INST 2403 Activity

Retrograde Motion

Usually, planets drift eastwards along the ecliptic. In other words, they move just like the sun and sun moon with respect to the stars. This is known as *prograde motion*. From time to time, a planet will slow down and reverse its normal motion with respect to the stars. This westward drift is called *retrograde motion*. It is important to note that regardless of this slow motion with respect to the stars, the planet will move fast from east to west due to the rotation of the celestial sphere. Planets always rise in the east and set in the west.

To get a sense how this works, consider the table below detailing Mars's changing celestial coordinates in 2003. In 2003 Mars came historically close to Earth (of course, still being about 60 million km away). The region of the sky between 21h and 0h of *right ascension (RA)* or *celestial latitude* just south of the celestial equator (i.e. slightly negative *declination* or *celestial latitude*) is occupied by the zodiac constellations *Capricornus* and *Aquarius*. So Mars appeared in these constellations which lie along the *ecliptic*, i.e. the sun's apparent path among the stars.

	Date	RA (Cel. Longitude)		Declination (Cel. Latitude)
1.	May 15, 2003	21 h 06 m		- 18° 43' ← $43' = \left(\frac{43}{60}\right)^\circ \approx 0.75^\circ$
2.	June 1, 2003	21 h 43 m	increasing RA	- 16° 36'
3.	June 15, 2003	22 h 10 m	= prograde motion	- 15° 00'
4.	July 1, 2003	22 h 35 m		- 13° 37'
5.	July 15, 2003	22 h 49 m		- 13° 05'
6.	Aug 1, 2003	22 h 56 m		- 13° 29'
7.	Aug 15, 2003	22 h 50 m	decreasing RA	- 14° 36'
8.	Sep 1, 2003	22 h 34 m		- 16° 04'
9.	Sep 15, 2003	22 h 21 m	= retrograde motion	- 16° 30' ← $30' = \left(\frac{30}{60}\right)^\circ = 0.5^\circ$
10.	Oct 1, 2003	22 h 16 m		- 15° 41'
11.	Oct 15, 2003	22 h 21 m		- 13° 59'
12.	Nov 1, 2003	22 h 39 m	increasing RA	- 11° 01'
13.	Nov 15, 2003	23 h 01 m	= prograde motion	- 8° 4'

1. Plot the position of Mars in the graph on the next page. See graph.

2. During which time period was Mars moving prograde?

   May 15 – August 1, then again from Oct 15 on

3. During which time period was Mars moving retrograde?

   August 15 – Oct 1

4. How long was Mars moving retrograde?

   6 weeks

$22^h56^m - 22^h16^m = 40^m$

5. How big is Mars's retrograde loop?

Clearly impossible to tell in miles or km, but about $40^m = \frac{40}{60} \times 15^\circ = 10^\circ$ in RA

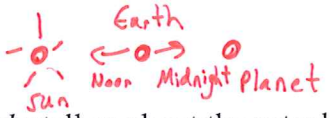
$15^\circ = 1^h$

6. Where did Mars rise on the day of opposition, i.e. in the middle of its retrograde motion?

Rising always occurs on the eastern horizon.

7. Define the term opposition – what does it mean for a planet to be in opposition?

Planet is opposite of the sun.



8. What does the apparent motion of Mars *in the sky* tell us about the actual motion of Mars *in space*?

Not much without a theory/explanation of what is "really" happening.

9. What maximal altitude does Mars (at opposition) reach in the sky of an observer at 40° N?

Celest. Eq. at 40°N is 50° above S horizon, Mars is at −15° dec, so $50^\circ - 15^\circ = 35^\circ$.

10. Where in the sky is Mars when it reaches maximal daily altitude?

Max altitude always on meridian, here South.

11. At what time does this happen?

At opposition at midnight, see 7.

12. Is the intersection of the celestial equator and the ecliptic the vernal or autumnal equinox?

Spring equinox. As the sun moves eastward to higher RA, it will go from below the Cel. Eq. to above the CE.