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Helicity Pattern of CME Source Active Regions

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Coronal mass ejections are thought to originate from the over accumulation of magnetic helicity (Rust & Kumar, 1994). While recent studies revealed the incompetence of CME associated active regions in creating enough helicity for CMEs (Nindos, Zhang, & Zhang, 2003 and references therein), we have tried to seek, on the other hand, if particular helicity patterns are retained by CME-associated active regions.

We select 14 CME-associated ARs. The selection is based on the correlation study of CMEs and surface magnetic activity by Zhou, Wang and Cao (2003). All the CMEs are Earth-directed halo CMEs whose source regions and associated surface activity were well identified. The very CME-prolific ARs took priority in the selection.

Two proxies are used in this work to quantify the helical nature of the AR fields. The first proxy is the force-free coefficient, α_{best}, by which the extrapolated force-free fields fit best the observed transverse fields in the photosphere. It is related the magnetic helicity under the force-free assumption (Wang, 1996; Georgoulis, 2003). The second proxy is the fractional current helicity (Abramenko, Wang, & Yurchishin, 1996), $h_{\|}$. Under the assumption of force-free field, the h_c and α are of the same sign.

Contrary to the helicity charging picture, the newly emerging flux often brings up the helicity of the sign opposite to that of the dominant helicity of the active regions. Moreover the flare/CME initiation site was always characterized by the close contacting of opposite sign helicity. This revelation suggests that the interaction of different flux systems with opposite sign helicity is a key factor in the magnetism of CME initiation.

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