Higgs time crystal in a high-T_c superconductor

Guido Homann,[1] Jayson G. Cosme,[1,2,3] and Ludwig Mathey[1,2]

[1] *Zentrum für Optische Quantentechnologien and Institut für Laserphysik, Universität Hamburg, 22761 Hamburg, Germany*
[2] *The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany*
[3] *National Institute of Physics, University of the Philippines, Diliman, Quezon City 1101, Philippines*

We propose to induce a time crystalline state in a high-T_c superconductor, by optically driving a sum resonance of the Higgs mode and a Josephson plasma mode [1]. The generic cubic process that couples these fundamental excitations converts driving of the sum resonance into simultaneous resonant driving of both modes, resulting in an incommensurate subharmonic motion. To test the rigidity of this effect, we implement a semiclassical driven-dissipative lattice gauge theory on a three-dimensional layered lattice, which models the geometry of cuprate superconductors. We find that the subharmonic motion is robust against perturbations of the drive as well as thermal fluctuations. We demonstrate this light-induced time crystalline state for mono- and bilayer systems and show that it can be detected in pulsed operation.

[1] G. Homann, J. G. Cosme, and L. Mathey, *Phys. Rev. Res.* **2**, 043214 (2020).