Superconductivity and structure transition in Fe-based superconductors: analysis based on the orbital fluctuation theory

H Kontani[a], T. Saito[a], and S. Onari[b]

[a]Department of Physics, Nagoya University, Nagoya, Japan
[b]Department of Applied Physics, Nagoya University, Nagoya, Japan

The main features in Fe-based superconductors are summarized as (i) orthorhombic transition accompanied by remarkable softening of the shear modulus C_{66}, (ii) high-T_c superconductivity close to the orthorhombic phase, and (iii) stripe-type magnetic order induced by orthorhombicity. To understand them, we analyze the multiorbital Hubbard-Holstein model with Fe-ion optical phonons. In the random-phase-approximation (RPA), a small electron-phonon coupling constant ($\lambda \sim 0.2$) is enough to produce large orbital (=charge quadrupole) fluctuations. The most divergent susceptibility is the O_{xz}-antiferro-quadrupole (AFQ) susceptibility, which causes the s-wave superconductivity without sign reversal (s_{++}-wave state). [1] The $_{s++}$-wave state is robust against impurities, [2] consistently with experimental observations. At the same time, divergent development of $O_{x^2-y^2}$-ferro-quadrupole (FQ) susceptibility is brought by the "two-orbiton process" with respect to the AFQ fluctuations. The derived FQ order not only triggers the orthorhombic structure transition, but also induces the instability of stripe-type magnetic order. Therefore, abovementioned features (i)-(iii) are well explained based on the orbital fluctuation theory.

[1]H. Kontani and S. Onari, Phys. Rev. Lett. **104**, 157001 (2010).
[2]S. Onari and H. Kontani, Phys. Rev. Lett. **103**, 177001 (2009).

INVITED PAPER