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Correction for the observed intensity distribution in solar corona

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Abstract. An estimation of the correction for the broadening of the intensity profile of the solar corona caused by atmospheric turbulence, scattering in the photographic emulsion, focusing errors *etc.* is made from the coronal observations of the sun during 1980 February 16 total solar eclipse.

Key words : total solar eclipse—solar corona—atmospheric turbulence

1. Introduction

Abhyankar & Subrahmanyam (1982) suggested a method for estimating the broadening of the intensity profile of the solar corona caused by atmospheric turbulence, scattering in the photographic emulsion, focusing errors *etc.* This method has been slightly modified and applied to the coronal observations of the sun made by the scientists of Indian Institute of Astrophysics, Bangalore, from Raichur station during the total solar eclipse of 1980 February 16.

2. Computed effect

Abhyankar & Subrahmanyam (1982) represented the true intensity distribution, $J(x)$, by the following expression, which was given by Baumbach (1937) for the mean corona :

$$J(x) = \frac{A}{(x+1)^{2\cdot 5}} + \frac{B}{(x+1)^{7}} + \frac{C}{(x+1)^{17}}, \qquad \ldots(1)$$

where $x = (r/R_\odot) - 1$, $A = 0.0532$, $B = 1.425$ and $C = 2.565$, J is expressed in units of $I_0\ 10^{-6}$, I_0 being the intensity at the centre of the solar disc. Using the method of least squares it was found from the actual coronal intensity distribution in the region 1.1 $R_\odot$ to 2.30 $R_\odot$ measured from the centre of the sun that $J(x)$ can be better represented by

$$J(x) = \frac{A}{(x+1)^{2\cdot 5}} + \frac{B}{(x+1)^{7}} + \frac{C}{(x+1)^{17}} + \frac{D}{(x+1)^{n}}, \qquad \ldots(2)$$

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where

$$\left.\begin{aligned} D &= 4.31 \pm 0.39 \\ n &= 5.62 \pm 0.19 \end{aligned}\right\} \text{for position angle } 0^\circ \text{ (N)}$$

$$\left.\begin{aligned} D &= 12.46 \pm 0.92 \\ n &= 7.44 \pm 0.16 \end{aligned}\right\} \text{for position angle } 90^\circ \text{ (E)}$$

$$\left.\begin{aligned} D &= 1.53 \pm 0.12 \\ n &= 5.23 \pm 0.18 \end{aligned}\right\} \text{for position angle } 180^\circ \text{ (S)}$$

and

$$\left.\begin{aligned} D &= 9.38 \pm 1.6 \\ n &= 7.14 \pm 0.38 \end{aligned}\right\} \text{for position angle } 270^\circ \text{ (W)}$$

Then, following Abhyankar & Subrahmanyam (1982), the observed intensity distribution along the common diameter at the time of the second and third contacts will be given by

