Magnetostriction study of Weyl semimetals at millikelvin temperatures

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Symmetry-protected topological states, such as those in Weyl semimetals, are at the focus of fundamental physics and potential applications in quantum electronics. In real materials, however, their coexistence with trivial states obscures the topological signatures, which become more pronounced as the Weyl points shift toward the Fermi level. It was recently shown [1] that presence of relativistic fermions in topological semimetals manifests as a linear term in the magnetostriction observed in the ultra-quantum regime, i.e., when an applied magnetic field B exceeds the fundamental frequency of quantum oscillations produced by the relativistic fermion pocket. Combined with its high sensitivity to small electron pockets, the magnetostriction thus becomes a powerful tool for probing relativistic charge carriers. Here, we report on the effect of uniaxial stress on the Weyl semimetal NbP with the noncentrosymmetric tetragonal structure. We measured the field-induced length change $\Delta L/L$ along the a-axis for $B \parallel c$ at 25 mK. Under ambient conditions, the magnetostriction is relatively small, $\Delta L/L \approx 4.5 \times 10^{-6}$ at 16 T, and dominated by quantum oscillations with large amplitudes of $\sim 30\%$ of the classical B^2 background. This characteristic is qualitatively altered when uniaxial strain is applied along the a-axis. Application of strain results in a large linear expansion in $B > 4$ T, unveiling the presence of relativistic quasiparticles. This is accompanied by enhancement of the $\Delta L/L$ by a factor of four and the disappearance of the quantum oscillations. Our study shows that Weyl points can be tuned towards the Fermi level using uniaxial strain, paving the way for experimental studies of yet unexplored physical phenomena.

Acknowledgments *This work was supported by the Polish National Science Centre, project No.2021/43/O/ST3/03000 (PRELUDIUM BIS 3). Yu.V.S. acknowledg*

References

[1] T. Cichorek et al., Nat. Commun. 13, 3868 (2022)..