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Competing Order and Superconductivity Precursor in High-T_c Cuprates

S. Tajima, E. Uykur, K. Tanaka, T. Masui and S. Miyasaka
Department of Physics, Osaka University, Osaka 560-0043, Japan

One of the most important problems in high-T_c superconducting cuprates (HTSC) is the pseudogap problem. One scenario is that the psuedogap is a precursor phenomenon of superconductivity, while in the other scenario it is a competing order linked to an insulating state. In my talk, I will examine these completely opposite opinions, based on our recent results of the c-axis optical study for Zn-doped $YBa_2Cu_3O_y$.

Removing an additional spectral feature due to the transverse Josephson plasma by Zn-doping, we could unambiguously discuss the spectral weight transfer with temperature. The result clearly showed that the pseudogap originates from some competing order but not a precursor of superconductivity. Moreover, we found that the pseudogap persists even below T_c, which becomes pronounced by Zn-substitution. This indicates that the pseudogap and the superconducting gap are coexisting, presumably in a phase separated form.

The most interesting problem is whether or not such a coexistence of competing order plays a positive role in superconductivity mechanism. Examining precisely the T-dependence of the spectral weight transfer, we found that except for the pseudogap temperature T^* there are two additional temperatures characterizing the electronic state of HTSC. One is the onset temperature T_c' for superconducting fluctuation which follows the T_c behaviors such as the dependences of hole- and Zn-concentration. The other is the superconductivity precursor temperature T_p ($> T_c'$) below which the superconducting condensate is observed. In contrast to T_c', T_p increases with decreasing hole concentration like T^*, while it decreases with Zn-substitution like T_c and T_c'. It means that the superconductivity precursor phenomenon is stabilized with decreasing hole concentration, suggesting some interplay between the competing order and the superconductivity.