

CALIFORNIA INSTITUTE OF TECHNOLOGY

BIG BEAR SOLAR OBSERVATORY

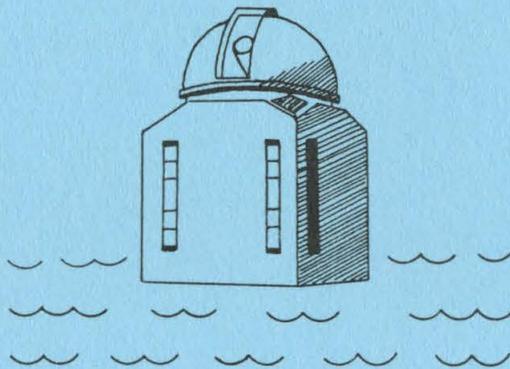
HALE OBSERVATORIES

DEVELOPMENT OF ACTIVITY IN MCMATH 128

AND THE 24 JANUARY 1971 FLARE

by

Harold Zirin



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The development of McMath 11128 is a fascinating example of the role of magnetic field reconnection and solar activity. When this active region came over the limb on January 14, it was an ordinary active region. The sunspots in the leading part, consisting of two p spots ($p1$ and $p2$) and one f spot ($f1$) remained almost identical for the entire period. However on January 19 a new sunspot group developed in the following part of the region and rapidly spread to overtake the f spot of the first group. In the subsequent reconnection of fields, a considerable amount of activity took place, finally leading up to the great flare of the 24th.

The material for our discussion is provided by coverage with four telescopes: two refractors at Big Bear which give large scale on-band and off-band $H\alpha$; a patrol refractor in Pasadena giving back-up coverage with a small image, and the Tel Aviv photoheliograph

covering the Pasadena night. Fairly continuous coverage is available during the disc passage of the region.

The development of the region is shown in Figure 1. We number the p spots $p1$ and $p2$ in the leading group, and $p3$ in the follower; $f1$ in the lead group (best seen January 22) and $f2$ in the follower.

The emerging flux region to be designated Mt. Wilson 18284 was first seen by us on the 19th at 0700 UT on the Tel Aviv films. Its further growth was followed at Tel Aviv on the 20th. We have no film on the 21st, but on the 22nd it could be seen as a rapidly expanding bipolar region. By that time the lead spot $p3$ of 18284 had pushed deep into the f plage of 18281, almost touching the second p spot $p2$ of that group.

On January 22nd we see that $p3$, had reconnected to the f plage of the older group. A number of bipolar flares took place this day, with branches in $p3$ and $f1$. Note that there was no cancellation between the colliding p and f polarity, just reconnection. In fact the f spot even grew a bit. At the same time the big filament curling around $p1$ and $p2$ curled into a much tighter arc as the f plage pushed forward. The region along the filament grew considerably brighter, until on the morning of the 24th the filament was completely surrounded by bright plage, a situation often preceding flares.

On the 23rd at 1929 a flare occurred with a p branch in the N arc of the filament and f branch near spot $f1$. On the 24th the filament had also encroached on the penumbra of $p2$ so that it was sharply cut off. A precursor flare occurred along the filament at 2046, accompanied by an expulsion from the $p1$ spot and an impulsive radio burst. At 2230 UT gradual brightening started all over the area. There was very little motion of the filament, which just appeared to fade out. This is verified by the simultaneous off-band ($-\frac{1}{2}\text{\AA}$) films and a λ scan from -1 to $+1\text{\AA}$ at 2300. The real brightening starts at 23:08:45, the two strands starting to separate at 2310. The bright p strand curled out from the N arc of the filament to cover the spot $p2$, while the bright f strand spread over the entire f plage, but interestingly enough did not remain parallel to the filament. The most energetic part of the flare seems to have been a bifurcation of the filament near its northernmost arc, where some new flux has pushed up; it was here the f strand broke away from the filament.

On the 25th some structural change could be seen. The plage under the big filament was no longer bright, but the filament was back in place. The spot $p1$ was split in two, and the spot $p2$, over which the flare had occurred, was much diminished in size. On the 26th $p2$

had disappeared. It is surely no accident that the most significant spot changes in five days occurred after this big flare.

