LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN
ARNOLD SOMMERFELD CENTER FOR THEORETICAL PHYSICS

Arnold Sommerfeld Lecture Series

Professor Boris Altshuler

Columbia University, USA

Public Lecture:

How to tell Quantum Condensates from Pendulum Clocks?

During more than 100 years of its history Quantum Mechanics passed all of the experimental checks and transformed itself from a counterintuitive concept to the undisputable foundation of the modern physics. Along with this it did not lose its ability to surprise and still allows for new astonishing discoveries such as Bose-Einstein condensation of ultracold gases.
Manifestations of the quantum mechanics on the macroscopic scales are especially impressive. In recent years the interest in condensed matter physics evolved from studying bulk properties of naturally occurring materials to constructing complex materials and systems not found in nature, and controlling rather than observing quantum mechanics. Within this tendency the concept of quantum condensation remains the central one.
Controllable quantum behavior can be achieved in systems of weakly coupled locally coherent elements. An array of Josephson junctions between superconducting islands is a representative but not the exclusive example. Other examples of such systems are ultracold gases in optical lattices, excitons and photons in semiconductor cavities, etc. Global phase coherence exists in these systems can be destroyed by reducing the coupling. In Josephson arrays this destruction is manifested by the phase transition from superconducting to insulating state.
This talk is about the relation between the classical and the quantum worlds. Some of the quantum effects, e.g. interference, can be realized in classical systems, others like Einstein-Podolsky-Rosen paradox are "truly quantum". It turns out that the quantum condensation has a classical analog: synchronization (mode-locking) in nonlinear dynamics. Discovered by Huygens almost 350 years ago the synchronization is the most fundamental nonlinear phenomenon. However the synchronization happens when the system is driven by outside forces, while one can think about BEC in thermodynamic equilibrium. On the other hand

quantum systems can be also driven. One of the familiar examples is coherent state of photons generated by a laser: this generation happens only in the presence of a pumping and does not exist in the equilibrium. The interest to the quantum systems out of equilibrium is rapidly growing due to the desire to control and manipulate quantum states. I will discuss the similarities between macroscopic quantum and classical behaviors. It looks like new interesting physics emerges on the crossroads of the quantum mechanics, condensed matter physics, and nonlinear dynamics.

Tuesday, May 22, 2012, 17:15 h, Room B 052, Theresienstr. 39, LMU

Prof. J. von Delft