Modelling Convection and Its Effects on Stellar Pulsation

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Introduction

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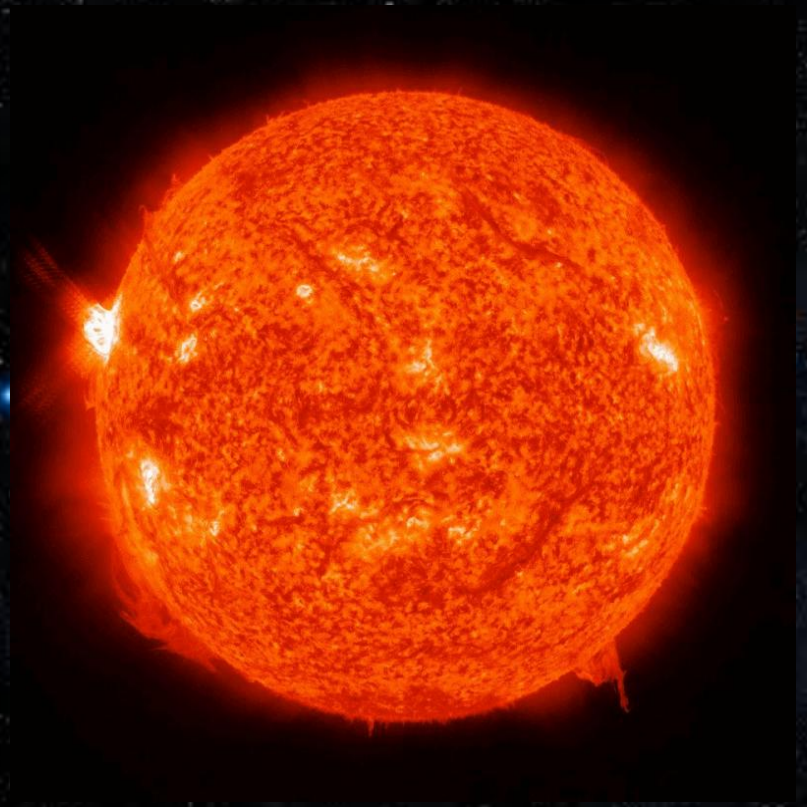
What is a star?

A star is a massive, luminous sphere of plasma held together by gravity.



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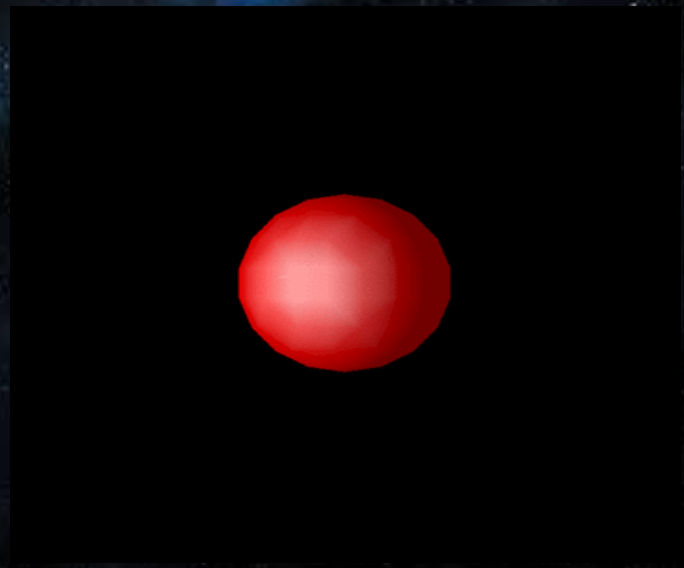
Stars are not static, they are pulsating (expand and contract). Pulsation



