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Magnetic Helicity of Solar Active Regions as Revealed by Vector Magnetograms and Coronal X-Ray Images

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We have used 15 vector magnetograms obtained with the Solar Magnetic Field Telescope at the Huairou Solar Observing Station (NAOC), the Solar Flare Telescope (NAOJ), and the Haleakala Stokes Polarimeter at the Mees Solar Observatory (U. Hawaii), from 1997 to 2000 to calculate the current helicity parameter $\alpha_{\rm av}$ at the photosphere. We have also calculated the parameter $\alpha_{\rm best}$, the linear force-free field parameter α that fits the observed transverse field. It is found that the sign of α is basically reliable; the values of α inferred from the three data sets agree in sign for more than 80% of regions in our sample. Discrepancies are found, however, for some active regions in which the value of $\alpha_{\rm av}$ is relatively small. The line-of-sight magnetograms observed with the Michelson-Doppler Imager (MDI) on SOHO and coronal X-ray images observed with the soft X-ray telescope (SXT) on Yohkoh have been used to determine the constant $\alpha_{\rm c}$ of the linear force-free field model ($\nabla \times \mathbf{B} = \alpha \mathbf{B}$) in the corona. The value of $\alpha_{\rm c}$ corresponds to the extrapolated coronal field whose field lines best match the structure of coronal loops in X-ray images. It is found that the signs of α in the photosphere and in the corona agree for more than 60% of regions in our sample. By assessing differences in measurements, observing conditions, data reduction methods, and limitation in linear force-free-field extrapolation, we are able to discuss true dispersion or fluctuation in the hemispheric sign rule of helicity.