A FOCUSING X-RAY TELESCOPE MONOCHROMATOR*

AARON S. FILLER and BENJAMIN S. FRAENKEL
Laboratory of X-ray and Far Ultra-Violet Spectroscopy, Racah Institute of Physics, The Hebrew University, Jerusalem, Israel

In order to resolve clusters of X-ray lines emitted by flares (Fritz *et al.*, 1967; Neupert and Swartz, 1970) and to determine line shapes, a considerable resolving power is needed. The angular size of flares, typically about 2′ will not allow the necessary resolution to be obtained without a very fine slit system combined with the flat crystal X-ray spectrometer. In stellar X-ray spectroscopy large plane diffracting crystals will be associated with large counters, which in turn would act as a source of considerable noise.

A focusing X-ray telescope consisting of a large single crystal, Bragg diffracting on its surface and bent parabolically, will focus parallel X rays to a fine line. However, due to the curvature of the crystal, the Bragg angle varies along the crystal. In order to maintain monochromatic reflectivity throughout the surface of the crystal, the interplanar spacing has to be varied along the crystal.

Ge-Si alloys are known to form good single crystals with any relative proportions of the components. The interplanar spacing equals the mean spacing obtained by considering the ratio of the components. It therefore seems feasible to make single crystals with continuously varying composition giving the desired variation in lattice spacing.

A given variation of d in a suitably bent crystal will fit the Bragg condition over the whole surface, for a given wavelength λ_0 of parallel radiation. When the crystal is tilted to scan a spectrum, without changing the curvature of the crystal, it will focus a neighbouring wavelength λ_1, though only within certain limits of size of the crystal. In order to maintain good resolution for the λ_1 length of the crystal will have to be limited. The resolution will be a function of the rocking curve and of the dispersion.

As an example a crystal varying from pure Ge to pure Si, bent to give a distance of 2 m between the crystal and the focus, is considered. 40 resolution units may be scanned without serious loss of resolution, for a wavelength range about 1.89 Å, with (220) planes and X-ray beam width of 90 mm. In order to cover the wavelength range from 1.88 to 1.90 Å with a resolution of 0.0002 Å (100 resolution units), the maximum beam width would be 35 mm and the rocking curve 10″.

References

Fritz, G., Kreplin, R. W., Meekins, J. F., Unzicker, A. E., and Friedman, H.: 1967, *Astrophys. J.* **148**, L133; see also Meekins, J. F., Kreplin, R. W., Chubb, T. A., and Friedman, H.: 1968, *Science* **162**, 891.

Neupert, W. M. and Swartz, M.: 1970, *Astrophys. J. Letters* **160**, L189; see also Neupert, W. M., Gates, W., Swartz, M., and Young, R.: 1967, *Astrophys. J.* **149**, L79.

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