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Estimating rotation periods and magnetic cycle lengths of active stars

Title of the dissertation	From periodic to cyclic processes in stellar magnetic activity research: time series analysis methods and their applications
Contents of the dissertation	In this dissertation, we introduce and develop time series analysis methods, which are dedicated to period and cycle length estimation of magnetically active stars. Knowing both of these quantities is important as it makes observable reality comparable with predictions from the dynamo theory. Magnetic activity is primarily manifested through dark spots on the surface of the star. However, the rotation of the star is not uniform, but differential, which makes the period estimation not a trivial task. Furthermore, over time the number of spots changes, forming a cyclic process. For instance, for the Sun the activity cycle is known to last approximately 11 years, while both the length of each individual cycle as well as the amplitude is varying. Such a behavior is called quasi-periodic. In the introduction of the dissertation, we give an overview of the relevant questions in the domain of period estimation for unevenly sampled time series and subsequently introduce several practical methods applicable to quasi-periodic as well as nonstationary time series. In the applications, we have used datasets of several Sun-like stars, for which we have estimated the mean rotation period, magnetic cycle length, made comparison to earlier studies and discussed the results in the light of dynamo theory. One of the interesting and yet not understood finding from the study is the pattern how the stars group when plotted on a so-called activity diagram. Besides real world data, we have analysed the data from fully 3D global magnetohydrodynamical simulations, which have only quite recently become possible to carry out. The main challenge in the latter analysis is the vast amount of multidimensional data, thus the algorithms used must be well scalable. For the computation, we have used parallelisation and the help of supercomputers.
Field of the dissertation	Computer Science
Doctoral candidate	Nigul Olspert, M.Sc.
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