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Helium Flash Structure Dependence on the Core Energy Balance: Imprints on ΔP_g

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Low-mass stars ($0.6 - 2.0 M_{\odot}$) at the tip of the red giant branch (TRGB) feature a highly degenerate and inert helium core surrounded by a hydrogen-burning shell. As the star evolves, conditions in the core trigger the ignition of helium, that lifts the core out of degeneracy, through an explosive event called the helium flash. However, the structure of this event is sensitive to the core's energy balance. Energy perturbations, such as thermal neutrino emission, can cool the central region, shifting the point of maximum temperature and leading to an off-centered ignition followed by a sequence of sub-flashes.

Despite being predicted almost 60 years ago, the helium flash lacks direct optical signatures, making its observation a challenge. To address this issue, this thesis explores the use of asteroseismology and hot subdwarf stars, where gravity modes (g -modes) can propagate to the surface, carrying the information about the stellar interior. Using the MESA code, we model different core energy perturbation scenarios to correlate internal energy distributions with asteroseismological parameters, specifically the period spacing (ΔP_g).

Preliminary results indicate that distinct perturbations leave imprints on ΔP_g , allowing for differentiation between core energy distributions. This work aims to provide a method to detect and understand what impacts the helium flash structure, with the prospect that in the future, our results can be compared with real data from the upcoming PLATO mission.

Field of Research/Work

Cosmology, Astrophysics, and Gravitation

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