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Volume element structure and roton-maxon-phonon excitations in superfluid helium-4 beyond the Gross-Pitaevskii approximation

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Abstract content
   (Max 300 words)

We propose a theory which deals with the structure and interactions of volume elements in liquid helium II. The approach consists of two nested models linked via parametric space. The short-wavelength part describes the interior structure of the fluid element using a non-perturbative approach based on the logarithmic wave equation; it suggests the Gaussian-like behaviour of the element's interior density and inter-article interaction potential. The long-wavelength part is the quantum many-body theory of such elements which deals with their dynamics and interactions. Our approach leads to a unified description of the phonon, maxon and roton excitations, and has noteworthy agreement with experiment: with one essential parameter to fit we reproduce at high accuracy not only the roton minimum but also the neighboring local maximum. The sound velocity and structure factor are also computed and found to be in a very good agreement
with the observed values.

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