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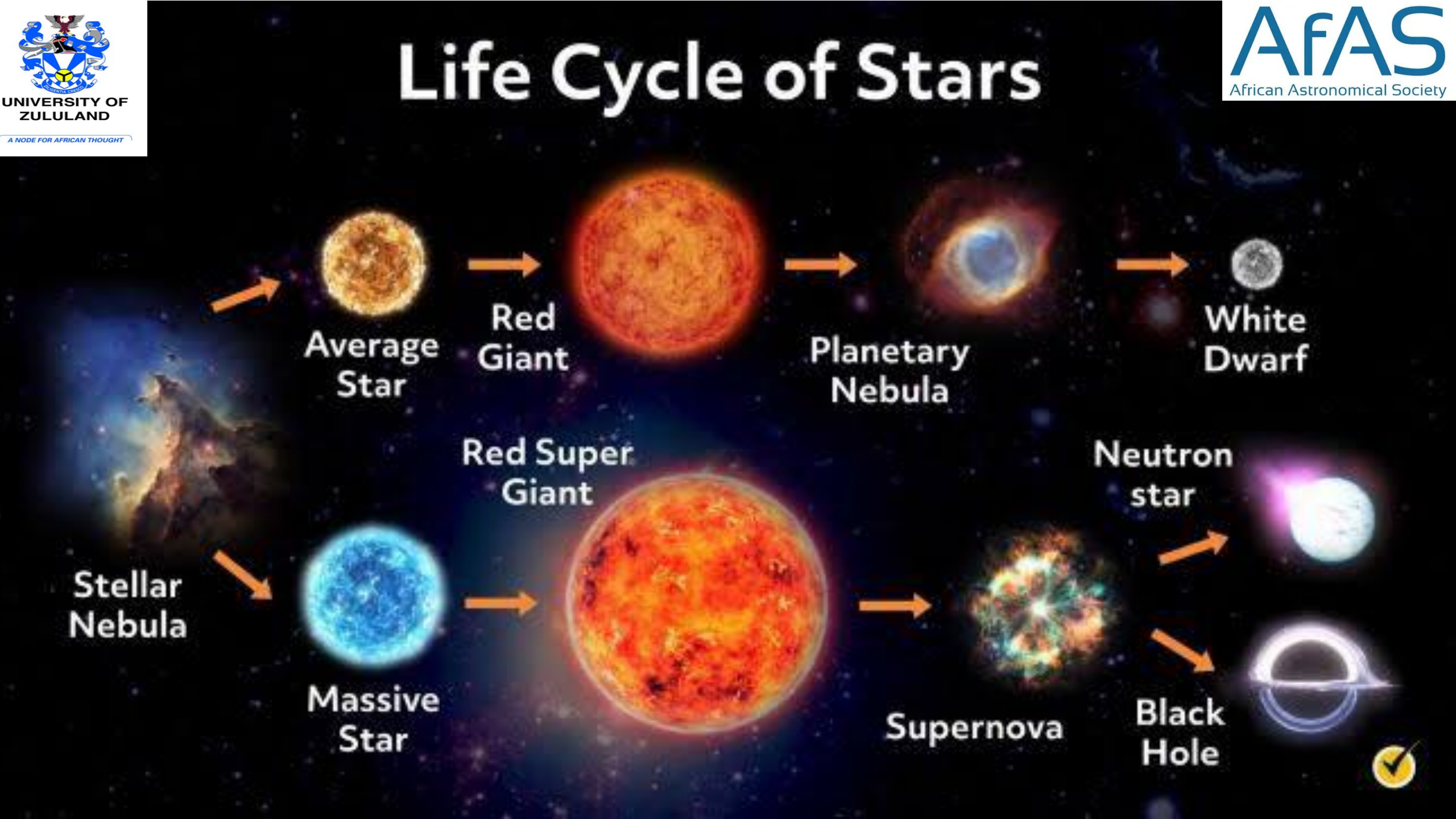
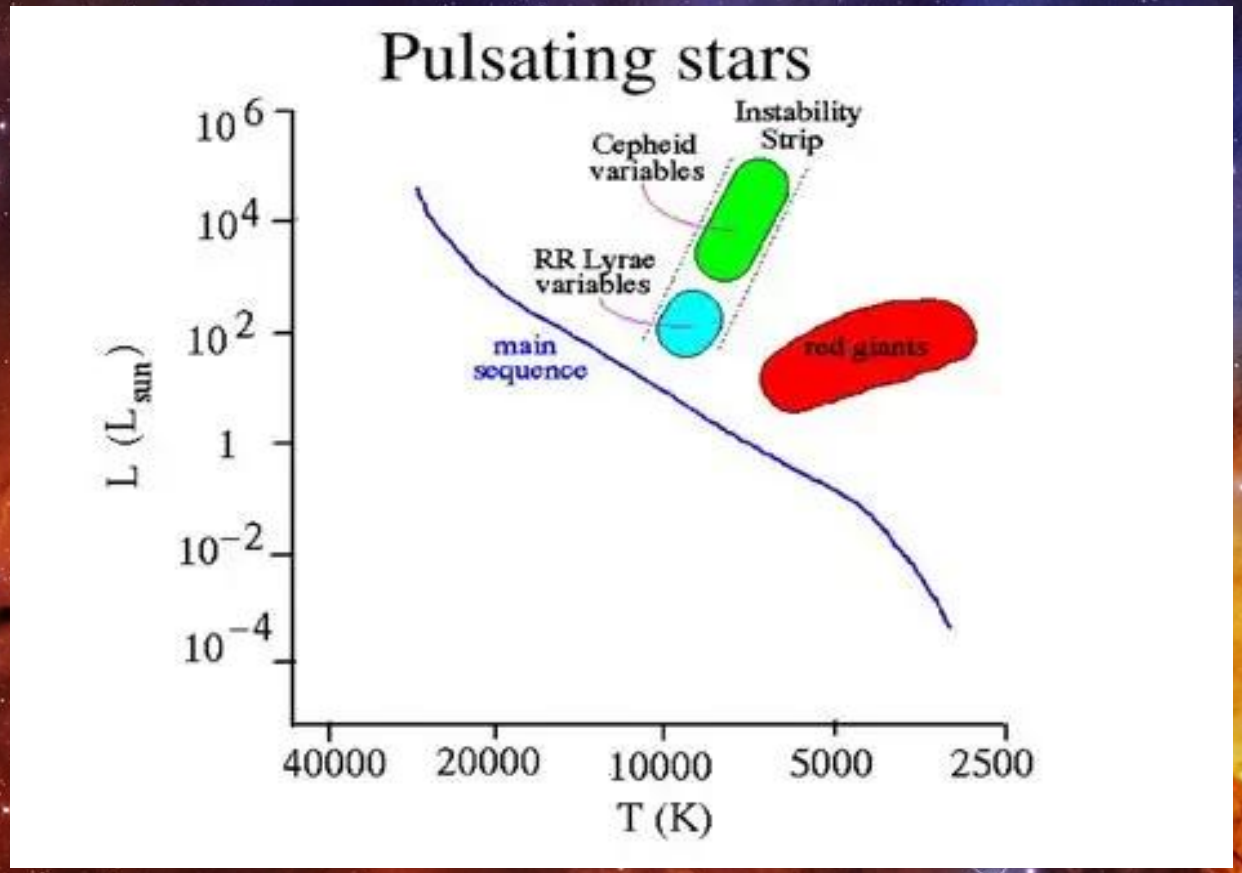
