ASTR/PHYS109 2008 : THE COSMOS
Lecture Topics Covered for :
Models of the Universe, Our Galaxy, More Galaxies, Cosmology, Life

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Topics Term 4 to September 26

1. Early ideas of the Cosmos

Early temples/structures to record the motions in the sky of sun moon planets & stars: many exist - examples - Mayan temples (Mexico), Bighorn (Wyoming USA), Stonehenge (England) etc.

The models and work (with approximate dates) of:
Thales -600 BC
Anaximander - 560 BC
Eudoxus (crystal spheres model) - 300 BC
Eratosthanes - measured size of the Earth - 250 BC
Aristarchus - estimated distance to the Moon - 200 BC
- attempted to measure distance to the Sun.
Ptolemy - complied work of the earlier Greeks and recorded star positions - 150 AD
Copernicus sun-centred circular orbits model of solar system - 1520 (d 1543)
Tycho Brahe - made accurate measurements of planets (particularly Mars) - 1580
Kepler - used Tycho Brahe measurements, summarized laws of planetary motion -1600
Galileo - how bodies move; observed Jupiter's satellites as miniature solar system 1630
Measurement of distance of Mars (1672) provided scale of solar system.
Newton - idea of universal gravity as reason for all motion in the Cosmos - 1680
Halley - (1680) used gravity idea to predict the return of Halley's comet in 1749
Newton's gravity model accurate enough to predict motions of planets and comets in the solar system – example of orbit of Comet captured by Jupiter and collides with Jupiter.
Einstein's Relativity model (1905-15) later able to described motions more fundamentally.
Transit of Venus gave method provided the Earth-Sun distance 1769 and 1875
Herschel - (William) measured star positions; model of our Galaxy - 1780
Wright - (Thomas) early idea of many galaxies (island universes) - 1780
Distance to a star first measured by method of parallax 1838.

2. Our Galaxy

The appearance of the night-sky in New Zealand,.
Bands of light - zodiacal light and the Milky Way.
Milky Way is the plane of our Galaxy;
Appearance of the stars over the sky results from our position in the Galaxy.
William and Caroline Herschel (1790) made counts of the numbers of stars in all directions in the sky - to map the shape of our Galaxy and estimate the Sun's position relative to the

centre.
The effect of absorption (and “reddening") of starlight by interstellar dust (presence unknown in Herschels' time) complicates the method: they deduced Sun at centre – which is incorrect - we are about half way out and near the galactic plane.

Star distances measured by methods of –
Parallax,
RR Lyrae pulsating stars,
Cepheid pulsating stars.
Star spectrum tells us start temperature, type and so star's luminosity.
For a cluster we know the brightest star must have maximum luminosity

Reddening of starlight tells us the size of dust grains in interstellar space.
Spectrum features tell us what the dust is composed of.
Dust together with gas formed our Solar System.

Clouds of atomic hydrogen mapped by using radiowaves - emission produced by electron/proton spin changes.
Radio telescopes measure Doppler shift to measure hydrogen cloud speeds enables mapping the spiral arms of the Galaxy.

Spiral Arms – H, dust, hot stars, excited H emission nebulae, molecular clouds.
How the red light is produced in H emission nebulae.
How the blue light is produced in a reflection nebula

Complex molecules in interstellar space - e.g CO carbon monoxide, H_2O water, NH_3 ammonia, CH_4 methane, H_2CO formaldehyde and more complex hydrocarbons like methanol - in molecular clouds. Consequences for life-formation.
Detection of these molecules by radio-telescopes.

Content of Galaxy is about 10^{11} stars.

Percent composition = H (70%), He (28%) heavy atoms 2% (mainly as dust).

How to measure the mass of our Galaxy – we need to measure the velocity of and distance from galactic centre of luminous objects (or of H clouds using radio).
Need to use the relation between speed of rotation and distance.

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