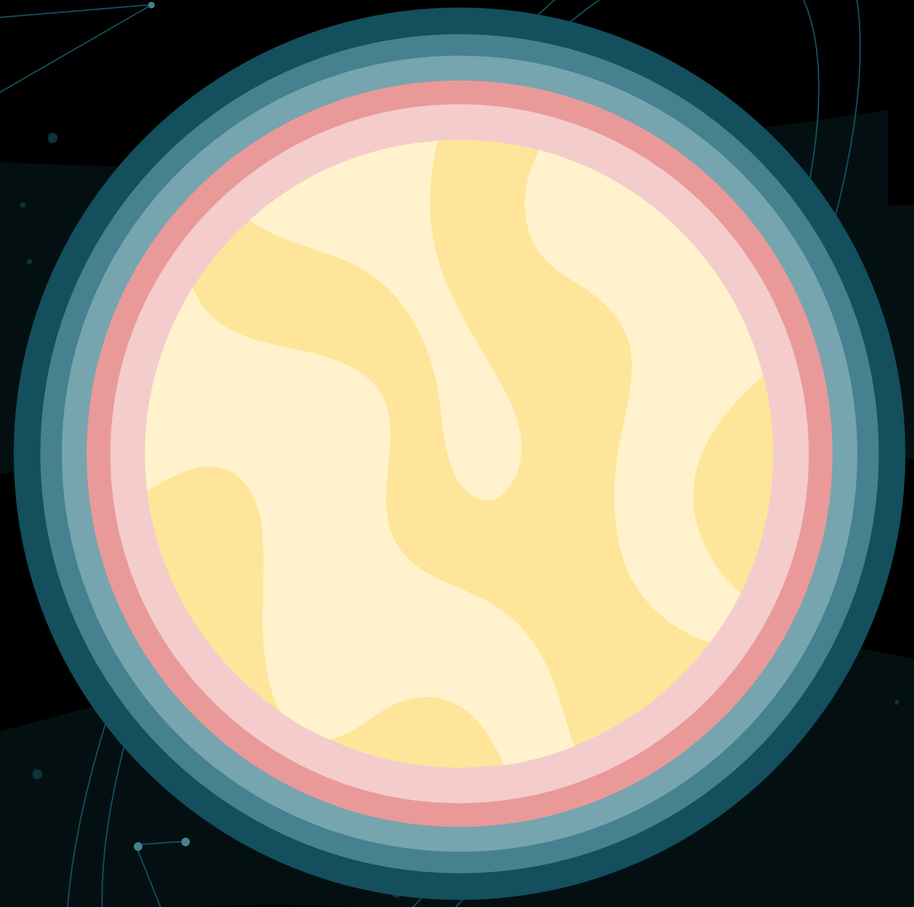
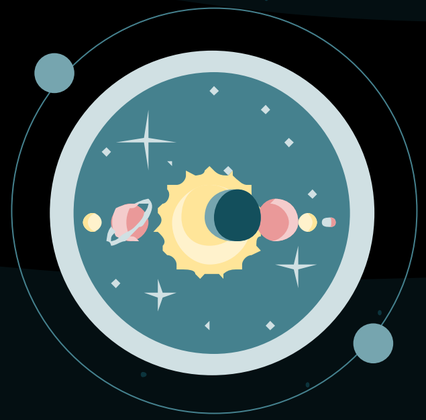
Science Coffee House
IIT Kanpur

ASTRO IIT KANPUR

STELLAR ODYSSEY

End-term Progress Report





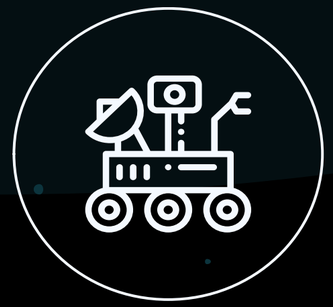
INTRODUCTION

This project deals with the Astrophysics aspect of Science. It is about the field of Astronomy by applying concepts of Physics and understanding and analyzing raw data of official resources like NASA and ISRO and understanding the fate of stars.

