Quantum and Topological Criticalities of Lifshitz Transitions－in Relation to Metal-Insulator Transitions

Y.Yamaji, T.Misawa, and M.Imada

Department of Applied Physics, University of Tokyo,
Hongo 7-3-1, Bunkyo-ku Tokyo 113-8656, Japan.

We study electron correlation effects on quantum criticalities induced by changes of the Fermi surface topology, namely Lifshitz transitions, using the mean-field theory based on a preexisting symmetry-broken order. In the Lifshitz transition, the Fermi surface topology plays a crucial role as the spontaneous symmetry-breaking does in the second-order phase transition. In the presence of electron interactions, the Lifshitz transition may become discontinuous in contrast to the continuous transition in the original proposal by Lifshitz for non-interacting systems. We focus on the quantum criticality at the endpoint of discontinuous Lifshitz transitions, which we call the *marginal quantum critical point*. In the case that electron and/or hole pockets vanish, we obtain the critical exponents $\beta=1$, $\gamma=1$ and $\delta=2$ [1,2], where the order parameter is given by the preexisting symmetry-broken order. Especially for the *grand canonical ensemble*, the uniform charge compressibility κ diverges as $|\delta n|^{-1}$, where δn is the electron density measured from the critical point. Such criticalities arise from its nature as a topological transition and must be involved in physics of competing orders around transitions between quantum liquids and metal-insulator transitions.

[1] M.Imada, J.Phys.Soc.Jpn. **73**, 1851 (2004); ibid **74**, 859 (2005); Phys. Rev. B **72**, 075113 (2005)
[2] T.Misawa, Y.Yamaji, and M.Imada, cond-mat/0604387, to appear in J.Phys.Soc.Jpn.