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GODDARD SPACE FLIGHT CENTER
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IMPLICATIONS FOR FLARE BUILD-UP AND HEATING FROM OBSERVATIONS MADE BY OSO-7

By

W. M. Neupert

NOVEMBER 1975

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Rust at this meeting has already presented a discussion of EUV and Hα observations of a slow rise flare on January 19, 1972 that was preceded by filament activation and eruption. He noted the first appearance of an EUV bright point near a region of emerging magnetic flux as the "trigger phase" of this event. Because of the slow development of this event and its relatively large size, the OSO-7 observations with 20 arc sec spatial resolution and one minute resolution in time (the time required for the instrument one 5 arc min x 5 arc min raster over the region) were adequate to distinguish the various phases of this event (Rust, Nakagawa and Neupert, 1975). It is therefore appropriate to discuss the evolution of the EUV and soft x-ray emission in this event in terms of the slow (passive) and fast (active) phases of flare evolution that were discussed by Schindler and others in earlier papers at this meeting and to summarize the implications for a flare build-up model which we derive from these observations. Let us consider the observations in temporal sequence.

1. The gradual, smooth untwisting of the filament prior to 1636 UT (Figure 1) can be considered the slow phase of this event. EUV emission from an Mg VIII emission lines began to increase near a region of emerging flux (Point A) during this time (Figure 2a). Concurrently, a small rise (a factor of two) in the original level of soft X-ray emission observed in the 7.95Å - 9.51Å

spectral band by OSO-7 (Figure 2b). This increase is distributed along the length of the filament, i.e., there is no specific point, as there is in the Mg VIII emission recorded simultaneously, that is especially bright. This gradual, small increase in soft X-ray emission apparently corresponds to the precusor emission discussed by Taske and Thomas (1969).

2. A change of the filament motion from a slow untwisting to a rapid eruptive phase occurred at 1637. This is the time we identify as the beginning of the fast (active) phase of the event. The first bright Mg VIII point reached maximum intensity at this time and a second region of Mg VIII emission (Point B) was rapidly brightening. At this time there also began a rapid rise in the soft X-ray emission from which we infer the development of a high temperature thermal plasma. Concurrently the hard X-ray emission (UCSD reported a very weak burst with $I \sim h\nu^{-6.6}$) rose rapidly (Datlowe, 1974).

3. During the filament eruption the high temperature plasma (T_e as high as 20 - 30 x 10^6K with a distribution of emission measure that decreases with increasing T_e) appears between the original trigger point and a second bright point that appears near one end of the erupting filament. Again, the soft X-ray source is a linear one in contrast to the bright EUV points. Its location coincides with that of the erupting filament. The X-ray source is stable in size so we presume that the hot plasma is localized in a magnetic field which connects regions of

opposite magnetic polarity. Assuming an X-ray source having dimensions of 5 arc sec x 5 arc sec cross-section (typical of similar ATM X-ray sources) and a length of 1 arc minute (derived from the OSO-7 data), we infer a density of $n_e \sim 5 \times 10^{11}$ cm^{-3}. This is probably comparable in density to the filament which disappears as the soft X-ray source developes. Although heating of the filament appears attractive as a source of material for the hot plasma, a possible difficulty is that the filament appears to be in a disruptive motion while the subsequent X-ray source is stationary and stable in size. The primary heating (and, apparently, the conversion of energy required to bring about this heating) occurs when the magnetic field is highly disorganized and the plasma is perhaps in a turbulent state. It seems difficult to reconcile these observations with models of energy release via magnetic field line reconnection that require particular, stable orientations of field lines.

REFERENCES

Datlowe, D.: 1974 Private communication

Rust, D. M., Nakagawa, Y. and Neupert, W. M.: 1975 Solar Physics

Teske, R. G. and Thomas, R. J.: 1969 Solar Physics 8, 348.

FIGURE CAPTIONS

Figure 1. Comparison of Hα, Mg VIII and soft X-ray observations prior to and during the flare of January 19, 1972. Points A, B, and C, the sites of successive EUV brightenings, are indicated. Weak soft X-ray emission was observed in the region of the activating filament before the beginning of the event. The intervals of time identified as the "slow" and "fast" phases of development for this event are indicated.

Figure 2a. EUV (Mg VIII at 315.0Å) emission as a function of time for three locations (Points A, B, and C on the previous figure). Maxima of Mg VIII emission were associated with the trigger phase of the flare (Point A), with one end of the disrupting filament (Point B), and with the rapid expansion of Hα emission (Point C).

