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] Nier[4] 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.

This research was assisted by grants from the National Research Council and Geological Survey of Canada, the Research Council of Ontario, and Imperial Oil Limited.

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

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(Received April 27, 1954)

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 5×10^3 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 ± 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 3×10^3 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 ± 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.

We wish to thank Mrs. M. Carter and Mr. J. E. Smith for processing these emulsions, and Mrs. M. Hall, B. Cozine, A. Lea, and M. Bracker for invaluable aid in the microscopy.

* Work performed under the auspices of the U. S. Atomic Energy Commission.
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Beta-Decay Interaction*

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(Received March 5, 1954)

Existing arguments, presented exhaustively by Mahmoud and Konopinski[1] and since supplemented and firmly established by the electron-neutrino angular correlation experiments on helium-6[2] 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 theory[4] whose consequences are discussed below.

The new treatment gives a pseudoscalar contribution to the l-forbidden group ($\Delta j=\pm1$, $\Delta l=\pm2$). 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 ft values. The pseudoscalar l-forbidden correction factor is approximately (neglecting nuclear force corrections):

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

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

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

As a fair estimate, we consider $|\int\boldsymbol{\sigma}|\approx|\rho^{-1}\int\boldsymbol{\sigma}\cdot\mathbf{r}|\approx|\rho^{-2}\int\mathbf{r}(\boldsymbol{\sigma}\cdot\mathbf{r})|$, where we take for the tensor matrix element the ordinary allowed (not superallowed) value of the matrix element—i.e., we consider all transitions to be subject to the same "unfavored factor." Repeated occurrence of fortuitously extremely small matrix elements is unlikely, as ft values in any group tend to be pretty uniform, and major irregularities here would lead us to expect them elsewhere as well. The presence of a large nuclear force contribution to the pseudoscalar interaction would depress g_P in order to fit of the observed l-forbidden ft values. From the ratio C_{1P}/C_{0T} determined from observed ft values for the extensively studied carbon-14[7] and phosphorus-32 and neighboring allowed nuclides, we obtain $|g_P/g_T|\approx 4$ and 20, respectively; the $Z\approx 30$ group yields a ratio near 15. Even a ratio of 20, however, leads to log $ft\approx 8$ for C_{1P} for the highest Z—a trifle small to compete equally with the other interactions, and certainly inadequate to account for log $ft\approx 5.5$ among the high-Z $\Delta j=0$ (yes) group. Thus it appears that the pseudoscalar interaction does not play a detectable role in beta decay, if it is present at all.

I wish to thank Dr. M. E. Rose for making his results available to me ahead of publication and for a number of fruitful discussions.

* Work supported in part by the U. S. Atomic Energy Commission.

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Ground State of Al^{26}

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It has recently been suggested[1,2] that the state in Al^{26}, which decays by positron emission with a half-life of 6.7 sec, and which was generally accepted as the ground state, might be the $T_z=0$ component of the lowest triplet with isobaric spin $T=1$ and ordinary spin $J=0^+$. The lowest $T=0$ state in Al^{26}, which might well have an ordinary spin $J=5^+$,[3] might be situated either above or below the 6.7-second state. In Li^6, B^{10}, N^{14} and Na^{22} the ground state is a $T=0$ state, while in Cl^{34} the ground state has $T=1$. In any case such a low $J=5^+$ state would have a very long half-life.

There is much conflicting experimental evidence[4–11] about the lowest levels in Al^{26} (see Table I). The differences in the threshold measured by neutron detection and by positron detection both for $Al^{27}(\gamma,n)Al^{26}$ and $Mg^{26}(p,n)Al^{26}$ point to a long-lived state in Al^{26}. Moreover, it is found that the neutron yield of the $Al^{27}(\gamma,n)Al^{26}$ reaction is three times larger than the positron yield.[12,1]

In the present investigation the $Mg^{25}(p,\gamma)Al^{26}$ reaction was used to obtain more information on the lowest states in Al^{26}. By bombarding thin targets of separated Mg^{24}, Mg^{25}, and Mg^{26} (obtained from Dr. M. L. Smith, Atomic Energy Research Establishment, Harwell, England) by protons in the energy region from $E_p=200$ to 700 kev, it was possible to assign six resonances to Mg^{25}, *viz.*, at $E_p=315$, 389, 436, 508 (possibly unresolved doublet), 586, and 620 kev. The first four resonances have been observed previously from natural magnesium targets by Tangen[13] and by Hunt and Jones.[14] Tangen assigned the 436-kev resonance to Mg^{26}, as he did not detect positrons at this resonance. Hunt and Jones interpreted also the 315- and 387-kev resonances as Mg^{26} resonances.

