凝縮系物理学ゼミナール
Condensed Matter Seminar

Location: Room 413, School of Science Bldg. 5 (理学 5 号館 413 号室)
Time and date: 13:30 – 15:00, Wednesday, 22 May 2013

Thermal Transport and Field Theory in a Curved Spacetime

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Abstract:
Although thermal transport is as important as electric transport, it is not understood quantum-mechanically. Recently the thermal Hall effect was experimentally measured in ferromagnetic metals [1] and the effects of inelastic scattering on the anomalous Hall effect was discussed, but a systematic theory of quantum transport is desired beyond the Boltzmann semi-classical theory. By introducing "gravitational potential" coupled to the Hamiltonian density [2], a quantum-mechanical formula of thermal Hall conductivity was obtained [3].

Here we discuss a general framework of thermal responses by using the Keldysh Green function in a curved spacetime. We develop the idea to introduce gravitational potential only [2,3], and perform a systematic perturbation theory with respect to generic gravitational field by extending the previous work on electromagnetic responses [4]. The Dyson equation is written in a compact form by the extended Moyal product between the extended Wigner representations, which is perturbed by two gauge potentials, vielbein and spin connection, of gravity in the Cartan formalism. As a representative, we calculate thermal conductivity in the clean limit.

References:
[1] Y. Shiomi *et al*., Phys. Rev. B **81**, 054414 (2010).
[2] J. M. Luttinger, Phys. Rev. **135**, A1505 (1964).
[3] T. Qin *et al*., Phys. Rev. Lett. **107**, 236601 (2011).
[4] S. Onoda *et al*., Prog. Theor. Phys. **116**, 61 (2006).