Asteroseismology of a mild Am δ Sct star HD 118660: TESS Photometry and Modelling

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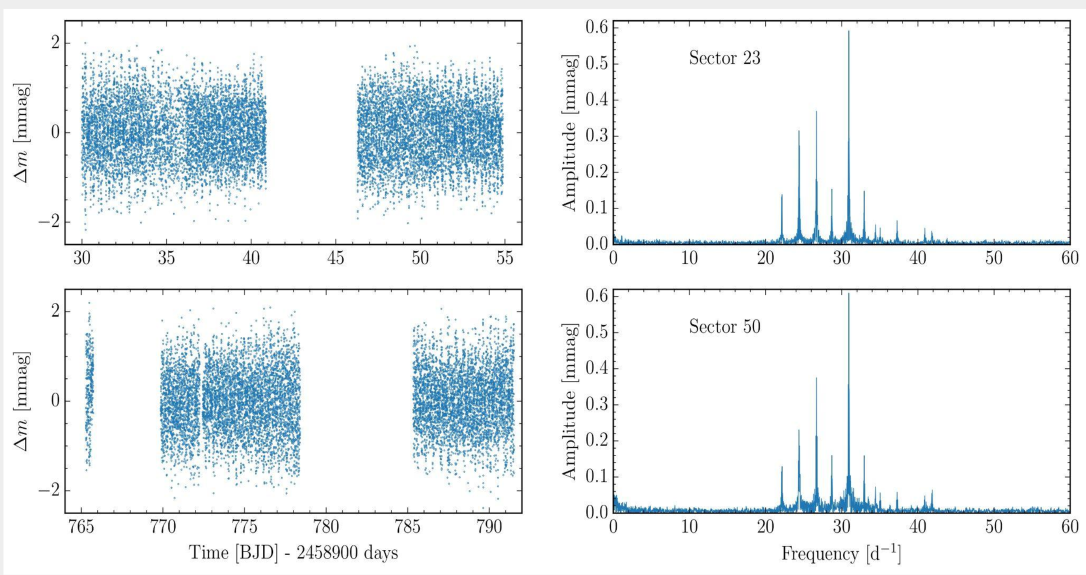
Abstract

We report the asteroseismic analysis of HD 118660 (TIC 171729860), a chemically peculiar (mild Am) star with δ Scuti (δ Sct) pulsations. This study analyzes two sectors of time-series photometry from the Transiting Exoplanet Survey Satellite (TESS) mission and seismic modeling. It detected 15 and 16 frequencies for TESS sectors 23 and 50, respectively. The detected pulsation modes are four radial (l = 0) and five dipolar (l = 1). Radial modes are overtones with order n between 3 and 6. Stars with the effective temperature of HD 118660 (Teff = 7550 K) near the red edge of the δ Sct instability strip are unlikely to have such high values of n. A grid of stellar models was created to estimate asteroseismic parameters, assuming a solar metallicity of Z=0.014 and varying values for the convective overshooting parameter $(0.1 \leq \alpha_{ov} \leq 0.3)$. We find that radial mode analysis cannot constrain α_{ov} and Z for δ Sct stars. The equatorial velocity of HD 118660, determined from seismic radius and rotational frequency, matches literature values.

