the 91-kev γ-ray is approximately 0.9. Comparison with Hebb and Nelson's formulas[3] and Rose's tables,[4] makes it appear that the 91-kev γ-ray is probably a mixture of magnetic dipole and electric quadrupole radiations.

Using Feenberg's curves[5] the comparative half-lives for the β-components were found to be 350 kev (11-day) log (ft) = 6.6, 780 kev (11-day) log(ft) = 7.4, 1.05 Mev (2-day) log(ft) = 6.96. Applying the considerations of Nordheim[6] all these three can be placed in the first forbidden group with a change in parity and a change in spin of 0 or 1.

A probable disintegration scheme for Nd^{147} is suggested in Fig. 1.

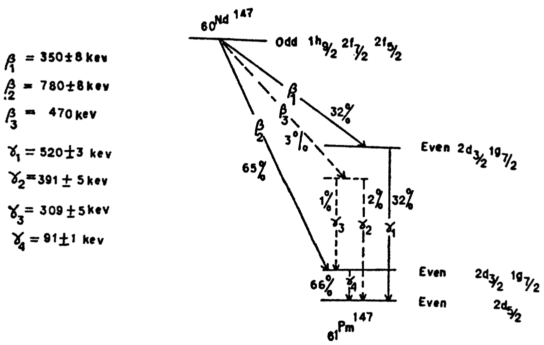

FIG. 1. Probable disintegration scheme for Nd^{147}.

The energies of the γ-rays add up well within the experimental errors mentioned. The β_3-component, having maximum energy of about 470 kev, was not obtained from the Fermi analysis of the 11-day β-spectrum. This is probably due to its low intensity ($\sim$3 percent). However, the possibility that the 391- and 309-kev γ-rays may arise from some impurity of a nearby half-life cannot be entirely ruled out, so these two γ-rays and the corresponding β-ray are shown by broken lines.

Pm^{149} appears to decay by a single β-ray of maximum energy 1.05 Mev. No γ-rays having this period (2 days) were observed.

The term scheme given in Fig. 1 was arrived at from the spin-orbit coupling model of the nucleus.[7,8] A detailed paper describing the experimental details will be published in the *Arkiv för Fysik*.

I wish to convey my sincere thanks to Professor Manne Siegbahn, the director of this institute. My thanks are also due Dr. Kai Siegbahn for kindly supervising this work.

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K^{40} and the Age of the Atmosphere

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January 12, 1951

NOW that the decay scheme of K^{40} seems to be rather well established,[1] it is of interest to attempt a calculation of the age of the atmosphere from the amount of this isotope in the earth and the A^{40} content of the atmosphere. Calculations of a similar nature have been made by Poole[2] and Suess[3] using incorrect data.[4] The main difficulties lie in the estimation of (a) the relevant figures for the K^{40} abundance, and (b) the time elapsed since the crust became so well solidified that further additions to the atmosphere have been inappreciable.

With regard to (a) we can take the abundance of ordinary K in the upper crust layers as[5] 2.60 percent, the K^{40} isotopic abundance as[6] 0.0119 percent, the density of the crust as[5] 2.8, and the depth of the K-bearing crust as 4×10^6 cm. This latter figure is admittedly something of a guess.[5] With respect to (b) let us suppose the argon to have been generated from a time t_0 until a time $t=2\times10^9$ yr ago when the crust first began to solidify. Undoubtedly, some argon would have escaped since then, so that we shall derive an upper limit for t_0. Alternatively, if we allow an interval from t_0 to only $t=1\times19^9$ yr ago, we shall obtain a value for t_0 which is perhaps nearer to a lower limit. We then easily derive the relation

$$\frac{\lambda_e}{\lambda_e+\lambda_\beta}(e^{\lambda t_0}-e^{\lambda t})\left(\frac{2.60}{100}\right)(4\times10^6)\left(\frac{0.0119}{100}\right)2.8=76\times13.5\times\frac{1.44}{100}$$

by equating the mass of K^{40} per cm^2 of the earth's surface which has decayed to the actual amount of argon observed.

