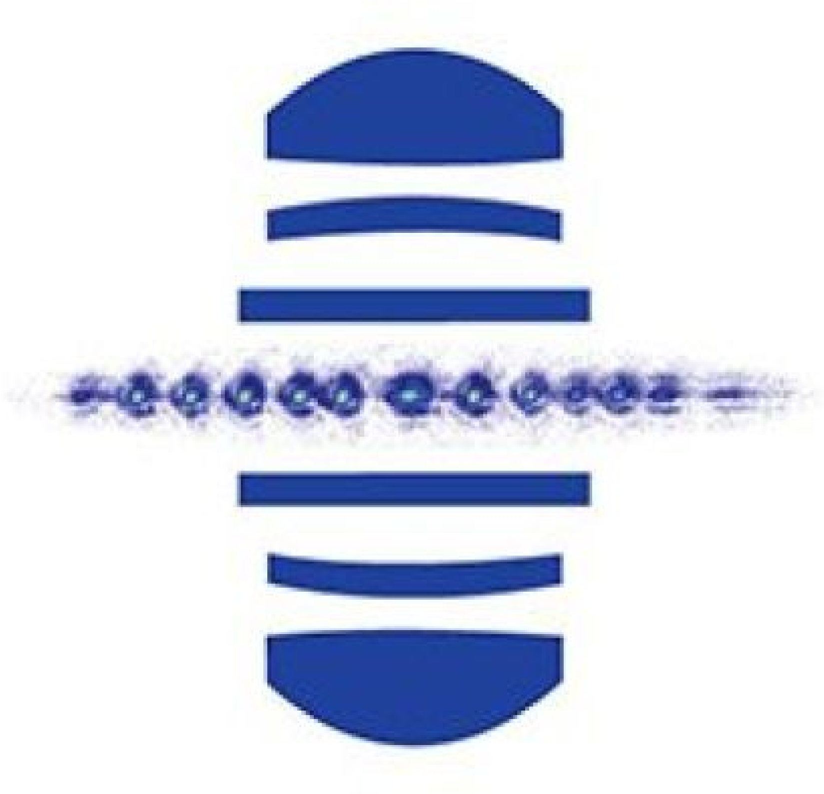

PhD Thesis Defense JULIO SANZ SANCHEZ 'Two-Component Bose-Einstein Condensates with Competing Interactions'

JULIO SANZ SANCHEZ

February 10, 2020

10:30

ICFO Auditorium

Thesis Defense, February 10, 10:30. ICFO Auditorium

JULIO SANZ SANCHEZ

Ultracold Quantum Gases

ICFO-The Institute of Photonic Sciences

This thesis reports the experimental study of two-component Bose-Einstein condensates with tunable interactions, which are exploited as a platform to perform quantum simulation of many-body quantum systems.

To perform this experiments, we have implemented an atomic source consisting on a glass cell 2D MOT vacuum chamber and a high resolution optical system to image and manipulate the atoms. Furthermore, we develop and characterize a polarization phase contrast technique which is able to probe optically dense atomic mixtures at intermediate and high magnetic fields in open transitions. This technique has been used to either probe the total column density of a two-component atomic cloud or the difference in column density between both components.

We report on the first observation of composite quantum liquid droplets in an incoherent mixture with residual mean field attraction. Strikingly, this novel phase is stabilized due to the repulsive beyond mean field corrections in a weakly interacting system. Moreover, we have characterized the liquid to gas phase transition which occurs for small atom numbers.

Additionally, we have compared two different self-bound states in a quasi-1D geometry with incoherent mixtures: quantum droplets and bright solitons. Depending on the atom number and interaction strengths both states can be smoothly connected through a crossover or be distinct entities separated by a transition. We have measured its composition, its phase diagram and mapped out the soliton to droplet transition.

Finally, we report on a technique to modify the elastic and inelastic interactions in a two-component Bose-Einstein condensate with very unequal and competing interactions under the presence of strong coherent coupling. This technique provides a wide flexibility and has allowed us to observe bright solitons in quasi-1D in a coherently coupled dressed state.

We exploit the fast temporal control of the effective interactions to quench them into the attractive regime and study the resulting modulational instability which develops into a bright soliton train.

Monday, February 10, 10:30. ICFO Auditorium

Thesis Advisor: Prof Dr Leticia Tarruell

Julio Sanz Sanchez's Thesi Cover