THE SOLAR MASS EJECTION OF 8 MAY 1979

D. J. Michels, R. A. Howard, M. J. Koomen, & N. R. Sheeley, Jr.
E. O. Hulburt Center for Space Research
Naval Research Laboratory
Washington, D. C. 20375, USA
and
B. Rompolt
Astronomical Observatory of the Wroclaw University
51-622 Wroclaw UL. Kopernika 11, Poland

Abstract: This paper describes the main features of the 8 May 1979 solar mass ejection, including the eruption of a polar crown filament to 1.5 $R_\odot$ during 0810-1036 UT and the passage of material through the outer corona, from 2.6 to 10.0 $R_\odot$, during 1028-1246 UT.

An earlier paper in this Symposium (Sheeley et al., 1979) described the NRL SOLWIND coronagraph. Briefly, it is optically similar to the NRL coronagraph on NASA's OSO-7 satellite (Koomen, et al., 1975), but it has greatly improved temporal resolution. With this instrument in orbit on the P78-1 satellite, images of the entire outer corona, from 2.6 to 10.0 $R_\odot$, are obtained every ten minutes.

Figure 1(a) is a composite, showing the appearance of the sun in Hα at 0701 UT on 8 May. As is typical at epochs near solar maximum, polar crown filaments encircle the north and south poles. One of these filaments, is visible as a prominence at S55W90 (prominence photo at

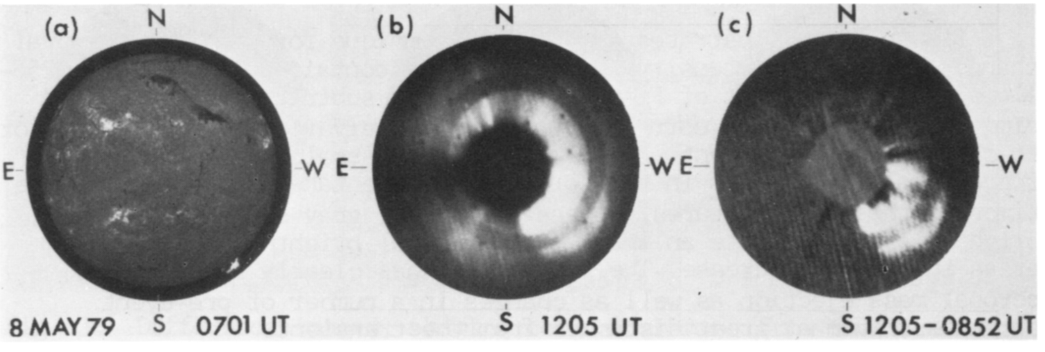

Fig. 1: (a) Composite, showing Hα limb and disk observations of the south polar crown filament prior to its eruption at S55W90. (b) Outer corona at 1205UT (c) Same data as (b), but with pre-event image at 0852 UT subtracted.

M. Dryer and E. Tandberg-Hanssen (eds.), Solar and Interplanetary Dynamics, 387-391.

https://doi.org/10.1017/S0074180900067875 Published online by Cambridge University Press

0704 UT). This filament later erupted, (Figure 2), beginning at about 0810 UT and reaching maximum distance of 1.5 $R_\odot$ from the center of the sun at 1021 UT. Subsequently the prominence faded, and some of the material fell back to the solar surface. By 1120 UT, vestiges of the Hα prominence had disappeared. The bulk of the prominence material displayed radial velocities averaging 40 km s^{-1}; the maximum velocity observed was 165 km s^{-1}.

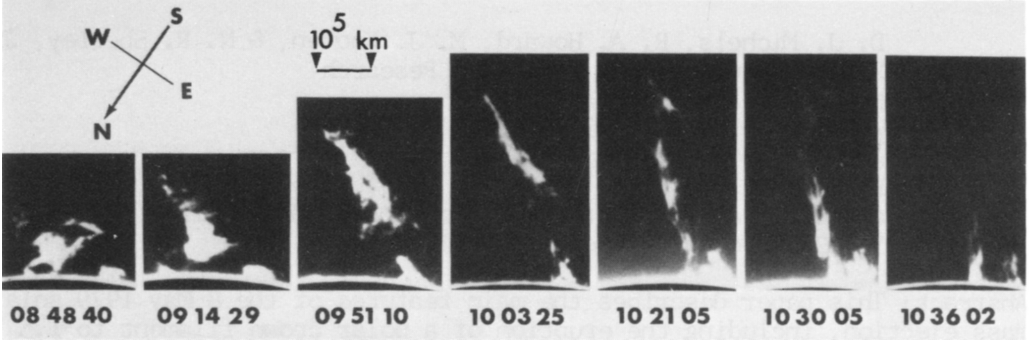

Fig. 2: Sequence showing eruptive prominence in Hα.

