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Visualizing the Cuprate Pair Density Wave State

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When Cooper pairs are formed with finite center-of-mass momentum, the defining characteristic [1,2] is a spatially modulating superconducting energy gap $D(\boldsymbol{r})$. Recently, this concept has been generalized to the pair density wave (PDW) state predicted to exist in a variety of strongly correlated electronic materials such as the cuprates [3,4]. It is also the fact that a possible presence of a cuprate PDW state emerges from recent experimental studies. An example of the observed signature is a spatial modulation of the Josephson current detected in Cooper-pair tunneling that is established by Scanned Josephson Tunneling Microscopy [5]. Another indication is obtained by a simultaneous imaging of the local-density-of-states $N(\boldsymbol{r},E)$ that reveals electronic modulations with wavevectors $\boldsymbol{Q}$=(1/8,0);(0,1/8) and $2\boldsymbol{Q}$=(1/4,0);(0,1/4) inside a vortex core when a high magnetic field is applied [6]. These signatures are indeed anticipated when the PDW coexists with homogeneous superconductivity. In this talk, I will present the recent development of the cuprate PDW studies as stated above and discuss a possible role of the PDW in the cpurate.

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