A new type of evaporative cooling for neutral atoms [Review of: H. Stoop (1998) Comment on "A new type of evaporative cooling for neutral atoms"]

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Comment on "A New Type of Evaporative Cooling for Neutral Atoms"

We believe the Letter by Stoop [1] contains a serious conceptual error and that the conclusion that Bose-Einstein condensation (BEC) can be approached using the proposed method is wrong.

The Letter proposes a method to cool a trapped gas of metastable atoms in such a way that the energy distribution remains thermal even in the absence of thermalizing collisions. This is achieved by arranging a loss mechanism that is proportional in strength to the potential energy of the particles, which will cause particles to be removed from all trapped states, but preferentially from the highest energy states.

In the Letter [1], an explicit analysis is given of the cooling dynamics in the one-dimensional case. However, the conclusion that BEC is attained is based on incorrect use of Eq. (18), which is valid only for a harmonic trap in three dimensions. Actually, as is clearly seen from Eq. (14), the proposed cooling method does not increase the occupation of any trap state. This is not a coincidental feature of the specific system chosen by the author. For a more general class of cooling mechanisms, Ketterle and Pritchard have shown [2] that *in the absence of collisions* no loss process or time dependent term in the Hamiltonian can lead to increase in the occupation number of any trapped state.

When we extend the analysis of the author to 3D, a step that was not performed in the Letter, we find that the value of $\Omega \mathcal{N}^{1/3}/k_B T$ becomes independent of time. Hence, the proposed type of cooling does not lead to BEC.

In conclusion, we would like to emphasize that collisionless loss processes, such as were considered in the Letter, cannot bring a trapped gas closer to quantum degeneracy.

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