"Along the track" scanning of K^+ mesons in nuclear emulsions has shown a number of interactions in flight[3]; in addition, 19 events have been found in which there is a single outgoing track of grain density less than that of the incoming K^+ meson. In each of these events the mass of the incoming particle was determined by grain counting and multiple-scattering measurements and its identity as a K^+ particle was thus established. If these events were due to interactions in flight, one would expect to find some stars with a lightly ionizing track coming out together with one or more black evaporation prongs. No such stars were observed. Also, none of the interactions in flight so far seen[3] give off a visible L meson. It therefore seems reasonable to identify all events of this type as the decay of K^+ mesons in flight. From the number of decays in flight found and the proper slowing-down time of all the K^+ mesons followed, a mean lifetime is obtained.

Stacks of stripped 600μ Ilford G.5 nuclear emulsions were exposed edge on to the focused K^+-meson beam[4] of the Bevatron. The mesons were produced from a copper target at an angle of 90° to the 6.2-Bev proton beam and travel a distance of 2.7 m from the target to the emulsion stack. Exposures were made with two different momentum-acceptance bands, positive particles of 390 to 450 Mev/c momentum and 335 to 360 Mev/c momentum. In such an exposure the protons, K mesons, and π mesons, all of the same momentum, have different ranges in the emulsion stack, increasing in that order.

The scanning technique used is as follows. In the region of the plate just beyond where the protons stop, tracks are chosen on the basis of grain density. K-particle tracks have about twice the minimum grain density, while π mesons of the same momentum are essentially at minimum. Tracks between 1.8 and 3 times minimum grain density are picked and followed through the stack. Nearly all tracks selected in this way turn out to be K particles or τ mesons, except for a contamination of about 15% caused by stray protons and π mesons scattered into the stack and prongs of stars formed in the emulsion. Excluding the track length due to τ^+ mesons, a total of 31.6 meters of K^+-meson track has been followed. The corresponding total proper slowing-down time was calculated using the tables of Barkas and Young[5] and was found to be 19.2×10^{-8} sec. The mass of the K meson was taken as equal to that of the τ meson for this calculation. Since decays in flight near the end of a track may not be readily identified, the proper time spent in the last 2 mm before a stopping has not been included. From the 19 decays in flight observed we find a mean lifetime for K^+ mesons of

$$\tau_{K^+}=1.01_{-0.21}^{+0.33}\times10^{-8}\text{ sec.}$$

The error given is the statistical standard deviation combined with a 10% uncertainty in the length of track scanned. If the decays in flight are due to K^+ mesons of two or more different mean lifetimes, the quantity that has been measured is an average of the form

$$\tau_{K^+}=\left(\sum_i\frac{\alpha_i}{\tau_i}\right)^{-1},$$

where α_i is the fraction of the K^+ mesons entering the stack that is associated with a mean lifetime of τ_i. Owing to the time of flight from the target to the emulsion stack, less than 3% of any particles of mean life 0.3×10^{-8} sec or less would arrive at the emulsion stack. Any such short-lived particles would thus be highly discriminated against in this measurement. In the course of the experiment 1.7 meters of τ^+-meson track was followed which corresponds to a total proper slowing-down time of 1.07×10^{-8} sec. No decay in flight of a τ^+ meson was observed. The results of this experiment are consistent with those of Mezzetti and Keuffel[1] and Barker *et al.*[2]

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Radiations from Long-Lived $Tc^{(98)}$*†

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A NEW beta-emitting isotope of technetium has been separated from Ru which was subjected to intense neutron irradiation in the Materials Testing Reactor ($\sim2\times10^{21}$ neutrons/cm^2). After the initial purification, made one year after the end of irradiation, the predominant activity was 90-day Tc^{97m}. The decay was followed with an end-window β-ray counter, an argon-filled x-ray counter spectrometer, and a scintillation counter with Pb absorbers of various thicknesses. Whereas the 90-day period predominated with the first two detectors, the γ radiation measured through 6 g

Pb/cm^2 showed a 60-day period and a long-lived tail which showed no decay during the last six months. The 60-day component was probably Tc^{95m}.

