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RESULTS FROM THE GSFC OSO 7 SPECTROHELIOGRAPH

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One of the prime goals of the pointed spectroheliograph on OSO 7 is to record the evolution of solar active regions and solar flares. The design philosophy of the instrument, which was successfully implemented and launched, is that it is necessary to observe each level in the solar atmosphere that might be involved in a particular solar phenomenon.

A concrete example is that to observe the evolution of a solar flare one must observe at several different heights of the solar atmosphere at which that event might occur or to which it might spread.

The solar atmosphere is a plasma existing under a wide range of physical conditions. Various levels (or components) in that atmosphere are differentiated primarily by their electron temperature and are observed by recording the radiation of ions that exist primarily at the appropriate temperature. The experiment then becomes one of observing specific spectral lines which carry the required physical information.

This brings us to the first attribute of the OSO instrument that distinguishes it from its predecessors. That is, it can record radiation over a wide range of wavelengths. The spectral range extends from the red portion of the visible spectrum (H-alpha), which is used to obtain easy comparison with ground-based observations, to soft X-ray radiation at 0.2 nm. We therefore have the capability of observing the solar atmosphere from the 10000 K level (in H-alpha, from unionized hydrogen) to short-lived flare-associated regions at 30 million K (in the radiation of 24 times ionized iron, Fe-XXV). Needless to say, the observations are far from complete. For instance, they carry no information about the magnetic field.

A second observational requirement immediately becomes obvious, and that is that the emission lines must be recorded as simultaneously as possible to obtain the complete picture at one instant in time. In the Goddard experiment there are four separate data channels giving observations simultaneously. The signals are used to build solar maps point by point by raster scanning across the surface of the Sun. Each set of four maps taken in the small raster mode required 1 min and covers an area of 5 by 5 arcmin as seen from the Earth. The separation of data points in a raster line corresponds to an angular separation of 12 arcsec, and that, together with a resolution limit of about 15 arcsec on the EUV telescope, limits the detail that we are able to resolve.

Figure 1 shows two maps of an active region on the Sun that was observed 3 hr after turning on the instrument on October 3. The two radiations recorded in Figure 1 are H-alpha, which I referred to earlier, and soft X-rays from 1.3 to 1.6 nm. The darkest region in H-alpha corresponds to a sunspot, a cooler region in the solar photosphere and chromosphere. The brighter region represents an elongated bright plage in H-alpha, corresponding perhaps to an increased magnetic field in the chromosphere. This map corresponds quite well to ground-based observations but emphasizes that two small regions are of greater intensity than the remainder of the plage. In a soft X-ray channel, we find that the X-ray source is elongated with two brighter regions. The upper bright spot in H-alpha corresponds to the tip of the upper X-ray source; the lower one is near but not coincident with the lower X-ray source. What we may be seeing here is an X-ray loop which has its feet in the solar chromosphere and has an enhancement at the two ends. The diameter of this strand of hot plasma is less than the resolution of the system and is probably only a few arcseconds (1 arcsec = 700 km on the Sun).

About 2 hours later we observed our first solar flare in this region, as shown in Figure 2. The region has moved slightly toward the left in the field of view, corresponding to the solar rotation. The solar flare emission is the highly localized and intense region to the left of center. In this figure, as in the previous figure, the actual source diameter is less than the resolution of the telescope.

An interesting comparison can be made by superimposing the first two figures as done in Figure 3. Notice that the H-alspha flare was produced primarily between the original two bright spots that existed in H-alpha. The X-ray flare source, however, is displaced toward the west from the original preflare region. This displacement is of the order of the resolution of the instrument but is obviously real and suggests that the source is not in the original region or that that region had shifted slightly in the solar corona.

These figures represent only a small amount of data – two channels for 1 min each. The observations for the event consist of four channels of data and the event lasted for on the order of 4 hr. It should be possible, by combining the OSO observations with ground-based observations, to construct a fairly complete picture of this event.

CHAIRMAN:

Are there any questions?

