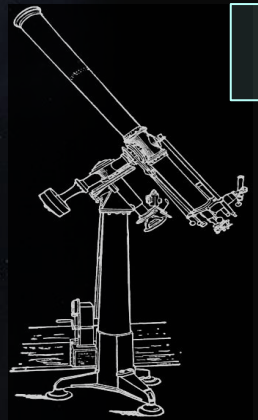
ENDTERM PROGRESS REPORT

OPTICAL ODYSSEY



Peeking at the Beginning of the Universe

Mentors:
Anushree Shukla
Princy Chauhan
Shreya Rajak

WEEK -1

ABOUT THE PROJECT

We aim to learn about history, working of telescopes, JWST and its components, about ISIM (Integrated Science Instrument Module), multiple-mirror optics and conditions in space by building a light collector similar to that of the primary mirror of the James Webb Space Telescope.

History and working of Telescopes

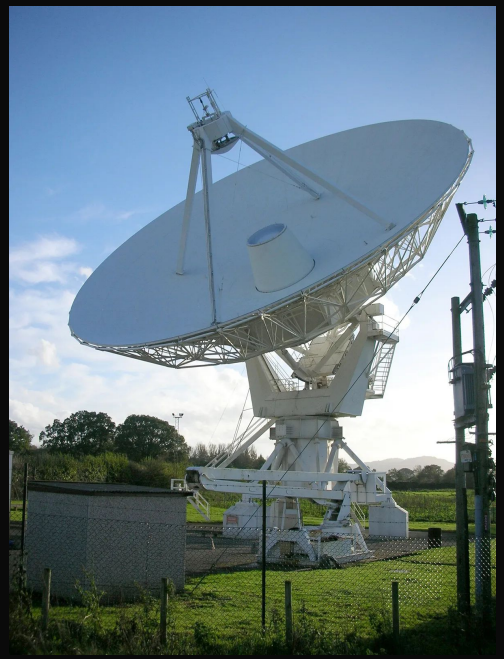
