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Unraveling Intertwined Orders in the Strongly Correlated Kagome Metal CsCr3Sb5

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While correlated phenomena of flat bands have been extensively studied in twisted systems, the ordered states that emerge from interactions in the intrinsic flat bands of kagome lattice materials remain largely unexplored. The newly discovered kagome metal CsCr3Sb5 offers a unique and rich platform for this research, as its multi-orbital flat bands at the Fermi surface result in a complex interplay of pressurized superconductivity, antiferromagnetism, a structural phase transition, and density wave orders. Here, using ultrafast optical techniques, we provide strong spectroscopic evidence for a charge density wave transition in CsCr3Sb5, resolving previous ambiguities. Crucially, we identify rotational symmetry breaking that manifests as a three-state Potts-type nematicity. Our elastoresistance measurements directly demonstrate the electronic origin of this order, as the rotational-symmetry-breaking E2g component of the elastoresistance shows a divergent behaviour around the transition temperature. This exotic nematicity results from the lifting of degeneracy of the multi-orbital flat bands, akin to phenomena seen in certain iron-based superconductors. Our study pioneers the investigation of ultrafast dynamics in flat-band systems at the Fermi surface, offering new insights into the interactions between multiple elementary excitations in strongly correlated systems.

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