

Bose-Einstein condensates and antiferromagnetic interactions: An illustration of symmetry breaking

J. Dalibard¹

¹*Collège de France and Laboratoire Kastler Brossel, CNRS - ENS - UPMC, 11 Place Marcelin Berthelot, 75005, Paris*

Presenting Author: jean.dalibard@lkb.ens.fr

In a spinor Bose gas, contact interactions can induce effective spin-spin interactions [1]. In the case of sodium atoms (^{23}Na , spin 1), these effective interactions are antiferromagnetic, which leads to a series of interesting phenomena. Here I will focus on recent experimental investigations that we have performed at ENS on a sodium condensate in the so-called Single Mode Approximation [2]: in this low temperature regime, all atoms occupy the same orbital wave function and only the spin degree of freedom is relevant. In the absence of external field, the exact ground state is expected to be the (massively entangled) singlet state, with a zero total spin [3]. However one can also use an approximate symmetry-breaking approach, in which all atoms condense a single spin state $S_z = 0$ along an arbitrary z direction. I will discuss both approaches and connect them with the notion of a fragmented condensate [4], i.e., a situation where several states of a many-body system are simultaneously macroscopically populated [5].

This research has been performed in collaboration with Fabrice Gerbier, Tilman Zibold, Luigi De Sarlo, Emmanuel Mimoun, David Jacob, Lingxuan Shao, Vincent Corre and Camille Frapolli. It is supported by the ERC Synergy program (UQUAM project).

References

- [1] D.M. Stamper-Kurn and M. Ueda, *Rev. Mod. Phys.* **85**, 1191 (2013)
- [2] see e.g. David Jacob, Lingxuan Shao, Vincent Corre, Tilman Zibold, Luigi De Sarlo, Emmanuel Mimoun, Jean Dalibard and Fabrice Gerbier, *Phys. Rev. A* **86**, 061601(R) (2012)
- [3] C.K. Law, H. Pu and N. Bigelow, *Phys. Rev. Lett.* **81**, 5257 (1998) ; T.L. Ho and S.K. Yip, *Phys. Rev. Lett.* **84**, 4031 (2000) ; Y. Castin and C. Herzog, *C. R. Acad. Sci.* **2** 419 43 (2001) ; S. Ashhab and A. J. Leggett, *Phys. Rev. A* **65**, 023604 (2002)
- [4] E.J. Mueller, T.L. Ho, M. Ueda and G. Baym, *Phys. Rev. A* **74**, 033612 (2006)
- [5] Luigi De Sarlo, Lingxuan Shao, Vincent Corre, Tilman Zibold, David Jacob, Jean Dalibard, Fabrice Gerbier, *New Journal of Physics* **15**, 113039 (2013).