HISTORY OF TELESCOPES

Lippershey's Telescope

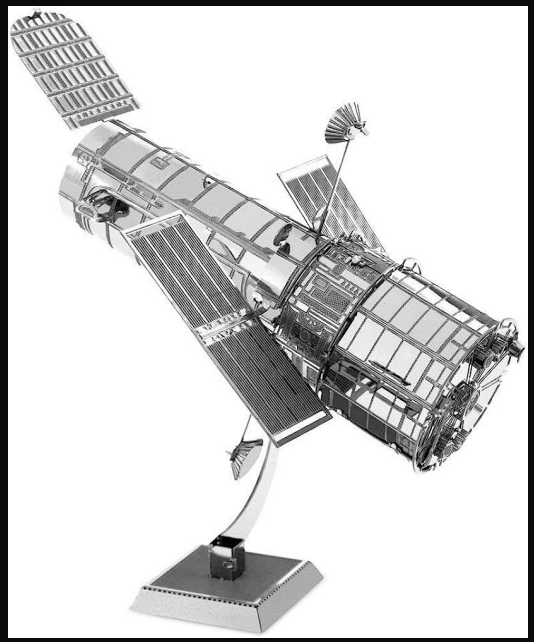
Galileo's telescope

Newtonian telescope

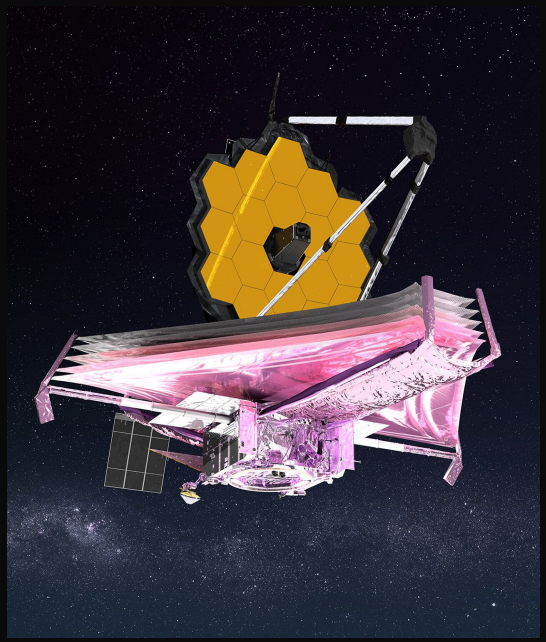
HISTORY OF TELESCOPES



Radio telescope



Hubble Telescope

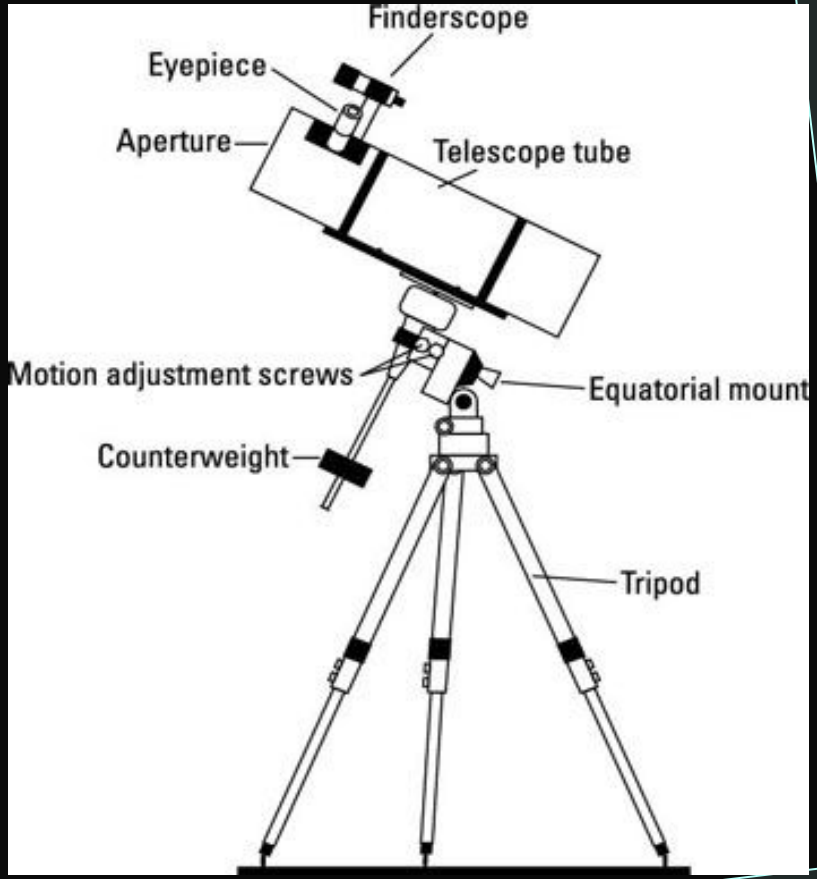


James Webb Space Telescope

Telescopes: window to the stars

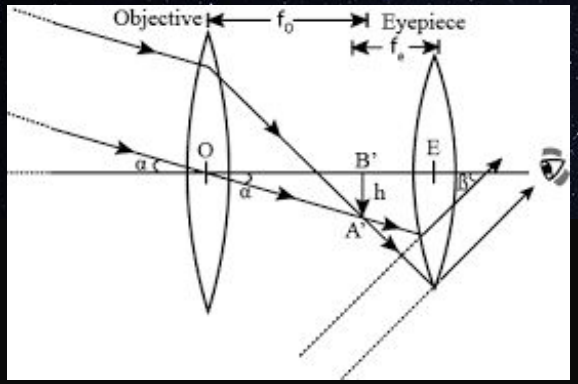
- An optical instrument used to study and observe the cosmos
- Collects light emitted by the distant astronomical objects
- Focuses the collected light into one point or image

