Excitation and Detection of Surface Gravity Waves on Normal and Superfluid ^{3}He

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Surface gravity waves can be used to accurately measure the properties of the fluid surface. Previously surface tension has been determined in normal ^{3}He and superfluid ^{4}He by measuring the resonance frequencies of the waves.[1,2] In superfluid ^{3}He the studies of the surface gravity waves are challenging since the superfluid transition temperature T_c is several orders of magnitude lower than in ^{4}He. Only at temperatures far below T_c the fraction of very viscous normal component of ^{3}He is small enough not to fully damp the waves. Recently the waves have been observed in superfluid ^{3}He with NMR technique.[3]
We have measured surface gravity waves both in normal and superfluid ^{3}He. The waves were excited mechanically by rocking the whole cryostat pneumatically with an air spring at desired frequency. The waves were detected with an interdigital capacitor mounted on a vertical wall of the cuboid experimental volume. Capacitance of the interdigital capacitor was measured with a capacitance bridge and a lock-in amplifier. Variations of the measured capacitance were detected with another lock-in amplifier which was synchronized to the mechanical excitation.
In superfluid ^{3}He we have observed at least eleven resonance frequencies below 12 Hz and at temperatures around 0.2 mK whereas in normal fluid only a few resonances were observable above 50 mK.

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