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Gamma-ray spectrum of Chernobyl fallout

SIR—The activity in Oxfordshire due to the plume of radioactive material released from the Chernobyl reactor reached a peak on 2 May[1]. On 8 May we examined the 'Polyfoam' air filters routinely used in our laboratory air supply system and monitored a small but distinct amount of β- and γ-radiation activity. We have measured the γ-ray energy spectrum from the filters using a high-efficiency (40%) germanium detector, shielded from room background.

Figure 1 shows the complex γ-ray spectrum from the filters. The background is due to Compton-scattered γ-rays, which do not deposit their full energy in the detector. An analysis of the full-energy peaks yields a definite identification of 16 radioisotopes, with a further three (weaker) tentatively identified radioisotopes. The activity of each radioisotope is categorized as strong or weak in Table 1. The relative activities for the most prominent isotopes vary significantly from those deduced by Fry *et al.*[1], which serves to emphasise that these coarse filters were not designed to collect fallout products. The measured activity of ~ 2,000 Bq m^{-2} of ^{131}I on each 0.1m^2 filter suggests that ~ 1% of the local iodine activity[1] was deposited by the air flow of 2×10^4 m^3 per day.

Table 1 Relative γ-ray activities of radioisotopes measured in laboratory air filters

Isotope	Relative activity*	Half-life
^{131}I	S	8 d†
^{137}Cs	S	30 yr
^{132}Te	S	3 d
^{132}I	S	2 h
^{103}Ru	S	39 d
^{134}Cs	S	32 yr
^{106}Ru	S	367 d
^{140}Ba – ^{140}La	S	13 d–40 h
^{136}Cs	W	13 d
^{95}Zr – ^{95}Nb	W	64–35 d
^{141}Ce	W	33 d
^{99}Mo	W	3 d
^{144}Ce	W	284 d
^{129}Te^m	W	33 d
[^{127}Sb]	[W]	4 d
[^{105}Rh]	[W]	1.5 d
[^{143}Ce]	[W]	1.5 d

*Identified radioisotopes are listed in order of activity. Isotopes with activities greater than 10% that of ^{131}I are labelled strong (S) and those with activities less than 5% are labelled weak (W). † Days.

All of the identified radioisotopes are ^{235}U fission decay products. The criteria for observing a particular fission product in such a simple γ-decay experiment are: (1) the feeding mass chain should have a lifetime ⩾ 1 day and ⩽ 500 yr; (2) the fission yield should be ⩾ 0.5% for the mass chain; (3) the β-decays should significantly populate excited nuclear states which subsequently γ-decay. Using these simple criteria, we find that all of the expected mass chains are accounted for, except masses 133 and 147, whose identifications are made difficult by the complexity of the spectrum.

Most of the activity (70%) will decay over the next month and the levels will approach those measured normally from the natural thorium and radium background. Air-supply filters with greater air flows or greater capture efficiency will have proportionally greater activity.

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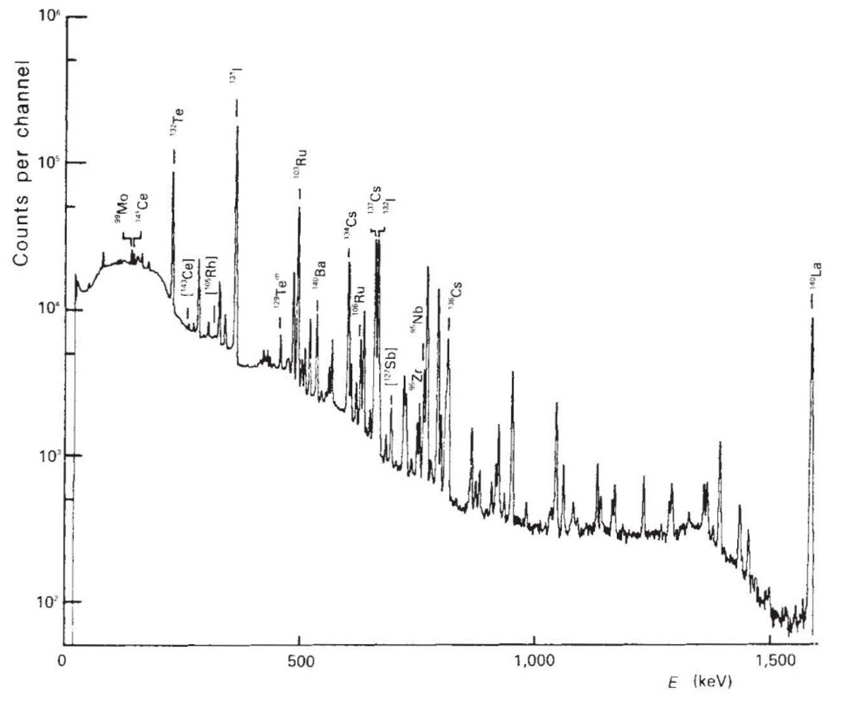

Fig. 1 Part of the γ-ray spectrum obtained with a Ge(Li) detector from a typical air filter. The strongest identified peak of each radioisotope is labelled.

Q1146+111B,C quasar pair: illusion or delusion?

SIR—The quasar pair Q1146+111B,C[1] has been re-observed by Turner *et al.*[2] who argue that it comprises two gravitationally lensed images of a single source. In this letter, we show that we are probably observing two distinct though neighbouring quasars.

Were quasars placed randomly on the sky, the probability of finding another quasar of apparent magnitude m within an angle θ of a given quasar would be[3] $P_r(\theta, m) \simeq n\pi\theta^2$, where $n(m)$ is the sky density of quasars brighter than magnitude m. For Q1146+111B,C, θ = 157 arc s, n (18.5) ~ 1 per deg^2 (ref. 4), giving $P_r \sim 6 \times 10^{-3}$. However, quasars are probably not distributed uniformly throughout the Universe, and there is evidence that they are clustered in much the same way as are galaxies[5,6] (but see ref. 7), so their two-point correlation function is $\xi(r) \simeq (r/r_0)^{-1.8}$, where $r_0 = 5(1+z)^{-1}h^{-1}$ Mpc, h = the Hubble constant H_0/100 km s^{-1} Mpc^{-1} and the cosmological density parameter Ω_0 = 1. The probability associated with this excess for a given quasar to have a companion within angle θ brighter than magnitude m is then

$$P_c(\theta,m,z) = 2\pi(1+z)^3 \int_0^{D\theta} db\, b \times \times \int_{-\infty}^{\infty} dl\, \Phi\, \xi[(b^2+l^2)^{1/2}] \quad (1)$$

where $D(z)$ is the angular diameter distance of the quasar, and $\Phi(L,z)$ is the integral luminosity function for quasars with luminosity $L(m,z)$. Now, $\Phi(L,z) = (dn/dz)/D^2(1+z)^{1/2}$ (ref. 8) and observations[4] indicate that for $0.5<z<2$, quasars of a given magnitude are uniformly distributed in redshift with $dn/dz \simeq 0.5n$. Substitution in equation (1) then gives $P_c(\theta,m,z) = 38(1+z)(\sqrt{1+z}-1)\theta^3\xi(\theta D)dn/dz$ for $D\theta \leqslant 2r_0$, where n is per steradian and θ in radians. Numerically, $P_c \sim 2 \times 10^{-4}$.