Multiple Wave Mixing in a Room Temperature Altermagnet

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Crystalline symmetries determine the linear and nonlinear response of materials to external stimuli such as mechanical pressure and electromagnetic fields, governing phenomena such as piezoelectricity, optical activity, and multiple wave mixing with wide ranging technological applications. Altermagnets present a new class of materials with magnetic crystal order that manifests in a non-relativistic spin-splitting of the electronic band structure. Hence, the electric material properties of altermagnets should uniquely mirror these underlying symmetries, potentially giving rise to novel phenomena in response to external driving fields. Here, we report the discovery of a broadband third-order nonlinear anomalous Hall effect in altermagnetic CrSb at room temperature that exhibits a distinct spatial anisotropy [1]. The comparison of our experimental observations with symmetry analyses and model calculations shows that this nonlinear Hall response is induced by the nonlinear electric susceptibility of a Berry curvature quadrupole. This quadrupole is embedded in the spin-split electronic band structure of CrSb, and its properties precisely reflect the magnetic and crystalline symmetries encoded in the altermagnetic g-wave order parameter. We then utilize this third-order nonlinear electric susceptibility of CrSb to realize a multiple wave mixing device with pronounced four wave mixing output, which could, in principle, be extended to THz frequencies. Hence, the results of our study provide a generalized understanding of the impact of magnetic crystal order on the electric material properties of altermagnets beyond the linear response regime. Moreover, our work significantly expands the technological scope of altermagnets beyond previously discussed spintronics applications and explicitly demonstrates their potential for high-frequency electronics, THz generation, communication networks, and energy harvesting.

[1] S. Sankar, B. Jäck, et al., *under review* (2026), arXiv:2511.10471 **[cond-mat.mes-hall]**