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Limit to spin squeezing in finite temperature Bose-Einstein condensates

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Quantum correlations could be used in atomic clocks and interferometers to increase their sensitivity with respect of using uncorrelated atoms. A simple class of states useful for metrology are spin squeezed states. Recently such states could be obtained using interactions in condensates with two internal states [1,2]. A crucial question is the scaling of the spin squeezing (or metrology gain) with the atom number.
We show that, at finite temperature, the maximum spin squeezing achievable using interactions in Bose-Einstein condensates has a finite limit when the atom number N tends to infinity at fixed density and interaction strength. We calculate the limit of the squeezing parameter for a spatially homogeneous system and show that it is bounded from above by the initial non-condensed fraction [3,4].
The last step towards a full theoretical understanding of the spin squeezing dynamics, includes the effect of the trap present in the experiments. Although significantly complicates the theoretical analysis, we will see that an analytical treatment can be pushed to the end to obtain the maximum squeezing in the large system-size limit [5].

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