$$W_1 = |a_3(R_0)|^2(1-p_1)^2 + |a_1(R_0)|^2 p_1^2 + 2\mathrm{Re}\, a_1(R_0) a_3(R_0) p_1(1-p_1) \times$$
$$\times \cos[\phi_1(R_1) - \phi_3(R_1)], \qquad (4)$$

$$W_2 = |a_3(R_0)|^2 p_1^2 (1-p_2)^2 + |a_1(R_0)|^2 (1-p_1)^2 (1-p_2)^2 + |a_2(R_0)|^2 p_2^2 +$$
$$+ 2\mathrm{Re}\, a_3(R_0) a_1(R_0) p_1(1-p_1)(1-p_2)^2 \cos[\phi_1(R_1) - \phi_3(R_1)] +$$
$$+ 2\mathrm{Re}\, a_2(R_0) a_3(R_0) p_1 p_2 (1-p_2) \cos[\phi_2(R_2) - \phi_3(R_2)] +$$
$$+ 2\mathrm{Re}\, a_1(R_0) a_2(R_0) p_2 (1-p_1)(1-p_2) \cos[\phi_1(R_1) + \phi_2(R_2) + \phi_3(R_2) -$$
$$- \phi_3(R_1)], \qquad (5)$$

$$W_3 = |a_3(R_0)|^2 p_1^2 p_2^2 + |a_1(R_0)|^2 (1-p_1)^2 + |a_2(R_0)|^2 (1-p_2)^2 +$$
$$+ 2\mathrm{Re}\, a_1(R_0) a_3(R_0) p_1 p_2 (1-p_1) \cos[\phi_1(R_1) - \phi_3(R_1)] +$$
$$+ 2\mathrm{Re}\, a_2(R_0) a_3(R_0) p_1 p_2 (1-p_2) \cos[\phi_2(R_2) - \phi_3(R_2)] +$$
$$+ 2\mathrm{Re}\, a_1(R_0) a_2(R_0) (1-p_1)(1-p_2) \cos[\phi_1(R_1) + \phi_2(R_2) + \phi_3(R_2) -$$
$$- \phi_3(R_1)], \qquad (6)$$

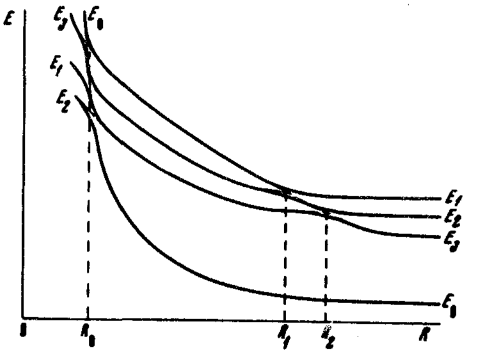

Fig. 2. Term scheme of the quasimolecule.

where $a_i(R_0)$ are the initial amplitudes of the population of the terms E_i; p_1 and p_2 are the probabilities of the (Landau-Zener) transition between the terms at R_1 and R_2; $\phi_i(R)$ is the change of the phase in the interval $R - R_0$. Since the arguments of the cosines in (4), (5), and (6) do not depend on the impact parameter, the corresponding effective cross sections will oscillate in accordance with the same laws. The probability W_3 corresponds in our case to the probability of the charge exchange (1), while W_1 corresponds to the probability of excitation of the 736-Å line in the process (3). It is seen from (4), (5), and (6) that as a result of the intersection of the terms of the three inelastic channels at R_1, $R_2 > R_0$, the cross sections of these channels oscillate at resonant frequencies. For example, the oscillation frequency of W_3 can exceed the frequency of W_1.

The connection between the cross sections of (1) and (3) confirms the nonadiabatic behavior of the terms of Na-Ne$^+$ and Na$^+$-Ne* at large R, and makes it possible to estimate the excitation cross sections of (3) from the known absolute values of the cross section of (1).

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SCATTERING OF 4-MeV NEUTRONS AT ANGLES CLOSE TO 180°

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Measurements were made of the elastic scattering of a polarized beam of

4-MeV neutrons[1] by In, Sn, Pb, Bi, and U nuclei in the scattering-angle range 146 - 177°. We used the setup described in [1], the geometry of which was suitably modified (the scattering samples were moved away from the output aperture of the collimator shaping the neutron beam, and the detectors of the scattered neutrons were placed between the collimators and the samples). To decrease the background, the shielding of the measurement room was greatly increased, but nonetheless the background in the measurements with In, Sn, and U reached 80 - 90% of the total detector count at $\theta = 177°$. The registration threshold of the detectors (scintillation counters with stilbene crystals) corresponded to a neutron energy 3 MeV. To increase the effect, scatterers of relatively small transparency were used ($T_0 = 0.55$).

