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Cyclic fluctuations in the differential rotation of active stars

Pascal Petit

Observatoire Midi-Pyrénées, 14 avenue Edouard Belin, F-31400 Toulouse, France
email: petit@ast.obs-mip.fr

Abstract. Differential rotation is described in stellar dynamo models as one of the fundamental phenomena governing the amplification of magnetic fields in active stars. Using indirect imaging methods, the measurement of photospheric differential rotation is now achieved on a growing number of very active stars, a fraction of which exhibit temporal fluctuations of potentially large amplitude in their latitudinal shear, on a time-scale of a few years. I first describe the modeling tools on which such analysis is based, then discuss the implications of this observational work on our understanding of stellar dynamos and of the impact stellar magnetic fields may have on the dynamics of convective envelopes.

Keywords. Stars: magnetic fields, stars: late-type, stars: rotation

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Differential rotation is one of the basic ingredients invoked to explain the generation of the solar magnetic field, through its ability to transform a large-scale poloidal field into a stronger toroidal component. However, much details of this general principle are still poorly understood, and a major aim for stellar differential rotation measurements is to evaluate, in the stellar parameter space, how various properties of stellar activity (magnetic field intensity, existence of activity cycles) can be connected to differential rotation.

The spatial distribution of photospheric magnetic fields can be reconstructed for fast rotating stars (with a significant rotational broadening of spectral lines) by means of tomographic inversion techniques very similar to Doppler imaging (Vogt & Penrod 1983), but based on the inversion of polarized light and therefore called Zeeman-Doppler Imaging (Semel 1989; Donati & Brown 1997). For cool stars, circularly polarized signal is generally used alone. The location of magnetic regions is obtained very similarly to that of star-spots in classical Doppler mapping. Some information about the orientation of field lines can also be determined by following the distortion of Zeeman signatures during the transit of magnetic regions over the stellar disc.

The short-term temporal evolution of surface structures can be analyzed with Zeeman-Doppler Imaging. Measurements of differential rotation can in particular be performed, using cool spots or magnetic regions as tracers of the large-scale surface flows (Petit *et al.* 2002). A solar-like surface shear (the equator rotating faster than the pole) has been detected on several stars (see, e.g., Donati *et al.* 2003; Petit *et al.* 2004a; Petit *et al.* 2004b).

An exciting result is also the recent detection, on the young dwarf AB Dor, of secular fluctuations of differential rotation (Collier Cameron & Donati 2002; Donati *et al.* 2003; Marsden *et al.* 2005), about 40 times stronger in amplitude than fluctuations reported for the Sun (Howe *et al.* 2000; Vorontsov *et al.* 2002). This observation may unveil, for the first time on a star other than the Sun, the feedback effect of magnetic fields on the dynamics of convective zones (through Lorentz forces) during stellar activity cycles (Applegate 1992).

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References

Applegate, J. H. 1992, *ApJ*, 385, 621
Collier Cameron, A., & Donati, J.-F. 2002, *MNRAS*, 329, 23
Donati, J.-F., & Brown, S. F. 1997, *A&A*, 326, 1135
Donati, J.-F., Collier Cameron, A., & Petit, P. 2003, *MNRAS*, 345, 1187
Howe, R., Christensen-Dalsgaard, J., Hill, F., *et al.* 2000, *Science*, 287, 2456
Marsden, S. C., Waite, I.A., Carter, B. D., & Donati, J.-F. 2005, *MNRAS*, 359, 711
Petit, P., Donati, J.-F., & Collier Cameron, A. 2002, *MNRAS*, 334, 374
Petit, P., Donati, J.-F., Wade, G. A., *et al.* 2004a, *MNRAS*, 348, 1175
Petit, P., Donati, J.-F., Oliveira, J., *et al.* 2004b, *MNRAS*, 351, 826
Semel, M. 1989, *A&A*, 225, 456
Vogt, S. S., & Penrod, G. D. 1983, *PASP*, 95, 565
Vorontsov, S. V., Christensen-Dalsgaard, J., Schou, J., *et al.* 2002, *Science*, 296, 101

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