ABOUT THE PROJECT

Astrophysics

From nuclear physics to black holes



Sci-Talks

Talks on various topics related to Astronomy and Astrophysics

MATLAB

Data Analysis and Plotting

Tour to OAAR

A visit to the observatory

Case studies

Detailed case studies on Kepler 452b and Betelgeuse

TIMELINE

01 **Week 1**

Astronomical coordinates, telescopes, Stellar Evolutions and LaTeX

02 **Week 2**

Presentations and MATLAB

03 **Week 3**

Stellar Properties, HR Diagram

04 **Week 4**

Tour to OAAR, Moon observation

05 **Week 5**

Case Study : Kepler-452b

06 **Week 6**

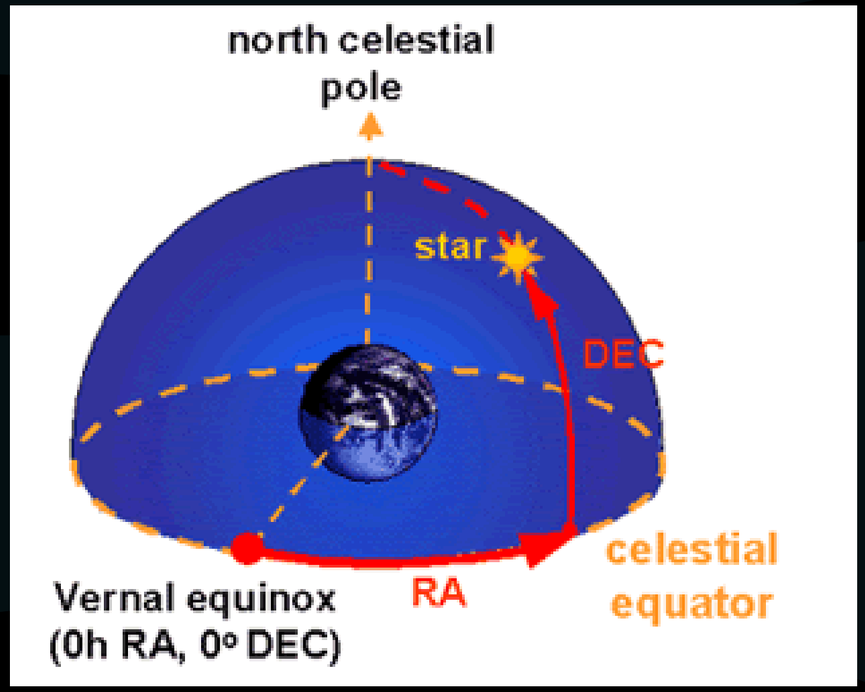
Case Study : Betelgeuse

WEEK 01

1. Astronomical Coordinate System
2. Telescopes
3. Evolution/Life Cycle of Star
4. LaTeX

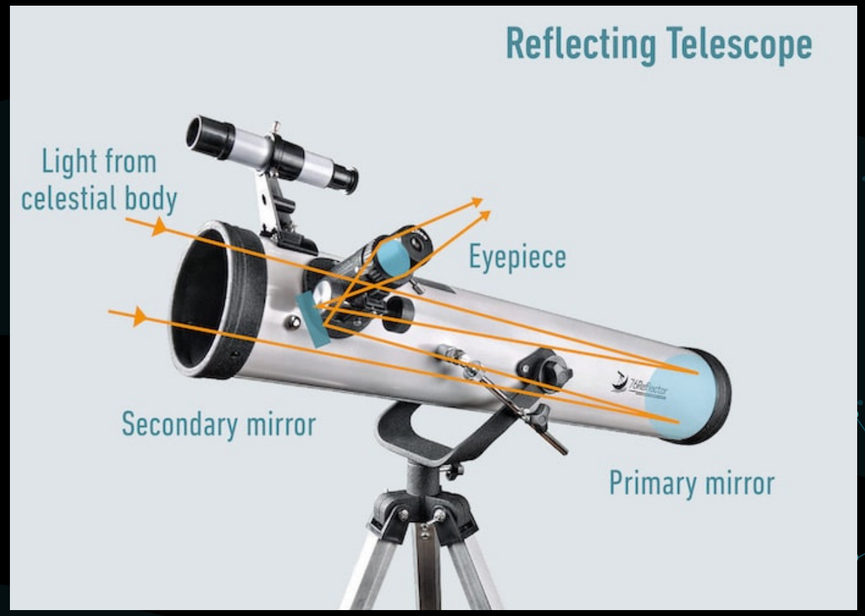
Astronomical Coordinate systems

