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Analogue cosmological particle creation in an ultracold quantum fluid of light

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In inflationary cosmology, the rapid expansion of the early universe resulted in the spontaneous production of cosmological particles from vacuum fluctuations, observable today in the cosmic microwave background anisotropies. The analogue of cosmological particle creation in a quantum fluid could provide insight, but an observation had not yet been achieved. In this presentation, we report the spontaneous creation of analogue cosmological particles in the laboratory, using a quenched quantum fluid of light [1]. We observe acoustic peaks in the density power spectrum, in close quantitative agreement with the quantum-field theoretical prediction. We find that the long-wavelength particles provide a window to early times, and we present a possible interpretation of the cosmic microwave background based on this concept. This work introduces a new quantum fluid, as cold as an atomic Bose-Einstein condensate.

[1] J. Steinhauer, M. Abuzarli, T. Aladjidi, T. Bienaimé, C. Piekarski, W. Liu, E. Giacobino, A. Bramati, Q. Glorieux, arXiv:2102.08279 (2021)

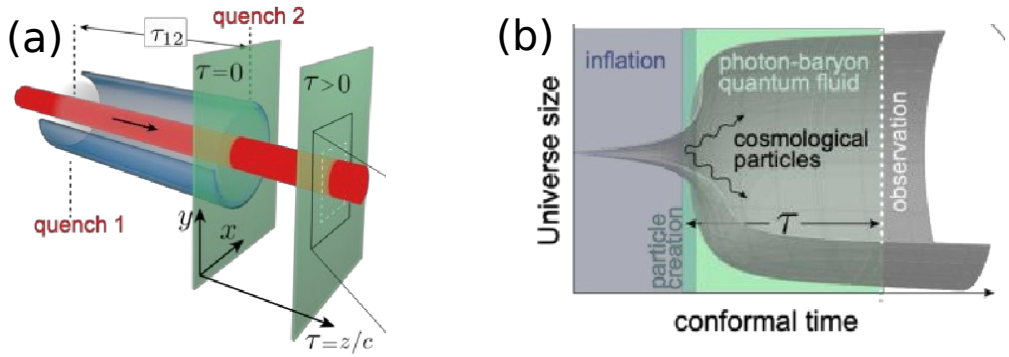

Figure 1 : The analogue universe. (a) The fluid of light (red) is a laser pulse traversing a heated ^{85}Rb vapor cell. The quenches occur at the entrance and exit of the vapor cell. (b) Cosmological particle creation in the early universe. The gray surface indicates the radius of the universe.