# Thermoelectric Study of Two-dimensional Heavy Fermions

We measured the thermoelectric responses of the Cr-based Kagome material $CsCr_6Sb_6$ using a novel thermoelectric technique for nm-sized flakes. The temperature-dependent Seebeck and Nernst coefficients resemble those of the heavy fermion $CeCu_2Si_2$, indicating Kondo interactions near the 2D limit. Furthermore, by integrating this technique with diamond anvil cells, we resolved sub-nV signals in $CeSb_2$ up to 29 T under pressure. This establishes a robust probe for future studies and tuning of 2D heavy-fermion systems.

The recent realization of two-dimensional (2D) van der Waals heavy fermions provides a fertile ground for exploring enhanced quantum fluctuations and novel correlated phases, such as quantum criticality and unconventional superconductivity [1-5]. Yet, the advancement of this field is severely hindered because standard bulk experimental probes for heavy fermions are challenging to apply at the 2D limit. Here we developed the thermoelectric technique for nm-sized thin flakes which show potential for the studies and tuning of 2D heavy-fermions systems.

Fig.1 shows the Seebck (S) and Nernst (N) coefficient of a Kagome material $CsCr_6Sb_6$ thin flake as a function of temperature. Below $T_F$~70K, the onset of frustrated magnetism from the resistivity measurements [3], the S/T drops sharply to a minimum near the Kondo temperature $T_N$~28 K, then rapidly increases and change sign below 10 K. Concurrently, the 12 T Nernst signal peaks sharply near $T_N$, with the maximum value reaching 1 $\mu V/K$. These temperature profile of S/T and N closely resemble those of the famous heavy fermion $CeCu_2Si_2$, providing compelling evidence for Kondo interactions approaching the 2D limit.

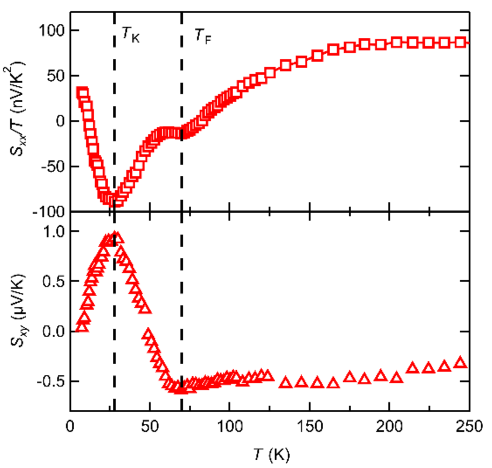


Fig. 1 The temperature dependent Seebeck and Nernst coefficient of $CsCr_6Sb_6$ thin flakes. The Seebeck was measured at 0 T while the Nernst effect was measured at 12 T.

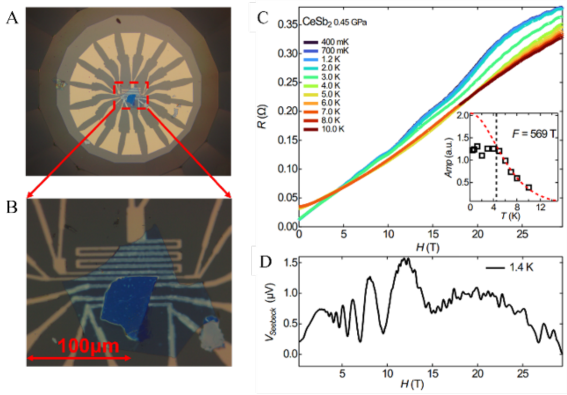


Fig. 2(A-B) The pre-patterned electrodes for thermoelectric measurements on the top of a diamond anvil. (C-D) The resistance and Seebeck coefficient of $CeSb_2$ under pressure.

Fig. 2A and 2B details the integration of the same methodology in a diamond anvil cell, enabling simultaneous resistivity and thermoelectric power measurements of a thin flake under pressure. Tested under high magnetic field up to 29 T in a $^3$He calorimeter, the Seebeck coefficient of the heavy fermion compound $CeSb_2$ achieves sub-nanovolt precision (Fig. 2D). It reveals pronounced quantum oscillations starting from 2 T, which match the frequencies from resistivity but offer significantly better resolution. This establishes the superior capability of our thermoelectric technique for probing 2D heavy fermions under pressure.

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