Figure 2b. Soft X-ray (Mg XI, Mg XII and continuum at 7.95 - 9.51Å) emission as a function of time for three locations (Points A, B, and C). Soft X-ray emission increases most rapidly during the eruptive (fast) phase of the filament activation.

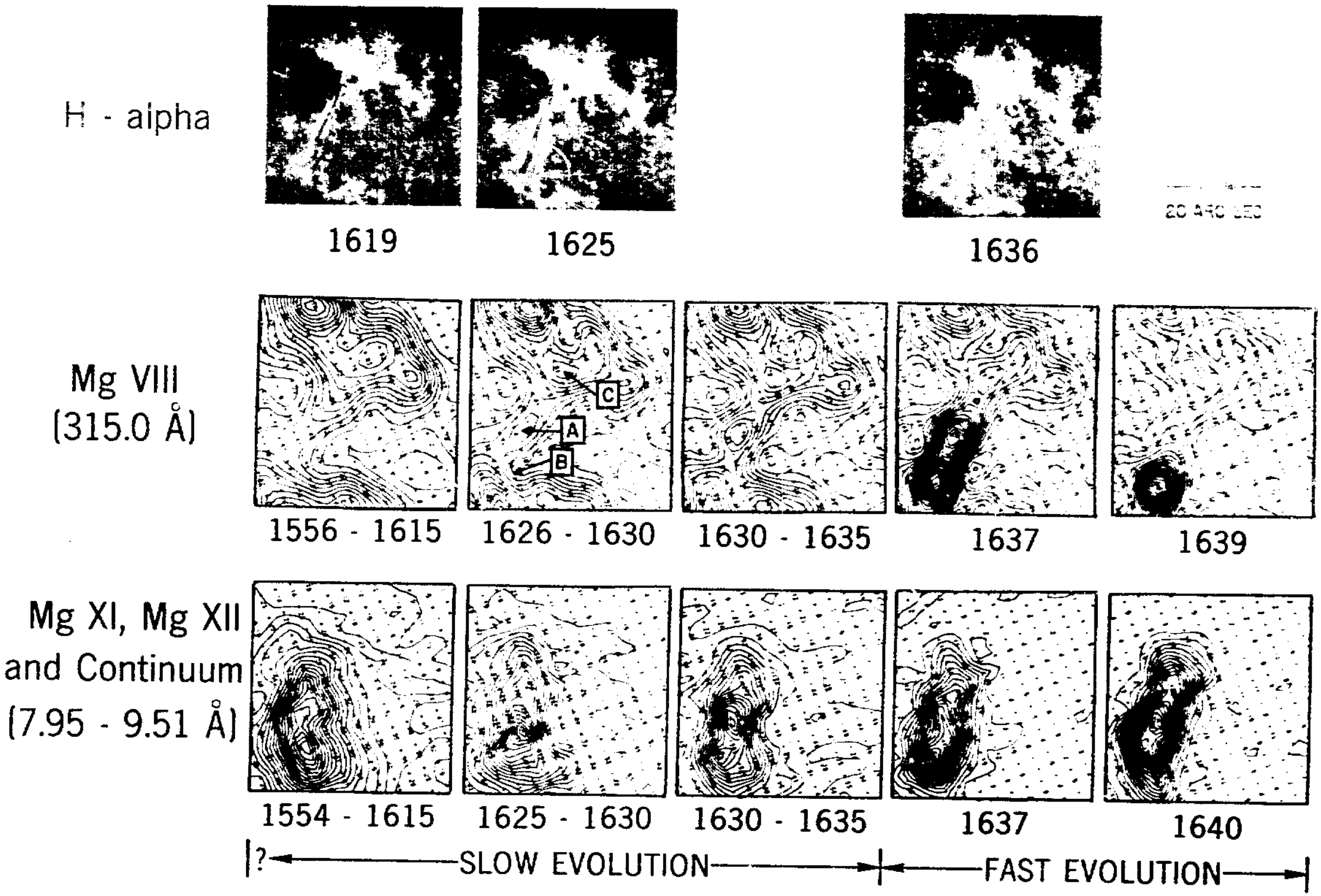
H - alpha
1619
1625
1636
20 ARC SEC
Mg VIII
(315.0 Å)
C
A
B
1556 - 1615
1626 - 1630
1630 - 1635
1637
1639
Mg XI, Mg XII
and Continuum
(7.95 - 9.51 Å)
1554 - 1615
1625 - 1630
1630 - 1635
1637
1640
?
SLOW EVOLUTION
FAST EVOLUTION

