

NOTE ON THE DESIGN OF TWO ROSS TYPE PHOTOGRAPHIC OBJECTIVES

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SUMARIO

A fin de examinar y medir la deflexión de la luz en las cercanías de un campo gravitacional, predicha por Einstein, se diseñó un objetivo fotográfico tipo Ross. Este objetivo tiene una relación focal de 30, un diámetro de 12.5 cms. y un campo de 4°. Aquí se dan los detalles de este diseño.

For an astronomical experiment, Einstein deviation of light, during the total solar eclipse of 1970 in Oaxaca, Mexico, two similar high resolution photographic objectives were needed. The Optics Department, which is part of the Institute of Astronomy of the University of Mexico, was asked to design and construct such objectives. The design of these lenses is given here.

The characteristics required from this lens, which were kindly given by Dr. S. Vasilevskis from Lick Observatory, are:

- a) 12.5 cm diameter.
- b) Focal ratio equal to 30.
- c) Good resolution within a field diameter of 4°.
- d) Color corrected in a spectral region from 4000 Å to 4600 Å.

After a few design trials, a Ross type lens (Ross 1921) was chosen because of its large useful field. The glass selection was made following the advice of J. G. Baker (1963), finally choosing Kz FS-2 for the central negative elements and SK-5 for the outer positive elements.

Using a semi-automatic lens design program developed here, at the Institute of Astronomy, a reasonably good design was found, the description of which follows:

The shape of the finished lenses with its separations is shown in Fig. 1. The refractive indices did not coincide exactly with the catalog figures but were very close as shown in Table 1.

