for a discussion, and G. S. Chernyshev and V. A. Yudin for technical help.

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PHOTOELECTRONIC EMISSION FROM ALUMINUM - ALUMINUM OXIDE - GOLD FILM SYSTEM

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We observed photoelectronic emission from the system Al-Al_2O_3-Au when a strong electric field was applied to the dielectric.

The film system was prepared in the following manner: An aluminum film approximately 1000 Å thick was evaporated in high vacuum (~10^{-7} mm Hg) on a polished glass plate and then oxidized by anodizing in a 3% solution of ammonium citrate [1]. The thickness of the oxide film was determined by the anodizing voltage and monitored by measuring the capacitance of the three-layer system at low frequency (100 Hz). The low-frequency dielectric constant of the aluminum oxide was assumed equal to 8.4 [2]. The thickness of the Al_2O_3 film measured in this manner was 170 Å. The work function of the upper electrode (Au) was lowered by adsorption of BaO molecules [3] to a value 2.6 eV. The investigated samples were illuminated through the upper semitransparent electrode with monochromatic light from a spectrophotometer (SF-4A) with an incandescent lamp as a light source. All measurements were made with direct current.

Figure 1 (curve I) shows the spectral characteristic of the photoelectronic emission from the Al-Al_2O_3-Au film system to the vacuum without applied voltage. The long-wave photoemission limit is 2.6 eV and is equal to the work function of the upper gold electrode, which was measured independently. Photoelectrons are thus emitted only from the upper electrode in the absence of an electric field.

When a voltage of several volts is applied to the film system (with the upper electrode positive), noticeable photoemission

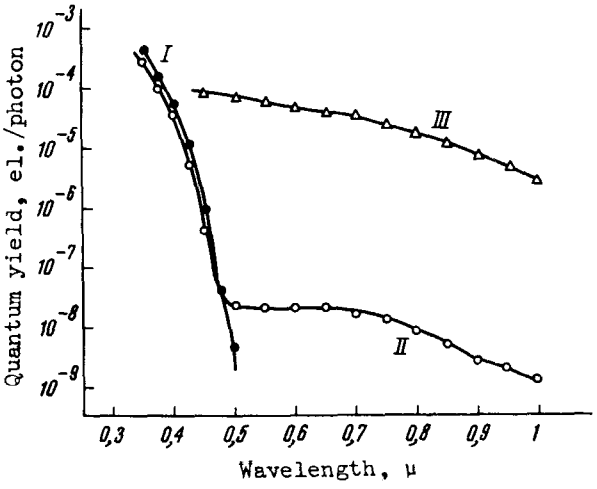

Fig. 1

to the vacuum appears in the spectral region 0.5 - 1 μ. The spectral characteristic of the photoemission is shown in Fig. 1 for a system voltage of 6 V (curve II). The same figure (curve III) shows the spectral characteristic of the photoelectronic emission from aluminum to the aluminum oxide at the same system voltage (photocurrent between the metallic electrodes of the film system). All the spectral characteristics shown in Fig. 1 are normalized to the number of incident photons.

Comparison of Curves II and III shows that the spectral dependence of the photoelectronic emission into vacuum from the system coincides in the region from 0.5 to 1 μ with the spectral dependence of the photoelectronic emission from the aluminum to the aluminum oxide. In both cases, the long-wave limit of photoemission depends on the applied voltage and corresponds at 6 V to a photon energy $h\nu_0$ = 1.15 eV. This indicates that the source of the photoelectrons is the aluminum film, for both external photoemission and photocurrent between metal electrodes.

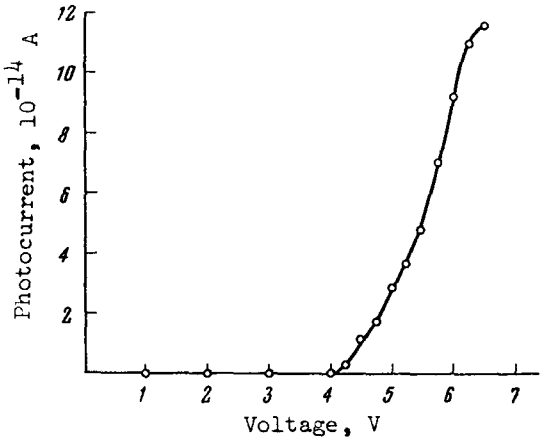

Fig. 2

The voltage-current characteristic of the photoemission (at λ = 0.7 μ) is shown in Fig. 2. It is seen from the figure that the photoemission sets in at approximately 4 V on the film system and increases rapidly with increasing voltage. When the polarity of the voltage is reversed, the external photoemission in the 0.5 - 1 μ region disappears. Photocurrent between the metallic electrodes of the film system flows in this case only after irradiation with ultraviolet light, a fact connected with the great height of the contact barrier between the gold and the aluminum oxide.