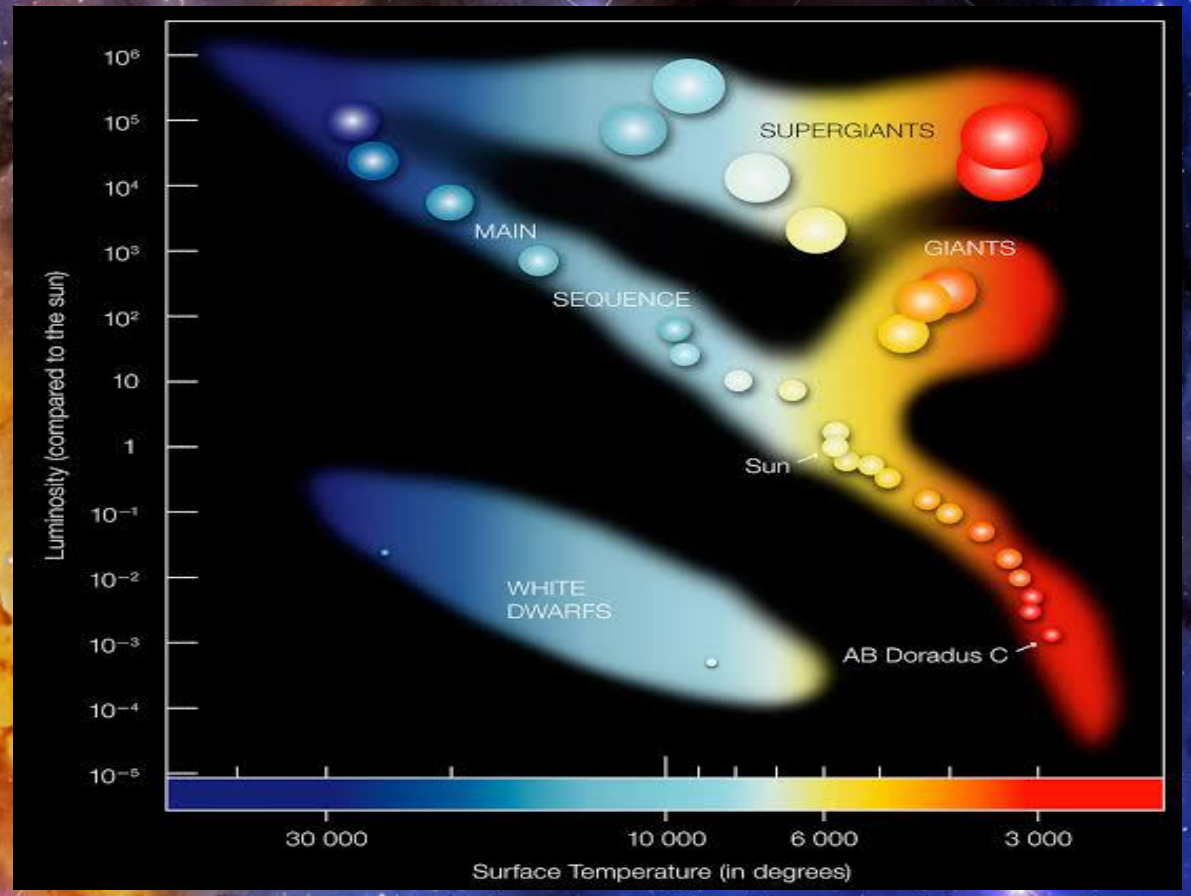
Life Cycle of Stars