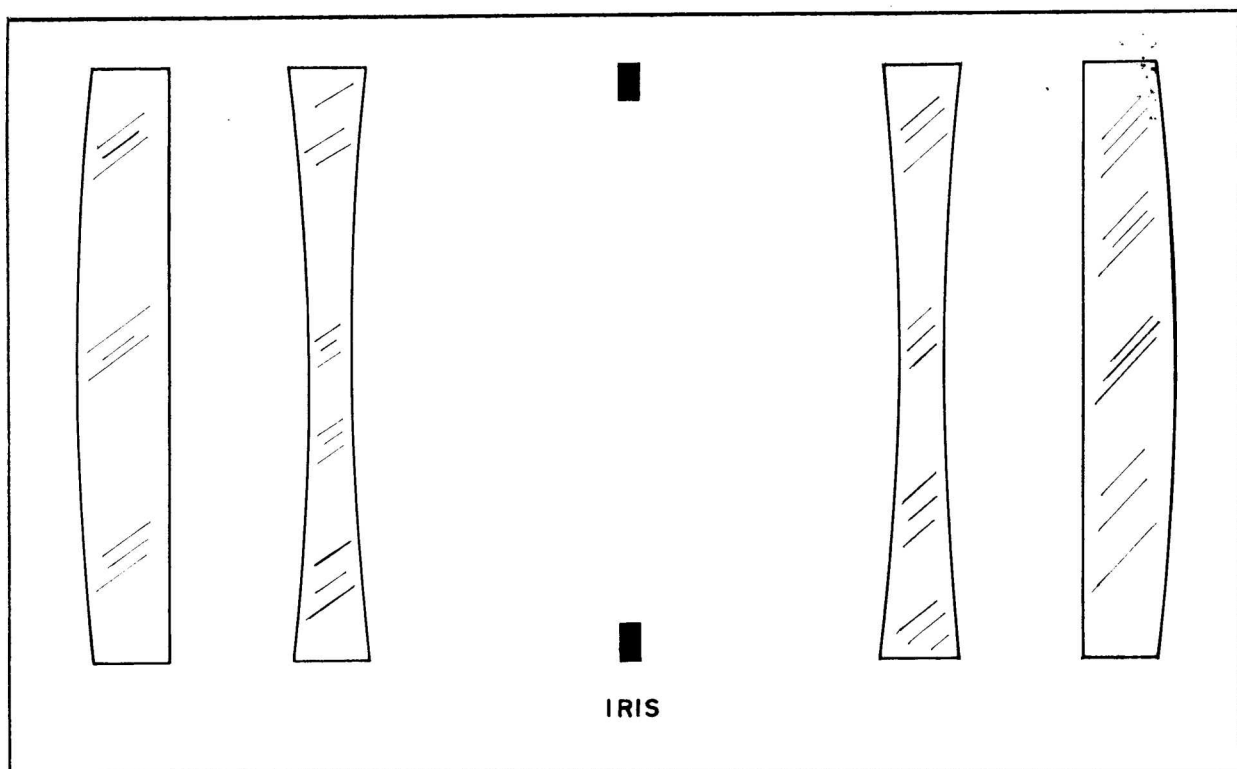


Fig. 1.—Ross Lens.

The final design with its tolerances is shown in Table 2. As expected, the on axis image was very good, as shown in Fig. 2, for three colors.

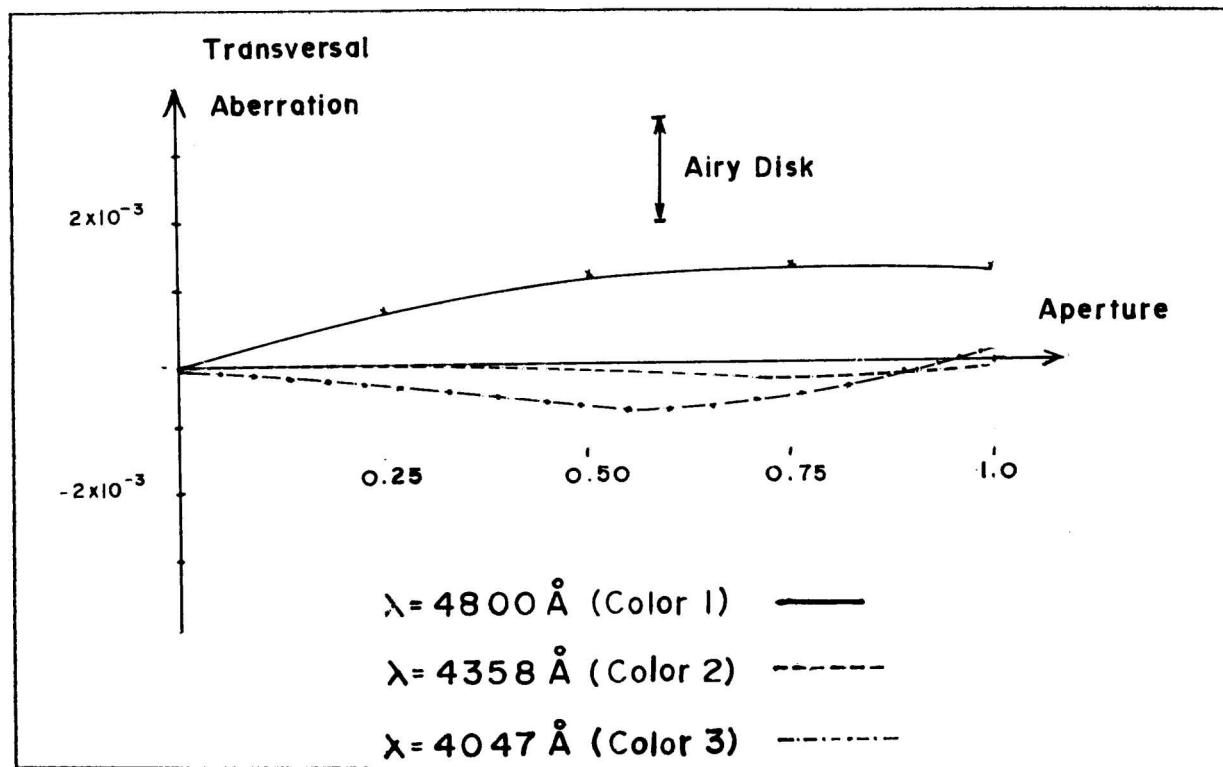


Fig. 2.—Axial Aberration curves for 3 Colors.

