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Spin Momentum Transfer and Oersted Field Induce a Vortex Nano-Oscillator in Thin Ferromagnetic Film Devices

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A nonlinear model of spin-wave excitation involving a point contact in a thin ferromagnetic film that includes the Oersted magnetic field contribution is presented. We consider the case of an external dc field applied perpendicular to the film plane. The two-dimensional vectorial model reduces to an exact one-dimensional equation of motion. Large-amplitude vortex modes are computed, which represent a fundamental shift in the geometrical understanding of spin transfer nano-oscillators. Odd symmetry forces the magnetization to be pinned in the center of the point contact. Using the spin transfer efficiency as a single fitting parameter, the calculated dependence of frequency on current and contact size is in good agreement with recent experimental data. These vortex states are geometrically very different from previously computed cylindrical modes that exhibit even symmetry when the Oersted field is ignored.