The Magnetic and Velocity Fields of Solar Active Regions
ASP Conference Series, Vol. 46, 1993
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TEN YEARS OF THE OKAYAMA VECTOR MAGNETOGRAPH

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INSTRUMENTATION AND OBSERVATION

The vector magnetograph of the Okayama Astrophysical Observatory (Makita et al. 1985a,c) is equipped on the 65cm solar coude telescope with the 10m Littrow spectrograph. Results of observations are vector magnetograms, velocitygrams, maps of the broad-band polarizations, maps of the magnetic lines of force, and maps of the electric currents. Their examples are given in figure 1. The data books, which give the vector magnetograms, have been published every year since 1983.

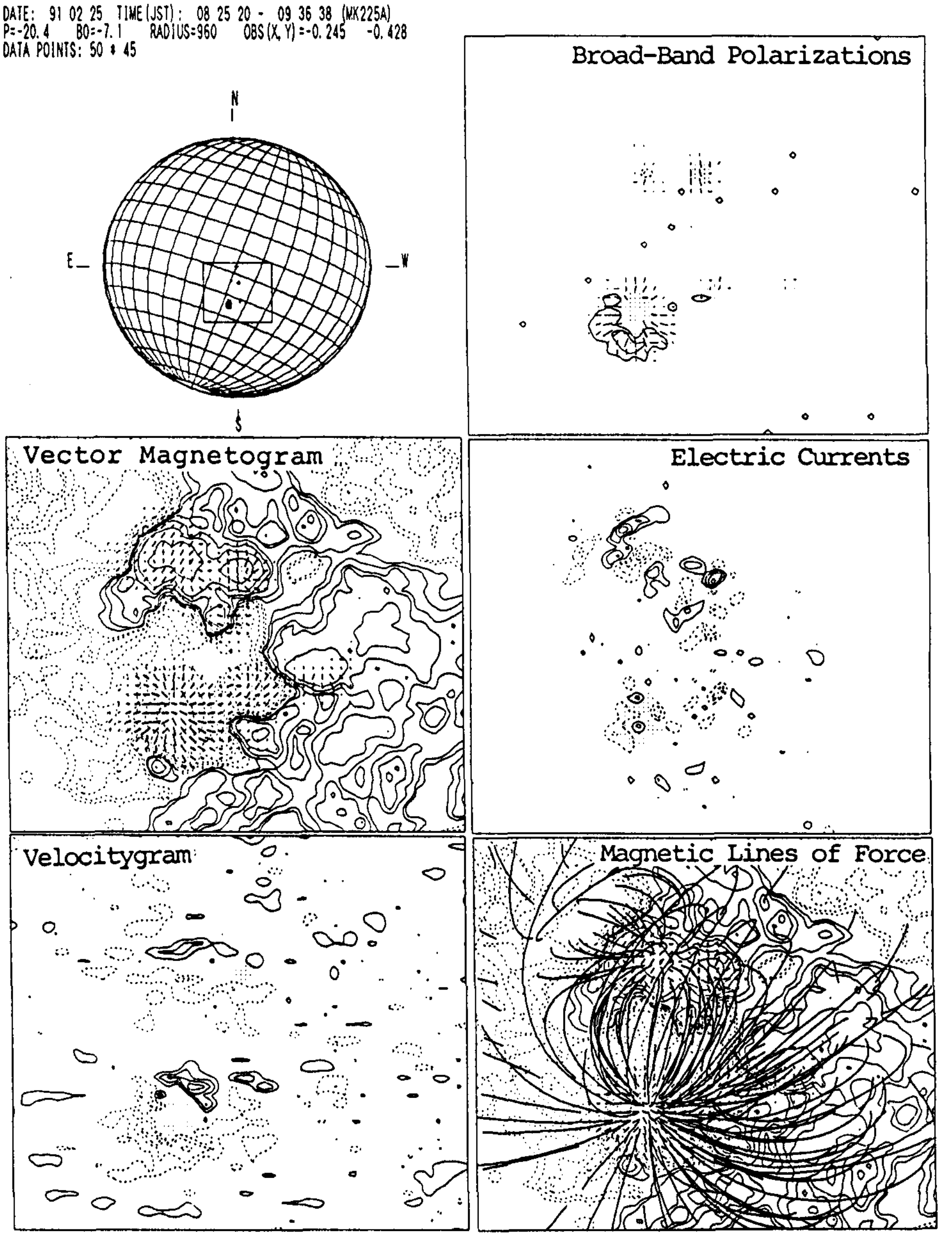
Calibrations of the polarization degree and the overall accuracy were discussed (Makita et al. 1982, 1987; Makita and Li 1992). The accuracy of the polarization measurement is 10^{-3} for the line observation and 10^{-4} for the continuum observation. Conversion of the polarization degrees to the magnetic field vector has been tried by Sakurai (1987) with the use of the weak field theory and the observed magnetic field strength of sunspots. A simultaneous observation of the same active region was once made with the Sayan Observatory (Makita et al. 1985b). Distributions of the magnetic polarity were quite similar and azimuths of the magnetic field agreed very well.

