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Inhomogeneous Superconductivity in $YBa_2Cu_3O_y$ and $La_{2-x}Sr_xCuO_4$ Above T_c[1]

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An exciting development in the immense research effort focused on resolving the origin of high-T_c superconductivity, is the growing experimental evidence for signatures of superconductivity in cuprate materials at temperatures far above T_c. Recent STM experiments on $Bi_2Sr_2CaCu_2O_{8+\delta}$ have provided new insight into the precise nature of these pairing correlations, by revealing the occurrence of nanometre-sized pairing regions above T_c. Whether nanoscale inhomogeneous superconductivity is universal to the cuprates, and whether T_c is driven by Kosterlitz- Thouless physics or Josephson coupling between nanometre-sized superconducting regions are matters of current debate. Very recently we have used μSR to probe the local response in the bulk of $YBa_2Cu_3O_y$ and $La_{2-x}Sr_xCuO_4$ single crystals to a large applied magnetic field (H = 7 T). At temperatures above T_c, we detect a spatially inhomogeneous magnetic field that tracks the hole-doping dependences of both T_c and the superfluid density at $T = 0$ K. Our experiments are inconsistent with the field inhomogeneity above T_c being caused by electronic magnetic moments or a vortex liquid. Instead they are explained by the existence of nanometre-size superconducting regions with a local T_c that exceeds the bulk T_c. In $YBa_2Cu_3O_y$, we detect a spatially inhomogeneous response to field that persists beyond $T = 200$ K, indicating that the basic ingredients for superconductivity near room temperature already exist in spatially localized regions of this material. A lingering question is the origin of the weak magnetism detected earlier in $YBa_2Cu_3O_y$ by zero-field μSR, at temperatures below the pseudogap temperature T^*.

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