Abstract for an Invited Paper
for the DAMOP07 Meeting of
The American Physical Society

**Quantum Information Processing in Artificial Molecules**[1]

JACOB TAYLOR, Massachusetts Institute of Technology

Isolated atomic and molecular systems are known for their robust coherence properties. Further, their quantum states can now be controlled with exquisite precision, which provides an excellent starting point for implementing fundamental ideas from quantum information science. In this talk, we describe recent progress in developing techniques for quantum control of artificial molecules composed of coupled semiconductor quantum dots. We first focus on the electron spin degrees of freedom associated with such systems and show that the coherence properties of electron spins are determined by hyperfine interactions with large ensembles of lattice nuclear spins. Next we determine that the fine-structure states of quantum dot molecules provides a mechanism for robust manipulation of electron spins, while coupling to nuclei can be mitigated by using local, electrical control of the system. We further consider possible applications of such systems in quantum information science. We conclude with a discussion of the long-term prospects and fault tolerance properties of semiconductor quantum dots for large scale quantum information processing.

[1]Thesis work performed at the Department of Physics, Harvard University, under advisor Mikhail D. Lukin