COSMOLOGY - its history

By MIKE MACKINNON

Dedicated to my brother, Tim . . .

Where are we in this vast universe? Cosmology (study dealing with origin and structure of the universe) is the only answer to this question. Early cosmology existed in its simplest form. The Earth was supported on the backs of three huge elephants which stood on the shell of a tortoise. To the Egyptians the universe was a universal Nile which provided the path for the travels of the sun god, Ra.

Our views of the universe have changed to become what they are now — the scientific views of the twentieth century. Here now is a short look at the history of the study of the universe through the more important scholars of this area of study.

PHYTHAGORAS

From Pythagoras came the principle of Pythagorean philosophy which is the correspondence between numbers and mechanical nature. His ideas of "rational numbers" were adopted as the basis for describing the universe. He is considered to be the father of science. From him came the first clear ideas of the fundamentals of the methods of science; methods which used mathematical formulism to explain the phenomena of the universe.

To him the planets appeared to travel in orbits rather than in the unorganized patterns which they were believed to travel in at the time. He believed that the earth was a sphere and not a disc floating in air. It was Pythagoras who came up with the concept of the Sun, the moon and the other planets, travelling around the Earth, a concept later dispelled by Copernicus. The universe was thought to be filled with air.

Although Pythagoras' theory about the movement of the planets was wrong, he was right in saying they obey some laws in their movements.

PHILOLAUS

Pythagoras ran into trouble in the middle of the fifth century BC, when it was found that more than whole numbers were needed to explain the planet movements. This seemed to be the end of harmonious planet movement. There were also political problems at this time which resulted in the dissolution of the brotherhship. The leading members later returned to go on with their studies and teachings. Among them was Philolaus.

He was in fact the first one to question the concept of Earth as the center of the planetary system. He thought the center was somewhere else and had a picture with a central fire around which orbited the Earth, the moon, the sun and then the other five known planets. What is important about his study is the concept of a moving Earth.

PLATO

All the scientists before Plato used simple observation of the heavens to come up with explanations of this phenomena. They were not all that concerned with why they moved, just how they moved. Plato wanted a principle capable of explaining the whole system.

Plato decided the Earth was a perfect sphere and its movements along with the movements of the other bodies, was a perfect circle. Also, their speeds would be constant.

ARISTOTLE

Aristotle presented Plato's theory in such a manner that it was appealing not only to man's reason but also to his heart. Other problems concerning philosophers at the times: is the universe constant or is it always changing and was water or air the material cause of things.

Aristotle devised a system where the Earth was at the center of the system followed by nine transparent, concentric spheres which were at increasing distances from the previous ones. These spheres belonged to a body in the following order: the Moon, Mercury, the Sun, Mars, Jupiter, Saturn and the stars. The final outer sphere belonged to God.

Aristotle thought that everything above the Moon's sphere was eternal, remained constant and was unchangeable while everything below this sphere was tainted and temporary, constantly changing.

The lower region was made up of earth, air, water and fire. These four elements were combined with opposites such as cold and heat, dryness and wetness and moved in fixed patterns. The patterns were: earth from top to bottom, water from bottom to top and fire and air moved horizontally.

In the upper region a fifth element, ether, was combined with the first four.

This conception of concentric spheres with Earth at the center was the dominant concept of science at the time with the exception of one Greek who put forth an idea that was not to be accepted until seventeen centuries later. This Greek was Aristarchus of Samos.

ARISTARCHUS

Aristarchus regarded the Sun as the centre of the solar system and not the Earth. This idea was not taken very seriously by the philosophers of the time. He thought the Sun and the sky were stationary and that the Earth described an oblique pattern in its orbit of the Sun. He was obviously the forerunner of the ideas accepted after the studies of Copernicus, Kepler and Newton. Why was this concept that is so obviously brilliant rejected for the old Aristotelian theory?

Aristarchus could not find any proof to substantiate his theory. His arguements did have the merit of simplicity though, a quality which was important to Albert Einstein.

MODERN ASTRONOMERS

COPERNICUS

Copernicus is the first of the five pioneers that opened the eyes of the world to the real set-up of the universe. His work is considered the start of the Renaissance scientific movement. The main point of his argu ments is that the Earth is not the centre of the solar system; it was just another planet in a string of planets orbiting the sun, the true center of the system. For a long time no one knew of the findings of Corpernicus (not until he was almost seventy years old). Even then it took the urgings of his younger scholars to make Copernicus publish his work.

As was previously mentioned the focal point of Copernicus' work was that the Earth was rotating around the Sun and not vice versa. The book that contained his theories was called "The Book of Revolutions" and in the preface of the book Copernicus states that the reason he did not publish his book until late in his life was that he feared he would be ridiculed for his radical ideas.

"Yet in considering this subject, the scorn which will be directed for my new and (apparently) absurd opinions has failed to make me abandon my project."

RHAETICUS

It was at this time that Rhaeticus arrived on the scene. He was a twenty-four year old professor of mathematics and held the chair of mathematics and astronomy at the University of Wittenberg. Rhaeticus preferred the theory of Aristarchus to the theories of an Earth-centered universe. He heard about Copernicus and took a leave of absence from the university to talk to him.

Because of Copernicus' reluctance to publish his book, Rhaeticus decided to publish a book summarizing the findings of Copernicus. This he did in a seventy-six page book that did not mention the name of Copernicus once.

Although this book was a brilliant summarization of Copernicus' findings it did not satisfy scholars who followed Copernicus' teachings. They cried for the publishing of Copernicus' book. This prompted him to have another meeting with Rhaeticus and in the following spring Rhaeticus did not go back to classes but started to re-write the tables and manuscript of Copernicus' book.

