

High-order van Hove Singularities, Topological Dirac-Cone States and Unusual Superconductivity in LaAl_2

Shovan Dan,¹ Suman Nandi,¹ Bikash Patra,¹ Gourav Dwari,¹ Ruta Kulkarni,¹ D. Kaczorowski,² Bahadur Singh,¹ and Arumugam Thamizhavel¹

¹*Department of Condensed Matter Physics and Materials Science,
Tata Institute of Fundamental Research, Colaba, Mumbai 400005, India*

²*Institute of Low Temperature and Structure Research,
Polish Academy of Sciences, Okólna 2, Wrocław 50-422, Poland*

Coexistence of high-order van Hove singularities (vHSs) with nontrivial topological states in intermetallic compounds can enhance electronic interactions and give rise to exotic quantum phases. Here, we show that LaAl_2 is one such intermetallic compound with a superconducting transition at $T_c = 3.2$ K. In the normal state, LaAl_2 exhibits an unsaturated linear magnetoresistance, suggesting Dirac-like band dispersion in its electronic structure. This is further supported by the low effective mass determined from de Haas–van Alphen measurements. First-principles calculations reveal multiple high-order vHSs near the Fermi level coexisting with topologically protected bulk Dirac cone states. These results establish LaAl_2 as a novel material, akin to recently discovered kagome metals, where high-order vHSs, nontrivial topology, and superconductivity coexist without complex symmetry-lowering charge ordering states.