f_1 and f_2 act upon the spin variables of the first and second proton, respectively.

Indicating

$$\chi_{1x} = -2^{-1/2}(\chi_1^1 - \chi_1^{-1}); \tag{6}$$

$$\chi_{1y} = i2^{-1/2}(\chi_1^1 + \chi_1^{-1}); \quad \chi_{1z} = \chi_1^0$$

and making use of (1) we can write $F\chi_0$ in the form

$$F\chi_0 = A^2\chi_0 - B^2(\mathbf{n}_1\mathbf{n}_2)\chi_0 \tag{7}$$

$$+AB(\mathbf{n}_1 - \mathbf{n}_2, \vec{\chi}_1) - iB^2([\mathbf{n}_1\mathbf{n}_2], \vec{\chi}_1),$$

from which

$$(F\chi_0, F\chi_0) = \sigma_0^2(\theta)[1 - P^2(\theta)(\mathbf{n}_1\mathbf{n}_2)], \tag{8}$$

where $\sigma_0(\theta) = |A|^2 + |B|^2$ is the scattering cross section for the nonpolarized beam. The m summation in the right side of (4) is obtained from the condition that when $q = q_0$, $D \sim \sigma_0^2(\theta)$

$$\sum_m (F\chi_1^m, F\chi_1^m) = 4\sigma_0^2(\theta) - (F\chi_0, F\chi_0). \tag{9}$$

Accordingly, Eq. (4) takes the form:

$$D \sim \sigma_0^2(\theta)\left[1 - \frac{3q-1}{3(q+1)}P^2(\theta)(\mathbf{n}_1\mathbf{n}_2)\right], \tag{10}$$

and for the determination of P^2 it is sufficient to measure D for $(\mathbf{n}_1, \mathbf{n}_2) \sim 1$ and for $(\mathbf{n}_1\mathbf{n}_2) = -1$.

Unfortunately, the experiment under discussion will require considerably longer exposures than for usual double scattering. Indeed, the maximum permissible current in the incident beam is determined by the ratio of the effect under investigation to the background of chance coincidences. Let ν denote the number of scattered protons entering each of the counters, n the number of H_2^+ ions incident on the target, τ the resolving time of the coincidence circuit. The numbers of true and accidental coincidences are $\nu^2/2n$ and $2\tau\nu^2$, respectively, i.e., the condition $n \ll 1/4\,\tau$ must be fulfilled. Therefore, even when $\tau \sim 10^{-10}$ sec, the instantaneous value of the current into the target must not exceed 10^8 to 10^9 ion/sec, which is considerably less than current generally used in double scattering experiments. It should be noted that the formation of a molecular ion source of H_2^+ c $q \gg 1$ producing a current of the order of 10^9 ion/sec is apparently quite feasible.

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Isomeric Transition of the Sn^{117*} Nucleus

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A RADIOACTIVE source containing the tin isotope Sn^{117*} was obtained by bombarding chemically pure cadmium with α-particles in the cyclotron. Radioactive tin was obtained by the reactions $Cd^{110}(\alpha, n)Sn^{113}$; $Cd^{114}(\alpha, n)Sn^{117*}$ [1,2]. In addition, reactions with the formation of radioactive indium isotopes took place. The separation of the radioactive tin into pure form was carried out chemically. The irradiated cadmium was first kept for five days. In this time all short lived radioactive isotopes decayed. The central feature of the chemical separation of radioactive tin into pure form was its distillation in the form of bromide, $SnBr_4$, into a collector filled with concentrated hydrochloric acid[3-7]. This sufficed to separate tin and indium. The distillation mentioned above was carried out twice; the first product was radioactive, the second, not. The contents of the distillation apparatus in both the first and second case were radioactive. The experiments carried out gave reason to believe that the source obtained in this way contained radioactive tin. Later on, the γ-spectrum, electron absorption curve, decay curve and electron spectrum of this source were obtained. The results of these experiments agree well with the data in the literature if we consider that Sn^{117*} and Sn^{113} are in the source obtained. The radioactive transformations of these isotopes, in agreement with the published data of Ref. 8, follow the scheme shown on Fig. 1.

