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# Correlated phonon pairs in a time modulated Bose-Einstein Condensate

In standard cosmological models, inflation is driven by a quantum field, the *inflaton*, whose constant energy density drives the superluminal expansion of the universe [1]. When inflation stops, the universe has an extremely low density but the inflaton field starts to oscillate around its minimum of energy and decays into entangled pairs of particles [2]. This is known as the *pre-heating* phase. Created pairs of particles then start to interact leading to decoherence and thermalization : the *re-heating* stage.
Although *in situ* observation of inflaton particle creation process is impossible, this pair production through parametric amplification is analogous to the creation of phonon pairs in a Bose-Einstein (BEC) condensate whose interaction strength is temporally modulated. Modulating the stiffness of a dipole trap of a cigar-shaped BEC is equivalent to modulating the effective one-dimensional interaction strength in a BEC, and thus we are able to probe the correlation of entangled metastable helium atoms by the use of a micro-channel plate detector (MCP). Our experimental procedure is the following [3] : we modulate in time the trap stiffness of the dipole trap laser and then release the trap (see figure 1). During expansion, the phonon kinetic energy is adiabatically transferred to one atom that is detected by the MCP after a 300 ms time of flight. The number of phonon pairs is expected to depend on the duration of the excitation, its amplitude and the excitation frequency. However, the parameter range over which the entanglement of the phonon pairs can be observed is expected to be quite narrow [4]. We propose to investigate the entanglement and correlations of those pairs of particles.

**References**

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