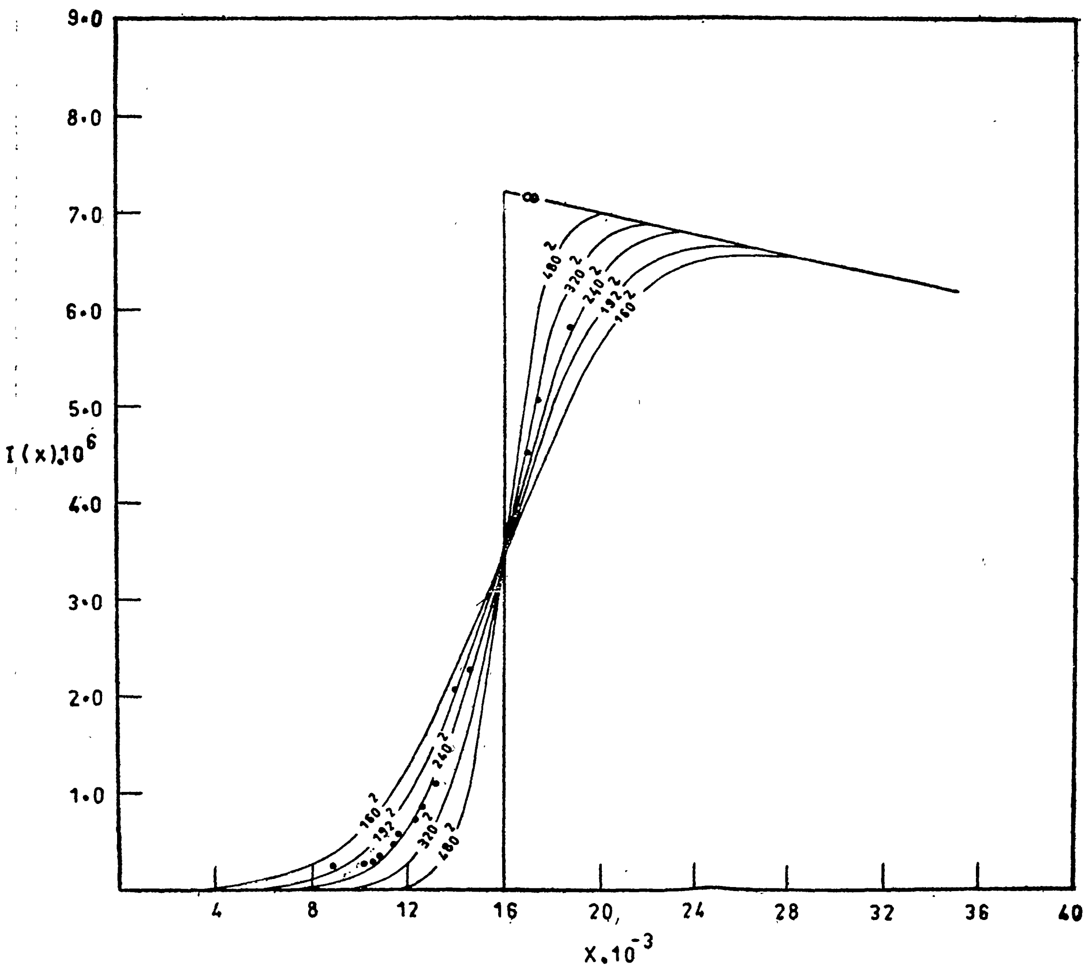

Figure 1. Coronal intensity profile near the north limb.

