Josephson junctions for ultracold gases

Markus Oberthaler

Kirchhoff Institut für Physik/Universität Heidelberg
Im Neuenheimer Feld 227
69120 Heidelberg

The recent realization of atomic Bose-Einstein condensates opens up the way to observe fundamental quantum mechanical effects on a macroscopic scale. Fortunately the situation is far from being an ideal gas realization and the interactions between particles play a crucial role and lead to new phenomena [1].
We will discuss a paradigm quantum effect namely tunnelling of Bose-Einstein condensates through a barrier. This situation is closely related to the physics of Josephson junctions known from weakly coupled superconductors. In contrast to the condensed matter experiments the population difference as well as the phase difference can be directly measured and the atom-atom interaction leads to new dynamical modes where tunnelling ceases to exist. It will also be discussed how this system can be utilized for the realization of the smallest possible thermometer which allows for temperature measurements in a regime where standard methods fail. Finally some light will be shed on the fact that the experiments are performed with particles and thus the description using a macroscopic wave function fails to predict certain measurable observables.

[1] Nobel laureate Eric Cornell pointed out: *"The overall picture [of BEC theory of an ideal gas] is sufficiently easy to understand that, if the system truly were an ideal gas, there would be little left to study at this point"*