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Injection of Helical Magnetic Field in Solar Active Regions

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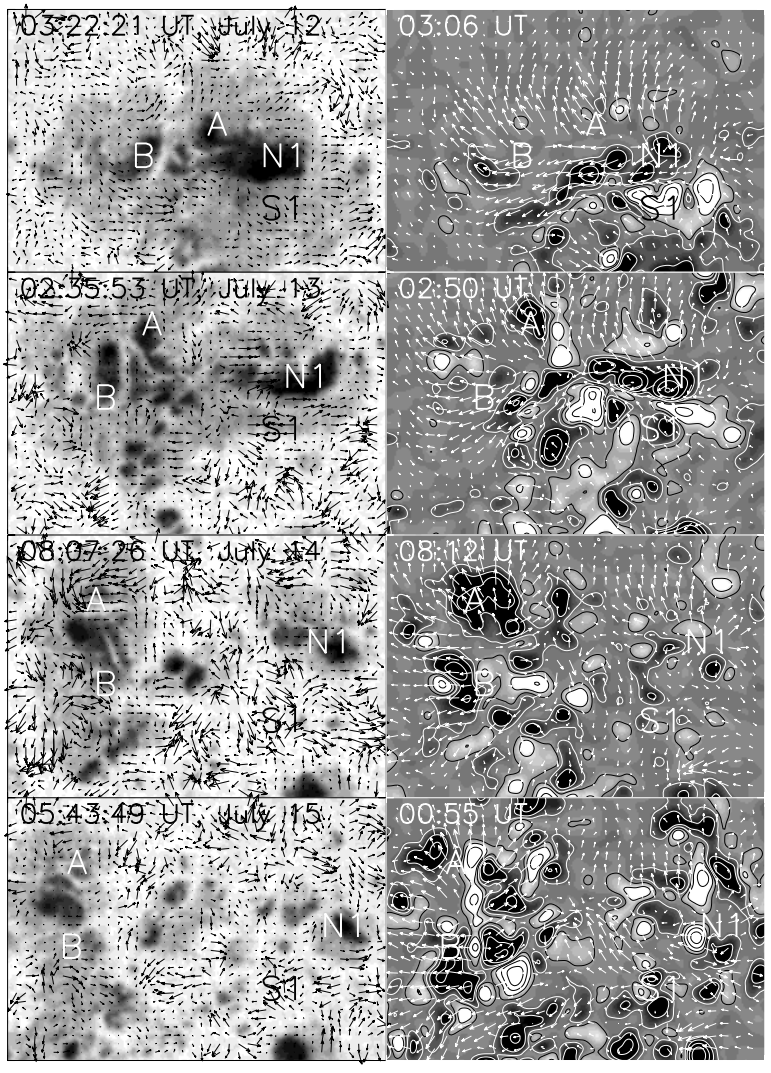

Figure 1. Horizontal velocity vectors and injective rate of magnetic helicity in active region NOAA 9077 in 2000 July

Figure 1 shows the horizontal velocity pattern of photospheric features in the main part of active region NOAA 9077 on 2000 July 12 – 15, where the horizontal velocity vectors

Date	dH/dt $(10^{37}Mx^2/s)$	$\overline{hcz}$ $(10^{-2}G^2/m)$
July 12	-0.323	-3.51
July 13	-0.724	-5.73
July 14	-0.996	-1.53
July 15	-1.189	-0.46

Table 1. Values of the injected rate of magnetic helicity and the corresponding mean current helicity density $\overline{hcz}$ in the main part of active region NOAA 9077 in Figure 1

are overlapped by white light images (left) and contours represent $G = -2\mathbf{U} \cdot \mathbf{A_p} B_n$ (injective rate of magnetic helicity) inferred from the horizontal velocity vectors and longitudinal magnetic field (right). The black (white) contours with white (black) areas mark the positive (negative) change rate of magnetic helicity of ± 5, 20, 50, 100, 180, 300 ($\times 10^{13} G^2 m^2 s^{-1}$). The arrows overlapped by G mark the transverse magnetic field.

