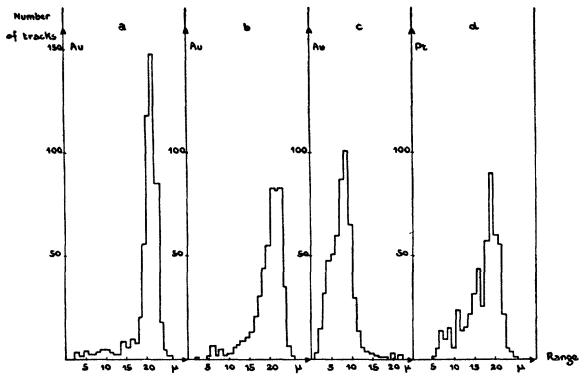

Initial cone: $0.44\cdot10^{-9}$N $0.11\cdot10^{-9}$N 10^{-13}N 10^{-13}N
Po deposit/cm²: 0.06 e.s.u. $0.67\cdot10^{-4}$ e.s.u. $0.68\cdot10^{-4}$ e.s.u. $0.42\cdot10^{-4}$ e.s.u.

FIG. 1. Distribution of α ranges.

measurements of about 500 traces. The deposits correspond, except where the contrary is indicated, to $4-5\times10^{-5}$ esu/cm² (initial alpha emission of 60 to 80 particles min./cm² or 10^{-11} mg/cm²). Note that the quantity necessary to cover 1 cm² of uniform monomolecular layer is 2650 e.s.u.

When the electrolysis is carried out in 10 cm³ of a solution containing 1.5 esu Po in order to obtain a deposit on gold of 0.06 e.s.u./cm² a range distribution is obtained as given by Fig. 1*a*, where a well-defined peak is found corresponding to 21.5μ (in the Ilford emulsion) and which is just the normal alpha-range for Po according to our calibration. However a not negligible number of tracks are found which possess ranges inferior to the normal value: e.g. 2.6 percent of 14.5μ, 1 percent of 9.4μ etc.

If the deposit in the same solution is stopped at an intensity of 60α/min. cm² (4.10^{-5} e.s.u./cm²), the distribution is considerably changed (Fig. 1*b*): the peak is here broader and corresponds to 19.5μ and the number of shortened tracks is much greater. In much more dilute solutions the deformation is more strongly accentuated, the maximum range and the distribution varying with the origin and the "history" of the metal, and probably with other experimental conditions. The quantitative reproductibility is consequently quite mediocre. As an example we reproduce the statistics corresponding to a deposit on gold foil in solution 10^{-13}N (Figs. 1*c* and 2). The

FIG. 2. 10^{-10}N 10^{-13}N
Po deposits on gold, in solution.

peak here is only of 7.5μ. An analogous distribution was found for deposits obtained in 10^{-14}N solutions.

For deposits on Ag obtained under similar conditions to those just described (10^{-13}N) we have observed a nearly normal distribution (analogous to that shown in Fig. 1*a*). On Pt and on Ni, the distribution is intermediate between Au and Ag.

It is interesting to note that traces of nearly the same length tend to be grouped together on the various parts of the surface. Furthermore, in the more concentrated solutions (5×10^{-12} to 10^{-10}N) we frequently observed stars which correspond to aggregations containing thousands of Po atoms, and whose centers often seem to be situated at a certain depth inside the electrode. Our solutions being strongly acid, the possibility is excluded of considering the stars as of a radio-colloidal origin.

These experiments clearly show that a fraction of the Po atoms, the proportion varying with the conditions and especially with the nature of the support, slightly penetrates the interior of the metal. This signifies a partial absorption of the alpha-rays with a shortening of their ranges. The phenomenon is certainly related to the surface structure and could be explained by the existence of "active centers" postulated for the interpretation of the kinetic and energetic results for deposits obtained in extremely dilute solutions.[1]

We think that our results explain the observations of Chang[2] on the existence of numerous groups of reduced tracks in the alpha-"spectrum" of Po. Chang's conclusions have been severely criticized by Feather[3] and by Zajac, Broda, and Feather[4] and have not been confirmed in the more recent experiments of Wadey.[5] This author attributes the groups to the diffusion of Po in the metal, but the normal diffusion at room temperature is undetectable, according to the measurements of Rona and Schmidt;[6] $D<10^{-14}$ cm²/day. Our experiments show that what has been observed by Chang is not the fine structure of the alpha-rays but the ultra-fine structure of the surface. They permit one to predict that the proportions of the feeble energy components of Chang's "spectrum" would strongly increase with the diminution of the source intensity.