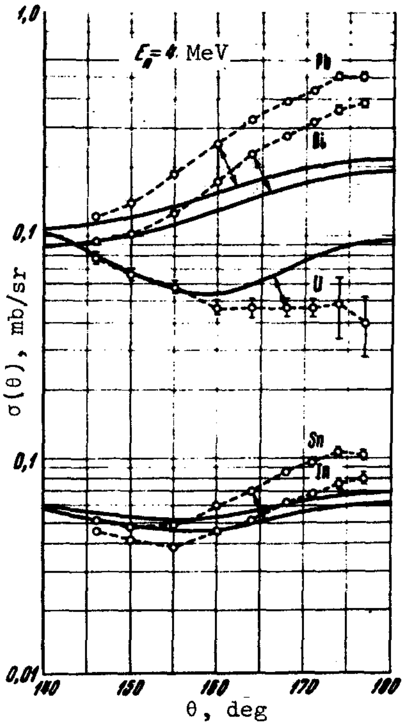

Fig. 1

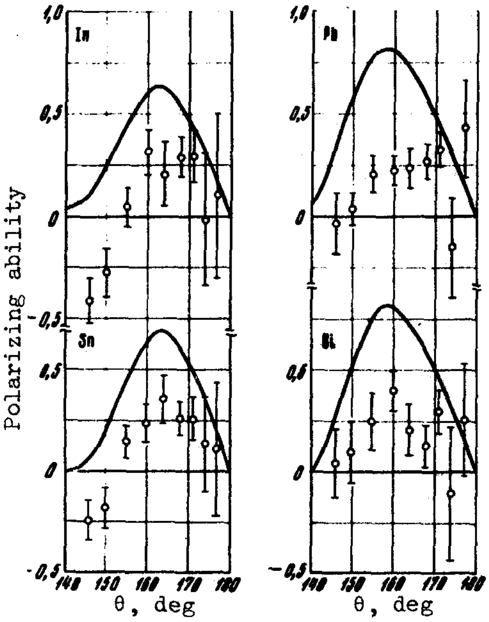

Fig. 2

We measured the angular distributions of the neutrons scattered by the investigated samples in a reaction plane perpendicular to the polarization vector of the neutron beam, to the right and to the left of the beam, and determined the absolute probability of neutron scattering in the geometry of the experiment at $\theta = 174°$.

From the measurement results we calculated the differential cross sections of the elastic scattering of the unpolarized neutron beam $\sigma(\theta)$ and the polarizing abilities $p(\theta)$ of the nuclei in elastic scattering of neutrons; the calculation was performed with allowance for two multiplicities of the scattering of the neutrons in the sample. The readings due to neutron fission, amounting up to 30% of the total number of the counts for U, were excluded from the

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[1] The neutron source was the D-D reaction and the neutron beam polarization amounted to ∿15%.

experimental data for U before calculating the differential cross section[2]. Although there exists a noticeable probability of inelastic scattering of the neutrons U with an energy drop less than 1 MeV, no such corrections were introduced, since they were difficult to estimate.

The results of the calculations of the differential neutron elastic cross sections are shown in Fig. 1 with the statistical measurement errors (the dashed curve is drawn through the experimental points). The absolute value of the cross section was determined accurate to ∿10% for the heavy elements and ∿13% for In and Sn. As seen from the figure, an increase of the differential cross section of the elastic scattering of the neutrons with increasing scattering angle (a maximum in the background scattering) was observed for all the investigated elements with the exception of U.

Figure 2 shows the polarizing abilities of the investigated nuclei In, Sn, Pb, and Bi with their statistical errors[3].

The solid curves on the figures represent the results of calculations with the aid of the optical potential from [4], the parameters of which were chosen earlier from the experimental data for $\sigma(\theta)$, $p(\theta)$, and σ_+ for a number of elements at the same scattered-neutron energy. The curves shown for Pb, Bi, and U were obtained by adding to the results of the calculations the cross sections for the scattering via the compound nucleus (isotopic), amounting to 80, 60, or 30 mb respectively.

The potential of [4] predicts the existence of a diffraction maximum for all the investigated elements. This does not agree qualitatively with the results obtained in the experiments for U. The value of the calculated cross section in inelastic backward scattering from all elements differs from the experimentally observed value by approximately a factor of two.

We note that the optical potentials used in [2, 5] to describe the elastic scattering of 4-MeV neutrons by U also predict a maximum in the backward scattering cross section. All these potentials do not take into account the non-sphericity of U. It can be assumed that the observed effect is due precisely to this non-sphericity.

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[2] To estimate the number of counts due to the fission neutrons we used data on the number of detector counts with amplitude exceeding the amplitude of the signal from 4-MeV protons, and also data on the form of the fission-neutron spectrum [2] and on the dependence of the detector registration efficiency on the neutron energy [3].

[3] We present no data for uranium, since the uncertainty introduced in the polarizing ability by the unaccounted-for contribution of the inelastically scattered neutrons makes these data unreliable, owing to the small absolute value of the cross section of neutron scattering in the investigated scattering-angle region.