Theory of liquid Helium-4 in a deformed Heisenberg space

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Effective method for studying the Bose liquid is method of collective variables. In this representation the Hamiltonian a system of spinless Bose-particles of mass m each with Cartesian coordinates $\mathbf{r}_1, ..., \mathbf{r}_N$, which are moving in a volume of V, we can write the sum of Hamiltonians infinite set of harmonic oscillators that describe the density fluctuations in a Bose liquid and the sum of contributions from anharmonicity of the vibrations. Difficulties with regard to two and three-particle correlations we throw at deformation commutation relations between the generalized coordinates $Q_{\mathbf{k},\mu}$ and momenta $P_{\mathbf{k},\mu}$:

$$[Q_{\mathbf{k},\mu}, P_{\mathbf{k},\mu}] = i\hbar\sqrt{1 - \beta_k Q^2_{\mathbf{k},\mu}} \tag{1}$$

where the deformation parameter β_k is written via the structure factor S_k of liquid Helium-4 obtained from X-rays scattering measurements. As follows multimode Hamiltonian Bose liquid in the image of collective variables changes of single-mode Hamiltonian and obtain good agreement with the results of perturbation theory for the spectrum of elementary excitations of a Bose liquid.

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