



On May 31, 2012 the Grail 'Ebb' spacecraft and the Lunar Reconnaissance Orbiter (LRO) will come very close to each other in their orbits around the moon. LRO is in a polar orbit, while Grail Ebb is in an equatorial orbit. Although there is no scientific value in the encounter, it does represent one of the first times that two NASA spacecraft orbiting the same astronomical body have passed so close to each other, and with the capability of actually seeing each other.

Time	Distance	Time	Distance
4:00:38	190	4:01:23	110
4:00:42	180	4:01:35	105
4:00:46	170	4:01:46	110
4:00:51	160	4:01:56	120
4:00:56	150	4:02:03	130
4:01:01	140	4:02:09	140
4:01:07	130	4:02:14	150
4:01:14	120	4:02:20	160

The table to the left gives the encounter times in the afternoon (Eastern Standard Time in hours, minutes and seconds) and distances (in kilometers) between the spacecraft.

**Problem 1** – At what time were the spacecraft at their closest distances from one another?

**Problem 2** – About how fast, in kilometers/hour was the distance between them changing just before closest approach?

**Problem 3** - Calculate the elapsed time of the encounter since 4:00:38 in seconds. Graph the tabular data in terms of elapsed time in seconds and distance in kilometers. What shape does the plotted curve resemble?

**Problem 4** - The Grail 'Ebb' spacecraft will attempt to take a picture of LRO. At a distance of 50 kilometers, Grail/Ebb can just resolve an object if it is 8-meters across. That means that the angle corresponding to 8 meters at a distance of 50 kilometers is just large enough to be discerned by Grail. The LRO spacecraft is about 4 meters across. Using simple proportions, and the fact that the angular size of an object is inversely proportional to its distance, will Grail be able to see any details on the LRO spacecraft at the time of closest approach?