Scientific report on Short Visit Grant

Ref: QUDEDIS Grant 466

During the visit that I did to the BEC Center from Univerisity of Trento, Italy (March 5-12, 2005) I had the opportunity to discuss with the various members of the group that were in the Center these days, as well as tell them what we are studying in my group in Barcelona. (Unfortunately, Prof. Stringari and Prof. Pitaevskii were in Paris that week.)

First, I gave a seminar on various aspects of my PhD research in Barcelona, from boson-fermions mixtures to spinor condensates. After this talk, several interesting points of discussion raised. In particular, I discussed several times with Dr. Iacopo Carusotto on how to properly simulate the quantum and thermal fluctuations in a realistic time-dependent study of spinor condensates, a work we are currently developing in our group in collaboration with Dr. Anna Sanpera and Dr. Maciej Lewenstein.

I could also discuss with Prof. Franco Dalfovo on a recent paper we have submitted on a microscopic study of an ultracold, bosonic system for which the use of the mean-field Gross-Pitaevskii theory is not valid [1]. Prof. Dalfovo made a couple of suggestion on how to continue this work, which we will carefully study.

Finally, I could also discuss with Dr. Chiara Menotti and Dr. Gregory Astrakharchik on how to calculate the excitation modes of a two-dimensional Fermi gas. This is a point of present interest as the study of excitation modes has long been used to identify different quantum phases in ultracold gases, in particular the superfluid nature of bosonic condensates [2]. It is a matter of present interest to study fermionic systems, and finding a way to determine if they are superfluid or not would be of great importance. We have made the prediction that this superfluid transition would be easier in a (quasi)-2D geometry [3], so the determination of the excitation modes of a two-dimensional Fermi system becomes very interesting. From the discussions with Dr. Menotti and Dr. Astrakharchik I have learned some results known from the study of bosonic and fermionic systems in 3D and 1D, and the tecniques to apply for the study we want to perform in the near future.

From all this, I conclude that my visit to the BEC Center in Trento has been very useful for our present research on spinor condensates and also for our project to study the excitation modes of two-dimensional, fermionic gases.

Jordi Mur-Petit
Barcelona, March 14th, 2005

References

[1] J. K. Nilsen, J. Mur-Petit, M. Guilleumas, M. Hjorth-Jensen and A. Polls, Phys. Rev. A (to appear, 2005).

[2] M.-O. Mewes *et al.*, Phys. Rev. Lett **77**, 988 (1996); F. Dalfovo, S. Giorgini, L. P. Pitaevskii and S. Stringari, Rev. Mod. Phys. **71**, 463 (1999).

[3] J. Mur-Petit, A. Polls, M. Baldo and H.-J. Schulze, Phys. Rev. A **69**, 023606 (2004).