

Terahertz Magnon-Polariton Control Using a Tunable Liquid Crystal Cavity

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In the strong light–matter coupling regime, polariton modes emerge as hybrid excitations combining electromagnetic cavity modes and material resonances. While magnon–polaritons in ferromagnets have been extensively explored at microwave frequencies, antiferromagnetic systems enable access to the terahertz (THz) range, where strong coupling can be achieved using Fabry–Perot cavities. However, antiferromagnetic magnons are typically tunable only via temperature or high magnetic fields, which limits dynamic control of magnon–polariton states. Here we demonstrate remote electrical control of antiferromagnetic magnon–polaritons by combining an antiferromagnetic crystal with an electrically tunable photonic environment. The system consists of a nickel oxide (NiO) slab, chosen for its low spin damping and temperature-dependent resonance frequency near 1.0 THz above room temperature, placed adjacent to a nematic liquid-crystal cell and separated by a controlled gap of approximately 2.5 mm. The magnon frequency is tuned via the NiO temperature, while an applied electric field reorients the liquid crystal, modifying the cavity-mode frequencies and spatial field distributions. Using terahertz time-domain spectroscopy, we measure reflection spectra as functions of temperature and applied voltage and observe voltage-controlled avoided crossings between cavity modes and magnons, as well as changes in the magnon–photon coupling strength. These results demonstrate remote electrical control of antiferromagnetic magnon–polariton states at room temperature without direct physical contact between the magnetic material and the electrically active element.

References:

[1] D. Yavorskiy et al, ACS Photonics 12, 5c01879 (2025)

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