Parametrically Excited Coherent Roton Aggregates

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A coherent aggregate of roton pairs in liquid helium around a dielectric resonator can be excited by an electromagnetic field in the microwave range[1,2]. Experimentally, this parametric resonance manifests as an ultra-narrow peak[3,4,5] in the resonator loss at the roton frequency. Coupling of the microwave radiation to the rotons is due to the dependence of individual roton energy ε on the electric field $\mathbf{E}(t)$: $\delta\varepsilon \sim \alpha E(t)^2/2$, where α is the roton polarizability. Elementary process of such parametric excitation is the transformation of two photons into two rotons. Coherence of the emerging roton state means that the electromagnetic resonator and the superfluid around it effectively behave together as a "laser of rotons". This coherence also allows for the phenomenon similar to Josephson effect in superconductors between separate roton reservoirs.

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