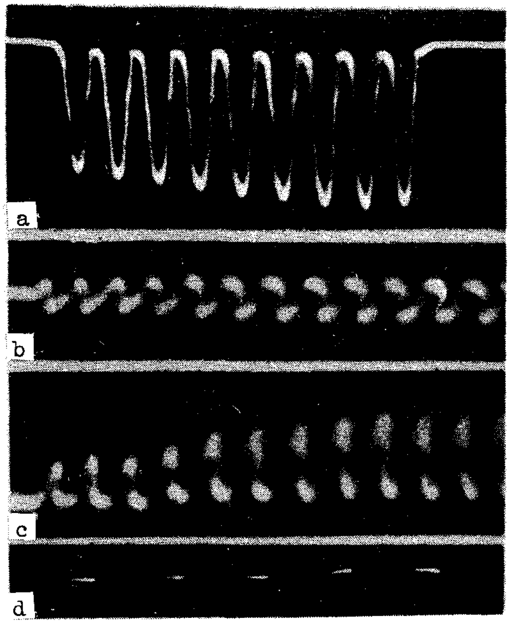


Fig. 3

acter of the electric oscillations, indicating that many harmonic components that are phased with one another, the presence of which had been noted in [2], are simultaneously excited in the circuit with distributed reactances.

The optical pulsations caused by the self-oscillations of the highest frequency ($f \approx 1000$ MHz) in a circuit made up of a cable segment 5 cm long, were registered with a scanning electron-optical converter (Fig. 3d). In all cases, the optical and electric pulsations were produced only when the radio-frequency circuit was connected to the SL.

To increase the frequency f, it is necessary to use waveguide oscillating systems with distributed interaction and to produce synchronism between the slowed-down electromagnetic wave and the electronic perturbation in an SL with periodically alternating injection sections [2], which can also be represented in the form of a superposition of traveling waves. Optical-pulsation frequencies up to 10^5 MHz were registered in similar lasers operating in the mode locking regime, and the frequency can be expected to be increased by one more order of magnitude. Thus, the upper frequency limit of the observed phenomenon lies apparently in the far infrared.

[1] N.G. Basov, V.V. Nikitin, and A.S. Semenov, Usp. Fiz. Nauk 97, 561 (1969) [Sov. Phys.-Usp. 12, 219 (1969)].
[2] L.A. Rivlin, Elektronnaya tekhnika, Elektronika SVCh (Electronic Engineering, Microwave Electronics), No. 5, 172 (1968).
[3] L.A. Rivlin, Izv. Vuzov Radiofizika 12, 1796 (1969).
[4] V.D. Kurnosov, O.N. Prozorov, and L.A. Rivlin, Fiz. Tekh. Poluprov. 3, 1091 (1969) [Sov. Phys.-Semicond. 3, 921 (1969)].
[5] V.D. Kurnosov, A.A. Pleshkov, L.A. Rivlin, V.V. Tsvetkov, and V.S. Shildyaev, 9th International Conference on the Physics of Semiconductors, Proc. 1, 550 (1968).

OBSERVATION OF REGULAR OSCILLATIONS OF THE TOTAL CROSS SECTION FOR THE EXCITATION OF Ne RESONANCE LINES IN COLLISIONS WITH Na^+ IONS

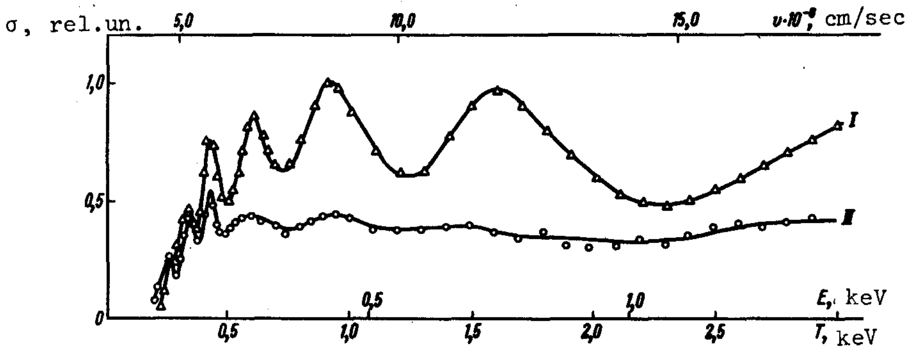
S.V. Bobashev
A.F. Ioffe Physico-technical Institute, USSR Academy of Sciences
Submitted 16 March 1970
ZhETF Pis. Red. 11, No. 8, 389 - 391 (20 April 1970)

We investigated the excitation functions of the resonance lines of the Ne atom, Ne 736 Å (I) and 744 Å (II), emitted upon collision of the Na^+ ions with Ne atoms

$$Na^+ + Ne \rightarrow Na + Ne^* - 16.85\ \mathrm{eV}; - 16.67\ \mathrm{eV} \qquad (1)$$

in the Na^+ ion energy interval from 0.2 to 11 keV. The experimental setup and the measurement procedure are described in [1]. In the present investigation we used as the quantum detector an open electron multiplier (VEU-1) with an electrometric amplifier (U-1-6).

