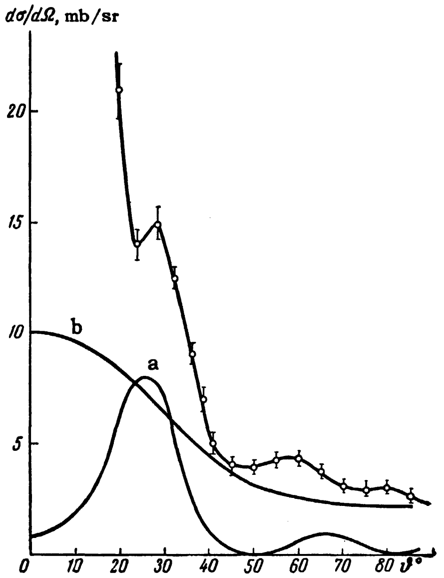

The maximum value $(d\sigma/d\Omega)_{max}$ for process a depends weakly on E_d. With increasing E_d, the first maximum shifts toward smaller ϑ, but does not go beyond zero, since $m_d = m_{d'}$ and $|\mathbf{k}_d - \mathbf{k}'_d| \rightarrow 0$ for increasing E_d. According to Eq. (1), for process b the dependence of $(d\sigma/d\Omega)_{max}$ on E_d should be stronger, since even for ordinary stripping $(d\sigma/d\Omega)_{max}$ depends on E_d approximately as E_d^{-2}, while the first maximum in the angular distribution is shifted, for large E_d, to the left of zero angle (since $|\mathbf{k}_p - \mathbf{k}_d|$ for a given ϑ varies approximately as $E_d^{1/2}$). Apparently these qualitative conclusions are in agreement with the presently available experimental data on excitation of first excited levels by inelastic scattering of deuterons on Mg^{24} (references 4 and 10), Be^9 (references 4 and 11), and Mg^{24} with excitation of the 4^+ level.[10] In the last case, the absence of a maximum at $\vartheta \sim 0$ is explained by the fact that to excite the level it is necessary that l_i and l_f be large (for example, $l_i = l_f = 2$). With increasing l_i and l_f, the reaction amplitude drops if E_d is not very large, while the peak in the angular distribution is shifted toward large scattering angles.

In the scattering of deuterons by nuclei with different external shells, different intermediate states give the main contribution to process b. Thus, in the scattering of deuterons by C^{12}, apparently the 1p-state is most important, for Mg^{24} the main contribution is from the 1d+2s states, and possibly the 2p states, for Ca^{40}, the 2p states.

In conclusion the authors express their gratitude to G. S. Tyurikov for aid in carrying out the numerical computations.

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COMPETITION BETWEEN NEUTRON EVAPORATION AND FISSION IN THE REACTIONS OF MULTIPLY CHARGED IONS WITH HEAVY NUCLEI

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In this work we use certain experimental results[1-3] to estimate the relative importance of two competing processes — neutron evaporation and fission — in the de-activation of the compound nuclei formed when heavy elements are bombarded by multiply charged ions.

As is well known, the reaction cross section σ_{xn} for the evaporation of x neutrons when a particle interacts with a nucleus can be written

$$\sigma_{xn}(E) = \sigma_c(E)\, \overline{G}_n^x P(E, x).$$

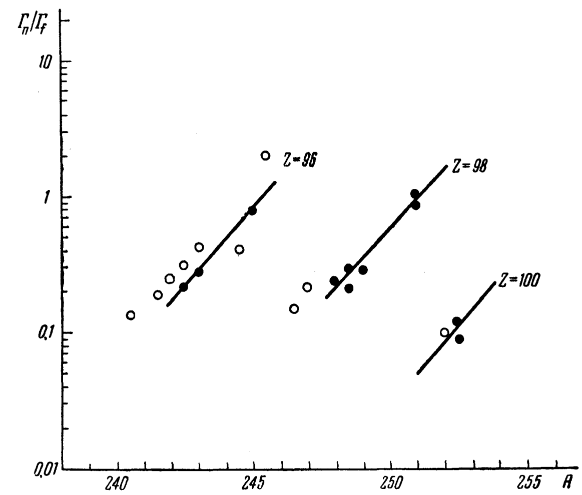
We used this relation to approximate the experimental values of the cross section for neutron evaporation. $\sigma_c(E)$ is the cross section for formation of the compound nucleus and was calculated

