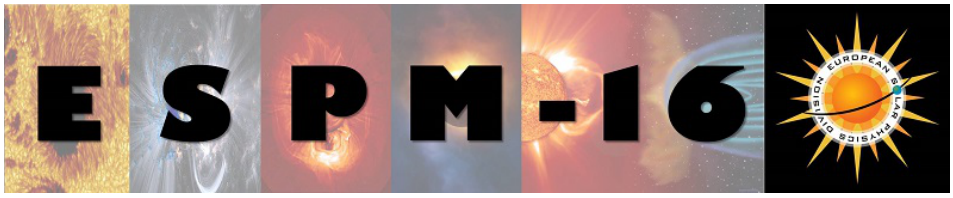

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A new generation of Babcock-Leighton solar dynamo model

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The Babcock-Leighton (BL) mechanism, in which the poloidal field is produced by the emergence and subsequent dispersal of sunspot groups, has been received more and more observational evidence during the past decade. Most BL-type dynamo models assume that the toroidal field is generated in the tachocline. However, recently the importance of the tachocline has been questioned by magnetic activity of fully convective stars. We aim to develop a new generation of BL-type dynamo model, in which the dynamo operates mainly within the convection zone. We introduce the near-surface turbulent pumping into the BL-type dynamo model with a vertical upper boundary condition. Other ingredients include solar-like internal differential rotation, a single-cell meridional flow with penetration depth of 0.7R, and the magnetic diffusivity of $5.0 \times 10^{11} cm^2 s^{-1}$. The pumping causes the poloidal field within the convection zone to be almost in the purely latitudinal direction. Due to the latitude shear in the bulk of the convection zone, most of the toroidal field is generated there. Our model reproduces the basic properties of the solar cycle, including a) 22 years magnetic cycle; b) equatorward propagation of the activity belts; and c) phase difference between the activity belts and polar field. The results do not depend on the existence of the tachocline or not. The near-surface pumping enhances the coupling of the poloidal field between the northern and southern hemispheres to reproduce solar-like dipolar parity.

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