How are astronomical instruments helping us in locating Earth 2.0?

By Dhruva Teja Turaga

Why did I chose this subject?

- Fascination towards Space and Astronomy – especially thinking about “What if” scenarios
- Chapter about Intelligent life in “Brief Answers to the Big Questions” by Stephen Hawking
- Using telescopes in my free time to observe planets like Jupiter and craters on the moon
- Interest towards physics, maths and engineering pushed me to further investigate around like watching TedX talks

Why Earth 2.0?

- For 3 reasons:

- A new home

- The answer to the biggest question: Are we alone in the universe?

- Human curiosity

Aims & Objectives

- Investigate the mathematical concepts we developed to be able to quantify space
- Discover how the invention of the first telescope led to astronomical instruments becoming so advanced
- Assess the impact of sensors and how vital they are in categorising planets
- Examine the processes which scientists use to get the best image of planets
- Determine the location in the sky has the highest potential for habitable exoplanets

My Hypothesis

- Telescopic lens will show the greatest view of exoplanets more than sensors on cameras
- Using my DSLR camera, the best and most informative pictures can be attained from the lowest shutter speed, aperture and the highest ISO of the Andromeda galaxy due to its high light projection.

Methodology

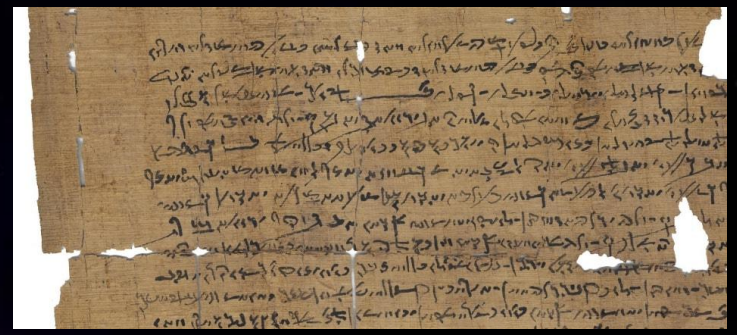
- To approach the research project I had to define how I would compare different types of telescopes and factors which affect how we can see different star systems and exoplanets in the night sky.

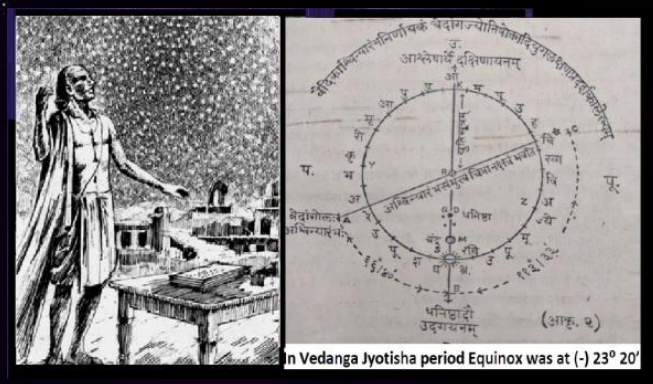
Factors I looked at for telescopes:	Factors I looked at for analysing the night sky:
Focal Length	Types of star systems in the picture
Aperture	Distance from Earth
Magnification	Possibility for a habitable exoplanet
Mounting	Magnification achieved to see the system
Editing	Number of photos and editing needed to construct the photo
Cost	Cost to take the photo

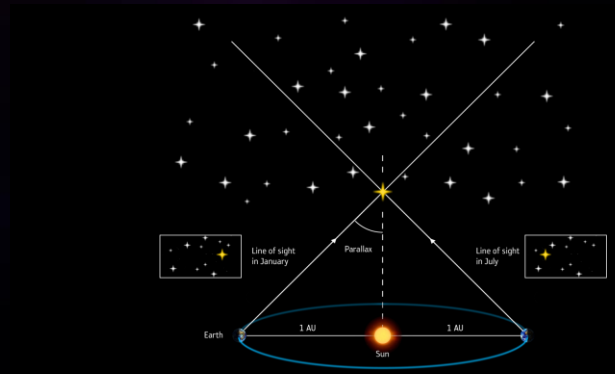
How we modelled the cosmos

- Dissimilarity of data from the Egyptians, Mesopotamians and Babylonians and parallax
- Unification of maths with German astronomer Friedrich Bessel in 1838

With the help of Bessel we could build a map of the universe using basic standardised principles