We also learnt about the various parts of telescopes

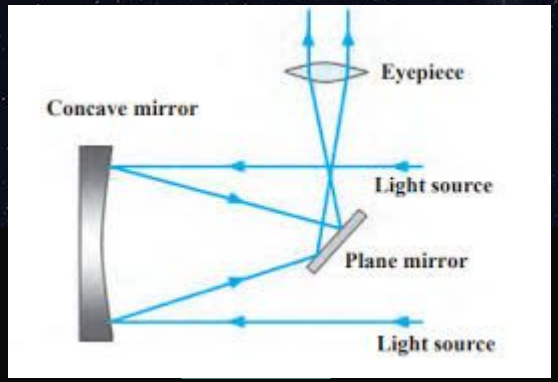


WEEK -2

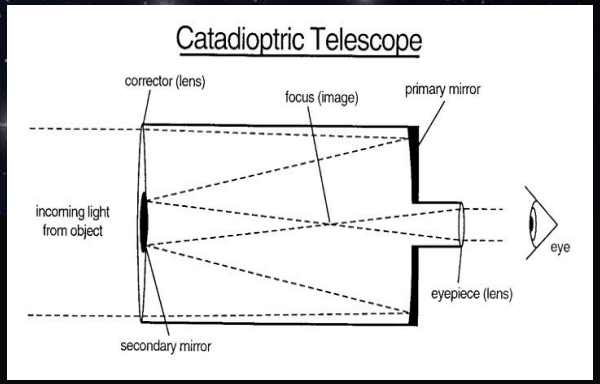
Types of Telescopes



Refracting Telescope



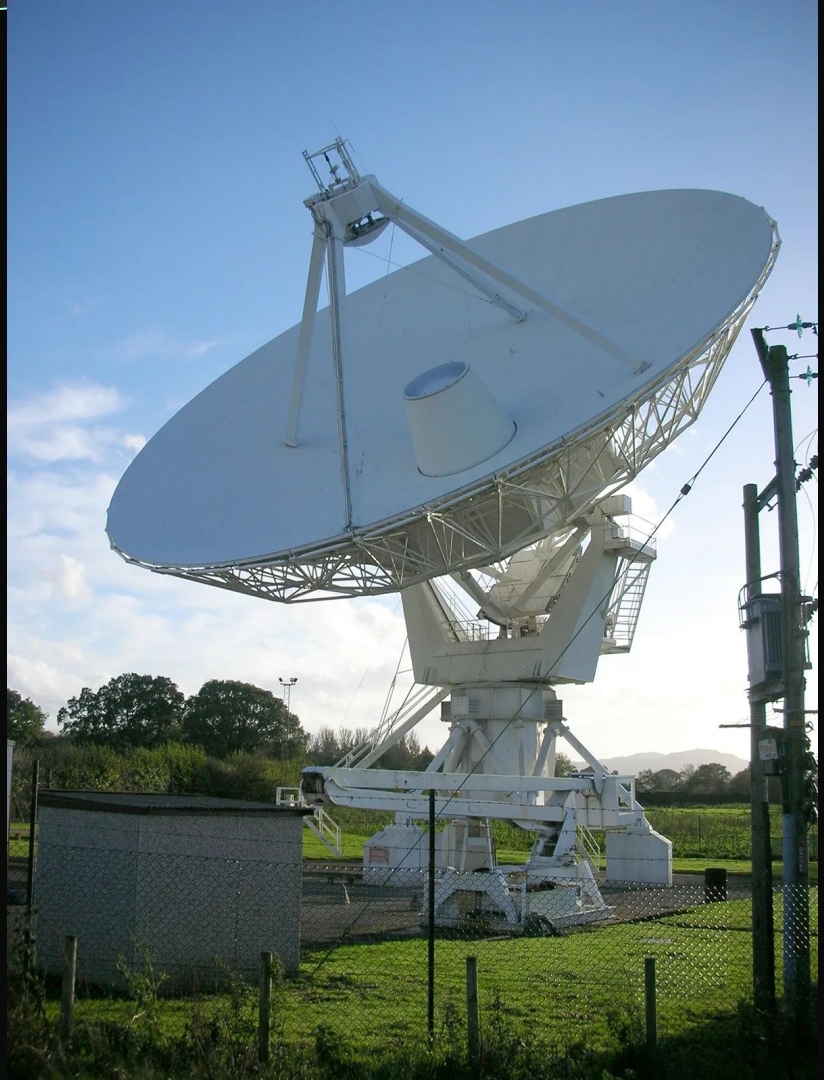
Reflecting Telescope



Catadioptric Telescope

Radio Interferometry

- It is a technique which combines signals from multiple radio telescopes arranged in an order
- By correlating these signals we can observe and study distant astronomical objects like pulsars,quasars ,etc.

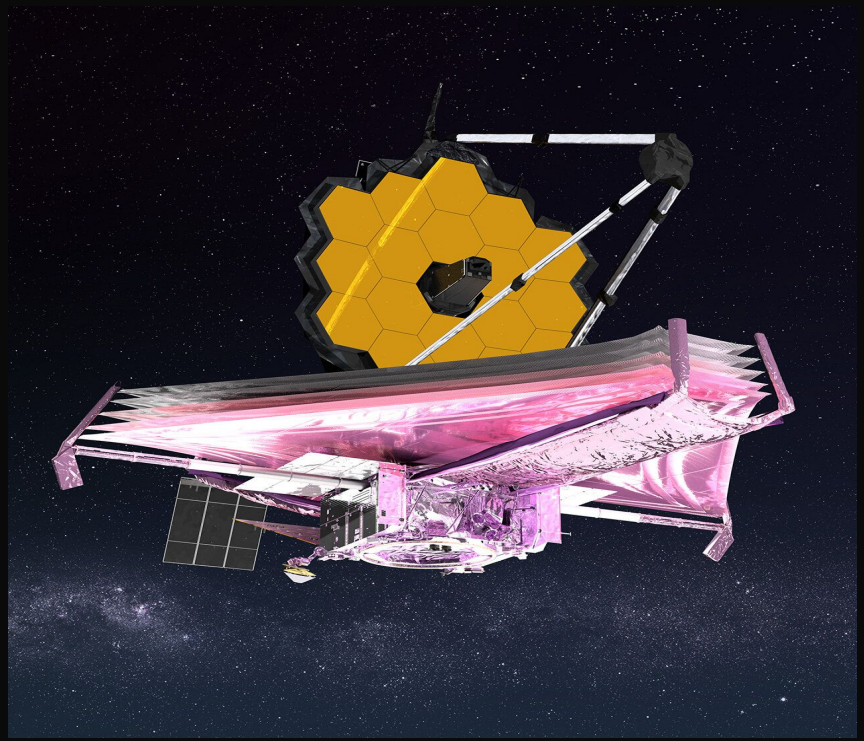


Assignment : 1

With the help of this assignment we learnt the following things:-

- Resolving power of telescope.
- Resolution of telescope.
- How to derive the magnification of refracting telescope .
- How to solve the problems based on the working of cassegrain telescope.