Using

$$\lambda_e/(\lambda_e+\lambda_\beta)=0.13/1.13,\quad \lambda=5.45\times10^{-10}/\text{yr},$$

we get for the limits of t_0, 3.5×10^9 and 3.1×10^9 yr.

While considerable uncertainty must be attached to these figures, it is perhaps of interest that they agree so well with the age of the earth as calculated by the lead method by Holmes and others.[7]

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Radioactive Strontium Produced by Deuteron Bombardment of Rubidium

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January 15, 1951

THE bombardment of rubidium by protons has been reported[1,2] to produce a strong activity in the chemically separated strontium fraction. These studies[1] disclosed the presence of three activities which were assigned to Sr^{85m} (70-min half-life, gamma-ray and internal conversion electron emission), Sr^{87m} (2.75-hr half-life, gamma-ray and internal conversion electron emission), and Sr^{85} (66-day half-life, K-capture decay and gamma-ray emission). The radiations from these isotopes have been reinvestigated using a 14-cm radius of curvature, uniform field, semicircular magnetic spectrometer.[3]

Radioactive samples were prepared through the bombardment of rubidium chloride with 10-Mev deuterons in the Washington University cyclotron. After bombardment the RbCl was dissolved in water, a small amount of strontium carrier was added in the form of $SrCl_2$, and the strontium precipitated by the addition of Na_2CO_3. This precipitate was washed several times.

A small fraction of one of the separated samples was mounted in a plastic holder, and its decay followed for a period of 140 days. The results indicate a half-life of 65±3 days, in good agreement with the value reported by DuBridge and Marshall.[1]

The secondary electrons ejected from a 50-mg/cm^2 uranium radiator shows K and L shell photo-electron peaks for the 65-day activity, corresponding to a gamma-ray of energy 513±3 kev. This was at first thought to be annihilation radiation. However, an uncovered electron source revealed a relatively strong internal conversion peak whose energy also corresponds to a transition energy of 513 kev. This indicated that at least part of the radiation was really gamma-radiation and not annihilation radiation. The experimental data are shown in Fig. 1.

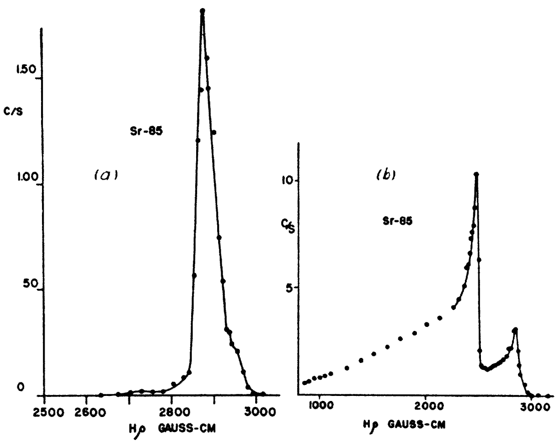

FIG. 1. (a) Internal conversion electron spectrum for the 513-kev gamma-ray from 65-day Sr^{85}. (b) Photo-electron spectrum for the same transition.

To check for the existence of positrons, two scintillation counters were used in coincidence. When separated by an angle of 180° at the source, coincidences between annihilation quanta should be recorded if positrons are present. This method and the apparatus used has been described in an earlier paper.[4] If the electromagnetic radiation is caused by the annihilation of positrons, there should be a sharp peak of coincidences when the two detectors and the source lie in the same straight line.[4] The results for this experiment are shown in Fig. 2. As a reference a known positron

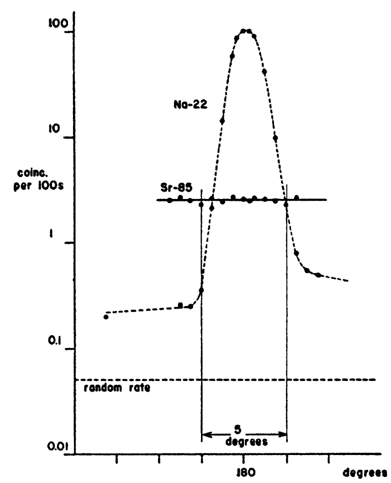

FIG. 2. Results of the experiment showing the absence of annihilation radiation in Sr^{85}. The constant coincidence rate for strontium may be compared to the increase in the coincidence counting rate for Na^{22} when the two detectors are separated by an angle of 180° at the source, this increase being caused by annihilation-annihilation coincidences. From this one deduces that Sr^{85} decays only by orbital electron capture.

