actual magnitude is not markedly affected by the form of the dispersion relation and is roughly that of the observed anisotropy.

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Relativistic and Screening Effects in Radiative Electron Capture

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(Received October 26, 1955)

THE continuous gamma-ray spectrum (inner bremsstrahlung) accompanying orbital electron capture was recently investigated theoretically.[1] This theory takes the p-electron capture as well as the s-electron capture and the Coulomb effects into consideration and gives a better agreement with experiments in the low-energy region than earlier theories.[2,3] A check of the theory was subsequently made[4] by investigating the inner bremsstrahlung from A^{37} by the method of scintillation spectroscopy with particular emphasis on the low-energy region.

A general formulation of the problem of radiative capture from the various electronic states has been made.[5] According to this theory, the general expression for the radiative events ω_k per 1S-electron capture $(\omega_c)_{1S}$ can be written, in the absence of relativistic and screening effects, as

$$\frac{\omega_k dk}{(\omega_c)_{1S}}=\frac{\alpha}{\pi}\sum_l\left(\frac{Z^2\alpha^2}{2}\right)^2\left[1-\frac{x-(E_l-E_{1S})}{x_{\max}}\right]^2 I_l(x)dx, \quad (1)$$

where x is the photon energy given in units of Z^2 ry $=Z^2\times 13.5$ ev; $x_{\max}$ is the upper limit of the photon energy; E_l is the ionization potential for the l-electron, and $I_l(x)$ is a tabulated function. The summation has been carried out for $l=1S$, $2S$, $2P$, and $3P$. In Fig. 8 of reference 4 is shown the application of this theory to the inner bremsstrahlung from A^{37}. The agreement down to 100 kev is excellent. As predicted by the theory, the experimental distribution does show a sudden increase at around 30 kev. However, the experimental points below 100 kev lie below the theoretical curve. This discrepancy was found also for the inner bremsstrahlung from Fe^{55} by Madansky and Rasetti (Fig. 9, reference 4).

In order to explain these discrepancies, the calculations have recently been performed[5] taking account of the relativistic effects for the S-state spectrum, and including correction factors for screening. Both the

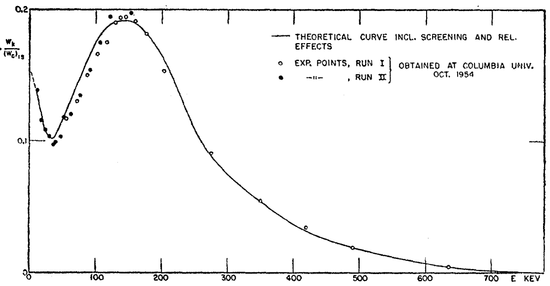

FIG. 1. Inner bremsstrahlung from A^{37}.

relativistic and screening corrections are energy- and charge-dependent, but the variation of the latter with energy is very small. The general expression (1) can therefore be written

$$\frac{\omega_k dk}{(\omega_c)_{1S}}=\frac{\alpha}{\pi}\sum_l\frac{S_l(Z)}{S_{1S}(Z)}R_l(x,Z)\left(\frac{Z^2\alpha^2}{2}\right)^2 \times\left[1-\frac{x-(E_l-E_{1S})}{x_{\max}}\right]^2 I_l(x)dx, \quad (2)$$

where $S_l(Z)$ is the screening correction factor for the lth electron and $R_l(x,Z)$ is the relativistic correction factor for the energy x and charge Z. The numerical values for these correction factors were determined.

The experimental data[4] on A^{37} have been used in a comparison with the theory given by formula (2). The treatment of the data is exactly the same as before,[4] i.e., the experimental points are corrected only for background and the theoretical curve is corrected for the various effects in the NaI scintillation counter. Figure 1 shows the result. The agreement is now excellent over the whole energy region.

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Decay of Co^{61} and Cu^{61}†

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(Received November 28, 1955)

THE decay of 1.66-hr Co^{61} and 3.33-hr Cu^{61} was investigated in this institute with β- and γ-scintillation spectrometers in various coincidence setups, with the following results. Co^{61} was found to decay into a 70-kev excited state of Ni^{61} by emission of an electron spectrum with a maximum energy of 1220 ± 40 kev and a half-life of 1.66 ± 0.01 hr. $95\pm15\%$ of the electron decays lead to the 70-kev level. An upper limit of less than $\frac{1}{2}\%$ could be set to the intensity of any other γ ray between 400 and 660 kev.[1] The decay of Cu^{61} is accompanied by γ rays of 70 ± 1, 280 ± 3, 380 ± 10, 580 ± 20, 660 ± 10, 940 ± 50, 1150 ± 50, and 1220 ± 50 kev with intensities of $4\pm1\%$, $12\pm2\%$, $2\frac{1}{2}\pm1\%$, $1\frac{1}{2}\pm\frac{1}{2}\%$, $11\pm2\%$, $1\frac{1}{2}\pm\frac{1}{2}\%$, $1\pm\frac{1}{2}\%$, and $5\pm2\%$ per decay respectively; γ-γ and β-γ coincidence measurements indicated the decay scheme given in Fig. 1. It is curious