WEEK -3



JAMES WEBB SPACE TELESCOPE

-THE NEXT GENERATION OF HUBBLE-

Introduction

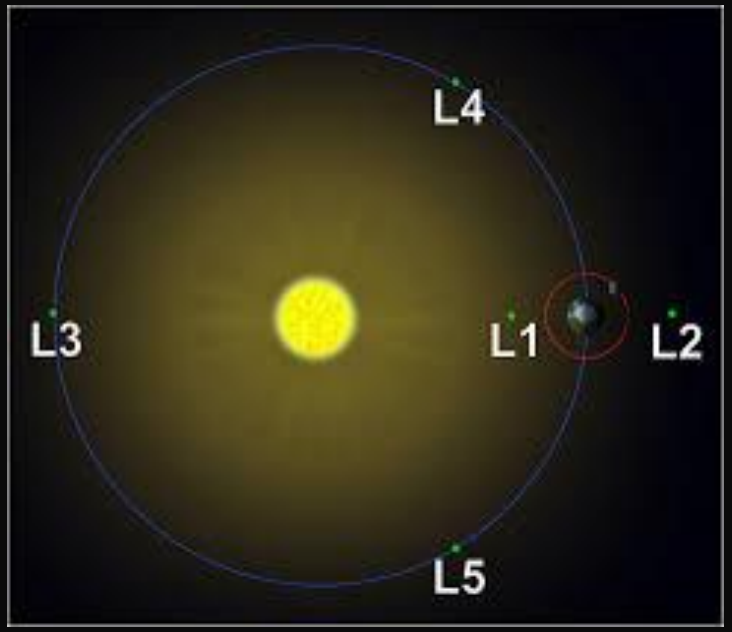
The JAMES WEBB SPACE TELESCOPE is the largest and most powerful space telescope to date. The telescope has over 1200 skilled scientists and engineers from 14 countries building it and it took more than two decades and $10billion to build.

LAUNCH

1. NASA'S infrared space observatory, launched on Dec 25,2021, from ESA 's launch site at Kourou in French, Guiana ,at 7:20am EST abroad an Arianespace Ariane 5 rockets.

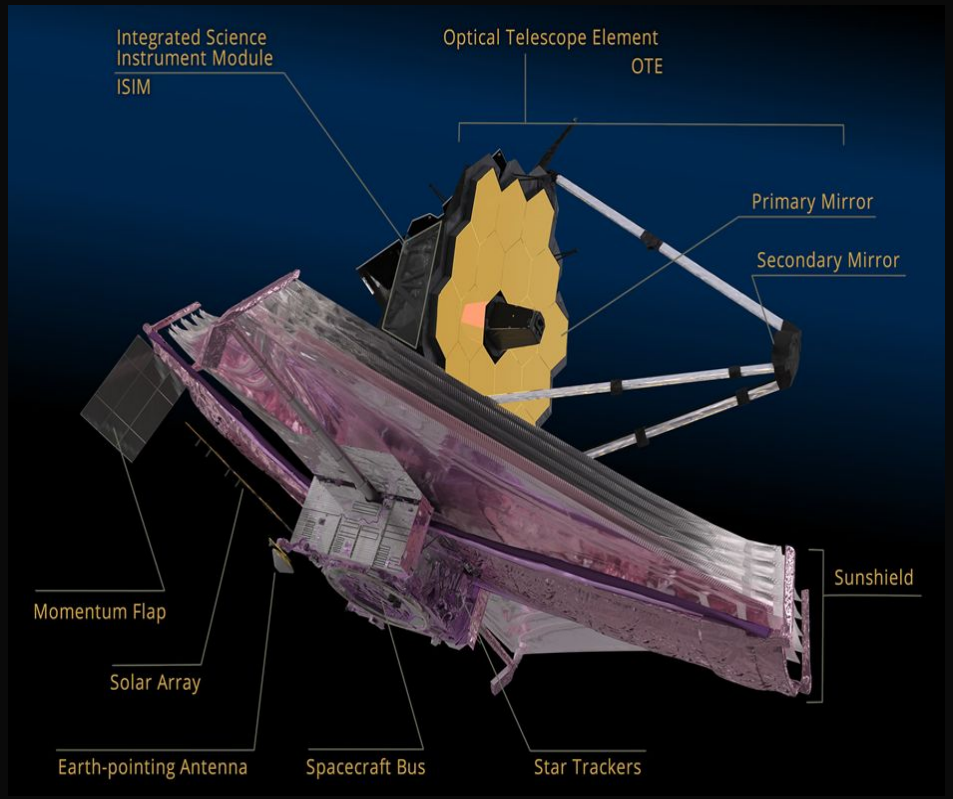
2. JWST Is placed 1.5 million KM away from Earth at second Lagrange point. It is done because

- Away from radiation of earth and moon
- Infrared Telescope
- Lesser Solar Radiation



