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Time-symmetry breaking for modulated cold atoms as a realization of meanfield critical behavior MYOUNG-SUN HEO, YONGHEE KIM, GEOL MOON, Seoul National University, MARK DYKMAN, Michgan State University, WONHO JHE, Seoul National University — Cold atoms have been widely used for the studies of many-body physics and critical phenomena in particular. However, most of the work on critical phenomena focused on systems effectively close to thermal equilibrium. Here we show that cold atoms make it possible to reveal and explore, qualitatively and quantitatively, critical behavior far from thermal equilibrium. We study periodically modulated atomic cloud in a magneto-optical trap which is invariant under the discrete time-translation by the modulation period τ_F. Once the number of atoms reaches a critical value, they preferably occupy one of the two parametrically excited vibrational states, which has the time-translation symmetry of $2\tau_F$. We find that, even though the states are explicitly time-dependent, the system displays an ideal mean-field critical dynamics. It is seen in the critical exponents of the order parameter and the static susceptibility, as well as in the dynamic response. The cold atoms dynamics is determined by the interplay of the interaction and fluctuations; it is quantitatively described. The results demonstrate that fluctuations in interacting systems far from equilibrium lead to new types of collective behavior and provide a qualitative and quantitative insight into an important type of such behavior.

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