History of Telescopes:

Galileo Galilei (1564-1642) used a simple refracting telescope made from 2 lenses in a tube to observe the night sky. James Gregory suggested using mirrors instead of lenses in 1663, and Sir Isaac Newton made a reflecting telescope in 1668.

Early reflecting telescopes used mirrors made from speculum metal (an alloy of tin and copper). Lord Rosse of Parsonstown (now Birr) in Co Offaly made a 72" (183cm) reflecting telescope in 1845.

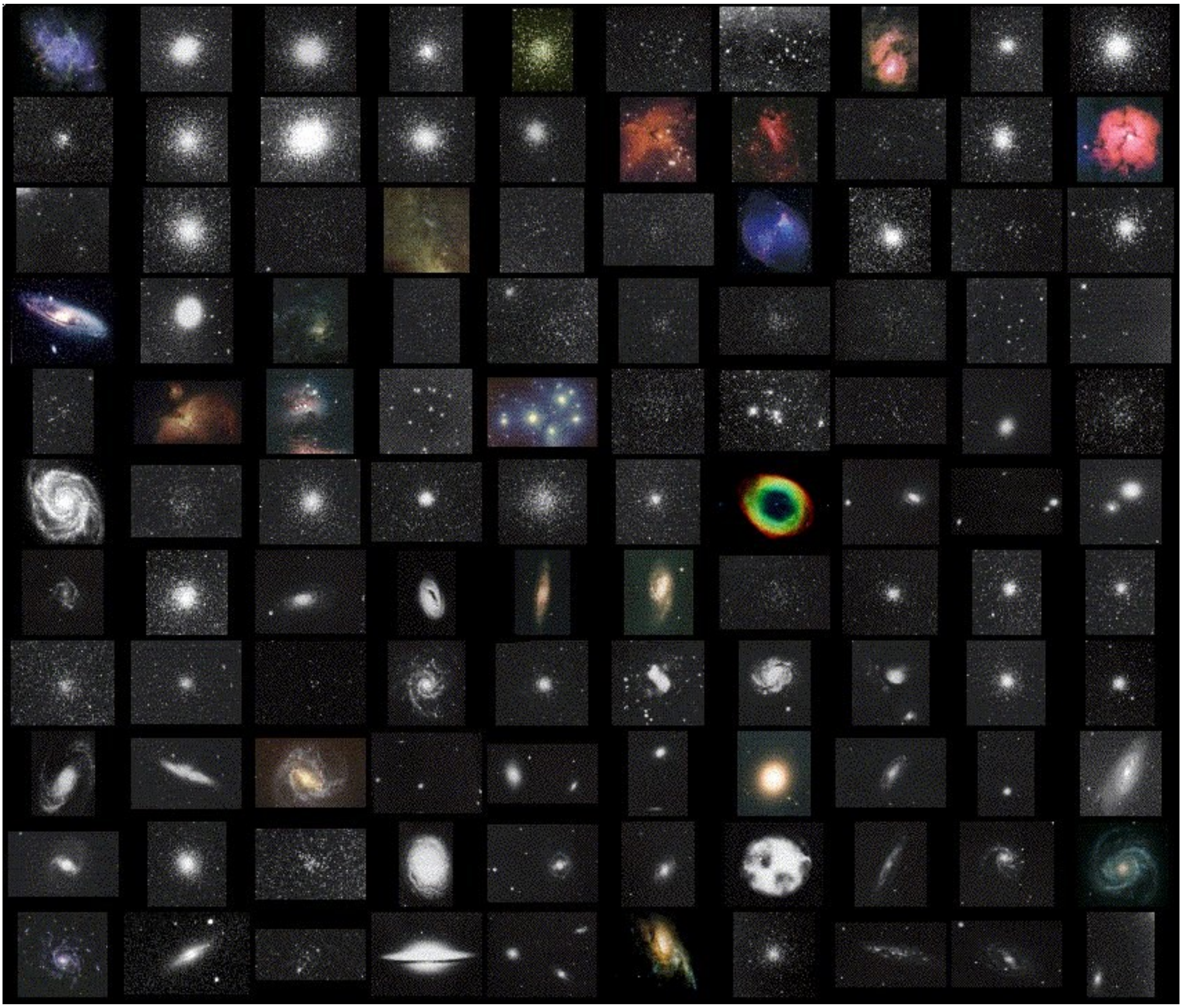
The largest optical telescopes in the world are reflectors, since the mirrors can be supported from the back.

Messier Objects:

Charles Messier (26 June 1730 – 12 April 1817) was an astronomer who made a list of objects to help in his search for comets. The objects he listed are not comets, but appeared unclear or 'nebulous' in his telescopes. There are 110 Messier objects, and they are a variety of different 'deep-sky' objects, including star clusters (both open and globular), supernova remnants, planetary nebulae, diffuse nebula (which can be star forming regions) as well as galaxies.

The Messier objects are listed from M1 to M110. Messier used a range of refracting and reflecting telescopes, equivalent to modern 4" or 10cm telescope.

Examine each Messier Object - what do you think it is? Your space image is a Messier object - can you find a match to your image in this picture from the SEDS Messier Catalog?



Source: The SEDS Messier Catalog Webpages. By Hartmut Frommert, Christine Kronberg, Guy McArthur, and Mark Elowitz. SEDS, University of Arizona Chapter, Tucson, Arizona, 1994-2023. http://messier.seds.org/

Comparing Eyes to Telescopes:

Size of Opening: How big is the opening of your eye that lets light in?

