Radiations of 34-Day Xe^{127}†

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The gamma rays of Xe^{127} have been studied in a sodium iodide scintillation spectrometer and by gamma-gamma coincidence techniques. The results support a decay scheme published previously by Bergström.

XENON-127 exists in two isomeric forms with half-lives of 75 seconds and 34 days, respectively. A recent publication from our laboratory has discussed the 75-second Xe^{127m}.[1]

The 34-day Xe^{127} has been previously studied by several workers, but in great detail by Bergström.[2] Bergström studied the electron spectrum of mass-separated Xe^{127} and reported gamma rays at 56, 145, 170, and 200 kev. His scintillation spectrometric studies did not resolve the gamma rays of energies 145, 170, and 200 kev, but he found an additional gamma ray (at 368 kev), the conversion electrons of which were not detectable in a beta-ray spectrometer. Bergström proposed a tentative decay scheme reproduced in Fig. 3 below.

During the course of some other studies on the isotopes of xenon[1,3] it was convenient to make some measurements of the gamma radiations of Xe^{127} with sodium iodide crystals and gamma-gamma coincidence techniques. The results complement the beta-ray spectrometer studies of Bergström and support his tentative decay scheme.

We prepared Xe^{127} by the (p,n) reaction on I^{127} in the linear accelerator. The iodine was bombarded in the form of potassium iodide. After bombardment, xenon was isolated on 0.1-mil aluminum foil by the glow-discharge method described in previous publications.[1,3]

A sodium iodide-photomultiplier assembly coupled to a 50-channel pulse-height analyzer[1] was used to study the gamma spectrum of Xe^{127}. The results are shown in Fig. 1. Photopeaks at 56, 170, 200, and 368 kev were observed in agreement with Bergström.[2] The small peak at 75 kev is due to lead x-rays produced by the lead castle enclosing the sodium iodide-photomultiplier assembly and the Xe^{127} sample. The peak at 110 kev is due to the backscattered radiation of the most prominent gamma peak (at 200 kev) in the gamma spectrum of Xe^{127}. The gamma ray of 145 kev reported by Bergström was not detectable in the gamma spectrum because of its low intensity, but it was observed in our gamma-gamma coincidence studies (see below). No annihilation radiation was observed, indicating that 34-day Xe^{127} decays entirely by electron capture.

Gamma-gamma coincidence measurements were carried out on the equipment mentioned in a previous paper.[1] These studies established that a 56-kev gamma ray was in coincidence with 145- and 170-kev gamma rays and with 28-kev iodine x-rays, as suggested by Bergström[2] because of the fact that the sum of the energies of 145 and 56 kev is 201 kev. In agreement with this, the 200-kev radiation is not in coincidence with the 56- and 145-kev gamma radiations but is in coincidence with the 170-kev gamma ray and the 28-kev iodine x-radiation. Quantitative studies indicate that the 56-kev level should be below the 145-kev level, while the 170-kev radiation should be higher than the 200-kev radiation. For example, in the study of the 170 to 200 kev coincidence, the ratio of coincidence pulses to gate pulses was greatly increased when the gamma ray selected by the