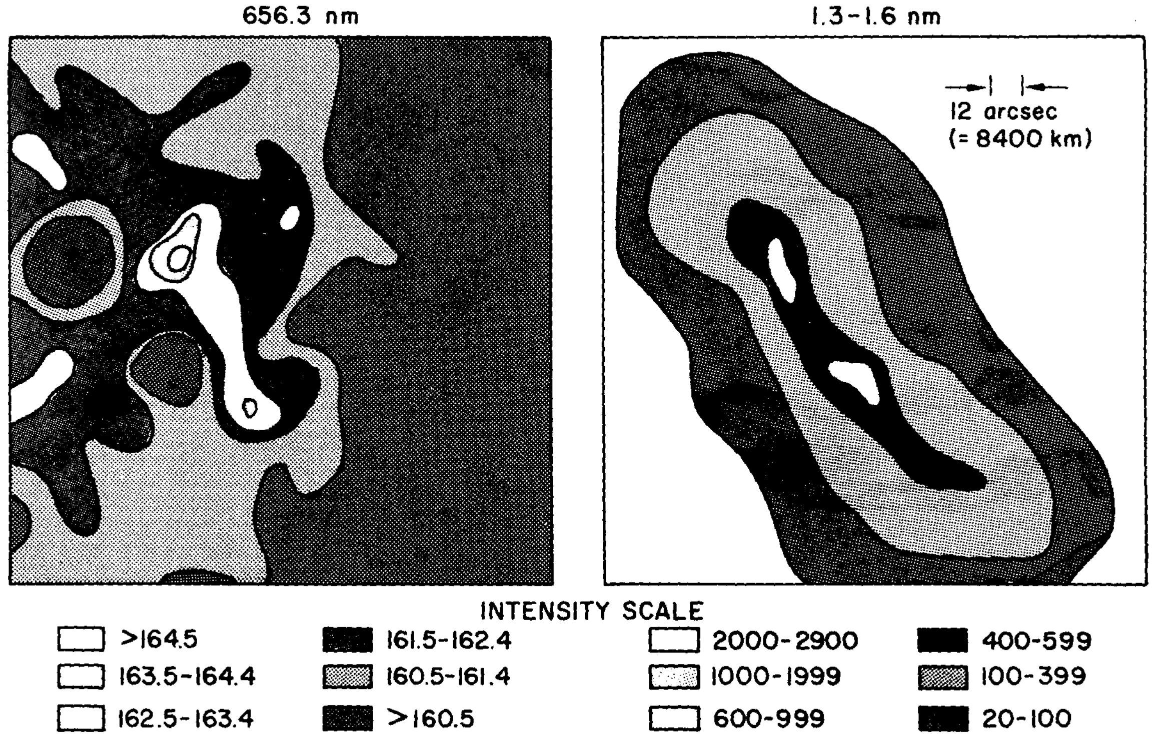

Figure 1–Observations of an active region in H-alpha and soft X-rays from OSO 7; October 3, 1971, 11:21 UT.

