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# Twist of Magnetic Fields in Solar Active Regions

Hongqi Zhang*, Lirong Tian, Shudong Bao & Mei Zhang, *Beijing Astronomical Observatory, National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China.*
*email: zhq@sun10.bao.ac.cn*

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## 1. Extended abstract

In the solar atmosphere, the magnetic and current helicity have played an important role in the study of twisted magnetic field. Current helicity parameter $h_{\|} = \mathbf{B}_{\|}\cdot(\nabla\times\mathbf{B})_{\|}$ and force free factor $\alpha = h_{\|}/B_{\|}^2$ can be used to analyze the distribution of twisted field (current helicity) in the photosphere (Seehafer 1990; Pevtsov *et al.* 1995; Bao & Zhang 1998). Bao & Zhang (1998) and Zhang & Bao (1999) computed the photospheric current helicity parameter $h_{\|}$ for 422 active regions, including most of the large ones observed in the period of 1988–1997 at Huairou Solar Observing Station of Beijing Astronomical Observatory.

The calculated results (Pevtsov *et al.* 1995; Abramenko *et al.* 1996; Bao & Zhang 1998) show that most current helicities in sunspot groups in the northern hemisphere show negative sign in the northern hemisphere, while positive in the southern hemisphere, which is consistent with Seehafer's result (Seehafer 1990). The distribution of current helicity parameter $h_{\|}$ in active regions also shows the butterfly pattern through the solar cycle. And, less than 30% of the active regions do not follow the general trend (Zhang & Bao 1998).

The longitudinal distribution of current helicity parameter $h_{\|}$ of active regions in both the hemispheres in the last decade was presented by Zhang & Bao (1999). We can find that the current helicities of solar active regions tend to be uniformly distributed in the different solar longitudes, but the reverse ones show a tendency to occur in some special longitudes. In these longitudes, the reversed magnetic helicities of active regions maintain some kind of coherence over a long period of time, e.g. about 20–40 solar rotation cycles (about 1.53 years).

Relationship in sign between twist parameters $h_{\|}$ and tilt angles of magnetic polarity axis have been investigated for 286 active regions in which bipolar magnetic fields are dominant from data set in the 22$^{nd}$ solar cycle. Fig. 1 shows the relationship in sign between tilt angles of magnetic polarity axis, that of a line joining N-S polarity with the equator (denoting writhe of an $\Omega$-flux tube) and mean twist parameters $h_{\|} = (\mathbf{J}_{\|} \,.\, \mathbf{B}_{\|})$ (denoting twist of magnetic lines in the flux tube) for the 262 bipolar active regions of which tilt angles are between –90° and 90° (Tian *et al.* 1999a, 1999b).

A positive/negative tilt is set for an active region of which the leading spot is S/N polarity and the polarity is closer to the equator in the northern/southern hemisphere. It is found that almost 60% of bipolar active regions have "normal chirality", with

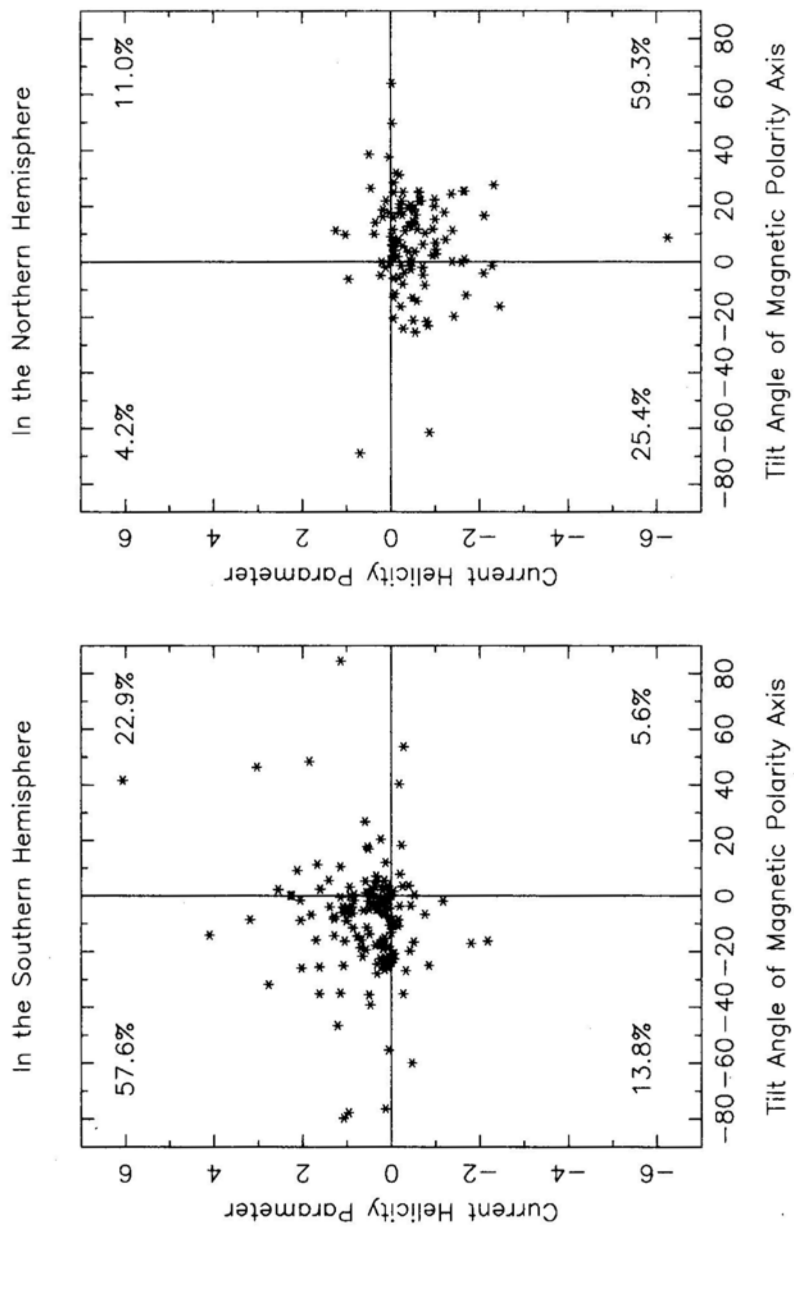


**Figure 1.** The relationship in sign between tilt angles of magnetic polarity axis and current helicity parameter $h_{||}$ in the $22^{nd}$ solar cycle.

magnetic fields twisted as left/right-handedness (denoted by a —/ + $h_{||}$) in a flux tube writhed in right/left-handedness (denoted by a +/– tilt) in the northern/southern hemisphere. But, about one-fourth of bipolar active regions have “abnormal chirality”, with magnetic fields twisted as left/righth-andedness in a flux tube writhed in opposite-handedness in both hemispheres.

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