Multifractality in the astrophysical time series

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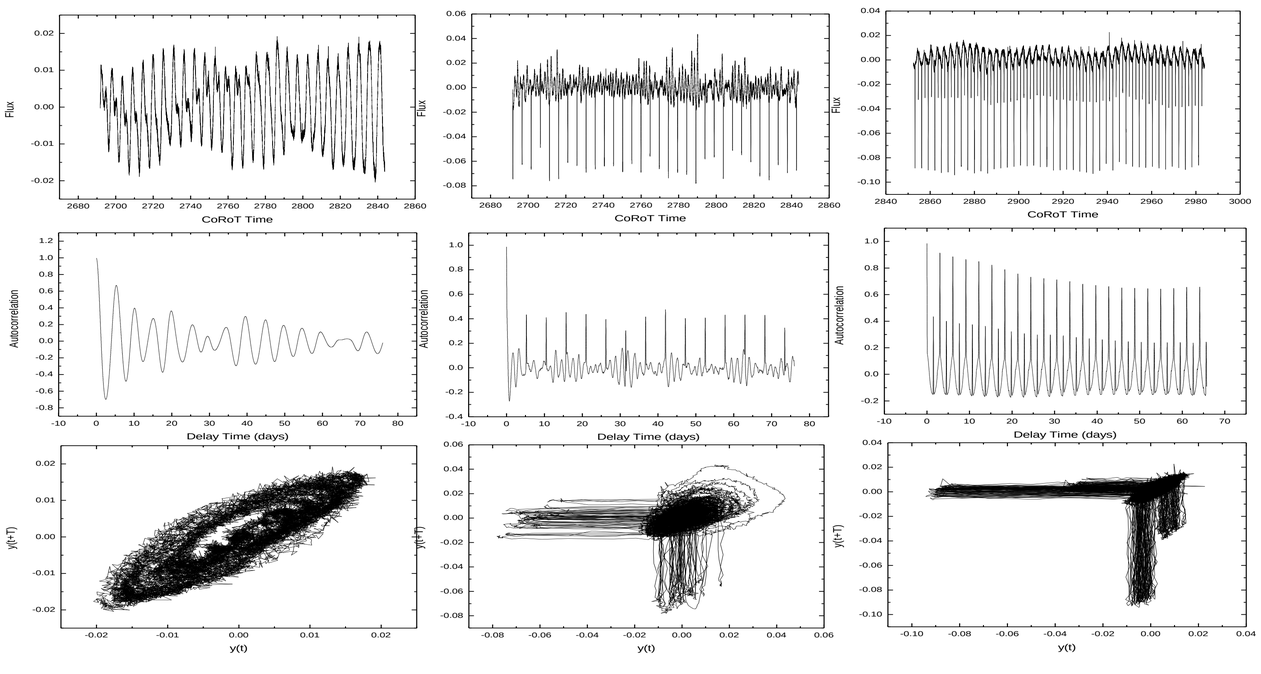
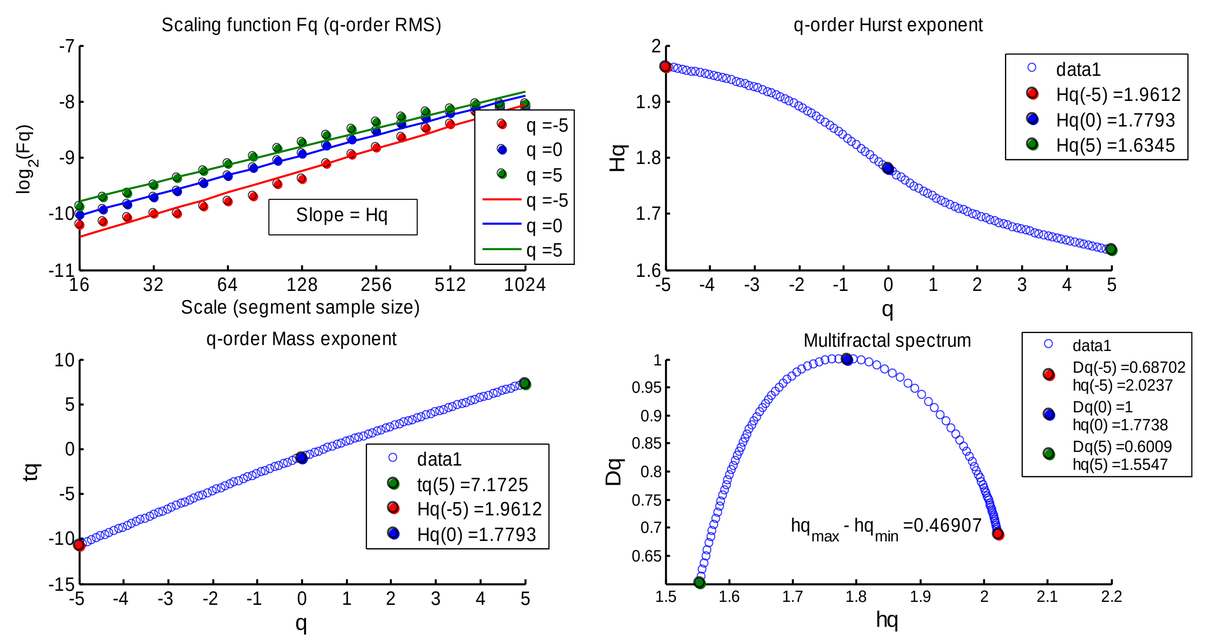
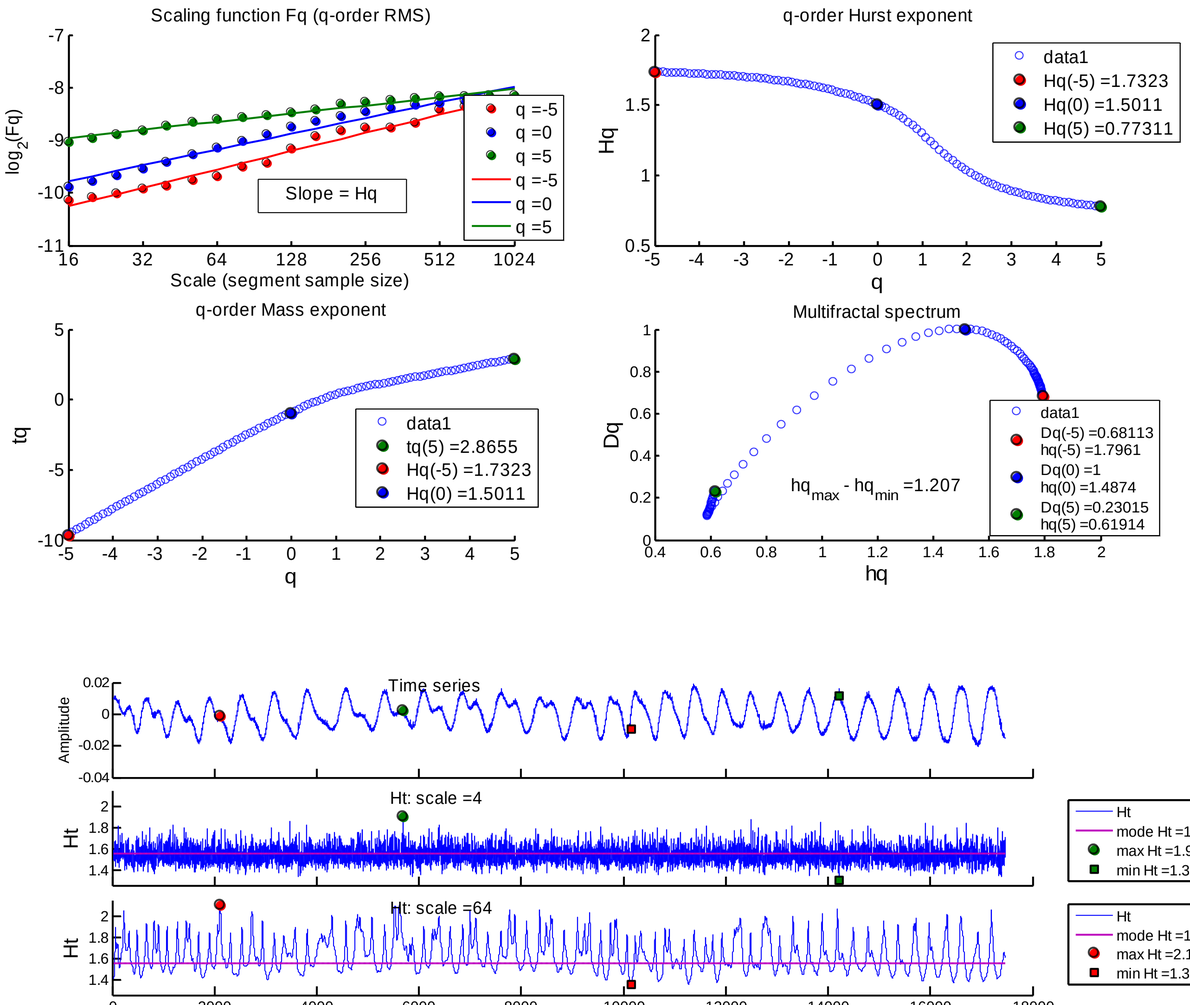
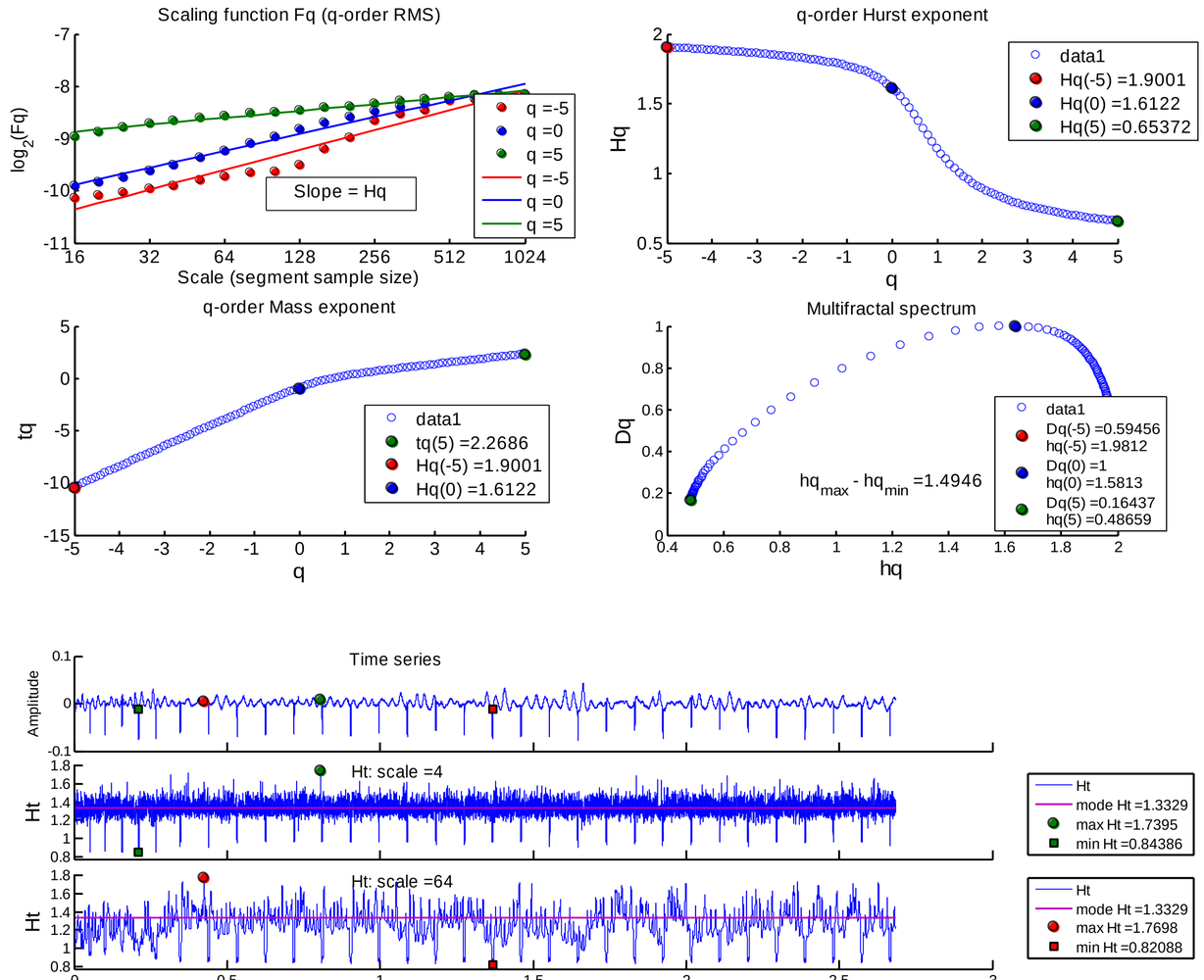
Introduction: Multifractality theory provides an elegant statistical characterization of many complex dynamical variations in Science, in particular, in Stellar Astrophysics. This work investigate the multifractality properties of CoRoT Light Curves. Speciality, we studied this behavior on stars with planet and without detected planet. We use Multifractality Detrended Fluctuation Analysis (MF-DFA) to study light curves fluctuations. We develop a model to test the relationship between these kind of light curves and the multifractality degree. Our preliminary results reveal a robust evidence that higher multifractality is associated with a presence of planet.

