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PHYSICAL FEATURES IN THE AR5395

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The active region Boulder # 5395 (N34, L257), which appeared on the disk in March 1989, is one of the biggest active regions in fifty years. Study on the structure and dynamical characteristics of the region can help to understand the physics of solar flares. Many authors have studied morphology and sunspot motion of the region (e.g.Wang *et al.* 1991, and Zhao 1990); the magnetic emergence and shear; the relationship between the extrusion and the flares and the characteristics of the magnetic and velocity fields in the flare sites (Chen 1990; Li *et al.* 1990; Zhang *et al.* 1990). It comes into question that most of the regions display the features mentioned above but only a few of them produce such a high activity as AR5395 does. In other word, AR5395 must possess some particular features that are probably related to its high activity. Our attempt is to find what the special features are.

The new features found from AR5395 are briefly described and shown as follows:

1. The magnetic negative areas are surrounded by the closed or almost closed neutral lines and form the negative 'magnetic islands'. In addition, the ratio of the positive magnetic flux to the negative one is 4:1. This may show that the divergence of the negative polarity is much greater than that of the positive (Fig. 1).

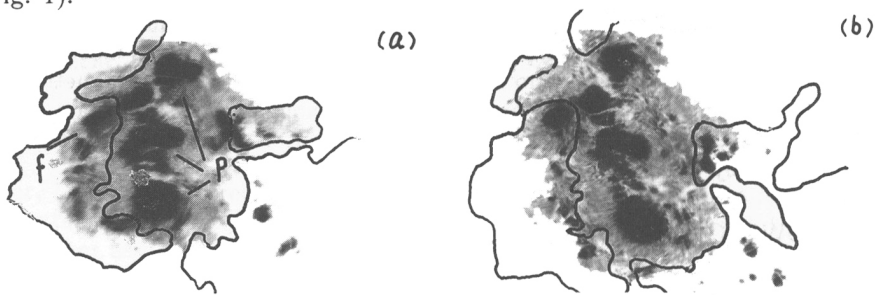

Fig. 1. Images of the sunspots superposed by the neutral lines ($H_{\parallel} = 0$) and the positive(p) and negative(f) umbrae at (a)$10^d025409$UT and (b)$11^d024443$UT, March, 1989.

2. All the main negative umbrae of the region are involved in the velocity redshift area of the photosphere but the positive ones in the blueshift area. In other word, the redshift areas seem to have the tendency to 'avoid' the positive enhanced field (main umbra) (Fig. 2 a,b).

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3. Surrounding the main umbrae, some smaller spots and their fibres compose a 'U'-shape vortex pattern, as pointed out by the arrows in Fig. 2c. In the place where the 'U'-shape structure lies, the line-of-sight velocities of both photosphere and chromosphere equal to zero ($V_{\parallel} = 0$) (Fig. 2).

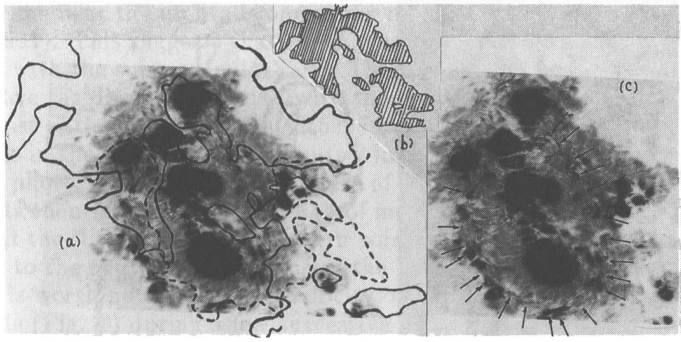

Fig. 2. (a) The sunspots (11^d0244UT) superposed by the $V_{\parallel} = 0$ line in $\lambda 5324\AA$ (11^d0209UT); (b) The receding velocity in (a) shown by the hatched area; and (c) The 'U'-shape vortex pattern.

4. The plage boundaries coincide with the $V_{\parallel} = 0$ lines both in shape and in position. The plage area corresponds to the redshift area of the chromospheric velocity. In the main part of the region, *i.e.* the area including the main umbrae of the region (both the N-polarity and S-polarity), the chromospheric velocity remained to recede in a few successive days (Fig. 3).

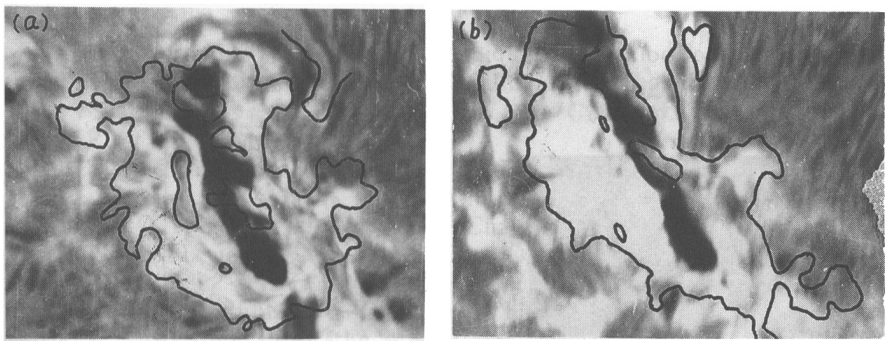

Fig. 3. The H_α images superposed by the zero-velocity lines ($V_{\parallel} = 0$) in H_β at (a)$12^d032539$UT and (b)$13^d035405$UT.

