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Christoph Westbrook: Using phonons to simulate the behavior of other quantum fields

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In a quantum fluid such as a condensed Bose gas, elementary excitations such as phonons behave as quantized fields with dispersion relations and non-linearities that bear some resemblance to those of the electromagnetic field. The very low temperatures of these gases means that in some cases quantum fluctuations are important. Several remarkable phenomena in quantum electrodynamics have found acoustic analogs, and I will discuss two of them. The first is the dynamical Casimir effect, a prediction that the vacuum can generate real particles when boundary conditions are suddenly changed. That is, photon pairs can be spontaneously generated in an empty cavity with nonuniformly accelerating boundaries. A second is Hawking radiation. Here again photon pairs are generated at the horizon of a black hole. I will discuss how certain aspects of both these effects can be mimicked in a Bose Einstein condensate, and outline the state of the experimental art in this domain.