Thermodynamics of an isolated Bose gas and the role of observation

Krzysztof Góral[1], Mariusz Gajda[2], and Kazimierz Rzążewski[1]

[1] *Center for Theoretical Physics,* [2] *Institute of Physics,*
Polish Academy of Sciences, Aleja Lotników 32/46, 02-668 Warsaw, Poland
E-mail: goral@cft.edu.pl

Understanding the quantum behavior of a Bose-Einstein condensate at non-zero temperatures remains a challenge. There exists no simple and convenient technique describing the condensate in dynamical equilibrium with the thermal cloud, at temperatures close to the critical one. Here we report the discovery of such a tool [1]. We show that the whole isolated system may be viewed as a single 'classical field' undergoing nonlinear dynamics leading to a steady state. It is the observation process and the finite detection time that allow for splitting the field into the condensate and the thermal cloud.

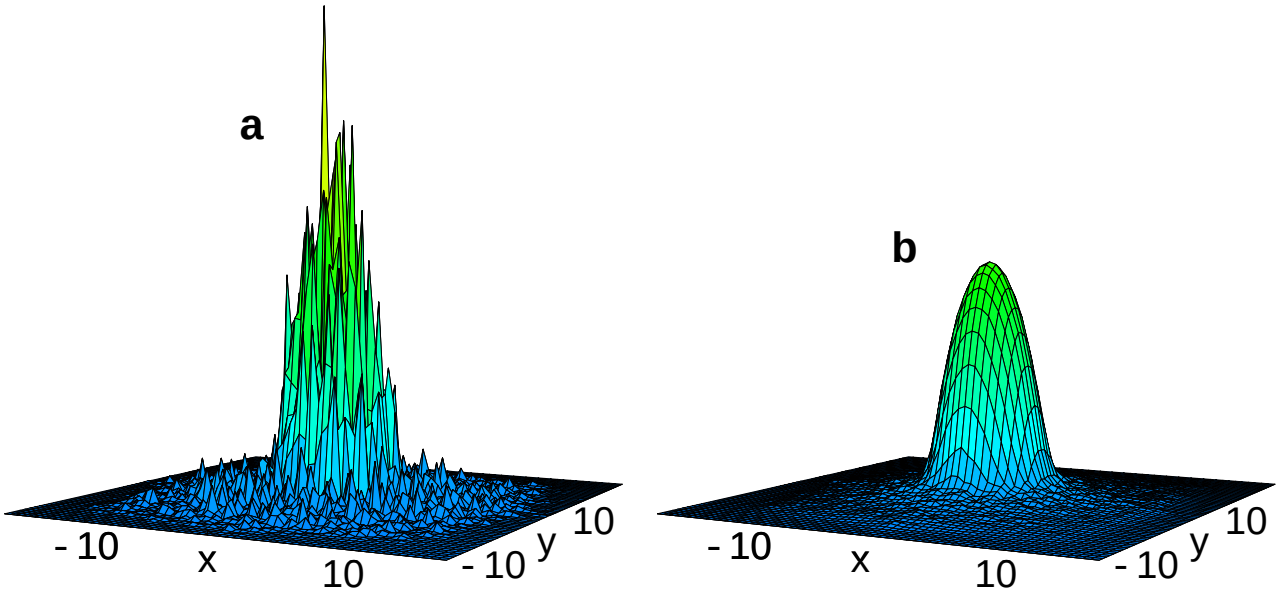

Figure 1: Cross-section of the density distribution of the Bose gas with the total energy $E = 70\,\hbar\omega$ and composed of $N = 10^5$ ^{87}Rb atoms trapped in a spherically symmetric trap of frequency $\omega = 2\pi 100$Hz. **a** Instantaneous snapshot. **b** Distribution averaged over one period of the trap. Lengths are given in units of $d = \sqrt{\hbar/m\omega}$.

[1] K. Góral, M. Gajda, and K. Rzążewski, cond-mat/0203259.