Hertzsprung-Rusell diagrams





Problem Statement

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- Stellar pulsation assists in studying star's interiors, but current models poorly represent convection.
- Traditional theories like Mixing Length Theory (MLT) oversimplify how convection interacts with pulsation, leading to mismatched between observed pulsation (e.g., frequency, amplitudes and lifetime) and theoretical models.
- This research aims to develop improved models that better describes convection's role in stellar pulsation.

Aim

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To develop a mathematical model that explains how stellar oscillations are influenced by convection in stars.

Objectives

- Derive the linearized pulsation equation, include MLT and time-dependent convection, and integrate them into a non-adiabatic framework
- Analyze how convection affects (i) Oscillation frequencies and (ii) Mode stability (driving and damping)
- Apply the model to stars with outer convective zones.

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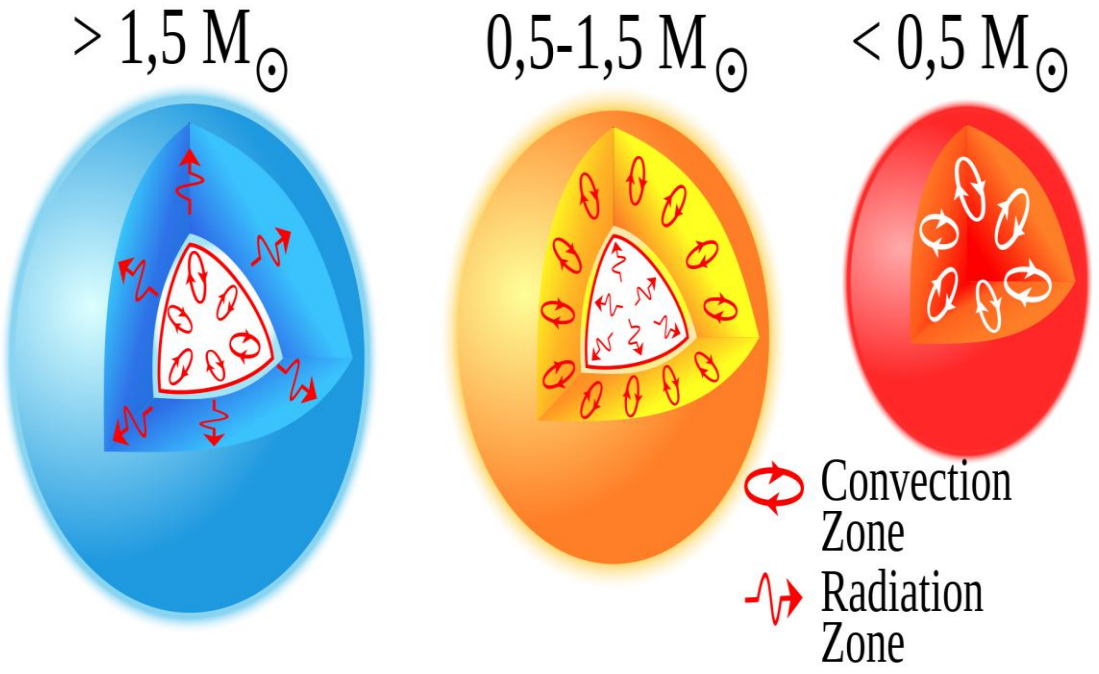
Heat Transfer of Stars



