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"Devil's staircase" in nanomagnetism: fractional synchronization of a nonlinear spin-torque nano-oscillator SERGEI URAZHDIN, PHILLIP TABOR, Department of Physics, West Virginia University, ANDREI SLAVIN, VASYL TYBERKEVYCH, Department of Physics, Oakland University — When an oscillator is driven by a periodic external force, the oscillation can become synchronized in a certain phase and frequency relationship with that force. At the main resonance, the frequency f of the oscillation becomes equal to the frequency f_e of the driving signal. An infinite number of synchronization regimes with rational values of $r = f_e/f$ ("Devil's staircase") develop at large driving amplitudes. For magnetic nano-oscillators driven by spin transfer effect synchronization has been demonstrated only at the main resonance, when f_e is close to the auto-oscillation frequency f_0. By using a new device geometry utilizing a microwave field as the driving force, we demonstrate the "Devil's staircase" in magnetic nano-oscillators. Analysis shows that fractional synchronization becomes possible only due to the simultaneous action of both the microwave magnetic field and the microwave current, and is characteristic of the complex nonlinear nature of the magnetic precession.

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