Meeting between mathematicians and physicists on Bose Einstein condensates

Thursday, March 29th 2018
Institut Henri Poincaré, Paris, room 314

Please register by sending an email to amandine.aftalion@math.cnrs.fr
(saying whether you want to stay for lunch)

9:30 **Frédéric Chevy**
(LKB, ENS)

Dynamics of ultracold Fermi gases: Gross-Pitaevskii and beyond

10:15 **Christos Sourdis**
(Institute of Applied and Computational Mathematics, FORTH, Heraklion, Greece)

Domain wall solutions in the Gross-Pitaevskii system for two-component Bose-Einstein condensates

11:00 Break

11:15 **Simon Pigeon**
(LKB, UPMC)

Vortices in driven dissipative superfluid

12:00 **Etienne Sandier**
(Laboratoire de mathématiques, Université Paris-Est)

Analysis of a rotating two-component Bose-Einstein condensate

12:45 Lunch (please register)

Abstracts below.

Abstracts

Frédéric Chevy
(LKB, ENS)
Title : Dynamics of ultracold Fermi gases: Gross-Pitaevskii and beyond
Abstract: With Bose-Einstein condensation, fermionic superfludity is one of the main paradigms in quantum many-body physics. In the early 80's, Leggett, Nozières and Schmitt-Rink suggested that they could be unified within a single model, the so-called BEC-BCS crossover describing the ground state of an ensemble of attractive fermions. In this scenario, weakly attractive fermions are described by Bardeen-Cooper and Schrieffer's (BCS) theory while in the strongly attractive regime they form a Bose-Einstein condensate of deeply bound bosonic dimers. The BEC-BCS crossover hypothesis was confirmed experimentally in 2003 using ultracold vapours. However, an accurate and comprehensive theoretical description of the properties is still missing. In my talk, I will present an overview of recent advances in the experimental and theoretical study of strongly correlated fermions. I will show how Gross-Pitaevskii equation can be extended to address the dynamics of these systems within the hydrodynamic approximation and I will discuss numerical strategies pursued to capture the dynamics of solitons or vortices in these systems.

Christos Sourdis
(Institute of Applied and Computational Mathematics, FORTH, Heraklion, Greece)
Title: Domain wall solutions in the Gross-Pitaevskii system for two-component Bose-Einstein condensates
Abstract We study the boundary of two mixed Bose-Einstein condensates interacting repulsively, in the case of spatial separation, as described by a one-dimensional domain wall solution of two coupled nonlinear Gross-Pitaevskii equations. We prove uniqueness of such a solution and study its behaviour in the cases of weak and strong separation.

Simon Pigeon
(LKB, UPMC)
Title: Vortices in dissipative driven superfluid
Abstract : Exciton-polaritons, microcavity half-matter half-light quasi-particles, when resonantly driven exhibit a superfluid regime. Accordingly, topological excitations similar to those predicted in equilibrium superfluids may spontaneously appear. However, the driven-dissipative nature of polaritons requires the system to be continuously pumped in order to compensate for losses. This driving plays a crucial role in the formation and dynamics of such topological excitations. I will illustrate how the jointed addition of an incoherent dumping rate and a coherent driving in the standard Gross-Pitaevskii equation modifies the physics of superfluids.

Etienne Sandier
(Laboratoire de mathématiques, Université Paris-Est)
Title: Analysis of a rotating two-component Bose-Einstein condensate
Abstract: In this joint work with Amandine Aftalion we study the ground states of a rotating two-component condensate in a two-dimensional domain. We find that, at least until the rotation becomes too large for the vortex structure to be well-defined, the two components behave like simple condensates in regions determined by the volume fraction and a minimal interface criterion.