Anomalous Hall Effect and Electron Transport in Co$_2$Si Nanocluster Films

BALAMURUGAN BALASUBRAMANIAN, TOM GEORGE, BHASKAR DAS, RALPH SKOMSKI, DAVID SELLMYER, Nebraska Center for Materials and Nanoscience and Department of Physics and Astronomy, University of Nebraska — Magnetic nanoparticles or clusters are of fundamental and technological importance, since they exhibit entirely different and/or improved magnetic and electronic properties as compared to bulk alloys. Our recent research shows large average magnetic moments of up to 0.70μ$_B$/Co at 10K and 0.49μ$_B$/Co at 300K for cluster-deposited Co$_2$Si nanoparticles, in sharp contrast to the nearly vanishing bulk magnetization. In this talk, we present interesting electron-transport properties in Co$_2$Si nanoparticle films. The film shows a room-temperature negative magnetoresistance (MR) of 0.14% at 1T, which become as high as 1.8% at low temperatures. We also observed anomalous field-dependent Hall resistivities ($\rho_{xy}$) in the nanoparticle film, which corroborate the magnetic hysteresis loops. Interestingly, the longitudinal metallic resistivity ($\rho_{xx}$) shows a resistivity minimum at around 10K, similar to Kondo effects observed in the case of non-magnetic metals due to dilute magnetic impurities. The transport properties will be discussed in terms of the underlying spin correlations in the Co$_2$Si nanoparticle films. This work is supported by the U.S. DOE-BES-DMSE (Grant No. DE-FG02-04ER46152) and NCMN.