We have thus observed in the described experiment photoelectronic emission from aluminum to aluminum oxide and the emergence of photoelectrons to the vacuum through a thin gold film under the influence of an electric field in the dielectric. The long-wave limit of this photoemission is determined by the height of the barrier at the metal-dielectric interface and decreases with increasing field in the film.

The low values of the quantum yield of photoemission from the metal into the dielectric (~10^{-5} el/photon) and of the photoemission into vacuum (~10^{-8} el/photon) are apparently peculiar to this system and to the technology used in its manufacture. There are published descriptions of systems in which the quantum yield of photoemission from a metal into a dielectric reaches high values (for example, the quantum yield is ~0.1 el/photon for a Cu-CdS system [4]).

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HYDRODYNAMIC DRIFT-DISSIPATIVE INSTABILITIES OF A PLASMA WITH NON-UNIFORM TEMPERATURE

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Moiseev [1] was the first to note low-frequency drift instability in an inhomogeneous plasma with collisions, and called attention to the important role that longitudinal ion motion plays in its development. We show in this paper that allowance for the plasma temperature and viscosity inhomogeneities leads to the appearance of a number of new low-frequency instabilities.

In considering a plane plasma layer with initial density $n_0(x)$, electron and ion temperatures $T_{0e}(x)$ and $T_{0i}(x)$, and velocities $\vec{V}_{0e}(x)$ and $\vec{V}_{0i}(x)$, principal attention was paid to time intervals during which the initial distribution can be regarded as stationary. If $T_{0i} \neq T_{0e}$ this means that $\tau \approx 1/\omega \ll (m_i/m_e)\nu_e^{-1}$. When $T_{0e} = T_{0i}$ the limitations on the time intervals are weaker; they are connected with slow dissipative processes transverse to a strong ($\Omega_\alpha \gg \nu_\alpha$) magnetic field. We investigated the stability of the initial state of the plasma against potential perturbations $\vec{E} = -\vec{\nabla}\Phi$. For perturbations of the type $f(x)\exp(i\omega t + ik_y y + ik_z z)$ we can obtain the following system of linearized equations of hydrodynamics

$$\omega n^\alpha + \frac{k_y e\Phi}{m_\alpha \Omega_\alpha}\frac{\partial \ln n_0}{\partial x} + k_z V_z^\alpha n_0 = 0; \tag{1}$$

$$V_z^e\left(im_e\omega + \frac{4}{3}\frac{k_z^2}{n_0}\eta_0^e\right) = -ik_z T^e(1 + S + a^e) - ik_z T_{0e}\frac{n^e}{n_0}\left(1 - a^e\frac{\partial \ln T_{0e}}{\partial \ln n_0}\right) + ik_z e\Phi; \tag{2}$$

$$V_z^i\left(im_i\omega + \frac{4}{3}\frac{k_z^2}{n_0}\eta_0^i\right) = ik_z ST^e - ik_z T^i(1 + a^i) - ik_z T_{0i}\frac{n^i}{n_0}\left(1 - a^i\frac{\partial \ln T_{0i}}{\partial \ln n_0}\right) - ik_z e\Phi; \tag{3}$$

$$T^e\left(\frac{3}{2}i\omega + k_z^2\chi_\parallel^e/n_0\right) = i\omega T_{0e}\frac{n^e}{n_0} - \frac{ik_y e\Phi}{m_e\Omega_e}T_{0e}\left(\frac{3}{2}\frac{\partial \ln T_{0e}}{\partial x} - \frac{\partial \ln n_0}{\partial x}\right) - 3\frac{m_e}{m_i}\nu_e(T^e - T^i); \tag{4}$$

$$T^i\left(\frac{3}{2}i\omega + k_z^2\chi_\parallel^i/n_0\right) = i\omega T_{0i}\frac{n^i}{n_0} + \frac{ik_y e\Phi}{m_i\Omega_i}T_{0i}\left(\frac{3}{2}\frac{\partial \ln T_{0i}}{\partial x} - \frac{\partial \ln n_0}{\partial x}\right) + 3\frac{m_e}{m_i}\nu_e(T^e - T^i). \tag{5}$$

In the derivation of these equations it was assumed that $T_{0e} = T_{0i} = T_0(x)$; for the transverse motion, terms containing $k_y^2\rho_\alpha^2$ were omitted[1] (ρ_α = Larmor radius of the particles α; see