Stationary Josephson tunnel current in junctions involving *d*-wave superconductors with charge density waves

A.M. Gabovich[1], M.S. Li[2], H. Szymczak[2], A.I. Voitenko[1]

[1] *Crystal Physics Department, Institute of Physics, Natl. Acad. of Sci. of Ukraine, Nauka Ave. 46, Kyiv-03680, Ukraine,*
E-mail: gabovich@iop.kiev.ua

[2] *Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, PL-02-668, Warsaw, Poland.*

Josephson current between *d*-wave superconductors differs substantially from that between isotropic *s*-wave ones. Namely, the type (0- or π-junction) and temperature, T, dependences depend strongly on crystal orientations with respect to the junction plane. On the other hand, the so-called pseudogap is observed above and below critical temperatures, T_c, in *d*-wave high-T_c oxides. Most probably, pseudogaps are manifestations of charge density wave (CDW) distortions originating from Fermi surface (FS) nesting [1].

We used the model of CDW-induced partial FS gapping to examine the stationary Josephson current I_c between CDW superconductors with the *d*-wave superconducting pairing (CDWdSs). Specific calculations were carried out for symmetric junctions between two identical CDWdSs, and non-symmetric ones composed of a CDWdS and a conventional isotropic *s*-wave superconductor. The tunnel directionality was made allowance for. In all studied cases, the dependences of I_c on the angle γ between the crystal orientation and the normal to the junction plane were found to be significantly influenced by CDWs. In particular, it was shown that the *d*-wave driven periodicity of $I_c(\gamma)$ in the CDW-free case is transformed into double-period beatings depending on the system parameters. The results of calculations testify that the orientation-dependent $I_c(\gamma)$ measured for CDWdSs allow the CDW configuration (unidirectional or checkerboard) and the symmetry of superconducting order parameter to be determined. The predicted effects can be used to indirectly reveal CDWs in underdoped cuprates by the break-junction technique. The dependences $I_c(T)$ were shown to deviate from those in the absence of CDWs.

1. *Gabovich A. M., Voitenko A. I., Ekino T., Li M. S., Szymczak H., Pękała M.* Competition of superconductivity and charge density waves in cuprates: Recent evidence and interpretation // Adv. Condens. Matter Phys.-2010.**-2010.-** ID 681070.