Bulk and Surface Excitations of He II at Interfaces

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We solve the problem of superfluid helium excitations, phonons and rotons, interacting with solid surfaces. A simple hydrodynamic model enables us to describe both phonons and rotons in a consistent and unified way and to derive analytic expressions for the probabilities of transmission, reflection and mode changes of each quasiparticle incident on an interface with a solid; the dispersion curve of the medium acts as the only "input parameter". Dependence on the energy of the excitations and their angle to the interface, are analysed; backward reflection and refraction for the rotons with negative dispersion are discussed.
In the frame of the same approach, we reconstruct the dispersion relation of the surface excitations of superfluid helium, ripplons, from the dispersion relation of its bulk excitations. This approach allows for analytic reconstruction in terms of polynomial roots, for the polynomial approximation of the bulk excitations' dispersion curve of any given precision. We derive the algebraic equation for the ripplon dispersion relation $\omega(k)$ and obtain its series expansion both at small wave vectors k and close to the roton minimum. It is shown that the ripplon dispersion curve ends at the energy of the roton minimum with zero derivative. A new unusual ripplon branch is found above the roton minimum at 2.6Å^{-1}, close to the instability point of the bulk spectrum, and is investigated.