with, but not necessarily uniquely indicative of, substantial variability in the solar luminosity on time scales $\sim 10^8$ yr. The fact that the Praesepe stars are approximately uniformly distributed through the width of the main sequence suggests that the excursion time off the main sequence is comparable with the time between mixings. Improved observation of Praesepe —and, possibly, M39 and the Ursa Major cluster— can shed further light on this problem. To the extent that climatic change caused by major solar variability produced major evolutionary advances on Earth, comparable biological evolution could have occurred on all other inhabited planets in the Galaxy.

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Effect of Low-level Radioactive Silver on Photographic Emulsions

LINDNER *et al.*[1] described the detection of low levels of radioactivity in silver bullion bars. Because this silver may be used in the manufacture of photographic emulsions the effects of the radioactivity are obviously of concern to photographic film manufacturers. We consider here the storage of photographic materials containing silver of the radioactivity level (10^{-4} μCi/g silver) given by Lindner *et al.*

We illustrate this point by calculating the rate of fogging that would result in a highly sensitive X-ray film for materials testing. Typically, such a film will be coated with about 2.3 mg of silver cm^{-2}. The silver bromide grains will have a diameter of about 1.5 μm. If such a film is irradiated with about 80 mR of γ-rays (0.3–2 MeV) an increase in optical density of about 0.3 will be the result. In a normal environment background, dose rate from cosmic radiation and radioactivity in the surroundings will be 80–100 mR yr^{-1}. Film manufacturers and users will rule out a film which, during storage, has obtained a fog level of optical density 0.3.

The film we describe will have about 3.5×10^8 grains cm^{-2}. With 10^{-4} μCi g^{-1} silver one will have a radioactive decay in 2.7×10^5 grains cm^{-2} $/yr^{-1}$. Thus about one per thousand of the grains will be directly involved in each year. If every radioactive decay involved one grain only, there would be no serious fogging, but the question "How many are involved ?" is not a trivial one.

As a first step, the decay of ^{110m}Ag can be simplified. We will assume: for βs 0.087 MeV (6.1%), 0.520 MeV (26%) and 1.5 MeV (0.6%); for γs 0.67 MeV (127%), 0.88 MeV (139%) and 1.4 MeV (38%). The 0.087 MeV β-rays will only involve one grain. The amount of silver involved with the 0.529 βs we will leave open.

To calculate the effect of the γs we assume that the film is stacked with fifty sheets per cm thickness. If film and polyester film base were to be ground together, we would get a substance with a density of about 1.5 g cm^{-3} and with absorption coefficients μ_s of 0.105 cm^{-1} (0.67 MeV), 0.090 cm^{-1} (0.88 MeV), and 0.072 cm^{-1} (1.4 MeV). The radioactivity of this substance would be 0.43 d.p.s. per cm^3, and result in a photon emission S_v of 0.56 s^{-1} cm^{-3} (0.67 MeV), 0.61 s^{-1} cm^{-3} (0.88 MeV) and 0.167 s^{-1} cm^{-3} (1.4 MeV). The photon flux in the centre of an infinite slab source of homogeneous activity is

$$\varphi = B\, S_v[1 - E_2(\mu_s d)]/\mu_s$$

where B is the build-up factor, $E_2(\mu_s d)$ is the exponential integral of the second order and the thickness of the slab is $2d$. If d is about 15 cm, $\mu_s d$ will be > 1; $E_2(\mu_s d) \sim 0.1$, so that $[1-E_2(\mu_s d)]$ can be neglected. Neglecting the build-up factor for the time being we obtain

$$\varphi \sim S_v/\mu_s$$

and with the data given we obtain photon fluxes of 5.3 s^{-1} cm^{-2} (0.67 MeV); 6.8 s^{-1} cm^{-2} (0.88 MeV); and 2.3 s^{-1} cm^{-2} (1.4 MeV) to give dose rates of 7×10^{-6} R h^{-1} (0.67 MeV); 12×10^{-6} R h^{-1} (0.88 MeV); and 6×10^{-6} R h^{-1} (1.4 MeV). Adding these fluxes gives a dose rate of 210 mR yr^{-1}. This result is obtained without taking a build-up factor of, perhaps, 2–5 into consideration. Strong fogging in this case is evident.

Workers requiring very sensitive emulsions must hope that the case described by Lindner *et al.* will be an isolated incident. Or will we have to purchase low-level counting equipment for raw materials control ?

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Radioactive Silver in East European Silver Bars

THE discovery of slightly radioactive silver in the form of the isotopes ^{108m}Ag and ^{110m}Ag in East European silver bars[1] is of considerable interest, because so far as is now known these short-lived radioactive isotopes have not been observed in natural materials[2]. Lindner *et al.*[1] have given four possible explanations for the presence of the radioactive isotopes, one of which is that the silver ore was mined by an underground nuclear explosion. An alternative natural explanation for the phenomenon seems more probable.

Some of the silver deposits in Eastern Europe contain uranium, chiefly as pitchblende. Most of these are veins and not particularly amenable to nuclear mining. Those in the Bohemian massif (Jáchymov) are well known and there are others in the Příbram area of Czechoslovakia and in the Tertiary and older rocks in the great metalliferous belt that extends through a number of Eastern European countries to the Black Sea.

The production of the ^{108m}Ag and ^{110m}Ag isotopes is essentially caused by slow neutron bombardment, the neutron capture reaction involving ^{109}Ag and ^{110}Ag being

^{109}Ag$_{(n,2n)}$ ^{110m}Ag