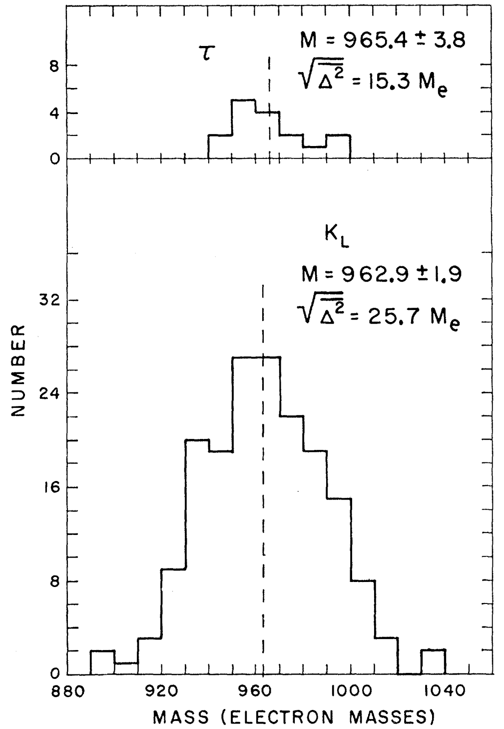

FIG. 2. Masses of 177 K_L and 16 τ mesons found in stack 17.

In the preliminary report, the stopping point of each K meson was used to determine its lateral position, and hence its momentum. We have now calculated the masses of all the K mesons in the first stack (stack 16), using the lateral position where the track was first picked up (about 3 cm from the end) to determine the momentum of the particle. The results plotted separately for K_L and τ mesons are shown in Fig. 1. The distribution includes 459 K_L mesons, 42 τ mesons, and 13 alternate decays of τ mesons into one charged pion.

Of the fifteen τ mesons in the preliminary report, three were found to have large angle scatters causing a large error in the projected range. These few events caused most of the apparent mass difference between the τ and K_L mesons. These events represent a large statistical deviation from the number of scatterings predicted using nuclear area for the interaction cross section. In the much larger sample of K_L mesons, such a fluctuation is unlikely.

In the emulsion exposed to 170-Mev K mesons (stack 17), each K meson track has been followed back to the stopping proton position to determine its momentum. The results shown in Fig. 2 include 177 K_L mesons, 12 τ mesons, and four alternate decays of τ mesons.

The mass values obtained in units of the electron mass are

	Stack 16	Stack 17
K_L	971±1.3	962.9±1.9
τ	978±4	965.4±3.8

The uncertainties given are $\sigma/\sqrt{N}$, where $\sigma=(\langle\Delta^2\rangle_{\mathrm{Av}})^{\frac{1}{2}}$ is the root-mean-square deviation from the average mass and N is the total number of events in the distribution.

The absolute values for the masses include systematic errors due to uncertainties in measurement of the momentum of the K particles, to the errors in the proton range measurement, and to scattering and ionization loss in the air path. In addition, the resolution is somewhat broadened from that expected, by multiple scattering in the window of the Bevatron tank and in the emulsions and by aberrations of the strong focusing lens. Relative masses of the mesons should not be affected by the above errors. However, a different interaction cross section for the τ and K_L particles could cause a range shortening of one with respect to the other and hence an apparent mass shift.

A more complete report of this work will appear in the summary of the International Conference on Elementary Particles held in Pisa, Italy, in June, 1955.

* This work was performed under the auspices of the U. S. Atomic Energy Commission.

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New Radioactive Isotope Scandium-42†

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THE nuclide Sc^{42} is of interest for several reasons: (1) Because of its probable configuration, Ca^{40} plus one neutron and one proton, a reliable theoretical treatment should be possible. (2) In analogy with three known 0^+-0^+ transitions in the positron decay of Al^{26}, Cl^{34}, and K^{38},[1–3] it may also decay by a 0^+-0^+ transition. (3) From the analogy to Li^6 and F^{18} the lowest $T=0$ state may be expected to have spin 1^+, if one extends the prediction of King and Peaslee.[4]

It cannot be predicted, however, whether the $T=0$ or the $T=1$ state would be the ground state since these states lie very close in neighboring similar nuclides. The separate positron decay of these states, which occurs in Al^{26}, Cl^{34}, and K^{38}, is rather unlikely because of the small spin difference. So the lower level will determine the half-life of the positron decay. If the 0^+ state ($T=1$) is lower, the decay will proceed by a pure Fermi-type super-allowed transition and its half-life will be about 0.6 sec.[2] But if the 1^+ state is lower, the half-life of 0.6 sec is expected only under the assumption of perfect LS coupling which is more or less unrealistic for such a heavy nucleus. Therefore, a somewhat longer half-life is expected from the 1^+ ground state. A $T=0$ state with higher spin is safely rejected since it would result in a longer-lived activity which would have been detected during the course of many other studies.

