MORPHOLOGICAL CHANGES IN A LARGE SUNSPOT GROUP BEFORE A 1/1 SOLAR FLARE DURING AUGUST 1972(U) NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA Z B KOROBOVA ET AL 23 JUL 77

UNCLASSIFIED NOSC/TD-125 F/G 3/2 NL
MORPHOLOGICAL CHANGES IN A LARGE SUNSPOT GROUP BEFORE A SOLAR FLARE DURING AUGUST 1972

Translated by CM Bigger from an article by ZB Korobova
Edited by MP Bleiweiss

23 June 1977

Approved for public release; distribution is unlimited

NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92152
ADMINISTRATIVE INFORMATION

This document was translated and edited under Program Element FGOV, Project O, Task NASA (NOSC M229). The work was accomplished during June-July 1977 and the document was approved for publication 14 September 1977.

Released by
Dr JH Richter, Head
EM Propagation
Division

Under authority of
JD Hightower, Head
Environmental Sciences
Department
MORPHOLOGICAL CHANGES IN A LARGE SUNSPOT GROUP BEFORE A SOLAR FLARE DURING AUGUST 1972

This document investigates morphological changes in sunspot groups during solar flares. Using photoheliograms taken previously, the investigators traced the fast changes in the morphology of the main sunspot umbrae for the flare active group No. 223. A comparison of the photoheliograms divided into intervals of a few hours showed that although the overall area of the sunspot was extremely stable, the contours of the umbrae and their configurations were changing noticeably.
TECHNICAL DOCUMENT 125

MORPHOLOGICAL CHANGES IN A LARGE SUNSPOT GROUP BEFORE A SOLAR FLARE DURING AUGUST 1972

ZB Korobova

Solar Data (Solnečnye Dannye) May 1974, p 92-95, Published by the Main Astronomical Observatory of the USSR Academy of Sciences

LA POSTA ASTROGEOPHYSICAL OBSERVATORY
The question of morphological changes in sunspot groups during solar flares has been examined by many investigators.\textsuperscript{1-3} It has been established through photoheliograms taken before and after a flare that it is possible to detect material changes in the configuration and area of the main sunspots as well as the appearance and disappearance of satellite spots.

Having at our disposal photoheliograms taken in Tashkent, Kislovodsk, and Ussurijsk during the period from 1 through 8 August, we decided to trace the fast changes in the morphology of the main sunspot umbrae for the flare active group No 223* having δ-configuration.

A comparison of photoheliograms divided into intervals of a few hours showed that although the overall area of the sunspot was extremely stable, the contours of the umbrae and their configurations were changing noticeably.\textsuperscript{4}

Among the deformations having a gradual evolutionary character, our attention was attracted to one case of abrupt changes which took place in a region of S-spot polarity and which preceded a series of powerful flares on August 2, 1972. The first of these was registered at 3\textsuperscript{h} 16\textsuperscript{m} UT and had a range of 1N - 2N.\textsuperscript{5} Before August 2 flares exceeding 1N had not been observed in the group.

The photoheliogram prints are presented in Ill. 1. The first of these was taken 24 hours before the flare which began at 3\textsuperscript{h} 16\textsuperscript{m}, the second was made 5 hours before it began, and the third close to its maximum intensity. The diameter of the sun's image on the prints equaled 50 cm. The umbrae of S-polarity (those which were leading in the given hemisphere) have been enumerated.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{image}
\caption{Ill. 1. From ZB Korobova's article (ref 4)}
\end{figure}

\begin{itemize}
\item[] * Enumerated according to the Solar Data Bulletin.
\end{itemize}

1. SI Gopasjuk i dr, Izv KrAO, 29, 15, 1963
4. ZB Korobova, Soln dannyc. No 4, 1974
As the prints show, a few hours before the flare (see the photoheliogram taken on 1 August 22:16 UT) umbra #3 disappeared, having separated prior to this from the large N-umbra by means of a thin penumbral bridge. The remainder of the S-umbra contracted in size, while the area of umbra #4, counted at 7h 35m as 44 m.s.h., diminished in size to 23 m.s.h. The deformation of this umbra is of the greatest interest. The umbra assumed an oval form in place of its circular form at 7h 35m. When comparing the print taken at 22h 16m with the longitudinal magnetic field map for August 2 (borrowed from ref 6, and presented in III. 2), it becomes obvious that contraction of umbra #4 occurred in a direction perpendicular to the position of line $H_{\parallel} = 0$, separating this umbra from the umbra of n-polarity. Umbra #1 and #2 were also stretched slightly along the line that divided the polarities, but this contraction is masked by perspective shortening. A narrow appendage which skirted line $H_{\parallel} = 0$ appeared by umbra #1.

