



Intermediate periodicity in stellar activity and stellar-planetary interactions

T. Zaqarashvili (1,4), R. Oliver (2), J.L. Ballester (2), M. Carbonell (2), M. Khodachenko (1), M. Leitzinger (3), H. Lammer (2) and P. Odert (3)

(1) Space Research Institute, Graz, Austria (2) Universitat de les Illes Balears, Palma de Mallorca, Spain, (3) University of Graz, Graz, Austria, (4) Abastumani Astrophysical Observatory, Ilia state University, Georgia

Abstract

We show that the slow modes of magnetic Rossby waves, which lead to intermediate periodicities in stellar activity, are trapped at polar regions of rapidly rotating stars. This may explain the observed high latitude location of spots on these stars. The polar location of active regions may lead to different structure of magnetic field in the stellar atmosphere and therefore may significantly affect the theory of stellar-planetary interactions.

1. Introduction

It has been recently shown that magnetic Rossby waves (Rossby waves in magnetised fluids) cause the observed intermediate (Rieger type, ~ 150 days) periodicities in the solar activity (5). The waves may also explain the observed intermediate periodicity in stellar activity (2). On the other hand, the star spots are observed at high latitudes of rapidly rotating stars (4). The observations are usually explained by transport of magnetic flux towards the poles during raise phase through the convection zone (3). The magnetic Rossby wave theory may lead to some additional consequences in stellar magnetic structure.

2. Magnetic Rossby waves

We use shallow water magnetohydrodynamic approximation and consider thin layer below the convection zone of star perceived with horizontal magnetic field. With the help of spherical coordinate system (r, θ, ϕ) we get an equation governing the linear dynamics of fast and slow magnetic Rossby waves. This equation is transformed into the Laguerre equation for the slow magnetic Rossby waves in the approximation of rapidly rotating star. The solutions are the Laguerre functions ψ_n^s , which are linked to Associated Laguerre polynomials L_n^s . The solutions are located near the

poles, which may indicate to the increased role of Rossby waves in the appearance of starspots at polar regions.

3. Summary and Conclusions

We found that slow magnetic Rossby waves tend to locate near the polar regions in rapidly rotating stars. The waves may cause the intermediate periodicities in the stellar activity and observed appearance of starspots at high latitudes in rapidly rotating stars. The polar spots may lead to complete change of magnetic field structure in the stellar atmosphere. This may reveal new aspects of stellar-planetary interactions (1).

References

- [1] Khodachenko, M.L. et al., Coronal Mass Ejection (CME) Activity of Low Mass M Stars as An Important Factor for The Habitability of Terrestrial Exoplanets. I. CME Impact on Expected Magnetospheres of Earth-Like Exoplanets in Close-In Habitable Zones, *Astrobiology*, 7, 167-184, 2007.
- [2] Massi, M., Neidhofer, J., Torricelli-Ciamponi, G., and Chiuderi-Drago, F., Activity cycles in UX ARIETIS, *A&A*, A&A, 332, 149-154, 1998.
- [3] Schussler, M., Caligari, P., Ferriz-mas, A., Solanki, S.A. and Stix, M., Distribution of starspots on cool stars, *A&A*, 314, 503-513, 1996.
- [4] Strassmeier, K.G., Starspots, *Astron. Astroph. Rev.*, 17, 251-308, 2009.
- [5] Zaqarashvili, T.V., Carbonell, M., Oliver, R., and Ballester, J.L., Magnetic Rossby waves in the solar tachocline and Rieger-type periodicities, *ApJ*, 709, 749-758, 2010.