

# Asteroseismic Modelling of Tau Ceti - a Benchmark for the PLATO Stellar Science

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**Context:** The PLATO mission (launch late 2026) will detect and characterize Earth-like planets around low-mass stars by characterising host stars to high precision. The "Benchmark Stars" aims to deliver a set of well characterized stars to the consortium to validate the pipelines, help prepare for the next generation of models, and to help validate PLATO data when it arrives.  $\tau$  Ceti is one of the catalogue's lowest-mass benchmarks with its published age and mass still scatter widely, because classical observables cannot resolve the age–mass degeneracy in which distinct evolutionary states share the same surface properties. Using asteroseismology, however, we can probe the stellar interior directly, breaking that degeneracy and delivering an independent, internally consistent determination of its fundamental parameters.

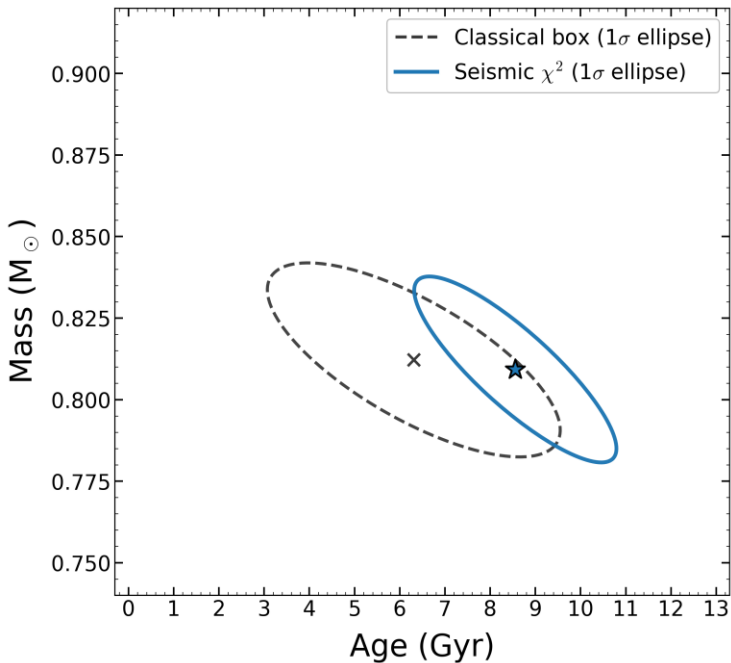
Observations	Value	Reference
Effective Temperature (K)	$5383 \pm 40$	Ibañez Bustos et al. (subm.)
	$5320 \pm 40$	Korolik et.al (2023)
Radius ( $R_{\text{sun}}$ )	$0.80 \pm 0.02$	Ibañez Bustos et al. (subm.)
Luminosity ( $L_{\text{sun}}$ )	$0.484 \pm 0.01$	Ibañez Bustos et al. (subm.)
Metallicity [M/H]	$-0.34 \pm 0.1$	Casamiquela et. al (2026)
log g (dex)	$4.48 \pm 0.05$	Korolik et.al (2023)

Observational constraints selected independently

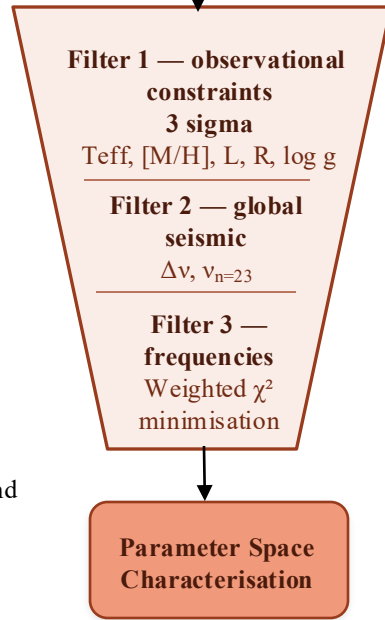
CESAM2k20 + ADIPLS  
Stellar evolution + oscillations

Parameter space of  $\tau$  Ceti  
Models vs. observations

Input Parameters	Range	Step size
Mass	0.76-0.84	0.01
Y	0.255-0.275	0.010
[M/H]	-0.55-0.25	0.05
$\alpha_{\text{MLT}}$	1.44-1.64	0.10
Age	0-12 Gyr	100 Myr



1 sigma error ellipsoid showing the position of tau Ceti in mass-age space without (Grey) and with (blue) seismic constraints.



Final parameter constraints

Parameter	Model (median, 1 $\sigma$ )	Observed ( $\pm\sigma$ )	(Obs–Model)/ $\sigma$
Mass ( $M_{\odot}$ )	<b><math>0.810 \pm 0.030</math></b>	<i>Inferred</i>	—
Age (Gyr)	<b><math>8.70 \pm 2.16</math></b>	<i>Inferred</i>	—
T <sub>eff</sub> (K)	$5332.5 \pm 58.5$	$5383 \pm 40$	+1.26 $\sigma$
Radius ( $R_{\odot}$ )	$0.816 \pm 0.011$	$0.800 \pm 0.02$	–0.78 $\sigma$
Luminosity ( $L_{\odot}$ )	$0.485 \pm 0.019$	$0.484 \pm 0.010$	–0.09 $\sigma$
log g (dex)	$4.525 \pm 0.009$	$4.48 \pm 0.05$	–0.90 $\sigma$
[M/H]	$-0.204 \pm 0.099$	$-0.34 \pm 0.10$	–1.36 $\sigma$