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DE FRANCE
—1530—



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Artificial Magnetism and Cold Atomic Gases

December 2, 2014, 2:00 PM

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The simulation of condensed matter systems is certainly one of the most appealing perspectives opened by the recent developments in the physics of cold atomic gases. Among the large variety of quantum collective phenomena that one hopes to address with atomic vapours, magnetism is one of the richest. However, the quest for the simulation of magnetism immediately raises a challenging question: can a system of neutral atoms behave as an assembly of charged particles in a magnetic field and/or experience a spin-orbit type coupling?

In this lecture I will discuss how atom-light interaction allows one to answer this question positively. The main ingredient in this approach is the Berry's phase or its non-Abelian generalization. Starting from the general notion of adiabatic following, I will discuss the physical phenomena that can appear when atoms move in a well-chosen energy landscape generated by coherent light, and I will describe recent experimental evidences obtained with ultracold atomic assemblies for this artificial magnetism.

Short Biography

Jean Dalibard is a pioneer in the field of modern atom and quantum optics. He developed many novel experimental methods for cooling of atomic ensembles together with the related theories. This includes the magneto-optical trap which is now a standard tool in cold-atom physics. With Claude Cohen-Tannoudji he discovered Sisyphus cooling, i.e. sub-Doppler cooling in polarization gradients. Jean Dalibard also used cold atoms for atom interferometry in the time domain. He became further well-known for experiments and theoretical models in the field of condensed matter physics with ultracold atoms. Among other effects, he studied the vibrational dynamics of Bose Einstein condensates and explored physics in fewer than three dimensions. At very low temperatures, atomic ensembles are well-suited for studying analogies to solid states systems in a well-controlled environment. Phase transitions, magnetic phenomena, Quantum Hall states and more can then be seen with less defects and on a visually more accessible scale.