Title:
The Many-Body Problem in Materials Science

Abstract:
Materials science spans a very rich variety of highly interesting problems of both scientific and technological importance. To mention one example, the phenomenon of high temperature superconductivity is still awaiting a theoretical explanation despite large efforts from the mid-eighties. Another equally important example is a large class of materials, which exhibit a drastic change in their properties upon small changes of external parameters such as pressure or temperature [1]. Some materials can undergo transition from metal to insulator under a slight change of pressure. These materials have been under intensive studies experimentally and theoretically since the last two decades. Apart from purely theoretical interest, this type of materials might offer a large potential for technological applications.

Materials consist of very many electrons, of the order of 10^{23}, moving around a lattice of nuclei. The electrons interact with each other and this interaction among the electrons is very hard to take into account due to the large number of electrons. It is precisely this interaction among the electrons that is crucial in determining the many interesting properties of materials. Many-body theories in materials science are concerned with approximate ways of solving the problems of interacting electrons. [2]
In this talk, we discuss what has so far been achieved in solving the many-body problem and what kinds of materials and what properties cannot be treated within the present theories. We then discuss the latest development in improving the present theories.

[1] G. Kotliar and D. Vollhardt, Physics Today 53 (March 2004)
[2] F. Aryasetiawan and O. Gunnarsson, Rep. Prog. Phys. **61**, 237 (1998)