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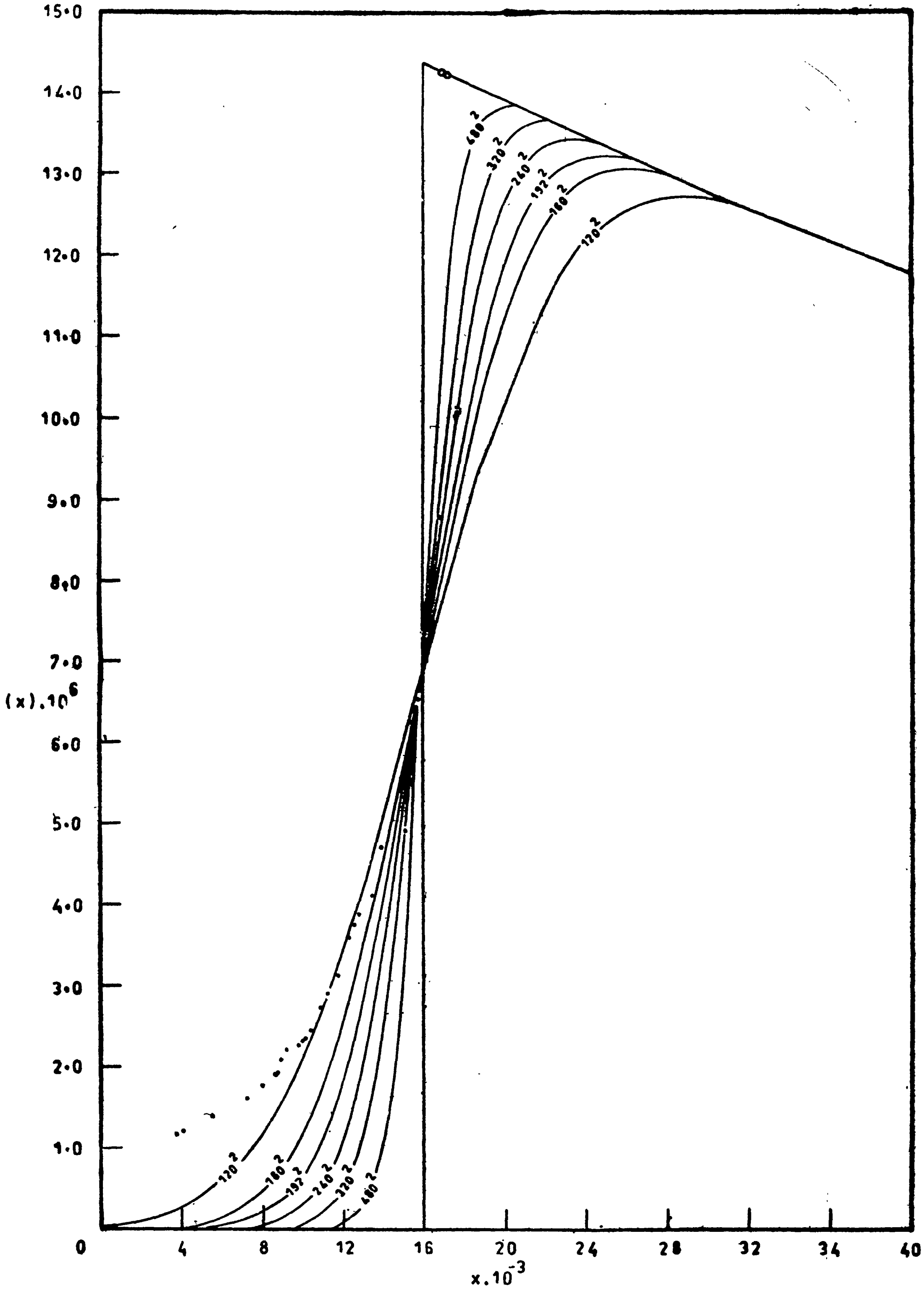

Figure 2. Coronal intensity profile near the east limb.

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$$I(x) = \sqrt{\frac{a}{\pi}} \int_0^\infty \left\{ \frac{A}{(\xi + 1)^{2.5}} + \frac{B}{(\xi + 1)^7} + \frac{C}{(\xi + 1)^{17}} + \frac{D}{(\xi + 1)^n} \right\}$$

$$\times \exp\left[- a(x - \xi)^2\right] d\xi, \qquad \text{...(3)}$$

and at the time of mideclipse of magnitude m the broadened intensity profile takes the form