PARTS OF JWST

- THE LAUNCH VEHICLE
- MIRRORS
- SUNSHIELD
- ACOUSTIC CRYOCOOLER
- THRUSTERS

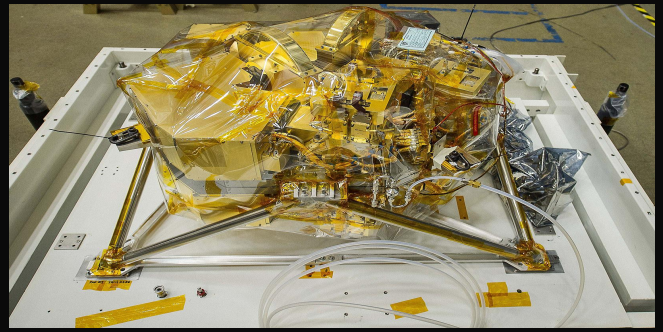


WEEK -4

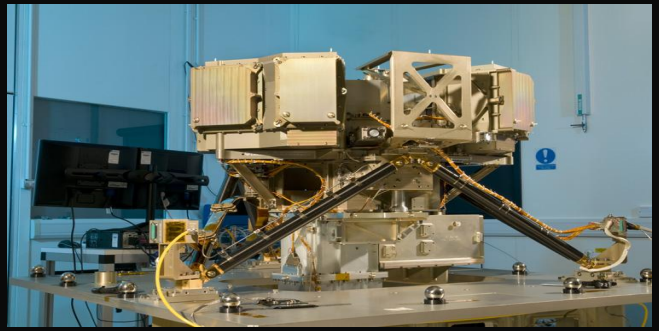
Introduction To ISIM JWST

The Integrated Science Instrument Module (ISIM) of the James Webb Space Telescope (JWST) is a critical component that houses four scientific instruments. These instruments work together to observe the universe in a wide range of wavelengths, from visible light to mid-infrared.

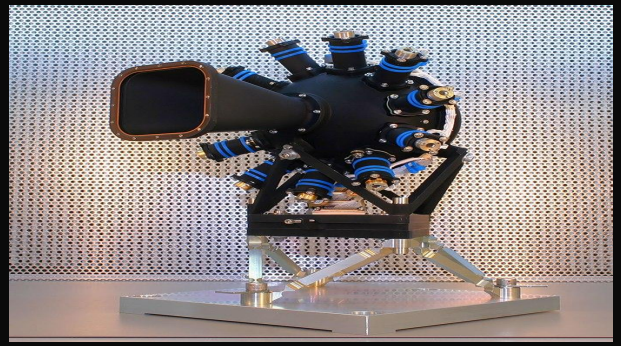
TYPES OF ISIM INSTRUMENTS



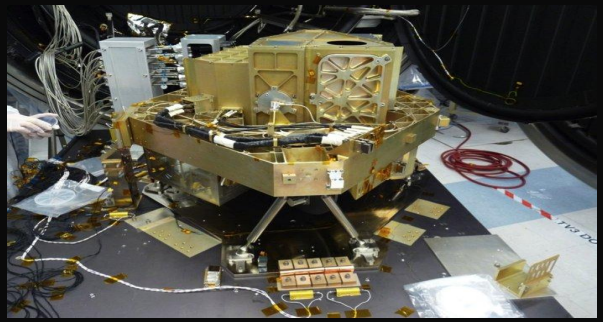
NIRCAM INSTRUMENT



MIRI INSTRUMENT



NIRSPEC INSTRUMENT



FGS/NIRISS INSTRUMENT

Assignment 2

- In assignment 2 we learnt about the one of the first images taken by JWST.
- We also learnt to make a document using latex.
- We were divided into three groups for this assignment, and each group was given the task of researching one image.
- We studied about Stephan's Quintet , Carina Nebula and SMACS 0723.
- Stephan's Quintet is a visual grouping of five galaxies.
- Carina Nebula is a large , complex area of bright and dark nebulosity in the constellation Carina.
- SMACS 0723 is a galaxy cluster , about 4 billion light years away from Earth within the southern constellation of volans.

IMAGES TAKEN BY JWST

Stephan's Quintet

Carina Nebula

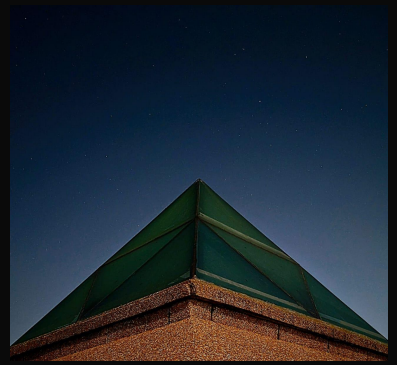
SMACS 0723

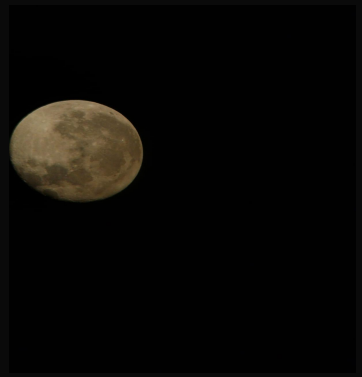
WEEK -5

ASTROPHOTOGRAPHY

Astrophotography is the photography of astronomical bodies and celestial events including stars, moons, the sun ,planets , asteroids and galaxies. The aim of astrophotography is to capture as much light as you can while minimizing the movement of the stars in the image.

