The intriguing T_0 =130 K phase transition in Ce_2Rh_2Ga : spin ordering, charge ordering, or both?

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Intermetallic compounds of the $4f^1$–electron element Ce have proven to be an exceptionally fertile ground for exploring new physics in magnetism, superconductivity and related condensed matter phenomena. Attributes of cerium-based compounds particularly at very low temperatures have been of enduring interest. This is due in part on spin- and charge coupling in cerium compounds being comparably weak and confined to low energies, but equally so because of new phases in matter that are found when different scales of energy compete with one another in determining the landscape of the ground state of cerium compounds [1].

By contrast, a small number of cerium compounds have been of special interest owing to having order parameters contiguous to that of mainstream cerium compounds, and they typically show phase transitions at relatively high temperatures. This presentation deals with the new compound Ce_2Rh_2Ga. We present experimental results of magnetic susceptibility and specific heat, plus thermal and electronic transport to demonstrate why this compound is a new member characterized by controversial behavior in the cerium materials class. Ce_2Rh_2Ga forms in an orthorhombic crystal structure with space group *Cmce* with a unique site provided for the Ce atoms. The structure may best be understood as puckered layers consisting of only Ce atoms interspersed between layers each containing Rh atoms and Ga atoms.

Among all the physical properties surveyed in this study a sharp, well-defined and hysteretic anomaly is found at T_0 =130 K. Figure 1 portrays the behavior in thermal and electrical transport. Further, the magnetic susceptibility between 200 K and 400 K is well represented by the Curie-Weiss law according to the full trivalent free-ion Ce^{+3} effective moment μ_{eff} =2.54 μ_B. It is noteworthy that La_2Rh_2Ga, -the isostructural twin of Ce_2Rh_2Ga shows ordinary, monotonous behavior throughout our experimental range of temperature.

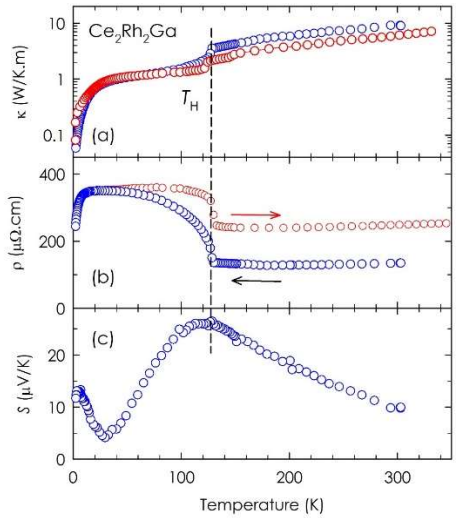

Figure 1: Temperature dependence in warming (red symbols) and cooling (blue symbols) measurement modes of;
(a) thermal conductivity,
(b) electric resistivity, and
(c) thermopower of Ce_2Rh_2Ga.

[1] V. Martelli et al., *Sequential localization and strange-metal behavior of a complex electron fluid*, https://arxiv.org/abs/1709.09376