PSF12-2012-000009

Abstract for an Invited Paper
for the PSF12 Meeting of
the American Physical Society

From cosmology to cold atoms: observation of Sakharov oscillations in quenched atomic superfluids[1]

CHENG CHIN, University of Chicago

Sakharov oscillations, conventionally discussed in the context of early universe evolution and the anisotropy of cosmic microwave background radiation, is the manifestation of interfering acoustic waves synchronously generated in an ideal fluid. In atomic superfluids, the ease to induce acoustic excitations makes them a convenient test ground to simulate and study this intriguing phenomenon in the laboratory setting. In recent years, many ideas have been proposed to associate cosmological and gravitational phenomena to the non-equilibrium dynamics of quantum gases. Here we report the laboratory observation of Sakharov oscillations in a quenched atomic superfluid. We quench the sample by Feshbach tuning and monitor the subsequent density fluctuations at different time and length scales by in situ imaging. Sakharov oscillations are identified as the multi-peak structure in the atomic density power spectrum, resembling that of the cosmic microwave background radiation. We also observe Sakharov oscillations in the time domain, from which we extract the energy dispersion of the superfluid, and determine the sonic horizon of the excitations. Our work opens up new perspectives to investigate non-equilibrium dynamics of quantum fluids and its analogues in cosmology and astrophysics.

[1]NSF Award PHY-1206095, ARO Grant W911NF0710576 with funds from the DARPA OLE Program, and the Packard foundation