

U3A- GROUP ASTRONOMY (26-1-2007)

How eventually the Earth was removed from the centre of the Universe

Ancient Greeks like Aristarchus were the first ones to develop a heliocentric model of the Universe, but nobody believed them. Until c. 1500 the ancient ideas with the Earth in the centre (Aristotle, Ptolemy) remained the basis of astronomy. But then came:

Copernicus (Mikolaj Koppernik, 1473-1543)

Born in Torun (N.Poland). He found Ptolemy's model of the Universe far too complicated to be correct and concluded that several movements of objects in the sky were far easier explained in a *heliocentric* Universe. Around 1514 he wrote a small (20 pp) booklet *Commentariolus* ('Little Commentary' – never published, only a small number of handwritten copies) - in which he described his ideas. For instance:

- Not the Earth but the Sun is the centre of the Universe
- The distance from the Earth to the Sun is insignificant compared with the distance to the stars
- The apparent daily motion of the stars is the result of the Earth's rotation on its own axis
- The apparent annual sequence of movements of the Sun is the result of the Earth's revolution around it.
- All the planets revolve around the Sun
- The apparent retrograde motion of some of the planets is merely the result of our position as observer on a moving Earth.

Few people read his pamphlet, but Copernicus started to elaborate on his ideas, which – after 30 years - resulted in a book of over 400 pages, *De revolutionibus orbium coelestium* (On the Revolutions of the Heavenly Spheres). It was published in 1543, .about a month before Copernicus died. Again, not many people read the book as it was very complicated and rather poorly written. So Copernicus did not receive much praise or recognition for his very important work. Some astronomers only believed part of his model, for instance:

Tycho Brahe (1546-1600)

A Danish nobleman who believed that the planets (except the Earth) orbit the Sun, but the Sun + planets orbit the Earth! Earth remained the centre! He became famous thanks to his fantastically accurate observations (5 times as accurate as available until then – without telescopes!). In 1588 Brahe moved to Prague, where he met:

Johann Kepler (1571-1630)

He believed in Copernicus and wrote a book to defend him. He also moved to Prague, where he became Tycho Brahe's assistant. After two years Brahe died and Kepler inherited the notes on his brilliant observations. On the basis of these he developed his likewise brilliant 'laws' about the orbits of the Planets around the Sun. He discovered that these orbits are not circles, but ellipses (almost circles!), with the Sun in one of the foci. Thus the distance between Planet and Sun varies, and so does the Planets' speed. This brought to perfection Copernicus's model and it provided a complete and accurate vision of our Solar System.

The findings were published in a substantial book in 1609 (66 years after Copernicus's death), but still most astronomers and philosophers and the Church refused to believe them.

But in the meantime "The Father of Science" had been born in Pisa:

Galileo Galilei (1564-1642)

Tremendous curiosity, took nothing for granted, but wanted proof of everything. In 1609 he heard about the invention of the telescope (Hans Lippershey, 1608) and soon began to build them himself, seeing the big importance for astronomy. He started to look at the Moon and was the first person to see its rugged surface. In January 1610 he discovered the four (largest) moons of Jupiter. Very important: *not everything orbits the Earth!* In the autumn of the same year he saw the phases of Venus, which had been predicted by Copernicus. He also saw that through his telescope the planets were visible as little discs, but that all the stars remained dots → much further away (as suggested by Copernicus).

He corresponded with Kepler and both agreed with each other's ideas, so it looked as if there was no doubt at all left about the correctness of Copernicus' model. But many astronomers still did not want to believe it (some even refused to look through Galileo's telescope). In 1616 the RC Church declared the model of the sun-centred Universe as heretic and Copernicus' *De Revolutionibus* was put on the index. Galileo wrote a very popular book *Dialogo* (Dialogue on the two chief World Systems). In 1633 Galileo was summoned to appear for the Inquisition, and was sentenced to infinite house arrest. He was ordered to recall his theory in an official lecture and the *Dialogo* was put on the Index. He died in 1642 and was refused a burial in consecrated ground.

Nevertheless more and more astronomers began to believe in the new model of the Universe. But it had taken about a century and a half since Copernicus published his 20-page leaflet *Commentariolus*.

(In the 1990's Pope John Paul II 'rehabilitated' both Galileo and Copernicus).