Enhancement of photoinduced sub-THz spin precession via the spin-plasmon coupling

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Ultrafast all-optical control of spins with femtosecond laser pulses is a trending topic at the crossroads of photonics and magnetism with a direct impact on future magnetic recording. Unveiling light-assisted recording mechanisms for increasing the bit density beyond the diffraction limit without excessively heating the recording medium is an open challenge. The development of the next generation magnetic memory devices will be driven by the demand for fast magnetization switching, low energy consumption, and high-density recording. It is now widely accepted that the future of high-density all-optical magnetic recording depends on the achievements of sub-diffractional nanophotonics featuring light localization on the nanoscale by surface plasmon resonances. As such, the fundamental understanding of the interactions of high-frequency coherent spin dynamics with plasmonic excitations on both nanometer and subpicosecond scales in opto-magnonic media is highly desirable.

Here, we show that surface plasmon-polaritons (SPPs) in hybrid metal-dielectric structures (Fig. 1) can provide spatial confinement of the inverse Faraday effect [1], mediating the excitation of localized coherent spin precession with 0.41-THz frequency [2]. We demonstrate two orders of magnitude enhancement of the excitation efficiency at the surface plasmon resonance within a 100-nm layer of a dielectric garnet. Our findings broaden the horizons of ultrafast spin-plasmonics and open pathways toward nonthermal opto-magnonic recording on the nanoscale [3].

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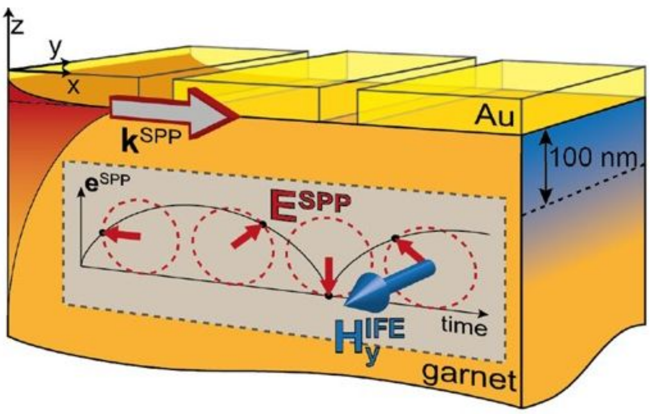

Fig. 1: Effective static magnetic field induced by a propagating SPP at the Au/magnetic garnet interface.