Pseudogap: superconducting fluctuations from quantum to thermal in high Tc copper oxide superconductor

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— We performed angular dependent torque measurement results on a series of Bi$_2$Sr$_{2-x}$La$_x$CuO$_{6+\delta}$ (La doped Bi2201) single crystals. Our measurement results show that the diamagnetic signal above superconducting transition temperature $T_c$ is a result of combination of thermal and quantum fluctuations. The pseudogap line, which could be a crossover line from thermal to quantum fluctuations, follows a universal equation, applied also in CeCoIn$_5$ and Pr$_{2-x}$Ce$_x$CuO$_{4-y}$. The quantum fluctuations in Bi2201 could be associated with two quantum critical points located in underdoped and overdoped region.

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