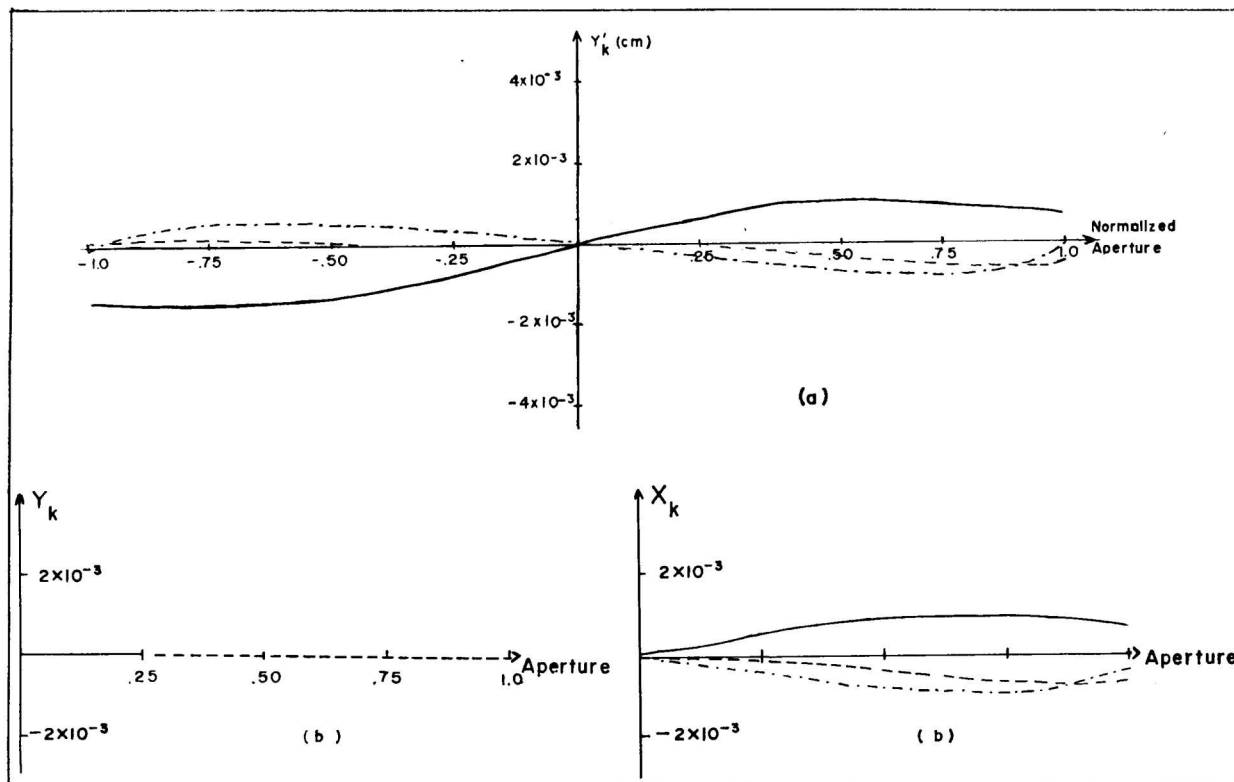


Fig. 3.—(a) Meridional Transversal Aberration Curves for 3 Colors, at 1.5° off axis. (b) Sagittal Transversal Aberration Curves for 3 Colors, at 1.5° off axis.

TABLE 1
Actual Refractive Index

	$N_{F'}$ (4800 Å)	N_g (4358 Å)	N_h (4047 Å)
SK-5	1.56603	1.57109	1.57580
KZFS-2	1.59631	1.60096	1.60527

At 0.75 of the field (1.5° off axis) as well as at the edge of the field (2°), the meridional curves and the sagittal curves were computed and plotted in Figs. 3 and 4, where, it can be seen that the aberrations are very small, well within the Rayleigh limit.

Figs. 5(a) and 5(b) show the spot diagrams obtained at 1.5° and 2° degrees respectively, for the central color, although they are not very meaningful due to its very small size.

