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Spontaneously broken time reversal symmetry in strongly interacting two dimensional electron systems in Si and Ge SAQUIB SHAMIM, Department of Physics, Indian Institute of Science, S. MAHAPATRA, G. SCAPPUCCI, W.M. KLESSE, M.Y. SIMMONS, Centre for Quantum Computation and Communication Technology, University of New South Wales, Sydney NSW 2052, Australia, ARINDAM GHOSH, Department of Physics, Indian Institute of Science — Time reversal invariance is a fundamental and robust symmetry of nonmagnetic quantum systems whose violation often results in nontrivial and exotic phenomena ranging from delocalization of electrons, quantum Hall liquid, the quantum anomalous Hall effect in topological insulators or chiral superconductivity predicted in graphene. An external magnetic field or magnetic impurities is employed in experiments to break the time reversal symmetry. Here we show that strong Coulomb interactions can lift the time reversal symmetry in two dimensional systems formed by atomically confined doping of phosphorus (P) atoms inside bulk crystalline silicon and germanium at zero magnetic field. Weak localization corrections to the conductivity and the universal conductance fluctuations were both found to decrease with decreasing doping in the Si:P and Ge:P δ-layers, suggesting delocalization driven by Coulomb interactions. In-plane magnetotransport measurements indicate the presence of local spin fluctuations at low doping, resulting in spontaneous lifting of the time reversal symmetry. Our experiments suggest the existence of a new delocalized many-body state in two dimensions when strongly interacting electrons are confined to narrow half-filled impurity bands.

Saquib Shamim
Department of Physics, Indian Institute of Science

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