The velocity vectors are inferred by the local correlation tracking techniques in white light images observed by TRACE at 03:22:21 and 04:03:39UT on July 12, 02:34:25 and 03:35:33UT on July 13, 08:05:55 and 09:22:47UT on July 14, 05:42:31 and 06:20:46UT on July 15 respectively, which provide the morphological evolution of the active region. It is noticed that magnetic pole N1 moved westward on July 12 and 13. Sunspot A moved at the speed of about 0.1km/s relative to B on July 13-14. The negative magnetic helicity injects into the solar atmosphere near magnetic pole $N1$ due to its shear motion on July 12 -13 and near magnetic pole A due to its rotation on July 14 significantly. The values of photospheric mean current helicity density h_{cz} and the change rate of magnetic current helicity injected from the subatmosphere in the areas of active region NOAA 9077 in Figure 1 are shown in Table 1. It was demonstrated by Zhang (2002) that the high intense current helicity density in the photosphere formed near magnetic pole $N1$ in the vicinity of the magnetic neutral line in the active region on July 12 and 13, and the "Bastille Day" flare on 2000 July 14 occurred after the decay of current helicity density in the photosphere.

It reflects that the decrease of positive photospheric current helicity density relates the injection of the magnetic helicity from the subatmosphere, as comparing the distribution of current helicity density near sunspot A on July 13 and 14.

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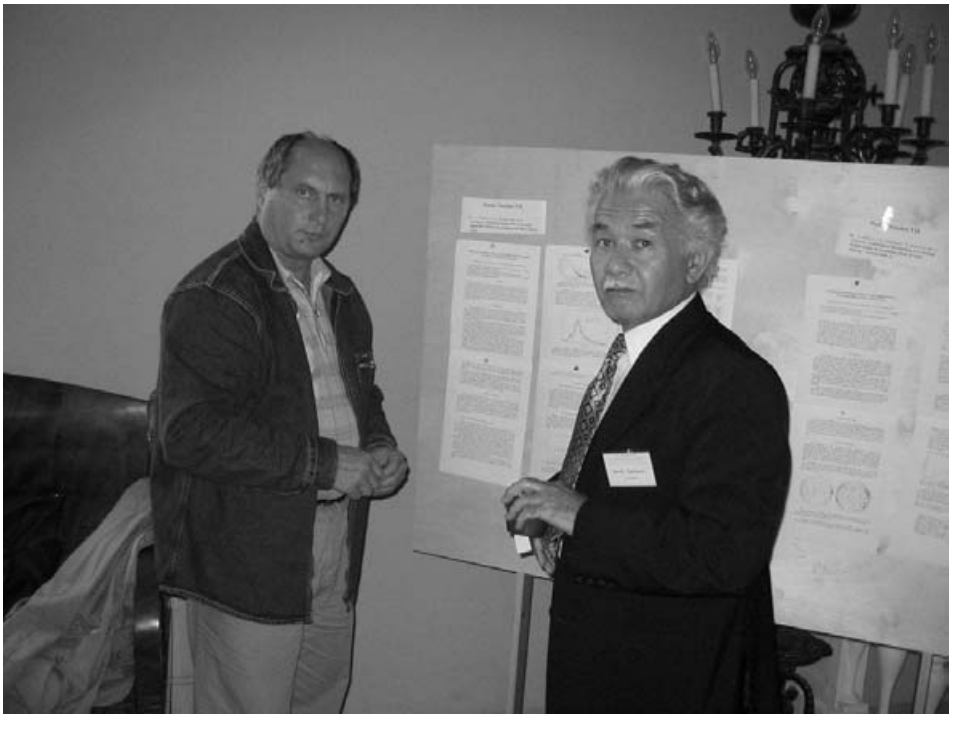

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