CEA - Saclay 91191 Gif-sur-yvette Cedex
**Service de Physique de l'Etat Condensé**

SÉMINAIRE

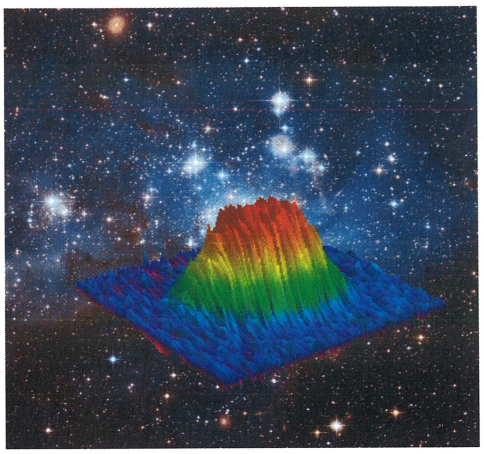
Mercredi 27 Novembre 2013 à 11h15

**Orme des Merisiers SPEC, Salle Itzykson, Bât.774**

# From ultracold Fermi Gases to Neutron Stars

## Christophe Salomon

Ecole Normale Supérieure, Paris France



The year 2011 witnessed the hundredth anniversary of the discovery by Kammerlingh Onnes of electron superconductivity in a mercury wire cooled to a temperature of about 4 kelvins. This discovery was the first observation of a modification of macroscopic properties of a system induced by collective quantum effects. With the discovery of superfluid liquid helium, it opened the way to a very active research domain and to a great variety of applications. In this vast family of quantum solids or fluids, ultracold gases and polaritons are the last born.

Thanks to the great flexibility of laser cooling and trapping methods, ultracold gases offer to study these quantum correlated systems with a new twist. It is possible for instance to tune the strength and sign of the interaction between atoms. Optical lattices, realized by interfering laser beams, create periodic optical potentials that mimic the crystalline potential seen by electrons in solids. Controlled disorder can be introduced to study the localization of matter-waves predicted by P.W. Anderson more than 50 years ago. Dilute atomic gases can thus be considered as model systems to address some pending problem in Many-Body physics that occur in condensed matter systems, nuclear physics, and astrophysics.

In this talk, we will describe the seemingly simplest case of attractive spin 1/2 fermions with tunable interaction. We will show that the gas properties can continuously change from those of weakly interacting Cooper pairs described by Bardeen-Cooper-Schrieffer theory to those of strongly bound molecules undergoing Bose-Einstein condensation. A new imaging method enable us to probe with high precision the thermodynamics of locally homogeneous ultracold gases [1,2,3] and to perform stringent tests of recent many-body theories. The equation of state of fermions has been measured as a function of interaction strength and temperature. Despite orders of magnitude difference in density and temperature, our equation of state can be used to describe low density neutron matter such as the outer shell of neutron stars.

[1] S. Nascimbène, N. Navon, K. Jiang, F. Chevy, and C. Salomon, *Nature* **463**, 1057 (2010)
[2] N. Navon, S. Nascimbène, F. Chevy, and C. Salomon, *Science* **328**, 729 (2010)
[3] S. Nascimbène, N. Navon, S. Pilati, F. Chevy, S. Giorgini, A. Georges, and C. Salomon,Phys. Rev. Lett., **106,** 215303 (2011)

A coffee break will be served at 11h00. The seminar will be given in English.

Contact : marcelo.goffman@cea.fr/sebastien.aumaitre@cea.fr - Tel : +33 1 69 08 55 29 / 74 37
http://iramis.cea.fr/spec/