Spontaneous emission of atoms via collisions of Bose-Einstein condensates

Radka Bach[1], Marek Trippenbach[2] and Kazimierz Rzążewski[1]

[1] *Center for Theoretical Physics, Polish Academy of Sciences*
al. Lotników 32/46, 02-668 Warsaw, Poland
[2] *Institute of Experimental Physics, Optics Division, Warsaw University*
69 Hoża Street, 00-681 Warsaw, Poland

The widely used Gross-Pitaevskii equation treats only coherent aspects of the evolution of a Bose-Einstein condensate. However, during the dynamics some atoms will inevitably scatter out of the condensate. Our aim is to understand and describe such losses.

We will present a method, based on the field theory formulation, describing the dynamics of incoherent processes which are due to elastic collisions. In this way processes of spontaneous emission of atoms into empty modes can be treated, as opposed to stimulated processes (which require non-zero initial occupation).

The connection with the well-known Bogoliubov method as well as the conditions of validity of our approximation are studied in more detail. The situation of two counter-propagating plane waves of atoms is treated analytically, giving insight not only into the full dynamics of mode occupation, but also into the statistics of scattered atoms.

The more realistic case of colliding wavepackets is approached as well. The losses, calculated within the first order perturbation theory in the coupling constant, are compared with the pre-existing results, producing an excellent agreement. An idealised version of a four-wave mixing experiment is also investigated.

Acknowledgments. R.B. and K.Rz. acknowledge the support of the subsidy from Foundation for Polish Science, while M.T. acknowledges support from KBN nr 2P03B7819.