	Reaction	"Mean" intermediate nucleus	Γ_n/Γ_f	T, Mev
1	Th^{232} (C^{12}, $4n$) Cm^{240}	$Cm^{242.5}$	0.22	1.3
2	Th^{232} (C^{13}, $5n$) Cm^{240}	Cm^{243}	0.27	1.5
3	U^{238} (C^{12}, $4n$) Cf^{246}	$Cf^{248.5}$	0.21	1.3
4	U^{238} (C^{12}, $5n$) Cf^{245}	Cf^{248}	0.24	1.3
5*	U^{238} (C^{13}, $5n$) Cf^{246}	Cf^{249}	0.29	1.5
6*	U^{238} (C^{13}, $6n$) Cf^{245}	$Cf^{248.5}$	0.29	1.6
7	Pu^{241} (C^{13}, $4n$) Fm^{250}	$Fm^{252.5}$	0.12	1.3
8	U^{238} (O^{16}, $4n$) Fm^{250}	$Fm^{252.5}$	0.09	1.4
	From the comparison			
9	**reactions 2 and 1**	Cm^{245}	0.81	
10	**reactions 5 and 3**	Cf^{251}	0.89	
11	**reactions 6 and 4**	Cf^{251}	1.00	

***In approximating the data for these reactions, we took into account the fact, demonstrated by supplementary experiments, that the energies of the C^{13} ions quoted in reference 1 were 2 Mev too high.**

using the experimental results in reference 4 and the formula obtained by Maksimov.[5] P(E, x) is the probability that the nucleus de-excites itself by the emission of x neutrons and was calculated on the basis of Jackson's model,[6] as modified for fissionable nuclei.[7] The calculations were carried out for various nuclear temperatures T so as to obtain the best possible fit to the experimentally measured position of the maximum for the reaction. $\bar{G}_n^x$ is the ratio $\frac{\Gamma_n}{\Gamma_n + \Gamma_f}$, averaged over the compound and intermediate nuclei, and was chosen so as to give a best fit to the absolute values of the cross section. The results are shown in the table. In rows 1 to 8 are given average values of Γ_n/Γ_f, obtained from the relation $\Gamma_n/\Gamma_f = \bar{G}_n/(1 - \bar{G}_n)$, while rows 9 to 11 give values of Γ_n/Γ_f for individual nuclei.

It is interesting to compare the values of Γ_n/Γ_f so obtained with values of Γ_n/Γ_f for the same nuclei obtained in a different way: for example, with He^4 ions. Such a comparison is of interest because in the interaction of heavy ions with nuclei, states of very high excitation and angular momentum can be formed, and such states are particularly likely to fission.[8] The figure shows Γ_n/Γ_f as a function of A for the nuclei Cm, Cf, and Fm, the solid circles (●) corresponding to heavy ion reactions and the open circles (○) to He^4 ions. Data for reactions initiated by He^4 were taken from references 9 to 11. From the figure it follows that values of Γ_n/Γ_f obtained with ions C^{12}, C^{13}, and O^{16} agree fairly well with values obtained for He^4 as the bombarding particle. The values of Γ_n/Γ_f from heavy ion reactions do tend to be somewhat smaller but by an amount within experimental errors. There seems to be no evidence for some effect associated with the heavy ions. Thus in-



creasing the angular momentum of the compound nucleus from 25ħ (reactions initiated by 44 Mev He^4 ions) to 45ħ (reactions initiated by 80 Mev C^{12} and C^{13} ions, and by 95 Mev O^{16} ions) does not significantly decrease Γ_n/Γ_f. This is a very important fact for the synthesis of new elements using accelerated heavy ions.

In conclusion, the author would like to express his gratitude to Prof. G. N. Flerov for discussion of these results.

