CORE-CM SEMINAR
Michigan State University

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Semiconductor Nanocrystals: Discovery, Milestones, and Recent Theoretical Developments

Semiconductor nanocrystals (NCs) are the most heavily studied of the nanoscale semiconductors. The size dependence of the NC optical properties was discovered independently more than 30 years ago in two different materials: in semiconductor-doped glasses by Ekimov et al (1981), and in aqueous solutions by Brus et al (1983). The 30 plus years of investigations of NCs got a critical burst when Brus' former postdoc, M. Bawendi, moved from Bell Labs to MIT where, in 1993, he and two of his students, C. Murray and D. Norris, published a paper that provided the first reliable technology of various colloidal nanocrystal growth. The technology allows growth of almost monodisperse NCs in a wide range of sizes. The paper demonstrated the extremely narrow NC size dispersion with remarkable control of the CdSe NC size. Finally the authors showed that various semiconductors could be grown in NC form. I will briefly discuss the history of the discovery, the main obstacles in the development of the field and the critical breakthroughs in establishing the field.

Today, semiconductor NCs have become much more than objects of scientific curiosity. The demonstration of tunable, room-temperature lasing using NC quantum dot solids, the development of NC-based light-emitting diodes and photovoltaic cells, and the first commercial products in the area of NC bio-labeling are just a few illustrations of the broad technological potential of these materials. Turn out that nonradiative Auger recombination is the central non-radiative relaxation process, which negatively affect the performance of all these devices.

I am going to discuss why the nonradiative Auger recombination is enhanced in NCs and how we can suppress them. Finally I am going to discuss magnetic properties of nonmagnetic semiconductor NCs. I will show that interaction between dangling bonds at the NC surface and NC excitons leads to the dynamical polarization of the dangling bond spins and the formation of a dangling bond magnetic polaron. The thermal depolarization of the polaron state explains the small activation energies observed in the temperature dependences of the exciton lifetimes of CdSe NCs and resolved 20 years old puzzle on unusual properties of low temperature photoluminescence in these NCs.

Thursday, Sept. 17, 2015
12:00 NOON
Room 1400 – Biomedical & Physical Sciences
Professor Carlo Piermarocchi – Host