CORONAL STRUCTURE OBSERVED AT THE TOTAL SOLAR ECLIPSE OF 11 JUNE, 1983 IN INDONESIA*

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(Received 22 March, 1985)

Abstract. From the photographs taken at the total solar eclipse of 11 June 1983, we derived the electron density for the north polar rays and for the thread-like fine structures above the active region, which are 10^8 at 1.4 solar radii and 3×10^9 at 1.15 solar radii, respectively. The brightness distributions of the corona at the polar region and above the active region, and the flattening index were also derived.

1. Introduction

The corona has thread-like fine structures, which presumably follow the coronal magnetic fields closely. Some structures extend radially and some show loops, surrounding the prominences. Coronal heating is probably related to the magnetic field and, therefore, the physical conditions of the thread-like fine structures in the corona would be important for considering the coronal heating.

For the purpose of obtaining details on fine structures of the corona, coronal observations at the total solar eclipse of 11 June, 1983 were carried out at Cepu and Mojokerto in Java island in Indonesia. The weather on the eclipse day was good at Mojokerto, but cloudy at Cepu.

2. Observing Instruments

A horizontal telescope of a doublet lens (ϕ = 20 cm, f = 11 m) fed by a 30 cm aperture Coelostat was used for observing the K corona by using an O-57 sharp cut filter with

* Paper presented at the IAU Third Asian-Pacific Regional Meeting, held in Kyoto, Japan, between 30 September–6 October, 1984.

Astrophysics and Space Science **119** (1986) 9–15.

a large aerial camera (WILD made in Swiss) at mid-totality. A part of the green line corona, observed with an interference filter of 5303 Å (bandwidth; 3.7 Å), and a part of the K corona, observed with an interference filter of 5000 Å (bandwidth; 450 Å), were both photographed with four 35 m/m Nikon motor drive cameras just after the second contact and before the third contact. The films used were Kodak Plus-X aerographic film 2402 for the large camera, and Kodak Tri-X for 35 m/m cameras. A 20 cm equatorial telescope with a doublet lens (f = 225 cm) was used for taking the K corona and green line corona by using interference filters of 5780 Å (bandwidths;400 Å) and 5303 Å (bandwidth; 3.7 Å), and their degree of polarization was measured with a linear polarizer. Kodak Tri-X 2B film was used for this purpose.

The K corona was also observed with a Celestron 5 (ϕ = 12.7 cm, f = 127 cm) and Celestron 8 (ϕ = 20 cm, f = 2 m) using Kodak 2415 film.

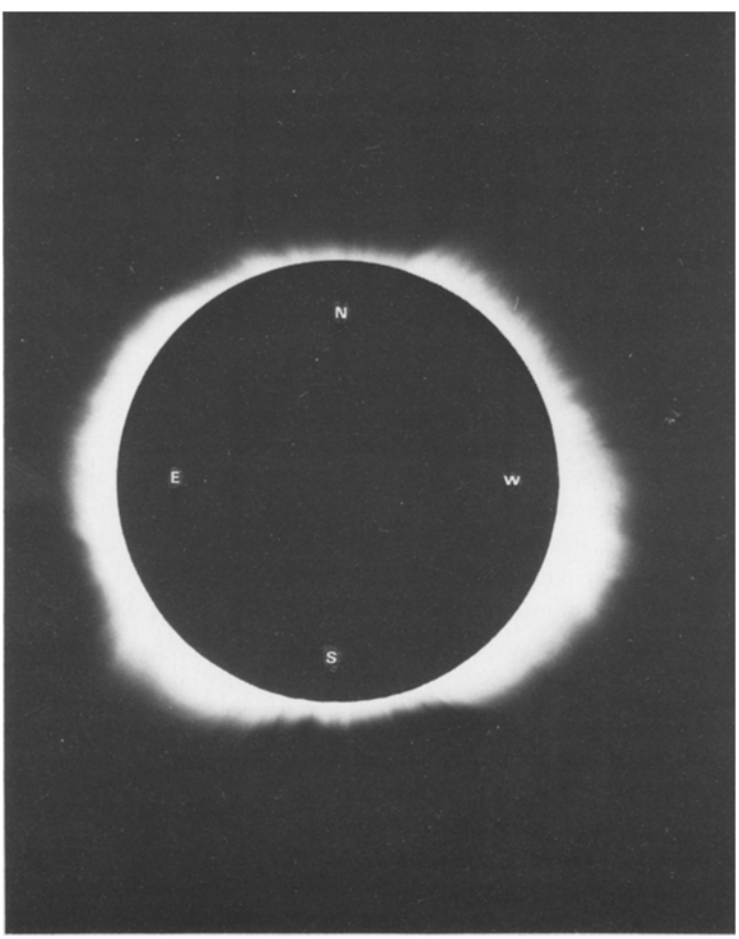

Fig. 1. Photograph taken with a 10 cm equatorial telescope (f = 110 cm) at Mojokerto. Effective wavelength: 6270 Å, film: Kodak 2415, and exposure time: 1 s.

