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PPD Seminar

Laser harmonic generation in chiral media: a beat-wave approach

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In recent years, we have developed a beat-wave approach to laser harmonic generation in nonlinear media. In this approach, all Fourier spectra take the form of regular grids [1]. This enables many extensions, such as the easy identification of harmonic frequency combs [2] and a natural connection with the symmetry theory of crystallography [3]. In this work, we extend our model to the nonlinear optical response of isotropic chiral media (molecules with left- and right-handed forms) driven by locally chiral light [4], in which the tip of the electric-field vector draws a chiral Lissajous figure in time. As in our earlier work on laser-solid interactions [1], the medium is represented by a zero-frequency (DC) driving mode. We show how a chiral DC mode (sensitive to the "handedness" of the medium) can be derived from the interaction of synthetic chiral light with a chiral medium. The beating between this DC mode and the EM fields then leads to a regular harmonic spectrum with alternating chiral and achiral modes. We will derive the criteria for these modes to overlap in Fourier space, so they can combine to yield enantio-sensitive interference patterns or line intensities. Finally, we will apply our framework to a variety of existing results [5-8] to validate its predictions.
[1] Trines et al., Nature Comms. 15, 6878 (2024). [2] Trines et al., Phys. Rev. Res. 8, 013241 (2026). [3] Trines et al., arXiv:2507.08635 (2025). [4] Trines et al., arXiv:2604.08354 (2026). [5] Ayuso et al., Nature Phot. 13, 866 (2019). [6] Ayuso et al., Nature Comms. 12, 3951 (2021). [7] Mayer et al., Nature Phot. 18, 1155 (2024). [8] Vogwell et al., Science Adv. 9, eadj1429 (2023).

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