Interference and Coherence in 1-d Bose-Einstein-Condensates

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Atom chips[1] promise manipulation of matter waves with high precision. Our exceptionally smooth atom chips potentials[2] allow to experiment with continuous 1 mm long 1d condensates at strong transversal confinement (>10kHz) and extreme aspect ratio up to 10000.

In these atom chip traps we employ RF induced adiabatic potentials[3] to split a 1d condensate along its long axis. Bringing the two split clouds together we observe interference between the two ensembles. The RF potentials allow unprecedented precise control enabling a coherent splitting process as demonstrated by the deterministic and stable phase of the interference[4]. The interference pattern itself is sensitive probe of the order parameter in the 1d quantum gas:

- It allows precise separation between 'condensed' and 'thermal' component
- Adjusting the barrier between the separated ensembles we study tunnel coupling and phase locking between two 1d condensates and employ phase noise thermometry[5] to measure the local temperature.
- Coherently splitting into two widely separated isolated 1d systems with a fixed phase between them, we investigate the dynamics of phase fluctuations in the order parameter of a 1d quantum gas.
- Preparing completely separated independent 1d condensates the interference allows us to study the dynamics of establishing an order parameter when going through the 'phase transition' in a finite 1d system.

In addition the RF coupling allows many *different* potential shapes to be realized, including a 2d cylinder shaped trap. The later allows to create a 2d condensate with periodic boundary conditions which exhibits peculiar interference.

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