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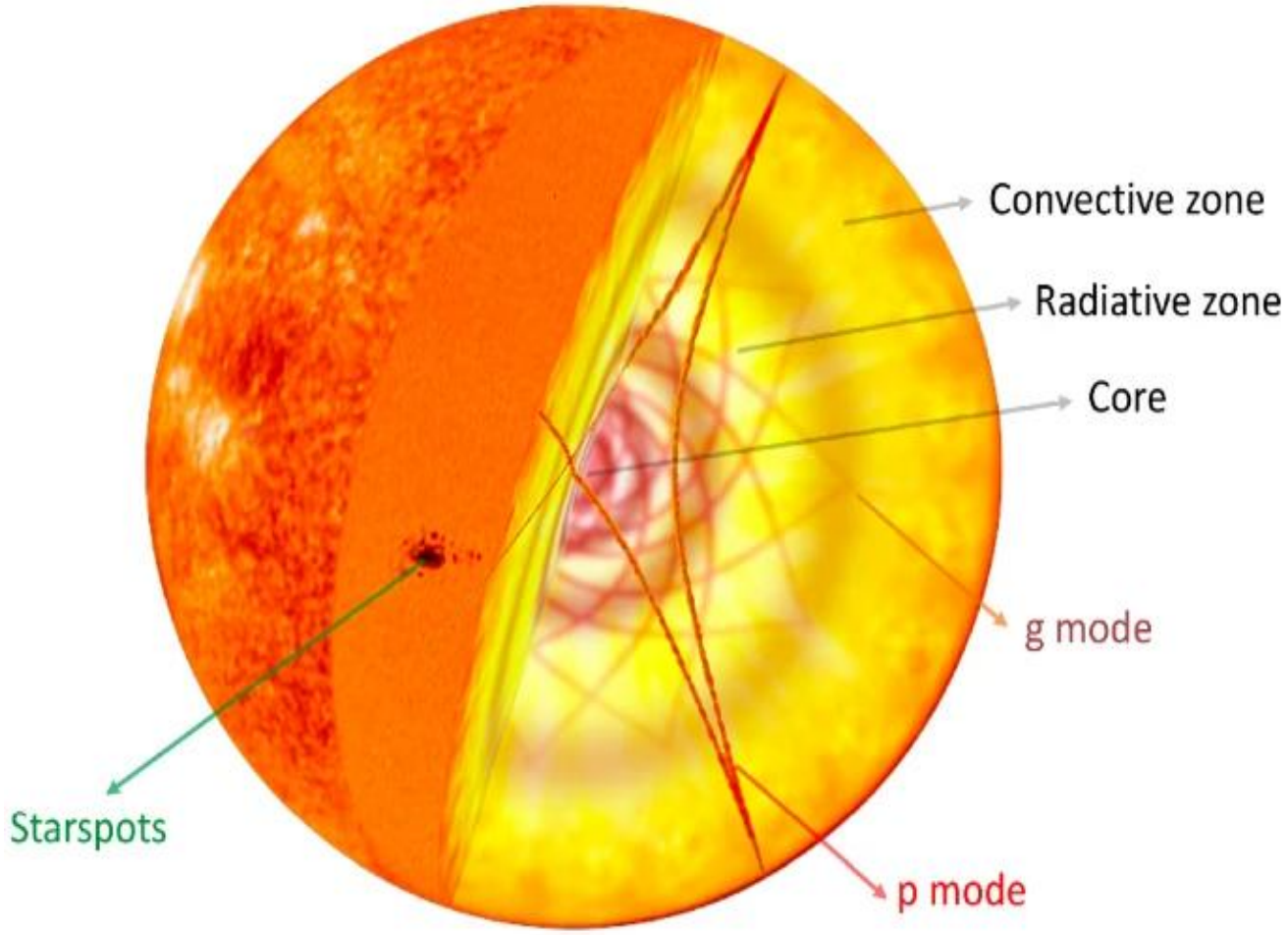

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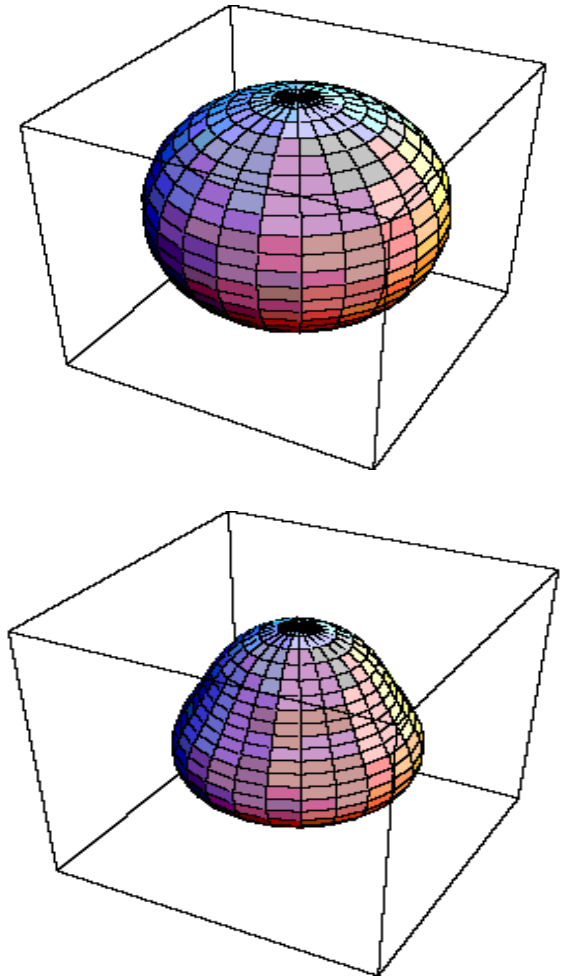
Stellar Pulsation