Some of the astrophotography images



Assignment 3

Intro to Python libraries

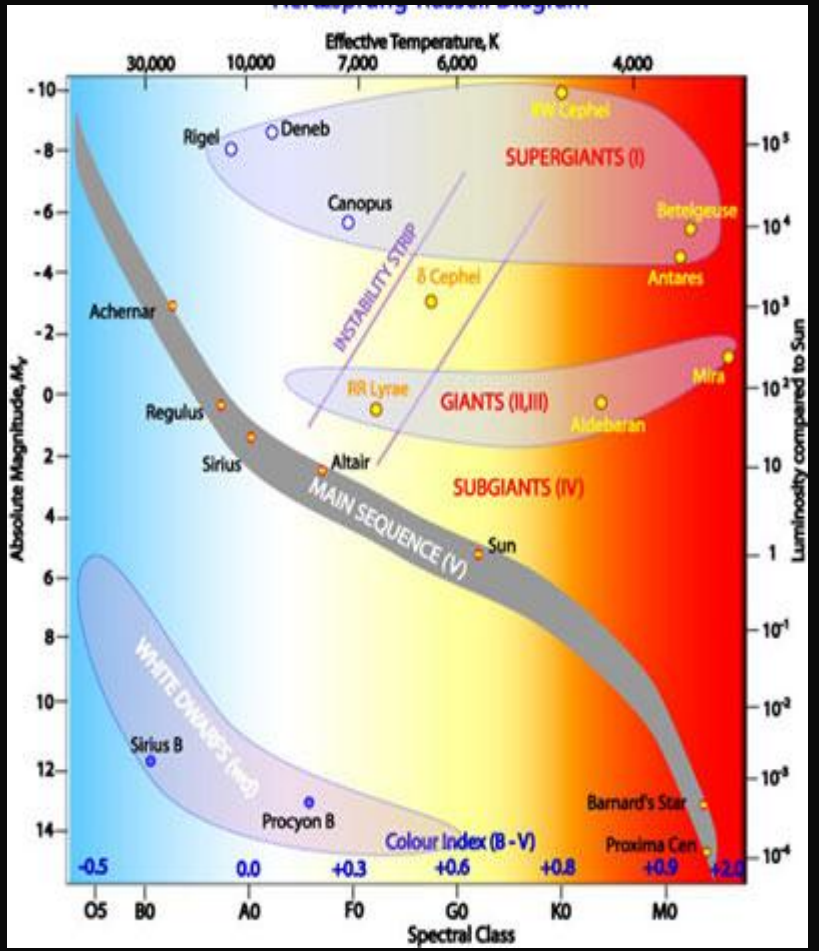
Python Libraries used to determine the age of Globular Clusters:

Astropy: Python's exclusive library for reading Astronomical data and subsequent conversion to graphs and table.

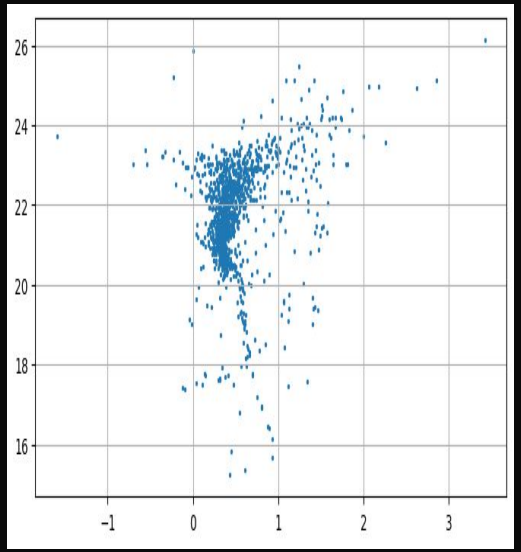
Matplotlib : Another Python library for data visualisation and graphical representation which used Numpy for numerical extensions.

Hertzsprung-Russell Diagram

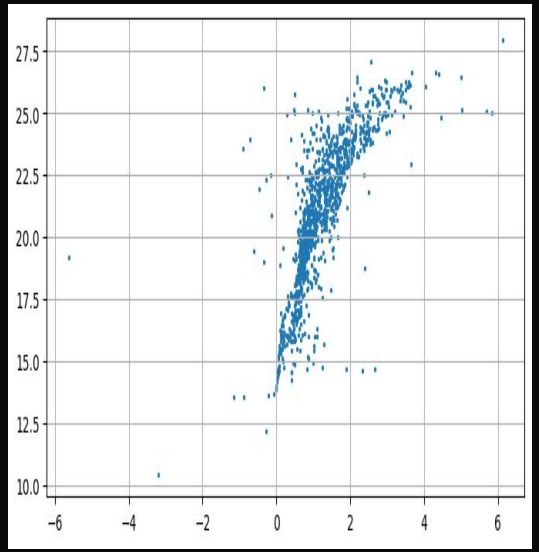
1. This graph plots temperature of stars against luminosity or color against their absolute magnitude.
2. Prominent feature is the main sequence(running from upper left to bottom right).Stars spend 90% of their life here.
3. Giants and SuperGiants stars occupy the region above main sequence and white dwarf stars found in bottom left are final evolutionary stage of lower to intermediate stars.
4. Stars tends to spend about 90% of their life in the main sequence stage , after this it spent remaining 10% of their life in Giant phase. Finally, they will explode into either a white dwarf star or a neutron star or black hole.



