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Eq.3.3. We notice that the major contribution of AHC comes from the neighborhood of nodal lines. The AHC as a function of $E - E_F$ is shown in Fig.3.6c. The calculated AHC value at E_F is found 77.29 S/cm, which well matches with the experimentally found intrinsic AHC of 78.6 S/cm. We have also calculated the energy-dependent AHC as shown in Fig.3.6c and it is evident that Fermi level shift in Co₂FeGe will result in an increased AHC.

3.4 Conclusion

In conclusion, we have experimentally investigated the AHE in Co₂FeGe Heusler alloy and performed first principle calculations to understand the origin of intrinsic AHE. Experimentally AHC was found close to 100 S/cm at 300 K with an intrinsic contribution of 78.6 S/cm. Berry curvature calculations give AHC about 77.29 S/cm due to magnetization-induced gapped nodal line near the E_F , which is in good agreement with the experimentally calculated intrinsic AHC.

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Now we will discuss the ANE in the present compound. The ANE is the thermoelectric counterpart of AHE, where the temperature gradient is used for the motion of charges instead of the electric field [61]. The origin of ANE is closely related to the AHE and the key difference is that the AHE is the summation of the Berry curvature over all occupied states, while the ANE is the sum of the Berry curvature of states close to the Fermi energy *i.e* the ANC is the sum of the Berry curvature on the Fermi surface [52, 61]. The magnitude of ANC is related to the variation of the AHC near the Fermi energy. The strong Berry curvature on the Fermi surface gives the $\frac{\alpha^A}{T} = 0.013 \text{ A/m-K}^2$ and hence the ANC reaches the $\sim 3.98 \text{ A/m-K}$ at 300 K, which is similar to the highest reported value of ANC is 4.0 A/m-K in the Co_2MnGa experimentally. The variation of the ANC with the Fermi energy is shown in Fig. 6.4 (b). The large ANC value of about 40 A/m-K below 250 meV of the Fermi energy might be due to the flat band at this energy level. The flat band is a known route to produce the large anomalous Nernst effect in the material [62, 63].

6.4 Conclusion

In conclusion, we theoretically investigated the electronic, magnetic, and anomalous transport properties of Cu_2CoSn full Heusler compound. We have shown that the gapped NLs at the Fermi energy lead to the large AHC and ANC in the system. Therefore, the Cu_2CoSn is added as a new candidate in the family of Heusler compounds with high AHC and ANC. This work provides a comprehensive understanding of the anomalous transport properties in the NL hosting magnetic materials and motivates the further exploration of the Cu_2CoSn Heusler compound through experimental studies.

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change interaction, and dipolar interactions. This study presents indirect evidence of the signature of skyrmions and triggers the additional observation through Lorentz transmission electron microscopy (LTEM) or diffraction studies in the future. Owing to the high Curie temperature and significant THE, this material is useful for potential technological applications at room temperature as well as high temperatures.

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Publications

Publication included in the thesis

1. Gaurav K. Shukla, Jyotirmay Sau, Nisha Shahi, Anupam Singh, Manoranjan Kumar, Sanjay Singh, “Anomalous Hall effect due to gapped nodal line in Co_2FeGe Heusler compound”, [Phys. Rev. B 104, 195108 \(2021\)](#).
2. Gaurav K. Shukla, A. K. Jena, N. Shahi, A.K. Jena, N. Shahi, K.K. Dubey, I. Rajput, S. Baral, K. Yadav, K. Mukherjee, A. Lakhani, K. Carva, S.C. Lee, S. Bhattacharjee and S. Singh, “Atomic disorder and Berry phase driven anomalous Hall effect in a Co_2FeAl Heusler compound,” [Phys. Rev. B 105, 035124 \(2022\)](#).
3. Gaurav K. Shukla, J. Sau, V. Kumar, M., S. Singh, “Band splitting induced Berry flux and intrinsic anomalous Hall conductivity in the NiCoMnGa quaternary Heusler compound”, [Phys. Rev. B 106, 045131 \(2022\)](#).
4. Gaurav K. Shukla, U. Modanwal, and S. Singh, “Nodal-line symmetry breaking induced colossal anomalous Hall and Nernst effects in Cu_2CoSn Heusler compound,” [Appl. Phys. Lett. 123, 052402 \(2023\)](#).
5. Gaurav K. Shukla, N. Shahi, and S. Singh, “Observation of the topological Hall effect and signature of skyrmions in high Curie-temperature Co_2FeAl Heusler compound” (Manuscript to be submitted).

Publication not included in the thesis

6. P. Chaudhary, K. K. Dubey, Gaurav K. Shukla, S. Singh, et.al “Role of chemical disorder in tuning the Weyl points in Vanadium doped Co_2TiSn ”, [Phys. Rev. Mater. 5, 124201 \(2021\)](#).
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8. A. K. Singh, Gaurav K. Shukla, and S. Singh, “Intrinsic anomalous Hall conductivity and real space Berry curvature induced topological Hall effect in Ni₂MnGa magnetic shape memory alloy,” *J. Phys. D: Appl. Phys.* **56**, 4, 044004 (2022).
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