ders of magnitude than the reserve of chemical energy. The reaction vessel was a tube with calcium-fluoride windows mounted at the Brewster angle. Generation was obtained at many lines of the vibrational bands of the HF* molecule in the wave-number range 3600 - 4200 cm^{-1}, corresponding to the vibrational transitions in the HF molecule. Figure 2 shows the oscillograms of the chemiluminescence pulses (a) and generation pulses (b) at the transition P_4 of the 2 - 1 vibrational band (the scale of oscillogram b is 100 times larger than that of a). The generation pulse duration at half-height was ~5 μsec. A calorimeter was used to measure the total energy Q_L of the light in the pulse. It is possible to introduce the concepts of "electric" and "chemical" efficiencies of such a laser: the electric efficiency is $K_E = Q_L/Q_E$ and the chemical efficiency is $K_C = Q_L/\eta Q_C$, where η is the degree of burnup of the mixture and Q_C the reserve of chemical energy. Estimates based on the results of the experiments yielded K_E = 2 - 10% and $K_C \gtrsim 0.2\%$. These quantities exceed by several orders of magnitude the efficiencies attained in known photochemical pulsed lasers. Apparently we have come in this case much closer to a truly chemical laser, if we take $K_E \geq 100\%$ as the criterion for such a laser.

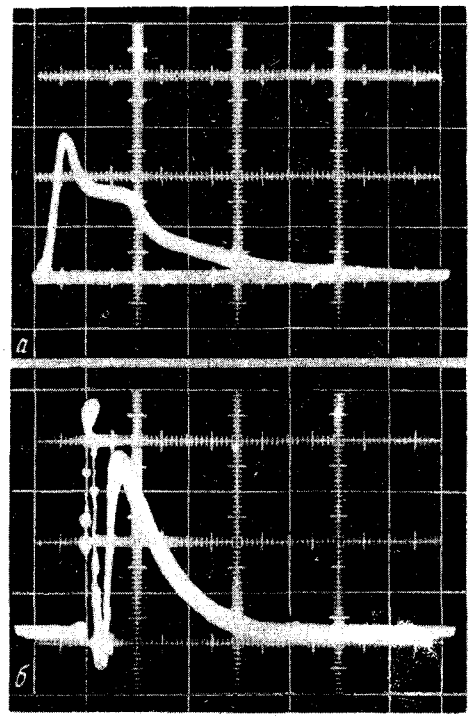

Fig. 2. Oscillograms of pulses: a - chemiluminescence, sweep 50 μsec/cm; b - generation, sweep 5 μsec/cm.

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THRESHOLD BEHAVIOR OF THE CROSS SECTION FOR THE EXCITATION OF Cs II RESONANCE LINES IN THE PROCESS $Cs^+ + He$

S. V. Babashev, V. B. Matveev, and V. A. Ankudinov
A. F. Ioffe Physico-technical Institute, USSR Academy of Sciences
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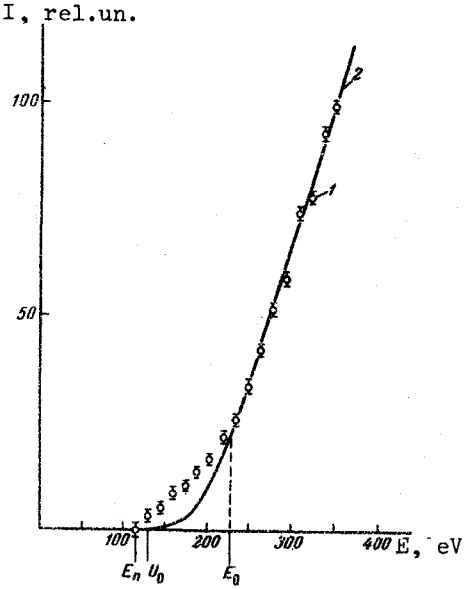
In the present investigation we have observed experimentally that the approach of the turning points and of the pseudointersection point of the potential terms of the quasimolecule



Intensity of Cs II$^+$ and He line. 1 - experimental points, 2 - calculation by means of formula (2).

Cs^+He affects the behavior of the cross section for the excitation of the Cs II lines near threshold.