Asteroseismic Modelling

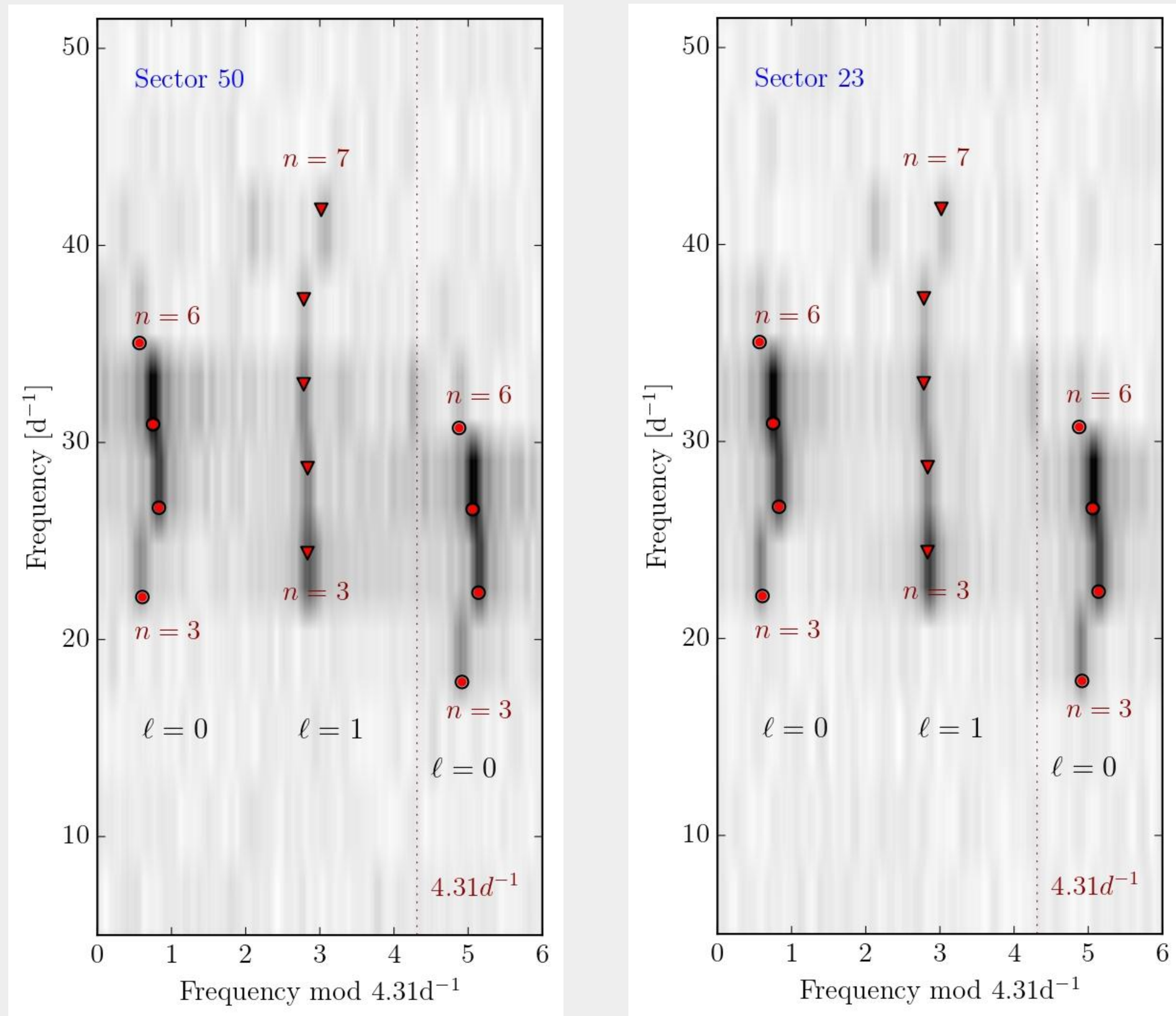
TESS Observations:

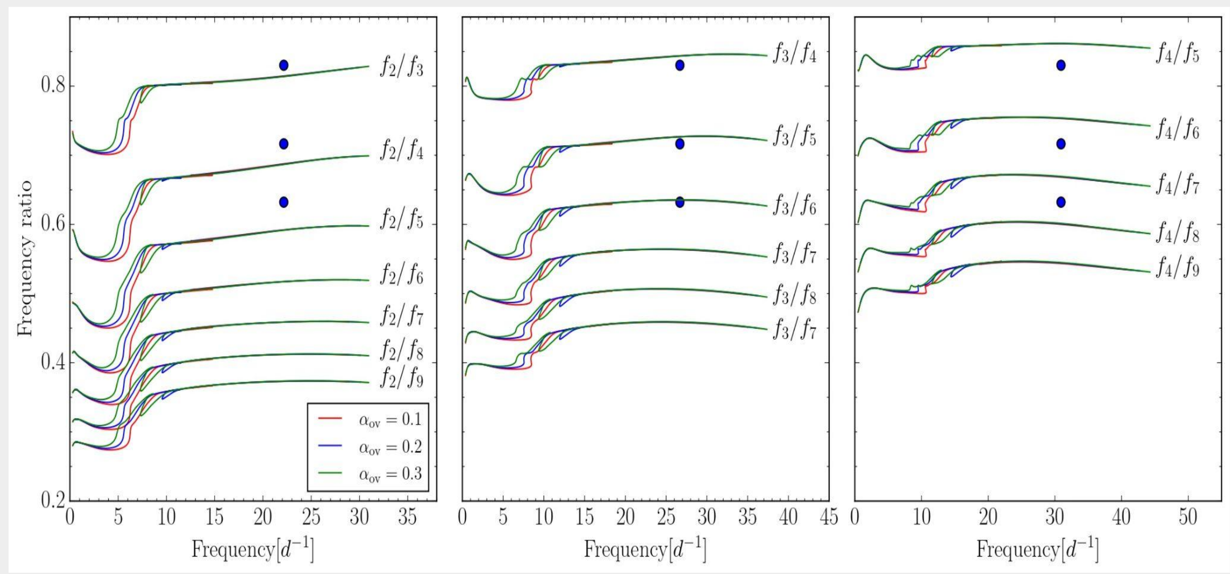
HD 118660 was observed in the TESS sectors 23 and 50. Here we have utilized the 200 sec cadence data for our seismic analysis with a *Nyquist limit* nearly 360 c/d. The periodogram is generated using PERIOD04. The frequencies having SNR>5 criteria is used.



