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Seminar

Two quantum resistors: Next generation explorations

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In the 1980s, the era of mesoscopic transport while clearing many mists about the microscopic nature of electrical resistance, simultaneously unveiled new and counter-intuitive aspects about it. An example being that of double barrier tunneling and its hallmark consequence - two "quantum" resistors in series may give rise to an equivalent resistance that is smaller than that of each component! This aspect has been extensively studied in the context of microelectronic applications of resonant tunneling diodes (RTD). In this talk, while keeping the motif of "two quantum resistors", we draw attention to some next generation applications in the realm of spintronics and energy conversion-an area commonly referred to as spin-caloritronics.

Starting from the basic tenets of quantum transport in the double barrier context, we present novel double barrier applications in spintronics based on the physics of resonant spin filtering. We demonstrate an ultra-enhancement in the tunnel magneto resistance (TMR), well in excess of 2000%, as a result of highly sensitive and tunable spin filtering physics. With myriad applications possible by utilizing such a tunable spin filtering scheme, we present device designs catered toward emerging logic, memory and sensing functionalities that include (i) ultrahigh sensitivity magneto resistance H-field sensors (ii) Improved spin transfer torque switching resulting from the non-trivial spin current profiles, and (iii) high-power output microwave generators and oscillators based on resonant spin-transfer torque dynamics.

We also discuss how double barrier tunneling may aid the thermoelectric performance of heat-engines designed for power generation. Here, we demonstrate the importance of resonant conduction in relation to electron filtering and electronic thermal conductance. These ideas, we believe would be useful in the next generation of spintronic logic-memories that combine in-chip heat to spin current co-harvesting.

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4:00 PM (Tea/Coffee at 3:45 PM)

Seminar Hall, TCIS