GLANCING INCIDENCE TELESCOPES FOR SPACE ASTRONOMY

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In the past several years we've reported on our efforts to develop glancing incidence telescopes for Space Astronomy Applications. By glancing telescopes I'm referring to the Wolter Type I and II, and the Cassegrain systems. Figure 1 shows a Wolter type II designed for use in the extreme ultraviolet region. The incoming rays first are incident on a concave parabola and reflect to a convex confocal hyperbola. The rays reflected by the hyperbola are then directed to the other hyperbolic foci which is the system focus. The Wolter type I and the Cassegrains operate similarly.

The subject of this report deals with a technique that we've found for determining the state of polarization of a light source by evaluating its image at the focus of a glancing telescope. This is a significant discovery in that we've extended the information gathering capabilities of the glancing telescopes, from solely collecting spatial and spectral information to include polarization information. An analysis of the central disc of the diffraction image will reveal

- If the light source is polarized
- The plane of polarization
- The degree of polarization

When polarized light is incident at the aperture of a diffraction limited glancing telescope, the central disc of the diffraction pattern takes on an elliptical configuration. This ellipticity

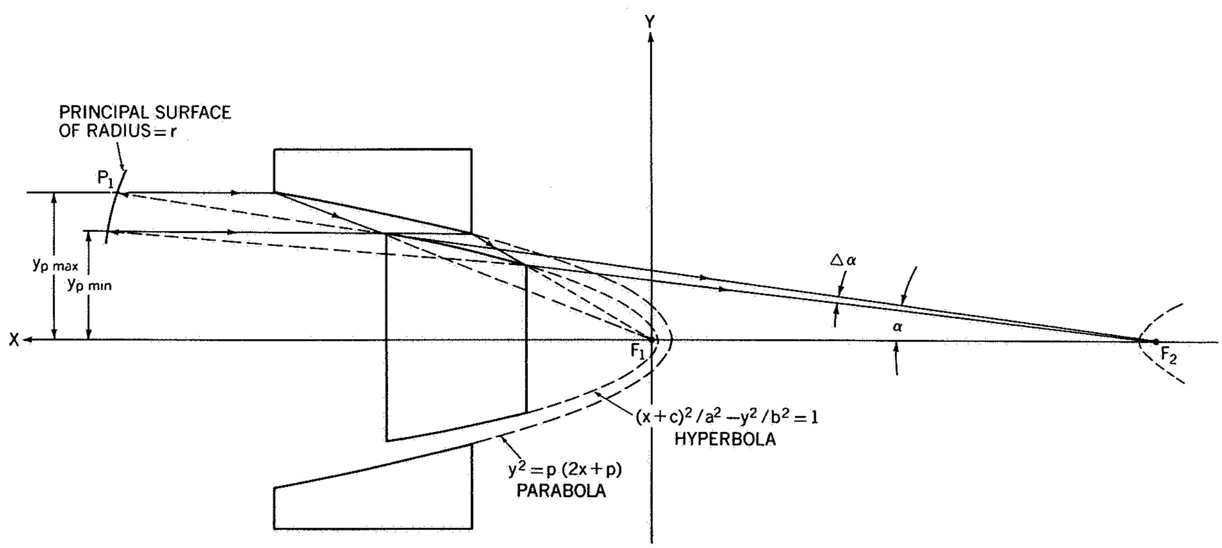

Figure 1. Wolter type II glancing telescope.

is caused by the tendency of the electric vector component in the plane of incidence to be absorbed by the reflecting material.

Figure 2 shows the image of a Type II telescope illuminated with plane polarized laser light of 6328Å wavelength. Note that the major axis of the ellipse is along the plane of polarization, and the ratio of the ellipse axes is about 1.33. This same result was obtained by program "Daphne" (a computer program designed to evaluate the electric field at the image of an optical system). We reported on the development of this program in 1970. In Figure 3, using the program to further the investigation of this ellipticity phenomena, the following is shown: As the state of polarization goes from plane polarized to decreasing degrees of elliptically polarized light, the ellipticity of the central disc goes from a maximum at plane polarization to zero at circular polarization. These curves give us a direct relationship between the degree of polarization of a light source and the ellipticity of the central disc for this particular telescope, independent of the light source wavelength.

