Quantum manipulations and measurements of semiconductor quantum dot hybrid qubits

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Among many plausible experimental implementations of quantum technology, the similarities between gated quantum dots and transistors in modern microelectronics – in fabrication methods, physical structures, and voltage scales for manipulation – have led to significant interest in the development of quantum bits (i.e., qubits) in semiconductor quantum dots.In this talk, general control and measurement schemes in the field of semiconductor-based qubit research is discussed with examples of charge and spin qubits, the electron's natural degrees of freedom for constructing artificial quantum two level systems.

The quantum dot charge qubitoffersa simple architecture and high-speed operation, but generally suffers from fast dephasing on the order of nanoseconds due to strong coupling of the environment to the electron's charge. On the other hand, quantum dot spin qubits have demonstrated long coherence times over tens of microseconds,buttheir manipulation is often slower than desired for important future applications.As a main topic of this talk, we presentexperimental progress of a newly developed 'hybrid' qubit formed by three electrons in a Si/SiGe double quantum dot, which combines desirable characteristics (speed and coherence)in the past found separately in qubits based on either charge or spin degrees of freedom.