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Superconductivity nearby quantum critical point in hole-doped organic strange metal κ-(ET)$_4$Hg$_{3-\delta}$Br$_8$

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The hole-doped organic superconductor κ-(ET)$_4$Hg$_{3-\delta}$Br$_8$, (κ-HgBr), where δ=11% and ET=bis(ethylenedithio)tetrathiafulvalene, has been the key to bridge the knowledge gap between half-filled organics and doped cuprate systems. Nonetheless, the isotropic triangular lattice of ET dimers of κ-HgBr, unlike the square lattice in cuprates, is suspected responsible for its susceptibility which is well scaled with the organic spin liquid insulator κ-(ET)$_2$Cu$_2$(CN)$_3$. However, both κ-HgBr and cuprate have a region at high temperature and high-pressure corresponding to the $strange\ metallic$ state where resistivity exhibits a linear temperature dependence which is non-Fermi-liquid (non-FL) behavior. In κ-HgBr this non-FL region gradually changed to an FL state by pressure [1], like the change of metallic state from optimal to overdoped cuprates. The ^{13}C-NMR concluded that the antiferromagnetic fluctuations contribute to the origin of the non-FL in κ-HgBr [3]. This evidence may locate superconducting κ-HgBr nearby quantum critical point (QCP) in between FL and localized states, where in its non-FL state the incoherent conductivity was observed [1,3].

Our zero-field μ^+SR experiment showed the relaxation rate from around 10 K down to 0.3 K is temperature-independent. This is a high possibility of the superconducting state that preserved time-reversal symmetry. There was almost no change in the 120 Oe of transverse-field-μ^+SR time spectra, at 0.3 K and above the superconducting temperature T_c = 4.6 K, indicating that the London penetration depth is longer than a μm order, while we estimate the lower critical field, $H_{c1} = 25(5)$ Oe. These could be an indication of a strong-coupling superconductor. We will discuss a possible mechanism of preserved time-reversal Cooper pairing formation from strong-coupling non-FL metal with geometrical frustration.

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