Mode Identification

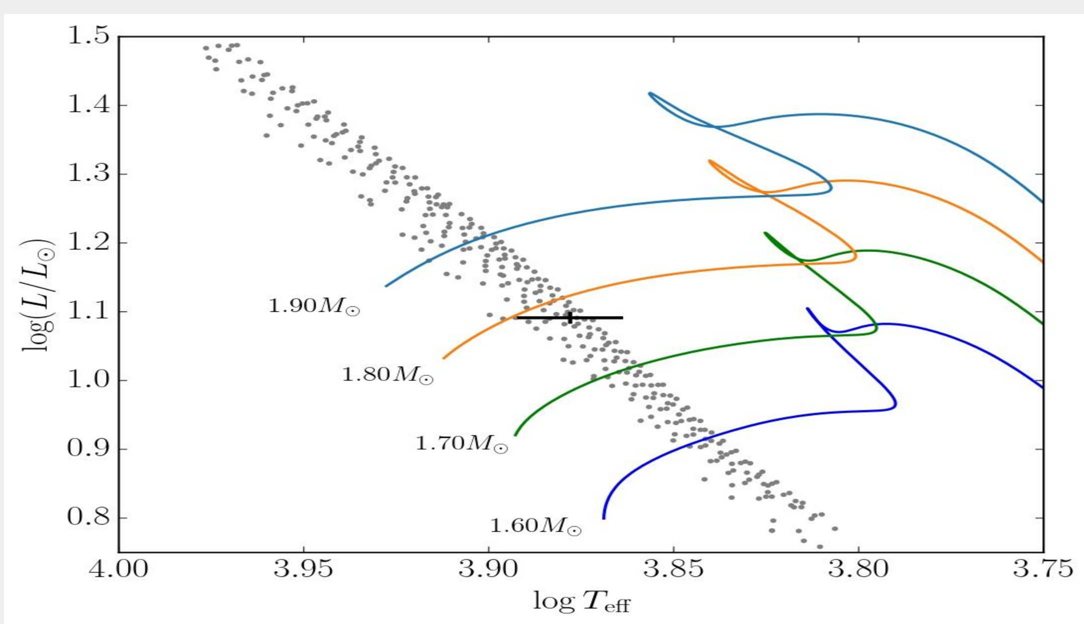
The identification of pulsation modes was conducted using three different methods: the echelle diagram, frequency ratio analysis and stellar models. The echelle diagrams align the frequencies in the form of vertical structures based on their angular degrees. This helps to catagorize the frequencies according to radial and non-radial orders. The radial overtones are identified using comparison of frequency ratios with theoretical petersen diagram.





