CEA-Direction des sciences de la matière

Institut de physique théorique

Unité de recherche associée au CNRS

Cours de physique théorique

Organisé en collaboration avec

École doctorale de physique de la région parisienne - ED 107

Quantum criticality and high-temperature superconductivity

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Les vendredis 13/9/2013, 20/9, 27/9, 4/10, 11/10 à 10h00.

In these lectures we discuss the behavior of a physical system near a quantum critical point separating different phases. The word "quantum" reflects the fact that the transition occurs also at zero temperature, with tuning parameters (like doping) characterizing the system.

For quite a long time it was assumed that quantum critical behavior in d dimensions is similar to classical critical behavior in d+1 dimensions, where the extra dimension is time. This makes it possible either to obtain scaling relations and calculate critical exponents, or to conclude that the transition is of the first order.

Unexpectedly, a completely different scenario has been discovered recently in 2+1 dimensional models of fermions interacting with critical spin waves near a quantum antiferromagnet-normal metal transition. Near such a quantum phase transition the system develops an SU(2) order parameter, which characterizes the mixture of superconductivity with a charge density wave. The resulting states, which completely differ from the original antiferromagnetic state, are described by a non-linear sigma model and can be studied using the renormalization group. In particular, at low temperature, the system can exhibit d-wave superconductivity. Accumulating experimental evidence suggests that this scenario may well describe the physics of high temperature superconducting cuprates.

The lectures will begin with the introduction of the concept of quantum criticality. It will then be demonstrated how the symmetry is spontaneously broken, and why gapless fluctuations are described by the SU(2) non-linear sigma model. Renormalization group equations will be derived, leading to the phase diagram. Finally, the relevance of these ideas to high temperature superconductivity in cuprates will be explained.

Lieu *: IPhT, CEA Saclay, Orme des Merisiers, Bât. 774, p. 1A Salle C. Itzykson.*

Accès *: Par lignes de bus publics (Mobicaps : 9 et 10, Albatrans : 91.06 et 91.10).*
ou navettes CEA (RER B Le Guichet vers CEA Ormes D128, toutes les 15 min. de 8h00 à 9h45)

Renseignements *:* ***http://ipht.cea.fr*** *ou* ***ipht-lectures@cea.fr***

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