The best investigated is the level scheme of Au^{197} (see Figure). The latest measurement[3] of the ICC for the 191 kev transition gave the value $\alpha_K = 2.5$. If the transition was a pure $M1$, then $\alpha_K = 1.0$; with a mixture of $E2$, the ICC would be still smaller. The possibility of a higher spin contradicts the β-decay character. It remains therefore to assume that the spin of the 268 kev level is ½ and that the 191 kev transition is a mixture $M1 + E0$. Evaluating T_γ for an $M1$-radiation by Moszkowski's formula[4], we obtain from (3) $T_{e0} \approx 4 \cdot 10^{11}$ sec^{-1}. The corresponding value of ρ is $\rho \approx 0.5$, which is in agreement with the value of ρ obtained from $0+ \rightarrow 0+$ transitions. The table gives a compilation of the data on $E0$-transitions.

It seems of interest to determine the contribution of $E0$-transitions to the conversion spectra of other nuclei, *e.g.* In^{115} and Hg^{199}; there are indications[5] that these nuclei have two spin ½ levels with same parity. One would also like to confirm the results of Potnis *et al.*[3], which we used here.

Nucleus	Type of $E0$-transition		E (Mev)	ρ
C^{12}	0+	0+	·7,68	1/2
O^{16}	0+	0+	6,06	1/2
Ge^{72}	0+	0+	0,69	1/9
Po^{214}	0+	0+	1,42	~1/20
Au^{197}	1/2+	1/2+	0,191	~1/2
Pt^{192}	2+	2+	0,30	⩽1/45
Pt^{196}	2+	2+	0,33	⩽1/34
Hg^{198}	2+	2+	0,68	⩽1/14

[1] J. Blatt and V. Weisskopf, *Theoretical nuclear physics.*

[2] E. L. Church and J. Weneser, Phys. Rev. **103**, 1035 (1956); **100**, 943 (1955).

[3] Potnis, Mandeville and Burlew, Phys. Rev. **101**, 753 (1956).

[4] S. A. Moszkowski, *Beta and Gamma—Ray Spectroscopy*, Chapter 13.

[5] B. S. Dzhelepov and L. K. Peker, *Decay Schemes of Radioactive Isotopes*, (Academy of Sciences Press (1957).

Translated by E. S. Troubetzkoy
149

Internal Conversion Coefficient of the 53 kev Gamma-Radiation on the L shell of Th^{230}

A. A. VOROB'EV, V. A. KOROLEV, A. P. KOMAR AND D. M. SELIVERSTON

Leningrad Physico-Technical Institute, Academy of Sciences, USSR

(Submitted to JETP editor December 17, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) **32**, 623 (March, 1957)

THE energy of the first excited state of Th^{230} is now determined to be of 52.5 kev[1]. From the data available in the literature, it can be concluded that the conversion coefficient of the 53 kev γ-radiation is large[2].

For the measurement of the conversion coefficient we have used the α-γ coincidence method. An enriched source of U^{234} was used. The α-particles were recorded by an impulse ionization chamber,

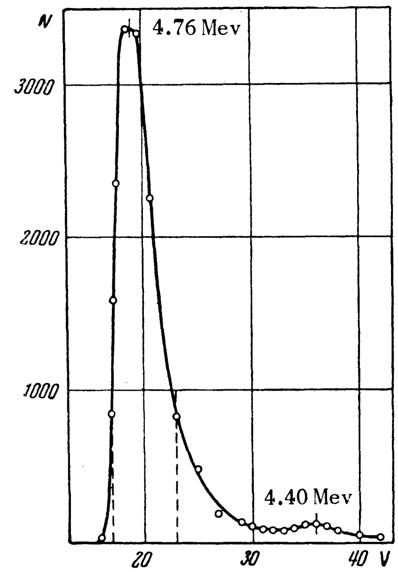

FIG. 1. The volts (V) show the discriminator level.

