Probing High-Temperature Superconductors Atom By Atom Using Scanning Tunneling Microscopy

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Superconductors exhibit unusual physical behavior characterized by two fundamental properties: 1) zero resistance below a critical temperature known as T_C and 2) the Meissner effect where magnetic fields are expelled from the material below T_C. Though a microscopic theory exists for "conventional" superconductors, there is much which is not known regarding the more recently discovered high-temperature superconductors. Using scanning tunneling microscopy, we can probe a superconductor's atomic structure and underlying electronic structure with atomic resolution. By understanding microscopic variations in the underlying structure, we gain insight into the workings of high-temperature superconductors, which are expected to be important in future technology.

In my presentation, I will begin with an introduction to scanning tunneling microscopy and the types of measurements we can make using this technique. After introducing some of the salient features and concepts pertaining to conventional superconductivity, I will highlight some of the crucial differences observed in high-temperature superconductors. In the final part of the talk, I will present our recent studies which examine the temperature evolution of the electronic structure of the high-temperature superconductor $Bi_2Sr_2CuO_{6+\delta}$ through T_C, along with the understanding we gain from these studies.