Starting from this decay scheme, identification of the peaks of the γ-spectrum from this source was carried out. This spectrum is shown in Fig. 2. It was obtained on a 20-channel luminescence spectrometer developed by G. R. Kartashev. A crystal of NaI was used. Four peaks are indicated on the spectrum. The peak at 154 kev relates to the cascade γ-transition of Sn^{117*}; the peaks at 260 and 398 kev, to the cascade γ-transition of In^{113}. A peak at an energy of 325 kev is also present in the γ-spectrum. Of all possible combinations of

γ-transitions of radioactive In^{114} or Sn^{117*} isotopes, such an energy can be obtained only from the sum of two γ-transitions of Sn^{117*}; therefore, it is natural to assume that this peak comes from the direct transition of Sn^{117*} from the metastable to ground state. This transition has not previously been observed experimentally. Including this, the decay can be considered to follow the scheme shown on Fig. 3.

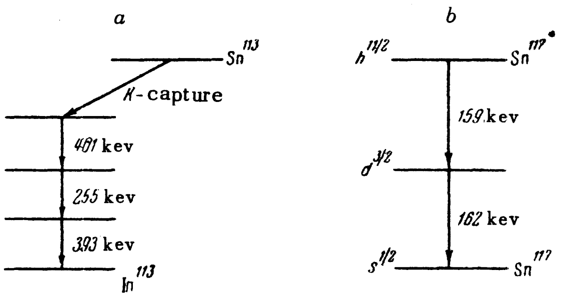

FIG. 1. *a*--Decay scheme of Sn^{113}. *b*--Transition scheme for isomeric Sn^{117*}.

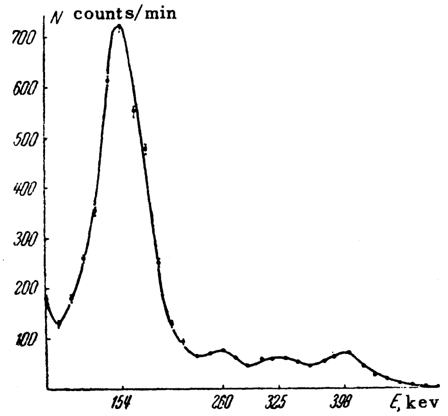

FIG. 2. γ-spectrum of the radioactive tin isotopes Sn^{113} and Sn^{117*}.

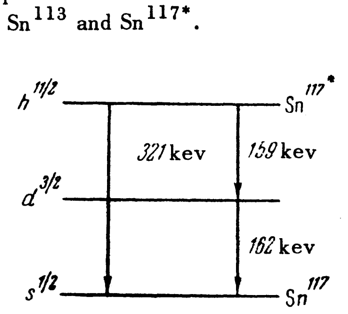

FIG. 3. Transition scheme for isomeric Sn^{117*}.

From selection rules the multipolarity of the new transition should be $E5$ or $M6$. Under the assumption that the 160 kev transition $h^{11/2} \rightarrow d^{3/2}$ of Sn^{117*} corresponds to an $M4$ multipolarity, and the new 320 kev transition to an $E5$, the relative probability of these transitions was calculated and found to be $W_{M4}/W_{E5} \sim 100$.

This theoretical calculation is in satisfactory agreement with the area of the 154 and 325 kev peaks. The large multipolarity of the radiation in the new transition indicates that this transition might be found by conversion electrons. In fact, such a transition was found when the electron spectrum of the source was obtained. This electron spectrum is shown in Fig. 4. This spectrum was obtained on a wide-aperture magnetic toroidal spectrometer developed by Vladimirskii, Trebukhovskii and Tarasov[9]. Spectrum *a* (Fig. 4) shows two electron peaks; the energy of the large peak was determined as 368 kev*. If we take into account the binding energy of the K-electron in indium of approximately 27 kev, then the electron energy of 368 kev obtained is in good agreement with the energy of the conversion electrons of the γ-ray from the isomeric transition of In^{113}. The energy of the small peak in this graph was determined as 291 kev. Taking into account the binding energy of about 29 kev of a K-electron in tin, this energy agrees very well with the energy of conversion electrons from the direct γ-transition of Sn^{117*} from the metastable state to the ground state. A month-and-a-half later this electron spectrum was taken again (Fig. 4*b*). The peak at 291 kev did not occur in the spectrum obtained. This is understandable if the 291 kev peak is considered to come from the isomeric transition of Sn^{117*}, which has a half-life of 14 days. Therefore, this confirms the assumed decay scheme (Fig. 3) of Sn^{117*}.