FIGURE 1

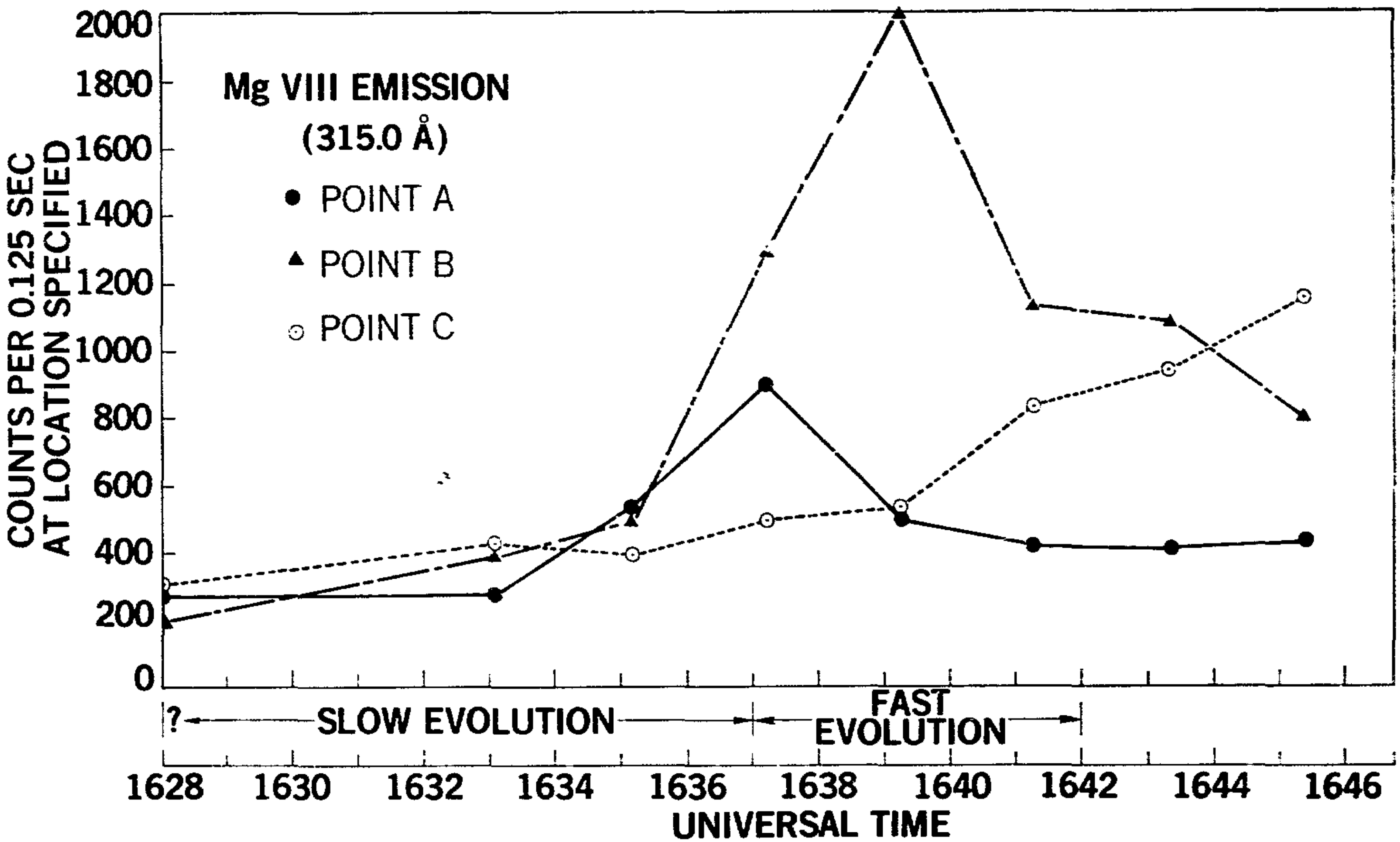
Mg VIII EMISSION
(315.0 Å)
POINT A
POINT B
POINT C
COUNTS PER 0.125 SEC
AT LOCATION SPECIFIED
2000
1800
1600
1400
1200
1000
800
600
400
200
0
? SLOW EVOLUTION
FAST
EVOLUTION
1628
1630
1632
1634
1636
1638
1640
1642
1644
1646
UNIVERSAL TIME

