The Mott insulator Ca_2RuO_4 in a non-equilibrium steady state

I. Terasaki[1]

[1] *Department of Physics, Nagoya University, Nagoya 464-8602, Japan*

The non-equilibrium steady state (NESS) is a steady state with constant flows of particle and energy. Obviously, it is the simplest system for non-equilibrium states, and many researchers have expected that the thermodynamics and statistical physics are able to be upgraded to include NESS. However, still missing is a real substance that exhibits essentially non-equilibrium characteristics.

Non-ohmic conduction is a typical example for NESS, and in particular we have focused on nonlinear conduction in strongly correlated electrons. As is generally agreed, strong correlation is a fertile source of electronic phase transitions such as high-temperature superconductivity in copper oxides, colossal magnetoresistance in manganese oxides, and multipole ordered states in heavy fermion intermetallics. Since some of such ordered states are susceptible to external impetus, we have searched for an ordered state susceptible to external electric field.

We have eventually arrived at the Mott insulator Ca_2RuO_4; this particular oxide undergoes a metal-insulator transition at around 360 K, and a low external pressure easily breaks the low-temperature insulating state. Nakamura et al. [1] have recently discovered a small electric field also breaks the insulating state. By controlling the sample temperature using black body radiation [2], we have observed the Seebeck coefficient in various external currents simultaneously. The resistivity decreases with increasing current density, and the Seebeck coefficient is significantly enhanced by 50-100 μV/K, which cannot be ascribed to a simple self heating. We have further found that the volume is changed with external current density in isothermal conditions.

In the present talk, we will show various anomalous properties of Ca_2RuO_4 in the nonlinear conduction regime, and compare them with those of other materials.

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References

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