

uses an entirely different procedure for the extraction and measurement of radiogenic argon. He obtained an A^{40}/K^{40} ratio approximately 35 percent larger than our value.² We now find that this difference was caused by the fact that our sodium flux extracted less argon than the sodium hydroxide flux used by Wasserburg. Comparison runs have now been carried out at Toronto using both sodium metal and sodium hydroxide fluxes. The following results are typical of those obtained. In each case sodium hydroxide extracted more of the argon than metallic sodium.

The Lee Lake microcline was the same sample used for our previous measurements.¹ Using the same age of 1750 million years we obtain with the sodium hydroxide flux a branching ratio of 0.090. For our Bessner sample Wasserburg's measurements give a branching ratio of 0.088, assuming an age of 940 million years. This age we determined on a uraninite collected with the feldspar. These estimates of the branching ratio suggest that the radiogenic argon measurements as now carried out at Chicago and at Toronto are in reasonable agreement.

Both the ages quoted above were determined at Toronto by the lead ratio method applied to uraninites found in the same pegmatites as the potassium feldspars. It has been our experience that the lead ratio method generally gives the most reasonable ages for old minerals.³

As pointed out by Wasserburg and Hayden,² Nier⁴ has dated a specimen identified as "Bessner Ontario uraninite" by the lead ratio method and obtained an age of only 825 million years. Through the kindness of J. P. Marble, Chairman, Committee on the Measurement of Geologic Time, we obtained some of Nier's original Bessner sample and for it found an age of 860 million years in agreement with Nier. Thus there are either uraninites of two ages at Bessner or Nier's sample was collected for him at some other locality. For this reason we have used our age for Bessner determined on the uraninite which we collected.

Additional potassium-argon measurements and a more detailed discussion are being published elsewhere.

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¹ Russell, Shillibeer, Farquhar, and Mousuf, *Phys. Rev.* **91**, 1223 (1953).

² G. J. Wasserburg and R. J. Hayden, *Phys. Rev.* **93**, 645 (1954).

³ Collins, Farquhar, and Russell, *Bull. Geol. Soc. Am.* **65**, 1 (1954).

⁴ A. O. Nier, *Phys. Rev.* **55**, 153 (1939).

K-Particle Production by Protons of 2.2 and 3.0 Bev*

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STACKS of Ilford 400 μ G5 stripped emulsions have been exposed to radiations from a 6 mm thick copper target bombarded by the circulating proton beam of the BNL Cosmotron. No magnetic analysis was used.

Four events attributed to stopping K mesons have been found in area-scanning of the emulsions. Preliminary values of the masses of these mesons have been determined from range, ionization, and multiple scattering measurements. Each K particle was observed to enter the emulsion in the target-to-emulsion direction.

At one stack position, (a), the target-to-emulsion path, 28 cm long, made an angle of 90° with the proton beam direction; at another position, (b), the target-to-emulsion path was 50 cm long and made an angle of 45° with the proton beam. At both positions the radiations incident on the stacks from the target traversed the steel wall (1.1 cm) of the Cosmotron, and at position (b) they traversed an additional 7.5 cm of copper.

With protons of 2.2 Bev, and emulsions at (b), one stopping K^- meson (range in the emulsion 31 mm) has been found in a scanned area of 36.2 cm², in which 231 stopping π and μ mesons were observed. In these emulsions, the flux of fast particles coming from

the target was about 5×10^8 cm⁻². The K^- meson formed a star consisting of a 50-Mev π meson (as shown by grain count and scattering) and a heavy fragment of 600 μ range. The π meson makes a two-pronged star in flight after traversing 3.1 mm of emulsion. This K^- star resembles closely the one found at the Cosmotron with magnetic selection.¹ The mass of the K^- meson has been measured as $970 \pm 150 m_e$. If it came from the target, as is indicated by its direction, then it is estimated that it left the target with 270-Mev kinetic energy. This kinetic energy is consistent with the production of the K meson either single or paired with a hyperon; it is inconsistent with production of a pair of K mesons of mass as low as 920 m_e in a single nucleon-nucleon collision, assuming a maximum Fermi energy of 25 Mev.²

With protons of 3.0 Bev, 10.8 cm² of emulsion exposed at position (a) have so far been scanned. The flux of fast particles from the target was about 3×10^8 cm⁻². In this area, 386 π and μ meson endings have been found and three tracks due to stopping heavy mesons (ranges in emulsion 19 mm, 40 mm, 46 mm) have been identified. In each of these events the heavy meson gave rise to a single minimum ionizing particle, with no visible recoil or electron track. The events are, then, typical of positive K meson decays. It is not yet known whether the decay particles are π mesons or μ mesons. The measured masses of these three K mesons are in the range $1050 \pm 250 m_e$, and their kinetic energies on leaving the copper target lie between 90 and 130 Mev.

All the K mesons observed lived at least 2×10^{-9} sec before coming to rest in the emulsion.

Emulsions exposed at position (b), with 3.0-Bev protons, have not yet been scanned.

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¹ J. Hornbostel and E. O. Salant, *Phys. Rev.* **93**, 902 (1954).

² R. M. Sternheimer, *Phys. Rev.* **93**, 642 (1954); Brookhaven National Laboratory Report No. RS-41, March 8, 1954 (unpublished).

Beta-Decay Interaction*

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EXISTING arguments, presented exhaustively by Mahmoud and Konopinski¹ and since supplemented and firmly established by the electron-neutrino angular correlation experiments on helium-6² and neon-19,³ indicate that the beta-decay interaction contains tensor and scalar contributions (in a ratio of the order of unity), but no vector or axial vector. Previous conclusions concerning the pseudoscalar interaction are largely invalidated by a recent re-examination of the theory⁴ whose consequences are discussed below.

The new treatment gives a pseudoscalar contribution to the l -forbidden group ($\Delta j = \pm 1, \Delta l = \pm 2$). Direct evidence for the validity of l assignments comes from deuteron stripping experiments which yield the shell model l even when lower l values could compete,⁵ as in phosphorus-32.⁶ A mixture of single-particle states, with a $\Delta l = 0$ contribution of the order of a percent or less, is possible and sometimes expected. If we ascribe the whole transition probability to pseudoscalar interaction (despite competition from the other interactions and $\Delta l = 0$ admixture), we shall find an upper limit to g_P consistent with the observed f^2 values. The pseudoscalar l -forbidden correction factor is approximately (neglecting nuclear force corrections):

$$C_{1P} = g_P^2 (4M^2)^{-1} (\alpha Z / 2\rho)^2 \left| \rho^{-2} \int \mathbf{r} (\boldsymbol{\sigma} \cdot \mathbf{r}) \right|^2,$$

as against the allowed tensor $C_{0T} = g_T^2 \left| \int \boldsymbol{\sigma} \boldsymbol{\sigma} \right|^2$ and Rose and Osborn's first-forbidden pseudoscalar correction factor, which is ap-