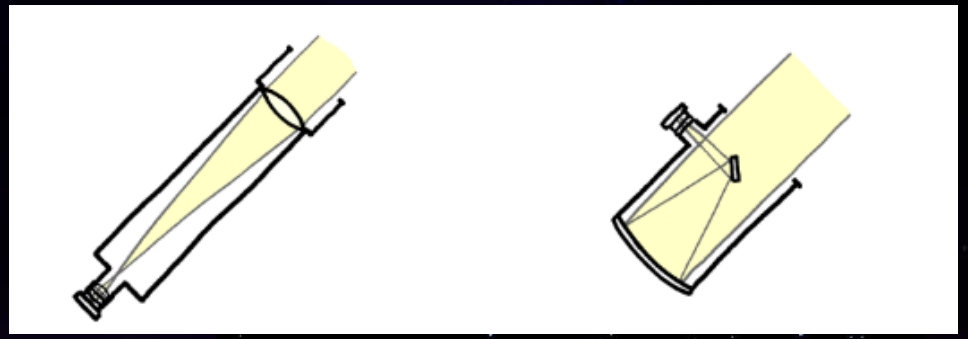






Earth based telescopes

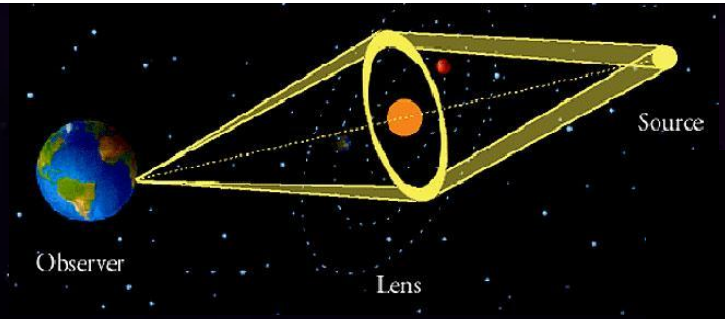
- The invention of the telescope with Hans Lipperhey and then Galileo



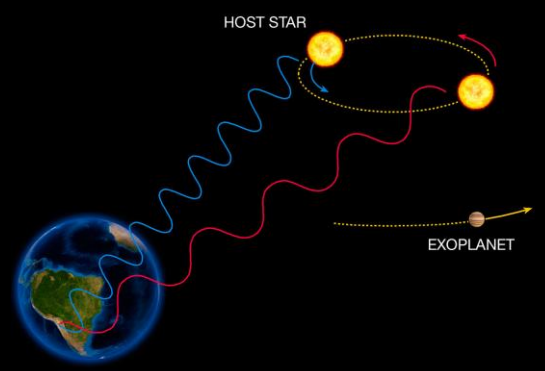
- Refractors
- Reflectors

The 2 main methods used to identify planets and star systems:

- Microlensing

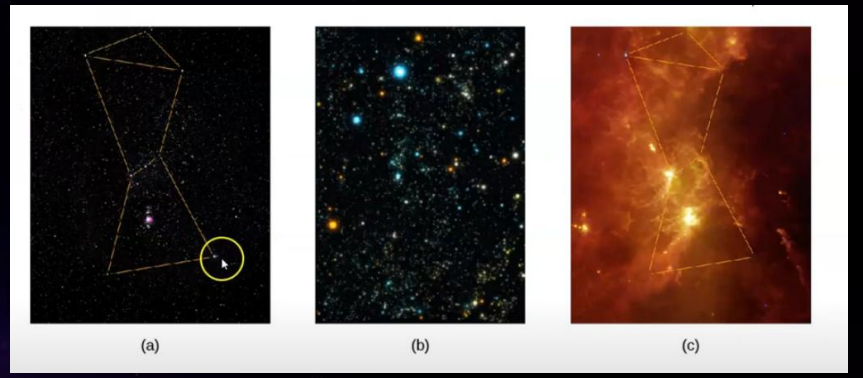


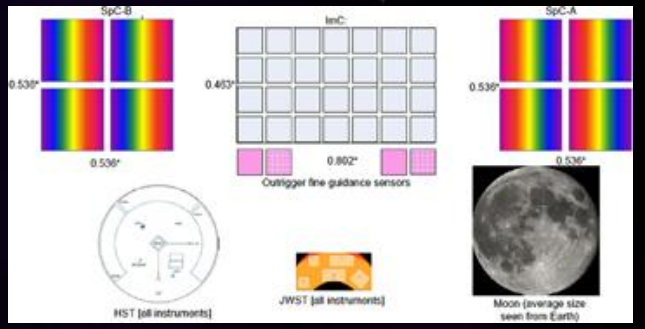
- Radial Velocity

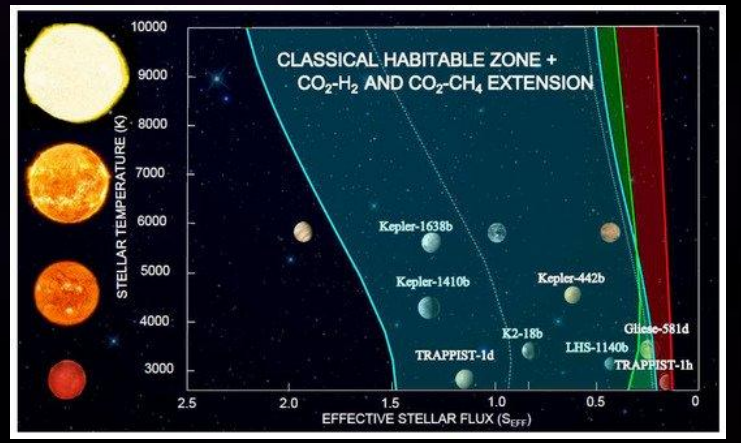


The development of sensors

- Sensors analyse and separate light so scientist can piece together to form of view of planet.
- The light can show orbital period of a planet, its density, equilibrium temperature, atmospheric composition etc.
- For example based on sun type we can estimate where the goldilocks zone lies. Using the radiation absorbed from the exoplanet we can determine its composition.
- Interferometer
- Oxyometer

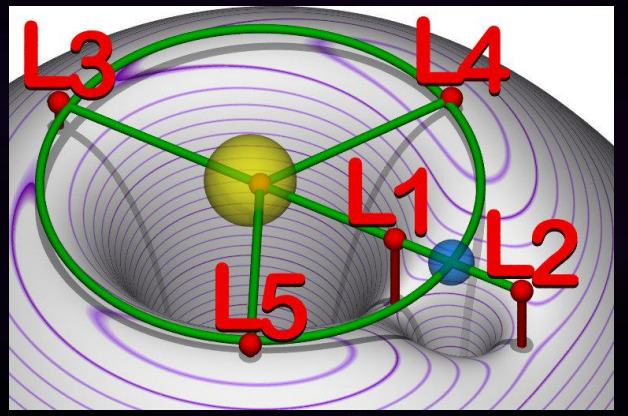


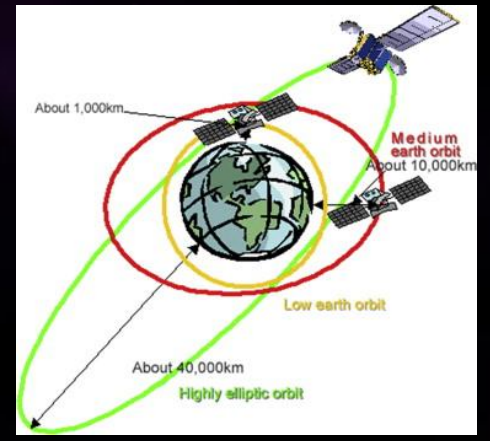




Space based telescopes

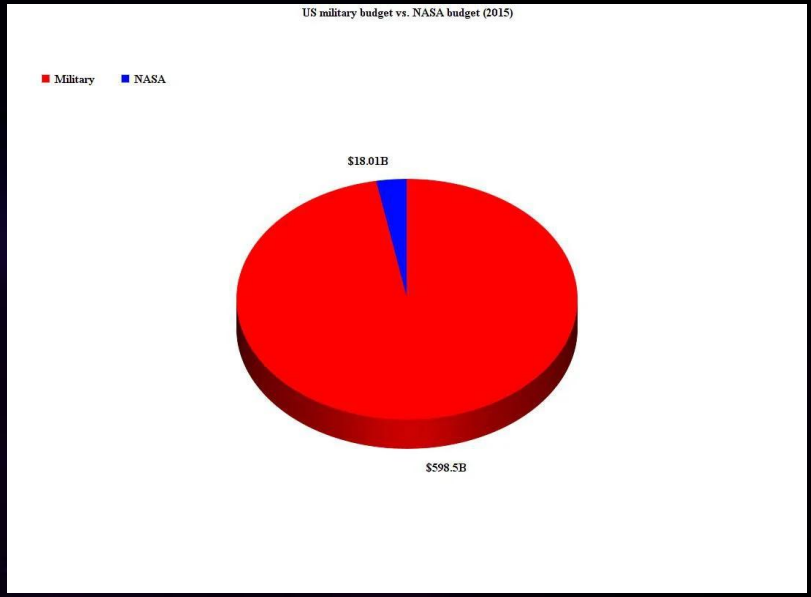
- The mixture of sensors, and the virtually zero light pollution makes these specific types of telescopes very effective in detecting exoplanets.
- Rotate about their own axis
- LEO and Lagrange points
- Communication and unpredictability of space