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EFFECT OF CONDUCTIVITY ANISOTROPY IN A MAGNETIC FIELD ON THE STRUCTURE OF A SHOCK WAVE IN MAGNETOGASDYNAMICS

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A systematic study of shock waves in a magnetized plasma must also take account of its anisotropic properties. Such a study is very difficult because of the cumbersome character of the initial equations, and can be carried out only by numerical integration. However, one can obtain a quantitative estimate of the thickness of the shock front in the plasma in a quite elementary way, and study the qualitative peculiarities of the effect of conduction anisotropy on the structure of shock waves.

We shall begin with the induction equation for an anisotropic plasma, which for the stationary case can be written in the form[1]

$$-\operatorname{curl}[\mathbf{u}\times\mathbf{H}] = \frac{c^2}{4\pi\sigma}\left\{\nabla^2\mathbf{H} - \frac{\omega\tau}{H}\operatorname{curl}[\operatorname{curl}\mathbf{H}\times\mathbf{H}]\right\} \quad (1)$$

Here $\sigma = \tau n e^2/m$ is the electrical conductivity, $\omega = eH/mc$ is the Larmor frequency for electrons, and τ is the time of free flight; the remaining notation is standard. We assume that the plane of the front coincides with the coordinate plane $x = 0$. In passage through the front of an oblique shock, the conditions of conservation of mass flow $j = \rho u_x = \text{const}$, of momentum flux (we need only the tangential components $u_{y,z} = H_x H_{y,z}/4\pi j$), and also $H_x = \text{const}$. Taking it into account that all the parameters in our case change only with x, Eq. (1), written in components with account of the conservation conditions, can be integrated once. We get

$$H_z(u_x - H_x^2/4\pi j) = \frac{c^2}{4\pi\sigma}(H_z' - \omega\tau H_x H_y'/H) + \text{const},$$
$$H_y(u_x - H_x^2/4\pi j) = \frac{c^2}{4\pi\sigma}(H_y' + \omega\tau H_x H_z'/H) + \text{const}, \quad (2)$$

and the x component of Eq. (1) vanishing identically. If the dependence of u_x and $\omega\tau H_x/H$ on the coordinates is not taken into account, integration of (2) gives

$$H_y \pm iH_z \sim \exp\left\{x\frac{4\pi\sigma}{c^2}\left(u_x - \frac{H_x^2}{4\pi j}\right)\frac{1 \pm i\omega\tau H_x/H}{1 + (\omega\tau H_x/H)^2}\right\}. \quad (3)$$

In the perpendicular wave $H_x = 0$, (2) reduces to equations already considered (see, for example, reference 2). The thickness of the front here is of the order $\Delta x = c^2/4\pi\sigma u_x$. Thus the conduction anisotropy has no effect on the structure of the perpendicular shock wave.

In an oblique gasmagnetic shock wave, $H_x \neq 0$. It then follows from (3) that the vector $\{0, H_y, H_z\}$ inside the front rotates about the x axis with period

$$p \approx \frac{2\pi c^2}{4\pi\sigma}\frac{1 + (\omega\tau H_x/H)^2}{(u_x - H_x^2/4\pi j)\,\omega\tau H_x/H} \simeq \frac{c^2}{2\sigma}\frac{\omega\tau\cos\varphi}{u_x - H_x^2/4\pi j}.$$

This effect can be considered as a generalization to nonlinear motion of the well known rotation of the plane of polarization of waves in an isotropic medium. An appreciable change in the absolute value takes place at distances of the order

$$\Delta x \approx \frac{c^2}{4\pi\sigma}\frac{1 + (\omega\tau H_x/H)^2}{u_x - H_x^2/4\pi j} \approx \frac{c^2}{4\pi\sigma}\frac{(\omega\tau\cos\varphi)^2}{u_x - H_x^2/4\pi j},$$

which must be considered in the thickness of an oblique shock front in an anisotropic magnetized plasma. Here φ is the angle of inclination of the front to the magnetic field. Thus the conduction anisotropy leads to a very great increase in the front thickness of oblique gasdynamic shocks. It should be noted that the front thickness of oblique gasmagnetic shock waves is proportional to the square of the magnetic field intensity.

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