Quantum Criticality of $Sr_3Ru_2O_7$ Probed by Magnetothermopower

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Introduction

The magnetic field tuned quantum criticality in the double-layer ruthenate $Sr_3Ru_2O_7$ is associated with itinerant *metamagnetic* transitions, where strong interaction between itinerant electron and the quantum critical fluctuation of magnetization causes unusual transport and thermodynamic properties near the critical field (H_c). Thermoelectric power (TEP), also called as thermopower, is one of fundamental properties of metals and semiconductors which can probe both thermodynamic and transport properties. We measured magnetothermopower (MTEP) of $Sr_3Ru_2O_7$ and have observed the quantum critical behavior around H_c in both temperature and field dependence.

Experimental

MTEP was measured using a low frequency alternating thermal gradient method with the SCM2 magnet. The sample holder was indium sealed at room temperature and the field dependence of gold lead wires and temperature sensors were calibrated exploiting zero TEP of $Bi_2Sr_2CaCu_2O_8$ superconductor.

Results and Discussion

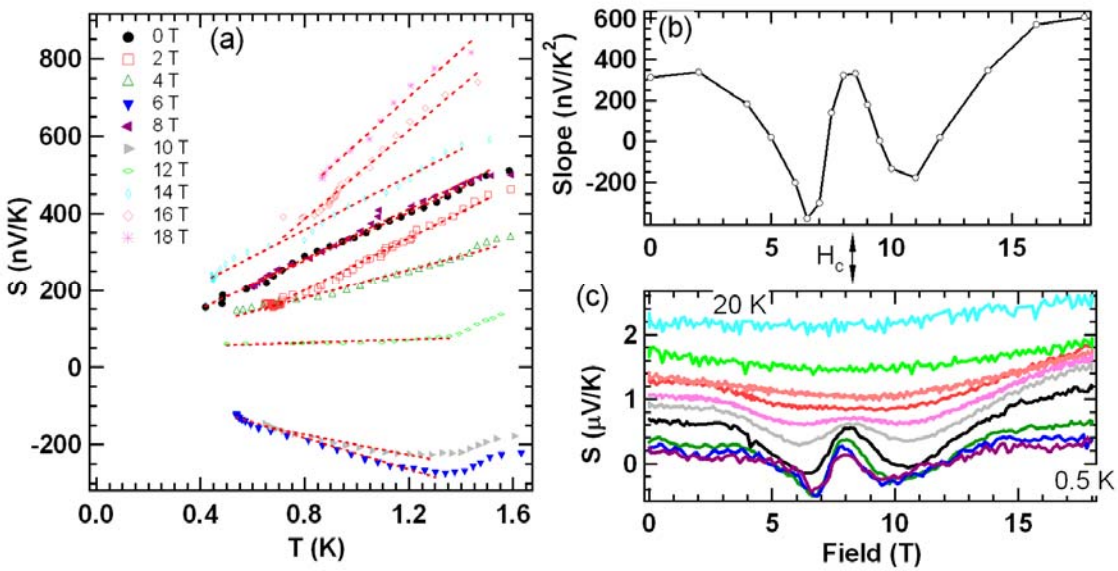

Fig. 1. (a) The temperature dependence of the TEP and (b) the slope of TEP of $Sr_3Ru_2O_7$ at different fields (c) MTEP at different temperatures (20 K to 0.5 from top to bottom)

Fig. 1 shows the magnetothermopower of $Sr_3Ru_2O_7$ with field perpendicular plane configuration (field parallel to the plane configuration shows similar behavior with different H_c). The metamagnetic transitions are clearly seen as a peak in magnetothermopower. It is of note that the slope of the temperature dependence at low temperature shows a very sharp peak around 8.5 T, which indicates an unusual increase of derivative of the density of states and/or scattering rate.

Considering the thermodynamic term of thermopower which measures the derivative of density of states at the Fermi energy ($n'(\varepsilon=\varepsilon_F)$), the field dependence accompanying sign changes suggests an abrupt change of density of states possibly with a van Hove singularity around H_c while the other mechanisms which involves an emergent resistive state in the vicinity of the quantum critical end point is less likely.