The former two instruments were operated at Cepu by the team of the Tokyo Astronomical Observatory, and the two Celestrons were operated by the team of LAPAN (Indonesian National Institute of Aeronautics and Space).

The team of the International Latitude Observatory took the fine K corona at Mojokerto with a 10 cm equatorial telescope (f = 110 cm) at an effective wavelength 6271 Å by using an interference filter (bandwidth; 98 Å).

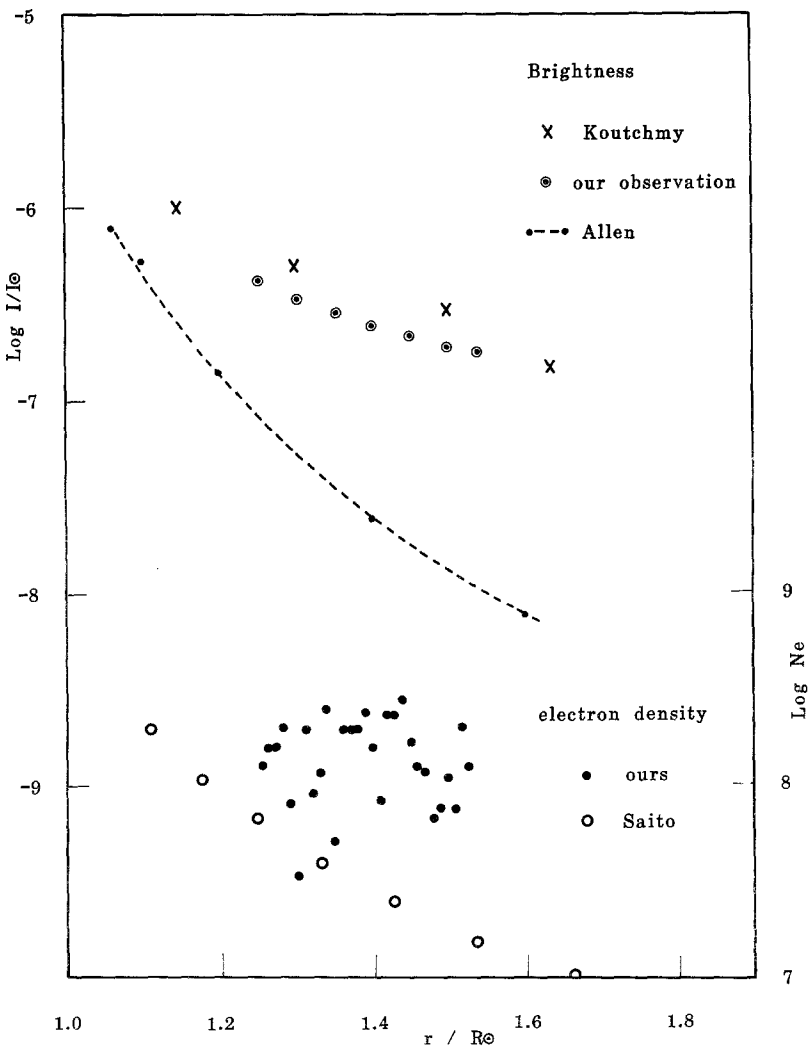

Fig. 2. Brightness distribution of the corona at the north polar region (above), and derived electron density (down) with height in units of the solar radius. The left ordinate is expressed in units of the continuum brightness at the disk center at 6270 Å. The cross represents brightness measurements by Koutchmy and Nitschelm (1984), and 'Allen' means the smoothed coronal brightness at the pole, at minimum phase, in the K corona (Allen, 1973). The circle represents the electron density derived by Saito (1965).

3. Observations

The geodesic positions of the observing sites at Cepu and Mojokerto were determined by Doppler observations of the NNSS satellite. The positions are at longitude = E 111°35′25″.909; latitude = S 7°7′52″.350; h (height from sea level) = 92.07 m at Cepu, and at E 112°26′39″.540; S 7°27′1″.355; h = 77.53 m at Mojokerto.

The eclipse observations at Cepu were carried out under a cloud, though the films taken with longer exposure times of 30 s show some coronal features. At Mojokerto, however, fine coronal photographs were obtained at an exposure time of 1 s as shown in Figure 1.

