Large-scale Cyclic Features of Solar Magnetic Field

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It is well accepted that the solar cycle originates from a magnetohydrodynamics dynamo deep inside the Sun. Many dynamo models have long been proposed based on a lot of observational constraints. In this paper, using 342 NSO/Kitt Peak synoptic charts we study the large-scale solar cycle features of photospheric magnetic flux to set further constraints. According to the flux behaviors we categorize each hemisphere into four typical latitudinal zones: the polar region, the high latitude region, the activity belt and the low latitude region. (1) We find the mean latitudes of the boundaries of polar regions to be near 55.35$ˆ{\circ}$ during solar minimums and 67.61$ˆ{\circ}$ during solar maximums. (2) There is an unipolar poleward magnetic flux found in the high latitude region during solar maximums. (3) For the activity belt, the flux peak time (or the main phase of solar cycle) are steady and has a period near 11 years. From the higher latitudinal strips to the lower ones, the total (positive or negative) magnetic flux accumulates with a speed of $2.48\times10ˆ{20}$ Mx/deg. Moreover, we find that the latitude migration of magnetic flux which represents the Sp\"{o}rer law starts in this belt and can be written in a formula like $\phi=29.02-3.150t+0.1123tˆ{2}$. (4) The flux peak time of the low latitude region shifts forward with an average speed of 32.2 day/deg. From the higher latitudinal strips to the lower ones, the total magnetic flux dissipates with a speed of $3.63\times10ˆ{20}$ Mx/deg. General speaking, dynamo theories are developed for reproducing the solar cycle. These typical characteristics can provide hints for constructing a more reliable solar dynamo.