Atom interferometry with a weakly interacting Bose-Einstein condensate

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Bose-Einstein condensates have been considered since long the most appropriate source for interferometry with matter waves, due to their maximal coherence properties. However, the realization of practical interferometers with condensates has been so far hindered by the presence of the natural atom-atom interaction, which dramatically affects their performance. We will report on the realization of an interferometer based on a Bose-Einstein condensate of ^{39}K atoms, where the contact interaction between atoms can be tuned by means of a Feshbach resonance [1]. We observe that the coherence time of the interferometer is greatly enhanced by a reduction of the contact interaction by orders of magnitude from the standard value[2]. We also study the effect of the residual magnetic dipole-dipole interaction.

Our results indicate that interferometry with well suited Bose-Einstein condensates is possible, with an expected gain in performances. Our specific interferometer, which is based on Bloch oscillations in an optical lattice under gravity, features a high spatial resolution that is promising for future application to the measurement of fundamental forces in proximity of surfaces.

[1] G. Roati, M. Zaccanti, C. D'Errico, J. Catani, M. Modugno, A. Simoni, M. Inguscio, and G. Modugno, "^{39}K Bose-Einstein condensate with tunable interactions", Phys. Rev. Lett. **99**, 010403 (2007).

[2] M. Fattori, C. D'Errico, G. Roati, M. Zaccanti, M. Jona-Lasinio, M. Modugno, M. Inguscio, and G. Modugno, "Atom interferometry with a weakly-interacting Bose-Einstein condensate", Phys. Rev. Lett. **100**, 080405 (2008).