Using the setup of [1], we investigated the threshold behavior of the cross section for the excitation of three Cs II lines produced as a result of the collision $Cs^+ + He \rightarrow Cs^{+}* + He$. We observed the experimental thresholds of three resonant lines of Cs II: $\lambda = 926.7$ Å; $\lambda = 901.1$ Å, $E_n = 116$ eV; and $\lambda = 808.7$ Å, $E_n = 160$ eV. All three lines exhibit a similar behavior with increasing Cs^+ ion energy (see the figure).

When Cs^+ collides with He, the Cs II lines are excited most probably as a result of the pseudointersection of two terms $U_1(r)$ and $U_2(r)$ of the quasimolecule Cs^+He, where the first term corresponds to the normal state, when the unexcited Cs^+ and He come closer, and the second pertains to the case when Cs^+ is excited and He is in the ground state.

The approach of the two terms should be most favored, apparently, upon excitation of resonant levels, when the electronic term of the initial state first intersects only the terms corresponding to the resonant levels, and only then, possibly, other higher terms. The excitation of the resonant lines of Cs II is a particularly favorable case, for when the energy of the Cs^+ ions increases the first to be excited are the resonant lines of Cs II, and the He I lines are excited only at much higher energy.

If the energy of the relative motion of Cs^+ and He is $E \gg U_0$ (U_0 is the ordinate of the pseudointersection point $U_{1,2}(r)$; the turning point is far enough from U_0), then the probability of the non-adiabatic approach is given by the Landau-Zener formula [2]

$$W_{1,2}(v) = 2\exp\left(-\frac{2\pi\rho^2}{\hbar v \Delta F}\right)\left[1 - \exp\left(-\frac{2\pi a^2}{\hbar v \Delta F}\right)\right] \qquad (1)$$

and the cross section is written in the form [2,1]

$$\sigma(E) = 2\pi \int_0^{\rho_m} W_{12}(v)\rho\, d\rho, \qquad (2)$$

where a is the matrix element connecting the two states under consideration, and U_0 and r_0 are the coordinates of the pseudointersection point

$$\Delta F = |F_1 - F_2|, \quad F_{1,2} = -\left.\frac{\partial U_{1,2}(r)}{\partial r}\right|_{r=r_0}, \quad v = dr/dt\Big|_{r=r_0},$$

$$\rho_m = r_0\sqrt{1 - (u_0/E)}.$$

The experimental curve for $E \geq 250$ eV was matched by least squares to the cross section calculated by formula (2) (see figure) [1]. This matching, carried out with the aid of the BESM-4 computer, has made it possible to determine the two parameters that enter in Eq. (1): $U_0 = 127.5$ eV and $\beta = 2\pi\sqrt{\mu}a^2/\hbar\Delta F = 41.25$ eV$^{1/2}$. From β we can determine directly the quantity $a^2/\Delta F$, which characterizes the region of the pseudo-intersection of $U_1(r)$ and $U_2(r)$. The table lists the values of ΔF for different values of a.

a, eV	2a, at. un.	ΔF, at. un.	F, at. un.	ΔF/F
0.5	0.04	0.022	1.05	0.02
1.0	0.07	0.09	2.1	0.04
1.5	0.11	0.20	3.3	0.06
2.0	0.15	0.36	4.2	0.08
2.5	0.18	0.56	5.4	0.10

It is seen from the figure that the experimental and theoretical cross sections disagree at energies $E \lesssim U_0 \cong 225$ eV ($\rho_m \cong 0.66 r_0$). The observed effect is apparently connected with the approach of the pseudo-intersection point to the turning points. So long as $E \gg U_0$, the cross section of the transition is well described by formula (2), and when E aproaches U_0 the character of the pseudo-intersection of the terms begins to exert a stronger influence on the course of the cross section; a deviation from the calculation of (2) is to be expected beyond a certain energy.

