Forbidden Beta-Spectra of Sb^{124} and I^{124} *

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IN a recent letter,[1] an attempt was made to fit the 2.291-Mev beta-spectrum of Sb^{124} with a linear combination of twice-forbidden factors instead of the once-forbidden p^2+q^2 factor previously proposed.[2] This suggestion arises, in part, from the apparently high comparative half-life ($\log ft=10.1$) for the transition.

It is interesting to note that in the decay[3] of I^{124}, the 2.2-Mev positron transition appears to be in the same excited state of Te^{124}. Taking account of the alternative modes of decay, including those by K-capture,[4] one finds that the comparative half-life for this transition corresponds to $\log ft=8.1$, with $\log(W_0^2-1)ft=9.5$. These values are quite in line with those found for other once-forbidden transitions involving a spin-change of 2. The spectrum of I^{124} is also fitted by the C_{1T}, p^2+q^2 factor.

According to the nuclear shell model, the state in Sb^{124} is best described as $I=3$, +, arising from the combination of a $g_{7/2}$ proton and an $s_{1/2}$ neutron. The state of I^{124} is also expected to be $I=3$, +, arising from a $d_{5/2}$ proton and an $s_{1/2}$ neutron. The resultant "L" state would then be 4 for the Sb^{124} and 2 for the I^{124}.

Although there seems to be some tendency[5] for the first excited state of an even-even nucleus to be $I=2$, +, this rule is not without exceptions. It is therefore not unreasonable, in view of the spectrum shapes, to assign $I=1$, −, to the 0.60-Mev level in Te^{124}.

The somewhat high comparative half-life for the Sb^{124} transition apparently results then from its being "ΔL-forbidden" in addition to its involving a parity change and a total angular momentum change of 2 units.

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[1] Nakamura, Umezawa, and Takebe, Phys. Rev. **83**, 1273 (1951).
[2] Langer, Moffat, and Price, Phys. Rev. **79**. 808 (1950).
[3] Mitchell, Mei, Maienschein, and Peacock, Phys. Rev. **76**, 1450 (1950).
[4] L. Marquez and I. Perlman, Phys. Rev. **78**, 189 (1950).
[5] M. Goldhaber and A. W. Sunyar, Phys. Rev. **83**, 906 (1951).

A Search for Gamma-Rays from the 4.8-Mev Level in Li^7 *

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IN order to make a preliminary determination as to whether Li^7 in the 4.8-Mev excited state[1] decays by gamma-emission, a comparison was made between the gamma-spectrum from the reaction

$$C^{12}(p,p')C^{12*}\rightarrow C^{12}+\gamma+4.5 \text{ Mev}$$

and that from Li$^7(p,p')$Li^{7*}, $Q=-4.8$ Mev, using the 8-Mev protons from the MIT cyclotron. The gamma-spectrum was measured alternately from thin, unbacked carbon and lithium targets using a NaI-Tl scintillation counter located at 90° to the beam. The carbon gamma-spectrum showed a pronounced peak corresponding to the 4.5-Mev gamma-ray, whereas in the case of the lithium target there was no evidence of a gamma-peak in the 4.8-Mev region above a low background of very high energy gammas. The inelastic proton groups from the two targets were roughly equal in intensity, as measured in a double proportional counter. It appears that the preferred mode of decay for the 4.8-Mev level in Li^7 is not by gamma-emission but by particle emission —probably breaking up into He^4 and H^3.

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[1] H. E. Gove and J. A. Harvey, Phys. Rev. **82**, 658 (1951).

The Decay of Bi^{207}

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BISMUTH 207 has been prepared by bombarding lead foil with 25-Mev protons in the Harwell cyclotron and extracting the bismuth chemically as bismuth oxychloride. The decay of the bismuth isotopes was followed for 300 days and the Bi^{207} identified by its long half-life and the presence of lead K-radiation resulting from the K-capture decay.

Measurements using a NaI(Tl) scintillation detector show prominent γ-ray lines at 0.56±0.03 Mev and 1.1±0.05 Mev. These can probably be identified with the 0.565- and 1.063-Mev lines reported by Neumann and Perlman.[1] Although the resolution of the scintillation spectrometer is less than that of the β-ray spectrograph, the former has the advantage that the measured magnitude of the peaks is simply related to the γ-ray intensities provided that the γ-rays are only weakly converted. We conclude that the two lines are of equal intensity within the experimental error. This suggests that the two γ-rays are emitted in cascade, and coincidences between them were detected using two scintillation counters. A pulse-height analyzer operating on one counter was gated by pulses from the other, and the results show that at least half of the 0.56- and 1.1-Mev γ-rays are emitted in cascade.

