

# Superconductivity-enhanced phonon angular momentum in fullerides

Natsuki Okada<sup>1</sup>, Philipp Werner<sup>2</sup>, and Shintaro Hoshino<sup>1</sup>

<sup>1</sup>*Department of Physics, Chiba University, Chiba 263-8522, Japan*

<sup>2</sup>*Department of Physics, University of Fribourg, 1700 Fribourg, Switzerland*

Phonon angular momentum (PAM), a novel degree of freedom of lattice vibrations, has attracted considerable attention. Its generation by optical excitation, heat currents, and other external drives has been widely studied [1,2]. However, how superconductivity modifies PAM remains poorly understood. Since superconductivity modifies low-energy electronic states through gap formation, nontrivial changes in PAM may occur across the superconducting transition.

We address this issue for alkali-doped fulleride superconductors, where intramolecular Jahn-Teller phonons play a central role in Cooper pairing [3]. The fivefold-degenerate  $H_g$  phonon mode carries an angular-momentum  $L = 2$  structure, making fullerides a natural platform for studying the interplay between superconductivity and PAM in a correlated electron-phonon system. We apply an orbital Zeeman field to the electronic system, which induces PAM through the electron-phonon coupling. We solve the Eliashberg equations for a Jahn-Teller-Hubbard model and analyze the temperature evolution of the phonon angular-momentum response across the superconducting transition.

We find that the PAM is strongly enhanced in the superconducting phase and changes sign below the transition temperature [4]. To clarify the origin of this behavior, we construct a low-energy effective theory for the superconducting state. The enhancement is traced to a change in the relevant energy scale: the normal-state response is controlled by the electronic bandwidth  $D$ , whereas the superconducting response is governed by the Jahn-Teller phonon energy  $\omega$ , leading to an enhancement of order  $D/\omega$ . The sign reversal follows from the competition between Fermi-surface and Fermi-volume contributions, which enter with opposite signs. In this presentation, we report these numerical results and the low-energy effective-theory analysis.

[1] L. Zhang and Q. Niu, Phys. Rev. Lett. 112, 085503 (2014).

[2] D. M. Juraschek et al., Nat. Phys. 21, 1532 (2025).

[3] Y. Nomura et al., J. Phys.: Condens. Matter 28, 153001 (2016).

[4] N. Okada *et al.*, arXiv:2605.26794 (2026).