Title: Evolution and diversity of solar-type stars dynamo

Abstract:

The solar magnetic field is generated and sustained through an internal dynamo process. This process is determined by the intertwined action of turbulent convective motions and differential rotation. It can sometimes lead to magnetic cyclic variabilities, like the 11-years solar cycle. Evidence of magnetic cycles have been detected for other solar-type stars as well, ranging from a few years to a few tens of years. How are these cycles controlled?
During their life, the rotation of stars is subject to a complex evolution. Recent 3D numerical simulations of solar-type stars show that different regimes of differential rotation can be characterized with the Rossby number. How the dynamo process can be impacted by such changes ?
We performed a numerical multi-D dynamo study with the STELEM and ASH codes to understand the magnetic field generation of solar-type stars under various differential rotation regimes. We particularly focused on the existence of magnetic cycles in a “Sun in Time” context.
We find that short cycles are favoured for small Rossby numbers (fast rotators), and long cycles for intermediate (solar-like) Rossby numbers. Slow rotators (high Rossby number) are found to produce only statistically steady dynamo with no cyclic activity in most cases considered. We further assess the various energy transfers in these stellar dynamos and quantify the amount of magnetic energy available (up to 3% of the stellar luminosity) to power possible surface eruptive events. We finally show that the Rossby number dependency of the large-scale surface magnetic field in the simulation ($B_{L,surf} \propto Ro_f^{-1.26}$) agrees better with observations ($B_V \propto Ro_f^{-1.4}$) than dynamo scalings ($B_{bulk} \propto Ro_f^{-0.5}$) based on the global magnetic energy.

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