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Noise in Spin Torque Oscillators

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In a spin torque oscillator _(STO)_, a direct current passing through a reference magnetic layer becomes spin polarized and transfers angular momentum to a second magnetic layer that is excited into steady-state oscillation. The oscillating magnetization causes an oscillating device resistance, through either the giant magnetoresistance effect or the tunneling magnetoresistance effect, which in combination with the bias current generates an oscillating voltage as the output signal. Interest in potential applications of STOs in integrated microwave circuits is driven by their rapid frequency tunability, small size __(<100 nm)_, and compatibility with standard semiconductor processing techniques. For any oscillator, noise is both an important figure of merit for applications and a useful probe of internal physical processes. I will summarize the theoretical and experimental state of our understanding of frequency and phase noise in a variety of oscillators, considering both time domain and frequency domain measurements. Some aspects can be explained by the effects of thermal fluctuations. Others, such as frequency noise that varies as 1/f at low frequencies, are not yet understood.