

# Hybridization of terahertz phonons and magnons in disparate and spatially-separated material specimens

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In the strong light–matter coupling regime, hybrid polariton modes emerge that combine cavity photons with material excitations. Antiferromagnets enable access to this regime in the terahertz (THz) frequency range, where magnons coexist with other low-energy excitations such as phonons. Here we report cavity-mediated coupling between magnons in nickel oxide (NiO) and phonons in CuB<sub>2</sub>O<sub>4</sub> at THz frequencies. A tunable Fabry–Perot-type cavity is formed by parallel slabs of the two materials separated by a well-controlled gap, allowing the cavity-mode frequencies to be adjusted independently of the material excitations. Using THz time-domain spectroscopy, we observe distinct avoided crossings between cavity modes and the NiO magnon near 1.0 THz, as well as broader avoided crossings with the CuB<sub>2</sub>O<sub>4</sub> phonon at 0.92 THz. At approximately 360 K, where the magnon and phonon frequencies become comparable, we observe hybrid polariton modes simultaneously coupled to both excitations. These tripartite phonon–magnon–polariton modes exhibit enhanced mode splitting and narrower linewidths compared to pure phonon–polaritons and are realized without direct contact between the two materials over distances of several millimeters. The results presented here are presented in detail in Ref. [1].

## References:

[1] M. Białek et al, *Advanced Functional Materials* 35, 2416037 (2025)

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