Taken with the β-ray spectrograph measurements of Neumann and Perlman[1] these results give the ratio of K internal conversion coefficients. This is consistent with the level assignment given by Goldhaber and Sunyar[2] in which the 1.1-Mev γ-ray is $M4$ and precedes the 0.56-Mev γ-ray which is $E2$ (electric quadrupole). These γ-rays are presumably to be identified with those found by Campbell and Goodrich[3] in the 0.9-sec isomeric state of Pb^{207}.

We are indebted to the Director of A.E.R.E., Harwell, for the cyclotron irradiation, to Mr. C. H. Collie for drawing our attention to this problem, and to Dr. P. F. D. Shaw for assistance with the chemistry.

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[1] H. M. Neumann and I. Perlman, Phys. Rev. **81**, 958 (1951).
[2] M. Goldhaber and A. W. Sunyar, Phys. Rev. **83**, 906 (1951).
[3] E. C. Campbell and M. Goodrich, Phys. Rev. **78**, 640(A) (1950).

Positron Spectra of Certain Mirror Nuclei*

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THE positron energy end points and half-lives of the "mirror" nuclei Mg^{23}, Si^{27}, S^{31}, Cl^{33}, K^{37}, and Ca^{39} have been investigated with a scintillation spectrometer and pulse recording equipment. These nuclei were produced by (γ,n) and $(\gamma,2n)$ reactions induced by 70-Mev x-ray irradiation.

Most of these activities have been studied previously by cloud chamber and absorption techniques.[1–5] The present work provides confirmation of some earlier values, and yields the additional end points of K^{37} and Ca^{39}.

Except in the case of Mg^{23} where magnesium foil was used, sources were prepared from finely-powdered compounds, chosen so as to yield no short-lived high energy activities which might interfere with those of the isotopes being investigated. Each powdered compound was mixed with a small amount of Zapon lacquer, which acted as a binder, and was formed into a thin wafer. This was supported by 0.00025-inch-thick paper covering a ⅛-inch opening in a source holder made of 0.005-inch thick nickel. The surface densities of the samples were 20–30 mg/cm². Background activity due to the source holder was always less than 2 percent of the activity being studied. Samples were irradiated at maximum beam energy for approximately one half-life of the desired activity.

Table I. Observed radiations.

Activity	Compound irradiated	Half-life (sec)	End point (Mev)	*ft* (sec)
Mg^{23}	Mg	12.3±0.4	2.99±0.09	4670±720
Si^{27}	SiO_2	5.4±0.4	3.48±0.10	3740±630
S^{31}	S	3.2±0.3	4.06±0.12	4320±770
Cl^{33}	NH_4Cl	1.8±0.1	4.43±0.13	3440±550
K^{37}	KI	1.2±0.2	4.57±0.13	2700±610
Ca^{39}	CaF	1.1±0.2	5.13±0.15	3990±940

By use of a pneumatic tube the irradiated samples were transferred from the x-ray beam to an anthracene scintillation spectrometer in about 0.1 second. Each disintegration detected was displayed in the form of a dot on an oscilloscope screen which was photographed on a rapidly moving film.[6] The height of the dot above the base line was proportional to the amplitude of the light pulse produced by the scintillation crystal. An amplitude analysis of these dots provided an energy spectrum and a time analysis yielded a decay curve. The amplitude analysis was calibrated by comparison with the β-end points of Y^{90} at 2.25±0.03 Mev[7] and Cl^{34} at 4.45±0.11 Mev.[8] Resolution corrections involving the first and second derivatives of the number of counts *vs* amplitude curve were applied to the data.[9]

Table I gives the compounds irradiated, half-lives, end points, and *ft* values for the activities. End points were obtained with the aid of Fermi plots. The values for half-life were obtained by observing approximately three half-lives of each activity. Values of *ft* were obtained by use of the graphs by Feenberg and Trigg.[10]

Reasonable agreement with positron energies calculated from available coulomb repulsion energy[11] is obtained. Increased accuracy may be expected with this technique when more preise magnetic spectrometer measurements of high energy beta-spectra become available for calibration use.

A value of $r_0 = (1.40 \pm 0.07) \times 10^{-13}$ cm for the nuclear radius is indicated from this work.

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[1] White, Delsasso, Fox, and Creutz, Phys. Rev. **56**, 512 (1939).

[2] White, Creutz, Delsasso, and Wilson, Phys. Rev. **59**, 63 (1941).

[3] D. Elliott and L. King, Phys. Rev. **60**, 489 (1941).

