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Renewed Understanding on Doped Mott Insulators[1]

MASATOSHI IMADA, Dept. Applied Physics, Univ. Tokyo and JST CREST

Mott transitions and nearby underdoped metals in two dimensions remain a major challenge in condensed matter physics, because of large spatial and quantum fluctuations, with its relevance to cuprate superconductors. Recent theoretical and computational developments have renewed its understanding with a unified picture for the unconventional metals. We overview historical backgrounds followed by a recent coherent picture obtained by path-integral renormalization group, many-variable variational Monte Carlo methods, and cluster-type dynamical mean-field theory [1]. Coexisting zeros and poles of the single-particle Green's function hold a key for Mott physics. Non-Fermi-liquid caused by topological transitions of Fermi surface including Lifshitz transitions naturally emerges. The energy-momentum dependent spectra reproduce the arc/pocket and pseudogap formation. We propose that the pseudogap in the cuprates is d-wave-like only below the Fermi level while it retains s-wave-like full gap above the Fermi energy even in the nodal point. In addition, the spectral asymmetry, back-bending and waterfall dispersions as well as the low-energy kink emerge within the same framework in agreement with the underdoped cuprates, excluding the scenarios by preformed pairs and d-density-waves, but supporting the proximity to the Mott insulator. We also propose that an extension of the exciton concept to doped Mott insulators by using cofermions accounts for the above unconventionality and superconductivity [2].

[1] S. Sakai et al., Phys. Rev. Lett. 102, 056404 (2009); Phys. Rev. B 82, 134505 (2010)
[2] Y. Yamaji and M. Imada, arXiv:1009.1197.

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