Look at the pupil of your friend's eye (that's the black part of the eye) or look at your own eye in a mirror. Compare the size of the pupil with the grey circles below to find a match. Then measure the width of the circle with a ruler. (CAUTION: Never put a measuring device or other object near anyone's eye!) Note that the size of the pupil changes depending on whether you are in bright or dim light.

Match pupil size, then measure:

The BCO telescope has an opening (aperture) of about 16" or 40cm. On some A2 paper (or 4 pieces of A4 stuck together) draw out a circle that is 40 cm in diameter. How much wider is that than your pupil?

Larger aperture telescopes collect more light from the object they view. The Hubble Space Telescope has an aperture of 2.4m, the Webb Telescope has an aperture of 6.5m—you can find out more about these telescopes with this resource from Space Week 2021. On Earth, telescopes can be made bigger - the Very Large Telescope consists of 4 telescopes, each with an 8.2m aperture and the planned European Extremely Large Telescope will be nearly 40m wide!

Exposure time: Does your eye have a 'shutter speed'?

Cameras can image faint objects because they can collect light for a long time. Our eyes don't have a shutter that can open and close, but we have a kind of 'shutter speed': it's the time it takes the cells in your eyes to record an image before they send the image to your brain. You can estimate 'shutter speed' with a simple reaction test, in English and Irish. This gives you an estimate of how often your eye sends a message to your brain (and how fast your brain sends a message to your fingers!).

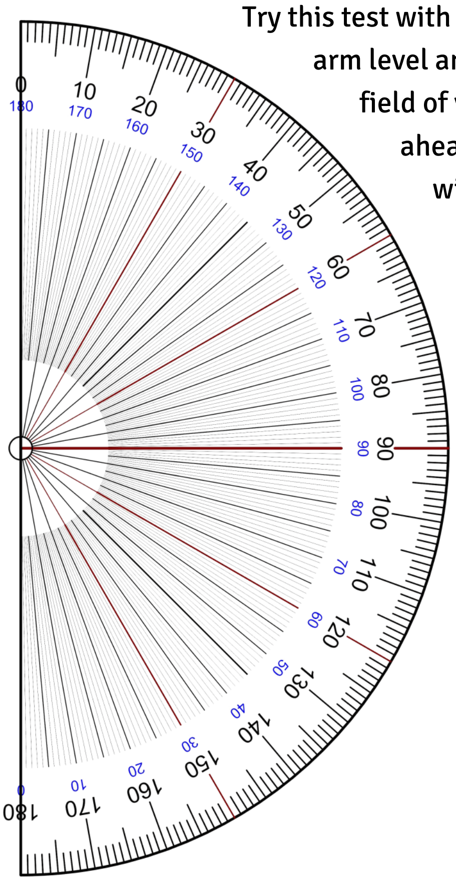
Telescopes use different exposure times depending on what they are trying to image. A long exposure with the BCO telescope is about 30 seconds, but the Moon can be imaged in less than a second. Because BCO's telescope is at the edge of Cork City and in a light polluted area, we tend to use longer exposures than someone in a true dark sky location. Many shorter exposures can be combined to create an image. This was done with the Hubble Space Telescope to create "Deep Fields."

Resolution or Sharpness of Vision: How sharp is your vision?

You can estimate the sharpness of your vision by seeing how close you must be to just make out two pinpoints of light that are side-by-side. Prepare two pinholes by punching two tiny holes in a square of aluminium foil, about 3 mm apart. Place the foil over a flashlight—you should be able to clearly see the light through both pinholes. Stand as far as possible away from the flashlight (a school corridor is good for this) and move towards the light until you can just make out the two points of light. This is the distance at which you can *resolve* the two objects.

Most people can distinguish the two points at about 10m, but this does vary . This is called 'angular resolution' and for humans it is about 1/60 of a degree. BCO's telescope has an angular resolution of 0.285 arcseconds (an arcsecond is 1/3600 of a degree).

Field of View: How 'wide' can you see?



Try this test with a partner: Sit at a table, keeping your eyes straight ahead. With your left arm level and outstretched, SLOWLY bring your arm from behind your head into your field of view, while wiggling your thumb. Make sure you keep your eyes straight ahead; don't look to the left or right. When you JUST see that your thumb is wiggling, stop the motion and have your partner measure the angle your arm makes with the straight-ahead direction. Do the same with your right arm. The total angle, from left to right, where you can see an object, is your field of view.

BCO's telescope has a field of view of about 1/2 a degree, but this depends on the exact set up of the telescope and the cameras used. 1/2 a degree is the angular size of the Moon and the Sun.

The Andromeda Galaxy has an angular size of 2.8 degrees.

From the 4 tests you have carried out, which is better—your eye or a telescope?

Make a working telescope

1. Get two magnifying glasses (it works best if one is larger than the other) and a sheet of printed paper.

2. Hold one magnifying glass (the bigger one) between you and the paper. The image of the print will look blurry.

3. Place the second magnifying glass between your eye and the first magnifying glass.

4. Move the second glass forward or backward until the print comes into sharp focus. You will notice that the print appears larger and upside down.

Explore pixels in images with [Pixel Your Space] for 8 to 11 year-olds from ESA Education.