Observation of Pseudogap State in Disordered NbN using Scanning tunnelling Spectroscopy

A. Kamlapure[a], M. Mondal[a], M. Chand[a], G. Saraswat[a], S. Kumar[a], J. Jesudasan[a], L. Benfatto[b], V. Tripathi[a], and P. Raychaudhuri[a]

[a]Tata Institute of Fundamental Research, Homi Bhabha Rd., Mumbai 400005, India.
[b]ISC-CNR and Department of Physics, Sapienza University, P.le A. Moro 5, 00185 Rome, Italy.

We present an experimental evidence of the formation of a "Pseudogap" state in a disordered conventional s-wave superconductor, NbN, as the system is driven towards the Anderson Metal-Insulator transition. Series of scanning tunnelling spectroscopy measurements done on films with increasing disorder shows that for strongly disordered samples the dip in the tunnelling spectra at Fermi level persists much above the superconducting transition temperature. We propose that the gap like feature at Fermi level is associated with superconductivity based on the observation of BCS like spectra with dip at Fermi level and diffused coherence peaks after correcting them with Altshular-Aronov background.
We propose a scenario based on phase fluctuations to understand the pseudogap state in strongly disordered NbN films. The superconducting order is characterized by the complex order parameter consisting of amplitude and phase. In presence of strong disorder superconductor segregates into phase disconnected islands where superconductivity exists locally, but the global superconducting state is destroyed because of phase incoherence.
Ref.: Phys. Rev. Lett. 106, 047001 (2011)