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Pressure- and strain-enhanced superconducting and normal-state electronic response of kagome LaRu_3Si_2

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The interplay between superconductivity and charge or spin order is a key focus in condensed matter physics, with kagome lattice systems providing unique insights. We discovered that the kagome superconductor LaRu_3Si_2 ($T_c = 6.5$ K) exhibits a characteristic kagome band structure and a hierarchy of charge-order transitions at 400 K and 80 K, as well as an additional electronic and magnetic transition at 35 K [1,2]. Furthermore, using magnetotransport and X-ray diffraction under pressures up to 40 GPa, we find T_c peaks at 9 K (2 GPa), remains stable up to 12 GPa, and decreases to 2 K at 40 GPa, forming a dome-shaped phase diagram [3]. Similarly, the resistivity anomaly at 35 K and magnetoresistance exhibit dome-like pressure dependence. Above 12 GPa, charge order transitions from long-range to short-range, correlating with T_c suppression, indicating superconductivity is strongly tied to the charge-ordered state [3]. Notably, T_c is maximized when charge order and normal-state electronic responses are optimized. This conclusion is further supported by our uniaxial stress experiments, which reveal an enhancement of both the superconducting transition temperature T_c and magnetoresistance [4]. These results offer fresh insights into the relationship between superconductivity and charge order, paving the way for theoretical advancements.

- [1] I. Plokhikh et. al., and Z. Guguchia, *Communications Physics* 7, 182 (2024).
- [2] C. Mielke III, et. al., and Z. Guguchia, *Advanced Materials* 37(40), 2503065 (2025).
- [3] K. Ma et. al., and Z. Guguchia, *Nature Communications* 16, 6149 (2025).
- [4] P. Král et. al. and Z. Guguchia, in preparation.

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