Scientific session of the Division of General Physics and Astronomy, Academy of Sciences of the USSR (26-27 April, 1978)

Usp. Fiz. Nauk 126, 689–700 (December 1978)

A session of the Division of General Physics and Astronomy was held on April 26 and 27, 1978 at the conference hall of the P.N. Lebedev Physics Institute of the Academy of Sciences of the USSR. The following papers were delivered:

1. *V. B. Shikin*, Electrons above the surface of liquid helium.

2. *M. S. Khaĭkin and A. P. Volodin*, Disturbance of stability of the charged liquid helium surface and formation of bubblons (film).

3. *D. M. Chernikova and L. P. Gor'kov*, Instability of the charged surface of liquid helium.

4. *V. S. Edel'man*, Investigation of the resonance properties of electrons above the surface of liquid helium.

5. *K. I. Zemskov, M. A. Kazaryan, and G. G. Petrash*, Optical systems with brightness amplifiers.

6. *L. I. Devyatkova, P. M. Lozovskiĭ, V. V. Mikhaĭlin, S. P. Chernov, A. V. Shepelev, and P. B. Éssel'bakh*, Vacuum-ultraviolet luminescence of LaF_3 single crystals

7. *L. I. Gudzenko, I. S. Lakoba, Yu. I. Syts'ko,* and *S. I. Yakovlenko*, Analysis of the possiblity of amplifying VUV radiation in a helium plasma.

We publish below brief contents of the papers.

V. B. Shikin. *Electrons above the surface of liquid helium.* Systematic study of localized electron states on the surface of liquid helium began comparatively recently. The first theoretical results, which were obtained independently in Refs. 1, 2, and reliable experimental data of Refs. 3, 4 that confirm the existence of localized electron states on the surface of liquid helium were published 4–7 years ago. Nevertheless, appreciable progress has now been made toward understanding of the properties of surface electrons (the term applied for simplicity to electrons localized on the surface of liquid helium). We refer to studies of the mobility of electrons along the interface, investigation of collective phenomena (plasma oscillations, Wigner crystallization) in a system of surface electrons, the stability of a charged helium surface in an external electric field, nonlinear phenomena at cyclotron resonance, and so forth. The object of the present report is to discuss the situation in the problem of electron mobility along the liquid helium surface.

Formally, the problem of electron mobility along a liquid helium liquid-vapor boundary is analogous in many respects to the problem of electron and hole mobility in semiconductors. However, the situation is much more definite and simple on the helium surface. Firstly, electron energy is a square-law, isotropic function of the two-dimensional wave number along the surface, whereas the use of a similar spectrum in semiconductors is a far-reaching idealization. Secondly, the only source of scattering for the low-energy electrons moving along the helium surface at low temperatures is thermal vibrations of the surface (capillary Rayleigh waves or ripplons), whose spectrum has been thoroughly studied in the longwave approximation essential for calculation of electron mobility. As a result, it becomes possible to construct a consistent theory of surface-electron mobility in an approximation linear in the guiding electric field—a theory that is free of undetermined parameters—provided that the form of the interaction between the surface electrons and the ripplons is clearly defined. The discussions[5-9] of the explicit form of the electron-ripplon interaction eventually made it possible to settle on the variant of this interaction that was proposed in Refs. 6, 7 with limitations on the range of its application. Corresponding concrete calculations of electron mobility along a liquid helium surface were made in Refs. 6, 7, 10–12 using the explicit form of the electron-ripplon interaction in various limiting cases of temperature, the frequency of the guiding electric field, the strength of the restraining electric field, etc. The theoretical results indicate a high mobility of electrons along the surface ($\mu \approx 10^7 - 10^8$ cm^2/V·sec) and a very low threshold for the appearance of phenomena nonlinear in the guiding field.

These peculiarities of surface-electron mobility made it necessary to abandon standard procedures for measurement of ion mobilities in the volume of liquid helium (time-of-flight technique) and to resort to new, high-frequency methods that are usually used in the study of metals and semiconductors. The experimental information obtained in this way on electron mobility in the approximation linear in the guiding field agrees well with the calculated mobility values obtained without use of fitting parameters (see Refs. 13–15).

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