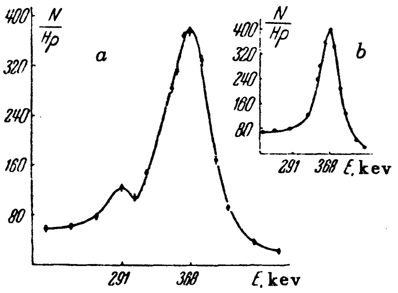

FIG. 4. *a*--Electron spectrum of the radioactive isotopes of tin, Sn^{113} and Sn^{117*}. *b*--The same spectrum 1½ months later.

The magnitude of the conversion coefficient of the observed 325 kev transition is of great interest. However, it is impossible to calculate a more or less reliable value from the data which were obtained in this experiment with spectrometers of poor resolution. A qualitative estimate of the magnitude of this conversion coefficient was carried out. To do this, the values of the conversion coefficients and the ratio N_K/N_L for In^{113} were assumed known. For the transition considered a ratio of $N_K/N_L \sim 0.3$ was obtained. The theoretical value of the conversion coefficient for a 320 kev, $E5$ transition in a nucleus with atomic number 50 is about unity. Therefore, the experimental and theoretical values of the conversion coefficients are near to each other.

In conclusion, I should like to use this opportunity to express my gratitude to Iu. V. Trebukhovskii, G. R. Kartashov and V. S. Kuryshev, who gave me the opportunity of using their apparatus for carrying out this experiment. The author is particularly thankful to V. V. Vladimirskii and N. P. Rudenko for valuable suggestions and advice.

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* This transition is convenient to use for calibrating the β-spectrometer.

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Theory of Interaction of Excitons with the Phonon Field

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THE presence of excitons in an ionic crystal lattice is responsible for its polarization[1-3] which, in turn, reacts on the exciton. This interaction with the lattice is small in crystals with a weak inertial polarization, and also when the effective mass of the electron and hole are approximately equal. In this case the exciton is called "nonpolarizing". The object.of this note is to clarify the influence of the inertial polarization of the lattice on several properties of nonpolarizing excitons. The polarization of the medium is calculated by macroscopic methods. The Hamiltonian is written in the effective mass approximation.

The Hamiltonian of the system consists of two terms $H = H_0 + H_i$, where H_0 is the Hamiltonian of the exciton and free phonon field

$$H_0 = \frac{P_R^2}{2m} + H_r + \Sigma_f E(f)\, a_f^+ a_f, \tag{1}$$

and H_i is the interaction

$$H_i = \sum_{\mathbf{f}} A_f \left[e^{i\mathbf{fR}} e_f(r)\, a_f + a_f^+ e_{-f}(r)\, e^{-i\mathbf{fR}} \right]. \tag{2}$$

Here we employ

$$H_r = \frac{P_r^2}{2\mu} - \frac{e^2}{xr}, \quad e_f(r) = e^{iy_1(\mathbf{f},\mathbf{r})} - e^{-iy_2(\mathbf{f},\mathbf{r})}; \tag{3}$$

$$A_f = -(e/f)\sqrt{2\pi\hbar\omega c/V}, \quad y_1 = \mu_2/m, \quad y_2 = \mu_1/m,$$

where μ_1 and μ_2 are the effective masses of the electron and hole, respectively; m and R are the mass and coordinate of the center of mass of the electron and hole; μ and r, the reduced mass and relative coordinate of the electron and hole; f, $E(f) = \hbar\omega$, the wave vector and energy of the phonon; ω the limiting frequency of the longitudinal optical oscillations; $c = 1/x - 1/\epsilon$ with x the square of the index of refraction of the crystal and ϵ, the dielectric constant; a_f is the Bose operator. In zero-order approximation the coordinate R describes the free motion of a quasi-particle of mass m and momentum P_R. The energy spectrum of the system in this approximation consists of a continuum labelled by the quantum states of relative motion.

In calculating the interaction H_i it is convenient to introduce the total momentum of the system,