Gnevyshev Gap from the Point of View of Solar Dynamo

KATYA GEORGIEVA¹

¹Solar-Terrestrial Infliuences Laboratory, Bulgarian Academy of Sciences

According to the Babcock-Leighion flux-transport dynamo mechanism [1, 2], the poloidal field of a sunspot cycle is generated from the field of the decaying sunspot pairs of the previous cycle. The way in which the dynamo operates depends on the diffusivity in the bulk of the convection zone. If the diffusivity is high enough, a part of the poloidal field generated at the mid-latitudes is advected by the meridional circulation toward the poles, down to the tachocline, and equatorward at the base of the convection zone where the toroidal field for the next cycle is produced, while another part "short-circuits" the meridional circulation and directly diffuses towards the tachocline at mid latitudes, again to be transformed into toroidal field and to emerge as the sunspots of the next cycle [3]. In this case, the sunspot maximum will be the superposition of these two surges of toroidal field - the one generated from the poloidal field advected all the way on the surface to the poles, down to the tachocline and equatorward to sunspot latitudes, and another one generated from the poloidal field diffused at midlatitudes from the surface to the tachocline and transformed there into toroidal field. In general these two surges do not coincide, leading to a double maximum in sunspot activity. Gnevyshev [4] suggested that all cycles have two peaks generated by different physical mechanisms, but sometimes the gap between them is too short for the maxima to be distinguished in the total sunspot area. They are, however, easily identified in sunspot activity in different latitudinal bands. Here we study the double peaks in the last 12 sunspot cycles in combination with geomagnetic activity data, to derive the parameters of the solar dynamo. We find that the speed of the deep equatorward circulation at the base of the solar convection zone is between 2 and 6 m/s, the speed of the surface poleward circulation is 5-20 m/s, and the diffusivity in the bulk of the convection zone is $\sim 10^8$ m^2/s . We comment the constraints which these set on solar dynamo models.

Keywords: solar dynamo; Gnevyshev gap; meridional circulation.

References

- [1] Babcock, H.W.. Ap. J. 133, (1961).
- [2] Leighton, R., Ap. J. 159, (1969).
- [3] Jiang, J., Chatterjee, P., Choudhuri, A.R., MNRAS 381, 4 (2008).
- [4] Gnevyshev, M. N., Solar Phys 1 (1), (1967).