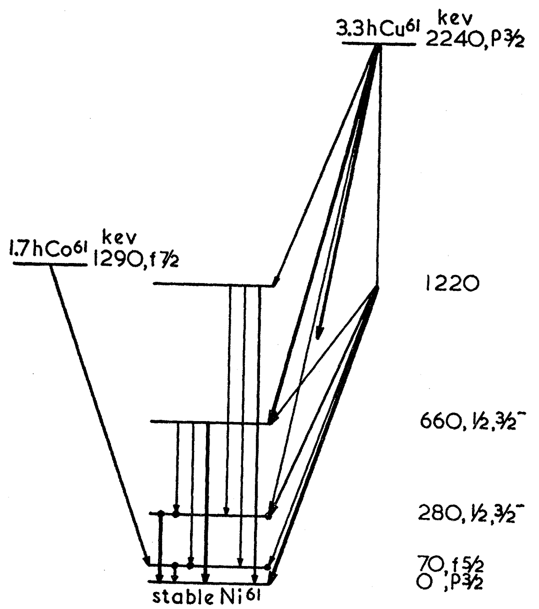

FIG. 1. Decay scheme of Co^{61} and Cu^{61}. Successful coincidence measurements are indicated.

to note that the excitation energies of the levels found in Ni^{61} deviate less than 5% from the simple formula $E_n=73n^2$ kev. A similar structure is found in the level scheme of Zn^{67},[2] where the levels fit the formula $E_n=23n^2$ kev ($n=2$–6) with about equal precision.

The positron spectrum of Cu^{61} was measured with care in a magnetic lens β-ray spectrometer and found to consist of three components with maximum energies of 1220 ± 15, 940 and 560 kev with intensities of $51\pm5\%$, $5\pm1\%$ and $3\pm1\%$ per decay: this measurement was not sufficiently precise to show the ($\sim2\%$ intensity) 1150-kev positron branch to the 70-kev Ni^{61} state that is present according to scintillation β-γ coincidence measurements. These results are compatible with the γ-ray measurements and the theoretical electron capture to positron emission ratios;[3] the total capture to positron ratio is 0.68.

The nuclear shell model assignments $f_{7/2}$, $p_{3/2}$, and $p_{3/2}$ for the Co^{61}, Ni^{61}, and Cu^{61} ground states agree with the proposed decay scheme. An assignment $f_{5/2}$ to the 70-kev Ni^{61} state explains both the allowed character ($\log ft=5.1$) of the Co^{61} decay and the l-forbiddenness ($\log ft=6.7$) of the Cu^{61} decay to this state. The 280- and 660-kev states should be assigned $1/2^-$ or $3/2^-$; the 1220-kev state $1/2^-$, $3/2^-$, or $5/2^-$. The experimental K-conversion coefficients 0.11 and 0.004 for the 70- and 280-kev lines (obtained from a comparison of the intensities of the conversion electrons with the total positron spectrum in the magnetic lens and of the γ rays with the total annihilation radiation) point to an $M1$ character for these γ rays, in agreement with the proposed level assignments in Fig. 1.

A more elaborate report of our measurements and a comparison with older measurements will be published elsewhere.

We thank Professor A. H. W. Aten, Jr., for his interest in this work, Mr. L. Lindner and Miss E. Klopper for the chemical separations and the crew of the Philips Synchrocyclotron for the many irradiations.

† This work is part of a program of the Foundation for Fundamental Research of Matter (F.O.M.) of the Organization of Pure Scientific Research (Z.W.O.).

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Halo of Radio Emission and the Origin of Cosmic Rays

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(Received November 21, 1955)

RECENT observations of radio emission in the Andromeda nebula ($M31$)[1] and on the background radiation from our own galaxy[2] (at a frequency of 81.5 Mc/sec) have shown that a considerable fraction of the radiation ($\sim\frac{2}{3}$ for $M31$), comes from roughly spherical regions centered on the galactic centers and having radii of the order of 15 kiloparsecs. An explanation of these results is that the emission is synchrotron radiation emitted by relativistic electrons moving in random magnetic fields in these halo regions. This then suggests that there is a much more widespread distribution of diffuse matter and magnetic field normal to the galactic planes than has previously been supposed. These ideas have previously been proposed by Russian astrophysicists.[3]

An analysis of the data of Baldwin, using the equations for the frequency and power emitted in the synchrotron mechanism, the stability of the sphere,