Figure 1(b) is an image from the orbiting coronagraph, recorded at 1205 UT. Here the transient is seen in the SE quadrant, midway through the instrumental field of view. The roughly circular brightening measures approximately 6 $R_\odot$ in diameter at this time. Note that the instrument's occulting disk forms a shadow that extends to 2.6 $R_\odot$. The outer edge of the field of view has been masked down to about 8 $R_\odot$. The slightly off-center ring at $\sim$5 $R_\odot$, darker than its surroundings, is caused by a focal plane polarizer with its axis everywhere approximately radial; the remainder of the focal plane contains a concentric polarizer with its axis everywhere at right angles to the solar radius, thus discriminating in favor of K-coronal radiation. There is a second annular ring, barely visible in this picture, at $\sim$8 $R_\odot$. (Koomen et al., 1975).

Figure 1(c) illustrates a powerful technique for studying temporal changes of coronal intensity. Here, the data contained in the 256 x 256-element picture matrix of Figure 1(b) has had subtracted from it a similar picture matrix corresponding to an observation at 0852 UT, prior to onset of the transient. The resulting gray-scale presentation then represents only changes in the corona that have taken place between the times of these two pictures. Areas of neutral gray signify no change; brighter areas indicate an increase in coronal brightness and darker areas indicate a decrease. The subtraction has clearly revealed the coronal mass ejection as well as changes in a number of pre-event streamers, even at great distances from the transient.

In Figure 3 one can trace the development of the transient from 1028 UT until 1246 UT, when the leading edge of the ejecta had almost reached the limit of the instrumental field of view at 10 $R_\odot$. The leading edge moves outward with a constant radial velocity of approximately 500 km s^{-1}. Projected back to the solar limb, this would indicate an onset near 0950 UT. Figure 2 of the accompanying paper (Sheeley et al., 1979) shows the pre-event corona at 0852 UT, which has been subtracted to produce these images. Comparison of the 0852 UT image with that at 1028 UT shows that the first manifestation occurred in the region of the pre-event streamers at S15-60W90. Also, there developed a brighter and more sharply-defined feature at S65. This

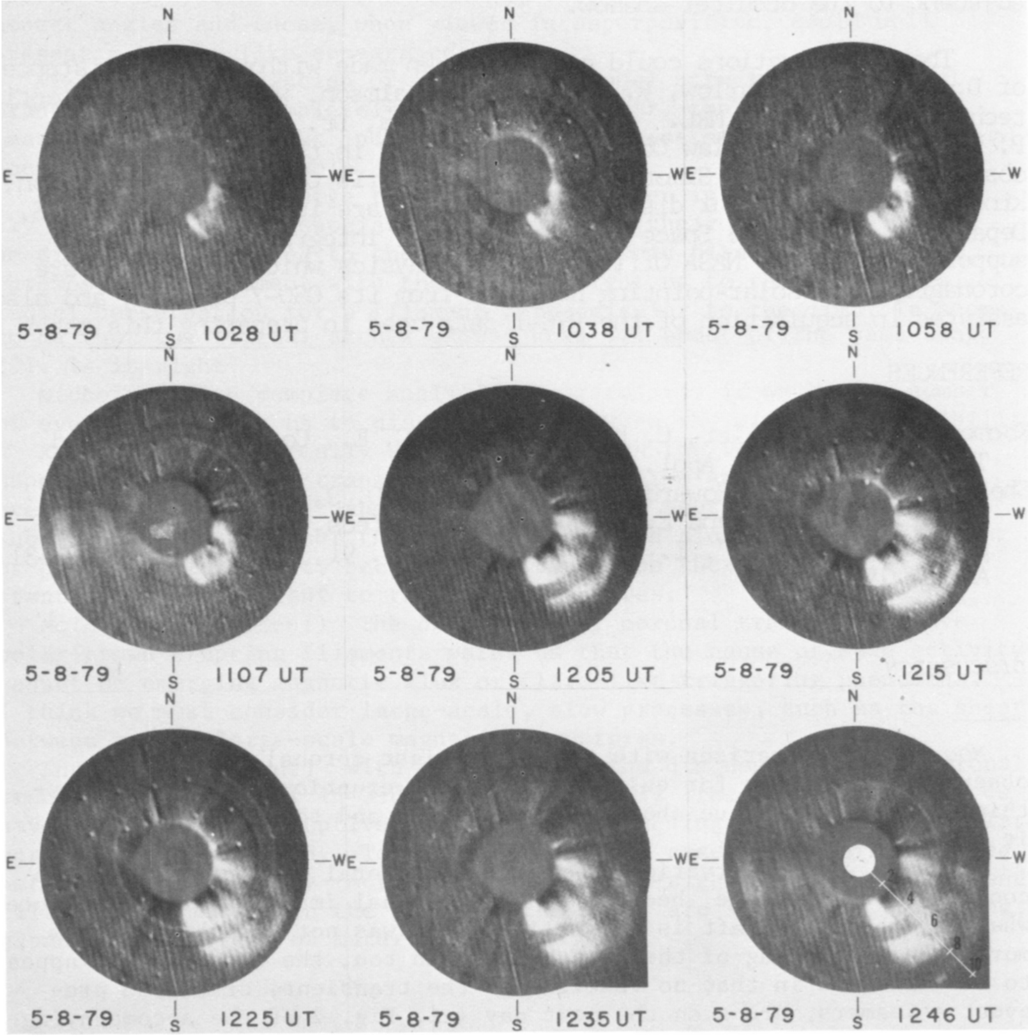

Fig. 3: Difference images, showing coronal changes from the time of a reference image at 0852 UT to the times indicated. In the last two images, the mask has been cut to show expansion of the transient to the instrumental limit of 10 $R_\odot$. The scale marks distance from sun center in solar radii; the white spot indicates the size of the photospheric disk.

