Stars and their variability observed from space
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ASTEROSEISMIC ANALYSIS OF THE SPB STAR HD 54967 OBSERVED BY *TESS*

P. Walczak[1], W. Szewczuk[1] and J. Daszyńska-Daszkiewicz[1]

Abstract. HD 54967 was observed by *TESS* with a 2-min cadence in Sectors 1 and 2. Its light-curve revealed a rich frequency spectrum, mostly in the region of high-order g-modes. That meant that the star is a Slowly Pulsating B-type pulsator. Our frequency analysis indicated the presence of quasi-equal period spacings, which support mode identification and detailed seismic modelling. We present the results of our initial analysis of the star. Further studies should supply constraints on physical processes occurring inside it, including various types of mixing processes.

Keywords: Stars: individual: HD 54967, variables: general, asteroseismology

1 Introduction

The luminosity of the star was calculated from the Gaia DR2 parallax (Gaia Collaboration et al. 2016, 2018; Lindegren et al. 2018), and bolometric correction from Flower (1996). The evolutionary tracks shown in the H–R diagram in the left panel of Fig. 1 were calculated with the MESA code (MESA Paxton et al. 2011, 2013, 2015, 2018), version 11701. We adopted a metallicity $Z = 0.010$, an exponential overshooting parameter $f_{\rm ov} = 0.01$ from the hydrogen-burning convective core (Herwig 2000), a hydrogen abundance $X = 0.7$ and the OPLIB opacity tables (Colgan et al. 2015, 2016). Two values for the rotational velocity were studied, $V_{\rm rot} = 0$ km s^{-1} and 200 km s^{-1}.

From the *TESS* light-curve of HD 54967 we derived about 200 independent frequencies. Most of them occupy the low-frequency region, but there are frequencies as high as 10 d^{-1}. The frequency spectrum is shown in the upper right panel of Fig. 1.

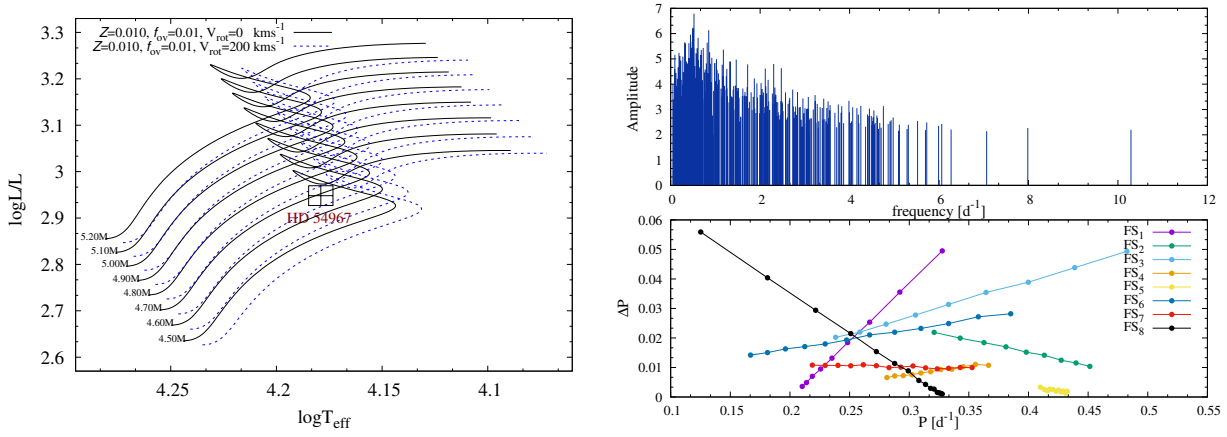

Fig. 1. Left: H–R diagram showing the position of the target star HD 54967. The evolutionary tracks were calculated for masses from 4.5M$_\odot$ to$_\odot$, and for different rotational velocities: $V_{\rm rot} = 0$ and 200 km s^{-1}. We also assumed metallicity Z = 0.01 and an exponential overshooting parameter $f_{\rm ov} = 0.01$. Right (upper): Frequency spectrum derived from *TESS* data. Right (lower): Diagram showing frequency sequences in the period vs. period differences

The frequency spectrum is very dense, and there are no obvious quasi-equal period spacings. However, a more detailed analysis revealed some regular structures. The lower right panel of Fig. 1 shows the most interesting frequency sequences in the diagram of period vs. period difference.

[1] Astronomical Institute Wrocław University, ul. Kopernika 11, 51-622 Wrocław, Poland

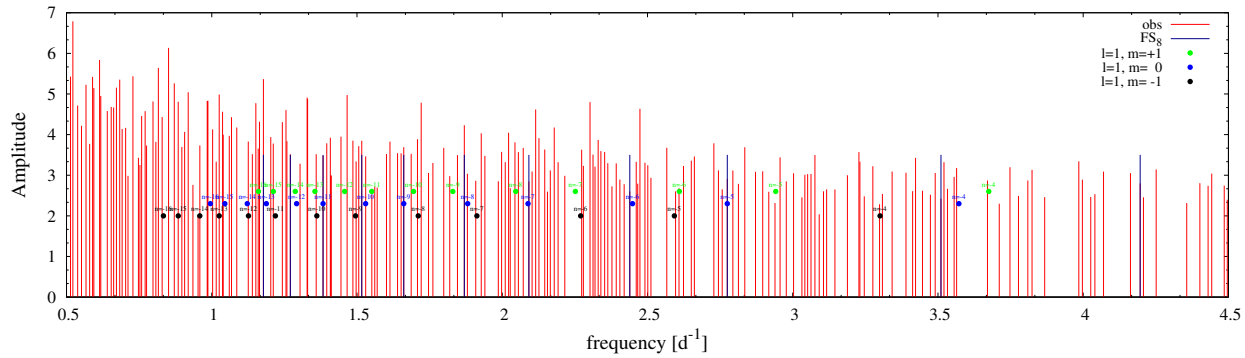

Fig. 2. A model example that fits some frequencies from frequency sequence No. 8.

Some of the sequences we found may be accidental. A detailed analysis consisting of simultaneous mode identification and frequency fitting is required in order to establish physical sequences of frequencies with the same degree and consecutive radial orders. For more information on the subject see Szewczuk & Daszyńska-Daszkiewicz (2018).

Here we present the result of a very preliminary analysis. The model fits frequencies from frequency sequence No. 8 under the assumption that it is a dipole mode series. We derived the following parameters: mass $M = 4.716\mathrm{M}_{\odot}$, rotational velocity $V_{\rm rot} = 70$ km s^{-1}, effective temperature $\log T_{\rm eff} = 4.1778$ and luminosity $\log L/L_{\odot} = 2.9206$.

2 Conclusions

Analysis of the *TESS* data obtained for HD 55967 resulted in the detection of a large number of pulsational frequencies. Most of them are low frequencies (g-modes) typical of SPB type stars. A detailed study of the frequency spectrum revealed a few frequency series that can be associated with consecutive radial orders of modes with a given mode degree (ℓ) and azimuthal number(m). Further seismic modelling of the star should yield constraints on different mixing processes that take place inside the star.

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