PHYSICS DEPARTMENT COLLOQUIUM

" Spin in GaAs Quantum Dots"

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Current understanding of the physics of spin in solid-state systems remains incomplete, with unresolved questions such as the role of spin-orbit interaction and the behavior of coupled spin systems. These questions persist in part because spin states interact weakly with the environment, making measurement difficult. However, that same weak interaction makes spin attractive for information processing applications.

This talk will present a series of transport measurements probing spin states in GaAs quantum dots. The dots described here were defined lithographically in a 2D electron gas; the tunability of this design enables us to study spin in confined systems over a broad range of parameters. Open dots, characterized by fully transmitting entrance and exit leads, show conductance fluctuations with signatures of spin degeneracy that depend strongly on in-plane magnetic field, dot size, and spin-orbit interaction. When the leads to the dot become weakly transmitting tunnel barriers, Coulomb-blockade peak position can be used to probe "atomic" shell filling and Zeeman energy for a range of dot sizes even down to dots containing a single electron.

Expanding beyond spin states in isolated devices, we have adapted the transverse electron focusing geometry to allow the preparation and detection of spin currents in more complicated mesoscopic structures. We use this to measure the spin polarization of transport current from open and Coulomb-blockaded quantum dots. While some aspects of the data are in agreement with current theoretical understanding, others remain to be explained. This experiment opens the door to a wide range of spin measurements, from probing transport polarization due to a spin-orbit interaction, to exploring many-particle entangled spin states."

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