The lenses were made and tested and they showed to have a very good resolution as expected. The lens is shown in Figs. 6 and 7 where it can be noticed that the assembled system resulted very compact.

TABLE 2
Final Lens Design

<i>Radius of Curvature in cm.</i>	<i>Thickness in cm.</i>	<i>Glass Shott</i>
58.30 ± 0.1	2.00 ± 0.1	SK-5
-341.25 ± 1.0	1.46 ± 0.05	AIR
127.32 ± 0.1	1.25 ± 0.1	KZFS-2
86.47 ± 0.1	7.64 ± 0.1	AIR
-86.47 ± 0.1	1.25 ± 0.1	KZFS-2
127.32 ± 0.1	1.51 ± 0.05	AIR
341.25 ± 1.0	2.00 ± 0.1	SK-5
57.69 ± 0.05		
Clear Aperture		12.50 cm.
Focal Length		374.43 cm.
Back Focal Length		367.14 cm.
Focal Ratio		29.95
Iris Diameter		12.30 cm.
Iris Position		Center
Field Diameter		4°

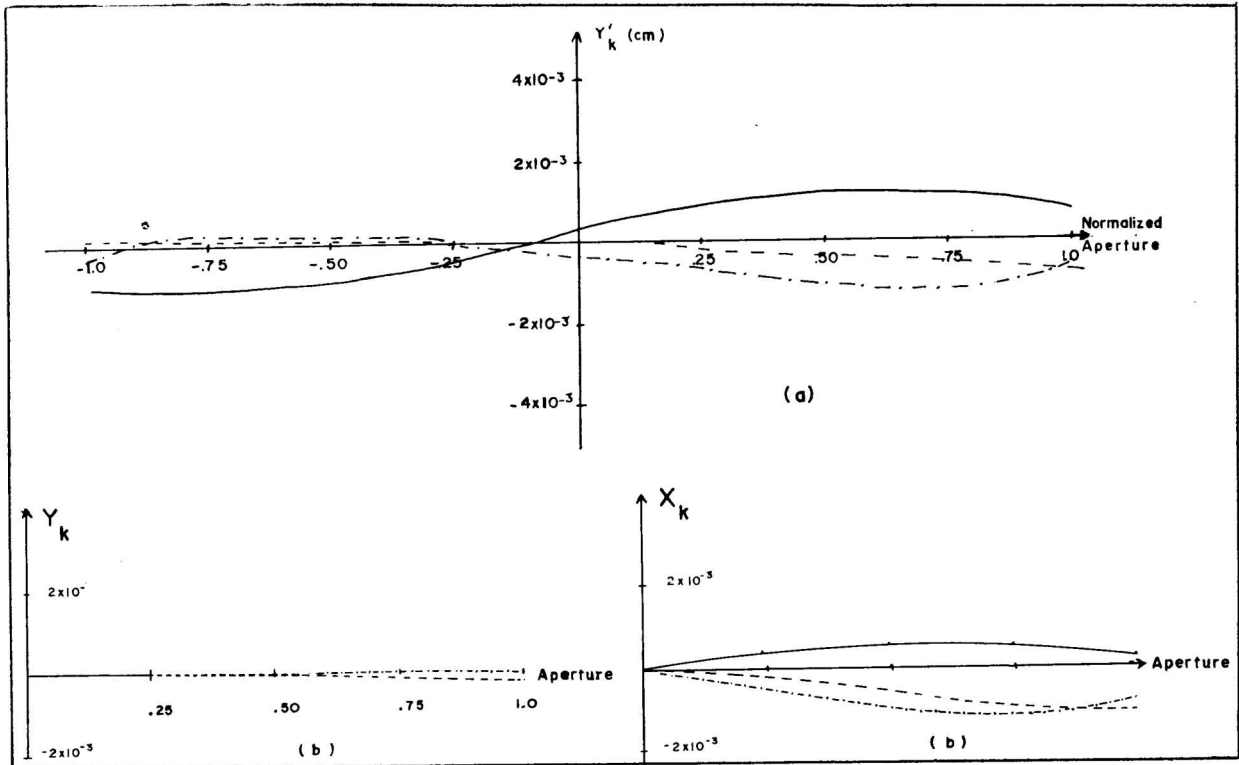


Fig. 4.—(a) Meridional Transversal Aberration Curves for 3 Colors, at 2° off axis. (b) Sagittal Transversal Aberration Curves for 3 Colors, at 2° off axis.

