PHYSICS 1020

Homework set 1

8 January 1997

[**1.4**] Describe an unaided-eye observation you could make to disprove the theory that the planets orbit Earth in a simple uniform circular motion.

Answer:

Follow the motion of a planet by recording its position relative to the stars. The change of direction of this motion ("retrograde motion") would provide evidence that the orbit is not on a circle centered on Earth.

[**1.6**] In seeking an explanation of retrograde motion, why didn't the Greeks just allow the planets to change their speed and direction of motion as the planets moved along circular paths around Earth, instead of resorting to circles within circles?

Answer:

Assuming that planets simply changed their speeds and direction along a circular path would be an "ad hoc assumption" to describe apparently irregular motion; a theory based on such an assumption would have no underlying pattern, and thus would not have any predictive power. The Greeks and scientists after them looked for an underlying regular pattern that would explain the apparently irregular observed motion.

[**1.8**] Use Copernicus' theory to predict whether Mars goes through moonlike phases. Do we ever see a "new Mars"?

Answer:

From Copernicus' theory (See figure 1.15), Mars appears "full" when we see all of that side of Mars which is illuminated by the Sun. This happens when it is farthest from Earth (directly on the far side of the Sun), and also when it is closest to Earth. At other times, Mars will appear less than full, but there would never be a "new Mars", or even a "crescent Mars". So, Mars goes through partial phases, but does not show all the phases that the Moon shows.

[**1.11**] Would Kepler's theory have agreed with the data available in Ptolemy's time? In Copernicus' time?

Answer:

It was only the presision of Tycho Brahe's data on planetary motion that allowed Kepler to realize that there was disagreement between the observations and the positions of the planets expected from Copernicus' model. Since the observation data available at the time of Ptolemaeus, as well as that of Copernicus were much less precise than those available to Kepler, his theory would also have agreed with those less precise data.

[**1.23**] Since there are some 100 billion stars in a typical galaxy and since there are at least 100 billion galaxies in the known parts of the universe, how many stars are there in all? Write out this number.

Answer:
One billion = 10^9, so 100 billions = $10^9 \times 10^2 = 10^{11}$; 100 billions times 100 billions = $10^{11} \times 10^{11} = 10^{22}$, i.e. a one followed by 22 zeroes:
(10 000 000 000 000 000 000 000)

[**1.24**] The 1 million galaxies shown in fig.1.29 represent only a tiny fraction of the 100 billion galaxies in the known part of the universe. How tiny? Write your answer as a decimal number.

Answer:
The fraction is one million divided by 100 billion =

$$\frac{10^6}{10^{11}} = 10^{-5} = \frac{1}{10^5} = \frac{1}{100000} = 0.00001$$