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Measurement of HighEnergy GammaRays with a Photographic Bent Crystal Spectrograph

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designed to view almost the entire diffraction ring. This gain should more than compensate for the higher efficiency attainable with detectors using gas phase converters. BF_3 counters may provide 80% efficiency whereas spark counters operated with enriched B^{10} converters should reach about 6% although this may be improved with converter designs other than a single flat plate.

It may be mentioned that spark counters operating in other atmospheres can be used to detect protons with reasonable efficiency so fast neutron image intensifiers should also be possible, using either (n, p) or (n, α) reactions.

The author wishes to express his appreciation to Mr. Robert Norton for assistance in these experiments.

* Supported in part by the Armour Research Reactor Participator Program.

[1] R. M. Payne, J. Sci. Instr. 26, 321 (1949).
[2] G. G. Eichholz, Nucleonics 10, 46 (1952).
[3] An electrode geometry similar to the present design has been applied to alpha range measurements by C. E. Weller (unpublished, private communication).
[4] During the time exposure, oscillation of the counter in its plane may be used to increase the effective resolution of the system for small beams. The resolution is dependent not only upon the distribution of alphas from the converter but also on the spacing of the electrodes.

Letters to the Editor

Prompt publication of brief reports of NEW ideas in measurement and instrumentation or comments on papers appearing in this Journal may be secured by addressing them to this department. No proof will be sent to the authors. Communications should not exceed 500 words in length. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Measurement of High-Energy Gamma-Rays with a Photographic Bent Crystal Spectrograph*

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IT has been shown by one of the authors[1] and his co-workers that it is possible to determine accurately the wavelengths of gamma rays with quantum energies up to 1.3 Mev by direct crystal diffraction methods using the Mark I 2-meter bent crystal spectrograph at the California Institute of Technology. They were able to record and to measure with a precision of one part in 10^3 the two gamma rays at 1.17 and 1.33 Mev which are emitted by a Co^{60} source.

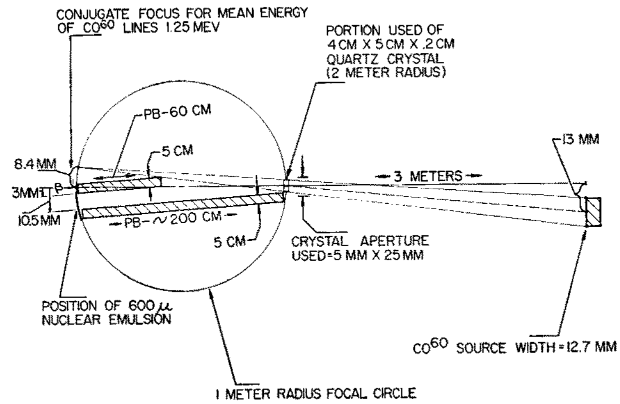

FIG. 1.

In this instrument a thin (~0.1 mm) line source is placed on the focal circle of the spectrograph and a counter together with a Soller slit collimator is placed on the convex side of the crystal.[2] The good collimation of the diffracted gamma rays makes it possible to observe radiations scattered through very small angles (~10^{-2} radian) since the long collimator protects the NaI detector from the very intense undiffracted beam.

Recently the Co^{60} gamma rays have also been observed by the use of the 2-meter bent crystal photographic spectrograph developed at UCRL, Livermore.[3] This instrument, which uses the geometry first suggested by DuMond and Kirkpatrick[4] and first applied by Y. Cauchois,[5] employs an extended source placed on the convex side of the crystal and a 600-micron Ilford G-5 emulsion placed on the focal circle to record the gamma-ray lines. As in the case of Mark I geometry, it is necessary to construct an extensive collimator in order to protect the emulsion from the intense undiffracted beam emitted by the source. A diagram of the shielding geometry is shown

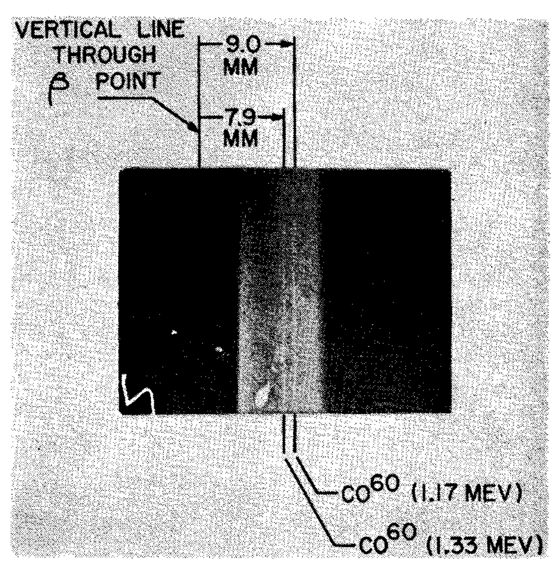

FIG. 2.

