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Photography of Neutron Diffraction Patterns*

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A scintillating screen of Li^6F-ZnS used in combination with sensitive light film has been used to record slow neutron images. The sensitivity is very high, being 15 neutrons per square millimeter for visible darkening in the best case, and the technique has been used to obtain powder, rotating crystal and Laue patterns with neutron diffraction equipment.

Photography of neutron diffraction patterns can be accomplished through use of fluorescent screens in which secondary radiation in the form of either beta-particles, gamma-

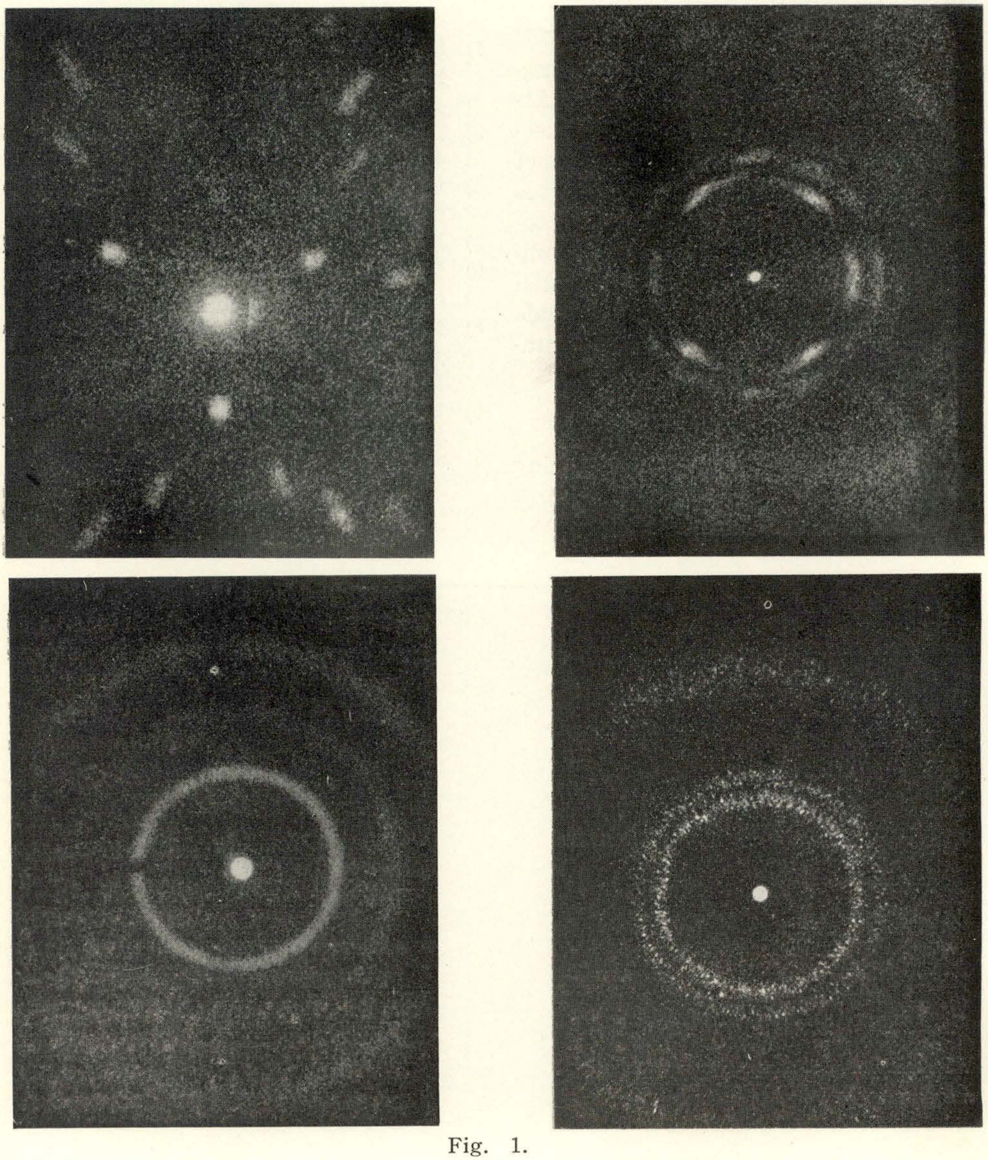

Fig. 1.

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rays or visible light is used to produce photographic action. Such screens that have been available in the past have been of low efficiency and consequently the required long exposure periods have served to defeat the usefulness of the technique. As the result of a study of new screen combinations coupled with the use of more sensitive photographic emulsions, we have been able to prepare a combination which is about ten times more sensitive than any reported in the literature and have used this in recording powder patterns as well as single crystal patterns with reasonable exposure periods.

Most of the present investigation has centered about the use of a Li^6F-ZnS scintillating screen and the parameters that have been studied include (1) the state of combination of the components (whether homogeneously mixed or heterogenously separated) (2) screen composition (3) screen thickness (4) wavelength sensitivity and (5) relative performance of screen when used in transmission or back reflection. The best arrangement that has been found is the homogeneously-mixed combination of weight ratio 1 Li^6F–4ZnS in fine powder form arrayed in back-reflection. When used with Tri-X film this exhibits a sensitivity of 60 neutrons per square millimeter for just visible darkening and with Polaroid Type 47 film this is reduced to about 15 neutrons per square millimeter.

Such a screen has been incorporated into a Polaroid camera to take advantage of the very high speed Polaroid film (ASA 3000) and as well, the advantages of the 10 second in-camera film development. Diffraction patterns taken with this assembly are shown in Fig. 1. The exposure times of the powder patterns were about 1 or 2 hours (this will vary with the monochromatic beam intensity and sample characteristics) and the Laue pattern (of a germanium crystal) was taken in 4 minutes. Such a camera assembly has been found to be extremely useful in assessing the position and intensity distribution in spectrometer monochromatic beams and in aligning specimens. Most monochromatic beams must be attenuated in photographing them with reasonable exposure time of 5 or 10 seconds. The screen is sensitive enough that monochromatic neutron beams can be seen visually in a darkened room.

DISCUSSION

G. E. Bacon: Can you say how the observed photographic response varies with the neutron intensity? I was wondering just how troublesome a rather high neutron background might be.

C. G. Shull: We have studied the variation of photographic density with exposure and find that it follows the usual logarithmic law.