A theory of non-adiabatic transitions, which takes into account the closeness of the turning and pseudo-intersection points, was developed in [3] for the case of two intersecting linear zeroth-approximation terms with constant interaction matrix elements. A direct comparison with [3] is difficult, since in [3] they calculated the transition probabilities and not the cross sections. Nonetheless, rough estimates can be obtained for the parameters of the theory and for the value of F. For $E \cong E_0$ we have introduced an "averaged" impact parameter $\rho_{av}^2 = (1/2)\rho_m^2$ and, following [3], we have considered two parameters defining the transition probability

$$\epsilon = \mathcal{E}\,\Delta F/2aF, \qquad b = 4\pi a\sqrt{\mu a}/\hbar\sqrt{F\Delta F},$$

where $F = (F_1' \cdot F_2')^{1/2}$, $\mathcal{E} = E - U_0 - \rho^2 E/r_0^2$, and F_1' and F_2' include the centrifugal force. Using the connection of ϵ and b with β and U_0, namely $b^2\epsilon^{-1} = 8\beta^2\pi^{-2}\mathcal{E}^{-1}$, and the boundary conditions for the probability (1) introduced in [3] ($b^2\epsilon^3 = 27$), we were able to calculate $\epsilon_0 = 1$ and $b_0 = 5.2$, corresponding to $E = E_0$, where a deviation of the two curves was observed (see the figure). It was shown in [3] that $b \geq 6$ and that $\epsilon \sim 1$ is the energy region below which the transition probability is given not by formula (1), but by the formulas of [3]. The quantity b depends little on ρ, so that there are grounds for assuming that in the case of $Cs^+ + He$ the main contribution to the cross section is made by values of ρ such that $b \approx 5 - 6$. The table lists the forces F acting on the particle

[1] It was observed in [1] that the form of the cross section for the excitation of the K II resonant lines produced in the $K^+ + He$ collision are described satisfactorily by formula (2) if the distance from the threshold is sufficiently large.

in the region $r = r_0$, for different values of the spacing between the terms $2a$ [1)], determined from ϵ_0 and b_0; F contains the centrifugal force, which can be readily shown to amount to 20 - 30% of $F_{1,2}$ when $E = E_0$.

Unfortunately, there are no formulas for the calculation of the cross sections in a wide range of variation of ϵ and b, making it impossible to compare the experimental curve with the calculation for $E < E_0$.

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SPIN WAVES NEAR THE CURIE POINT

G. M. Drabkin, A. I. Okorokov, E. I. Zabidarov, and Ya. A. Kasman
A. F. Ioffe Physico-technical Institute, USSR Academy of Sciences
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In the study of the critical scattering of neutrons in nickel [1], we observed flat maxima at $T < T_c$. With increasing angle of observation, these maxima shift towards higher temperatures (these maxima were called in [1] scattering of type II). In scattering in iron, similar maxima were observed by Jacrot [2].

In the present paper we show that these maxima are due to scattering of neutrons by spin waves.

As is well known [3], in the case of a quadratic dispersion of the spin waves, the scattering of neutrons occurs in a cone with apex angle $2\theta_0$. The angle θ_0 does not depend on the energy of the incident neutrons and equals $1/\alpha$, where $\alpha = 2mA/\hbar^2$ (m - neutron mass, A - constant in the spin wave dispersion law, $E_q = Aq^2 = A(\vec{K}_0 - \vec{K})^2$). The differential cross section of single-magnon scattering is given in this case by

$$d\sigma/d\theta \sim (\theta_0^2 - \theta^2)^{-1/2} \qquad (1)$$

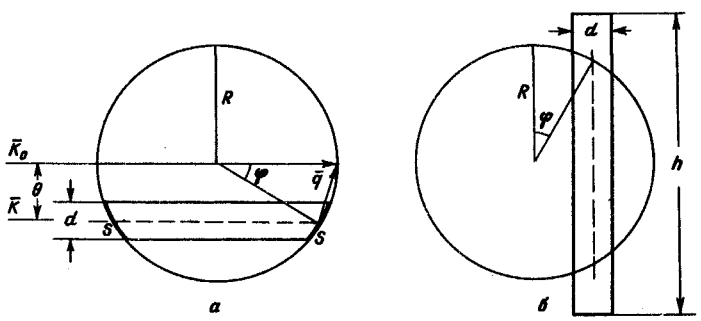

Fig. 1

We recall also that a quadratic disper-

1) For comparison, we determined the forces acting in the K^+ + He collision at the point $r = r_0$, where $U(r_0) = 127.5$ eV. We use for the estimate the potential for the Ar + He pair [4], which yields $F_0 = 9$ atomic units ($r_0 = 0.69$ A).