Gamma-Rays from Uranium Activated by Neutrons

A search has been made for gamma-rays emitted during the bombardment of uranium by neutrons. Uranium nitrate enclosed in a lead envelope 3 cm×12 cm and 0.85 mm thick was waxed to the inside wall of a cloud chamber filled with air and alcohol vapor in a magnetic field of 1500 gauss and bombarded with neutrons produced by 350 kilovolt deuterons on a heavy ice target. Out of 532 photographs 118 beta-ray tracks with energies in excess of 2.2 Mev were measured. The majority of the tracks originated in the walls of the chamber (or perhaps in the heavy material outside) and are attributed to recoils from gamma-rays and not to betas coming directly out of the uranium.

The experiment was repeated with the same amount of lead in the chamber but without the uranium. There were 238 photographs made and 23 recoils were measured whose energies exceeded 2.2 Mev. In Fig. 1 is plotted an integral curve for each of the runs. The upper curve shows the results with uranium in the cloud chamber. The lower curve represents the results without the uranium reduced to the same number of photographs as the upper curve and to approximately the same neutron intensity. (An estimate of the relative neutron intensities in the two experiments was made by comparing the number of recoil protons observed in an equal number of pictures. The ratio of the number of recoil protons without uranium to the number with uranium in the chamber was 1.5.)

Part of the difference in the number of low energy gamma-rays in the two cases might be attributed to radiative neutron capture in the uranium, but it seems quite clear that certainly the gamma-rays above 4 or 5 Mev are associated with the fission process, and probably are emitted by the excited products of the ruptured uranium nucleus. If in the products of the uranium disintegration, as in other excited nuclei, the gamma-ray energy is distributed over several quanta, one can conclude that these nuclei are in a very highly excited state after the fission in view of the high energy gamma-rays observed.

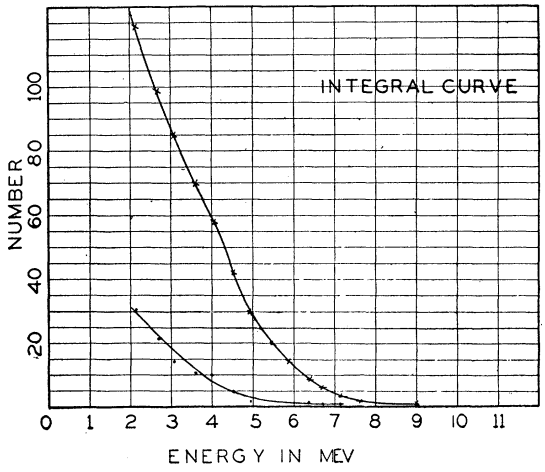

FIG. 1.

Because very few tracks came out of the lead envelope the present experiment might indicate that there are very few high energy beta-rays emitted during the actual fission. A few practically straight beta-ray tracks were observed in the cloud chamber, but it is possible that they were due to cosmic-ray shower particles, and consequently these were not included in the data in Fig. 1.

The data shown in Fig. 1 are not to be interpreted as representing a true distribution of the gamma-ray energies because only direct views of the tracks were photographed in the cloud chamber whose sensitive region was approximately 3 cm deep; and all tracks which could be measured, regardless of their lengths, were included in the data.

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Influence of Frequency on the Electro-Optical Effect in Colloids

Colloidal clay was separated into various particle sizes by centrifuging by the technique of Hauser and Reed.[1] A 1-percent suspension of particle size approximately 1500A was subjected to alternating electric fields from 30 to 12,000 cycles. The electro-optical effect on light moving perpendicular to the electric field between crossed Polaroids oriented at 45° to the field was observed. The transmitted light was measured by a photo tube and recording meter as the frequency was changed continuously. The r.m.s. field was held constant at 25 volts/cm and the temperature was 30°C.

As Mueller[2] reports, there is an enormous "Kerr" effect. (See Fig. 1.) Furthermore the continuous record shows one frequency where there is no light response to the voltage applied, although there is response at higher

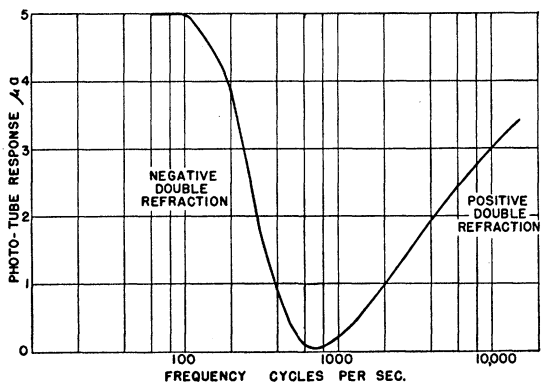

FIG. 1. Electric double refraction of colloidal clay.

and lower frequencies. The recorded minimum at 630 cycles is for a material called "colloidal talc" or "white bentonite." It is mainly magnesium silicate with very low iron content. Similar effects are shown by the ordinary yellow bentonite which is mainly aluminum silicate.