- Equatorial
- Altitude-Azimuth
- Ecliptic
- Galactic
- Super Galactic



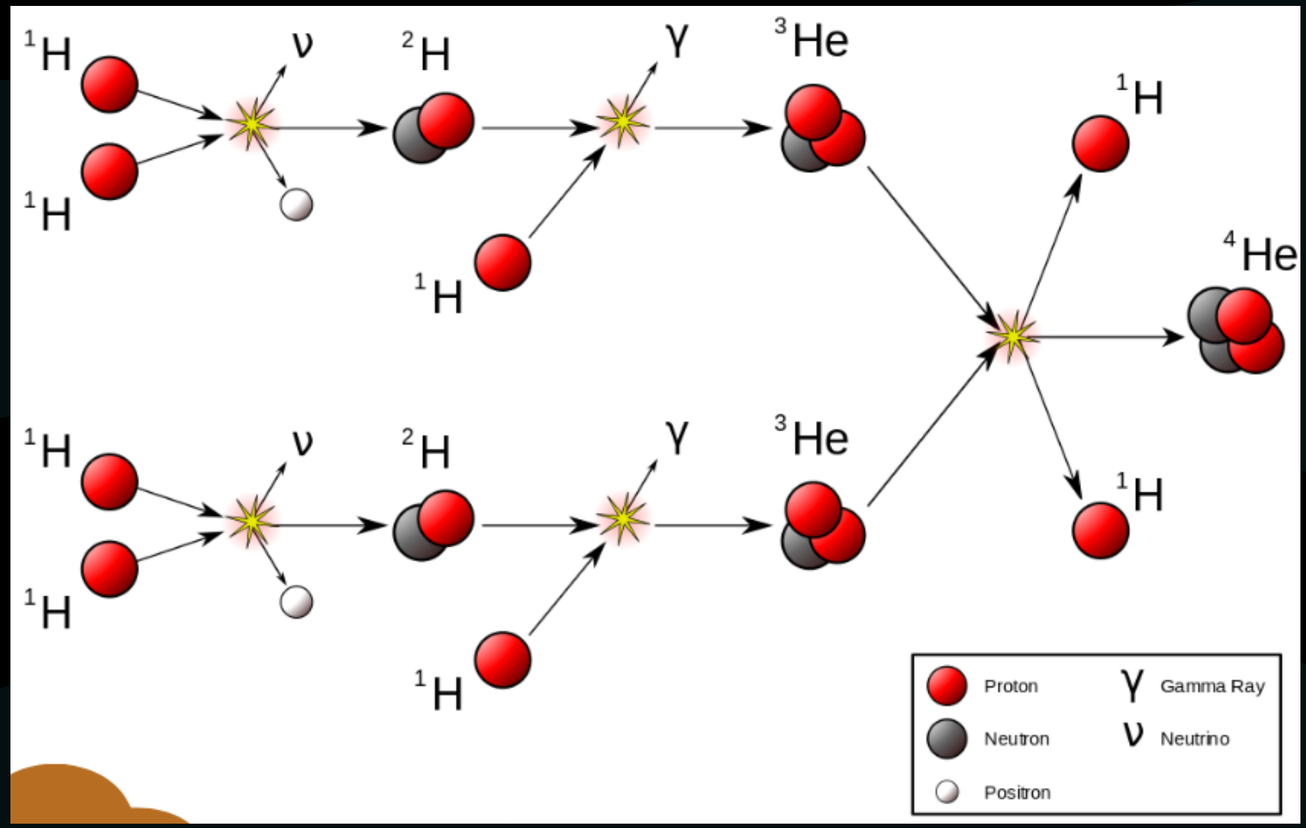
Telescopes

- What is a Telescope
- Functions
- Components
- Different types of Telescopes



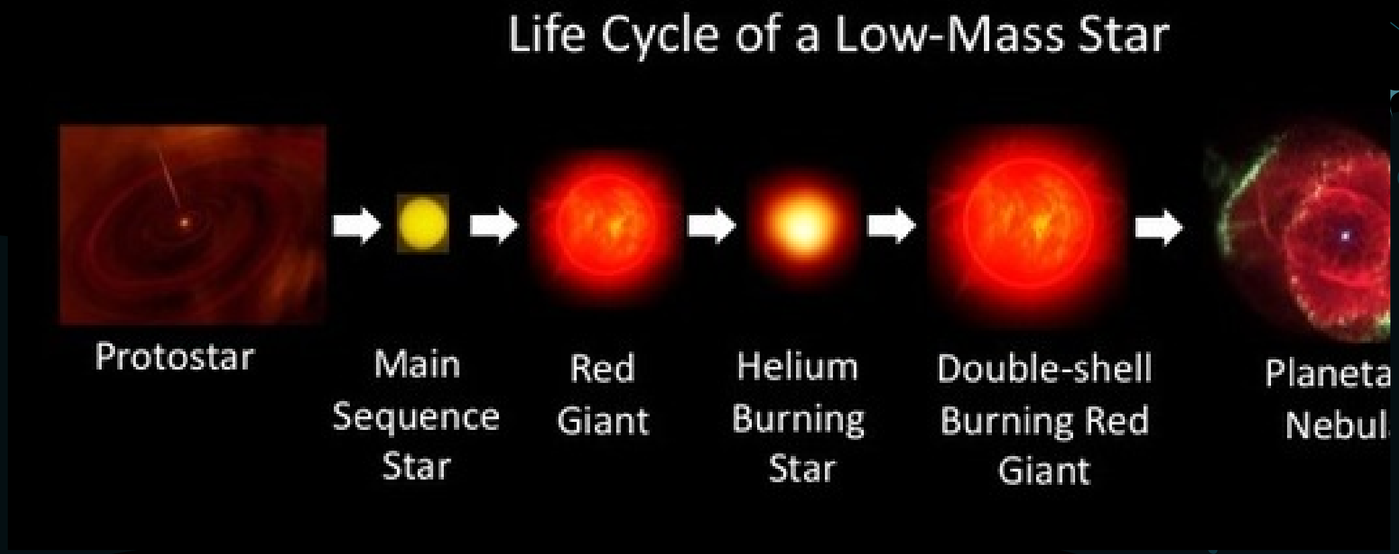
Life Cycle of a Star

- Birth of a star
- Initiation of Fusion reaction
- Main Sequence Phase (90% of its life-time)
- Red Giant Phase
- Death of a star

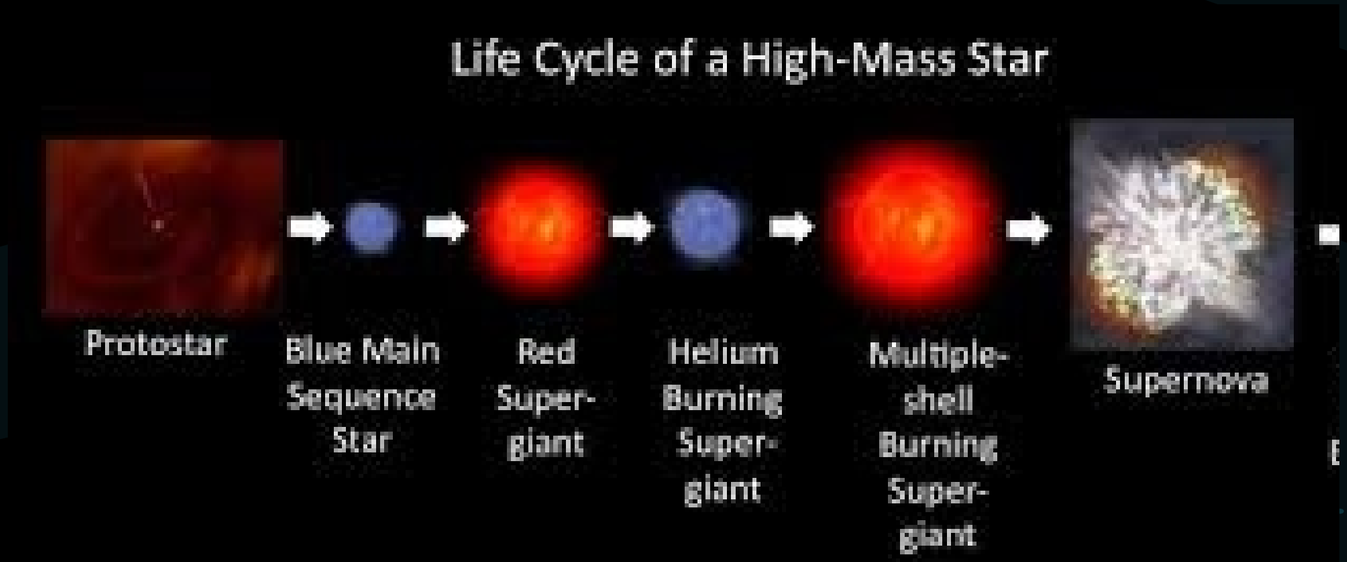


The fate of the star depends on its mass !!

- Low-Mass Stars
(< 8 Mo)



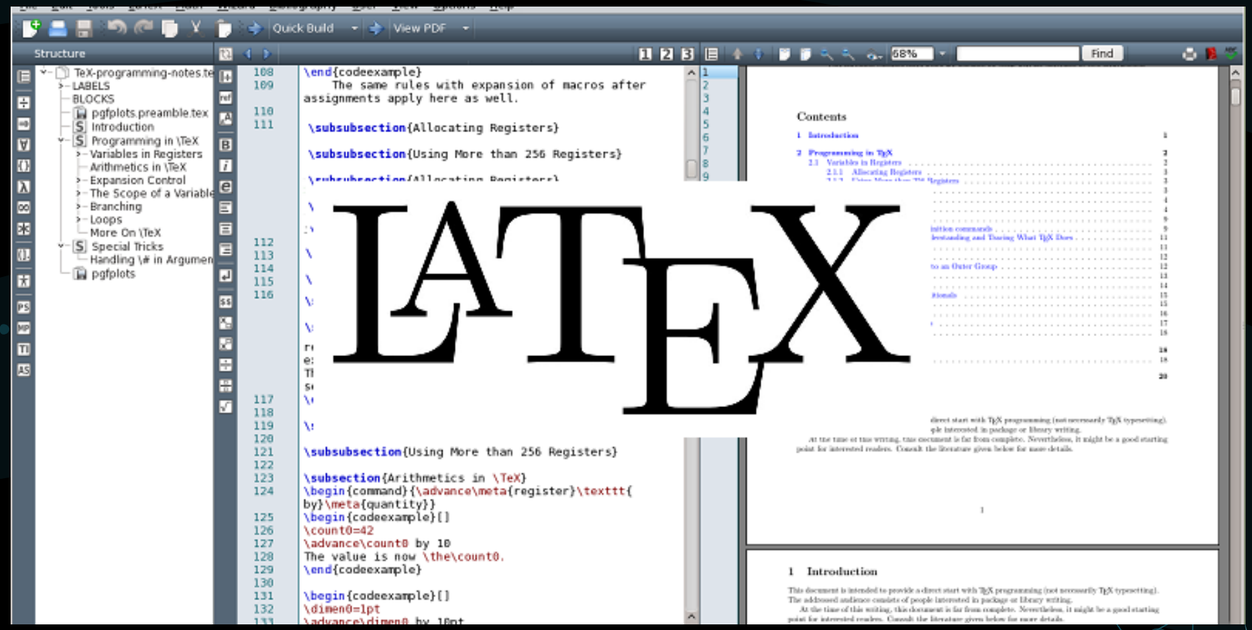
- High-Mass stars
(> 8 Mo)



LaTeX

- LaTeX is a high-quality typesetting system designed for the production of technical and scientific documentation.
- LaTeX is the de facto standard for the communication and publication of scientific documents.

