A Sub-Kelvin Scanning Tunneling Microscope and its Application to MgB_2 and $CeCoIn_5$

Abstract

by

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A low temperature, high magnetic field, ultra high vacuum scanning tunneling microscope has been constructed. Such an environment places many constraints upon the design of the instrument, but also allows the study of many exotic phenomena, in particular superconductivity. The low temperatures permit high energy resolution, and the high field allows access to novel material phases.

We have leveraged the rare ability to optically access the tunnel junction in order to study materials that are only available in very small sizes. Such samples would be difficult to study in many other low temperature systems.

We have recorded the first superconducting spectroscopy in $CeCoIn_5$ in the <100> direction. This required tunneling into a sample only a fraction of a millimeter wide. $CeCoIn_5$ shows a rich interplay of magnetism and superconductivity. Having measured superconducting spectroscopy, it may be possible to measure a vortex lattice and investigate various phenomena such as Pauli paramagnetic pair breaking and a possible FFLO state.

We have also tunneled into the Meissner rim of MgB_2. We have observed the effect of a transverse current on the spectroscopy.

The new STM has demonstrated its ability to measure novel materials in difficult configurations at low temperature.