emitter (Na^{22}) has been used. Whereas Na^{22} presents a very definite peak when the detectors are situated at an angle of 180° with the source, nothing similar can be observed for the Sr^{85}. Therefore, it can be concluded that the Sr^{85} decays by orbital electron capture without the emission of positrons, and that the 513-kev electromagnetic radiation is true gamma-radiation.

Internal conversion electrons associated with the shorter lived strontium activities were also observed. Internal conversion lines were found which corresponded to transition energies of 152 and 233 kev, and which decayed with a half-life of approximately 70 min. This half-life has previously been attributed[1] to Sr^{85m}. Also, there were internal conversion electron peaks corresponding to K and L shell conversions of a 388-kev transition energy. This appeared to decay with a half-life of about 2¾ hours, and would, therefore, be associated with Sr^{87m}.[1]

The authors wish to thank Dr. C. S. Cook for his advice and interest in the work and Mr. M. Cleland for his help in the annihilation coincidence studies.

* Assisted by the joint program of the ONR and AEC.

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Resonance in Antiferromagnetics

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January 19, 1951

In a recent communication[1] Bleil and Wangsness have given an explanation of the disappearance of microwave resonance signals in antiferromagnetics below the curie temperature. An alternative explanation can be given as follows. The total absorption of energy in a resonance experiment on free spins is given by[2]

$$K\,\mathrm{Spur}[\exp(-\mathcal{H}/kT)(S_x\mathcal{H}-\mathcal{H}S_x)S_x]/\mathrm{Spur}[\exp(-\mathcal{H}/kT)],$$

where $S_x=\Sigma_i s_x^i$, and K is a numerical constant. In a model in which $\mathcal{H}=g\beta H\Sigma_i s_z^i+\Sigma_{i<j}J_{ij}\mathbf{s}^i\cdot\mathbf{s}^j$, it is found readily that the area reduces to $\frac{1}{2}KH\bar{M}$, where $\bar{M}$ is the magnetic moment of the sample in the field, H. The value of $\bar{M}$ is known to decrease very sharply at the curie temperature as the temperature is lowered, so that the intensity of absorption will decrease correspondingly. In cases where this model can be applied there is no question of the resonance line moving outside the range of microwave experiments, as the exchange energy commutes with the measuring perturbation term, and the line should remain fixed in position. Thus, we prefer to explain the decrease in absorption at the curie temperature as an effect arising from the fact that the system occupies states from which the transition probabilities are small.

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Positron Search in K^{40}

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The gamma-ray of K^{40} is associated with K-capture, because its energy is greater than the beta-ray end-point energy, and its intensity is much less than that of the beta rays.[1-3] The gamma-ray energy is greater than $2m_0c^2$. Under these conditions positron decay is to be expected.

Annihilation quanta from K^{40} were, therefore, sought. The apparatus has been described previously.[4] The only modification was that the K_2CO_3 source was a shell 1¼ in. thick. (See Fig. 1 of reference 4.) The absorber between the crystal and position II (which is outside the K_2CO_3 container) was about 7 g/cm². Under these conditions, with a strong Zn^{65} source at position II, the curve B (Fig. 1) was obtained. Curve A is a Zn^{65} curve in which position (I), which is inside the container, was used, so that scattering effects were minimized. The effect of scattering in curve B is so severe that the beta-shield was changed (to a Pyrex beaker), and the inner support of the K_2CO_3 shell was made thinner. The Zn^{65} source was also made thinner and placed about 3 cm out from the masonite box wall instead of against it as before. These changes resulted in a total absorber thickness of about 4.3 g/cm². Under these conditions the data of curve D (Fig. 1) were obtained. It is