Tutorial Notes

An Empirical Relation For The Optical Quality And The Image Size

A. K. SAXENA and J. P. LANCELOT

Indian Institute of Astrophysics, Bangalore-560 034 India

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Surface accuracy of a reflecting optical surface is the governing factor in the formation of the image at its focus. The image size is normally given by the angle subtended by the image at the vertex of the element. This angular size, in a diffraction limited case using Rayleigh criterion is $\frac{.23}{D}$ where 'D' is the diameter of the reflective optical surface in meters. But normally fabrication of the optical surface exactly true to its theoretical profiles can not be achieved and the size of the image will depend upon the surface errors. It is thus necessary to specify the tolerance of the surface during any optical fabrication. In this note a handy empirical relationship has been given for a quick estimation of the image size for a given surface departure.

The size of the image is a linear function of the surface departure and the overall image size is a contribution of diffraction effect and the surface errors. Following relationship has been found suitable for finding the image size.

$$\phi = \frac{\Delta Z}{.32} + \frac{.23}{D} \quad (1)$$

where 'φ' is the image size in seconds of arc and ΔZ is the surface departure in waves.

This equation was empirically derived from the results of our evaluation of many optical surfaces during fabrication.

If the mirror surface is divided into smaller segments of equal areas and the value of the image size for the corresponding segment is obtained using above equation then these values can be used to find the image profile by plotting a histogram between the size of the image and the corresponding number of segments. The above results can also be used to find the root mean square surface departure and hence the Strehl intensity [1] *I* can be calculated from the following equation.

$$I = 1 - \left(\frac{2\pi}{\lambda} \right)^2 2\Delta Z_{rms}^2 \quad (2)$$

Where *I* is the normalised intensity at the Gaussian focus ΔZ_{rms} root mean square deformation of the surface and λ is the wave length at which departure is computed.

REFERENCE

1. D. Malacara, Optical Shop testing P 494 (1978). John Wiley & Sons.