observed experimentally compared to the values predicted by the rigid-core model and micromagnetic simulations. The experimental values are lower than the simulated ones due to the sample imperfections, which decrease the effective dipolar interaction and consequently the vortex annihilation field.



Supplementary Figure 3 – Single-polarity vortex core dynamics.
a, Stroboscopic MTXM images of vortex core oscillations in a 1100/30 nanodisk during a Gaussian-like pulse with a duration of 5.7 ns (full width at half maximum) and an amplitude of 16.5 mT. Image 0, taken before the onset of the pulse, was divided by a reference containing a vortex with the opposite spin circulation, images 1-5 by a reference in the saturated state. Green dots mark the approximate position of the vortex core. **b,** Images obtained by a micromagnetic simulation, divided by a reference in the saturated state. Comparison of these images to those in **a** helps to interpret the observed magnetic contrast. **c,** Schematic of the vortex core trajectory.

Supplementary Movie 1 – Dynamic spin circulation switching in a 100-nm-wide and 20-nm-thick nanodisk containing a magnetic vortex.
The final circulation is controlled by the orientation of the magnetic field pulse with respect to the wedge-like asymmetry located in the bottom half of the disk. The pulse parameters are the following: amplitude 42 mT, pulse duration 0.45 ns, rise time 0.001 ns, and fall time 0.15 ns.