[4] Barkas, Creutz, Delsasso, Sutton, and White, Phys. Rev. **58**, 383 (1940).

[5] McCreary, Kuerti, and Van Voorhis, Phys. Rev. **57**, 351 (1940).

[6] The detailed experimental equipment and procedure will be described in AEC report ISC-154.

[7] E. Jensen and L. Laslett, Phys. Rev. **75**, 1949 (1949).

[8] L. Ruby and R. Richardson, Phys. Rev. **81**, 659 (1951).

[9] J. Palmer, unpublished thesis, Iowa State College (1950).

[10] E. Feenberg and G. Trigg, Revs. Modern Phys. **22**, 399 (1950).

[11] E. Wigner, Phys. Rev. **51**, 947 (1937).

An Anomalous Effect in the Ultrasonic Absorption of Electrolytic Solution*

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In both theoretical and experimental studies of ultrasonic absorption in electrolytic solutions, it has been the custom to treat the absorption coefficient as the sum of the coefficient due to the solvent alone and that due to the solute.[1-3] These two contributions have then been treated independently, under the assumption that they are additive.

It has recently been suggested† that these quantities may not be additive. The following experimental results, obtained in the course of a general study of ultrasonic absorption in electrolytes, support this hypothesis.

The amplitude absorption coefficient α has been measured in aqueous solutions of sodium acetate, by means of the radiation pressure method, in the frequency range 9 to 45 megacycles. The results are shown in Fig. 1, in which the value of α/ν^2 (ν = sound frequency) is plotted against log ν. Measurements have been made at 20°C in 0.1 and 0.2 molal solutions, and at 5°C and 10°C in 0.2 molal solutions.

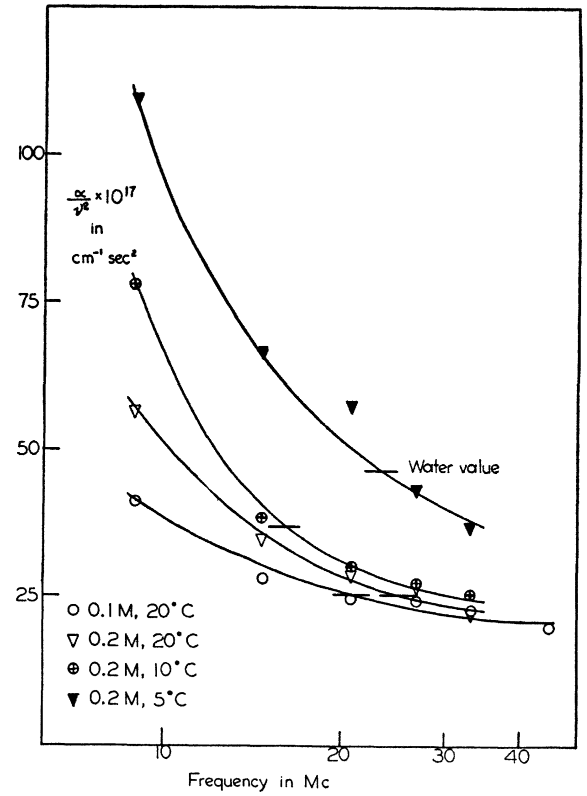

Fig. 1. Ultrasonic absorption in aqueous solutions of sodium acetate.

The average value of α/ν^2 for water at each temperature has been computed from published measurements.[4-6] These values are indicated in the figure by a horizontal bar through each curve at the appropriate point. (It should be recalled that α/ν^2 is independent of frequency for water at all frequencies so far studied.)

The results indicate that the absorption coefficient for these solutions varies from a value considerably above that of water at the low frequencies, to a value which is lower than the corresponding value of the absorption coefficient in water at the higher frequencies. At the highest frequency measured, (45 Mc), α for the solution was about 20–30 percent below α for pure water. The relative decrease in the absorption coefficient appears to be greater at the lower temperatures.

The measurements thus far are insufficient to indicate the concentration effect of the phenomenon. A few measurements made in 0.05 molar solution indicate that the effect is very small at such a concentration.

It is apparent from these results that some sort of extra absorption process due to the presence of the solute exists at the lower frequencies. The explanation of the high frequency effect would appear to lie in a disruption of the simple two-state process hypothesized by Hall[7] in order to explain the observed absorption coefficient for water.

In the Hall theory, water is considered as a mixture of molecules in an ice-like arrangement and molecules which are closely packed. The passage of the sound wave upsets the equilibrium between the two states and the resultant structural relaxation produces the sound absorption. The presence of the solute contributes an additional absorption, due presumably to some sort of