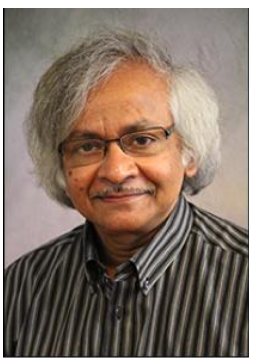
A Different Perspective on Topological Insulators / Rashba Conductors Inspired by Mesoscopic Physics

Shehrin Sayed, Seokmin Hong and Supriyo Datta, Purdue University

A charge current in 2D conductors with spin-orbit coupling induces a spin voltage, which can be measured with ferromagnetic contacts: This was predicted using a straightforward extension of mesoscopic physics and has been confirmed by multiple experiments. We will use this mesoscopic-inspired viewpoint (1) to obtain an expression for the effective spin Hall angle in terms of the number of currentcarrying modes and (2) to argue that multi-terminal measurements on such conductors should show certain striking properties which should be absent in twoterminal measurements in the linear response regime.

We will further show that these results can be modeled using a semiclassical theory that uses four electrochemical potentials (U+, D+, U−, and D−) depending on the sign of the z-component of the spin (U, D) and the sign of the x-component of the group velocity (+,−). This can be viewed as a synthesis of the spin diffusion equation (Valet-Fert model) that uses separate electrochemical potentials for U and D states, with the mesoscopic diffusion equation that uses separate potentials for states propagating along ± x.



BIO: Supriyo Datta received his B.Tech. from the Indian Institute of Technology, Kharagpur in 1975 and his M.S. and Ph.D. from the University of Illinois at Urbana-Champaign in 1977 and 1979 working on ultrasonics. Since 1985 he has focused on current flow in nanoscale electronic devices and the approach pioneered by his group for the description of quantum transport, combining the non-equilibrium Green function (NEGF) formalism of manybody physics with the Landauer formalism from mesoscopic physics, has been widely adopted in the field of nanoelectronics. This is described in his books Electronic Transport in Mesoscopic Systems (Cambridge 1995) and Quantum Transport: Atom to Transistor (Cambridge 2005). His latest book Lessons from Nanoelectronics: A New Perspective on Transport (World Scientific 2012) tries to make the insights gained from nanoelectronics accessible to a broad audience irrespective of their specialization. Datta is also known for several important conceptual proposals that have subsequently been demonstrated experimentally in diverse areas including molecular electronics, negative capacitance devices, and spin electronics.