our latest half-lives and energies for the members of the previously reported[1] Pa^{227} and Pa^{228} collateral chains. The radioactive properties of ThC, RaE, AcC, Po^{213}, and daughters are the accepted values taken from the literature.[8]

The cooperation of Professor R. L. Thornton, Mr. J. T. Vale, and the 184-inch cyclotron group is gratefully acknowledged. This paper is based on work performed under the auspices of the Atomic Energy Commission.

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Correction and Addendum: Scattering of Particles by the Gas in a Synchrotron*

[Phys. Rev. **74**, 140 (1948)]

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CORRECTION: The formula for P in the title of Fig. 1 should read like the right side of Eq. (18).

For the word "half" in the title of Table I, read "10 percent of."

For b in the second-last line of page 143, read B.

For $-A$ in Eq. (18) read 0.

For $\frac{1}{2}\pi$ at the end of the fourth-last paragraph of the article, read $1/2\pi$.

More accurate calculations show that for a 10 percent loss of particles, $\eta=0.0855$ rather than 0.089.

Addendum: This note considers the effect of an initial betatron oscillation on the probability of surviving scattering of a particle being accelerated in a synchrotron or betatron. Let β be the amplitude of this initial oscillation. With appropriate choice of $t=0$, this oscillation contributes to both sine and cosine oscillations the amplitude $\beta/2^{\frac{1}{2}}$. Thus, $(1/2)\beta^2$ should be added to the right sides of Eqs. (7) and (8), and $(1/2)\beta^2(T_i/T_f)^{\frac{1}{2}}$ to the right side of (10). The maximum value of $\eta=\langle b^2\rangle/2A^2$ now occurs when

$$T/T_1=4/(1+\beta^2/2A^2\eta_0)^2,$$

in which η_0 is the maximum value η would have if $\beta=0$; it is

$$\eta=(\eta_0+\beta^2/16A^2)^2/\eta_0$$
$$\approx\eta_0+\beta^2/8A^2$$

for small β/A.

For example, for 10 percent loss, $\eta_0=0.086$. If $\beta=2.5$ cm and $A=8$ cm, then $\eta=0.0982$. The higher loss can be read from Fig. 1—14.5 percent—or compensated for by a reduction in pressure of $\beta^2/8A^2\eta_0=14$ percent.

This calculation underestimates the loss by tacitly assuming not that the initial amplitude is β, but that the initial amplitudes obey a Rayleigh distribution with β the r.m.s. initial amplitude. It overestimates the loss by including that (small) loss which would have occurred while the amplitude of betatron oscillation was building up to initial value.

Another approach eliminates both of these errors but is unable to take account of the damping of the initial oscillation, thus overestimating the loss. This is to use the solution of (17) satisfying the boundary condition

$$p(0,B)=\delta(B-\beta) \text{ for } 0\leq B\leq A$$

rather than $\delta(B)$. This solution is

$$p=(2B/A^2)\sum_{s=1}^{\infty}J_0(\lambda_s\beta/A)[J_1(\lambda_s)]^{-2}\times J_0(\lambda_sB/A)\exp(-\lambda_s^2\xi/A^2),$$

whence

$$P(\xi)=\int_0^A p\,dB=2\sum_{s=1}^{\infty}J_0(\lambda_s\beta/A)\exp(-\lambda_s^2\xi/A^2)/\lambda_sJ_1(\lambda_s),$$

with $\xi=(1/2)\langle b^2\rangle$.

For $\eta=\xi/A^2=0.086$, $\beta/A=0.3125$, as before, this gives $P=18.9$ percent. For $\eta_0\geq0.3$, only one term of this series is significant, and it is seen that the number of protons surviving with $\beta=\beta$ is $J_0(\lambda_1\beta/A)$ times the number with $\beta=0$ ($\lambda_1=2.4048$, the first root of J_0); for $B/A=0.3125$ this ratio is 86.4 percent.

* Work done under the auspices of the Atomic Energy Commission.

The Beta-Ray Spectra of Cu^{64}

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RADIOACTIVE Cu decays either by positron- or negatron-emission to Ni or Zn with a half-life of 12.8 hours. In 1945 Backus[1] reported disagreement between the observed ratio of the number of positrons to the number of

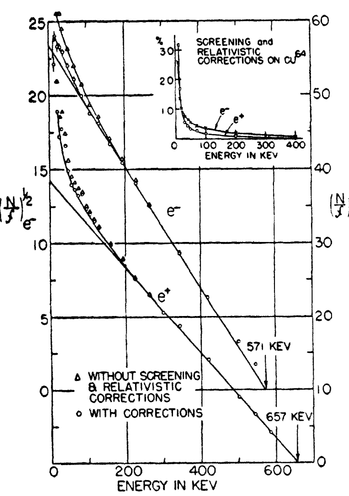

FIG. 1. Fermi plots of Cu^{64} negatron and positron spectra.