COPERNICUS WORLD SYSTEM

Copernicus had the Sun at the centre of the solar system with the planets orbiting it in the following order: Mercury, Venus, Earth, Mars, Jupiter and Saturn. The Earth was orbited by the Moon and also turned on itself. This accounts for the regular alternation between day and night.

KEPLER

Kepler's greatest contribution to astronomywere his two laws of planetary motion. His first law is that the planets orbit the Sun in ellipses, with the Sun occupying one focus of the ellipse. His second law is the radius vector line joining the centre of the planet to the centre of the sun sweeps out equal areas in equal time. This is often called the Laws of Areas.

It took Kepler six years of work before coming to these conclusions. It was almost another six years before his book, "New Astronomy" was published with these findings.

His ideas of elliptical orbits were not easily accepted and even Galileo preferred the idea of perfectly round orbits.

GALILEO

One common misbelief is that Galileo invented the telescope. He was not the person who invented it but he did perfect it and used it a lot in his studies. With the help of the telescope Galileo discovered four of Jupiters moons, a discovery which earned him the position of Chief Mathematician and Philosopher to the Medicis, in Florence.

In his book, "The Sidereal Messenger", Galileo through his discoveries, supports the theories of Copernicus. One example is his proving that Venus does in fact go around the Sun. He pointed out that the phases of Venus are dependent on the position of Venus with respect to the Sun. The only way that Venus could get into these positions is to orbit the Sun.

Many of Galileo's ideas were attacked; first by jealous professors and then by the Church. His brilliance allowed him to easily prove his opponents wrong time after time and therefore the ranks of his enemies were always growing. The way he was beaten was by drawing him into arguements about the work system and thereby causing him to refute Biblical statements. Because of this anything published on the world system was confiscated. This did stop the teaching by philosophers who believed in this system though.

The publishing of his book "Dialogues" in 1632 completely angered the Church. This book too was confiscated and Galileo was ordered to stand trial. After his trial, Galileo wrote his third and most valuable book "Discourse on the New Sciences". In 1637 he lost his sight and at the age of seventy-eight he died.

DESCARTES

Although the Copernican system had been adopted there were still those who had doubts about it and opposed it. The trial of Galileo caused Rene Descartes to delay the publishing of his book "Le Monde", in which he presented his rules for studying the universe. The book was not published until twelve years after his death. In this book Descartes outlined his principles of cosmology. His first principle is the anxiomatic principle of the principle of reason. His second principle was the geometrisation of physics or applying reason to the geometry of physics. The last principle was the principle of conservatism.

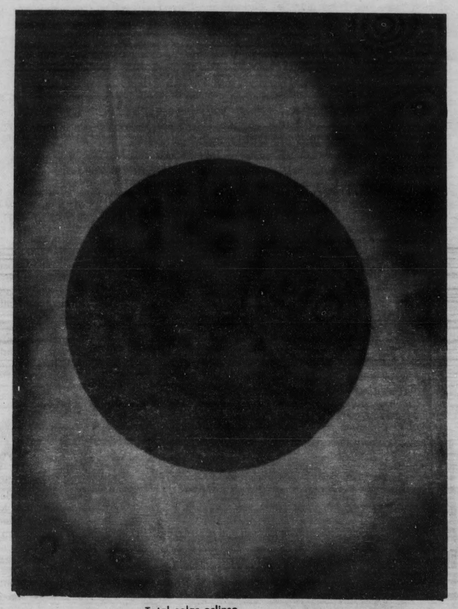
NEWTON

Newton, as is commonly known, discovered the effect that two bodies have on each other, or more specifically, gravity. Whether an apple fell on him or not is not known but it is known that after observing the effects of gravity it took Newton twenty years to derive the mathematical law of gravity. Newton's laws are famous to even those who have no inclination towards science at all. His work cleared up many misunderstandings that people had of the world and the universe. The riddle of comets had now been solved, the world now understood and believed the Copernican world system and astronomers could gaze at the moons of Venus and Jupiter.

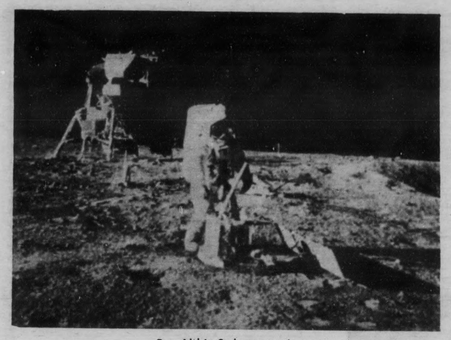
Newton tied in much of the knowledge that has been gathered in the last two thousand years and had solved many of the universe's mysteries. He refined Galileo's dynamics, proved Kepler's three laws and invented calculus, a mathematical tool that is very powerful in analysis and falling university students.

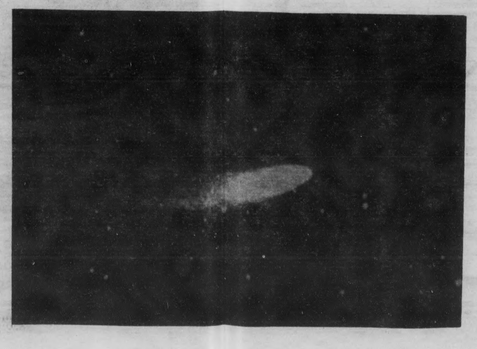
Other great scientists were to follow: John Heschel, the founder of the science of spectroscope analysis; Einstein, with his studies of relativity, gravity and the universe; Neils Bohr and others. Although many questions have been answered about the universe there are still many unanswered questions.

"Then came a change, as all human things change." — Alfred Lord Tennyson



Total solar eclipse.



Buz Aldrin 2nd man on the moon.

One of the universes many Nebula.