The obtained excitation functions of the resonance lines are shown in the figure. Since resonance lines are investigated, the measured intensities $\mathcal{J}$ of these lines, referred to a unit current I of the Na^+ ions, are proportional to the cross sections for the excitation of the corresponding resonance levels, $\sigma = \alpha(\lambda) \times (\mathcal{J}/I)$. The two investigated lines are of nearly equal wavelength, and therefore their coefficients $\alpha(\lambda)$ are equal (the absolute magnitude of $\alpha(\lambda)$ was not determined in our experiment).



The main feature of the obtained curves is their oscillating character, and the change of the intensity of the two Ne I lines occurs in such a manner that the positions of the maxima coincide (see the figure). The table lists the energies T and the velocities v, characterizing the positions of the maxima of the excitation cross section of line (I), where the structure is more clearly pronounced. The table shows clearly the regular character of the oscillations, since the maxima are equidistant with respect to v^{-1} with good accuracy.

K	T, keV	v^{-1}, 10^8 cm/sec	Δv^{-1}, 10^8 cm/sec
1	10,50	3,38	2,56
2	3,400	5,94	2.72
3	1,600	8,66	2,76
4	0,920	11.4	2,72
5	0,600	14.1	2,66
6	0,425	16,8	2,00
7	0,340	18,8	2,74
8	0,260	21,3	

Insofar as we know, regular oscillations of the total cross section for the excitation of the resonance states of atoms have been observed by us in this investigation for the first time.

The observed effect has a character peculiar to the clearly pronounced resonant process. To explain its nature, we propose the following hypothesis: When the Na^+ ions collide with the Ne atoms, the process (1) is also accompanied by the charge exchange process

$$Na^+ + Ne \rightarrow Na^0 + Ne^+ - 16.42 \text{ eV}. \qquad (2)$$

Thus, at large internuclear distances R, the $(NaNe)^+$ system has three isolated terms, two of which correspond to the system $Na^+ + Ne^*$, and the third to the system $Na^0 + Ne^+$. Two states of the Ne atom, $2p^5({}^5p^0_{1/2})3s$ (I) and $2p^5({}^2p^0_{3/2})3s$ (II) have a similar excitation character, and in the description of the collision we shall therefore regard them as one term of the $Na^+ + Ne^*$ system.

Qualitatively, the collision process is considered in the following manner. As the atomic particles come closer together ($R \rightarrow 0$), the ground-state term of the Na^+Ne system intersects two terms of the quasimolecule $(Na^+Ne)^*$ in the region $R = R_0$. The ordinate of this pseudo-intersection, U_0, is determined by the position of the threshold for the process (1), and lies at $U_0 < E = 100$ eV. Following the population process at the point $R = R_0$, which is described by the Landau-Zener theory, the two molecular terms vary adiabatically up to a certain internuclear distance $R_1 >> R_0$, at which the close approach leads to a non-adiabatic interaction that causes mixing of the wave functions of the molecular states under consideration. Two stationary states, corresponding to two inelastic channels (1) and (2) of the reaction $Na^+ + Ne$ are then formed in the region $R > R_1$.

The regular oscillations of the total cross section in process (1), according to the foregoing hypothesis, are the results of the fact that the time spent by the system in the region $R < R_0$, where integration with respect to the impact parameter ρ is significant, is much lower than the time of stay in the region $\Delta R = R_1 - R_0$.

The fact that the maxima are equidistant with respect to v^{-1} (see the table) in a wide range of relative-motion velocity v shows that the quantity determining the period of the oscillation is the phase difference in the section from R_0 to R_1, which does not depend on ρ.

An inevitable consequence of the considered collision mechanism are oscillations in the total cross section of the reaction (2), in counterphase with the oscillations observed in this investigation for the reaction (1).

Similar qualitative considerations were advanced by Rosenthal [2] to explain the structure of the excitation functions of two helium lines emitted in the visible region of the spectrum in $He^+ + He$ collisions [3].

We plan to publish in the nearest future a theoretical analysis that would make it possible to describe quantitatively certain features of the behavior of the measured excitation functions of the resonant lines of the Ne atom.

The author is grateful to V.A. Ankudinov, Yu.N. Demkov, and V.I. Perel' for useful discussions, to V.A. Kritskii for help in the measurements, and to V.M. Dukel'skii for constant interest in the work.

[1] V.B. Matveev, S.V. Bobashev, and V.M. Dukel'skii, Zh. Eksp. Teor. Fiz. 55, 781 (1968) [Sov. Phys.-JETP 28, 404 (1969)].
[2] H. Rosenthal, Abstracts of Papers of Sixth International Conference of the Physics of Electronic and Atomic Collisions, p. 302 (1969).
[3] S. Dworetsny, R. Novick, W.W. Smith, and N. Tolk, Phys. Rev. Lett. 18, 939 (1967).

INCOHERENT REFLECTION OF LIGHT BY A METAL

N.I. Mitina, V.G. Padalka, and K.N. Stepanov
Physico-technical Institute of the Ukrainian Academy of Sciences
Submitted 5 January 1970; resubmitted 16 March 1970
ZhETF Pis. Red. 11, No. 8, 391 - 393 (20 April 1970)

In metals, just as in a plasma, there exist fluctuations of the free-electron density, owing to the presence of fluctuation Langmuir oscillations and surface waves. Because of the nonlinear interaction between the incident waves and the fluctuations of the electron density, reflection of the electromagnetic wave from the metal surface should produce emission at the combination