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Photophysical Properties of Colloidal Mn(II)-Doped CdSe Nanoparticles: Exchange Fields, Exciton Storage, and Light-Induced Spontaneous Magnetization

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An attractive approach to controlling spin effects in semiconductor nanostructures for applications in electronics is to use light to generate, manipulate, or read out spins. The main focus of this presentation will be on the recent demonstration of spontaneous photoinduced polarization of Mn(II) spins in doped colloidal CdSe quantum dots, an effect due to the formation of excitonic magnetic polarons. Photoexcitation generates large dopant-carrier exchange fields, enhanced by strong spatial confinement, that lead to giant Zeeman splittings of the semiconductor band structure in the absence of applied magnetic fields. These internal exchange fields allow spontaneous magnetic saturation of the Mn(II) spins to be achieved at zero external magnetic field up to ca. 50 K, and photomagnetic effects are observed all the way up to room temperature. The factors that allow this fascinating effect to be observed in colloidal Mn(II)-doped CdSe nanoparticles will be discussed. Relevant Publications: 1) Beaulac, Schneider, Archer, Bacher, and Gamelin. Science, 325, 973 (2009) 2) Beaulac, Archer, Ochsenbein, and Gamelin, Adv. Funct. Mat., 18, 3873 (2008)