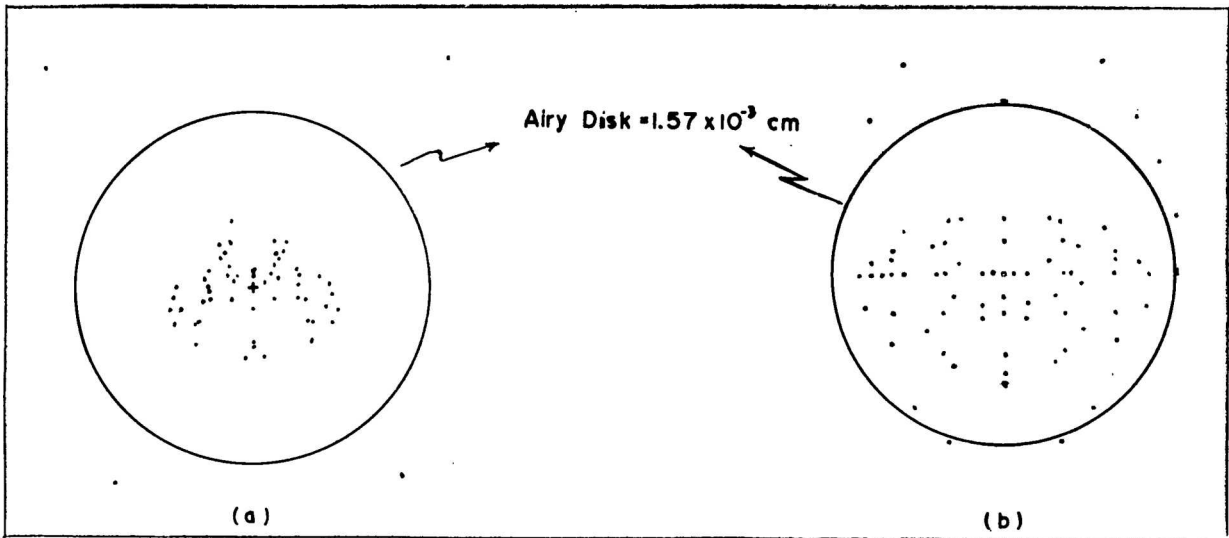


Fig. 5.—(a) Spot Diagram for central color, at 1.5° off axis. (b) Spot Diagram for central color at 2° off axis.

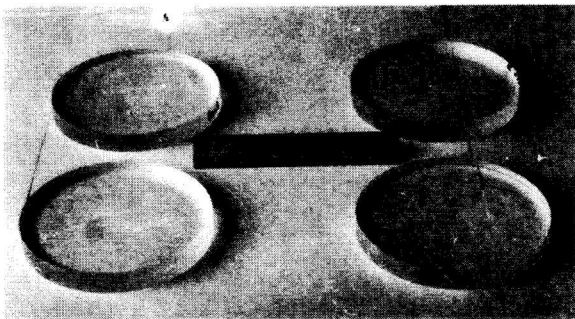


Fig. 6.—Finished Lenses.

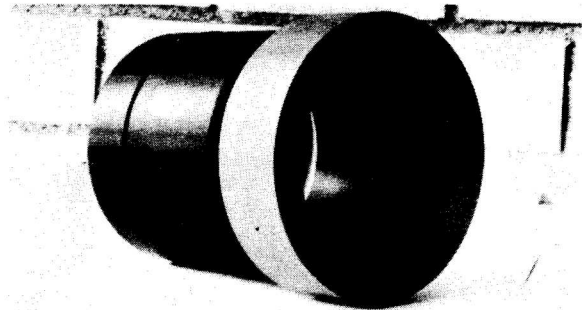


Fig. 7.—Complete Assembled Objective.

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REFERENCES

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