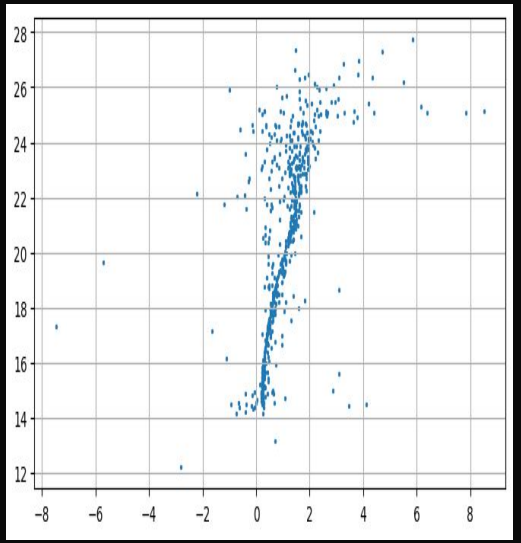
Plotted the HR diagram for varies globular cluster from the data obtained from **SDS** and hence determined their age my detecting the main sequence turnoff point.



PAL 5
11.5+/-1.0 billion years



NGC 2401
25 million years

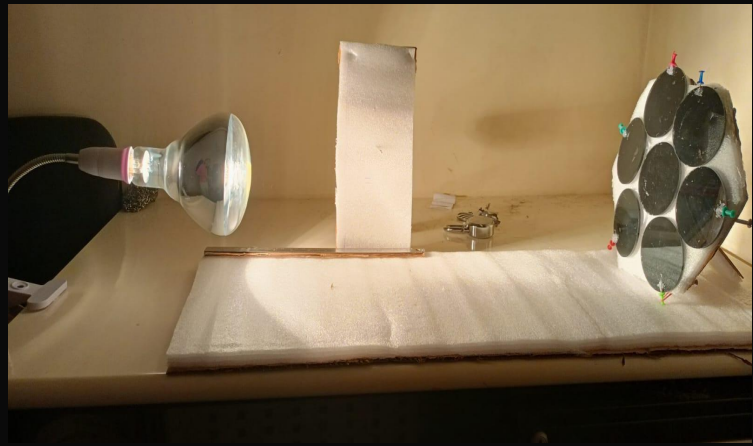


NGC 2420
2.5+/-0.5 billion years

WEEK -6

Experimental Setup of JWST

The goal of this project is to construct a multiple-mirror light collector similar to the Webb Telescope's primary mirror. This multiple-mirror assembly is then illuminated using a heat lamp instead of a far-off celestial object. We then develop a "sunshield" using Aluminium foil to study the effect of sunshield and mirror orientation on the temperature measured.

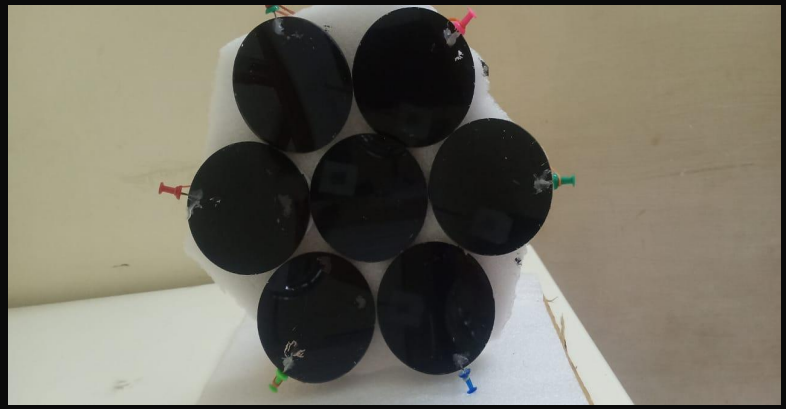


Experimental setup of JWST

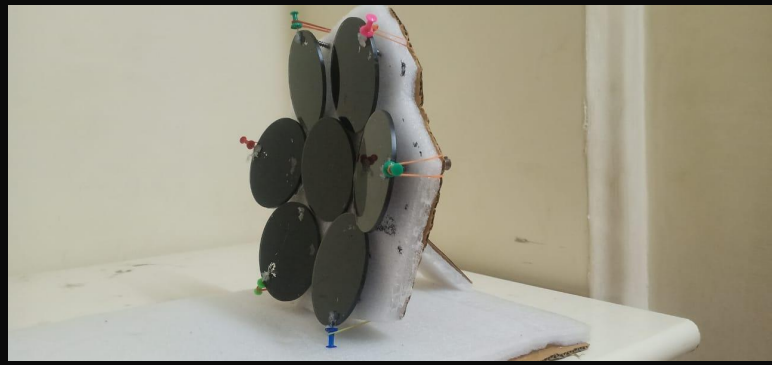
Construction of Setup

It involves three steps:

