36th XXXVI Pan-Hellenic conference on Solid-State Physics and Materials Science
26 - 28 September 2022, Foundation for Research and Technology, Hellas - Heraklion, Crete

Order parameters in underdoped copper oxides : charge and pair density waves

George Kastrinakis

Institute of Electronic Structure and Laser (IESL), Foundation for Research and Technology (FORTH), N. Plastira 100, Vassilika Vouton, 70013, Iraklio, Crete, Greece

kast@iesl.forth.gr

We use the formalism of the new fermion index, introduced a few years ago [1], in order to theoretically investigate order parameters in underdoped copper oxides. This fermion index is an additional degree of freedom for the electrons, which allows them to *participate similtaneously in several different pairs*. This is **impossible** without the new index. We use appropriate variational wavefunctions, which extend the well known BCS-type ones, while comprising a desired number of pairs of electrons for any given momentum. These yield a plethora of possible correlations, which are left unaccounted for in more traditional approaches. This is a self-consistent and strong coupling approach.

Applying the method to the underdoped copper oxides, we use a relevant model with one partially occupied energy band and one totally filled band. We consider a combination of electron **intra-band** and **inter-band** pairs. We use *realistic dispersion relations and electron-electron potentials*, in agreement with advanced first principles [2] etc. calculations.

We observe the emergence of charge (CDW) and pair density wave (PDW) orders, with characteristic finite momenta, in the low temperature limit. These may coexist with superconductivity. We make the connection with the results of X-ray scattering, NMR, etc. experiments [3],[4],[5], which probe these orders in the cuprates.

References

[1] G. Kastrinakis, Annals of Physics **349**, 100 (2014)

[2] J.B. More'e et al., arxiv:2206.01510 (2022)

[3] W.-S. Lee, J. Phys. Soc. Jpn. **90**, 111004 (2021)

[4] R. Arpaia and G. Ghiringhelli, J. Phys. Soc. Jpn. **90**, 111005 (2021)

[5] S. Kawasaki et al., J. Phys. Soc. Jpn. **90**, 111008 (2021)