Dip-effect in conductivity Q1*D* electrons over superfluid helium

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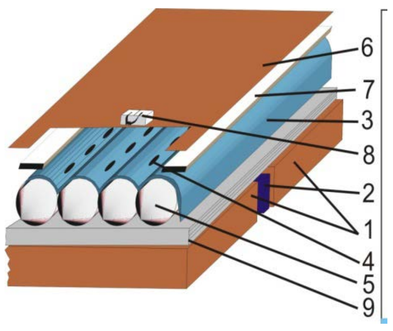
Introduction.

The particular effects has a place in quantum/size systems over superfluid helium which is good expressed at low *T* [1].

The quasi-one-dimensional surface electrons (Q1D-SEs) conductivity over helium in grooves between rows dielectric threads is investigated.

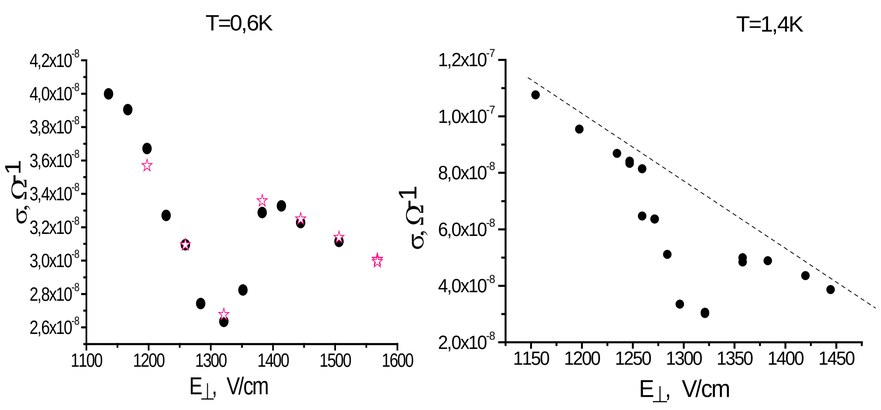
Setup and results.

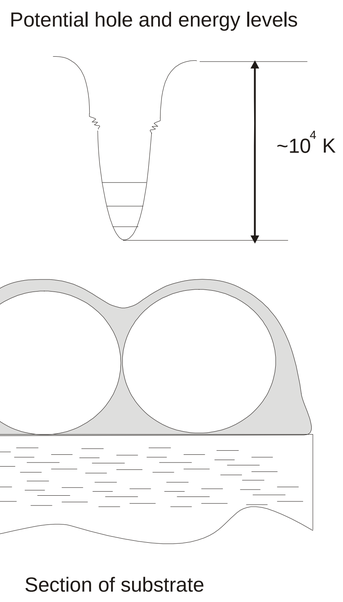


1 - measurement electrodes; 2 - screening stripe; 3 - helium film; 4 - 1D system of surface electrons: 5 - substrate (row of light guides); 6 - upper pressing electrode; 7 - guard ring; 8 - electron source (glow tungsten thread); 9 – insulating plate.

The measurements performed at low frequency by a technique using capacitive coupling of two electrodes with electron subsystem (sketch of cell).

Experiments was carried out with use nylon threads 100 μm in diameter at temperatures 0.5-1.5 K by scanning of electric field, *E* in the range 1.1 – 1.6 kV/cm. The dip-effect maximum taked a place at *E*=1.3 kV/cm (graphs below).





Analyze.

Difference of levels between substrate and helium, *h* set the curvature radius of liquid in grooves $R = \sigma / (\rho \cdot g \cdot h)$ (here σ and ρ are surface tension and density of superfluid helium; *g* is gravity constant) which typically was 35 μm.

The harmonic spectrum a 1D system in parabolic potential well $e \cdot E \cdot \delta$ (here δ is the helium surface deflection in groove) is $\omega^2 = eE/(mR)$.

The qualitatively explanation can be next. The conducting stripe at not smooth substrate at relative large *E* is divided on segments and in this moment takes a place electron percolation through quantum size distance (accompanied by noise in experiment).

Conclusion

In conclusion must be signed the dip-effect not depend from temperature or parameters the measurement signal and disappear at both the large radius, *R* and very smooth and very rough the substrate surface.

The conductivity dip-effects have been observed in 2*D* SE on a helium film with a weakly rough substrate [2].

Reference

1. *Ginzburg Vl.L., Monarkha Yu.P.* Surface electrons in helium over macroscopic structures // Fiz. Nizk. Temp. – 1978. – **4**. -P. 1236-1239.
2. *Leiderer P., Nazin S., and Shikin V.* Dip-effect in the conductivity of 2*D* electrons on a helium film with a rough substrate// Fiz. Nizk. Temp. - 2008, - **34**, - P.489–495