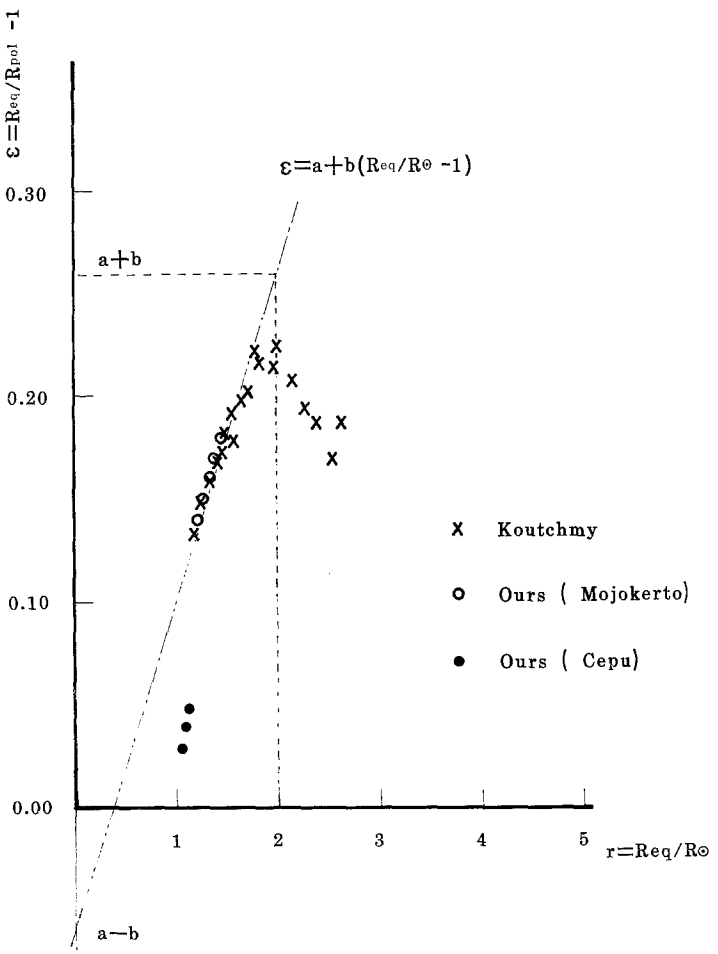

Fig. 3. Flattening index versus height. The crosses denotes the results of Koutchmy and Nitschelm (1984); the circles at Mojokerto; and points, those at Cepu, LAPAN.

4. Analysis

The films taken at Mojokerto and Cepu were traced with a microphotometer at the Tokyo Astronomical Observatory.

The brightness distribution of the corona was derived from the film taken at Mojokerto. The solar disk, reduced by neutral filters, was taken before and after the eclipse for an absolute calibration. The brightness distribution with height at the north polar region is shown in Figure 2, which is in good agreement with Koutchmy and Nitschelm (1984) result.

The intensity and width of a north polar ray were measured along its length. The intensity around the ray was assumed to be as a background and a total width at half intensity was measured at different heights. This width, on average, is about 10 arc sec, which is almost the same as the measurements by van de Hulst (1950).

The electron density for the ray is derived as shown in Figure 2, under the assumption that the length in line-of-sight of the ray is the same as its width. The deduced electron density is about five times larger in this ray than Saito's (1965) result.

The flattening index, defined by H. Ludendorff (van de Hulst, 1953), was computed by using the iso-intensity curves derived from the film taken at Mojokerto. The film taken by the LAPAN team at Cepu, which might be affected by cloud, also gives the flattening index near the solar limb. The index values at Mojokerto are in agreement with Koutchmy and Nitschelm (1984) result, as shown in Figure 3.

The thread-like fine structures above the active region at the west limb were measured on the film taken with the horizontal telescope at Cepu. Iso-intensity curves indicating