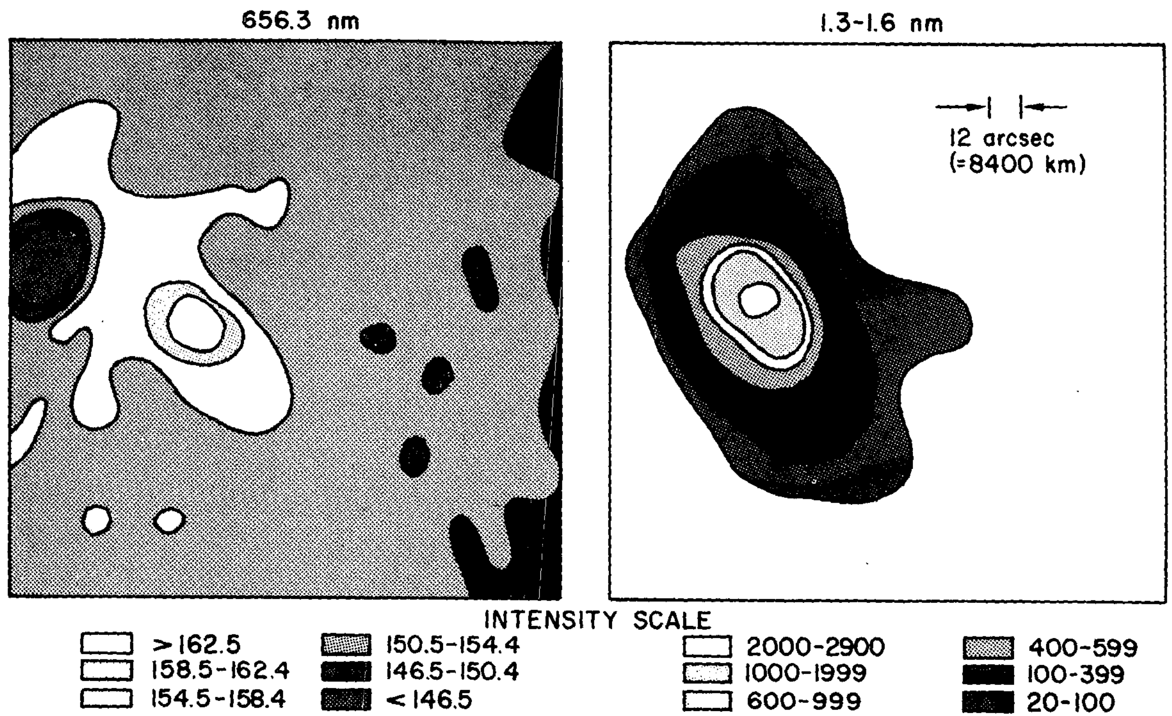

Figure 2–Observations of a solar flare in H-alpha and soft X-rays from OSO 7; October 3, 1971, 13:52 UT.

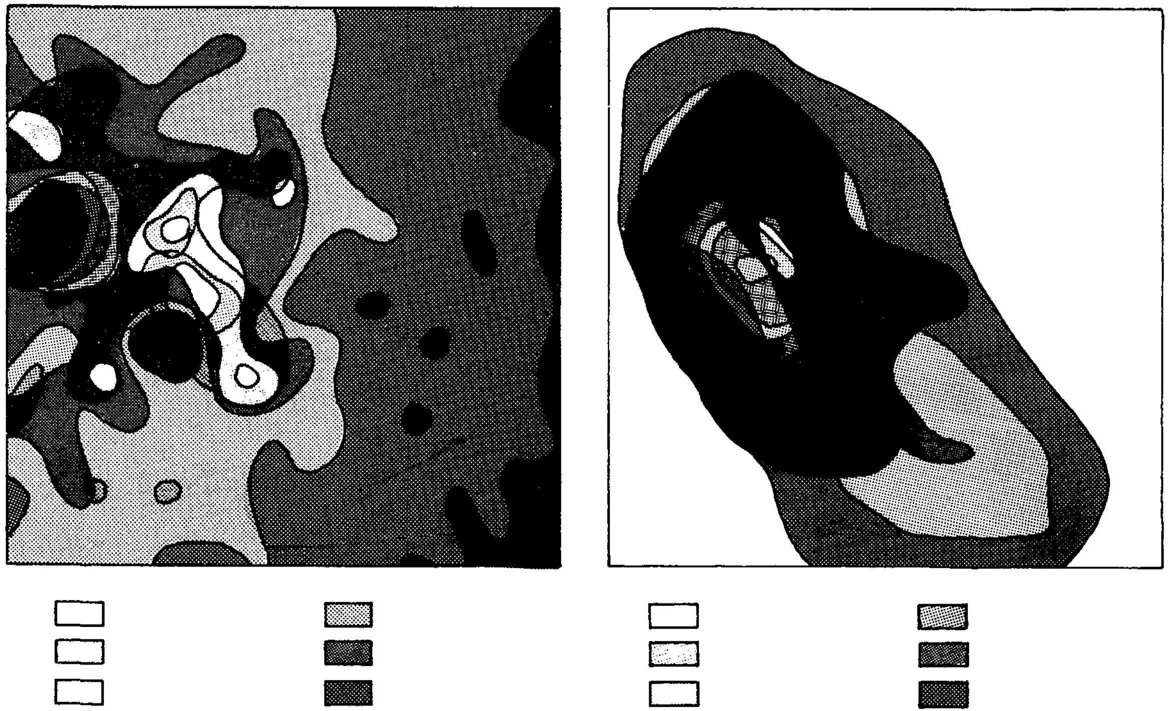

Figure 3–Superimposition of Figures 1 and 2.

MEMBER OF THE AUDIENCE:

The displacement of the X-ray source in relation to the H-alpha source might have been due to the height of the emission, if this was a limb flare; was that the case?

DR. NEUPERT:

This flare was very close to the meridian.

MEMBER OF THE AUDIENCE:

The big problem about solar flares is what triggers them. How will these observations help you to answer that question?

DR. NEUPERT:

For this flare we probably will be able to (in a very limited sense, because we were observing only for a matter of several hours) watch the evolution of a region prior to the event. What I am suggesting is that we may be able to identify particular configurations of coronal structures and magnetic fields that lead to flares. Now, whether that is going to tell us what triggers the flare, I do not know, but we certainly hope that we will be able to describe the circumstances under which flares do take place.

MEMBER OF THE AUDIENCE:

Do you have magnetic field data for this event?

DR. NEUPERT:

Observations of the active region, but not of the flare, were made. We are asking ground-based observers to make magnetic field observations on the groups simultaneously with the OSO observations.