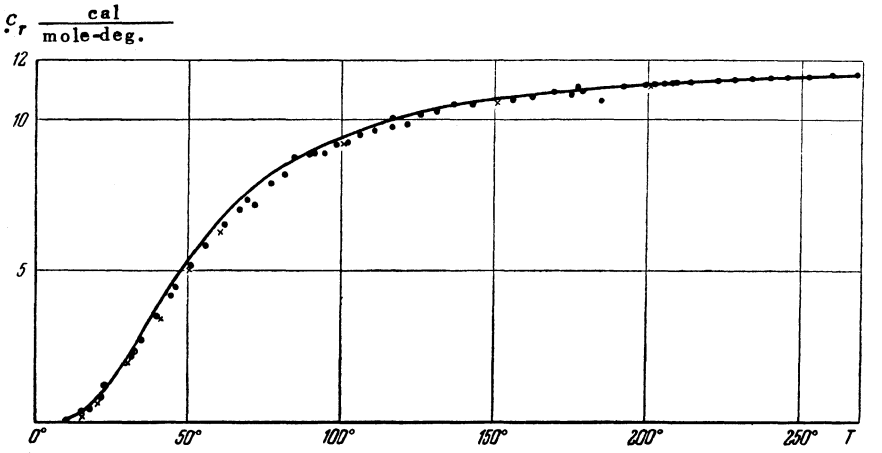

differences in mass of the K and Cl ions. The deformation of the ions was taken into account by the Tolpygo method [3,4].

The results of the calculations are shown in the Figure by the solid curve. On the same curve, in addition to the experimental data[5,6] and the heat capacities taken from the Kaye and Laby[7] and Landolt[8] handbooks, there are also the plotted heat capacities found from the Debye temperatures, determined by Iona[9] for a model of a point lattice and for equal mass of the K and Cl ions; these points are shown by crosses. As is evident from the Figure, it is impossible to express any preference for the present analysis by comparison with the results of Iona. This is associated with the fact that the heat capacity, being an integral value, is not very sensitive to calculation. The fact that at low temperatures the heat capacity was somewhat high indicates a somewhat high value of the parameters a_{11} and a_{22} of the non-electrostatic interaction forces between the ions of KCl, which were taken by the author from Ref. 3.

The author takes this opportunity of expressing his gratitude to K. B. Tolpygo for his constant interest in the work and for valuable comments.

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Investigation of γ-Rays from Po–Li and Po–Mg Neutron Sources

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WHEN lithium and magnesium are bombarded with α-particles of polonium, all (αn) and (αp) reactions are energetically possible with the exception of reactions αn upon Li^6 and Mg^{24}. Gamma rays are formed in the investigated sources as a result of the nucleus, the product of the corresponding reaction, being in an excited state, or because of its further radioactive decay.

The study of the γ-spectra was carried out by means of single or double crystal scintillation spectrometers and utilizing in the measurement system high stability multipliers FEU–12 which were kindly made available to us by G. S. Vildgrube. The resolution (relative width of the line at its half height) for the Cs^{137} 660 kev γ-line was in all cases not greater than 12%. The stability of the measuring system was so high that during the work extending over more than a month the apparatus did not require any additional calibration.

Figure 1 shows the γ-spectrum obtained from the Po–Mg source. The following γ-rays were found: 0.23; 0.8; 1.25; 1.85; 2.3; 4.2 mev. For lines

which were observed on a single crystal spectrometer, attempts made to detect $\eta-\gamma$ coincidences yielded negative results. Neutron–gamma coincidences could not be observed in measurements with the double spectrometer because of its low efficiency.

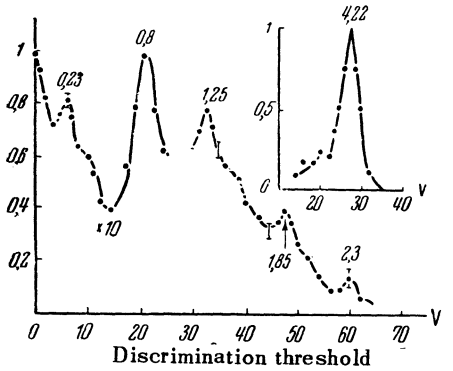

FIG. 1. γ-spectrum (in relative units) of Po-Mg source using a single crystal spectrometer. The γ-line $\sim$ 1 mev is not shown. In the upper right are shown results of measurements with a double spectrometer.