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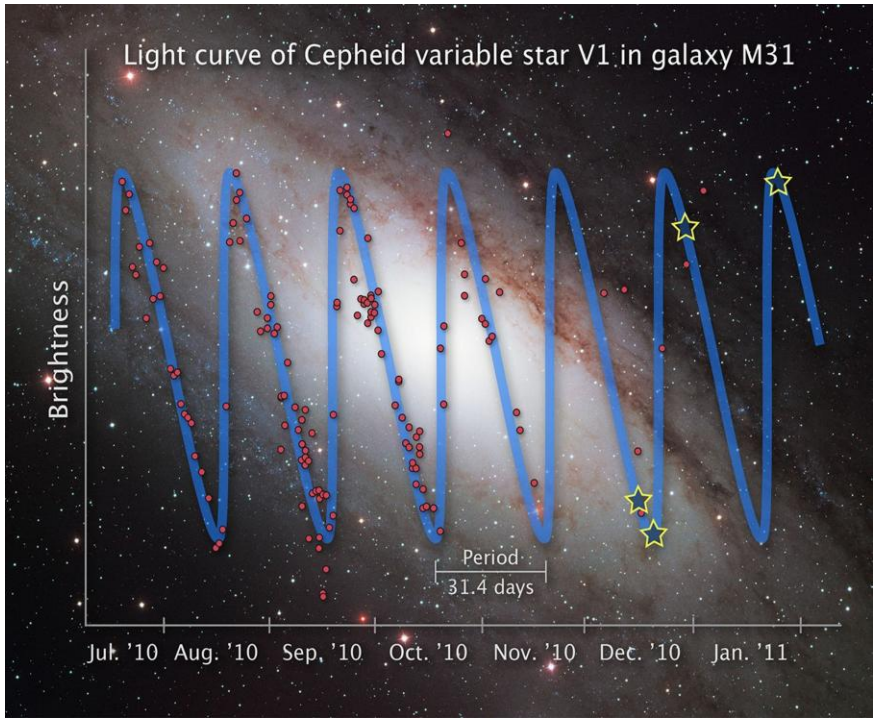

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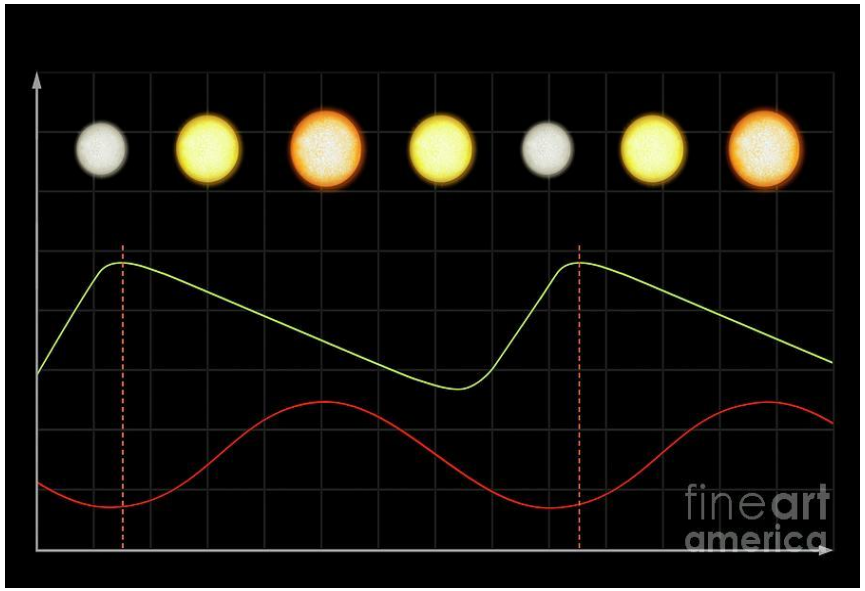