In summary, there is some evidence that the expansion of Mt. Wilson 18284 into Mt. Wilson 18281 gave rise to stresses which ultimately caused the great flare of 24 January 1971, but the case is not proven. The flare was also marked by intrusion of a filament onto a spot penumbra and rapid decline of that spot. The flares between *p3* and *f1* on the 22nd are a nice example of field reconnection.

This work was supported by NASA and NSF. I am indebted to Dr. J. Vorpahl for several valuable discussions.

FIGURE CAPTIONS

Figure 1 - Four stages in the development of McMath 11128.
(W top, N left)

1/20/71: The emerging flux region Mt. Wilson 18284 is seen at the bottom.

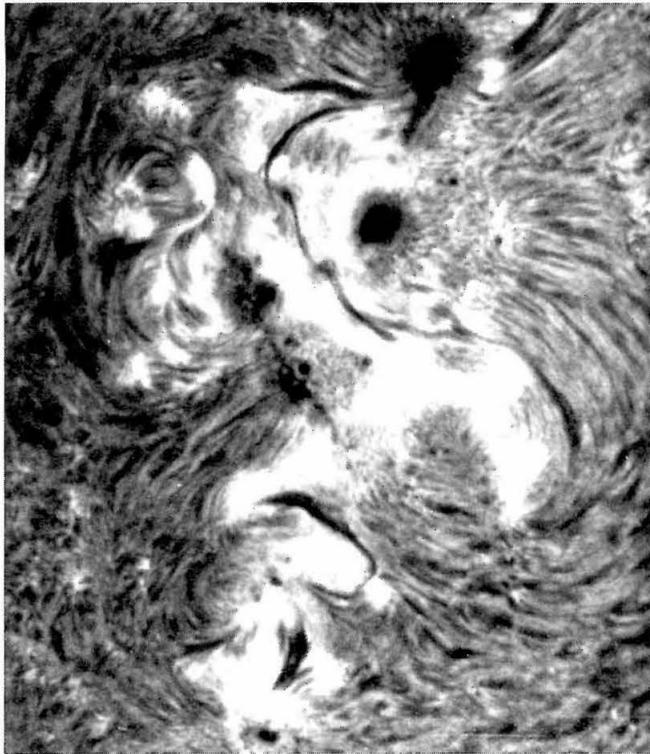
1/23/71: Mt. Wilson 18284 has grown into a serious bipolar group; its leader $p3$ shares a penumbra with the follower $f1$ of 18281, and the filament around that group has been compressed.

1/24/71: Just before the flare the filament is completely enveloped by plage and has moved closer to $p2$. The follower spot $f2$ has broken up.

1/25/71: After the flare the size of spot $p2$ is greatly reduced.

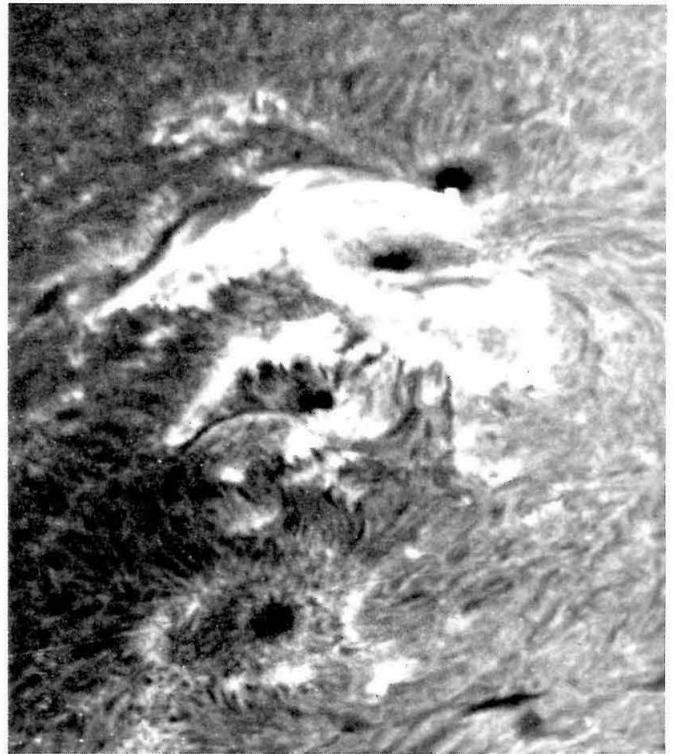
Figure 2 - Development of the flare. The print at 23:11:37 was redone at a different time from the others and is too contrasty; the actual flare brightness at that time is no greater than at 23:14:46, directly following. Note the steady separating of the two bright strands in the course of the flare. The lower strand fills the area of following polarity between $p3$ and the filament; the p strand fills the area inside the filament. The f side of the leading part of the filament plays no part in the flare.

