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X-RAYS ASSOCIATED WITH U_{234}

by

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ABSTRACT

The observation of L and M X-rays from U^{234} unaccompanied by appreciable K - X radiation is reported. The suggestion is made that these arise from recoil atoms following alpha emission.

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We should like to report the observation of X-rays associated with U234. L and M X-rays were found to occur spontaneously, the yield of the former, per alpha particle, being between one-third and two. Detection was accomplished by means of a thin-walled Geiger counter. The efficiency of the tube was between 0.25% and 1%, making the quantitative determination of yield uncertain as indicated. Adsorption curves in aluminum were measured to determine the energy of the L radiation. Film and counter wall adsorption made it impossible to obtain much information on the M X-rays.

The source of the X-ray was a thin film of U_3O_8 containing 0.245 mg of U_{234} plated on a 22 cm 2 disc. Other materials present contributed only 4% of the total alpha activity. The U_3O_8 film was prepared and counted within four hours after the removal of the natural decay products (UX_1, UX_2, UY, UZ). Figure 1, Curve A shows the results of an aluminum absorption experiment run on this source. In addition to the points shown, one millimeter of lead as absorber gave less than three counts per minute above background. The chief component found shows an absorption characteristic of the L X-rays of thorium or uranium as closely as we were able to determine. The M X-ray has not been identified as decisively but the presence of a soft component with the appropriate absorption coefficient has been shown in this work (Figure 1, Curve A) and in earlier experiments done in cooperation with Mr. L. E. Glendenin of the Monsanto Chemical Company. The absence of detectable K radiation was particularly notable in this work.

A second set of aluminum absorption measurements was made using a solution of the same quantity of uranium as nitrate in 20 ml of solution contained in a shallow dish and of uniform depth, 0.78 cm. These measurements (Figure 1, Curve B) show no change in the absorption characteristics of the radiation. The intensity relative to Curve A was 0.54. Calculating the effective intensity for 13 kev radiation from point sources distributed uniformly through the solution gives 0.51. This experiment together with the high yield of X-rays leads us to conclude that we are not dealing with a delta ray effect.

Our interpretation is that the L and M X-rays observed arise from rearrangement of the electrons in the recoil atoms, after alpha emission. The energy of these recoils is readily calculated to be about 82 kev by applying the law of conservation of momentum and the measured alpha energy of 4.76 mev[1]. This energy is insufficient to excite the K shell electrons (K limit = 100.4 kev)[2], but more than adequate to ionize the L and higher orbital electrons (L_{22} limit 16.3 kev)[2]. An adequate quantum mechanical treatment of such excitation by recoil has not come to our attention.

Dr. S. De Benedetti has pointed out the failure of Curie-Joliet[3] to observe K shell X-rays from polonium. Other natural alpha emitters are accompanied by interfering beta and gamma radiation to an extent sufficient to make observation of those recoil X-rays improbable.

1. G. T. Seaborg, Rev. Mod. Phys. 16, 1, (1944).
2. I. C. T. VI, 39.
3. Jour. Phys. et Rad. 7, II, 20 (1931).

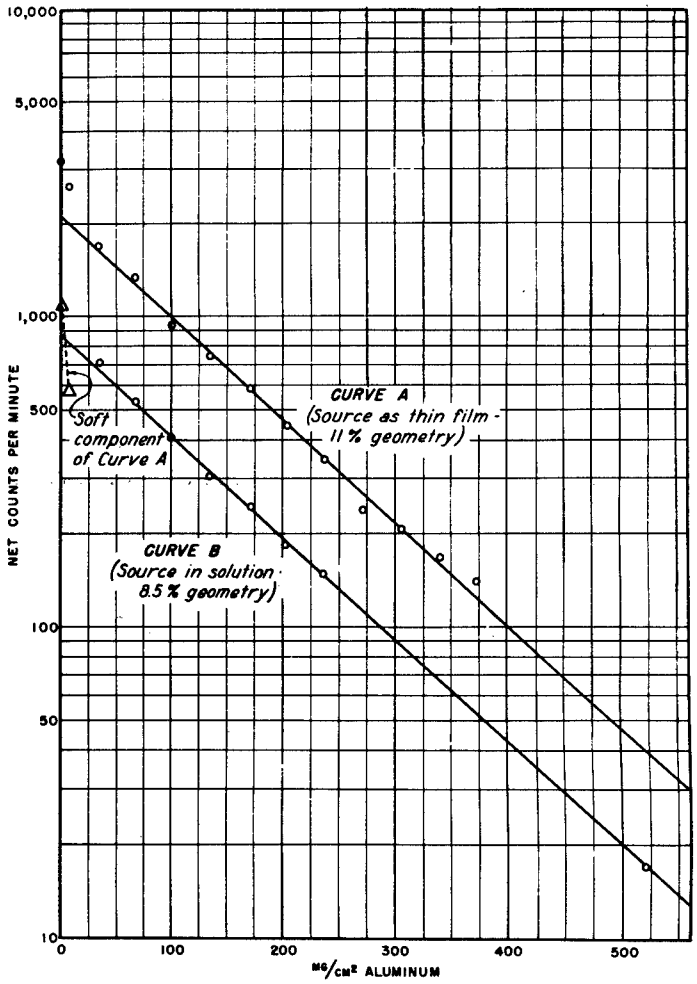

FIGURE 1

X-RAY ABSORPTION BY ALUMINUM