Matter-wave interference as a tool for simulation of cosmological phase transitions

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A remarkable effect revealed by the experiments with ultracold atoms in periodic potentials, e.g. [1], is the ability of quantum interference between the Bose condensates formed in separated potential wells. This fact can result in profound consequences for the theory of phase transitions of the scalar (e.g. Higgs) fields at the early stages of cosmological evolution and, particularly, for calculation of the number of topological defects (monopoles, strings, etc.) left after such phase transitions.

The available estimates of the defect concentration are based on the assumption that phases of the order parameter (scalar field) are formed independently in the spatial regions casually-disconnected during the phase transition. On the other hand, as follows from the above-mentioned laboratory findings, this assumption is insufficiently justified; so that the initial quantum correlations over the entire system (or the so-called entanglement) should be taken into account [2]. It is the aim of the present report to discuss how description of the phase transitions in the early Universe can be improved utilizing the recent laboratory data on the matter-wave interference.

References:

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2. Yu.V. Dumin, *Frontiers of Particle Physics*, p.289 (2003).