As a part of the project, we learnt how to write report and make presentations using LaTeX.

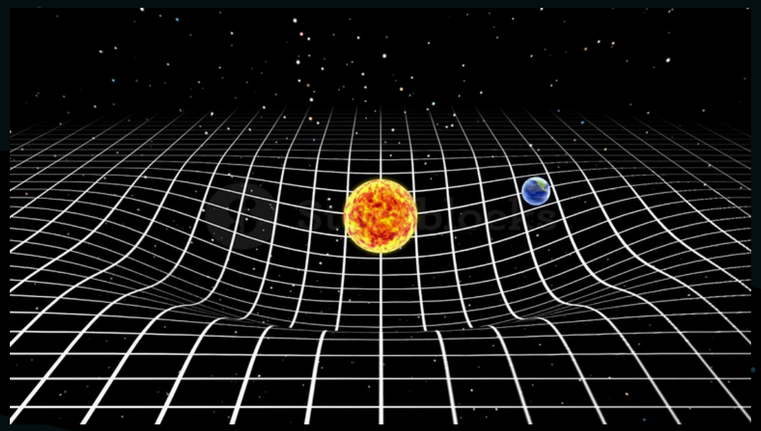


WEEK 02

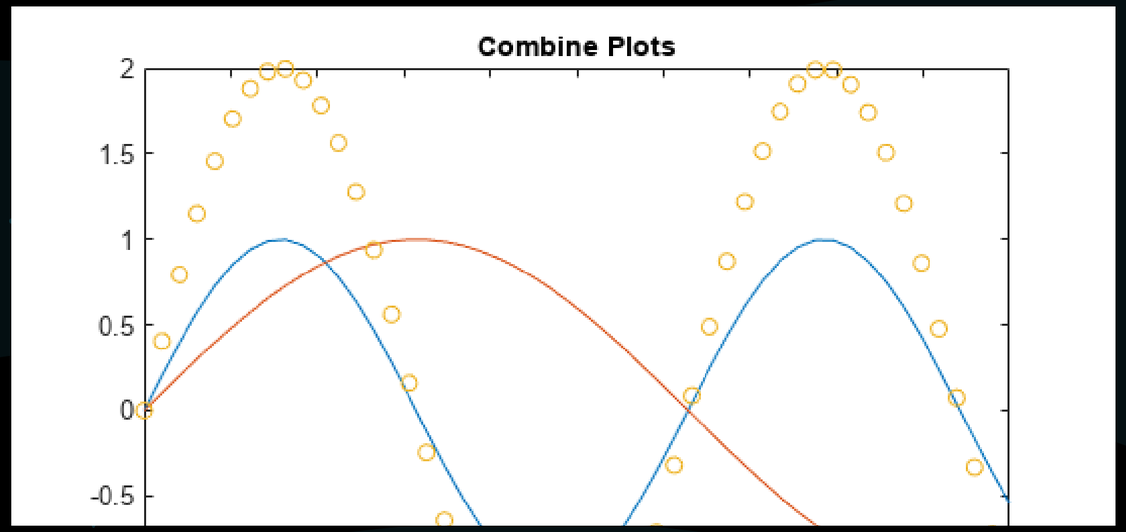
1. Basics of MATLAB

2. Applications of LaTeX : Report Preparation

3. Presentations and Sci-Talks



Basics Of MATLAB



- Basic Syntax
- Creating Matrices
- Plotting
- Learnt To Analyze The Light Recorded From Star, Using MATLAB
- Learnt To Determine Velocity Of Star

Applications of LaTeX : Report Preparation

1. Mathematical equations and symbols can be added.
2. Images and their captions can be inserted.
3. Access to many pre-defined templates for reports.

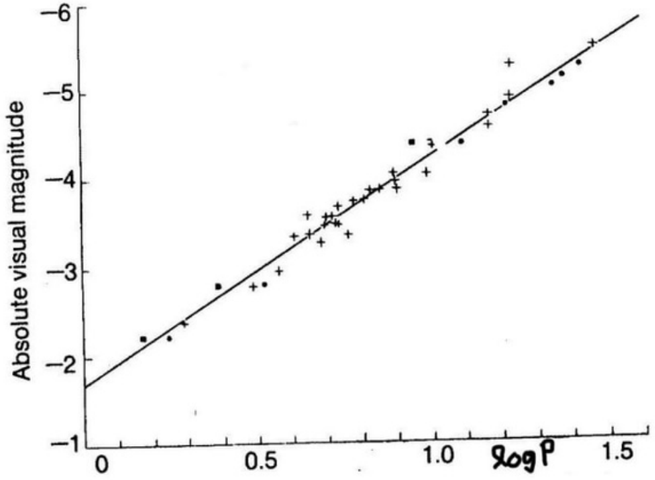


Figure 5: The period-luminosity relation for cepheids. The black points and squares are theoretically calculated values, the crosses and the straight line represent the observed relation.

Figure 6: Supernova Host Galaxies

3.4 Supernovae

A supernova is a star that explodes and this explosion generates a huge amount of light and heat. Some supernova host galaxies are shown in *figure 6.* From an observational point of view, a supernova is a star that suddenly appears in a galaxy, shines as brightly as an entire galaxy for a few weeks or months, and then gradually fades away. In many cases, a supernova can outshine all the stars in its host galaxy for a brief period.

