Telescopes and Detectors

Telescopes and Detectors are arguably the most essential part of how we observe the stars, galaxies, and beyond. Human eyesight can only show us so much, therefore we must use more advanced technology, to truly be able to study the night sky.

In this module you will learn about the different types of telescopes, detectors and sensors that are used by astronomers all around the world. We hope will inspire you to buy, build, or use a telescope either of your own or belonging to a space program. Happy learning!

Notes:
Telescopes and Detectors
Solar Eclipse Problem
(Introduction to Modern Astrophysics)

Books:
A Student's Guide To The Mathematics of Astronomy
Fundamental Astronomy

As the titles imply, these book pdfs will provide you with the framework into the mathematical component of astronomy, which admittedly is quite large, as well as the fundamentals needed to understand modern astrophysics. They contain more information than just that of which you would need for telescopes and detectors, but are a helpful guide into what will better prepare you for fully comprehending the logistics of it all. Throughout this module, use these books where guided to do so.

Task 1:
Observing Through Atmosphere

These videos show how we observe space from earth and vice versa. There are certain ideal “windows” in our atmosphere that provide for the best observational perspectives of the sky. Whereas on the other hand, we can use telescopes and satellites in our atmosphere to provide a broad, yet detailed, perspective on our planet.

Reading:
Fundamental Astronomy - Unit 3.1

Task 2:
Parallactic Angle and Angular Size:

Stars are a bit too far away for us to measure in kilometers or miles. That's why astronomers use The Parsec (learn more in video). But since the earth is in constant

motion, we can't just get one clear measurement, hence parallax. Watch these videos to understand this dilemma. Try to connect it to how telescopes are used and how we map the night sky.

Reading:
A Student's Guide To The Mathematics of Astronomy - Unit 4.1, 4.2

Task 3:
Optical Telescopes:

World's Biggest Optical Telescope
The Basic Telescope
Telescopes: Crash Course Astronomy
How Do Telescopes Work?

Perspectives, lenses, and some interesting telescope technology. After watching these videos, try and write up some reasoning behind why we use different lens types and telescopes sizes in different observational situations.

The ones you may want to focus on are:
Refractors
Reflectors
Catadioptrics

Reading:
Fundamental Astronomy - Unit 3.2
A Student's Guide To The Mathematics of Astronomy - Unit 4.3

Task 4:
Optics and Detectors:

This 3.2 Gigapixel Camera Will Record a Timelapse of the Universe
Stellar Spectroscopy

CCDs (Charge Coupled Device) and CMOS (Complementary Metal Oxide Semiconductor) are modern-day image sensors that convert incoming light from the sky into the charge. They are what astronomers and cosmologists have in their telescopes to then be able to capture images and recordings of the universe. At the simplest level, they convert photons into film photos. Detectors are what contain the CDD, and spectrographs are what contain the detectors. Watch these videos for in-detail explanations on all these concepts.

Try and compare CCDs and CMOS with regards to:

System integration
Power Consumption
Processing Speed
Noise and sensitivity

Reading:
Fundamental Astronomy - Unit 3.3
A Student's Guide To The Mathematics of Astronomy - Unit 4.4 (Exercises)

Task 5:
Radio Telescopes:

Ted Talk: How radio telescopes show us unseen galaxies

Radio Telescopes have the potential to reveal light spectrums in the universe that we wouldn't normally be able to see. With merely relying on optical wavelengths, only so much can be revealed. With being able to collect data from radio waves, the universe only seems to become so much larger.

Reading:
Fundamental Astronomy - Unit 3.4

Task 6:
Conclusionary Reading:
Solar Eclipse Problem
(Introduction to Modern Astrophysics)

Well Done! You have now learned about all the different types of telescopes and detectors we use to observe and gather information about the night sky. From optical to radio telescopes, to the math that astrophysicists use to measure and study the distant star in our galaxy.
Just as a little extra, here's some notes to help you summarize your knowledge. They include Len-Maker's Formula and the basics of sketching from lens to object.
Reading:

Fundamental Astronomy - Unit 3.5, 3.6