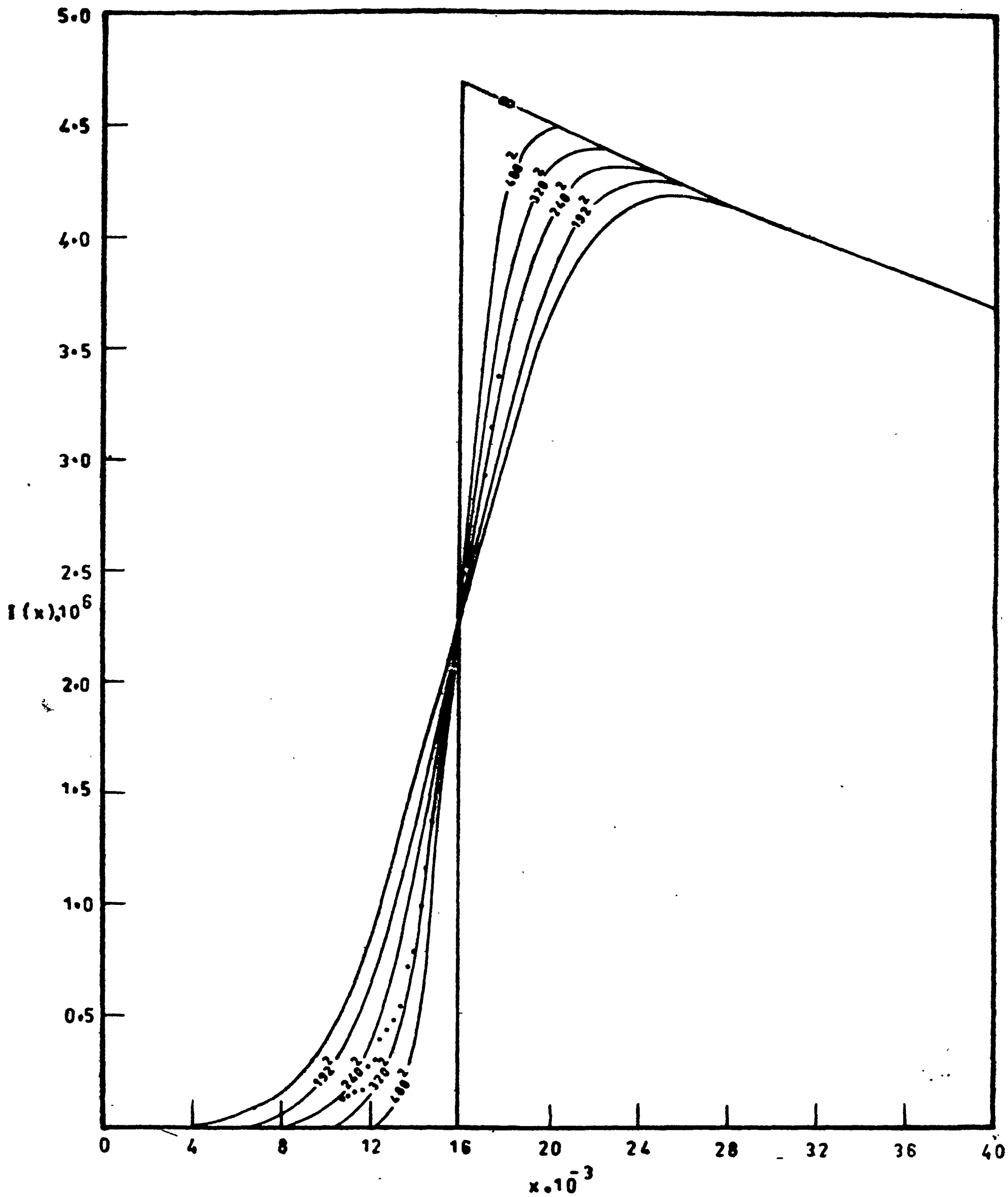

Figure 3. Coronal intensity profile near the south limb.

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$$I(x) = \sqrt{\frac{a}{\pi}} \int_{m-1}^{\infty} \left\{ \frac{A}{(\xi+1)^{2.5}} + \frac{B}{(\xi+1)^{7}} + \frac{C}{(\xi+1)^{17}} + \frac{D}{(\xi+1)^{n}} \right\}$$

$$\times \exp\,[-\,a(x-\xi)^2]\,d\xi. \qquad \ldots(4)$$

We have computed $I(x)$ from equation (4) for various values of a starting from $a = \infty$ which represents perfect seeing and ideal apparatus to $a = 160^2$ which corresponds to a spread of $960/160 = 6$ arcsec. In equation (4) we have taken $m = 1.016$ corresponding to the magnitude of the eclipse at Raichur (Subrahmanyam & Sreedhar Rao 1979). Figures 1 through 4 represent the calculated intensity