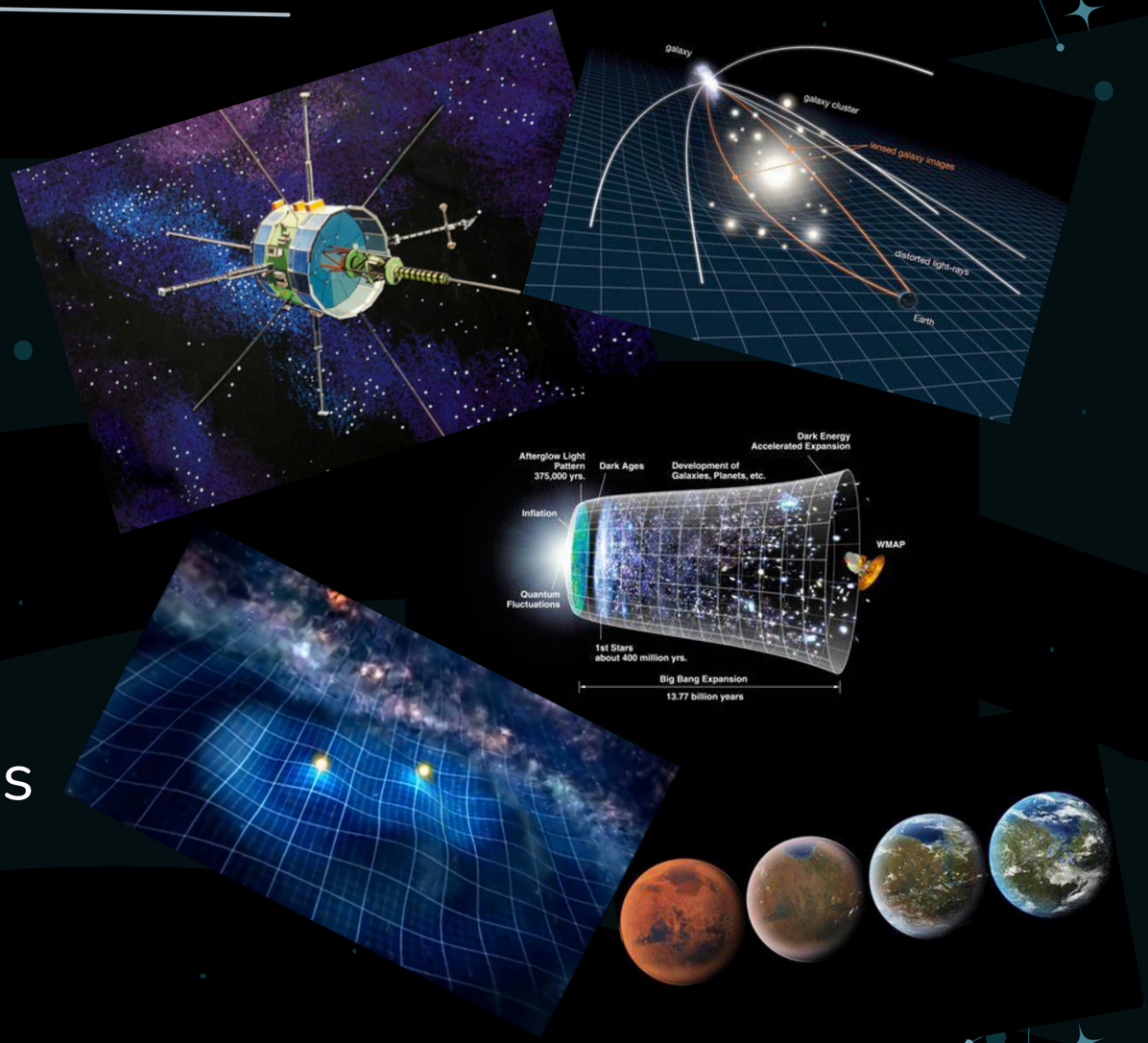
As supernovas are very luminous, they can be used as standard candles. And because of high brightness very far supernova is also visible. But a supernova appears unpredictably, so we can not be prepared in advance and it fades away within 2 to 3 months. So there is very less chance that we observe its maximum apparent magnitude to determine the distance.

In general, distance to other galaxies can be determined using the magnitude of supernovae in the distance modulus formula

Presentations and Sci-Talks

Topics Of Presentations

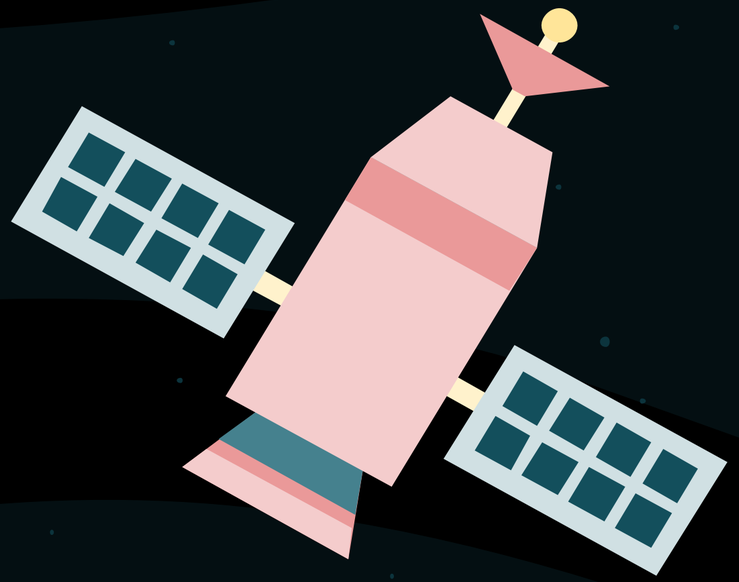
- Space Probes
- Astronomical Distances
- Quantum Gravity
- Quantum Tunneling and The Sun
- Gravitational Lensing
- Olber’s Paradox
- Terraforming
- Formation and Evolution Of Galaxies
- Fermi Paradox
- Age Of Universe
- Cosmic Rays
- Novae and their types



Talk Sessions

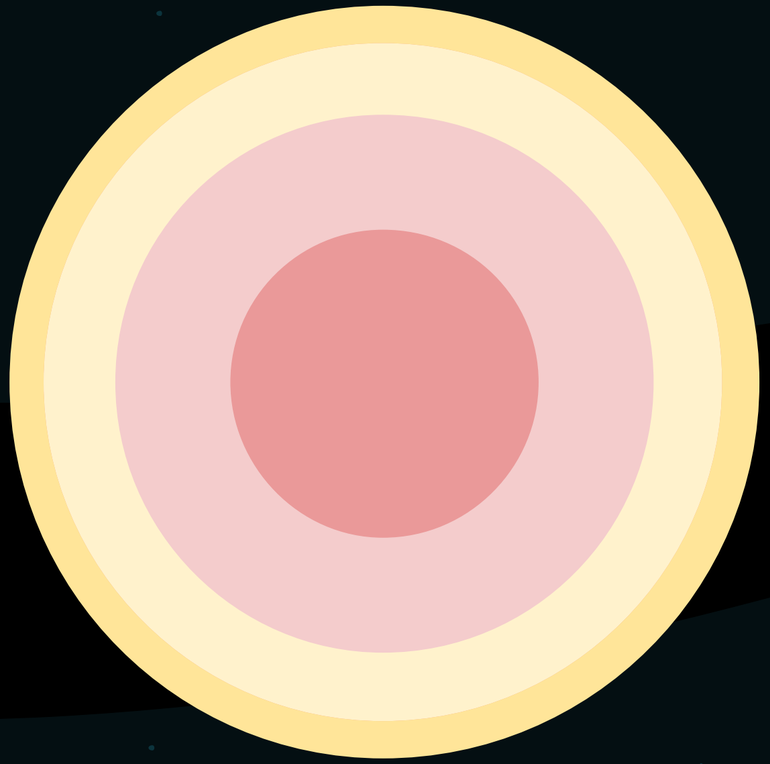
WEEK 03

Using MATLAB to plot a HR Diagram



Learning about Stellar Properties. Gathering Data and Plotting the HR Diagram of the Data

STELLAR PROPERTIES



Spectra

The missing lines in the spectra indicate the composition of the star.