Details of this research and its electrochemical aspects will shortly be described in the Journal de Physique et le Radium.

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The Forbidden Beta-Decay of Sr^{90} and Y^{90} *

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April 28, 1949

THE isotope Sr^{90} is a fission product which decays by β^--emission to Y^{90}. The half-life is $8\cdot10^8$ seconds and the energy release, including rest mass, is 2.04 mc² (kinetic energy 531 kev). The daughter product, Y^{90}, decays by β^--emission to Zr^{90}. The half-life for this transition is $2.25\cdot10^5$ seconds and the energy release is 5.40 mc² (kinetic energy 2.25 Mev). No gamma-radiation is observed. The decay scheme is pictured in Fig. 1 together with spin values and

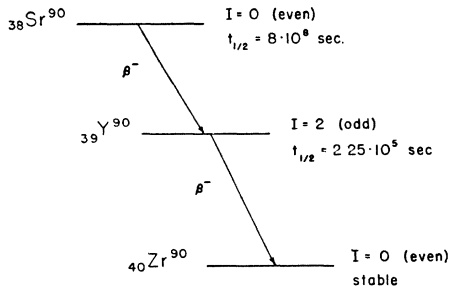

FIG. 1. Decay scheme for Sr^{90} and Y^{90}, showing spin and parity assignments as suggested in text.

parities as explained below. The arguments are based on two assumptions: (1) Gamow-Teller selection rules govern the beta-decay process, and (2) the nuclear shell model[1] is a reliable guide in the region $Z\sim40$ and $N\sim50$.

The nucleus $_{40}Zr^{90}$ contains closed shells of 40 protons and 50 neutrons. Thus, $I=0$ and the parity is even in the ground state.

$_{39}Y^{90}$ is an odd-odd nucleus. It is characterized by a $(3p)^{-1}(4d)^1$ configuration in the notation of Feenberg and Hammack. Thus, the ground state parity is *odd*.

$_{38}Sr^{90}$ is an even-even nucleus. It is characterized by a $(3p)^{-2}(4d)^2$ configuration. In the ground state the parity is even and, most probably, $I=0$.

Both beta-transitions are associated with change of parity. Thus by G-T rules, both are first-forbidden or both are third-forbidden. The *ft* product for the first transition is $\sim10^9$ and for the second $\sim10^8$. These values are appropriate for first-forbidden transitions with $\Delta I=\pm2^{(1-2)}$, but are too small for third-forbidden. Consequently, $I=2$ in the ground state of Y^{90}.

Thus the two beta-transitions of Fig. 1 should produce peculiar energy distributions similar to those found in Y^{91}, Cs^{137}, K^{42}, and Rb^{86} by various investigators.[2-7] In such cases the energy distribution differs[8] from the allowed form by a factor $G\sim(W_0-W)^2+(W^2-1)$.

A carrier-free sample of Sr^{90} was obtained from Oak Ridge. This sample had been aged to permit an associated 55-day activity of Sr^{89} to die out. Three spectra were measured: (1) Sr^{90} and Y^{90} in equilibrium together, (2) Sr^{90} alone, and (3) Y^{90} alone. For the latter two runs, the isotopes were chemically separated by a method due to Kurbatov and Kurbatov.[9] Samples were prepared for the spectrometer by evaporation from solution on thin Zapon films, following the insulin technique of Langer.[10]

The spectra were measured in the double-focusing spectrometer described by Kurie, Osoba, and Slack.[11] In the interests of higher counting rates, a wide counter window (0.25 in.) was used, which dropped the resolving power to 1 percent. The window was Zapon film of 3- to 4-kev stopping power, and was supported lengthwise by a single 5-mil wire. A pressure regulator[12] was used to avoid loss of counter pressure caused by window leakage.