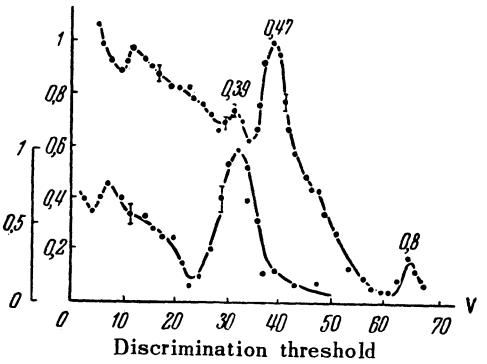

FIG. 2. γ-spectrum of Po-Li source obtained with a single crystal spectrometer. Lower curve: n-γ coincidences. Resolving time for coincidences 2×10^{-7} sec.

The 0.8 mev γ–rays are most likely the known line observed at disintegration of Po^{210} (ref. 1), γ–lines 1.85, 1.25 and 2.3 mev are apparently the result of one of the (αp) reactions. Line 1.85 mev probably corresponds to the disintegration of Al^{28} formed in the reaction (αp) on Mg^{25} (Ref. 2). Gamma rays 1.25 and 2.3 mev are apparently the result of disintegration of Al^{29} (Ref. 3).

Some indirect but quite difinite indications of the existence of γ–rays of the order of 4 mev are contained in Refs. 4–5. In this work we have found, using a double spectrometer, γ–rays of 4.2 mev. These lines may be related to one of the exothermic type (αn) reactions: either to Mg^{25} (αn) Si^{28} with reaction energy $Q = 2.7$ mev or to Mg^{26} (αn) S_i^{29} with $Q = 0.04$ mev, which may lead to the formation of the corresponding nuclei in a state excited to 4.2 mev. From energy considerations, other reactions cannot lead to products of such high state of excitation. For the reasons mentioned above it was impossible to find directly $n-\gamma$ coicidences with the 4.2 mev line. A special verification, using slowed down neutrons, indicated that the detected γ–rays cannot be related to the reaction of the neutron sticking to any material of the equipment.

The inensity of the weak line $\sim$ 1 mev was considerably increased when the measurement crystal CsI (Tl) or NaI(Tl) was surrounded by an I scatterer. It seems to us therefore more reasonable to ascribe this line to the inelastic scattering of neutrons by I rather than to the radiation from the excited state of Al^{28} or Al^{29} as is done in Ref. 4. The energy of the line, 1 mev, agrees well with the energy (1.01 mev), of one of the γ-lines observed in the inelastic scattering of neutrons by I (Ref. 6).

Several assumptions may be stated concerning the origin of the 0.23 mev γ-rays. They are not related to (αn) type reactions, since $n-\gamma$ coincidences did not yield a positive answer. No substantial changes in the intensity of the 0.23 mev line were observed when the measurement crystal was surrounded by the Na or I scatterers; the latter preclude the possibility of accounting for this line by the inelastic scattering of neutrons by the material of the crystal. Possibly these γ-rays are the result of one of the (αp) type reactions mentioned above. The possibility of their occurrence as a result of the excitation of the Mg nuclei by the inelastic scattering of α–particles cannot be rejected.

Figure 2 shows the γ–spectrum of the Po–Li source. Two γ–lines, 0.39 and 0.47 mev can be observed (besides the 0.8 mev γ–line of Po^{210}). The 0.47 mev line is most probably the result of excitation of Li^7 nuclei by the inelastic scattering of α–particles. The obtained γ–ray energy agrees well with results of other investigations.[7-8] When the measurement crystal was surrounded with Na or I scatterers the intensity of the 0.39 mev line practically did not change. Measurements of $n-\gamma$ coincidences indicate coincidence of γ-rays with 0.39 mev neutrons (see Fig. 2). This permits us to conclude that the 390 kev γ-rays are connected with the decay of the excited B^{10} state formed in the reaction Li^7 (αn) B^{10}. Indirect indications of theexistence of such a state of B^{10}

are contained in Ref. 9. No satisfactory explanation has yet been obtained of the origin of the low energy peak in the $n-\gamma$ coincidence curve (Fig. 2). The 1.5 mev γ– rays for Po–Li previously reported in Ref. 8, have not been observed by us.

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Concerning the Temperature Dependence of the Magnetic Susceptibility of the Elements

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THE experimentally-observed magnetization of a substance is made up of the diamagnetism and paramagnetism of the ionic lattice and the diamagnetism and paramagnetism of the free carriers of charge (for instance the conduction electrons of the metals). Accordingly, one can assume that for the susceptibilities of the elements

$$\chi_{exp} = \chi^{-}_{ion} + \chi^{+}_{ion} + \chi^{-}_{elect} + \chi^{+}_{elect} \qquad (1)$$

(the signs – and + designate the dia- and paramagnetic contributions to the measured susceptibility).

The accepted classification of magnetic substances is based on the sign of the susceptibility measured experimentally. Examination of the experimental data concerning the temperature dependence of the susceptibility of the elements permits us to suggest another method for classifying magnetic materials, based on the character of the temperature dependence of the susceptibility in weak magnetic fields. In line with this proposal, one has to consider four groups of elements, exhibiting 1) paramagnetism which is practically independent of temperature (the alkali and alkali-earth metals), 2) paramagnetism which depends on temperature (the rare earths and the transition metals), 3) diamagnetism which depends on temperature (Be, Mg, Zn, Cd, Hg, Al, Ga. In, Tl, C, Sn, Pb, As, Sb, Bi), and 4) diamagnetism which is independent of temperature (the noble gases, etc.). The character of the temperature dependence of the susceptibility within each group is determined by the predominance of one of the terms in (1). Thus, paramagnetism which is practically temperature-independent indicates the predominance of the paramagnetic contribution of the conduction electrons; temperature-dependent paramagnetism is related to the predominance of the paramagnetic contribution of the ionic lattice; temperature-dependent diamagnetism (as will be shown below) reflects the predominance of the diamagnetic contribution of the conduction electrons; and finally, the magnetic properties of the fourth group of elements indicates the predominance of the diamagnetic contribution of the ionic lattice.

One should pay particular attention to the fact that the elements of the four groups indicated occupy a definite place in the so-called long periodic system of the elements (Fig. 1).* For all metals of the third group, the de Haas-van Alphen effect is observed at low temperatures. With respect to their atomic spectra and the magnetic properties of their crystals, Be and Mg are closer to Zn and Cd than to the alkali-earth metals, and consequently they are situated in the 26th, rather than in the 2nd column of the periodic system. Copper, silver and gold occupy an intermediate position between the transition metals and the elements of the third group; the magnetic properties of sulfur, selenium, tellurium and polonium have been inadequately and insufficiently studied.

The existing theory of the magnetic properties of electrons in metals,[1,3] which includes an explanation of the essential features of the de Haas-van Alphen effect in assuming the existence in these metals of anomalously small groups of electrons, gives the following expression for the constant component of the magnetic susceptibility:[2,3]

$$\chi = \chi_0 (1 - \pi^2/12)(T/T_0)^2 \quad \text{for } T \ll T_0, \qquad (2)$$

$$\chi = {}^2/_3 \chi_0 T_0/T \quad \text{for } T \gg T_0, \qquad (3)$$

where

$$\chi_0 = \frac{\sqrt{2}}{4\pi} \cdot \frac{e^2}{hc^2} \frac{M_i}{\sqrt{m_1 m_2 m_3}} E_0^{1/2} \left[3 \left(\frac{m_{эфф}}{m_0} \right)^2 - 1 \right],$$