It was also found that on d.c. and at frequencies below the minimum the sol showed negative double refraction, and at frequencies above the minimum the double refraction was positive. Vanadium pentoxide sol was similarly examined and found to have a flat frequency characteristic with positive double refraction as does nitrobenzene. The position of the minimum and details of the bentonite curves were found to depend on the age and other characteristics of the particular sol. Double refraction was determined by a double quartz wedge.[3]

This effect is similar to the anomalous change in the Kerr effect found by Kitchin and Mueller[4] with rosin, and Raman and Sirkar[5] with octyl alcohol.

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[1] Hauser and Reed, J. Phys. Chem. **40**, 1169 (1936).
[2] H. Mueller, Phys. Rev. **55**, 508 (1939).
[3] Hull and Burger, Rev. Sci. Inst. **7**, 98 (1936); Baldwin, G. E. Rev. **40**, 319 (1937).
[4] D. W. Kitchin and H. Mueller, Phys. Rev. **32**, 986 (1928).
[5] Raman and Sirkar, Nature **121**, 794 (1928).

Raman Effect in Difluorochloromethane

We have observed thirteen Raman shifts in difluorochloromethane. The results are shown in Table I. The equipment used was described earlier.[1]

Three exposures were made by using Eastman Spectroscopic Plates Type 1J. Exposure times employed were 10.3, 27 and 36 hours.

Since difluorochloromethane boils at −40.8°C, a modification of our low temperature apparatus[2] was used to maintain the substance in the liquid state. The average temperature employed during these runs was −55°C.

The difluorochloromethane was furnished by the E. I. duPont de Nemours Company and was specified "Plant Product, refrigerator grade, probably 99 percent pure or better." About 50 grams of sample were available. The sample was supplied in a steel tank; connection to the cooling system was made by a Pyrex seal to a specially prepared copper fitting. Thus all connections were metal or glass, no pressure tubing, which might contaminate the sample, was used for joints. The sample was perfectly dust-free and gave spectrograms entirely devoid of background.

TABLE I. *The Raman shifts of difluorochloromethane.* $a=4358.34$A; $b=4046.56$A; $c=4077.8$A.

Raman Shift in cm^{-1}	Percent mean deviation	Exciting lines	Number of readings	Average relative intensity
3032.2	0.04	*a*, *b*	6	8 (*b*)
1353.6	0.22	*a*, *b*	4	3
1310.5	0.14	*a*, *b*	6	4
1127.9	0.24	*a*, *b*	3	0.5
1085.3	0.20	*a*, *b*	4	0.5
830.9	0.18	*a*, *b*	4	3
799.6	0.14	*a*, *b*, *c*	7	9 (*b*)
596.5	0.18	*a*, *b*	6	8
456.4	0.01	*a*	2	1
436.3	0.00	*a*	2	0.5
415.9	0.22	*a*, *b*, *c*	7	10 (*b*)
409.1	0.15	*a*	3	1
369.2	0.10	*a*	3	7

We wish to express our gratitude to Dr. A. F. Benning of the Jackson Laboratory for the loan of this substance. Further details concerning these results will be published later.

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[1] G. Glockler and J. H. Bachmann, Phys. Rev. **54**, 970 (1938).
[2] G. Glockler and M. M. Renfrew, Rev. Sci. Inst. **9**, 306 (1938).

Constancy of K^{40}

W. R. Smythe[1] has recently concluded that KCl prepared from old and deeply covered granite has essentially the same beta-ray activity as ordinary potassium salts. While this result alone appears to preclude the possibility of formation of K^{40} by present day processes associated with cosmic rays, it seems advisable to mention several experiments performed in this laboratory to test this very point.

A mass-spectrographic investigation of the relative abundance of K^{40} in comparatively fresh Vesuvius lava and in various clay soils failed to detect any measurable difference in the abundance ratio. In making these tests the samples were not subjected to any chemical treatment. In a further set of experiments the beta-rays of pure KCl extracted from Saratoga Spring water were contrasted with beta-rays of potassium from various commercial sources. The Saratoga Springs KCl was prepared by Dr. Oskar Baudisch who used the perchlorate method. The beta-ray measuring technique was the same as that described previously.[2] No detectable difference was observed between the various samples. These results are of interest since the best available geological information[3] indicates that Saratoga Spring waters derive their mineral content from deeply covered Pre-Cambrian formations. If the radioactivity is enhanced by any processes continually going on at the surface a change in the beta-ray emissivity should have been detected.

While these results are purely negative, they indicate, in agreement with those of Smythe, that the K^{39}/K^{40} abundance ratio is comparatively constant throughout nature. It seems justifiable, therefore, to use the $K^{40}-Ca^{40}$ ratio in estimating the age of matter.[4]

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[1] W. R. Smythe, Phys. Rev. **55**, 361 (1939).
[2] A. Bramley and A. Keith Brewer, Phys. Rev. **53**, 502 (1938); J. App. Phys. **9**, 778 (1938).
[3] Rudolph Ruedeman, Science **86**, 531 (1937).
[4] A. Keith Brewer, Ind. and Eng. Chem. **30**, 893 (1938).