凝縮系物理学ゼミナール

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場所：理学部５号館　413号室

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「Roles of zeros of electronic Green's function in the pseudogap state in high-Tc cuprates」

Various spectral anomalies observed by angle-resolved photoemission spectroscopy (ARPES) in the pseudogap state of high-Tc cuprates hold the key not only to understanding the mechanism of the superconductivity but also to a possible manifestation of a novel metallic phase distinguished from the Fermi liquid.

We propose a unified understanding of these anomalies based on the electronic structure microscopically calculated for the two-dimensional Hubbard model. We apply the cluster dynamical mean-field theory to hole- or electron-doped region to the Mott insulator. The key feature in the obtained electronic structure is that it contains two different types of singularities at low energy: One is poles of the single-particle Green function G, and the other is poles of the self-energy, i.e., zeros of G. The former is usual in metals, constituting the Fermi surface at the Fermi level, while the latter is unusual: The zeros of G characterize the gap in the Mott insulator, but they are found to persist in the slightly doped region![1]

The surface of zeros around the Fermi level characterizes the pseudogap. It results directly from the strong correlation effect - the proximity to the Mott insulator - and requires no symmetry breaking. Moreover, it indicates an unanticipated momentum structure of the pseudogap, i.e., s-wave like gap, which is distinctive from the previous theories assuming d-wave pseudogap but still consistent with ARPES data when considering that the location of the gap depends on momentum and that ARPES looks only the occupied states. Various spectral anomalies, such as electron-hole asymmetry, Fermi arc, pocket Fermi surfaces, back-bending dispersion and high-energy kink observed by ARPES in hole- or electron-doped cuprates, are comprehensively understood as interference effects of the poles and zeros of G.[2]

[1] T. D. Stanescu and G. Kotliar, Phys. Rev. B 74, 125110 (2006).

[2] S. Sakai, Y. Motome, and M. Imada, Phys. Rev. Lett. 102, 056404 (2009); Physica B 404, 3183 (2009); arViv:1004.2569.