Informal Seminar

Department of Physics

QUANTUM PHENOMENA IN NATURE: SUPERCONDUCTIVITY AND PECULIAR MAGNETISM IN MINERALS

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The manifestations of quantum cooperative phenomena, i.e. superconductivity and peculiar forms of low dimensional and frustrated magnetism, can be found in both common and rare minerals. Even the discovery of superfluidity in liquid helium is obliged in a sense to mineralogy since the first terrestrial source of this noble gas was mineral cleveite UO_2 subject to a radioactive decay. The superconductivity was found and investigated in details for miassite $Rh_{17}S_{15}$, palladseite $Pd_{17}Se_{15}$ and calaverite $AuTe_2$ minerals. The miassite demonstrates fascinating features of strongly correlated superconductivity as opposed to conventional superconductivity in palladseite, while calaverite exhibits superconductivity associated with breaking of Te_2 dimers. The most versatile are magnetic effects in minerals containing various transition metal ions. A fairly abundant ferromagnetic magnetite Fe_3O_4 is a host of important metal – insulator transition whose nature with regards to structural and electronic properties is still elusive. Apart from strongly magnetic minerals, an interest is attracted recently by minerals whose properties are directly opposite to that of magnetite. Some Cu-based minerals realize at low temperatures the states of gapped or gapless spin liquids. These are the cases of valence bond crystal in clinoclase $Cu_3(AsO_4)(OH)_3$ or spin singlet state in edwardsite $Cd_2Cu_3(OH)_6(SO_4)_24H_2O$. Another interesting class of magnetic materials is represented by minerals forming exotic long – range ordered magnetic structures, as are the cases of newly studied francisite $Cu_3BiSe_2O_8Cl$ and dugganite $Pb_3TeCo_3V_2O_{14}$. All in all, the investigations of basic properties of spin liquids and spin solids in minerals are quite instructive to get better insight into mechanisms of quantum ground state formation in matter.

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