RESULTS OBTAINED

Results obtained so far are the following.

The azimuths of the linear polarization obtained from the spectral line (FeI 5250A) wings and the nearby continuum (5282-5297A) were compared statistically and the effect of the Faraday rotation was detected (Makita 1986a).

Figure 1. Outputs of the Okayama Vector Magnetograph



https://doi.org/10.1017/S0252921100029043 Published online by Cambridge University Press

The comparison of the magnetic field azimuth with the Hα fibrils in active regions led to inclined and sheared magnetic configurations with increasing activity (Kawakami et al. 1989). Deviation of the azimuths of the facular magnetic field from the radial direction was explained by concentrated magnetic flux tubes around the vertical within 30° (Kawakami and Makita 1992).

The broad-band circular polarization of sunspots was interpreted as the combination of the differentially twisted magnetic field with the velocity gradient of the Evershed flow (Makita 1986b, 1988). In this model the polarity rule demands the left-handed twist of sunspot flux tubes in deep layers. This special preference might be due to some unknown connection between the stability of the twisted magnetic flux tubes and the equatorial acceleration or deceleration of the rotation.

SUBJECTS TO BE STUDIED

Data accumulated in ten years offer us numerous subjects to be studied.

Sakurai (1987, 1989) found that the static conditions for the magnetic field were not satisfied in many magnetograms. Some dynamical situation in magnetic structures is suggested with a little reservation of the accuracy of the measurement.

Differentiation of the transverse components gives vertical electric currents which will be a measure of the stored energy of the flare activities (Sakurai 1985, 1989). The pattern size of the electric current is smaller than the size of the magnetic patterns (see Fig.1). The differentiation also gives the vertical gradient of the longitudinal field with the use of the divergence-free condition of the magnetic field. Since this pattern is similar to the pattern of the magnetic field, the differentiation might be reliable to some extent.

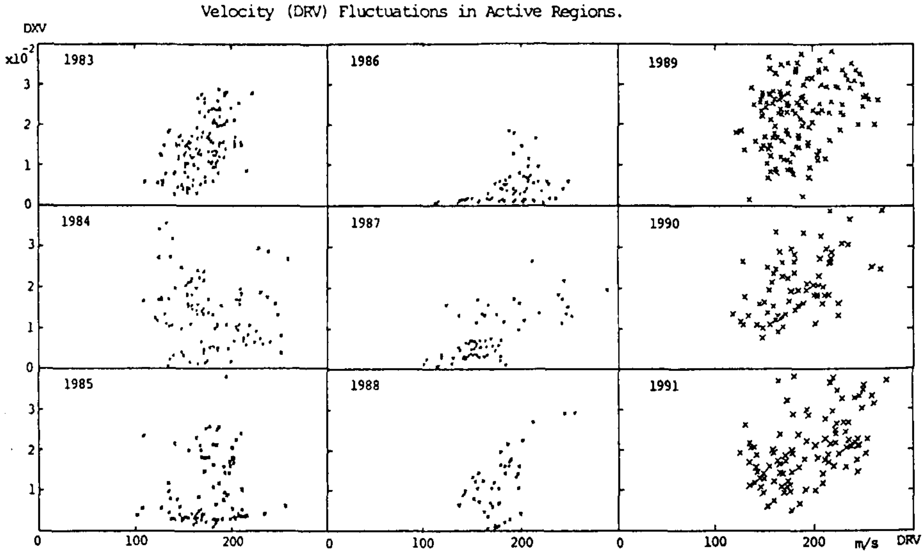
The fluctuations of the linear polarization are twice those of the circular polarization for the continuum. On the contrary, they are nearly the same for the line wing (Makita et al. 1987). The excess fluctuation of the circular polarization for the line wing may suggest a background longitudinal magnetic field of at least 5G on the average.

The magnetic configuration related to the flare activity was reported in two cases (Makita et al. 1985c, 1988). The activity seemed to be triggered by some interaction between high magnetic lines of force and low sheared magnetic arches.

A solar cycle variation might be seen in magnetic and velocity field fluctuations of active regions (Makita and Li 1992). The up to date correlation diagrams between them are given in figure 2.

Thanks are due to Mr. T. Shinkawa for the help to make the figures 1 and 2.

Figure 2. Nine Year Variation of the Circular Polarization (DXV, 6×10^{-4}/G) and Velocity (DRV) Fluctuations in Active Regions.



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https://doi.org/10.1017/S0252921100029043 Published online by Cambridge University Press