1. **Assembling the Optical Bench**
   It involves the making of the lower base of the setup and the thermometer holder.
2. **Creating the Multiple-Mirror Assembly**
   It involves the making of the mirror system which is used to reflect the light to thermometer to measure the temperature. It is fit with rubber bands and screw to change the angle of each mirror.
3. **Creating a Thermometer Sunshield**
   As the light directly falls on the thermometer so we have shield it from the direct rays coming from heat lamp so we have to build a sunshield for thermometer. It involves the use of aluminium foil to protect from direct rays from lamp.



Mirrors



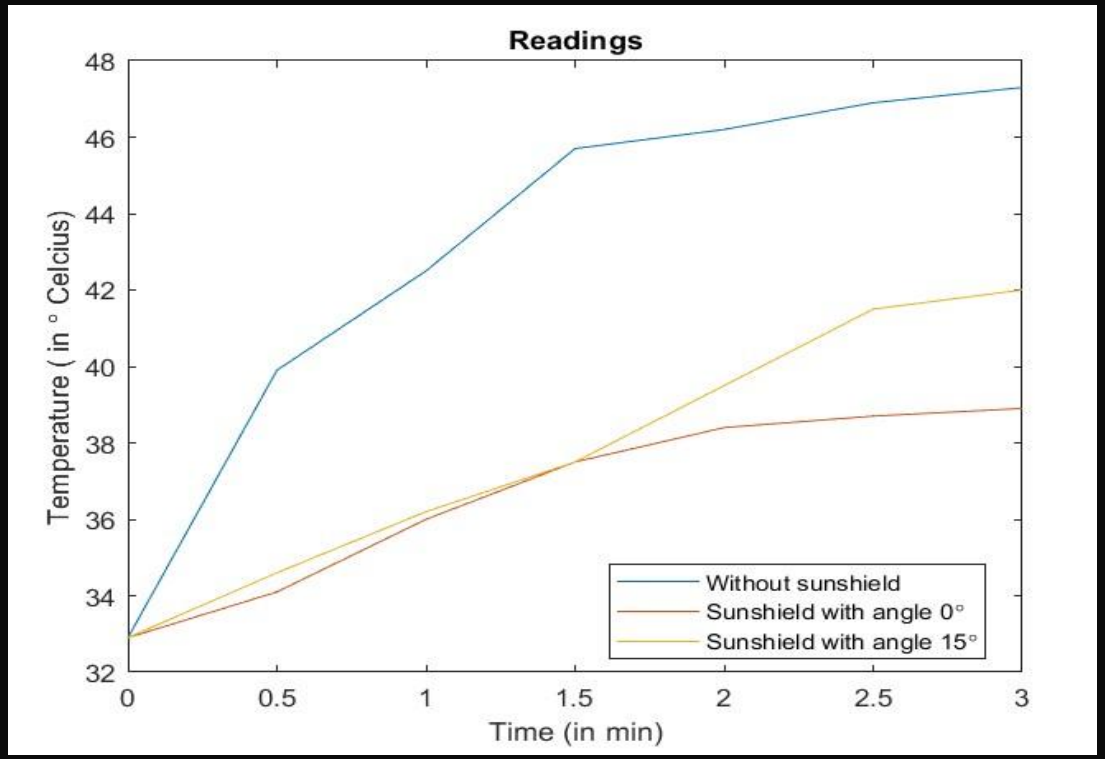
OBSERVED READINGS FROM THE TELESCOPE SETUP

Readings without Sunshield (At 0° Angle)	
Time (in Mins)	Temperature (° C)
0(R.T)	32.9
0.5	39.9
1	42.5
1.5	45.7
2	46.2
2.5	46.9
3	47.3

Readings with Sunshield (At 0° Angle)	
Time (in Mins)	Temperature (° C)
0(R.T)	32.9
0.5	34.1
1	36
1.5	37.5
2	38.4
2.5	38.7
3	38.9

Readings with Sunshield (At 15° Angle)	
Time (in Mins)	Temperature (° C)
0(R.T)	32.9
0.5	34.6
1	36.2
1.5	37.5
2	39.5
2.5	41.5
3	42

Graph of TIME(in mins) v/s temperature (°C)



CONCLUSION

So this was everything which we mentees learned and explored in the “Optical Odyssey” project under the Astronomy Club and the Science and Technology Council, IIT-K. It truly was a great experience of new insights and we feel immensely motivated to explore about Telescopes and Astronomy even more. We thank our mentors for their unconditional support and guidance in the project.

THANKS!!