MAR16-2015-002335

Abstract for an Invited Paper
for the MAR16 Meeting of
the American Physical Society

The Emergence of Superconductivity in Inhomogeneous, Mesoscopic Systems[1]

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Although low-dimensional, inhomogeneous superconductors have been intensely studied, the nature of the onset of superconductivity in these systems is still largely unknown. In this talk we present transport measurements on mesoscopic disks of granular, inhomogeneous Nb, where we determine the superconducting transition temperature as a function of disk diameter. We observe an unexpected suppression of superconductivity at micron diameters, length scales that are considerably longer than the coherence length of Nb. This suppression does not appear in large-scale films, and cannot be explained by single-grain small-size effects. By considering the diameter-dependence of the transition, as well as observations of strong fluctuations in the transition temperature as disk diameters decrease, we are able to explain this long length scale dependence by an extremal-grain model, where superconducting order first appears in unusually large grains and, due to proximity coupling, spreads to other grains. The extremal-grain onset of superconductivity has not previously been observed experimentally, and explains how superconductivity can emerge in granular or inhomogeneous superconductors.

[1]This work is funded by DOE-BES under Award DE-SC0012649