At this time, 2 years after the end of irradiation, further purification of the technetium was performed. In addition to distillations of Tc_2O_7 with H_2SO_4, a Dowex-1 anion exchange column was used to effect separation from Re.[1] Three different fractions were obtained, each purified to a different extent. The ratios of γ rays to 18.4-kev Tc x-rays (from Tc^{97m}) were identical, within counting statistics, for all three samples. Therefore the γ rays are associated with an isotope of Tc.

The decay characteristics were established by coincidence experiments performed with a gray-wedge scintillation spectrometer. Gamma rays were observed at 100, 203, 650, and 740 kev. The last two lines are the strongest and of equal intensity. They are in coincidence with each other but not with x-rays. Therefore the isotope is primarily a negatron emitter and cannot be Tc^{97}, which can decay only by electron capture. The 203-kev line is very weak and in coincidence with x-rays. This line probably is from a little Tc^{95m} still present in the samples; the most intense γ ray of Tc^{95m} is at 201 kev.[2] The 100-kev γ ray very probably represents the isomeric transition of Tc^{97m}. This line is not in coincidence with any other radiation.

Beta radiation was detected with a thin anthracene scintillator. The end point was at ~300 kev, the same end point as from a Tc^{99} standard. However, unlike Tc^{99}, β rays of this energy were also displayed in coincidence with either the 740-kev or 650-kev γ rays. A quantitative comparison of the β-γ coincidence rate of the Tc sample with that of a Co^{60} source showed that about half of the 300-kev β radiation was not in coincidence with the γ rays. The noncoincident fraction is attributed to 2.1×10^5-yr Tc^{99} which is known to emit no γ rays.[2] The above data indicate a decay scheme in which 0.3-Mev β rays are emitted followed by 0.74-Mev and 0.65-Mev γ rays in cascade. No cross-over transition of 1.39 Mev was observed.

A tentative mass assignment was made by comparing the total disintegration energy, 1.7 Mev, with values expected from the semiempirical mass equation[3] and beta-decay systematics[4] for various Tc isotopes: 0.4 Mev for Tc^{96}, 1.9, 0.2, 3.3, 1.7, and 4.8 Mev for Tc^{98} to Tc^{102}, respectively. Either mass 98 or 101 would be a satisfactory assignment; however the latter is already assigned[5] to the well-known 14.3-min Tc^{101} with an experimental decay energy of 1.7 Mev.[5] Further, the present isotope has not been observed as a fission product as expected for mass 101. Therefore mass 98 is most plausible. This assignment and the observed γ-ray energies also agree with the energy expected[6] for the first excited state of Ru^{98}; and if the 0.74-Mev γ is presumed to precede the 0.65-Mev γ, the ratio of the energies of the second to first excited states is 2.14, in excellent agreement with the corresponding ratios observed for nearly all even-even nuclei in this mass region.[7]

The half-life of Tc^{98} is of interest because of its bearing on the origin of Tc observed in certain stars, and on the possibility of naturally occurring Tc on earth.[1,8] For the Tc isotope reported in this paper the half-life is estimated as roughly 10^4 years, which is far too short for survival since original element formation. It was assumed that the $Tc^{(98)}$ and Tc^{99} in the sample were produced by (n,p) reactions from the corresponding Ru isotopes, and that the isotopic cross sections were the same, except for a factor of 3 to correct for the higher (n,p) threshold of Ru^{98}. The result corresponds to about one millibarn effective cross section, a reasonable value in view of the intensity of Tc^{95m} in the sample, an amount which indicates a substantial fast neutron flux to produce the $(n,2n)$ reaction on Ru^{96}. An upper limit of 10^5 years for $Tc^{(98)}$ is obtained by assuming that most of it was formed by (n,γ) on Tc^{97m} and/or Tc^{97}. This mode of production is improbable because a cross section $\geqslant 10^3$ barns would be required. Work is continuing on the mass assignment and half-life.

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π^--Proton Interactions at 4.5 Bev*

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THE interaction with protons of 4.5-Bev negative pions from the Bevatron is being studied by use of a hydrogen-filled diffusion cloud chamber.[1] The mesons were produced by circulating protons of 5.7 and 6.2 Bev striking targets of carbon or uranium. π^- mesons emitted in the forward direction from the target underwent momentum analysis by deflections of 17.6° in the magnetic field of the Bevatron and 10.8° in an external analyzing magnet. A 4-foot-long steel collimator with a 5-inch-wide gap was inserted between the Bevatron and the analyzing magnet. The mesons passing through the collimator then entered the cloud