https://doi.org/10.1017/S0074180900067875 Published online by Cambridge University Press

continued to be the brightest part of the transient. In the images starting with 1038 UT,there is a neutral gray spot (signifying no brightening) imbedded in the outward moving plasma, suggestive of a cavity within the ejecta. A small, denser region may be seen within this cavity, particularly in the 1058 and 1107 UT images. The spacecraft passed into the Earth's shadow after recording the 1107 UT image. In the next observation, at 1205 UT, there is evidence for disappearance of the pre-event streamer cluster, as indicated by the darkened area adjacent to the occulter shadow.

These observations could not have been made without the assistance of D. Roberts, F. Harlow, R. Seal,and R. Chaimson, who provided essential technical support at NRL. Dr. I. Garczynska, Dr. J. Paciorek, and P. Majer, of the Wroclaw Observatory assisted in the Hα prominence observations. Dr. P. Simon, University of Paris Observatory at Meudon, kindly supplied the Hα disk photograph. We are indebted to the U. S. Department of Defense Space Test Program for integration and launch support, and to the NASA Office of Solar Physics which provided spare coronagraph and solar-pointing hardware from its OSO-7 program, and also assisted in acquisition of the P78-1 data used in preparing this paper.

REFERENCES

Koomen, M. J., Detwiler, C. R., Brueckner, G. E., Cooper, H. W., and Tousey, R.: 1975, Appl. Opt. 14, 743.

Sheeley, N. R., Jr., Howard, R. A., Michels, D. J., and Koomen, M. J.: 1979, in M. Dryer and E. Tandberg-Hanssen (eds.), "Solar and Interplanetary Dynamics", I. A. U. Symposium No. 91, Cambridge, MA, 27-31 August 1979.

DISCUSSION

Moore: In comparison with the white-light coronal transients observed from Skylab for quiescent filament eruptions, was there anything unusual or unique about this transient and to what degree was it average or typical?

Michels: The observation is unique in several respects: first, in continuity of coverage, because we have coronal images every ten minutes whenever the spacecraft is in sunlight - it was not possible to show more than a sampling of the data here; then too, the event itself appears to be different in that no vestiges of the transient, or of the pre-event streamers, are seen the next day (cf. Fig. 2 of the accompanying paper (Sheeley et al., 1979)). Anzer and Poland have said that, in those Skylab events studied, residual "legs" of the transient remained for one to two days afterward. (Anzer, U. and Poland, A. I.: 1979, Solar Phys., 61, 95.)

Sheeley: It may also be mentioned that this event took place near solar maximum. No Skylab events involved polar crown filaments because there were none at that time.

Martres: In this session we learn that the three dimensional spatial extension of the coronal transients is mainly similar to a bubble. Now we try to associate these coronal transients to destablize filaments which have a quasi-planar extension: how do you explain this apparent contradiction?

Michels: The form of the ejected material is not made completely clear from this observation. For example, if the transient is associated with a pre-existing arcade of loops following the sinuous course of a typical filament channel, then loops would be seen at many aspect angles and these, when viewed in superposition, could well present a bubble-like appearance.

Newkirk: The question of the 3-dimensional structure of coronal transients is not completely answered. However, the polarization measures in white light indicate that this gross structure resembles a loop rather than a bubble.

Martres: If the large transient arches seen in the corona in the sky plane are to be associated to filaments, their "curvature" would be directly correlated to the angle of the main direction of the chromospheric filament with the line-of-sight up to the limit of a radial perturbation for a filament perpendicular to the limb. It seems to me that the coronal arches showed here are about of the same shape (?). Is it right?

Michels: More complete analysis, particularly if we have a number of events, may help us to discriminate between the different possibilities.

Kahler: I don't really see a problem with the three-dimensional aspect of the coronal transients. If we imagine an arcade of loops over-lying the filament and running along the neutral line, then it shouldn't matter whether the neutral line lies along the line of sight or perpendicular to it, because in either case there will be a substantial angular extent to the loop structures.

McIntosh: (Comment) The occurrence of coronal transients above polar-crown erupting filaments warns us that the cause of such activity cannot be emerging magnetic flux or flare-like triggering phenomena. I think we must consider large-scale, slow processes, such as the shear between moving large-scale magnetic structures.

Engvold: (Comment) With reference to the discussion on how coronal transients may appear in 3-dimensions, I would like to mention what we have learned about eruptive prominences (ascending prominences and flare sprays) in this regard. To my knowledge, the cases which are recorded both spectroscopically (motion in the line-of-sight) and on narrow band filtergrams (motion in the plane of the sky), are suggestive of rising, expanding "bubbles" of material.