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**Abstract:**

The PLATO mission, set to launch in late 2026, aims to detect and characterize Earth-like planets around low-mass stars, requiring precise determination of stellar properties. As part of the PLATO consortium's effort, a working group entitled "Benchmark Stars" aims to deliver a set of well characterized stars to the PLATO consortium to validate the pipelines, help prepare for the next generation of models, and to help validate PLATO data when it arrives. Within this context, we conducted a detailed modelling study of tau Ceti—one of the lowest-mass stars in the PLATO benchmark catalogue with available asteroseismic data and a planet host.

Using a dense grid of ~80,000 stellar evolution and pulsation models, our primary goal was to robustly constrain and systematically probe its stellar parameter space. We combined classical constraints with weighted seismic fitting and applied two independent model selection strategies: (A) broad $3\sigma$ sampling and (B) a $\chi^2$-based method incorporating observational uncertainties.

Both approaches reproduce the observed classical and seismic constraints within uncertainties, with Method B showing improved agreement with spectroscopic metallicity. The resulting best-fit models are structurally very similar, demonstrating that dense grids and rigorous seismic analysis are essential for precise stellar characterization, essential for the PLATO mission. We derive new robust values of the mass and age of tau Ceti, while exploring the full scope of the model parameter space.