Ph.D. Course in Materials Science and Nanotechnology

University of Milano-Bicocca, Department of Materials Science, via Cozzi 55, 20125 Milano

March 13, 2018 – 3.30 p.m.

Seminar room - Department of Materials Science U5

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Interacting Rydberg Excitons in Cuprous Oxide

Excitons determine the optical properties of semiconductors and insulators. Their description as hydrogen atom-like complexes has turned out to be an extremely successful concept. In Rydberg atoms an electron has been promoted into a state with high principal quantum number. Thereby the atom becomes a mesoscopic quantum object with dimensions up to the micrometer-range. Recently it was shown that also an exciton can be highly excited by observing states with principal quantum number up to n=25 in natural cuprous oxide crystals. This corresponds to an average radius of the wave functions of more than 1 µm so that the exciton wave function covers more than 10 billion crystal unit cells. In this contribution we will discuss possible limitations for the highest excitable principal quantum number in experiment. We will also address the behavior of these excitons when exposed to strong electric or magnetic fields, and compare this behavior to atoms. Rydberg excitons exhibit also giant interaction effects with other excitations in the crystal. An example is the giant exciton-exciton interaction, leading to the Rydberg blockade where the presence of one Rydberg exciton blocks the excitation of another one in its vicinity. The efficiency of this blockade scales with the 10-th power of the principal quantum number. Another example is the interaction of excitons with a low-density electron-hole plasma. Here the Mott transitions from an insulating to a metallic phase can be studied with unprecedented accuracy: while the band gap energy becomes renormalized by the plasma, the exciton energies surprisingly remain unaffected with micro-eV resolution.

PhD students and all interested in the seminar are kindly invited to participate.

The PhD Coordinator

Prof. Marco Bernasconi