Pulsed pumping of a Bose-Einstein condensate

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Atom lasers are coherent matter waves that are derived from Bose-Einstein condensates and bear striking similarities to optical lasers. The main reasons for the importance of optical lasers are their unique coherence properties and high brightness that offer significant advantages over thermal light sources. In a very similar way, the atom laser is a promising device where a high brightness coherent atomic source is required. In the context of high signal-to-noise measurement processes, the achievable brightness of an atom laser may open the route towards unachieved detection senitivities.

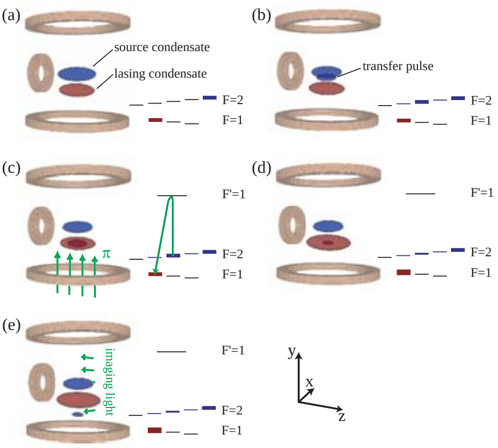

Fig. 1: Scheme for the pulsed pumping of a Bose-Einstein condensate.

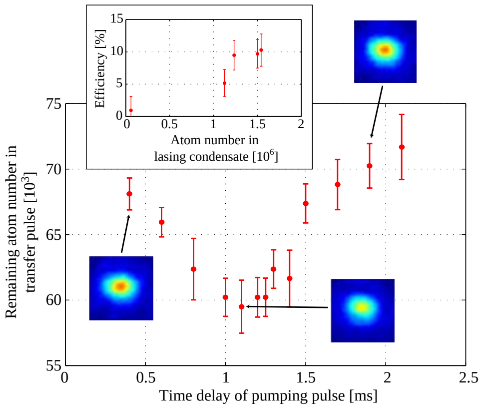

Fig. 2: Resonance depletion curve of the population in the transfer pulse.

In order to realize a truly high brightness and flux in atom lasers, it is crucial to implement a mechanism allowing for continuous operation of the device. So far, the average flux of an atom laser has been limited by the repetition cycle of the apparatus producing the Bose-Einstein condensate. An atom laser can only be output-coupled until the Bose-Einstein condensate that serves as a source (the lasing condensate) is depleted. For continuous operation it is necessary to implement a mechanism that coherently replenishes the lasing condensate. Recently, our group has achieved such a pumping mechanism in the regime where the replenishment is realized at time scales corresponding to quasi-continuous operation of the atom laser (of the order of 100 ms) [1]. Our aim in this work is to isolate and measure the process that drives the pumped atom laser. We present results on this pumping mechanism operating in the pulsed regime [2]. A coherent population transfer between a source and a lasing condensate is realized by means of an atom laser transfer pulse (Fig. 1). The timescales of the population transfer are of the order of the frequency width of the condensates. This offers the opportunity to characterize the pumping mechanism in a different temporal regime and to use a different detection channel on the underlying process. As opposed to the work in [1], we detect the population transfer by measuring the depletion of the transfer pulse (Fig. 2) instead of an increase of atom number in the lasing mode after the pumping. Additionally, we measure the temperature of the lasing condensate after the pumping pulse. The data shows a clear resonance both in number and in temperature, proving a coherent transfer of atoms into the lasing condensate and shedding light onto the underlying mechanism.

References

[1] Nicholas P. Robins, Cristina Figl, Matthew Jeppesen, Graham R. Dennis, John D. Close, Nature Physics **4**, 731 (2008).

[2] D. Döring, G. R. Dennis, N. P. Robins, M. Jeppesen, C. Figl, J. J. Hope, and J. D. Close, arXiv:0901.1484.