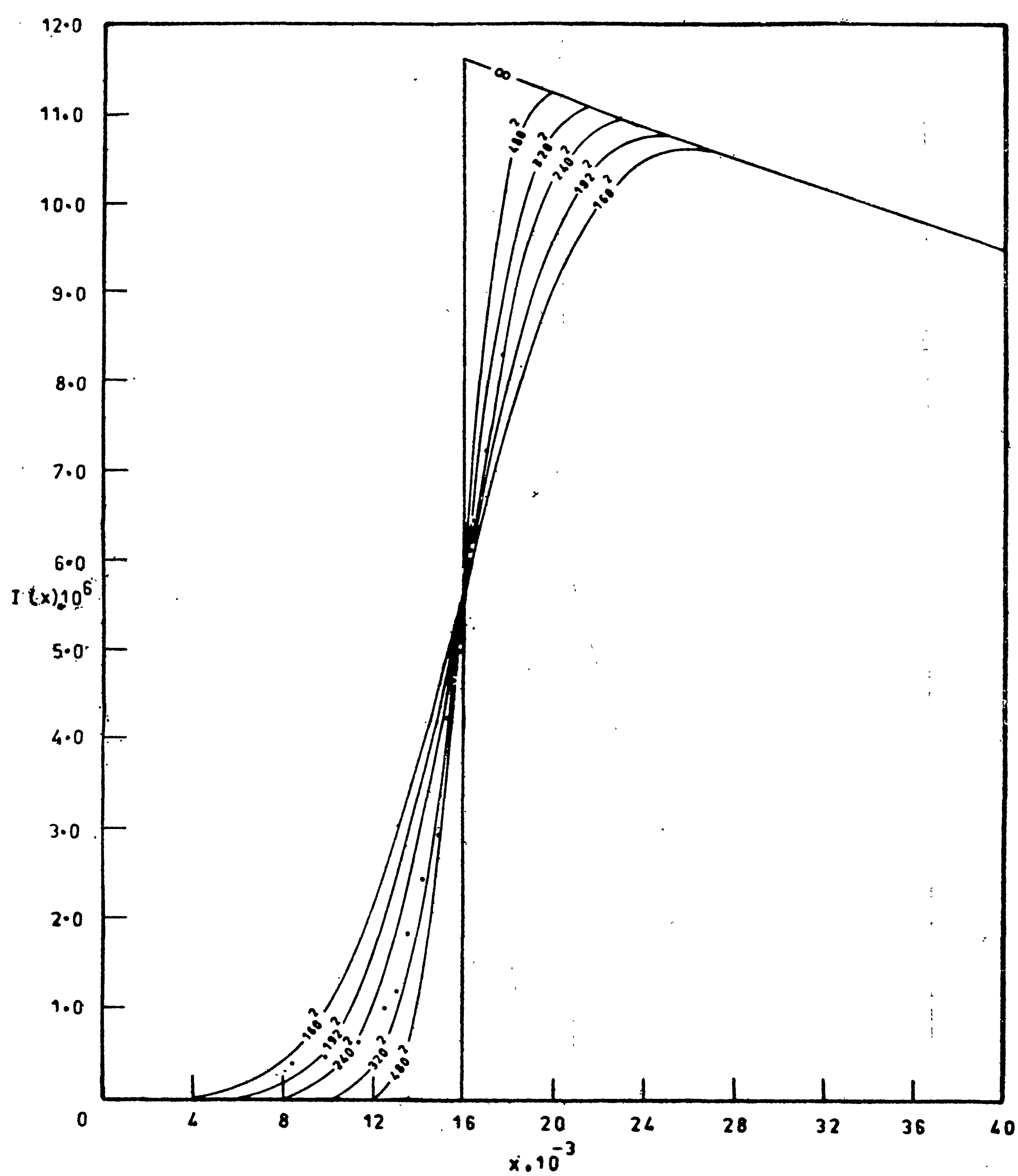

Figure 4. Coronal intensity profile near the west limb.

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profiles of the corona in the north, east, south and west directions from the centre of the sun, respectively; the dots in each curve represent the observed intensity.

3. Results

Comparing the observed intensity distributions with the computed ones, we find that the spread of the observed intensity distributions in the solar corona for observations made at Raichur station during the 1980 eclipse lies between 3 and 4 arcsec. It may be noted from figure 2 that there is some scattered light within the lunar disc in the east side.

Normally one comes across stellar seeing discs of 2 to 5 arcsec. Wanders (1934) had encountered broadening between 7 to 17 arcsec for his solar observations in daytime.

An application of this method to Raju & Abhyankar's (1982) coronal observations made from Japal-Rangapur observatory gave large values of about 16 arcsec for the south limb in blue and between 16 and 32 arcsec for the north limb in blue, and both south and north limbs in red. This has to be attributed to poor imaging by the instrument. An inspection of the original films showed that there is some smearing of the image due to small jumps of the film during exposure.

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