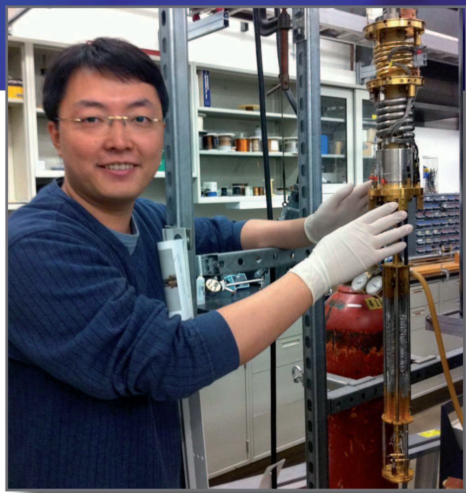
Lee-Osheroff–Richardson North American Science Prize 2011

Dr Jing Xia



Dr Jing Xia is the 2011 recipient of the Lee Osheroff Richardson North American Science Prize.

Dr. Xia has been working on topologically ordered condensed matter systems at low temperature and high magnetic fields. With Professor Kapitulnik at Stanford University, Dr. Xia developed a loop-less fiber optic Sagnac interferometer capable of measuring magneto-optic Faraday and Kerr effects with unprecedented resolution at cryogenic temperatures. They detected time-reversal-symmetry breaking (TRSB) in the superconducting phase of Sr_2RuO_4, providing strong evidence of chiral p-wave topological superconductivity. They have also discovered TRSB in the "pseudogap" state of high-Tc superconductor YBCO, identifying the "pseudogap" state to be a true broken-symmetry phase. With Professor Eisenstein at Caltech, Dr. Xia studied the competition between topological and non-topological states in 2D electrons near filling factor 5/2 at dilution fridge temperatures, discovering several novel correlated quantum phases including the "reentrant isotropic phase". Future research will be conducted below 1 mK in a nuclear demagnetization fridge that they constructed at Caltech.

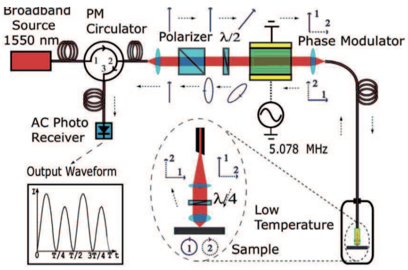


FIG 1: Loop-less fiber-optic Sagnac interferometer for ultra-high resolution magneto-optical Kerr or Faraday effects measurements at cryogenic temperatures.

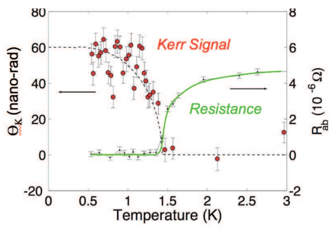


FIG 2: Polar Kerr (red) and resistance (green) measurements of a high quality crystal of Sr_2RuO_4, providing evidence for time-reversal symmetry breaking in the superconducting state.

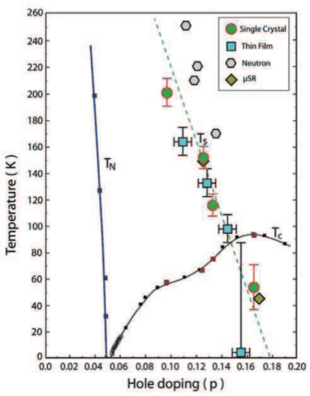


FIG3: Compilation of the onset temperature of time-reversal symmetry breaking signal Ts = "pseudogap" temperature T* for the four single crystal samples of $YBa_2Cu_3O_{6+x}$ with x = 0.5, 0.67, 0.75 and 0.92 (circles), as well as for four thin films samples (squares).

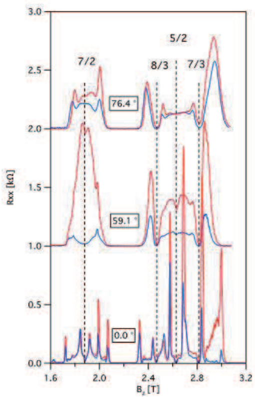


FIG 4: Longitudinal resistance R_{xx} (red) and R_{yy} (blue) of a high quality 2D electron system at different magnetic field tilting angles at 15 mK. At filling factor 5/2 (and 7/2), in-plane field drives phase transitions between three competing phases: fractional quantum Hall state (0°), anisotropic "nematic" liquid crystal phase (59°) and a reentrant isotropic compressible phase (76°).

Topological order is a new kind of collective order beyond Landau's symmetry-breaking classification. Certain types of topologically ordered materials including the "chiral p-wave" superconductors and "non-Abelian" fractional quantum Hall (FQH) states, both occurring at very low temperatures, may be used to realize fault-tolerant "topological" quantum computers that are immune from quantum decoherence. Dr. Xia has been working on experimentally identifying non-Abelian topological phases, and on understanding the competition between topological and non-topological phases in order to find ways to stabilize topological order.

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References:

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