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Thermal Current, Spin Current and Charge Current in Strongly Correlated Materials

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In the Seebeck effect, the electric voltage is generated in a conductor placed in a temperature gradient. The efficiency of the effect is given by the density and the scattering of the conduction electrons in usual metals and semiconductors. Recently, the transition metal oxides with strong electron correlation have attracted much attention as thermo-electric materials. Since the Seebeck effect is due to the entropy carried by the electric current, the spin and orbital degrees of freedom of conducting electrons in the strongly correlated materials may enhance the Seebeck effect [1]. In the first part of this presentation, the enhanced Seebeck effect is discussed in the transition metal oxides. In the second part, the spin-Seebeck effect is proposed [2], where the spin voltage, i.e., spin accumulation, is generated in a ferromagnetic metal placed in a temperature gradient. Then by utilizing the spin-detection method based on the spin-Hall effect, the spin voltage is converted to the electric voltage. The Spin-Seebeck effect is induced by a pure spin current, a flow of electron spin without electric charge current, and provides a variety of spintronics applications.

[1] ***Physics of Transition Metal Oxides***, by S. Maekawa et al. (Springer, 2004).
[2] ***Observation of the Spin − Seebeck effect***, by by K. Uchida et al. (to appear in Nature).