DISCUSSION AND CORRESPONDENCE

DISTRIBUTION OF INTENSITY IN THE FOCAL SPOT OF AN X-RAY TUBE

IN a recent article on the apparent shape of X-ray lines, Mr. F. K. Richtmyer[1] describes experiments showing that the distribution of X-ray brightness over the focal spot of an X-ray tube is not uniform. He suggests that the non-uniformity is due to space charge effects and shape of target. Though the effect may be partly due to these causes, we have evidence that, at least in tubes using a Coolidge filament, the chief cause is quite different.

During our spectroscopic work, we have had occasion to investigate the distribution of intensity over the focal spot. For this purpose we took X-ray pinhole photographs of the face of the target of a tube using a Coolidge filament. The plane of the target was normal to the cathode stream, and the photographs were taken in a direction as nearly normal to the face of the target as the shape of the tube would permit. Under these circumstances, if the exposures were so short that only the most intense rays were registered on the plate, the images of the focal spot were spiral in form and exactly what would be expected if the focal spot was a nearly orthogonal projection of the filament on the face of the target. In view of the small gaps between the spirals of the filament and the diameter of the wire, the sharpness of the images was surprising. When the photographs were taken through a narrow slit instead of a pin-hole, and in a direction making a small angle with the face of the target, the images contained striations running parallel to the jaws of the slit, exactly as was to be expected from the spiral nature of the focal spot. In using two very narrow slits in the manner described by Mr. Richtmyer, we find it of great advantage to have the line of slits fall on the most intense part of the focal spot as shown by these photographs.

In discussing the effect of slit width on the width of spectral lines, Mr. Richtmyer does not state how far his ionization chamber was from the crystal. Professor H. S. Uhler[2] has shown that, under certain rather rigorous conditions, when two very short slits of equal width are used, there is a portion of the monochromatic beam reflected from the crystal the width of which can not be greater than the width of the slits. This is only strictly true if the depth of penetration in the crystal is negligible and the crystal is a perfectly selective reflector. A finite depth of penetration in the crystal would tend to broaden the cross section of the portion considered, but probably by the same amount throughout its length. If there is a finite range of angles over which the crystal can reflect a given wave length, the reflected beam will be divergent even in Uhler's region of constant cross section. We have found that the $K\alpha_1$ line of silver reflected from a very perfect calcite crystal is broader when photographed in the portions of this region more remote from the crystal. Prof. Siegbahn[3] discusses the possibility of a finite range of reflection angles for a single wave length due to refraction in the crystal. Though we have not yet subjected the matter to a thorough investigation, the order of magnitude of this broadening is about what would be expected from the geometry of our spectrometer and the index of refraction of calcite, if this finite range of reflection angles really exists.

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1 *Phys. Rev.*, 26, p. 727, Dec., 1925.

2 *Phys. Rev.*, 11, p. 17, 1918.

3 Siegbahn, "The Spectroscopy of X-rays," English Trans. p. 23.

CO BANDS

IN a recent article (*Astrophysical Journal,* 62, p. 145, 1925) I reported the discovery of three new band systems which I attributed to nitrogen and called the second negative and the fifth and seventh positive bands of nitrogen. I have recently received letters from Professor O. S. Duffendack, of the University of Michigan, and from Professor Raymond T. Birge, of the University of California, calling my attention to the fact that these band systems belong to carbon and are probably due to CO. Duffendack and Fox find them to appear very strongly in the spectra of low voltage arcs in CO and are measuring their excitation potentials. Birge points out that the seventh positive bands are a portion of the fourth positive bands of carbon that have recently been obtained as absorption bands of CO at ordinary temperatures by Leifson (*Astrophysical Journal,* in press), while the second negative bands fit into his scheme of energy levels for the ionized CO molecule (*Nature,* in press). The fifth positive bands have rather complicated fine structure and their exact origin is still in doubt.

The very close agreement of the vibrational shifts in these bands and in the first negative and second and fourth positive bands of nitrogen is apparent from tables III, VII and VIII of my article. In the first and second negative systems the frequency differences between corresponding vibrational levels differ only one half to one per cent., while in the second, fourth and fifth positive bands the frequency differences are identical within the limits of experimental error. This is further evidence in support of the view that the structure of the CO molecule is very similar to that of the N_2 molecule. From a