in Fig. 1 in which the vertical dimensions have been exaggerated in order to show the details. The collimator is designed to leave open the position of the emulsion between quantum energies of 0.9 and 3 Mev. Figure 2 shows a print of the emulsion obtained from the Co^{60} exposure. The two lines correspond to the 1.17- and 1.33-Mev cascade gamma rays from levels in Ni^{60} populated by the β^- decay of Co^{60}. The calculated distances of these lines from the instrument β point (infinite energy position) are also shown in the figure. Experience has indicated[3] that it is possible to measure the line position on the emulsion to ± 0.01 mm so that it should be possible to determine the wavelengths of these lines with a precision of about one part in 1000.

The present arrangement has two disadvantages when compared with the Mark I geometry. One is that the collimator severely restricts the wavelength region over which lines can be simultaneously observed and the other is that very much stronger sources are necessary to make successful measurements. For this experiment a 20-curie Co^{60} source was placed in the spectrograph for 92 hr giving a total exposure time of 1840 curie-hr, whereas the measurements given in reference 1 were made with a 50-millicurie source and a total counter "on time" of $\sim 10^6$ sec, which gives an equivalent exposure of about 1.4 curie-hr. On the other hand, the Cauchois spectrograph used for the present measurements is very simple and inexpensive. Since high-intensity sources are available from research reactors, it is hoped that the present method will find applications both in the study of radioisotopes and in the direct observation of high-energy capture gamma rays emitted by samples placed near the core of the reactor.

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[1] Lind, Brown, and DuMond, Phys. Rev. **76**, 1838 (1949).
[2] J. W. M. DuMond, *Beta and Gamma Ray Spectroscopy* (edited by Kai Siegbahn, North Holland Publishing Company, Amsterdam, 1956), Chap. IV. A complete discussion of the various bent crystal geometries is given in this reference.
[3] Chupp, Clark, DuMond, Gordon, and Mark, Phys. Rev. **107**, 745 (1957).
[4] J. W. M. DuMond and H. A. Kirkpatrick, Rev. Sci. Instr. **1**, 88 (1930).
[5] Y. Cauchois, Compt. rend. **195**, 1479 (1932); Ann. Phys. **1**, 215 (1934).

Erratum: Direct Quartz Crystal Control of a Low-Level Pound-Knight-Watkins Spin Magnetometer

[Rev. Sci. Instr. **29**, 574 (1958)]

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THE line width of mineral oil was incorrectly given in several places as $1/T_2$ (140 cps, or 0.03 gauss), instead of the correct value of $(\sqrt{3}\pi T_2)^{-1}$, which is about 26 cps, or 0.006 gauss. The performance of the magnet servo was consequently underestimated by a factor of about 5.

The peak-to-peak amplitude of the field modulation in the servo application should be made equal to the full line width of the sample, not to half of it.

Erratum: Photoelectric Flow Birefringence Instrument of High Sensitivity

[Rev. Sci. Instr. **29**, 360 (1958)]

Bruno H. Zimm
General Electric Research Laboratory, Schenectady, New York

EQUATION (1) of this article should read:

$$T=\frac{1}{2}\left(\sin\frac{\delta}{2}\right)^2(1-\cos 4\gamma). \quad (1)$$

Equation (2) should read:

$$T=\cos^2\beta+\tfrac{1}{2}\sin\delta\sin 2\beta\sin 2\gamma - \frac{1}{2}\left(\sin\frac{\delta}{2}\right)^2\cos 2\beta(1-\cos 4\gamma). \quad (2)$$

This requires that elsewhere in the article "tanδ" should be replaced by "sinδ." Since δ was assumed to be small, none of the discussion is changed.

In the next to the last sentence of the paragraph below Eq. (2), the second half should read: "we have found that a value of β within a few degrees of 90° is satisfactory."