this view is provided by the existence of a 1.5 min isomer of Ir^{192}.[1]

It would be expected that the first excited state of each of the three nuclides Os^{192}, Pt^{192}, and Pt^{194} has spin 2 and even parity. Experimental evidence for this exists from the K/L ratio of the 328-kev line in Ir^{194}.[17] Moreover, angular correlation studies[21,22] indicate that some of the higher levels in the Ir^{194} decay scheme also have spin 2, but at the time these experiments were performed the complex nature of the spectrum was not realized, so that the interpretation of these experiments is open to question.

[21] C. E. Whittle and P. S. Jastram, Phys. Rev. **87**, 203 (1952).
[22] J. J. Krauschaar and M. Goldhaber, Phys. Rev. **89**, 1081 (1953).

ACKNOWLEDGMENTS

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Internal Conversion in Ne^{22}†

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The internal conversion coefficient of the 1.28-Mev γ ray in Ne^{22} has been measured to determine its multipole character. It has been found to be $E2$. The spin and parity assignments to the Ne^{22} excited state and the Na^{22} ground state are discussed.

THE internal conversion coefficient of the 1.28-Mev gamma ray of Ne^{22} has been measured in order to determine the spin and parity of the 1.28-Mev excited state. Two methods were used to find the total conversion coefficient. One way, the least accurate, was to compare the area under the conversion peak with the area under the continuous spectrum. The second way was to compare the conversion coefficient of the neon gamma ray with that[1] of the 1.33-Mev gamma ray of Ni^{60}.

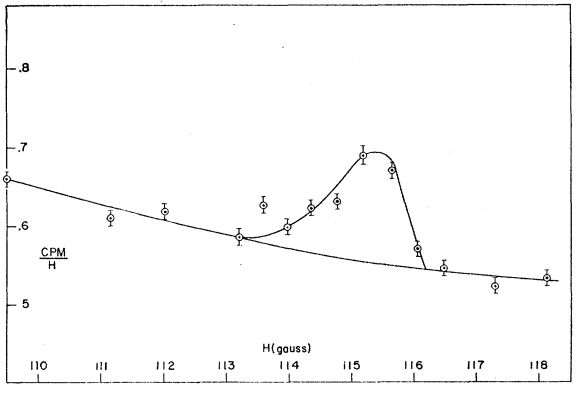

FIG. 1. Internal conversion peak of 1277-kev γ ray in Ne^{22}, source I.

† This research was supported by the U. S. Army Office of Ordnance Research.
[1] C. Y. Fan, Phys. Rev. **87**, 252 (1952); Waggoner, Moon, and Roberts, Phys. Rev. **80**, 420 (1950).

The source used in method one (source I) was prepared from cyclotron produced Na^{22} obtained from Oak Ridge in the form of NaCl. The NaCl was deposited on a zapon film covered by a 0.1-mg/cm² layer of silver. The average thickness of the source was 4 mg/cm² but was not very uniform; the total source area was 10 cm² and the source strength one millicurie.

The data taken on the conversion peak are shown in Fig. 1. Actually several runs were made, but only the data with the best statistics are included in the plot. The curve drawn indicates a somewhat poorer resolution than is usual for the counter and baffle arrangement used. The line was broadened by the thick source. A

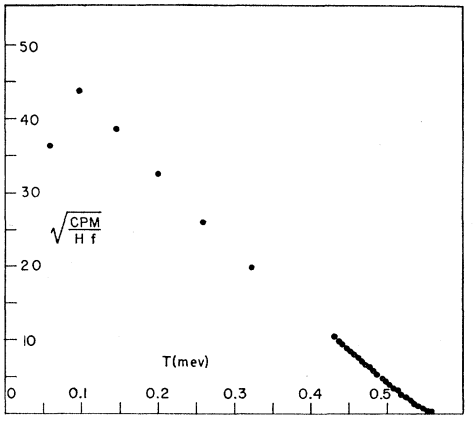

FIG. 2. Kurie plot of positrons from the decay of Na^{22}, source I, 4 mg/cm².

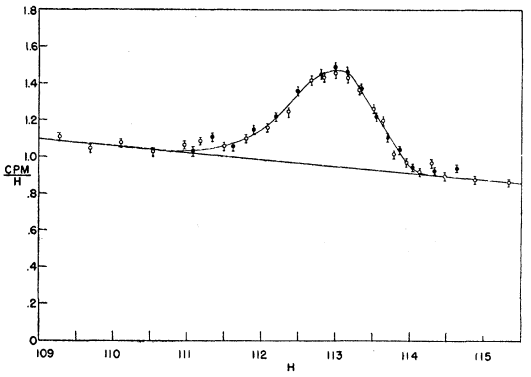

FIG. 3. Internal conversion peak of 1277-kev γ ray in Ne^{22}, source II; resolution, 1.22 percent. Open and closed circles indicate two different runs.

Kurie plot of the continuous positron spectrum is shown in Fig. 2. The number of low-energy positrons is too large because of the source thickness. Data taken on a thinner source showed a straight plot down to 170 kev. All deviations from straight Kurie plots are attributed to source thickness, for the spectrum is known to have an allowed shape.[2] For measurements of conversion coefficients a very thin source is not necessary, of course, for the area under the spectrum is the information desired.