5. The alignment of the filaments coincides with the neutral line only at some places (Fig. 4 a and b). At the places without the magnetic neutral line, the filaments align with the zero-velocity lines ($V_{\parallel} = 0$) both in the chromosphere and photosphere (Fig. 4b).

Furthermore, from the Dopplergram(Fig. 5a) of the region, we can see some black mottles (velocity approaching) near the region. The mottles can be recognized as the chromospheric spicules from their morphology, the velocity

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patterns and the size (20"—40") of-the polygon surrounded by the mottles. The polygon is confirmed as the chromospheric network. The velocity of the spicules is 500 m/s and the height of them is within the range from 9000 to 23000 km. The networks have the downward velocities of 300 m/s. Some features of the spicules and networks are found (see Fig. 5b):

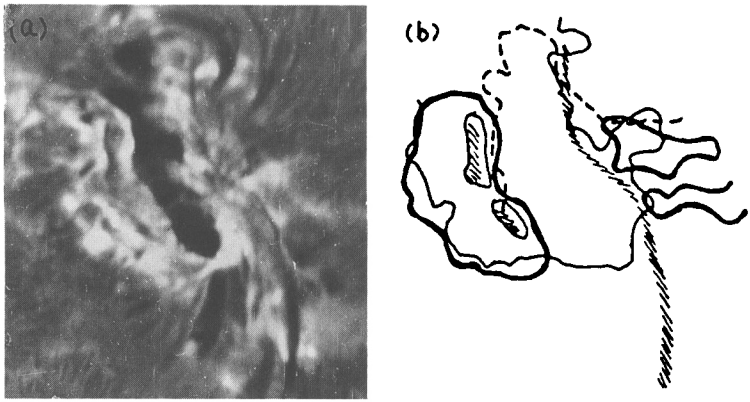

Fig. 4. (a) The H_α image at $12^d021339UT$, (b) the filaments superposed by the magnetic and velocity fields. The thick line stands for the $H_{\|} = 0$, and the thin line for $V_{\|} = 0$ in H_β, the dashed line for $V_{\|} = 0$ in $\lambda 5324 \mathring{A}$ and the hatched part for filaments.

6. The location of the spicules is related to the magnetic 'negative islands'(e.g. the ones labeled with '*1*' to '*6*') and the 'foot points' of the spicules fall on the borders of the islands, *i.e.* on the neutral lines. All the spicules have nearly the same trend that they point toward the positive magnetic area and separate from the region.
7. Most of the 'foot points' of the spicules fall on the H_β velocity-zero lines (e.g. the islands labeled with '*1*' to '*4*'). This implies that they are accelerating from the zero initial velocity.

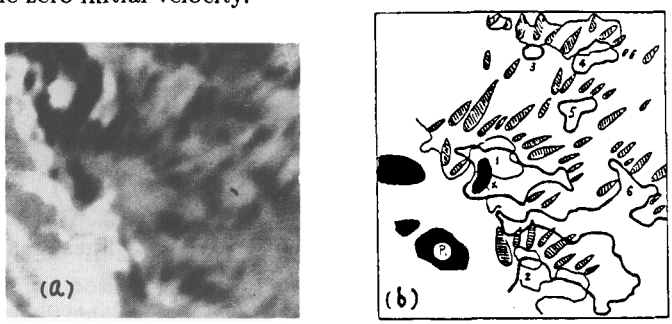

Fig. 5. (a) The Dopplergrams of AR5395 and (b) the spicules outlined from (a) superposed by the magnetic and velocity fields. The thick line stands for $H_{\|} = 0$, the thin line for $V_{\|} = 0$ in H_β, and the hatched part for the spicules and the dark part for the sunspot umbrae.

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8. Since the spicules outline the borders of the networks or supergranular cells, one larger network(e.g. Island '*1*') can be identified from March 11 to 13 and this indicates that the network has the lifetime of at least three days.
9. We can see a main umbra (marked with '×' in Fig. 5b) surrounded by the spicules, which means that there exists also the umbra in the network. The neutral line near the umbra is one of the main flare sites of the region (Wang *et al.* 1991). This suggests that the magnetic flux tube of the spot is probably 'frozen' with the supergranular cells. The appearance and disappearance of the spots have the direct correlation with the convection of the solar interior.

Most of the large flares in AR5395 occur near the filaments (Fig. 4a), which lie in the positions of the neutral line or along the zero-velocity lines of both photosphere and chromosphere of the region. This implies that the filaments themselves have a coupling of motion with the magnetic field. The fact that the 'U'-shape vortex pattern coincides with the zero-velocity line and parallel to the neutral line also shows the coupling in the 'U'-shape structures.

It is worth noting that the velocity of the H_α plage area remained to recede (Fig. 3) during a few successive days. The calcium plages were reported related to the magnetic field and the H_α plages coincide with the chromospheric velocity field.

What gives us much for thought is the imbalance of 4:1, the ratio of the positive magnetic flux to the negative one, and the occurrence of the negative polarity in the form of 'island'. One of the main spot umbrae coexists with the supergranular cell The 'live points' of the solar flares were reported to 'outline' the border of one supergranular cell (Svestka 1976). In order to explain the cause that the AR5395 produced such an intense activity, further studies must be made.

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