Gamma-Radiation from Na^{22} and Co^{60}

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TECHNIQUES of gamma-ray measurement using the lens spectrometer have been applied to the radiation occuring in 3y Na^{22} decay. As shown by Good, Peaslee, and Deutsch,[1] the Na^{22} nucleus emits a positron of 0.575-Mev maximum energy followed by a single gamma-ray of 1.30±0.03 Mev from the residual Ne^{22} nucleus. The mass of Na^{22} has been calculated in Rosenfeld's tables[2] by adding the mass equivalent of these two energies plus $2m_0c^2$ to the mass of Ne^{22}. The accuracy of the mass difference has been limited by the gamma-ray value.

The experimental method used is due to Hornyak, Lauritsen, and Rasmussen[3] and was first described by Dr. Lauritsen at the 1949 Washington American Physical Society meeting. It consists of converting the gamma-radiation photoelectrically in thin foils of a heavy element such as thorium and taking the extrapolated upper energy edge end point of the photoelectron distribution as a direct measure of electron momentum. The end point is found to be nearly independent of converter thickness and avoids the difficulties of correcting for scattering and energy loss in the converter when the momentum is referred to the position of the curve maximum.

The Brookhaven lens spectrometer[4] was used to observe photoelectrons from 21.5-mg/cm² lead, 14-mg/cm² thorium, and 44-mg/cm² uranium foils. Calibration values taken from the extrapolated front edge of K-shell photoelectrons due to Na^{22} positron annihilation radiation were in close agreement for the three converters. Regulation of the lens coil current was maintained to better than 0.1 percent by a Lawson and Tyler type photoelectric regulator.[5] This operates from a current shunt and employs a 10-turn Helipot for reference voltage to control the current in field of an exciter generator. Frequent checks on current linearity and stability of the system were made by measuring the voltage developed across a second shunt with a Leeds and Northrup Type K potentiometer.

The Na^{22} source was formed in the DTM Carnegie cyclotron by the reaction $Mg^{24}(d\alpha)Na^{22}$ and separated by the Chemistry Department of this Laboratory. The active NaCl solution was deposited in a 0.85-cm diameter brass source capsule to which the converters were attached. A complete curve of the gamma-ray secondary electron spectrum using the 21.5-mg/cm² Pb foil is shown in Fig. 1. The inner K and L photoelectrons of large intensity are due to the 0.5108-Mev positron annihilation radiation and the outer K and L peaks correspond to transition gamma-rays. These are superposed on a double Compton distribution background. In general, only the two K peaks were measured. The average value of five final measurements using the three converters previously mentioned was 1.277±0.004 Mev for the gamma-ray energy. This falls within the limits assigned by Good, Peaslee, and Deutsch. Using a probable error of 10 kev in the positron end point,[6] the $Na^{22}-Ne^{22}$ mass difference may now be placed at 0.003087±0.000011 Mev.

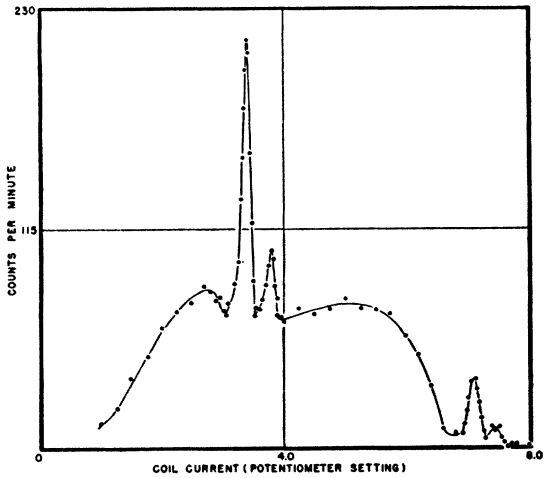

FIG. 1. Na^{22} gamma-ray secondary electron spectrum using a 21.5-mg/cm² Pb converter.

As a check on the method the gamma-rays of Co^{60} were investigated and energies of 1.175±0.006 Mev and 1.332±0.005 Mev obtained. These agree well with the new crystal spectrometer measurements of Lind, Brown, and DuMond,[7] namely, 1.1711 ±0.0010 Mev and 1.3318±0.0010 Mev but are definitely higher beyond the experimental limits than the values of Jensen, Laslett, and Pratt.[8] **

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[1] Good, Peaslee, and Deutsch, Phys. Rev. **69**, 313 (1946).
[2] L. Rosenfeld, *Nuclear Forces II* (Interscience Publischers, Inc., New York, 1949).
[3] Hornyak, Lauritsen, and Rasmussen, Phys. Rev. (in press). The author is grateful to Dr. Lauritsen for forwarding a copy of their paper in advance of publication.
[4] D. E. Alburger, Phys. Rev. **75**, 1442 (1949).
[5] J. J. Lawson and A. W. Tyler, Rev. Sci. Inst. **10**, 304 (1939). The actual circuit used is a modified version designed by Dr. G. Wadey.
[6] M. Deutsch, private communication.
[7] Lind, Brown, and DuMond, Bull. Am. Phys. Soc. **24**, No. 6, 12 (1949). The value 1.1171 in this reference is apparently a misprint and should be 1.1711 to agree with the wave-length in x.u.
[8] Jensen, Laslett, and Pratt, Phys. Rev. **75**, 458 (1949).
** See, however, the Letter to the Editor by Jensen, Laslett, and Pratt in this issue.

The Nuclear Spin and Magnetic Moment of Cs^{137}*

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THE decay scheme of Cs^{137} has recently been reported by Townsend, Cleland, and Hughes[1] in which they remark upon the desirability of determining the spin of this isotope. The atomic beam magnetic resonance method[2] as used by Zacharias[3] to determine the nuclear spin and magnetic moment of K^{40} has been used to determine the nuclear spin and magnetic moment of Cs^{137}.

Of the $Cs^{137}Cl$ obtained from the Isotopes Division of the Atomic Energy Commission, 210 microcuries in dilution of one part in one thousand with $Cs^{133}Cl$ were placed in the oven together with a slight excess of NaN_3. Upon decomposition of the azide, the sodium displaced the cesium in the chloride to furnish an atomic cesium beam. A fourteen-hour run was required for the present determination with the evaporation of 4×10^{-9} mole of Cs^{137} from the oven resulting in transition intensities for that isotope of several hundred atoms per second.

Because of the high frequencies of the hyperfine structure $\Delta\nu$ of both Cs^{133} and Cs^{137}, only $\Delta F=0$ transitions were observed having $\Delta m_F=\pm1$. These transitions permit direct comparison of g_F for the two isotopes. Search was made for transitions, having set the magnetic field (as determined by the Cs^{133} line) and radiofrequency for transitions corresponding to $I=1/2, 3/2, \cdots, 23/2$ with the mass spectrometer set for mass number 137. No resonances were observed except for $I=7/2$ which, because of the resolution of the mass spectrometer for this mass separation and number being only 0.4 percent, could be due to both cesium isotopes or to Cs^{133} alone. If both isotopes have the same spin but not identical nuclear magnetic moments, raising the value of the homogeneous magnetic field increases the separation between the transition frequencies because of the difference in $\Delta\nu$ until a value is reached where the resonances may be resolved. This procedure was followed until at 257 gauss two peaks were observed at about 96