Towards experimental studies of quantum droplets and false vacuum decay

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We report on an experimental platform for producing arbitrary potentials for ultra-cold gases based on steerable optical tweezers [1]. The apparatus is capable of loading a 3D potential with low temperature bosons (^{87}Rb) which can be degenerate, or cooled to degeneracy by modulating the potential [2]. Figure 1 shows the interference of two Bose-Einstein condensates (BECs) that have been cooled separately then merged.

We propose extensions to our setup allowing us to manipulate ^{41}K. This species shows potential for investigating false vacuum decay phenomena in ring traps. Here, a two spin component system with positive intra- and negative inter-species scattering lengths give rise to a symmetric false vacuum [3]. ^{41}K has a convenient Feshbach resonance with these properties at 675 G. Bosonic potassium isotopes have also been proposed [4] and realised [5] as a medium for the formation of quantum droplets. The existence of rubidium in our setup puts us in a position to produce ^{41}K-^{87}Rb dual-species droplets. We present preliminary results of cooling and trapping ^{41}K in our apparatus.

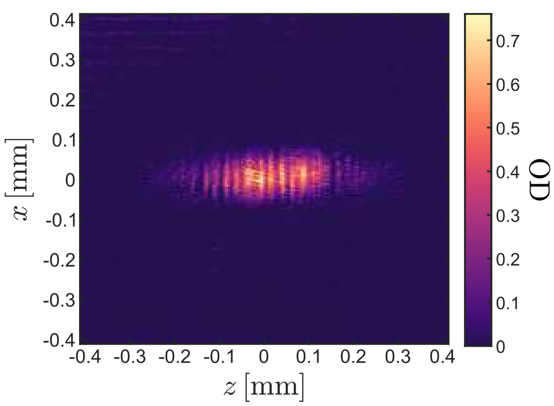

Figure 1: Interference fringes from two separate BECs expanding into each other in our apparatus. The BECs are formed in a double-well, then allowed to evolve in a cigar shaped trap.

KEYWORDS: FALSE VACUUM DECAY, BOSE-EINSTEIN CONDENSATION, ARBITRARY POTENTIAL, DIPOLE TRAP, MATTER WAVE INTERFERENCE, QUANTUM DROPLETS

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