

Poster-1-21

Light Matters: HHG Spectroscopy of SolidsUtso Bhattacharya^{1,2}¹ *Institute for Theoretical Physics, ETH Zurich, 8093 Zurich, Switzerland*² *ICFO - Institut de Ciències Fotoniques, The Barcelona Institute of Science and Technology, Avenida Carl Friedrich Gauss 3, E-08860 Castelldefels (Barcelona), Spain*

Intense laser pulses, with energies comparable to electron binding in solids, unlock a new regime: extreme nonlinear optics. This phenomenon produces high-order harmonic light from within the material, a breakthrough that birthed the field of attosecond science. It offers access to previously unseen spectral ranges, enabling attosecond-scale exploration and novel spectroscopy techniques. These techniques allow detailed probing of a material's electronic structure. This section focuses on our research utilizing high harmonic spectroscopy to investigate various solid-state systems. We explore properties like topology, superconductivity, disorder, and strong correlations in condensed matter. By correlating different optical excitations with high harmonic generation, we reveal the ultrafast dynamics of both single-particle and collective electronic excitations in these materials. We show how HHG spectroscopy can probe exotic Majorana fermions [1], reveal various strongly correlated phases in a cuprate superconductor [2], probe multifractality of wavefunctions in quasiperiodic materials [3], and track phase transitions from the Mott to a charge density wave phase in strongly correlated systems [4]. Our research emphasizes the significant potential of extreme nonlinear optics in understanding various solid state quantum phenomena.

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[2] High harmonic spectroscopy of quantum phase transitions in a high-Tc superconductor, Jordi Alcalà, Utso Bhattacharya, Jens Biegert, Marcelo Ciappina, Ugaitz Elu, Tobias Graß, Piotr T. Grochowski, Maciej Lewenstein, Anna Palau, Themistoklis P. H. Sidiropoulos, Tobias Steinle, Igor Tyulnev, PNAS 119 (40) e2207766119 [2022].

[3] Unraveling Multifractality and Mobility Edges in Quasiperiodic Aubry-André-Harper Chains through High-Harmonic Generation, Marlena Dziurawiec, Jessica O. de Almeida, Mohit Lal Bera, Marcin Płodzień, Maciej M. Maśka, Maciej Lewenstein, Tobias Grass, Utso Bhattacharya, arXiv:2310.02757 [2023].

[4] High Harmonic Tracking of Ultrafast Electron Dynamics across the Mott to Charge Density Wave Phase Transition, Marlena Dziurawiec, Jessica O. de Almeida, Mohit Lal Bera, Marcin Płodzień, Maciej Lewenstein, Tobias Grass, Ravindra W. Chhajlany, Maciej M. Maśka, Utso Bhattacharya (to appear in arxiv) [2024].