All of these morphological changes undoubtedly testify that the flare on August 2, which was followed by a whole series of flares in the range of 2 and 3 (among them four proton flares), was preceded by tangential movements in the photosphere, umbral deformation, and a pressing of the umbrae toward the neutral polarity line. In the N-field region material changes did not occur in the umbral form or area. Here the most noticeable changes were in the fibrous structure of the penumbra of the northern portion of the spot. For the analysis of these changes, more frequent prints are needed.

At the moment when the 3rd photoheliogram was received (between two successive flare maximums $^5$), the sizes of the umbrae were reestablished (see lower table) and umbra #4 again assumed a circular form.

The table contains values for the total area of the umbrae of differing polarity and for the magnetic fluxes of the corresponding umbrae.

For the measurement of umbral area, photoheliograms were projected on the screen of a coordinate-measuring device UIM-23* having 12 power magnification, and a transparent millimetre graph-network was then superimposed upon the image. The error limits for the determination of the area did not exceed 10%. The area is expressed in m.s.h. The magnetic flux values for the sunspots are calculated according to the formula $F = F_{S, r}$, where $H$ is taken from reference 7.

The table shows that for a few hours before the flare the excess of flux with $n$-polarity over $s$-polarity doubled. AB Severnyj has repeatedly noticed an increased difference in magnetic fluxes in an active region prior to a flare. This occurred before the August 2 flare due to an abrupt diminution and contraction of the sunspot’s S-umbra.

The values of the coefficient $K = \frac{F_n - F_s}{F_n + F_s}$ are presented in the last column of the table as a quantitative characteristic “imbalance” of the fluxes as proposed and again as in reference 2 the onset of the flare was preceded by an increase in $K$.

In conclusion, the author expresses his deep gratitude to VI Makarov and VF Čistjakov for the photoheliograms submitted.

---

**Translator’s note:** Universal measuring microscope

7. Magnitnye polya solnečnych pjaten Priloženie K bjull “Soln dannye”, No 8, 1972
8. AM Zvereva, AB Severnyj, Izv KrAO, 41-42, 97, 1970

---

<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME UT</th>
<th>$\Sigma S_{rS}$</th>
<th>$\Sigma S_{rN}$</th>
<th>$F_S$</th>
<th>$F_N$</th>
<th>$F_N-F_S$</th>
<th>$F_N+F_S$</th>
<th>$k$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 VII 1972</td>
<td>7h35m</td>
<td>97.0</td>
<td>152.8</td>
<td>2457</td>
<td>3901</td>
<td>1444</td>
<td>6358</td>
<td>23</td>
</tr>
<tr>
<td>1</td>
<td>22 16</td>
<td>55.5</td>
<td>149.1</td>
<td>1569</td>
<td>4579</td>
<td>3010</td>
<td>6148</td>
<td>49</td>
</tr>
<tr>
<td>2</td>
<td>4 38</td>
<td>90.3</td>
<td>153.5</td>
<td>2575</td>
<td>4721</td>
<td>2146</td>
<td>7296</td>
<td>29</td>
</tr>
</tbody>
</table>

*Translator’s note: Universal measuring microscope*
REFERENCES

1. SI Gopasjuk i dr, Izv KrAO, 29, 15, 1963
4. ZB Korobova, Soln dannye, No 4, 1974
8. AM Zvereva, AB Severnyj, Izv KrAO, 41-42, 97, 1970

Astronomy Institute
Acad Sci Uzbec SSR

Submitted for Editing 22 April 1974
END
I-87
DTIC