Notre Dame Science
Department of Physics

SEARCH FOR BROKEN TIME REVERSAL SYMMETRY IN UNCONVENTIONAL SUPERCONDUCTORS

Colloquium

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4:00 P.M. NSH 118
(Refreshments at 3:30 P.M. NSH 202)

Symmetry is central to our understanding and description of natural phenomena. For example, conventional superconductors break only gauge symmetry, while a signature of an unconventional superconducting state is the breaking of additional symmetries. The breaking of time-reversal symmetry (TRS) is of particular interest since the condensate will have an overall magnetic moment due to either the spin or orbital (or both) parts of the pair wave function. However, this moment will be screened by the Meissner effect and is thus difficult to detect using conventional magnetic probes. To this end we developed a new technique of detecting broken TRS using a Sagnac interferometer, in which left and right circularly polarized lights propagate in opposite directions in the Sagnac loop and interact with the sample. The two lights, being time-reversal mirror image of each other, will gain a difference in phase due to broken TRS in the sample. And this phase difference, usually referred to as Polar Kerr Effect (PKE) is measured with unprecedented accuracy of 10 nano-radian at 400 mK using interferometry. Our measurements on p-wave superconductor Sr2RuO4 revealed non-zero PKE as big as 65 nanorad appearing below Tc = 1.5 Kelvin, implying a broken time reversal symmetry state in the superconducting state, similar to 3He-A. Measurements on high Tc superconductor YBCO crystal samples with different doping levels showed broken TRS at temperatures tracking the so-called "Pseudo Gap" temperatures, marking what seems to be a true phase transition. Anomalous magnetic behavior in magnetic field training of the effect suggests that time reversal symmetry is already broken above room temperature.

All interested persons are cordially invited to attend.