measurements of the $\Delta\nu(E_p)$ dependence have made it possible to estimate the parameters of a sample whose threshold energy lies in a feasible pump range.

Lasing was attained in a YAG:Cr^{3+} sample grown specially for this purpose by the method of horizontally directed crystallization [4]. The sample was a cylinder 9.3 cm high and 1.0 cm in diameter; the Cr_2O_3 concentration in it was $\sim$0.5 wt.%. The loss coefficient normalized to the absorption in the R_1 line [5] was determined from data on the pump dependence of the luminescence line width and was found to equal 0.31. Multilayer dielectric mirrors were coated directly on the end faces of the crystal and had reflection coefficients $\sim$100 and 95%. Lasing was realized on the R_1 line at nitrogen temperatures. The lasing wavelength was 6874 Å. The generation threshold was reached at an approximate incident-light energy 300 J on the sample surface. This energy was measured with the calorimeter described in [6]. The laser beam divergence angle did not exceed 2°. The high lasing threshold, and also the appreciable beam divergence, can be attributed to the still inadequate optical quality of the sample and to the non-optimal ratio between its geometrical dimensions, the chromium concentration, and the mirror transparency.

Figure a shows lasing with a spike structure at the luminescence maximum. This structure is quite distinct at a higher sweep rate (Fig. b).

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OBSERVATION OF HIGH-PROBABILITY TWO-PHOTON PHOTOEMISSION FROM METALS IN ELECTROLYTE SOLUTIONS

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There have been many experimental and theoretical investigations of multiphoton photoemission of metals (see the review [1]), indicating that the theoretical value of the photocurrent is lower than the experimental ones by two or three orders of magnitude. The suggested causes of this discrepancy were the sharp polarization selectivity of the photoemission (in the surface-photoeffect model), the spatial inhomogeneity, and the deviation of the statistical characteristics of the radiation field from thermal. There is no detailed comparison of theory with experiment. A direct verification of the theory can apparently be based on the fact that in all the existing surface-photoeffect models

[2 - 5] the ratio of the photocurrents of order k and k + 1 is determined by the parameter

$$i_{k+1}/i_k \sim \Delta/U \qquad k = 1, 2, \ldots , \tag{1}$$

where $\Delta = e^2E^2/4m\omega^2$ is the energy of the classical electron in the field of the light wave, and U is the depth of the well of the metal ($U \approx 2\varepsilon_F$, where ε_F is the Fermi energy). Relation (1) is valid also for the simple model of the volume photoeffect if k = 1 [6]. A study of the photoemission from metals into electrolyte solutions makes it possible to measure j_{k+1}/j_k by using the same radiation source; this eliminates not only the mentioned extraneous phenomena, but also the variations of j_{k+1}/j_k due to different conditions of light absorption in the metal at different wavelengths.

Two- and three-photon photoemission from mercury into aqueous solutions of electrolytes, induced by ruby or neodymium lasers, was observed in [7]. A feature of photoemission in electrolyte solutions is that the applied potential decreases to atomic dimensions at the interface, and there are no electric image forces in the photoemission. As a result, the red boundary of the photoeffect depends linearly on the applied potential, and the dependence of the current on the energy of the emitted electrons is described not by Fowler's law, but by the "five-halves" law [8]. The results of experimental studies of these laws are summarized in [9]. Control of the red boundary of the photoeffect by means of applied potential makes it possible to observe photoeffects of different orders with one and the same photocathodes and under identical illumination conditions.

We have investigated one- and two-photon photoemission from mercury (work function $\hbar\omega_0 = 3.05$ eV at $\phi = 0$) under the action of a ruby laser ($\hbar\omega = 1.78$ eV), when the one-photon emission was observed at $\phi > 1.7$ V and the three-photon emission at $0.5 < \phi < 1.7$ V relative to a saturated calomel comparison electrode. The two-photon photoemission was measured also for copper and silver. The light pulses from the Q-switched ruby laser were 3×10^{-8} sec long at a maximum intensity 3 MW/cm^2 averaged over the beam area. The maximum light intensity at different points of the photocathode, obtained by photometry of photographic plates, exceed the mean value by not more than 2 - 2.5 times. The mercury photocathode was a hemisphere of 1.5 mm diameter, the central part of which was covered with a diaphragm, so that the incidence angle ranged from 60 to 90°. The latter kept the photocathode from being heated by the light incident normally to the surface. The copper and silver photocathodes were illuminated at an angle of 45°. The photocathode heating was determined by the relation

$$\Delta T = L_0 (t_u / c\rho\kappa)^{1/2} f(\theta), \tag{2}$$

where L_0 and t_p are the intensity and duration of the light pulse, and c, ρ, and κ are the specific heat, density, and thermal conductivity of the metal. The function $f(\theta)$ determines the light absorption in the metal and depends on its optical constants and the incidence angle. The obtained values of $\Delta T/L_0$ were 3.5×10^{-5}, 1.1×10^{-5}, and 0.25×10^{-5} deg/V-cm^{-2} for mercury, copper, and silver, respectively. In accord with this estimate, the maximum value of L_0 was chosen such that the metal temperature rise, with allowance for the inhomogeneity of the illumination, did not exceed 100°. The resultant thermionic emission current should be lower than the observed current by four or five orders of magnitude. Another interfering current is due to the temperature variation of the capacitance of the double layer [9]. However, the total charge produced by this current is zero if the registration time exceeds the thermal-relaxation time, as was the case in our experiments. An estimate of the temperature rise of the interface as determined from this current yields $\Delta T \leq 50°$. Thus, the measured photocurrent could be due only to the photoemission current. Figure 1 shows the current-voltage dependence of the photocurrent and reveals clearly