Therefore, ellipticity of the central disc indicates that the light source is polarized. The major axis of the ellipse indicates the direction of polarization for the plane polarized case; it also indicates the direction of the largest electric vector for the elliptically polarized case. And finally, with the use of Figure 3, the degree of polarization can be obtained with the ratio of the major axis to minor axis of the ellipse.

Figure 2. Results of wave analysis and actual photograpn.

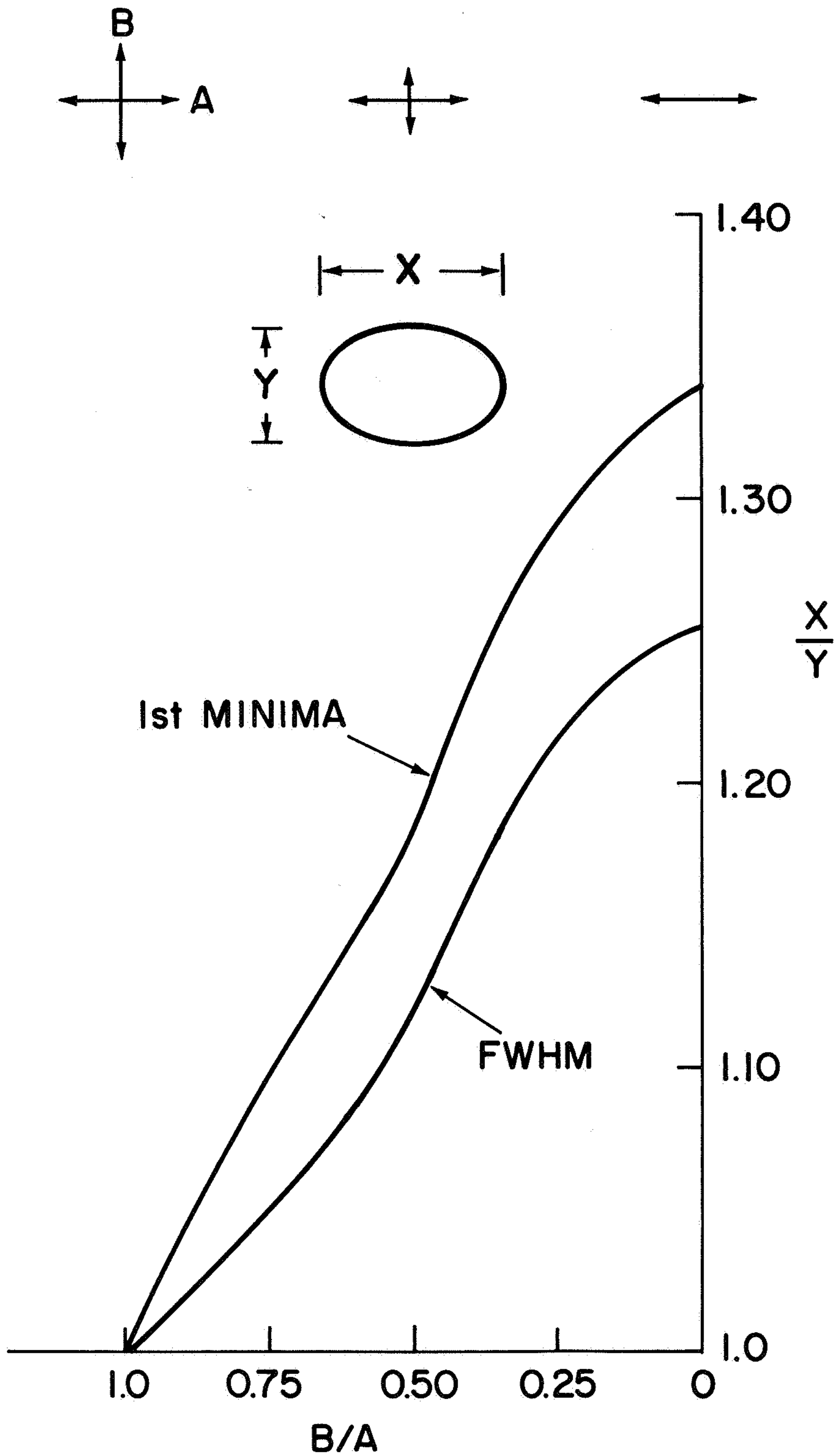

Figure 3. Degree of polarization versus image center ellipticity.