Uni-directional vs Bi-directional charge orders in underdoped cuprates
Yuxuan Wang\(^1\), and Andrey Chubukov\(^2\)

\(^1\) Institute for Condensed Matter Theory and Department of Physics, University of Illinois
\(^2\) William Fine Institute of Theoretical Physics and Department of Physics and Astronomy, University of Minnesota

Motivation

- Charge order has been found across different families of cuprates.
- The charge order is primarily uni-directional (Davis, Damascelli…).
- X-ray experiments in YBCO from Keimer group and Damascelli group both found a tendency towards bi-directional order at higher dopings.

Structure of the CDW

- Charge order has been found across different families of cuprates.
- The charge order is primarily uni-directional (Davis, Damascelli…).
- X-ray experiments in YBCO from Keimer group and Damascelli group both found a tendency towards bi-directional order at higher dopings.

Effect of PDW from Spin-fermion Model

- Metlitski and Sachdev pointed out a SU(2) particle-hole symmetry in the spin-fermion model, which "rotates" a CDW order parameter into a PDW one.
- The PDW component replaces a CDW component in one of the two directions, since this way the PDW and CDW couples to a secondary SC and hence lowering the free energy.
- In terms of the charge order, this is uni-directional order.

Effect of the Amperean Pairing

- The Amperean pairing was put forward by P. A. Lee to account for the ARPES data in the pseudo-gap region.
- It involves pairing of fermions of the same momentum, which mixes charge-density-wave and pair-density-wave orders at both bond directions.
- The CDW/PDW order which replaced the bi-directional pure CDW order again becomes bi-directional, although with unbalanced intensities along x and y directions. This is fully consistent with experiments.

Reference