INTERFEROMETRIC OBSERVATION OF THE F-CORONA RADIAL VELOCITIES FIELD BETWEEN 3 AND 7 $R_\odot$

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ABSTRACT. During the July 31, 1981 solar eclipse, F-corona interferograms near MgI λ 5184 Å were obtained using a Fabry-Perot etalon (FPE) with an FWHM of 0.5 Å (corresponding to 30 km/sec) and an image tube. Radial velocities V_r of the interplanetary dust (i.d.) were measured in different directions.

Both prograde and retrograde motions of i.d. in the ecliptic region is discovered. Most of velocity values do not exceed 50 km/sec. A negative velocity component appears after averaging all V_r for all directions. Its average increases to - 20 km/sec toward the Sun. Some ejections are observed. The strongest (+ 130 km/sec) is located at the north ecliptic pole at a distance of 6 to 7 $R_\odot$.

From the lack of unshifted Fraunhofer lines in the scattered sky light, we conclude that the sky brightness continuous component is predominant and its source is K-corona scattered light in the Earth's atmosphere.

1. INTRODUCTION

There are some difficulties in the problem of radial velocities V_r measurements during eclipses because of relatively low F-corona brightness at distances $R > 3\ R_\odot$. We know of only two such experiments: i) during the June 30, 1973 eclipse at a distance of 7.5 $R_\odot$ West of the Sun, the i.d. radial velocity (about + 50 km/sec) was measured using a Fabry-Perot spectrometer at MgI λ 5184 Å (Kozlov et al., 1974); ii) during the February 26, 1976 eclipse, the radial velocities at distances $R = 3.2\ R_\odot$ and $R = 4.3\ R_\odot$ West of the Sun were measured using the correlative radial velocity spectrometer (Beavers et al., 1980). The common feature of both velocity profiles is the existence of a maximum $V_r \approx 50$ km/sec. One can see that such measurements are

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not numerous and that our work will alleviate this situation to a certain degree.

2. MATERIALS AND METHODS

The optical design of the instrument is described in details by Shcheglov et al. (1983). The joint expedition of Astrophysical Institute, Alma-Ata and Sternberg Astronomical Institute, Mocow for the observation of the July 31, 1981 total solar eclipse was lain near Shortandy of the Tselinograd region. The duration of totality was about 75 sec; interferograms of the corona and of the reference emission line of Ar λ 5187 Å were recorded on Kodak 103-aG emulsion. Only one photograph (53 sec) has normal photograph density and was used for the treatment.

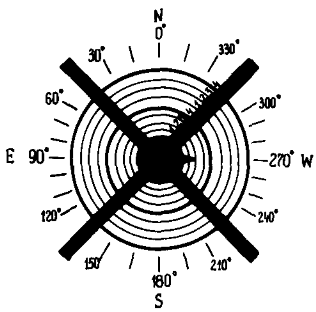

Figure 1. Representation of the 53 sec exposure interferogram. NS is the direction to the ecliptic poles. 1 - λ 5195 Å, 2 - λ 5192 Å, 3 - λ 5189 Å and 4 - λ 5184 Å MgI lines.

Fig. 1 represents the interferogram. It shows the central occulting disk which blocks the corona up to 2.5 $R_{\odot}$ and the 'cross' of the Ar lamp. Two interference orders are used for the treatment, each one has 4 rings formed by one or a few Fraunhofer lines. The definition of the center of the rings and the identification of the lines were made using the nonshifted lines of the day sky on a pre-eclipse photograph.

RMS deviation is 20 km/sec after the treatment using an automatic microdensitometer. The differential distortion errors relatively to Ar is small. The error due to the orbital motion of the Earth is less than 1 km/sec.

3. RESULTS

There is a velocity dispersion in the F-corona which exceeds the error bars at the change of the distance by value 0.5 $R_{\odot}$. The bifurcated lines both narrow and expansive are observed; mainly the bifurcation corresponds to the shift relatively main line to the negative direction.

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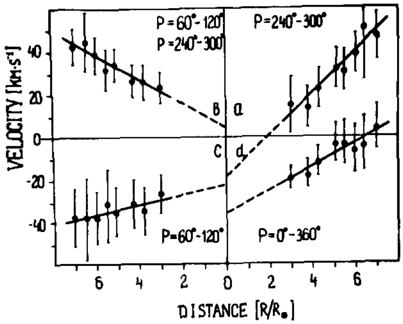

Figure 2. Measured and averaged radial velocities for different directions. a - West; b - West + (- East) - only direct Keplerian component; c - East; d - all components for all directions.

In the ecliptic region, the average velocity is negative on the east side of the Sun and positive on the west side. It proves the prograde Keplerian motion of matter. The average variation of the Keplerian velocity with the distance may be approximated by a linear dependence (Fig. 2b) V_r [km/sec] = (5.4 ± 0.7) $R/R_\odot$ + 5 ± 4.

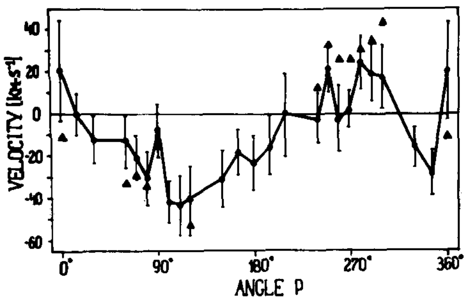

Figure 3. Solid line - V_r (P) averaged from 3 to 7 $R_\odot$; ▲ - retrograde motions and points with + 130 km/sec at P = 0° are excluded.

The absolute velocity averaged from 3 to 7 $R_\odot$ reaches a maximum near the ecliptic and a minimum near the poles (Fig. 3). There is a decrease of the velocity near the plane of ecliptic (P = 90 and P = 270°). The negative velocity component independent of the distance (Fig. 2d) shows the evidence of i.d. moving radially outward from the Sun. A local velocity peak of + 130 km/sec at the north ecliptic pole between 6 and 7 $R_\odot$ appears. On the negative, it is expressed in form of the distorsion of lines λ 5184 Å and λ 5189 Å. Up to a distance of 7 $R_\odot$ practically, there is no indication of a velocity component corresponding to nonshifted Fraunhofer lines in the scattered sky light.

4. DISCUSSION

The obtained velocity are values integrated over the line of sight. One can make no conclusion on the real dust velocity value at given distances from the Sun without a model (and assumptions) of the i.d. cloud.

Fig. 2a and 2c shows the prograde Keplerian motion. The different slopes for E and W is easily explained by the existence of a radial velocity component directed to the Sun and changing with distance (Fig. 2d). The asymmetric wide maximum of the prograde Keplerian velocities w.r.t. the abscissa axis may be explained by this cause too. The discovery of velocities in F-corona exceeding that the prograde Keplerian motion may be connected with the cometary dust scattered near the Sun, moving near the ecliptic in a retrograde direction. This comet was observed in July 20, 1981 (Sheely et al., 1982). The local decrease of the absolute velocitie for P = 90° and 270° (Fig. 3) may be also explained by the retrograde motion of cometary dust.

The absence of a "zero" velocity component corresponded to non-shifted lines in the eclipse sky is unexpected. It may be understood if one supposes that the sky brightness has a considerable continuous component. The scattering of the K-corona light in the Earth's atmosphere may be the main source of this component. According to our estimates, the Fraunhofer component of the eclipse sky brightness is weaker than the continuous component by at least one order of magnitude. This conclusion gives a new view on the possibility of spectral observations of the F-corona at large distances.

5. REFERENCES

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