

Coherent Spin Memory and Transfer in Chemically Synthesized Semiconductor Quantum Dots

Min Ouyang

Department of Physics
University of California at Santa Barbara

Semiconductor quantum dots (QDs) are among the most attractive candidates for scalable solid state implementations of quantum information processing based on electron spin states, where the crucial requirement of practical devices is to have efficient and tunable spin coupling between them. We will first discuss the general spin dynamic behavior of isolated colloidal quantum dots. Then we will focus on recent femtosecond time-resolved Faraday rotation studies of self-assembled multilayer spintronic devices of colloidal quantum dots bridged by conjugated molecules. The data reveal an instantaneous transfer of spin coherence through conjugated molecular bridges spanning quantum dots of different size over a broad range of temperature. The room temperature spin transfer efficiency is approximately 20%, which nearly doubles the value measured at $T=4.5\text{K}$. A molecular π -orbital mediated spin coherence transfer mechanism has been proposed to provide qualitative insight into the experimental observations, further suggesting the correlation between stereochemistry of molecules and spin coherence transfer process. These findings show that conjugated molecules can be used not only as physical links for the assembly of functional networks but also as a natural media for shuttling quantum information. The results suggest that this class of structures may be useful as room temperature two-spin quantum devices and offer a rational pathway for bottom-up hierarchical assembly of QDs into well defined functional nanometer-scale spintronic systems that can connect the nanometer through micrometer regimes.