Table I. Experimental data about the position of the two lowest states in Al^{26} relative to the Mg^{26} ground state.

Reaction	$Al^{26}-Mg^{26}$ (Mev)	$Al^{26*}-Mg^{26}$ (Mev)	Ref.
$Al^{26}(\beta^+)Mg^{26}$		4.4 ± 0.5	4, 5
$Al^{26}(\beta^+)Mg^{26}$		$(3.8)^a$	6
$Al^{26}(\beta^+)Mg^{26}$		(4.01)	7
$Al^{27}(\gamma,n)Al^{26}$	3.70 ± 0.20		8
$Al^{27}(\gamma,n)Al^{26}$		5.0 ± 0.4	9
$Mg^{25}(d,n)Al^{26}$	2.51 ± 0.10	4.51 ± 0.18	10
$Mg^{26}(p,n)Al^{26}$	~2.6	(4.3)	11

[a] The value has been put between parentheses, when the isotopic assignment is doubtful.

Gamma-ray energies were measured with a scintillation spectrometer ($2\times2\times3$ cm^3 NaI crystal). Pulses were fed both to a one-channel differential discriminator and to an ordinary discriminator, used as a monitor. Energy calibrations were performed with a Po-Be source ($E_\gamma=4.44$ Mev) and with γ rays from the $F^{19}(p,\alpha\gamma)O^{16}$ reaction ($E_\gamma=6.13$ Mev) and from the $C^{13}(p,\gamma)N^{14}$ reaction ($E_\gamma=8.06$ Mev).

At the 436-kev resonance a γ ray of $E_\gamma=6.77\pm0.08$ Mev is observed indicating an Al^{26} state (the ground state) 3.96 ± 0.08 Mev above the Mg^{26} ground state. At all resonances a γ ray was found proceeding to an Al^{26} level 4.42 ± 0.08 Mev above the Mg^{26} ground state, corresponding to 0.46 ± 0.08 Mev above the Al^{26} ground state (see Table II). No higher energy γ rays were found at any of the six resonances investigated. There are certainly present several lower energy γ rays, but their energy has not yet been accurately determined. In a preliminary survey positrons from the Al^{26} decay were observed at all of the investigated resonances. However at the 436-kev resonance the yield is certainly low, in agreement with Tangen's observation.[13]

Table II. Observed γ rays at six $Mg^{25}(p,\gamma)Al^{26}$ resonances.

Resonance proton energy (kev)	$E_{\gamma1}$ (Mev)	$Mg^{25}+p-Al^{26}$ (Mev)	Rel.[a] int.	$E_{\gamma2}$ (Mev)	$Mg^{25}+p-Al^{26*}$ (Mev)	Rel.[a] int.
315			≤3	6.28	5.98	18
389			≤2	6.20	5.83	8
436	6.77	6.35	25	6.28	5.86	6
508			≤2	6.38	5.89	10
586			≤2	6.43	5.87	18
620			≤2	6.50	5.90	19

[a] The relative intensity is given in percents of the number of γ-ray pulses larger than 1 Mev.

All experimental evidence cited in this letter is compatible with the assumption that the Al^{26} ground state has isobaric spin $T=0$ and the level at 0.46 Mev $T=1$. If the ground state really has a spin $J=5^+$, it probably decays by a second forbidden β^+ transition to the Mg^{26} level at 1.83 Mev (assumedly with $J=2^+$) with a β^+ endpoint of 1.11 ± 0.08 Mev. Taking log$ft=13.0$ leads to an estimated half-life of 4×10^4 years.

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Proton-Proton Scattering from 40 to 95 Mev*

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(Received April 26, 1954)

Proton-proton scattering has been studied with the external beam of the Harvard cyclotron, using scintillation counters to detect the protons scattered from hydrocarbon targets