By using the ratio of the area under the conversion peak to the area under the continuous spectrum, corrected for K capture, as the conversion coefficient, one obtains $\alpha_T = (0.85 \pm 0.20) \times 10^{-5}$.

The second method for measuring the α_T is much more accurate. This work was done on a different source (source II) also obtained from Oak Ridge as NaCl. The NaCl was deposited in solution on a zapon film covered with an evaporated aluminum coat and a layer of insulin to increase uniformity. It was approximately 0.3 mg/cm² thick, 8 cm long, and 1.0 cm wide. The conversion peak and the photopeak of the 1.28-Mev gamma ray were measured several times and the areas under them calculated. Typical curves are shown in

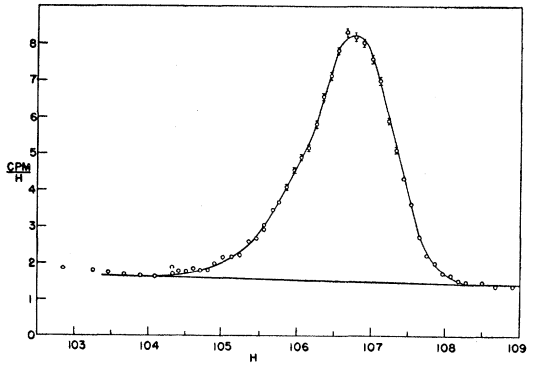

FIG. 4. Photopeak of 1277-kev γ ray of Ne^{22}, source II; resolution, 1.22 percent.

[2] Macklin, Lidofsky, and Wu, Phys. Rev. **78**, 318 (1950).

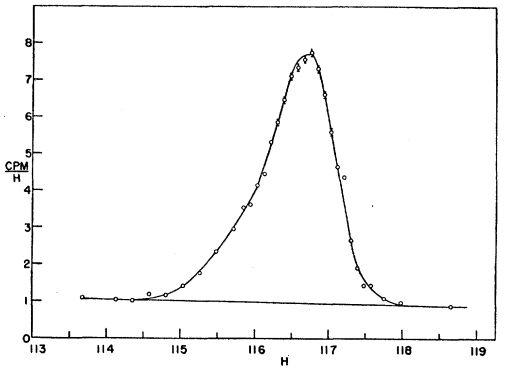

FIG. 5. Internal conversion peak of 1332-kev γ ray in Ni^{60}; resolution, 0.93 percent.

Figs. 3 and 4. The photoconverter used was lead 7.5 mg/cm² thick evaporated onto an aluminum plate.

The conversion coefficient of the neon gamma ray was found by comparing its conversion and photopeak areas with those for the 1.33-Mev gamma ray of Ni^{60}, for which the α_T is known.[1] The cobalt source used in the comparison was similar in shape to the sodium source described above and was prepared in the same manner from a $CoCl_2$ source obtained from Oak Ridge. Its thickness was approximately 0.3 mg/cm². A typical conversion and photopeak for the nickel gamma ray are shown in Figs. 5 and 6.

In order to indicate how the α_T(1.28 Mev−Ne) was calculated, the following definitions are necessary:

N(1.28 Mev−Ne) = number of conversion electrons for the 1.28-Mev gamma ray of Ne as measured by the area under the conversion peak,

N(1.33 Mev−Ni) = number of conversion electrons for the 1.33-Mev gamma ray of Ni as measured by the area under the conversion peak,

I(1.28 Mev−Ne) = number of 1.28-Mev gamma rays per second from the Na source,

I(1.33 Mev−Ni) = number of 1.33-Mev gamma rays per second from the Co source,

P(1.28 Mev−Ne) = number of photoelectrons for the 1.28-Mev gamma ray of Ne as measured by the area under the photopeak,

P(1.33 Mev−Ni) = number of photoelectrons for the 1.33-Mev gamma ray of Ni as measured by the area under the photopeak,

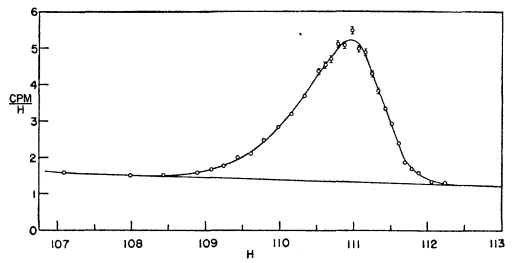

FIG. 6. Photopeak of 1332-kev γ ray of Ni^{60}; resolution, 1.14 percent.

σ(1.28 Mev−Pb) = photoelectric cross section in lead at 1.28 Mev,
σ(1.33 Mev−Pb) = photoelectric cross section in lead at 1.33 Mev.

