SPECTROPHOTOMETRY OF THE CORONA AND A QUIESCENT PROMINENCE BASED ON OBSERVATIONS OF THE TOTAL SOLAR ECLIPSE OF 7 MARCH, 1970 IN MEXICO

G. M. NIKOLSKY, R. A. GULYAEV, and K. I. NIKOLSKAYA
Laboratory of Solar Activity, Institute of Terrest. Magnetism, Ionosphere and Radio Wave Propagation, Academy of Sciences of U.S.S.R.

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Abstract. Slit spectrograms of a quiescent prominence and the inner corona (h ≤ 2.5 arc min) in the range λλ3400–7000 Å (dispersion 6–10 Å/mm) were obtained. From an analysis of the Stark effect on the Balmer lines (up to number 36) the electron density in the prominence n_e = (7 ± 3) × 10^{10} cm^{-3} was deduced. The kinetic temperature T_k and the non-thermal velocities v_n, found from a simultaneous consideration of the Balmer and metal lines, are T_k ≈ 10^4 K and v_n ≈ 6 km/s. Also the emission measure of the prominence along the line-of-sight was found: ME = 10^{31} cm^{-5}.

In the coronal spectrum 24 coronal lines were found. Thirteen of these lines were identified and measured photometrically to get their absolute intensities, profiles and halfwidths. For nine lines the intensities as a function of the height were studied and on this basis the coronal lines were divided into a few groups. The line-of-sight and non-thermal velocities are v_T ≤ 10 km/s and v_n ≈ 25 km/s. The coronal lines originate in at least three types of regions with different temperatures. The emission measure as a function of the ionization temperature was determined. The abundances of four elements of the iron group (V, Cr, Mn, Co) were estimated. The abundances of the other elements of the same group (A, Ca, Fe, Ni), found from EUV-data, are in a good agreement with our observations. The degree of inhomogeneity in the corona was estimated: n_e/(n_{e})^2 ≈ 3–10.

1. Introduction

Three persons from the Laboratory of Solar Activity of IZMIRAN observed the total solar eclipse of 7 March, 1970 near Miahuatlan in Mexico as a part of the Russian expedition. The observational program consisted of four experiments:

(1) A spectral experiment to obtain photographs of the chromospheric and coronal spectra utilizing an échelle spectrograph. The observers were R. A. Gulyaev and K. I. Nikolskaya.

(2) Observation of the polarization of the coronal continuum in the yellow-green spectral region with an instrument of 8 m equivalent focal length. The observer was A. A. Sazanov.

(3) Photographing the inner corona with a red filter, for photometric studies. The observer was R. A. Gulyaev.

(4) Photographing the outer corona on color negative film for three-color photometry. The observer was A. A. Sazanov.

The weather at the eclipse time was fine and the observations were carried out under perfect atmospheric conditions. All the parts of the observational program were fulfilled.

This paper contains the results of the spectral observations.

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2. The Equipment. Observations and Measurements

The equipment used was an échelle spectrograph (with a grating of 600 lines per mm, a 3° prism and \( f_{\text{cam}} = f_{\text{col}} = 980 \text{ mm} \) adopted for the simultaneous recording of three orders (IV, V, VI) covering the wavelength range from 3400 to 7000 Å. The dispersion in the different orders varied between 6 and 10 Å/mm. The solar image was formed on the slit with a spheric mirror \((f/15; f = 250 \text{ cm})\). A Zeiss transportable coelostat and additional plane mirror were used as a feeding system. The straight slit of the spectrograph crossed the solar limb in the point of the second contact under an angle of about 20° with the limb (the position angle was 35°). The slit was 0.03 mm wide. The spectra were photographed with panchromatic film of Type 17 \((12 \times 24 \text{ cm}^2)\). The slit position is shown on the picture of the corona (Figure 1), based on photographs taken by Dzubenko (Kiev) at the Mexican eclipse with an \( f = 10 \text{ m} \) camera.

Fig. 1. Position of the slit of the spectrograph. Part of the coronal structure scheme as drawn by Dzubenko and Ivanchuk is represented. The dotted line shows the position of the Moon's limb at the end of the 100 s exposure. Prominences are seen at the limb and faculae against the disk.