Berry curvature and anomalous thermal Hall effect in magnetic Weyl semimetal : A case study

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Topological Weyl Semimetals (WSM) have captivated focus in condensed matter physics due to their intriguing electronic, transport and optical properties as well as application potential. Anomalous Hall Effect (AHE) and Anomalous Thermal Hall Effect (ATHE) have been observed in presence of electric field and thermal gradient respectively, in various topological WSMs, where Berry curvature in parameter space plays the role of magnetic field. In this talk, after giving a brief overview, I shall discuss our recent work [1] on ATHE in magnetic Weyl semimetal $Co_3Sn_2S_2$, a Co-based Shandite material which is ferromagnetic with Curie temperature ~175K. It preserves inversion symmetry, but time reversal symmetry is broken, thereby making it a magnetic WSM [2,3]. Using a Wannier tight-binding Hamiltonian derived from first principles density functional theory calculations, we have identified the material as a tilted type-I WSM [1]. Within the quasi-classical framework of Boltzmann transport theory, a giant anomalous thermal Hall (ATHC) signal appears due to the presence of large Berry curvature at the positions of the Weyl nodes, that can be tuned with application of strain. The thermal Hall current changes and even undergoes a sign-reversal upon varying the chemical potential. Furthermore, a 33% enhancement in the conductivity has been observed on application of uniaxial compressive stress of 5% along z-axis, when the material turns into a non-tilted Weyl semimetal. We have also found the Wiedemann-Franz law to be well satisfied at low temperatures for this system.

References

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