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Dispersion Anomalies and High Frequency Optical Conductivity in Cuprate Superconductors.[1]

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We argue that the shape of the dispersion along the nodal and antinodal directions in the cuprates can be understood as a consequence of the interaction of the electrons with collective spin excitations. In the normal state, the dispersion displays a crossover at an energy where the decay into spin fluctuations becomes relevant. In the superconducting state, the antinodal dispersion is strongly affected by the (π, π) spin resonance and displays an $S-$shape whose magnitude scales with the resonance intensity. For nodal fermions, relevant spin excitations do not have resonance behavior, rather they are better characterized as a gapped continuum. As a consequence, the $S-$shape becomes a kink, and superconductivity does not affect the dispersion as strongly. We also analyzed recent infrared conductivity data in the normal state. We find that the high frequency behavior, which has been suggested as evidence for quantum critical scaling, is well described by the same interaction with overdamped collective modes. From explicit calculations, we find a frequency exponent for the modulus of the conductivity, and a phase angle, in good agreement with experiment.

[1]In collaboration with M. Norman (Argonne Natl Lab)