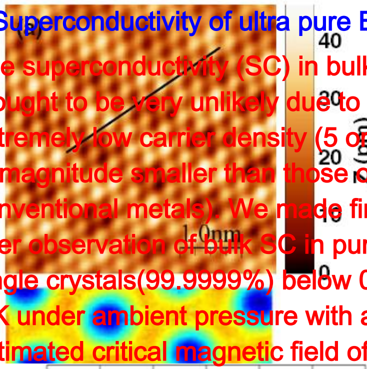
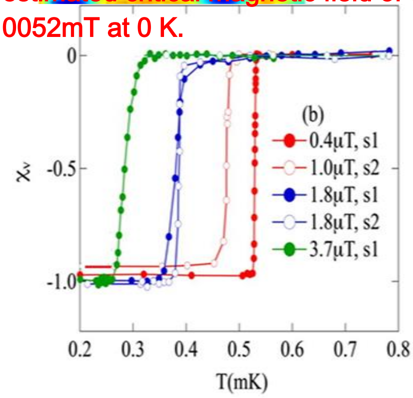
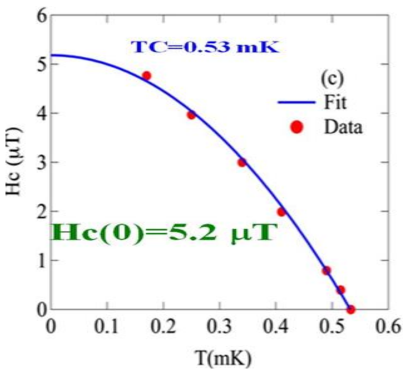
Superconductivity of materials with low carrier densities at ultralow temperatures

Superconductivity of ultra pure Bi



The superconductivity (SC) in bulk Bi is thought to be very unlikely due to extremely low carrier density (5 orders of magnitude smaller than those of conventional metals). We made first-ever observation of bulk SC in pure Bi single crystals(99.9999%) below 0.53 mK under ambient pressure with an estimated critical magnetic field of 0. 0052mT at 0 K.





Top: Superconductivity of ultrapure (99.999(%) two crystals of Bi with RRR=530 and 560.
Bottom:Temperature dependnence of the critical field of Bi crystal obtauned from magnetization data.

Om Prakash, Anil Kumar, Thamizhavel and S.Ramakrishnan Science, Vol.355, Issue 6320,52-55 (2017)

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Physics at Ultralow Temperatures

The ultralow temperature laboratory in TIFR focuses on the study of unconventional superconductivity of systems which have extremely low carrier density (2 to 5 orders of magnitude lower than in conventional metals). At present, we are studying superconductivity in materials like pure Bi, Tl doped PbTe and Nb doped SrTiO3 down to 0.1 mK. We have built an adiabatic nuclear demagnetization setup to measurements magnetization and transport from 0.1 mK to 1 K. We are also have mK fridge and cryostats to do bulk measurements up 300 K. In our lab, we look for phase transition from 0.1 mK to 300 K, 7 decades in temperature. We also study charge density waves and magnetic systems.

Adiabatic Nuclear Demagnetization setup

The adiabatic demagnetization setup consists 5 kg of copper stage which connected to a commerical dilution refrigerator (Leidon Cryogenics) which has a cooling power of 1.2 mW at 0.1 K. The nuclear spins of the copper stage are magnetized to 9 T using a superconducting magnet and the temperature demagnetization of nuclear spins of copper .We use combination of resistance thermometry , magnetic thermometry , noise thermometry and NMR thermometry to cover the temperature range from 0.04 mK to 1 K. We measure magnetization using DC squid and transport using low power ac bridges and pv probes using DC squids.

'a' shows the cryostat mounted on active vibration isolation pads.
'b' shows the cryostat hanging into the basement on pillars resting on a sand-bed.
'c' shows the magnetinsert.
'd' shows the dilution insert with the Copper stage.