The Global Flow Reconstruction of DF Cyg

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We found evidence for chaotic behaviour in the pulsation of an RVb-type star, DF Cyg, and we calculated the Lyapunov dimension of the underlying dynamics to be ~ 2.8.

1 Introduction

RV Tau-type pulsation is believed to be governed by chaotic dynamics under certain conditions. The success of chaos investigations depends on the data quality and length. Only two RV Tau stars have been found to be chaotic so far: R Sct (Buchler et al., 1996) and AC Her (Kolláth et al., 1998).

DF Cyg was monitored in the original *Kepler* mission providing the first extended, continuous and high-precision photometry for this RV Tau class so far (Bódi et al., 2016). We used the *Kepler* light curve in our global flow reconstruction to search for the quantitative properties of the pulsation dynamics such as the Lyapunov exponents and dimension (for detailed description of the method we refer to Serre et al., 1996). Since this star belongs to the RVb subtype, the analysis is complicated by the presence of the slow, large-amplitude variations atop the pulsation which may originate from disc obscuration (Vega et al., 2017). To eliminate these variations, we applied the Empirical Mode Decomposition (EMD) method (Huang et al., 1998) that was found to be useful for such application in a previous study (Plachy & Kolláth, 2013).

2 Results

We successfully performed global flow reconstruction on the short-term light variation of DF Cyg ($P \sim 24.9$ days) that was separated from the RVb phenomenon with the application of the first three intrinsic mode functions determined with the EMD method. We present the BK-projections (Broomhead & King, 1986) of these time series in Fig. 1 along with an example of the synthetic models from our reconstructions. We calculated the Lyapunov dimension of the models to be ~ 2.8.

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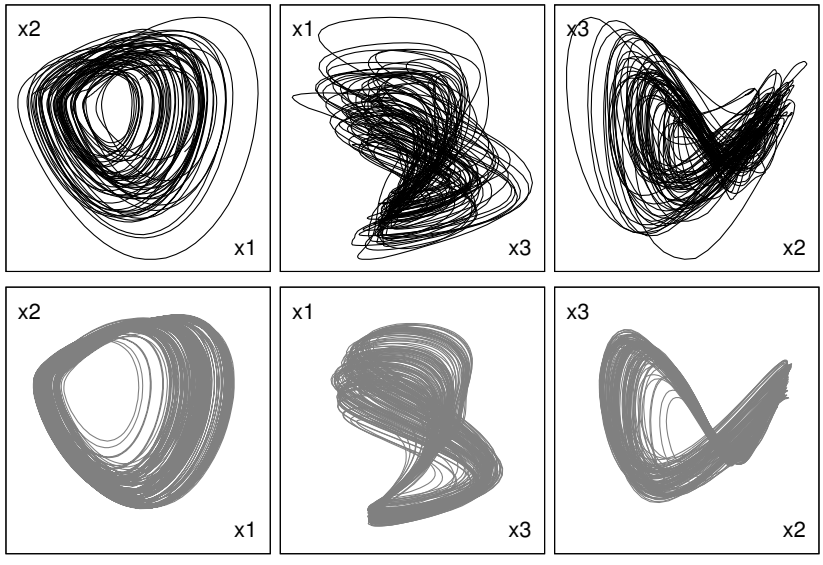

Fig. 1: Broomhead-King (BK) projections of the pulsation of DF Cyg (upper panels) and a chaotic synthetic signal from the global flow reconstruction with Lyapunov dimension of 2.8 (lower panels). The resemblance of the two signals is evident.

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