FIGURE 2a

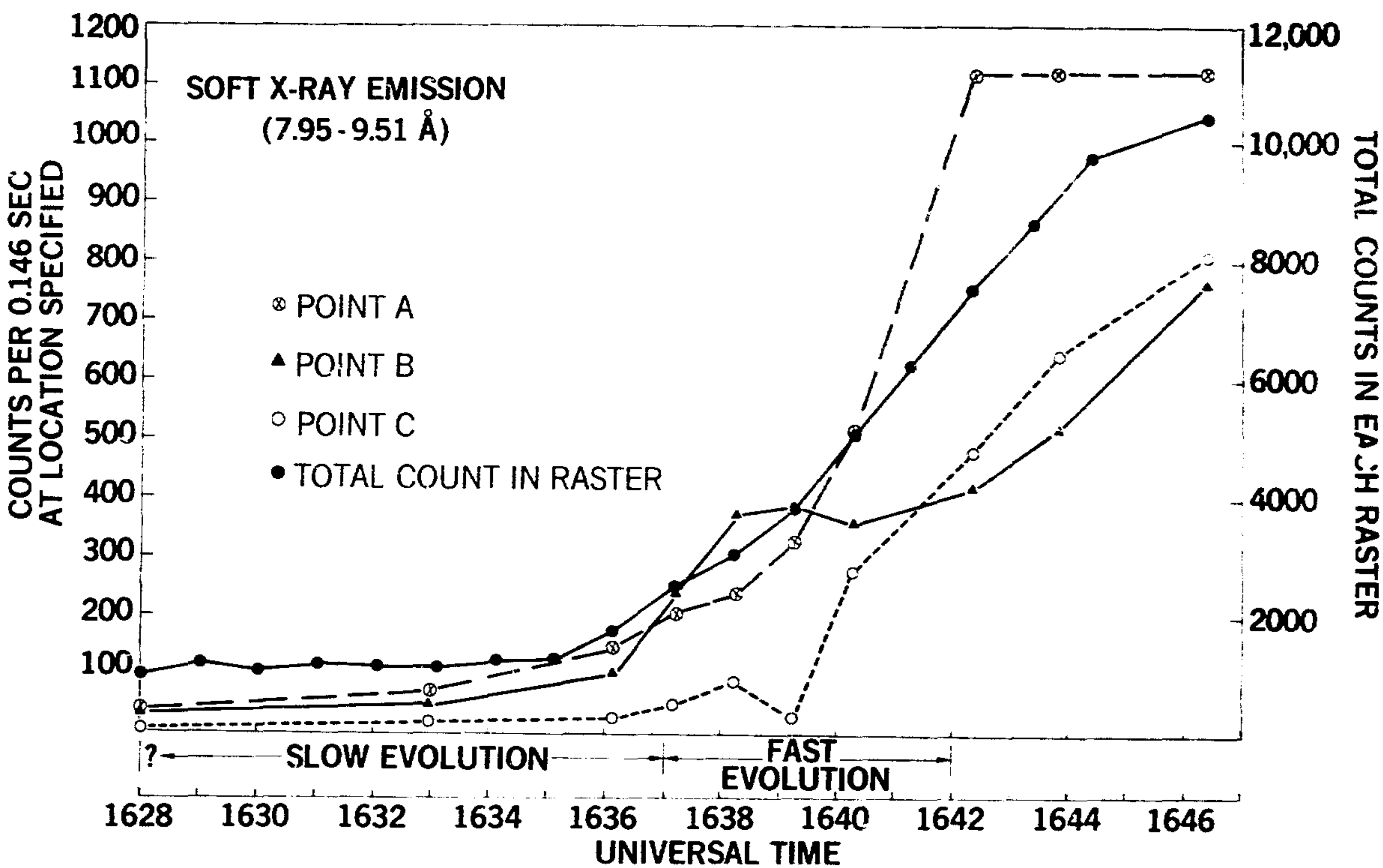
SOFT X-RAY EMISSION
(7.95 - 9.51 Å)
POINT A
POINT B
POINT C
TOTAL COUNT IN RASTER
COUNTS PER 0.146 SEC
AT LOCATION SPECIFIED
1200
1100
1000
900
800
700
600
500
400
300
200
100
TOTAL COUNTS IN EACH RASTER
12,000
10,000
8000
6000
4000
2000
?
SLOW EVOLUTION
FAST
EVOLUTION
1628
1630
1632
1634
1636
1638
1640
1642
1644
1646
UNIVERSAL TIME

FIGURE 2b