

Low-frequency quantum oscillations in LaRhIn₅: Dirac point or a nodal line?

Yu. V. Sharlai^{1,2,*}, Ł. Luszyński¹, T. Cichorek¹, and G. P. Mikitik²

¹Institute of Low Temperature and Structure Research, Wrocław, Poland

²B. Verkin Institute for Low Temperature Physics and Engineering, Kharkiv, Ukraine

*y.sharlai@intibs.pl

Recently, we highlighted a striking discrepancy in the experimental data for LaRhIn₅ [1], a non-4*f*-electron analogue and reference compound for the heavy-fermion superconductor CeRhIn₅, which exhibits unconventional Cooper pairing. Previous measurements of the magnetization oscillations in LaRhIn₅ by Goodrich *et al.* [2] strongly indicated the presence of a very small Fermi-surface neck (frequency $F = 7$ T) near a nodal line [3]. Conversely, a recent analysis of the temperature dependence of Shubnikov-de Haas oscillations by Guo *et al.* [4] attributed this frequency F to a Fermi-surface pocket surrounding a Dirac point.

In [1], we demonstrated that the experimental findings of Guo *et al.* do not inherently contradict the nodal-line hypothesis. Although the methodology used in [4] successfully detects charge carriers with linear dispersion, it cannot distinguish between carriers near a Dirac point and those near a nodal line, as both types of quasiparticles disperse linearly. Furthermore, the assumption of a Dirac point fails to explain the magnetization data reported by Goodrich *et al.* [2]. However, Guo *et al.* [4] also found that the frequency F of the Shubnikov-de Haas oscillations is independent of the magnetic field direction. This angular independence is inconsistent with the nodal-line model. Consequently, the true nature of the charge carriers in LaRhIn₅ remains unresolved, and we call attention to this puzzling situation.

We report an attempt to reveal the nature of these mysterious charge carriers using magnetostriction measurements. As was shown, the presence of relativistic fermions in topological semimetals manifests as a linear term in the magnetostriction [5]. This anomalous contribution emerges in the ultra-quantum limit - when the applied magnetic field B exceeds the fundamental frequency of the quantum oscillations - and is proportional to the small energy offset between the chemical potential and the Dirac point. This energy offset, in turn, depends linearly on temperature T . Therefore, magnetostriction arising from relativistic charge carriers near a Dirac point exhibits a distinct dependence on B and T . This signature should be detectable even in the presence of a large Fermi surface, such as that in LaRhIn₅. We show that our experimental magnetostriction results for LaRhIn₅ do not exhibit this characteristic Dirac-point dependence.

Reference

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