Stellar Models

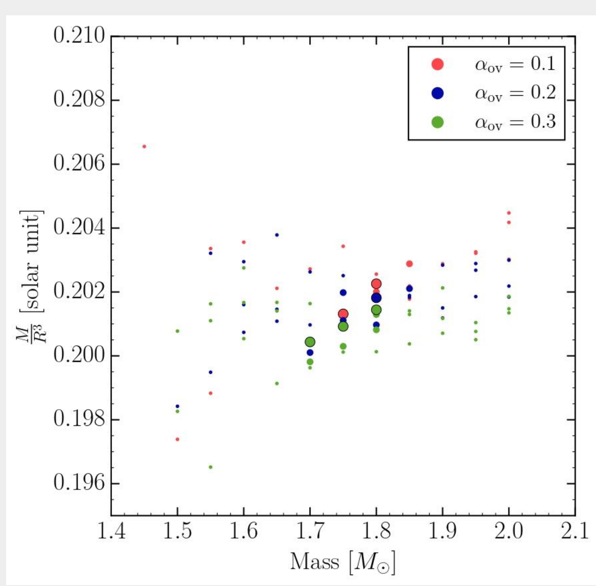
The stellar evolution models were created using the Code Liégeois d'Evolution Stellaire (CLÉS). The step-wise radial eigenfrequencies were calculated using the Liège Oscillation Code (OSC).
Our study is based upon a grid of 570 evolution tracks calculated for different values of the independent parameters *M* (19 values), *Z* (10 values), and α_{ov} (3 values). We used the seismic-$\chi 2$ distribution to find minima of the $\chi 2$ values from each of the grid.

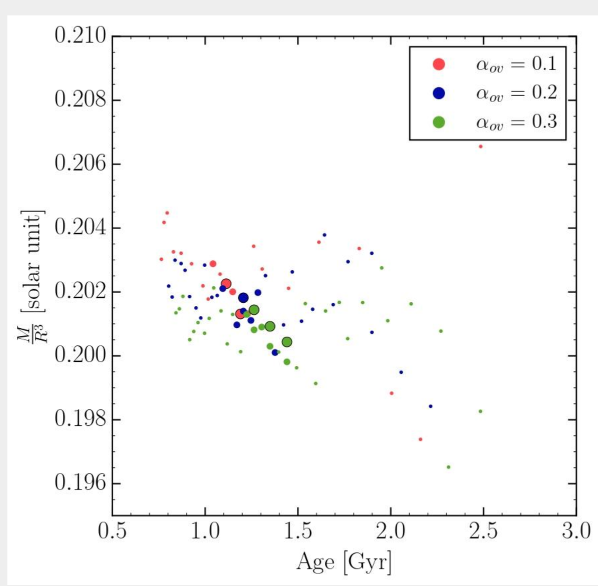


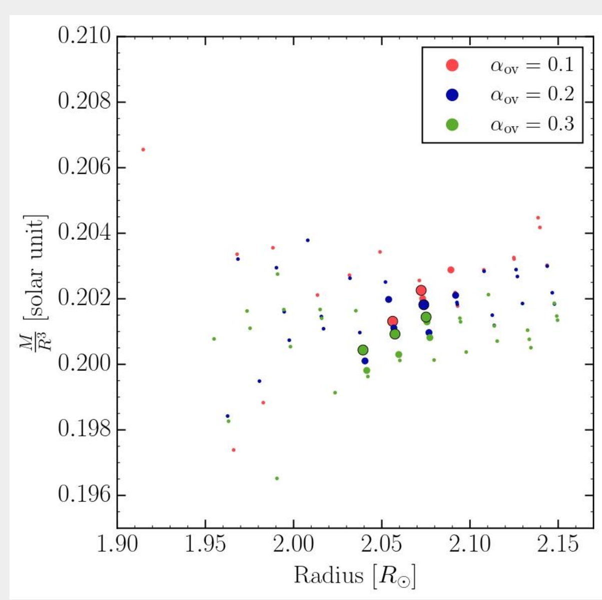
Seismic Parameters

The seismic parameters are estimated by fixing the radial overtones that constraints the mean density of the star. The plot of mean density with the mass, age and radius gives the respective parameters. And for a star in MS phase the seismic parameters do not show any dependance on α_{ov}.

α_{ov}	$\frac{M}{M_\odot}$	$\frac{R}{R_\odot}$	Age (Gyr)	$\frac{M}{R^3}$ [solar]	v_{eq} (km s^{-1})
0.1	1.77 ± 0.04	2.06 ± 0.01	1.15 ± 0.07	0.20	114 ± 1
0.2	1.80 ± 0.04	2.07 ± 0.01	1.21 ± 0.07	0.20	115 ± 1
0.3	1.75 ± 0.04	2.06 ± 0.01	1.35 ± 0.07	0.20	114 ± 1







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