

Dirac Fermions and crystalline electric field effect in Bi square net PrAgBi₂

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Recently, quasi-two-dimensional Bi-square net systems have been receiving significant attention as they appear to host relativistic fermions. We have investigated such a Bi-square net system, PrAgBi₂, by measuring its magnetic and magnetotransport properties and performing electronic band structure calculations. The magnetization and heat capacity data suggest the presence of a crystalline electric field (CEF) effect and the absence of magnetic ordering in PrAgBi₂. A multilevel energy scheme is used to analyze the CEF effect, demonstrating that the ground state of PrAgBi₂ consists of two doublets and five singlets. The de Haas–van Alphen quantum oscillation data show a single frequency with a very small cyclotron effective mass of approximately $0.11 m_e$. The quantum oscillation data also reveal a nontrivial Berry phase. The magnetotransport data show linear and unsaturated magnetoresistance, reaching up to $\sim 1100\%$ at 2 K and 9 T. A crossover from a weak-field quadratic dependence to a high-field linear dependence in the field-dependent magnetoresistance is observed. Moreover, the crossover critical field B^* follows a quadratic temperature dependence, indicating the existence of Dirac fermions in this material. The band structure calculations exhibit several Dirac-like linear band dispersions close to the Fermi level and a Dirac point near the Fermi level located at the boundary of the Brillouin zone. *Ab initio* calculations allow us to ascribe the observed quantum oscillation frequency to a particular feature of the Fermi surface. Our findings suggest that layered PrAgBi₂ is a promising candidate for hosting both the CEF effect and Dirac fermions in the Bi-square net.

References:

[1] S. Malick et al. PHYSICAL REVIEW B 111, 045144 (2025)