Size

The radius of the star.

Temperature

The surface temperature is inversely proportional to the maximum emitted wavelength in the spectra.

Luminosity

$L \propto r^2 \times T^4$

The intrinsic brightness of the star. The luminosity is related to the temperature by the Stefan-Boltzmann law

HR Diagrams

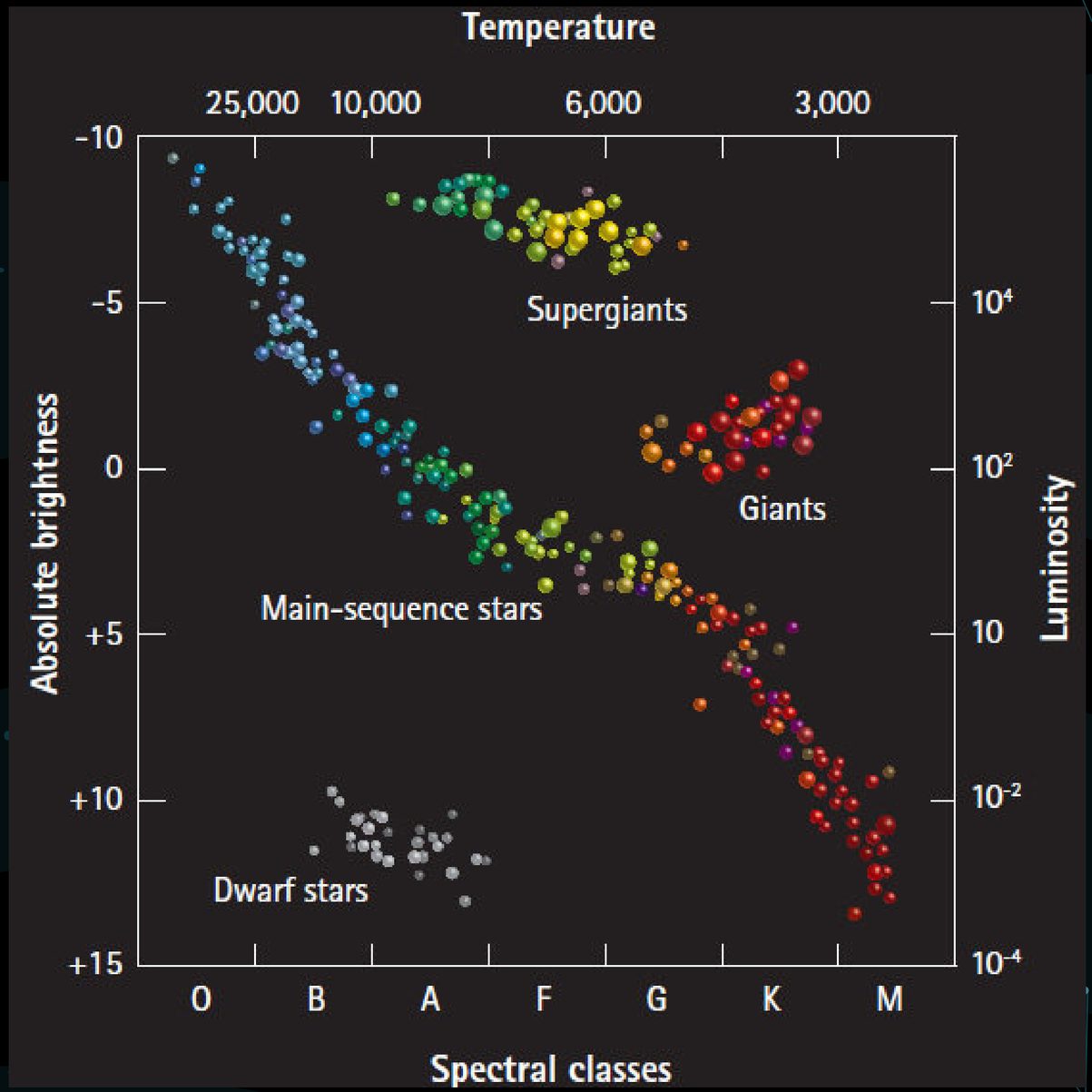
Main Sequence Stars

Red giants

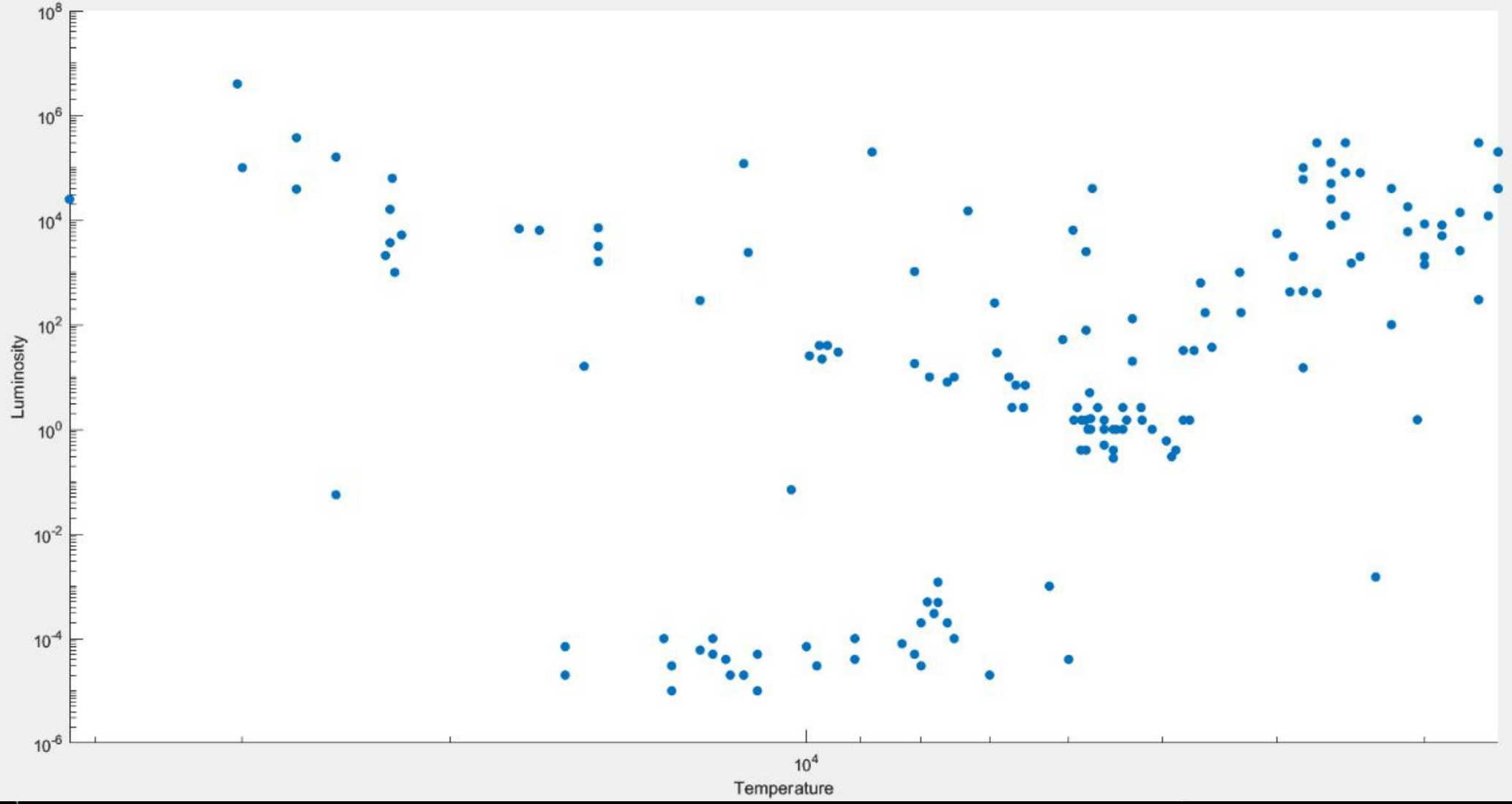
Blue giants

White dwarfs

Red dwarfs



HR Diagrams



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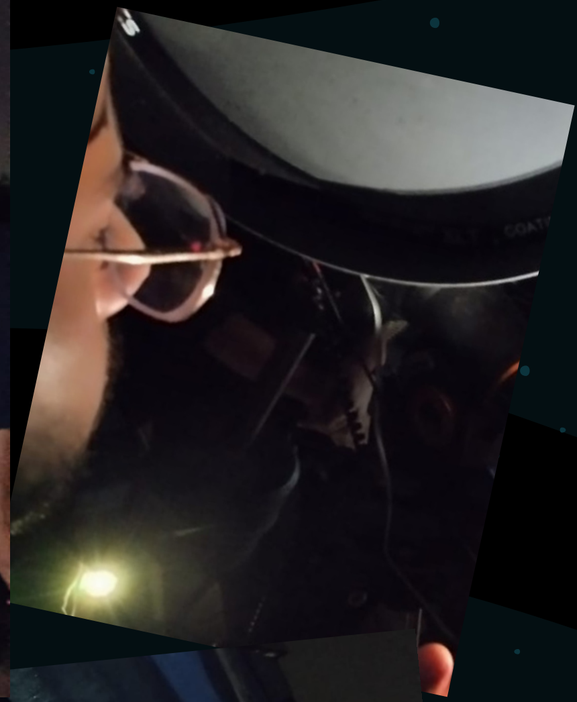
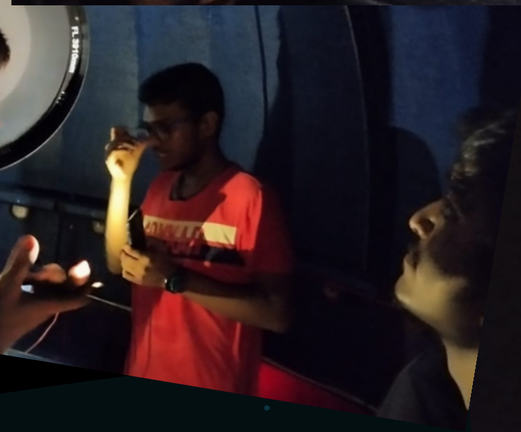
WEEK 04

1. Tour to Observatory for Astronomical Research (OAAR)

2. Moon observation session

Visit to Observatory





Working of the Telescope at the Observatory

1. The telescope is a Cassegrain telescope with an automated equatorial mount.
2. It has 3 scopes. The finder scope, the main eyepiece and one for taking photos.
3. PHD2 guiding software lets us type in the coordinates of the object and the telescope automatically points towards the object.
4. Once the photo is taken, the software compares the picture with an actual pic of the night sky from the same coordinates and makes changes to give us an even more accurate image.

Techniques for handling Telescopes

1. Set up the telescope in a stable and dark location.
2. Leave the telescope for about 20 minutes.
3. Align the telescope with the celestial poles(equatorial mount).
4. Calibrate the finder scope to aid in locating objects.
5. Choose the right eyepiece for your observing goals.
6. Focus the telescope carefully on bright, distant objects.
7. Observe objects patiently and avoid touching the telescope during use.

