Photometric Analysis of the Solar Corona on 1984 November 22/23

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Introduction

The total solar eclipse of 1984 November 22/23 was observed from a French naval vessel off Noumea (New Caledonia) in the Coral Sea. The observations were made by a team from the S.A.F., led by Serge Koutchmy and Christian Nitschelm of the Institut d'Astrophysique de Paris. The duration of the eclipse was considerably longer off New Caledonia (1 m 39 s) than in Papua-New-Guinea (55 s). However, the observational site – on board a ship well out to sea – greatly restricted the use of long-focal-length instruments that are normally employed. The equipment used to photograph this eclipse therefore was chosen with motion (pitching, rolling, etc.) of the support in mind. Short focal lengths were preferred, although one refractor with a focal length of 1.5 m was used as a trial.

Observations and Results

The geographic location of the observing site was 165° 11′ 36″ East, 20° 03′ 36″ South. The ship was practically on the central line. The altitude of the Sun was 50.5° and its azimuth 94°.

The results obtained were better than expected. In particular the 1.5-m f/15 refractor, fitted with a Zenith 80 body, obtained two images that did not show any motion. The film used was Ektachrome 400, 6 × 6, a good compromise between fine-grain and the speed needed when the support is in motion. The other objectives used either 35-mm Ektachrome or much faster films, such as 35-mm Fujicolor 1600.

With a radial neutral density filter, we processed the high-resolution images in order to accentuate fine detail in the corona. The resulting image showed coronal structure at the time of the eclipse, and jets and the magnetic-field lines could be seen easily.

Photometric Analysis

Using the best images and video-processing equipment at the Institut d'Astrophysique de Paris, we were able to construct sets of isophotes. Calibration was carried out by using existing coronal models. These isophotes allow the ellipticity of the corona to be calculated. This is given by the following equation:

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$$\varepsilon = \frac{R_{\text{eq}}}{R_{\text{pol}}} - 1 \quad .$$

Near the solar limb, this ellipticity follows a linear law:

$$\varepsilon = a + b\left(\frac{R_{\text{eq}}}{R_{\odot}} - 1\right)$$

where a and b must be determined for each eclipse.

The curve of the change in the ellipticity factor enables us to determine the values of $a - b$ and $a + b$ as -0.289 and 0.381, which gives values of 0.046 and 0.335 for a and b. These values appear high, especially $a + b$ (ε at $2\,R_{\odot}$), given the period of the cycle (beginning of solar minimum, $\phi = -0.23$).

Conclusion

This study shows that it is perfectly possible to observe a total solar eclipse at sea and obtain results that can be of some value. This work is only a beginning, however, and a more complete study is required.

The corona was near its least active phase (solar minimum in 1986), but it still showed distinct jets and polar plumes.

Even with the limited equipment and somewhat precarious observing condition, interesting results were obtained, confirming that observation of total solar eclipses by amateurs advised or trained by professionals should be standard practice for future eclipses.

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