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Magnetic Helicity as a Probe of Magnetic Flux-Tube Dynamics in the Solar Interior

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Magnetic helicity (volume integral of $\boldsymbol{A}\cdot\boldsymbol{B}$), or its proxy, the current helicity at the surface (surface integral of $\boldsymbol{J}\cdot\boldsymbol{B}$ or $J_z \cdot B_z$), is an important quantity which characterizes the helical nature of solar magnetic fields. The current helicity on the sun shows a tendency that it is positive in the southern hemisphere and negative in the northern hemisphere (the helicity sign rule), though with large dispersion. A possible interpretation is that untwisted magnetic fields generated in the sun acquire helicity by the effect of Coriolis force during their ascent through the convection zone. If this is the case the helicity sign rule will not change in time. However, there are indications (though not completely agreed by all) that the helicity sign rule may be reversed at activity minimum periods. We will discuss the significance of this property by focusing on the statistical distributions of helicity whether its dispersion follows Gaussian distribution or not.