\[ N_r = D \cdot G \cdot (\eta_t - g \cdot \eta_n), \quad (4) \]
these being the single-energy peaks corrected for counts lost in their sumpeak [Eqn (a)]. Equations (3), (4), and (a) then yield Eqn (2).

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Reply

The calculation of the activity of an I-125 source (1) from measurements of the pulse-height spectrum—in particular using the sum peak—was carried out using the classical coincidence-counting approach (2), since all observed photons are included in the photopeak and sum peak. The counting rates used were sufficiently low that random coincidences were negligible.

Let us consider \( N_0 = A \cdot \varepsilon_0 \) (a), and \( N_r = A \cdot \varepsilon_r \) (b), where \( A \) is activity, \( \varepsilon_0 \) and \( \varepsilon_r \) are the probabilities of detecting an event following a disintegration, \( N_0 \) is the counting rate for one component of a coincident pair, and \( N_r \) is the rate for the other. Let \( N_m \) be the coincidence rate. When the detection of two such coincident events is otherwise uncorrelated, the probability of detecting them in coincidence is the product of the individual detection probabilities. Thus, \( N_m = A \cdot \varepsilon_0 \varepsilon_r \) (c). Combining expressions (a), (b), and (c), \( A = N_0 N_r / N_m \) (d).

In the case of iodine-125, emission of the coincident photons is assumed to be isotropic without angular correlation, since the K-capture branch results completely from de-excitation of the atom, rather than directly from nuclear processes. Similarly, the events associated with the coincident decay from the 35-keV level (\( T_{1/2} = 1.6 \) ns), which follow the K capture, result in emissions that are 90.7% K fluorescent photons and 9.3% unconverted gammas. It appears impossible that any angular correlation could exist under such circumstances, and to the best of our knowledge, none has been reported.

In the spectrum of I-125 the single primary photopeak contains the K fluorescent photons resulting from K capture and those from internal conversion in the K shell following K and L capture, as well as the unconverted gamma photons. These are not resolvable with NaI(Tl). The sum-peak counting rate, \( N_{\text{sum}} \), represents events in which two coincident photons are detected simultaneously, i.e., \( N_{\text{sum}} = N_{\text{m}} \).

The total detection rate, \( N_r \), is thus equal to the photopeak rate plus twice the sum-peak rate.

Let \( \beta \) be the number of K x-rays emitted per disintegration, following K capture. This is the product of the K-capture fraction, 0.813 (3), and the fluorescence yield, 0.855 (4). Let \( \eta_t \) be the number of photons emitted during the coincident \( \gamma \) decay. This is the product of the K-capture fraction, 0.813, the K-conversion fraction 0.80 (5), and the K fluorescence yield, 0.855 (4), plus the product of the K-capture fraction 0.813 and the unconverted gamma abundance 0.0666 (6). The total number of emitted K and \( \gamma \) photons per disintegration is \( \beta = 1.4669 \) (5). Thus, \( N_r = \frac{\eta_t}{\eta_t} N_r \) and \( N_0 = \frac{\eta_t}{\eta_t} N_0 \).

Substitution in Eqn (d) gives the activity at the point where the coincident branching occurs, i.e., the product of total activity and the K-capture fraction:

\[ A = \frac{N_0}{2.04} \frac{N_r^2}{N_{\text{sum}}} \]

as reported previously, with a slight correction introduced by the more recent abundance figures (5). Under the conditions of I-125 decay, the independent detection probability of the two coincident photons permits the statement, objected to by van Damme, that \( \eta_t = \eta_t \) (van Damme’s notation). Measurements in a deep well crystal, where the geometry approaches 4\( \pi \), would remove even this theoretical objection.

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