The results are shown as FK (Fermi-Kurie) plots in Fig. 2 for Sr^{90} and in Fig. 3 for Y^{90}. As indicated in Fig. 2, the Sr^{90} data was obtained by subtracting the Y^{90} distribution curve from that for an equilibrium mixture of both Sr^{90} and Y^{90}.

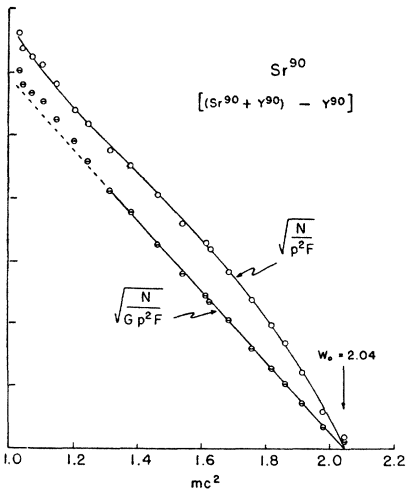

FIG. 2. Sr^{90} FK plots. "Allowed" plot (upper) and "forbidden" plot (lower), with ordinates as indicated.

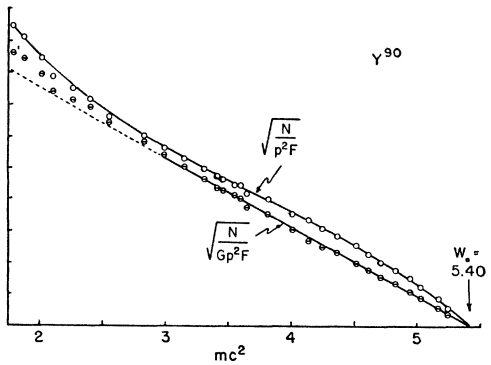

FIG. 3. Y^{90} FK plots. "Allowed" plot (upper) and "forbidden" plot (lower), with ordinates as indicated.

The upper curve in each figure (labeled $[N/p^2F]^{\frac{1}{2}}$) is a conventional or "allowed" FK plot, i.e., computed as though the transition were allowed. The lower curve in each figure (labeled $[N/Gp^2F]^{\frac{1}{2}}$) is a "forbidden" FK plot, i.e., computed as though the transition were first-forbidden, with $\Delta I=\pm2$ (yes). The near-straightness of the latter pair of plots confirms the assignment of spins and parities shown in Fig. 1.[13]

* Assisted by the joint program of the ONR and the AEC.

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The Forbidden Beta-Decay of Sr^{89}*

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THE isotope Sr^{89} decays by β^- emission to Y^{89} with a half-life of $4.75\cdot10^6$ seconds. The energy release, including rest mass, is 3.93 mc^2, so that the maximum electron kinetic energy is 1.50 Mev. No gamma-radiation is observed. The *ft* product for the beta-transition is $4.9\cdot10^8$.

Using the nuclear shell model notation of Feenberg and Hammack,[1] the Sr^{89} ground state is characterized by a $(3p)^{-2}(4d)^1$ configuration, so its parity is even. The ground state of Y^{89} is characterized by a $(3p)^{-1}$ configuration, so its parity is odd. The beta-transition between ground states, therefore, involves a parity change, and the transition is first-forbidden by Gamow-Teller rules. The large *ft* value favors a spin change of 2 units.[1,2]

A beta-transition for which $\Delta I=\pm2$ (yes) yields an electron energy distribution which differs from that for an allowed transition by a factor $G\sim(W_0-W)^2+(W^2-1)$, if it is assumed that Gamow-Teller rules apply to the beta-process.[3] Such distributions have been observed previously for Y^{91}, Cs^{137}, Rb^{86}, Sr^{90}, Y^{90}, and K^{42}.[2,3,4-10] If the above reasoning is correct, the Sr^{89} spectrum should display a similar forbidden "shape."

The spectrum was measured in the magnetic double-focusing spectrometer.[11] A source of Sr^{89}, containing also some Sr^{90}