In order to search for a short half-life due to Sc^{42}, potassium metal was bombarded repeatedly with alpha particles of energy of $\sim$18 Mev and the activity was counted with anthracene crystal. The counts were started about $\frac{1}{4}$ sec after the bombardments and displayed with the aid of a relay circuit on nine scalers each counting a period of 32/60 sec. A strong activity with a half-life of 0.62 ± 0.05 sec (error limit) was found. It is due to high-energy positrons since it was found with a bias of several Mev and the annihilation peak observed with a NaI crystal showed the same decay. The intensity of this radiation was several times stronger than the intensity of the activity due to Ti^{43} ($t_{\frac{1}{2}}\sim0.6$ sec) produced by alpha particles on calcium and measured with the same arrangement.

The activity is concluded to be due to Sc^{42} because of the following reasons: (1) From its intensity, it must be due to one of the major reactions from alpha particles on potassium. No possible impurity or minor reaction like $(\alpha,n\alpha)$ on potassium can produce higher activity due to the reaction $Ca^{40}(\alpha,n)Ti^{43}$, although there is strong competition between the latter reaction and the (α,p) reaction.[5] (2) The threshold for producing Sc^{41} (0.87 sec) by an $(\alpha,2n)$ reaction is higher than 20 Mev. (3) High-energy positrons are expected from Sc^{42}. (4) The half-life lies in the range of values expected.

In Fig. 1, the half-life of Sc^{42} is plotted together with the half-lives of known 0^+-0^+ positron transitions in the nuclides of this type. The observed half-life lies right on the curve, strongly suggesting that the 0^+ state is the ground state. This indicates that the energy suppression due to the spin interaction of the proton and neutron outside of the core is smaller than the energy suppression due to the configuration mixing in the 0^+ state.[6]

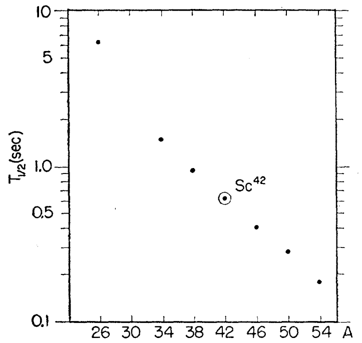

FIG. 1. Half-lives of the 0^+-0^+ transitions in $A=4n+2$ positron emitters.

No attempt has been made yet to measure the positron end point, but according to the semiempirical formula given by Peaslee[7] it should be 5.70 Mev. This energy together with the measured half-life gives a log*ft* of 3.6, which is considerably higher than in the cases of Al^{26}, Cl^{34}, and K^{38}. Actually, Peaslee's formula gives much higher log*ft* for higher A, in which cases only the half-life of the possible 0^+-0^+ transition[8] is known. Since this increase in log*ft* value, or the failure of complete overlap of $T=1$ wave function, is noticed in the measurements of Hunt and Zaffarano[9] on Cl^{34} and K^{38}, it is of interest to know the end point of the positrons of 0^+-0^+ transitions of this type in the higher-A region.

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New Type of Selection Rules in β Decay of Strongly Deformed Nuclei

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IT is well known that in regions between closed shells (especially in the region $150<A<190$) the nuclei have deformed equilibrium shapes.[1] A classification of the nuclear ground state and excited states in this region has been recently suggested by Mottelson and Nilsson.[2] They assume essentially a single particle moving in a spheroidal harmonic potential well with appropriate spin-orbit coupling.

It is instructive to study the limiting case of very large deformations, because then there is an approximate separation of the motion, into oscillations along the symmetry axis and oscillations in the plane perpendicular to this axis.[2] For a classification of the states, one can then use the quantum numbers N, μ_z, Λ, and Ω. N is the principal quantum number of the oscillator, μ_z the quantum number of the oscillations along the asymmetry axis, Λ the component of the particle orbital angular momentum along the symmetry axis, and Ω the projection of the total particle angular momentum on the symmetry axis.

TABLE I. Selection rules for allowed transitions.

Operators	Selection rules				
1	$\Delta N=0$,	$\Delta\mu_z=0$,	$\Delta\Lambda=0$,	$\Delta\Omega=0$,	No
σ	$\Delta N=0$,	$\Delta\mu_z=0$,	$\Delta\Lambda=0$,	$\Delta\Omega=0,\pm1$	No