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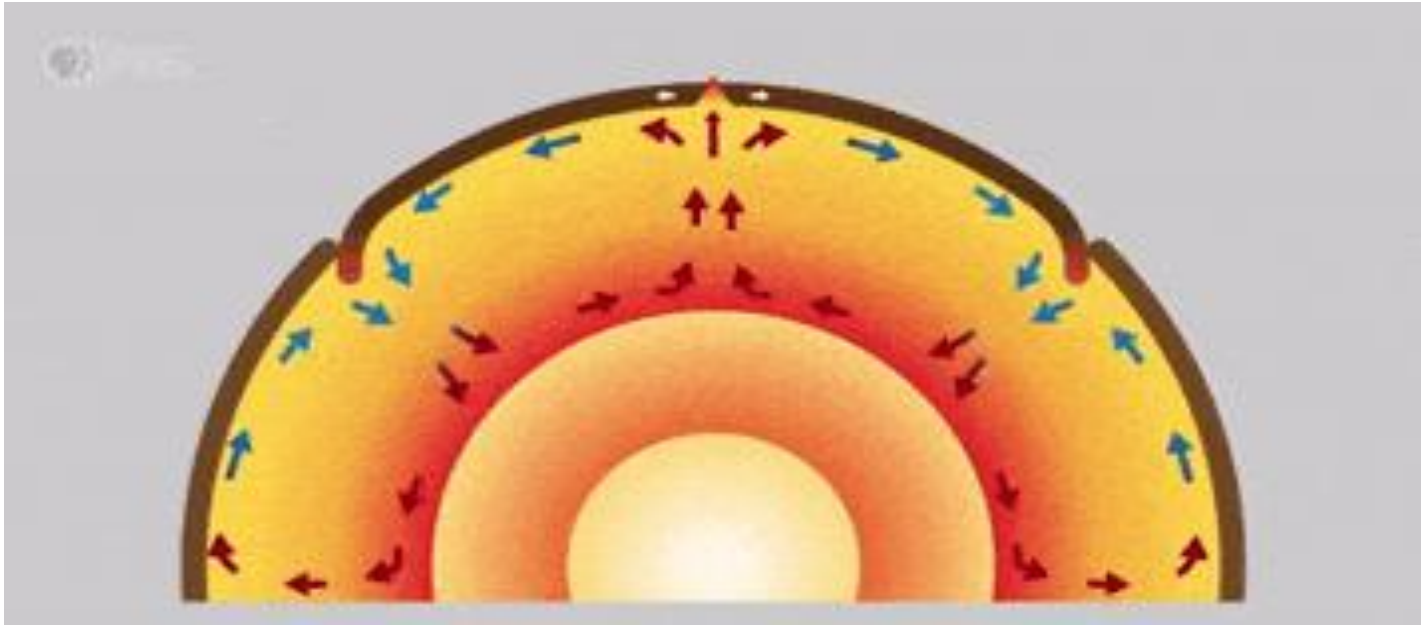

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Importance of convection

1. Mixing
2. Energy transport
3. Magnetic activity
4. Stellar evolution

How convection affects pulsation

1. Driving of pulsation
2. Damping of Pulsation
3. Modification

Research methodology

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Theoretical modelling

Numerical Simulation

Observational Data Analysis

Research Methodology

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Observational Data Analysis

- TESS
- Python
- MESA

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To be done...

- Apply time-dependent convection (TDC)
- Introduce non-radial oscillation terms
- Solve equations
- Eigenfrequencies & Mode identification relations

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Thank You! Any question?