

Area Seminar

Title	Thermodynamical Phase transitions, mean-field theories, and the renormalization (semi)group: A pedagogical introduction(*)
Date and Time	26/12/2013 16:00:00
Speaker	Dr. Navinder Singh
PRL	
Area	Theoretical Physics
Venue	Room No. 469
Abstract	<p>Lev Landau (the famous Russian physicist) made fundamental contributions in a wide spectrum of physical problems. While analysing second order thermodynamical phase transitions, he introduced a very vital concept, the concept of an "order parameter". This not only amalgamated the previous fragmentary theoretical understanding of phase transitions (an arsenal of mean-field theories) but also it put forward the important theory of "spontaneous symmetry breaking".</p> <p>Today, order parameter concept is a paradigm both in condensed matter physics and in high energy physics, and Landau theory is a pinnacle of all mean-field theories. Mean field theories are good qualitative descriptors of the phase transition behaviour. But all mean-field theories (including Landau's theory) fail at the critical point (the problem of large correlation length). The problems with large correlation length in quantum many-body systems are the hardest problems known in theoretical physics (both in condensed matter and in particle physics). It was Ken Wilson's physical insights and his powerful mathematical skills that opened a way to the solution of such hard problems. This presentation will be a perspective on these issues. Starting with simple examples of phase transitions (like ice/water; diamond/graphite etc) we will address the following fundamental questions: Why does non-analyticity (sharp phase transitions) arise when thermodynamical functions (i.e., free energies etc) are good analytic functions? How does Landau's program unify all the previous mean-field theories? Why do all the mean-field theories fail near the critical point? How does Wilson's program go beyond all the mean-field theories? What are physical meanings of various kinds of fixed points? What is emergence and universality? Although the presentation will deal with mundane phenomena, we will also discuss the Anderson-Higgs mechanism and the origin of mass (the Higgs boson) which is a consequence of spontaneous symmetry breaking of "the vacuum" (by comparing that with a similar phenomenon in superconductors). (*) This presentation is our tribute to Ken Wilson (the pioneer of the renormalization group) who expired few months ago.</p>