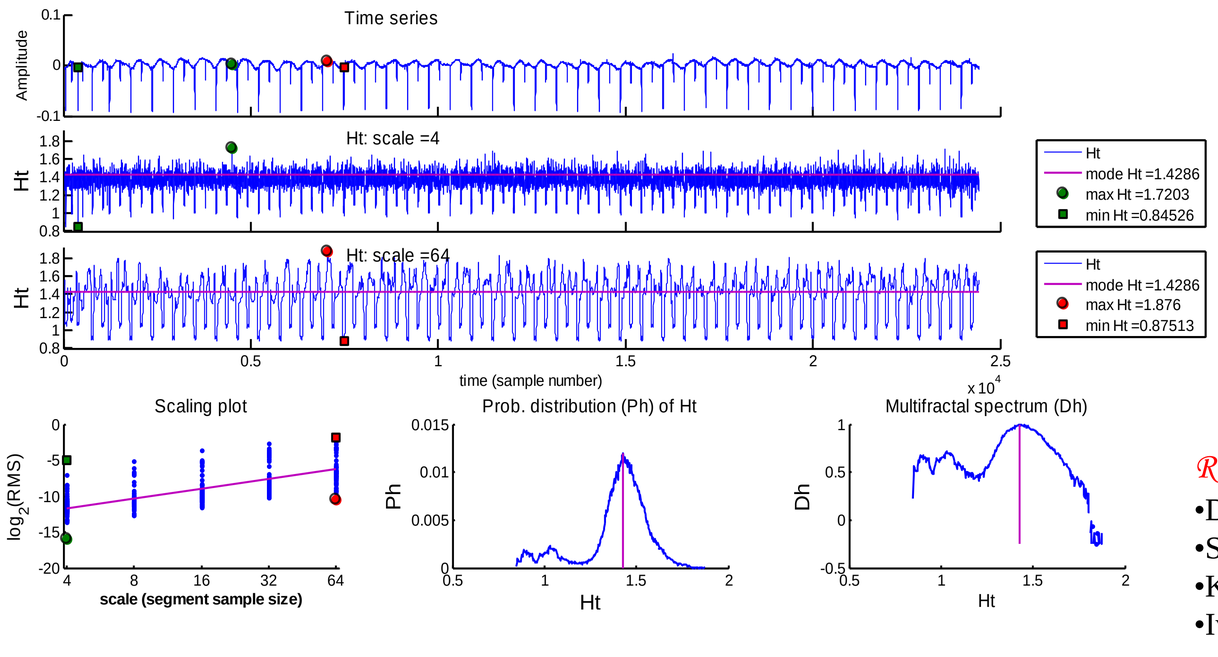
Methods and Procedures: Our study proposes to investigate the multi-similarity and multifractal nature between the Sun and three stars from the Kepler satellite rotationally analogous using a powerful statistical tool denoted by MultiFractal Detrented Fluctuation Analysis (MF-DFAm) method with free polinomial exponent able to eliminate trends of order "m" in the profile (Kantelhardt et al. 2002) . This method consists of a multifractal characterization of nonstationary time series, based on a generalization of Detrended Fluctuation Analysis (DFA). This last method is effective for characterization of the monofractal time series. This type of time series has the same scaling properties throughout the entire signal indexed by a single global Hurst exponent. On the other hand, multifractal time series reveal a wide Hurst exponent spectrum which quantify the local singular behavior and thus relate to the local scaling of the LC. Thus, the Hurst exponent defined by DFA method represents the average fractal structure of the LC, denoting the central tendency of multifractal spectrum. In addition, the MF-DFA approach for LC has the potential to describe a wide class of time series that are more complex than those characterized by a single scaling exponent as in case of the DFA.











Results and Conclusions:

The purpose of this work is to characterize the intermittent behavior of three CoRoT Light Curves with signatures of rotational modulation, planetary transit and binarity, respectively, in term of their multifractality and interpret the degree of multifractality as a measure of their complexity. In this context, we showed that there is a degree of complexity obtain by broadness or width of the singularity spectrum D(h) denoted by hq(max)-hq(min). This new approach way bring an insight into the different mechanisms which control different signatures in the light curves.

References:

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