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# Quantum Field Simulator for a relativistic scalar field in curved space time

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In most cosmological models, rapid expansion of space is a vital ingredient to explain the structure and contents of the universe. Therefore it is of great importance to have an experimental system in which a quantum field is subject to such an expansion. Here, we present an experimental implementation of a two-dimensional effective expanding space-time for phonons in a potassium Bose-Einstein condensate, which is described by a scalar quantum field in an FLRW space-time. Spatial curvature is realized by shaping the density profile of the condensate. We confirm the implementation of both hyperbolic and spherical geometries by studying wave packet propagation. The expansion of space is implemented by a temporal control of the atomic interaction. With different ramp shapes we realise uniform, accelerated and decelerated expansions. In all cases, the expansion gives rise to excitations on the condensate's density. Statistical analysis of the excitation structure and its time evolution reveals the production of phononic quasi-particles and allows the distinction between different expansion histories.

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