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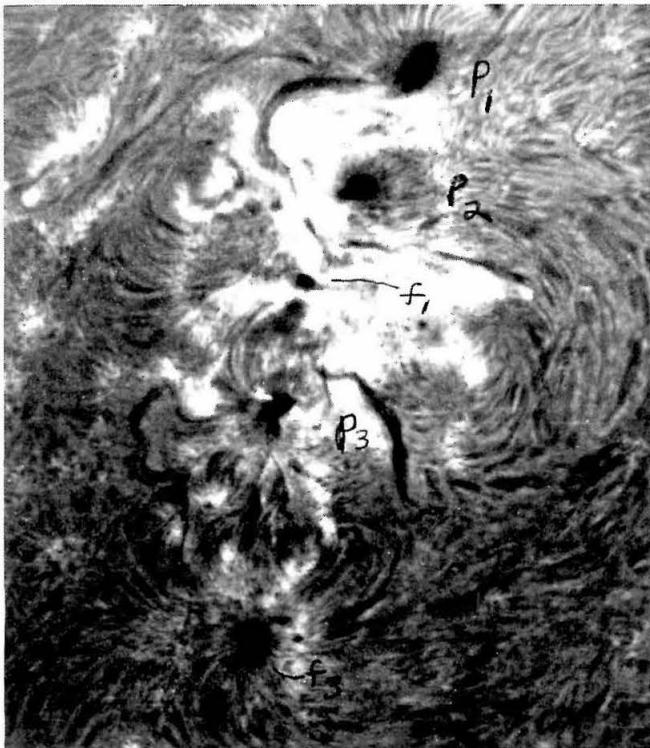


1-20-71 21:58:10

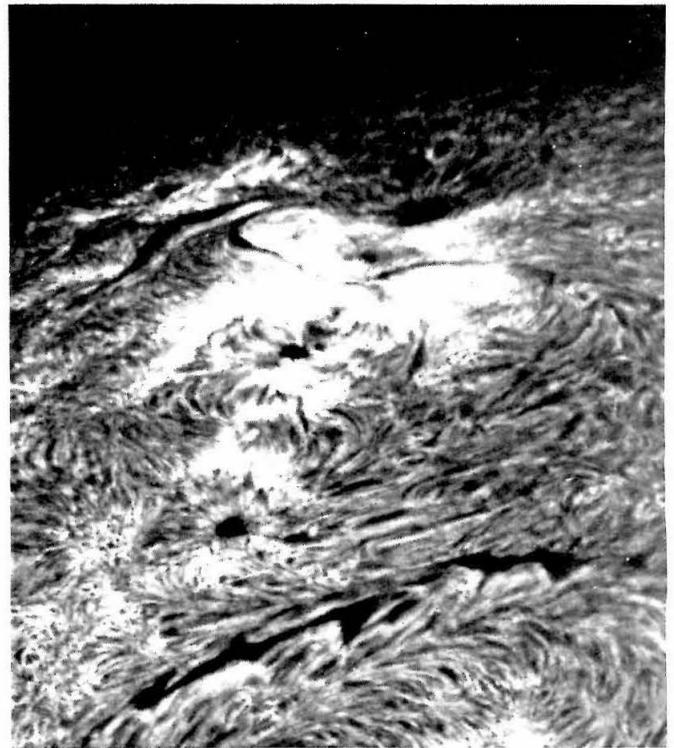
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1-24-71 20:58:55



1-23-71 19:29:35



1-25-71 22:43:46

BIG BEAR SOLAR OBSERVATORY
Proton Flare
January 24, 1971

