ULTRACOLD ATOMS

# Tabletop cosmology

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Analogies are useful when explaining difficult concepts. Take, for instance, William Unruh's 'sonic' black hole represented by a screaming fish falling faster than the speed of sound down a waterfall. The sound can never make it back up the river, akin to light past the event horizon of a black hole. But why stop at black holes? Indeed, Stephen Eckel and co-workers mimic the expansion of the Universe using ultracold sodium atoms.

Ultracold atoms in an optical lattice trap, where crossed laser beams create potential wells that replace a physical crystalline lattice, are useful simulators of condensed-matter systems as interactions and density can be controlled continuously and with precision. To study cosmic expansion, Eckel et al. prepared a ring-shaped Bose–Einstein condensate of $^{23}$Na atoms. They excite a sound wave and then expand the ring rapidly, during which the sound wave undergoes a redshift similar to the photon redshift during expansion. Measurements of the sound wave amplitude reveal a damping term, which the authors liken to a Hubble friction, which is actually not dissipative and thus reversible. After the expansion, the production of vortices and persistent currents in the ring reheat the condensate, which may emulate the 'preheating' after inflation. With so many models of cosmic inflation that can predict almost anything, it will be useful to have a physical model to investigate.

Of course, analogies only go so far, but the advantage here is that the ring can be compressed, so we can in principle watch the Universe contract as well.

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