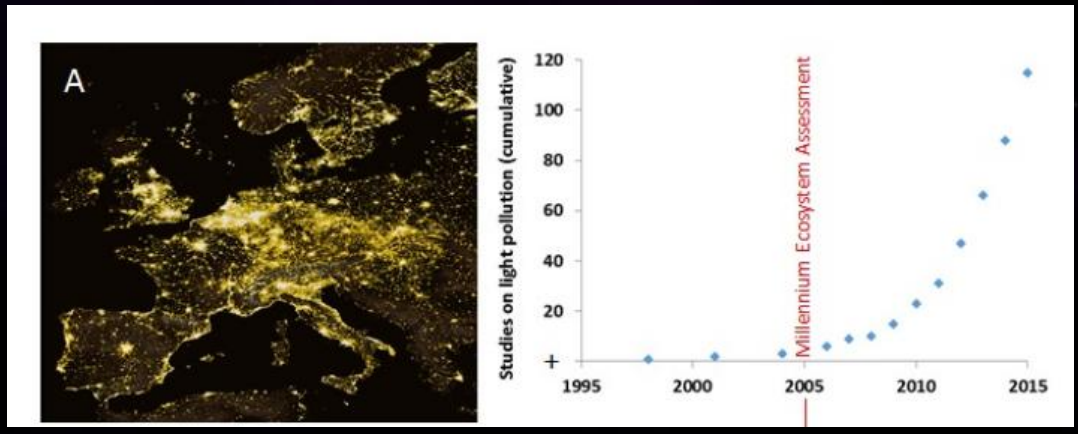




How are we slowing the search?

- Money and investment – very little funding
- Requirement of more resources
- Increased light pollution so it is harder to find suitable places in the world to look at the night sky





How are telescopes used to get images of planets?

- I investigated how space based telescopes are used to get immensely accurate photos with only lens.
- I used different types of lenses and telescopes: reflector, refractor, my DSLR camera, a phone and the Hubble telescope by NASA

How are certain areas in the night sky analysed to find exoplanets?

- Vega Star System

- The Deep Field photo by the James Webb

- The Messier 31 (Andromeda Galaxy)

Conclusion

- I found that through the leaps in human understanding of space have been able to understand the universe in such a massive way
- I have found that my hypotheses were true: telescopic lens did show a superior view of the moon and the Andromeda was the most informative picture compared to the Vega star cluster
- How are astronomical instruments helping us in locating Earth 2.0?
  - Helping us to pinpoint where we are in the universe
  - Helping to classify planets better so we can see the exact compositions of planets even better as technology increases

What went well

- Vast amount of resources
- Organisation - the ability to keep my work in order and keep subject lessons and notes together
- The conclusions I have made follow my hypothesis

Challenges & Solutions

Challenges	Solutions
Lack of responses from professors in the field of astronomy	I used various papers and other secondary sources from the same scientists and got an overview on the subject
Telescope broke	I had to design and 3D print the bracket so that I could use it again and continue my experiment
Time management	Using a Gantt chart and schedules I could manage my day within school and outside
FUPG Exams	By taking a hold on my EPQ and badminton I could concentrate on my exams more.
Understanding everything – this topic required me to understand very tiny details	I had to read around the subject a lot so that I could understand everything much clearer

Thank you for listening

Any Questions?

Acknowledgements & Sources

- https://bigthink.com/13-8/from-astrology-to-astronomy/
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With most if not all sources being from a NASA, ESA or peer reviewed sources with references confirming any additions to websites, videos and pictures.