Fan Pan

On the Properties of a Few Electron-Hole system in a Double One-dimensional Harmonic Trap

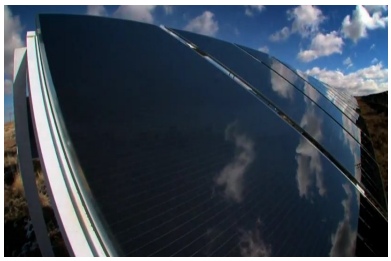
One of the most important concepts in condensed matter physics is that of ``quasi particles''. The exciton is one such quasi particle. In semi-conductors, excitons are formed by the excitation of electrons from valence band to the conduction band, which creates holes in the valence band. Because of the Coulomb force, the electron and the hole are attracted to each other and can form a ``hydrogen-like'' bound state called the exciton.

One notable property of excitons is that they are composite bosons. Bosons are known to form condensates, as was predicted already in mid 1920's (Bose-Einstein condensation, BEC). Such condensates manifest themselves in phenomena such as superfluidity and superconductivity. A question which has often been raised in the literature is: do excitons form condensates.

The issue of exciton condensate is more relevant today than ever before because a great deal of progress has been made in experimental techniques for producing condensates. Since 1995 one has been able to produce condensates of several different kinds of atoms, such as Rb, Na, Cs, Ca, and even hydrogen. These methods give a new hope for a more successful production and study of exciton condensates.

One major problem with excitons is their short lifetimes while in order to be possible to detect and study their condensates their lifetime should preferably be longer than the cooling time. The electron and the hole tend to recombine and emit light. Therefore recent experiments focus on semiconductor structures with two coupled parallel quantum wells, namely "indirect" excitons. The point is that these excitons can be made to have much longer lifetimes by increasing the strength of the applied electric field.

I would like to add that excitons have been investigated in many different materials, for example the single-walled carbon nanotubes, semiconductor quantum dots and organic polymers. One branch of these studies concerns solar cells. Since the excitons play an important role in converting photonic energy into electronic energy as well as for transport of energy, some researchers are trying to find high efficiency ``exciton-friendly'' materials that would be suitable to use in solar cells.



Solar cells
http://www.youtube.com/watch?v=P-3we8Dd76M

Supervisor: **Stephanie M. Reimann**
Thesis 30 credits in Physics
Department of Physics, Lund University