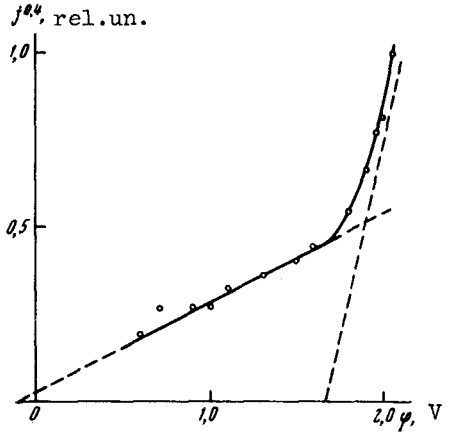

Fig. 1

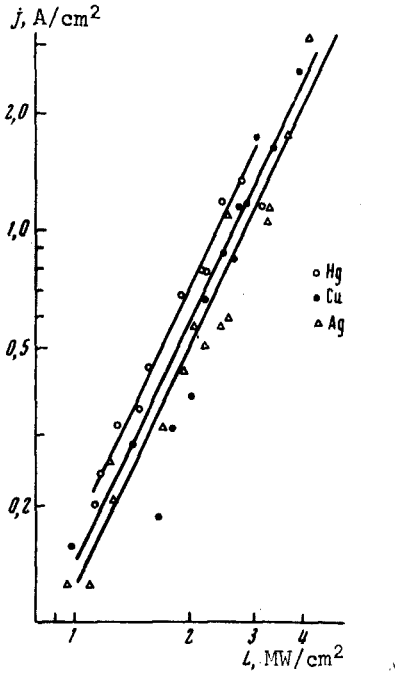

Fig. 2

Fig. 1. Photoemission current (j) from mercury in an electrolyte solution ($0.1N(C_2H_5)_4Cl$) vs. the electrode potential (ϕ). The dashed lines show the dependences of the currents due to single- and two-photon photoemission as determined from $j(\phi)$, on the electrode potential. The potentials are relative to a saturated calomel electrode.

Fig. 2. Photoemission currents from metals in an electrolyte solution vs. the light intensity (L). The observed plots correspond to a relation $j \sim L^n$ with $n = 2 \pm 0.2$.

the two sections corresponding to single- and two-photon photoemission. In the two-photon emission region, the photocurrent is proportional to the square of the light intensity (Fig. 2), and at $\phi > 1.7$ V this relation becomes nearly linear. The difference between the threshold values of the potentials (1.7 - 1.8 V) obtained by extrapolating the corresponding sections of the current-voltage characteristic correspond to the energy of the laser quantum. The $j_2(\phi)$ and $j_1(\phi)$ plots do not change when the light intensity is varied in the range indicated in Fig. 2. The quantum yield of the single-photon photoeffect for mercury agrees with the previously measured value [9] at low light intensities ($(1 - 2) \times 10^{-4}$ at a maximum emitted-electron energy $\varepsilon_m = 0.5$ eV). The ratio of the observed currents j_2/j_1 at equal values of ε_m is $(1 - 2) \times 10^{-3}$ at light intensities 1.5 - 2 MW/cm², which exceeds the theoretical value of Δ/U by almost four orders of magnitude. The quantum yield of the single-photon photoeffect for silver and copper is close in order of magnitude to that measured with mercury. The two-photon photoemission currents are also close (Fig. 2). The ratio j_2/j_1 for these metals is therefore also much larger than the theoretical value.

The cause of such a strong discrepancy may apparently be the volume character of the photoeffect, with the increase of j_2/j_1 caused by the complex structures of the energy bands of these metals. Another explanation may be connected with the participation of intermediate states [10], particularly those connected with the metal-electrolyte interface, in the two-photon photoemission.

In any case, the presented experimental data indicate, in addition to the already mentioned discrepancies between the theoretical and experimental values of the photoemission currents in vacuum, also the need for refining the existing models of multiphoton photoemission of metals.

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MAGNETOELASTIC INTERACTION IN ANTIFERROMAGNETIC $MnCO_3$

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This paper reports an experimental investigation of the behavior of a triply-coupled system, viz., the interaction of hypersonic waves with spin waves of an electronic subsystem interacting in turn with nuclear spins. The influence of the nuclear spins becomes manifest in a distinct temperature and frequency dependence of the magneto-acoustic resonance.

In this study, an investigation was made of the influence of the magnetic waves on the propagation velocity of transverse hypersonic waves in $MnCO_3$. The sound was excited by odd harmonics of X-cut $LiNbO_3$ plates (approximate fundamental frequency 80 MHz). To measure the velocity, an echo-pulse method was used (pulse duration 0.3 μsec). The change of the velocity was measured with a modified phase-pulse method, viz., the change of the phase $\Delta\phi_v = -(2\pi f\ell/v)(\Delta v/v)$ of a pulse-modulated signal, due to a change of the sound velocity in the sample (ℓ is the sample length and v is the speed of sound), was compensated for by a change of phase $\Delta\phi_c = 2\pi f c^{-1}\Delta L$ (c is the speed of light and ΔL the change in line length) in the delay line, so that $\Delta\phi_v + \Delta\phi_c = 0$; thus, $(v/c)(\Delta L/\ell) = \Delta v/v$. Invariance of the total phase was revealed by comparison with an HF signal taken from the same generator.

$MnCO_3$ single crystals were grown by a hydrothermal method using the apparatus of the Crystallography Institute of the USSR Academy of Sciences[1]. The samples were rectangular parallelepipeds with dimensions 2 - 3.5 mm.

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