The calculations then proceeded as follows, if one assumed, as was the case, that the source and instrument geometry were similar for the Co and Na:

$$\frac{N(1.28\ \text{Mev}-\text{Ne})}{N(1.33\ \text{Mev}-\text{Ni})}=\frac{\alpha_T(1.28\ \text{Mev}-\text{Ne})}{\alpha_T(1.33\ \text{Mev}-\text{Ni})}\frac{I(1.28\ \text{Mev}-\text{Ne})}{I(1.33\ \text{Mev}-\text{Ni})},$$

$$\frac{P(1.28\ \text{Mev}-\text{Ne})}{P(1.33\ \text{Mev}-\text{Ni})}=\frac{\sigma(1.28\ \text{Mev}-\text{Pb})}{\sigma(1.33\ \text{Mev}-\text{Pb})}\frac{I(1.28\ \text{Mev}-\text{Ne})}{I(1.33\ \text{Mev}-\text{Ni})}.$$

Eliminating the I's yields

$$\frac{\alpha_T(1.28\ \text{Mev}-\text{Ne})}{\alpha_T(1.33\ \text{Mev}-\text{Ni})}=\frac{N(1.28\ \text{Mev}-\text{Ne})}{N(1.33\ \text{Mev}-\text{Ni})}\times\frac{P(1.33\ \text{Mev}-\text{Ni})}{P(1.28\ \text{Mev}-\text{Ne})}\frac{\sigma(1.28\ \text{Mev}-\text{Pb})}{\sigma(1.33\ \text{Mev}-\text{Pb})}. \quad (1)$$

In order to find α_T(1.28 Mev−Ne) it is necessary to know the σ's and the conversion coefficient for the Ni gamma ray. Waggoner, Moon, and Roberts[1] give α_T(1.33 Mev−Ni) = (1.286±0.035)×10^{-4} and Fan reports it to be (1.24±0.12)×10^{-4}. An interpolation of the recent shielded K_1 and L_I coefficients of Rose *et al.*[3] gives a value α_T(1.33 Mev−Ni) = 1.24×10^{-4}, but this value is possibly a few percent off because the coefficients for L_{II}, L_{III}, M_I, etc., could only be estimated (they were assumed to total 0.03 of the K-shell coefficient). After considering the measured and calculated values, α_T(1.33 Mev−Ni) was taken to be (1.26±0.03)×10^{-4}.

The photoelectric cross sections required were taken from the paper of Davisson and Evans.[4] No correction was made for any variation in the angular distribution of the photoelectrons but this effect is small.

Substituting the measured and calculated quantities into the equation (1), α_T(1.28 Mev−Ne) = (6.74±0.67)×10^{-6}, where ±0.67×10^{-6} indicates our estimate of twice the standard deviation of the result arising from all known errors.

TABLE I. Total shielded internal conversion coefficients for Ne^{22}.

Multipole order	Electric (α_T)	Magnetic (α_T)
1	3.32×10^{-6}	4.97×10^{-6}
2	6.59×10^{-6}	9.3 ×10^{-6}
3	12.2 ×10^{-6}	17.0 ×10^{-6}

The theoretical conversion coefficients, with which the experimental value is to be compared, have been calculated using the calculations of Rose as a base. It is known that for light elements and high-energy gamma rays the conversion coefficient depends approximately only upon the value of the initial state electron wave function at the origin.[5] This fact makes possible a correction to the α_K calculated by Rose, which neglects shielding, to take account of the shielding and also to include α_{LI}. The coefficients α_{LII}, α_{LIII} are neglected as the wave function at the origin is zero for p electrons. The calculation of α_{LI} is exactly the same as that for α_K except that the $2S$ wave function rather than the $1S$ is used. Thus,

$$\alpha_T(\text{shielded})=\alpha_K(\text{unshielded})\times\left[\left(\frac{\psi_{1S}(\text{shielded})}{\psi_{1S}(\text{unshielded})}\right)^2+\left(\frac{\psi_{2S}(\text{shielded})}{\psi_{1S}(\text{unshielded})}\right)^2\right].$$

Excellent values for ψ_{1S} and ψ_{2S} are available[6] for Ne. Using them, α_T(shielded) = 0.967α_K(unshielded). The values of α_T(shielded) for various multipole orders of radiation are listed in Table I, from which it is clear that the radiation is $E2$. This makes the 1.28-Mev level of Ne^{22} a 2+ state if the ground state is 0+.

A considerable amount of information[7] has been gathered on the decay of Na^{22} which can be of assistance in classifying the Na^{22} ground state. The spin is known to be 3 and the parity is most probably plus although this makes the β^+ transition allowed and leaves the problem of understanding the large ft value ($\log ft$ = 7.6).

The authors would like to thank Mr. David Brower for help in taking part of the data on Na^{22}.

[3] Rose, Goertzel, and Swift (unpublished).
[4] C. M. Davisson and R. D. Evans, Revs. Modern Phys. **24**, 79 (1952).
[5] G. W. Hinman (to be published).
[6] F. W. Brown, Phys. Rev. **44**, 214 (1933).
[7] See review article by P. M. Endt and J. C. Kluyver, Revs. Modern Phys. **26**, 95 (1954). See also R. Sherr and R. H. Miller, Phys. Rev. **93**, 1076 (1954).