Moon observation session

WEEK 05 & 06

Case studies on

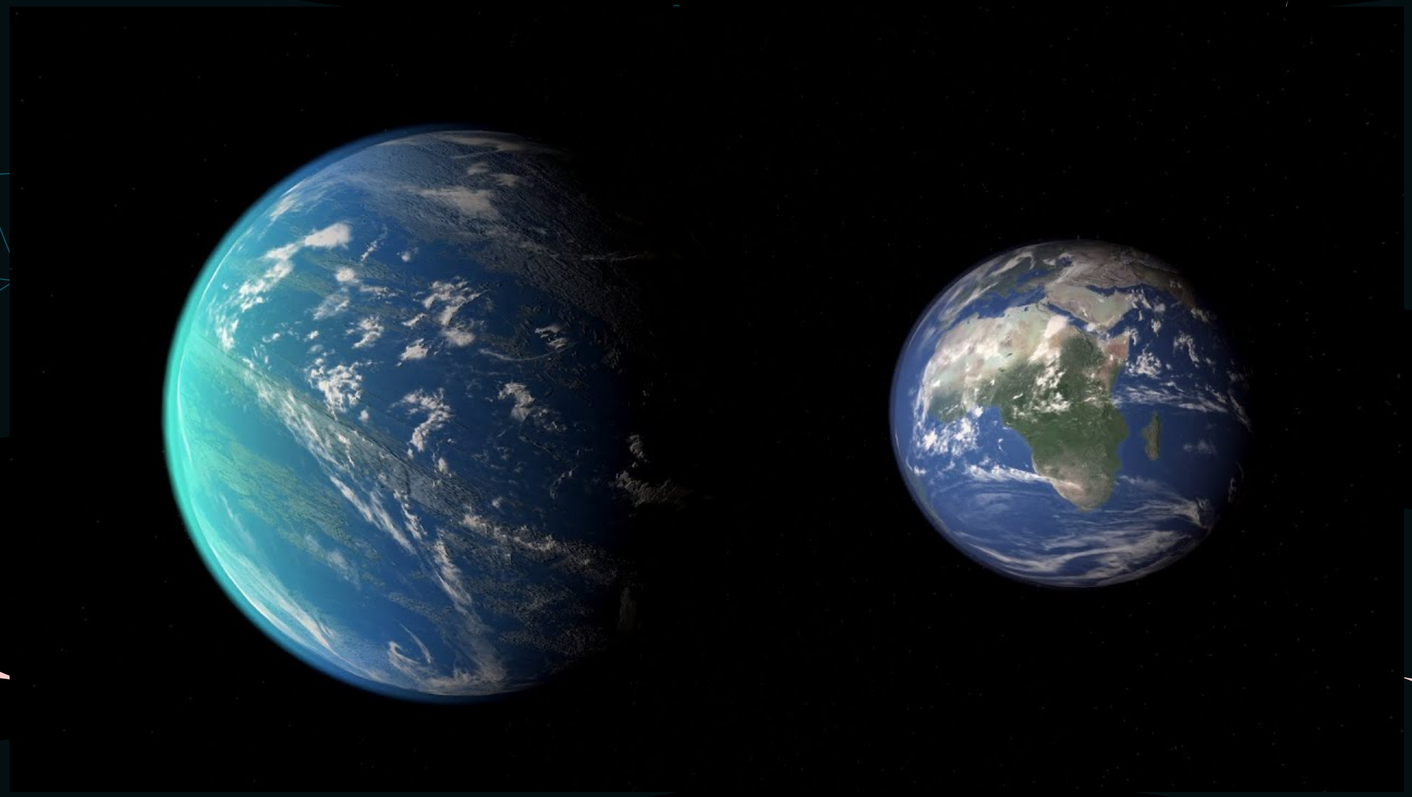
‘ Kepler - 452b ’ and 'Betelgeuse'

KEPLER-452b

what is so special about it?

1. It has many similarities with the Earth. It is known as Earth 2.0 or Earth's cousin
2. Its sun, Kepler 452 is similar to our sun and the planet is present in its habitable zone.
3. It is most likely habitable to extremophilic life.

KEPLER-452B



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BETELGEUSE

what is so special about it?

1. It is a red supergiant star.
2. It is the 10th brightest star in the night sky and second brightest in orion.
3. It is a semi regular variable star whose brightness waxes and wanes.
4. It is in its later stages of its life and is expected to go supernova very soon.

BETELGEUSE

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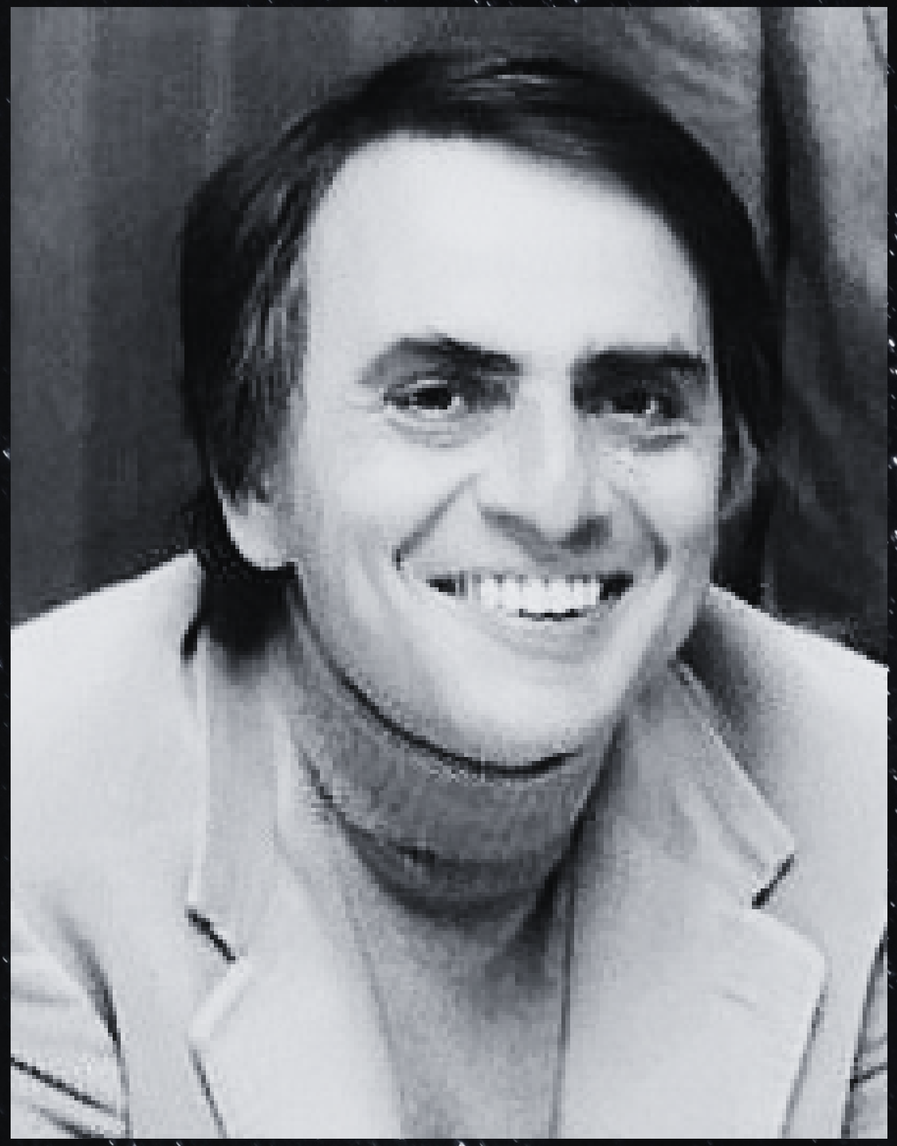

" The nitrogen in our DNA, the calcium in our teeth, the iron in our blood, the carbon in our apple pies were made in the interiors of collapsing stars. We are made of starstuff. "

~ Carl Sagan

THANK YOU!