INTERFERENCE EFFECT IN THE CROSS SECTION FOR THE CHARGE EXCHANGE OF Li^+ IONS WITH He ATOMS

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We have investigated the cross section of the charge-exchange process

$$Li^+ + He \rightarrow Li + He^+ \quad (1)$$

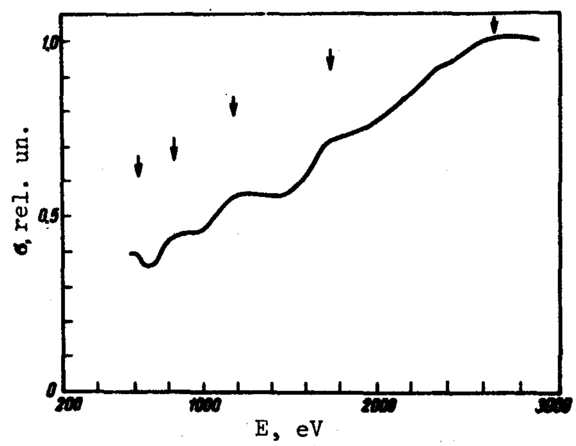
in the collision-energy interval $600 \leq E \leq 2800$ eV, by the method described in [1] (E - kinetic energy of the ions in the laboratory coordinate system). The Li^+ ions were obtained from a thermo-ionic source. The sensitivity of the method was increased by raising the frequencies of the primary-ion-beam pulsation and of the secondary-ion collecting electric field to 200 kHz. To plot the total cross section for the production of He^+ ions in the process (1) and in the process

$$Li^+ + He \rightarrow Li^+ + He^+ + e \quad (2)$$

against the energy, we used a two-coordinate automatic plotter together with a division network yielding the ratio of the current intensities $I(He^+)/I(Li^+)$. The charge-exchange cross section was obtained by subtracting the cross section of (2) from the joint cross section of (1) and (2). The cross section of (2) was measured in an independent experiment. The figure shows the cross section obtained for the charge-exchange process (1) by reducing the experimental data. The rms error in the relative cross sections is 3.5%, and the estimated absolute cross section at the point E = 2800 eV is 2×10^{-18} cm^2 (±50%). The obtained dependence of the charge-exchange cross section (see the figure) on the velocity v of the Li^+ ions can be represented as a sum of a smoothly-varying part and an oscillating part

$$\sigma(v) = \sigma_0(v) + a\cos\left(\frac{\beta}{v} + \delta\right), \quad (3)$$

where a is a weak function of v, $\beta = 3.25 \times 10^7$ cm/sec, and $\delta = 0.25\,\pi$. We see therefore that the charge-exchange cross section oscillates regularly as a function of the collision velocity.



Effective charge-exchange cross section in collisions of Li^+ ions with He atoms.

These oscillations are apparently the effect of interference of several states of the quasimolecule, when the terms of the corresponding inelastic processes interact at large internuclear distances. In the limiting case, at distances $R \rightarrow \infty$, the $^1\Sigma$ term of the system $Li(1s^2 2s) + He^+(1s)$ is at a distance 1.42 eV from the $^1\Sigma$ term of the system $Li^+(1s^2) + He(1s2s)$. Here the first term corresponds to the charge exchange process [1] and the ground state of the Li atom, while the second corresponds to the process of excitation of the states He(1s2s) of the helium atoms. An estimate of the potential of the interaction of the particles in these systems in the region of medium and large R, with allowance for only the polarization interaction of the ion and the atom, points to an intersection of these two potentials at $R \sim 9$ at.un. Consequently, the exact $^1\Sigma$ terms of these systems experience a pseudo-intersection in the region $R \sim 9$ at. un. and the observed oscillation of the cross section (1) is expected to be connected with the oscillations of the cross section for the excitation

$$Li^+(1s^2) + He(1s^2) \rightarrow Li^+(1s^2) + He(1s2s). \quad (4)$$

At the present time there are no published experimental data on the excitation cross section of (4). The cross sections of (4) and of the process

$$Li^+(1s^2) + He(1s^2) \rightarrow Li^+(1s^2) + He(1s2p) \quad (5)$$

were calculated theoretically in [2] for the energy interval $0.1 \leq E \leq 3.5$ keV, and it was shown that these cross sections oscillate. However, the magnitude and the form of the cross sections obtained in [2] depend on the method of calculation. Therefore, to establish a correlation between the charge-exchange cross section (1) and the excitation cross section (4) it is necessary to have more exact information on the cross sections of the processes (4) and (5). The need for this information becomes obvious from the results of [1], according to which the correlation between the cross sections of the inelastic channels can have a complicated character, depending on the number of terms interacting at large distances.

In the energy interval investigated by us and at the indicated experimental errors, the charge-exchange cross section (1) oscillates at one frequency ($\beta = 3.25 \times 10^7$ cm/sec). The presence of one oscillation mode in this cross section indicates that at large R the term of the charge-exchange channel (1) interacts with the term of only one inelastic channel. This term, as indicated above, is the term of the excitation channel (4). The region of the interaction of the terms lies at $R \sim 9$ at. un.

Thus, the investigation of the structures of the cross sections of inelastic atomic collisions makes it possible to obtain, at relatively large collision energies ($E \gtrsim 1$ keV), information on the long-range part of the interaction potential of an excited system consisting of two atomic particles. At the same time, information on the long-range potential of the interaction of a system of two particles in the ground state is usually obtained in experiments on elastic scattering at low energies ($E < 10$ eV).

[1] Z.Z. Latypov and A.A. Shaporenko, ZhETF Pis. Red. 12, 177 (1970) [JETP Lett. 12, 123 (1970)].
[2] B.F. Junker and J.C. Browne, VI ICPEAC, Abstracts of Papers, Cambridge, Mass., 1969, p. 220.

INFLUENCE OF A STRONG ELECTRIC FIELD ON THE TEMPERATURE OF THE DIELECTRIC-METAL PHASE TRANSITION IN $(V_{0.91}Cr_{0.09})_2O_3$

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Intensive studies have been initiated recently of the substitution solid solutions V_2O_3-Me_2O_3, where Me = Al, Cr, and Ti [1 - 3]. These metals,