Spin Torque Oscillators as Broadband Modulated THz Sources

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Interest in Spin Torque Oscillators (STOs) is rapidly increasing due to their potential use for microwave generation over large frequency ranges. While many recent studies now focus on vortex-based STOs with typical frequencies below 1 GHz, I will here address the opposite side of the frequency spectrum and explore the STO's potential for ultra-compact, ultra-broadband rapidly modulated THz sources. While hitherto essentially unexplored territory for STOs, this might very well be the frequency range where their intrinsic properties will outperform present signal generation technology, which is currently plagued by the so-called THz gap.

I will first describe the effect of a modulating radio-frequency current on an individual nano-contact STO and how it can be very well modeled, and also predicted from free-running parameters, using Non-Linear Frequency and Amplitude Modulation (NFAM) theory. In addition, I will also show data on current modulated STO *pairs*, both in their un-locked and phase-locked states. In the un-locked state the two STOs are modulated individually and non-interacting sidebands appear in the combined output signal spectrum. In the phase-locked state on the other hand, the two STOs behave as a single oscillator, and continue to do so even under relatively strong and rapid current modulation. The phase-locked state is hence readily modulated and exhibits a sufficient stability for applications. This demonstration is an important prerequisite for applications based on coherent STO arrays.

I will show how modulation is well behaved up to modulation frequencies as high as 3.2 GHz and operating frequencies as high as 40 GHz. I will show how we have pushed the operating frequency up to 65 GHz and what future steps that can be taken to push the operating frequency well above 100 GHz, possibly approaching 1 THz.