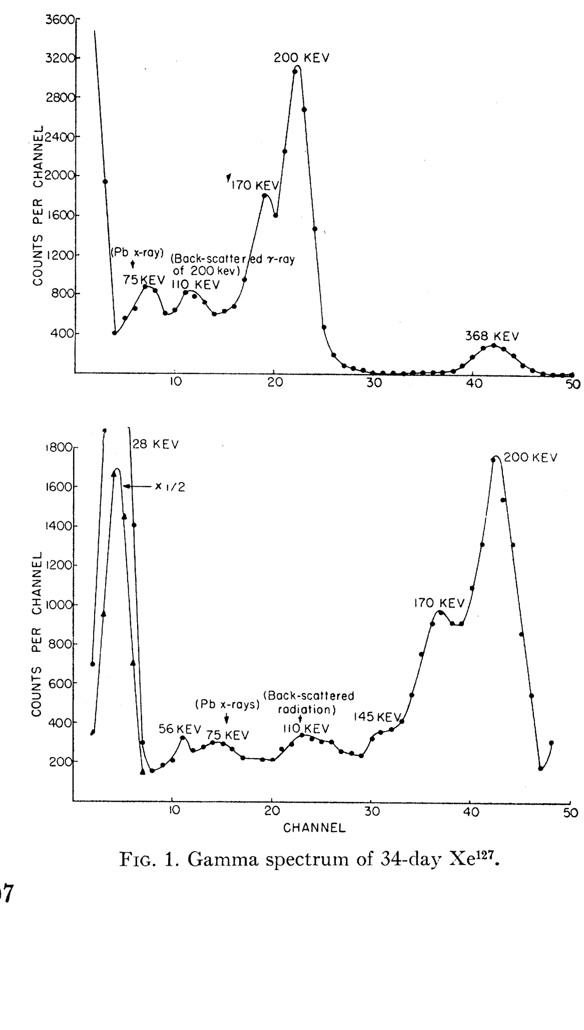

FIG. 1. Gamma spectrum of 34-day Xe^{127}.

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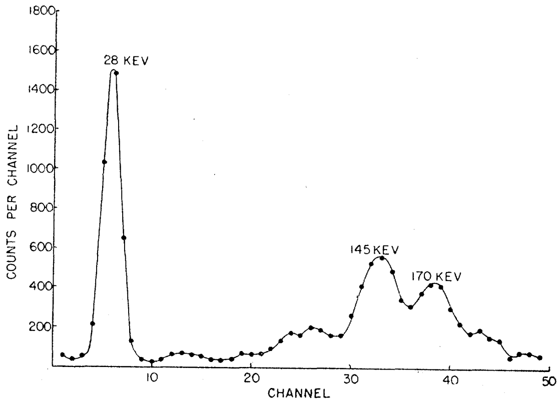

FIG. 2. Gamma spectrum of Xe[127] showing the gamma rays in coincidence with the 56-kev gamma ray.

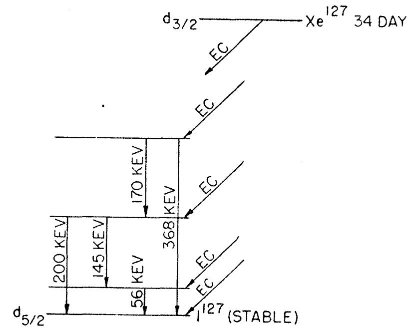

FIG. 3. Proposed decay scheme of Xe[127].

gate crystal was changed from 200 to 170 kev. The 368-kev gamma ray was in coincidence with the 28-kev iodine x-rays and with no other gamma rays. Since most of the coincidence measurements were straightforward the curves are not presented. In Fig. 2 the gamma spectrum in coincidence with the 56-kev gamma ray is shown because it indicates that the 145-kev gamma ray is clearly evident. This gamma ray was not resolved in the gamma curves of Fig. 1. All coincidence results are incorporated in the decay scheme of Fig. 3 which agrees with that proposed by Bergström.[2]

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Internal and External Bremsstrahlung in Connection with the Beta Decay of S^{35}

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The *internal* bremsstrahlung, emitted in the β decay of S^{35}, was investigated with a NaI scintillation spectrometer. Neither the shape of the spectral distribution nor the absolute yield was found to agree with theory. At 50 kev the experimental photon yield was 65 percent greater than the theoretical. At 100 kev it was even 180 percent greater. The total photon energy yield per β decay, $2.23\times10^{-5}\,mc^2$, was 35 percent greater than the calculated value.

The *external* bremsstrahlung, emitted when the β particles from S^{35} were stopped in matter, was also investigated with the same apparatus. With elements of low atomic number the experimental values agreed with those calculated. In experiments using elements of higher atomic numbers, however, the experimental values differed widely from those calculated, the difference increasing with the atomic number. Thus, for lead at 50 kev the experimental value was 60 percent greater than the theoretical, and at 100 kev it was 170 percent greater.

I. INTRODUCTION

STUDIES are available of the continuous electromagnetic radiation accompanying β decay, i.e., the internal bremsstrahlung (IB), and of the radiation emitted when β particles are stopped in matter, i.e., the external bremsstrahlung (EB), of β emitters with disintegration energies above 1 Mev. Thus at this laboratory[1] IB and EB were investigated in experiments using P^{32} (E_β^{max} 1.70 Mev). The scintillation spectrometer was used because of its good γ-detection efficiency. (Readers interested in a fairly complete list of references of investigations bearing on the problems under consideration are referred to Lidén and Starfelt.[1])

The present paper is concerned with an investigation of a β emitter with low disintegration energy. The investigation, which was carried out with S^{35} ($E_\beta^{max}=168$ kev) by means of a scintillation spectrometer, included the determination of the spectral distribution and the total radiation energy yield of both the IB and the EB

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