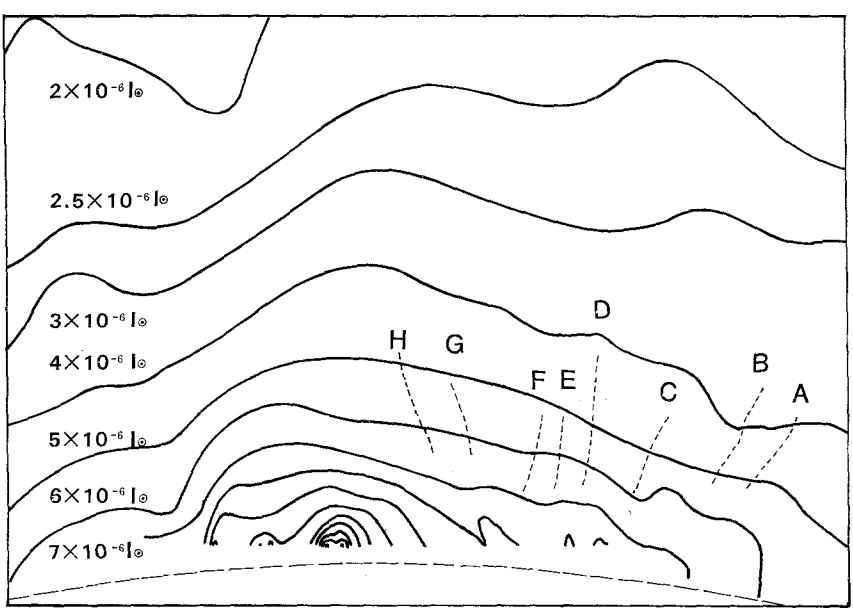

Fig. 4. Iso-intensity curves, and positions, of the thread-like fine structures derived from the film at Cepu.

the positions of the fine structures are shown in Figure 4. The absolute intensity has here been calibrated in such a way that the brightness above the equator at the west limb becomes equal to that derived from the Mojokerto data. The widths of the fine structures are about 10 arc sec on the average. The electron densities for these structures have been derived, as shown in Figure 5, under the same assumption of cylindrical shape of the structures. The widths of the thread-like structures above the active region, and the polar ray, are about the same. If the electron density above the active region decreases with height in the same way as Newkirk's (1967) model, then the electron densities above the active region at 1.4 solar radii are larger by 10 times than at the polar ray.

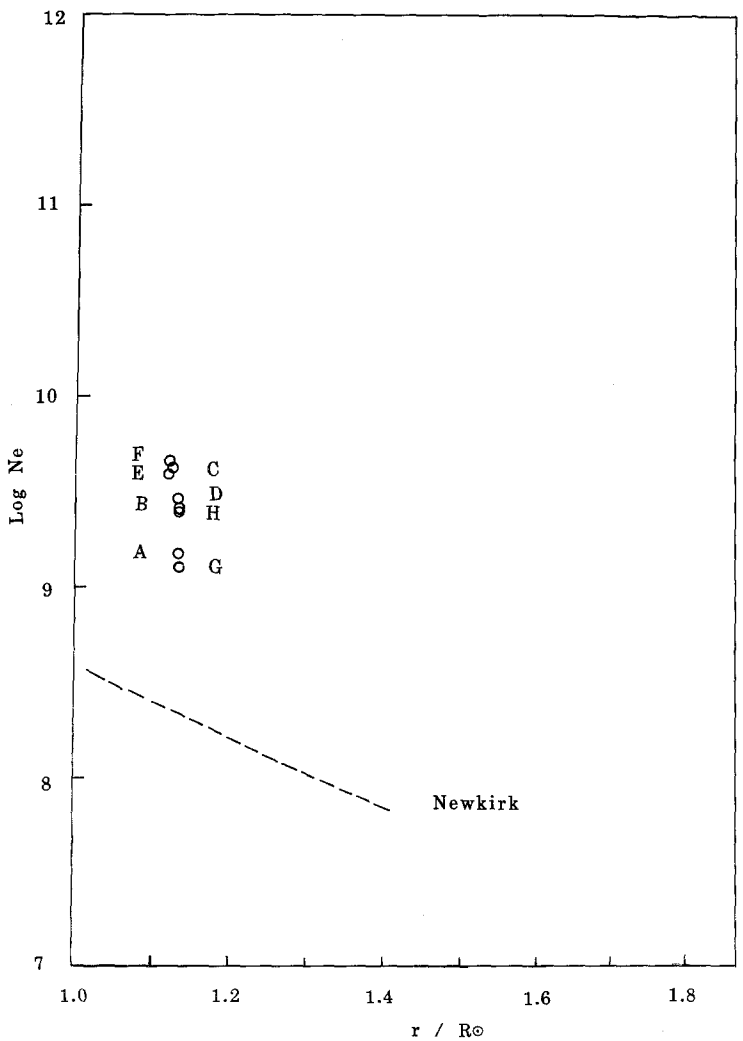

Fig. 5. Electron density of the fine structures with height. The dotted line is a model corona at maximum phase (Newkirk, 1967). *A*, *B*, ..., *H* are the electron density values in each fine structure.

Acknowledgements

We would like to express out hearty thanks to the National Committee for the 1983 Solar Eclipse in the Indonesian Institute of Sciences (LIPI) for giving us information and taking care of the customs arrangements for the eclipse, and to the Indonesian National Institute of Aeronautics and Space (LAPAN) for arranging the observing sites and sending the staffs to help our observations. The research of the eclipse observation was carried out with the support of the Overseas Scientific Research, Ministry of Education, Science, and Culture, Japan.

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