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Predicting asteroseismic properties of Red Giants in our Galaxy's inner parsec

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The inner parsec of the Milky Way hosts one of the most extreme stellar environments in the Galaxy, characterized by high stellar densities, strong tidal fields, and severe interstellar extinction. Despite these challenges, recent space missions have provided high-quality revolutionary asteroseismic data that have revealed a population of red giant (RG) stars spanning a very wide range of metallicities never observed in any other region, raising questions about their origin and suggesting a complex and still poorly understood star formation and chemical enrichment history in the Galactic Centre.

In this work, we model the evolutionary and asteroseismic properties of a sample of 83 RG stars observed in the inner parsec, with the aim of
constraining their fundamental parameters and assessing the presence of multiple stellar populations.

Stellar evolution models are computed using the MESA code over a range of masses and metallicities compatible with the observations. Limiting cases in metallicity and mass are explored to bracket the full observational sample, and the resulting Hertzsprung–Russell diagrams indicate that the observed stars can be reproduced by models with masses between approximately 0.6 and 1.6 $M_\odot$. The coexistence of metal-rich and metal-poor stars provides evidence for at least two distinct stellar populations in this region. Building on these models, we predict asteroseismic properties, including the large frequency separation $\Delta\nu$, the gravity-mode period spacing $\Delta\Pi$, the frequency of maximum oscillation power $\nu_{\max}$, and the internal propagation cavities of oscillation modes. Preliminary results show that propagation diagrams reveal the presence of mixed modes, characteristic of RG stars, and that the $\Delta\Pi - \Delta\nu$ diagram effectively disentangles mass and metallicity effects along the red-giant branch, highlighting its diagnostic power for stellar population studies in highly extincted environments.

Furthermore, inconsistencies between the highly uncertain observed surface gravities and the evolutionary expectations once more motivate the use of asteroseismic scaling relations to obtain more reliable stellar masses and radii.

Lastly, this dual-purpose work will also establish a theoretical framework for interpreting future asteroseismic observations of the Galactic Centre and provide predictions that will help guide upcoming missions such as JASMINE, PLATO, and ELT-METIS.

Field of Research/Work

Cosmology, Astrophysics, and Gravitation

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