(the α-spectrum is shown on Fig. 1) the γ-quanta by a scintillation counter with an NaI(TI) crystal. The γ-spectrum was photographed when in coincidence with the α-particles, which gave an impulse on the output of the multiplier in the interval 17 to 23 volts (Fig. 1), *i.e.*, when in coincidence with the α-particles going to the ground and first excited states of Th^{230}. On Fig. 2, the thin line shows the γ-spectrum photographed without absorption. As it can be seen, the main contribution to the spectrum comes from a 15 kev x-ray. Controlling experiments have shown that this radiation can

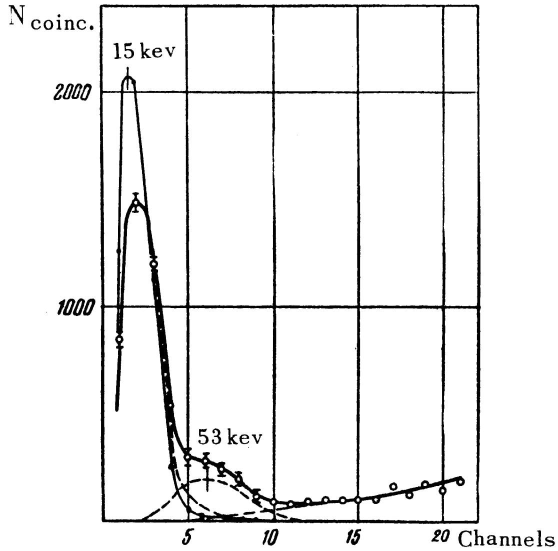

FIG. 2.

be neither the result of an excitation of Th atoms in the recoil process, nor the result of the excitation of the uranium atoms by the α-particles going through the source; it is due only to the internal conversion on the L-shell of Th^{230}. In the experiment, the 53 kev γ-rays have been separated by using 120 μ of Sn as an absorber (thick line on Fig. 2).

The conversion coefficient has been determined from the ratio of the number N_R of Roentgen quanta (without absorber) to the number N_γ of 53 kev γ-quanta, normalized to the same number N_α of recorded α-particles.

The following result is obtained: $N_R/N_\gamma = 130$. The experimental error does not exceed 50%. The extrapolation of the theoretical data gives for the sum of the conversion coefficient on L_{i}, L_{ii}, and L_{iii} shells, depending on the type of transition:

$E1$	$E2$	$E3$	$M1$	$M2$
$<1,0$	170	$>5\cdot10^3$	~25	>500.

The comparison with the experimental result enables one to conclude that the observed radiation is of the electric quadrupole type. The ground state moment of even-even nuclei being equal to zero, and its parity +, the total angular momentum of the first excited state of Th^{230} has to be equal to 2, parity+. The result obtained confirms experimentally the assumption of the rotational character of the level, according to the model of A. Bohr.

[1]L. A. Gold'in *et al.*, Academy of Science USSR Session on the Peaceful Use of Atomic Energy (Phys.-Math. Section) p. 226 (1955).

[2]T. Teillac, Compt. rend. **230**, 1056 (1950).

Translated by E. S. Troubetzkoy
150

Level Shift of π-Mesonic Atoms

S. M. BILEN'KII
United Institute for Nuclear Research
(Submitted to JETP editor December 18, 1956)
J. Exptl. Theoret. Phys. (U.S.S.R.) **32**, 624 (March 1957)

IN recently completed experiments[1-3], the energy levels of π-mesonic atoms of light elements have been measured. It was found out that the ground state level does not coincide with the energy level obtained by solving the Schrödinger equation in the potential of a point charge, taking into account the corrections for the finite size of the nucleus and the vacuum polarization. Theoretically, this problem has been investigated by Deser *et al.*[4] who obtained an equation expressing the level shift of π-mesonic atoms of light elements in terms of the scattering length of the π-meson on the nucleon; the assumption is made, however, that the scattering amplitude of the π-meson on the nucleus is, for small energies, equal to the sum of the scattering amplitudes on individual nucleons. An attempt to take into account the binding of the nucleons in the nucleus was made by Brueckner[5], but the agreement with experiment is worse than for the results of Deser *et al.*

We will describe the non-electromagnetic interaction between the π-meson and nucleus by a complex V, different from zero in a region of the order of the nuclear dimensions. For a sufficiently light nucleus, we apply the perturbation theory, and obtain the following expression for the shift of the ground state level of the π-mesonic atom:

$$\Delta E = \int \psi_0^* V \psi_0 d\tau \cong {}^4/_3\, (r_0 / a)^3 \overline{V} Z^3 A, \qquad (1)$$

where A and Z are the atomic weight and charge of the nucleus; $\overline{V}$ is the mean value of the interaction potential; $a = \hbar^2/\mu e^2$, μ is the meson mass; $r_0 = R/A^{1/3}$, R being the nuclear radius. According to this formula, one can determine the product $r_0^3 \overline{V}_R$ from the experimental data on the mesoatomic level shifts. If one takes $r_0 = 1.2 \times 10^{-13}$ cm. then the following values of $\overline{V}_R$ are obtained: