Magnetoresistance oscillations in superconducting films with coexisting charge orders

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Understanding the interplay between superconductivity and charge orders may provide important insights to the mechanism of novel superconductors. Here, I will introduce a distinct type of ordering in two superconducting systems: lithium intercalated $TiSe_2$ and lightly doped $Bi_2Sr_2CaCu_2O_{8+x}$ (Bi-2212). The ordering manifests itself as the magnetoresistance (MR) oscillations at low magnetic fields and at temperatures around the superconducting transition.

In $TiSe_2$, we realize a superconducting dome by lithium intercalation via back gating with solid ion conductor substrates. MR oscillations are observed in the nearly optimal-doped states where the charge density wave (CDW) and superconductivity coexist. In the over-doped regime where the CDW is fully suppressed, the MR oscillations disappear. The oscillations can be attributed to the flux effects in a periodic superconducting matrix, which forms because of the interaction between commensurate and incommensurate CDW. In Bi-2212 films, we control the carrier density continuously in a wide range by lithium intercalation or by varying the oxygen content directly. In the extremely under-doped states which exhibit coexisting superconductivity and charge orders, we observe MR oscillations at low magnetic fields and at temperatures around the superconducting transition. The oscillations can be explained by the Little-Parks effect if we assume spontaneously formed periodic structures with mesh size of about 50 nm.

The ordering we observed is distinctly different from well-established ones such as CDW or pair density wave, which seems to be a more intriguing piece of puzzle in novel superconductors.