A unified microscopic description of paramagnon and plasmon excitations in hole-doped high-T_c cuprates

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More than 30 years after the discovery of high-T_c superconductivity in copper oxides, the origin of Cooper pairing is still a matter of intense debate, with both purely-electronic- and collective-excitation-driven mechanisms being considered. Recent resonant inelastic x-ray scattering (RIXS) experiments have revealed unanticipated robust collective magnetic excitations (paramagnons), as well as low-energy charge modes (acoustic plasmons) in metallic paramagnetic phase of the cuprates (see, e.g., [1,2]), providing a new insight into the nature of those correlated systems. Very recently, we have formulated a new theoretical framework to discuss both equilibrium- and collective-dynamical properties of those materials [3,4]. It is based on a variational wave-function approach, combined with field-theoretical $1/\mathcal{N}_f$ expansion, accounting for leading-order quantum-fluctuation corrections. Our results are compared quantitatively with recent experiments [3, 5], showing a good overall agreement for both paramagnon- and plasmon-excitation branches. To test our method, we also benchmark our results against those of determinant quantum Monte Carlo and functional renormalization group [4].

References:

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