Controlled transport of an elongated BEC over large distances : a 3D numerical study

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Résumé

Since the development of laser cooling and trapping atoms, a multitude of cold-atom-based devices and sensors were realized. From time keeping to measurements of fundamental constants, these devices are pushing the boundaries of exlplored quantum phenomena. A very common technique put in parctice in these experiments involves atom interferometry, where the wave nature of matter is predominant close to absolute zero temperatures. Atom interferometers reached a level of precision allowing to test fondamental principles and predictions at the heart of modern physics controversies such as Einsteins weak equivalence principle, the detection of gravitational waves, or probing the quantum superposition principle at macroscopic scales. Going beyond state-of-the-art performance in these experiments requires long interferometer durations, of the order of several seconds, and optimized matter-wave sources whose dynamics is extremely well controlled. We present here a detailed 3D realistic numerical study of the transport of an elongated Bose-Eintein Condensate (BEC) on an atom chip. The aim is to test recent proposals of fast and controlled transport of BECs over large distances, of the order of 1 to 2 mm.The limits of these protocols will be investigated in terms both of residual oscillations and residual breathing of the final quantum state.

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