Contribution ID: **16** Type: **not specified**

Four-wave mixing and enhanced analog Hawking effect in a nonlinear optical waveguide

Monday 22 July 2019 16:15 (15 minutes)

We have studied the scattering of light on a soliton propagating in a waveguide, which has been proposed as an experimental system in which one could observe the analog Hawking effect. The linearized wave equation governing perturbations is shown to have the same structure as that governing phonon propagation in an atomic Bose condensate. By taking into account the full dispersion relation, the scattering coefficients encoding the production of photon pairs are shown to be amplified by a resonance effect related to the modulation instability occurring in the presence of a continuous wave. On the other hand, the scattering coefficients not subject to this enhancement behave similarly to those encoding the analog Hawking effect in subcritical flows. When using a realistic example of a silicon nitride waveguide on a silica substrate, we find that a soliton of duration 10 fs would spontaneously emit about one photon pair for every cm it travels. This rate is about six orders of magnitude larger than in previous works, making the effect readily observable.

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