

U3A-GROUP ASTRONOMY (22-9-2006)

THE MOON

Until c.1600 AD people could watch the Moon only with the naked eye. What they saw was a bright disk with variable forms, dotted with large dark spots, supposed to be seas or oceans (17th-century names such as *Mare Tranquillitatis* etc. are still used). Shortly after 1600 telescopes began to be used (Galileo!), showing the Moon to be a sphere with a rugged surface full of craters, mountains etc. It also became clear that the *Maria* are no seas and that the Moon is (the only object) orbiting the Earth, reflecting the light of the Sun. This explained the phases of the Moon.

A (very) short history of the Telescope

In the course of the following centuries telescopes became better and better (and bigger), revealing more and more details of the Moon's surface and movements. Early – *refracting* - telescopes made use of a lens: difficult to make, certainly at bigger sizes + problem of chromatic aberration (white light split up into all the colours of the spectrum). Around 1700 AD *reflecting* telescopes were developed, which used a mirror instead of a lens: bigger sizes possible and no aberration, but poor results as long as the mirrors were made of metal alloys. By the end of the 19th century it became possible to make mirrors of silvered glass, which gave much clearer views. During the 20th century these mirrors became constantly bigger: now with diameters of 8 – 10 metres (often not any longer made out of one piece, but out of large numbers of hexagonal segments). Plans for mirrors of 25 m and more.

What did these ever improving telescopes learn us about the Moon?

1. About the Moon's size and distance:

Diameter = 3476 km = 27% of the Earth. The Moon's volume is 2% and its mass only 1% of that of the Earth. The distance between Earth and Moon varies as the Moon follows an elliptical orbit. At *Perigee* the distance is 356,400 km, at *Apogee* 406,700 km, average: 384,000 km. As a result the apparent size of the Moon as seen from the Earth varies by 14%. The distance Earth - Moon increases by 38 cm p. year → no more total solar eclipses after 500 mln years from now!

2. About the Moon's movements:

The Moon orbits the Earth in 27 days, 7 hrs., 43 mins. It does not fall towards the Earth as it moves around at a speed of 3700 km/h. As a result of this it rises every day 50 minutes later than the day before. There is a very subtle gravitational balance between Earth and Moon, and as a result the Moon – which is not a perfect sphere – always turns the same side towards the Earth. In other words: the Moon's rotation period is also exactly 27 days, 7 hrs., 43 mins. We therefore always see the same side of the Moon (and tend to call the other side the Moon's '*back*' or '*farside*'). However, given the elliptical orbit + the fact that this orbit is inclined to the ecliptic by 5° + the fact that we observe the Moon from different angles, being carried around on the rotating Earth (especially near the equator), we can see a total of 59% of the Moon over a period of 30 years.

3. About the Moon's surface:

The better the telescopes became, the more craters etc. became visible. According to their diameter we distinguish: *craters*: Ø up to 100 km (there are c. 10,000 of them with a Ø of more than 3 km on the visible side only), *walled plains*: Ø 100-300 km, and *maria*: Ø over 300 km (there are 40 of them). All of these are the result of asteroid-impacts, subsequently filled with lava. Most mountains on the Moon are ring walls around these impact sites. The asteroid bombardments in the young Solar System ended c. 3.8 bn years ago and the Moon's own geological activity died out c. 3 bn years ago. Since then the Moon is geologically dead.

4. About the Moon's formation:

Most popular theory: impact of a Mars-sized object with the Earth c. 4.5 bn years ago. Moon was formed out of the debris, both from the Earth's crust and from the meteorite.

Which new elements brought the Space Travel Era (since c. 1960)?

- We could finally observe the 'back' of the Moon
- We could get a proper impression of what the 'moonscape' really looked like
- We could map the Moon in much greater detail than before
- We could bring rocks from the Moon to Earth and study them in laboratories.

