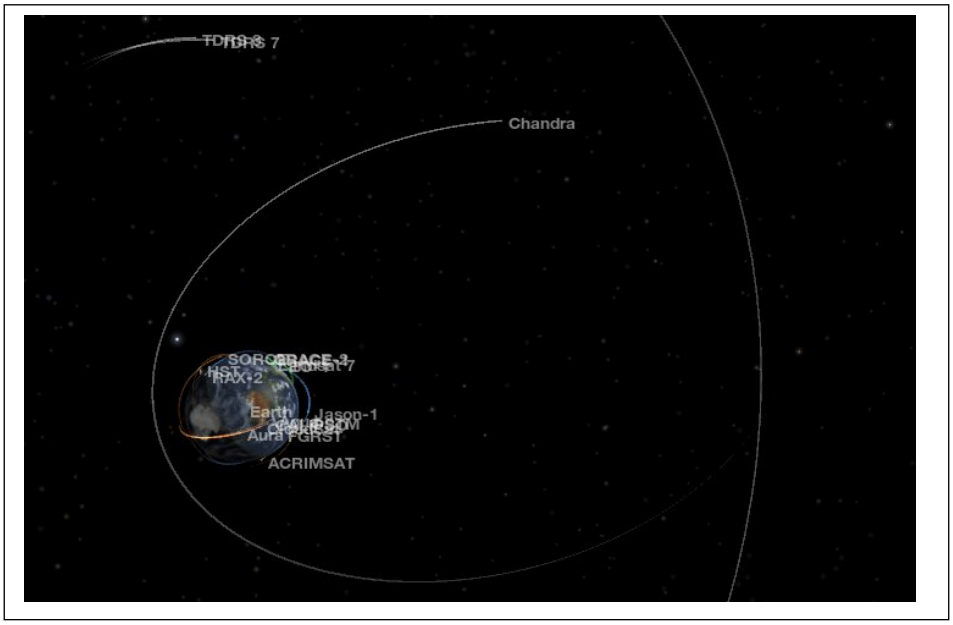
Eye Spy – Exploring the Chandra Spacecraft Orbit



Get the Data

Visit EOSS **http://1.usa.gov/MMAng9** to recreate the scene shown above. Recommended operating system: MS Vista or later; Browser: MS Internet Explorer 8 or later.

Step 1 – Click on the 'Visual Controls' tab and make sure that the following items are selected with a 'white spot': spacecraft, planets, labels, orbit lines, trails and metric.

Step 2 - Activate the Distance Measuring tool and measure the distance between Chandra and Earth for 17 points along the orbit separated by 2 hours in time starting on June 19, 2012 at 10:00 AM. Note the time in the 'Date and Time' window. The next measurement would be 2 hours later on June 19, 2012 at 12:00 PM. Enter the distance and time data into a two-column table. You may indicate the time as multiples of 2 hours rather than clock time.

Answering Questions

On July 23, 1999 the Chandra satellite was launched into an elliptical orbit around Earth. The image above from *Eyes on the Solar System* shows a portion of the orbit track along with other spacecraft nearby.

Problem 1 – What expression would give the distance, D, from the center of Earth to Chandra during its first two hours of travel, (T=2) starting at June 19, 2012 at 10:00 AM?

Problem 2 – What expression would give the distance, D, from the center of Earth to Chandra during its last two hours of travel, (T=30) starting at June 20, 2012 at 4:00 PM?

Math Challenge

The table gives information about one-half of the orbit of the Chandra satellite. A full orbit takes the spacecraft from its farthest distance to its closest distance and back to its farthest distance. The time required for a full orbit is called the orbit period.

A) What is the orbit period, P, for Chandra in hours?

B) Write an expression that gives the elapsed time, T, in hours when Chandra returns to its closest distance in the table after N orbits.

Answer Key

Hours	Time	Distance (km)	Hours	Time	Distance (km)
0	6/19/2012 10:00AM	3,473	22	6/20/2012 8:00 AM	135,800
2	6/19/2012 12:00 PM	28,750	24	6/20/2012 10:00 AM	139,400
4	6/19/2012 2:00 PM	50,240	26	6/20/2012 12:00 PM	142,100
6	6/19/2012 4:00 PM	67,220	28	6/20/2012 2:00 PM	144,000
8	6/19/2012 6:00 PM	81,270	30	6/20/2012 4:00 PM	145,100
10	6/19/2012 8:00 PM	93,180	32	6/20/2012 6:00 PM	145,400
12	6/19/2012 10:00 PM	103,300			
14	6/20/2012 12:00 AM	112,100			
16	6/20/2012 2:00 AM	119,600			
18	6/20/2012 4:00 AM	126,000			
20	6/20/2012 6:00 AM	131,400			

Problem 1 – What expression would give the distance, D, from the center of Earth to Chandra during its first two hours (T=2) of travel starting at June 19, 2012 at 10:00 AM? **Answer:** Between T = 0 and T = 2 hours, the distance changed from 3,473 km to 28,750 km, which is a difference of 25,277 km, but this happened over the course of T=2 hours, so the expression would be D = (25277 / 2) T or **D = 12638 T.** Note: 12,638 is the radial speed of the spacecraft in kilometers/hour

Problem 2 – What expression would give the distance, D, from the center of Earth to Chandra during its last two hours of travel, (T=30) starting at June 20, 2012 at 4:00 PM? Answer: Between T = 30 and T = 32 hours, the distance changed from 145,100 km to 145,400 km, which is a difference of 300 km, but this happened over the course of T=2 hours, so the expression would be D = (300 / 2) T or **D = 150 T**. Note: 150 is the radial speed of the spacecraft in kilometers/hour.

Math Challenge - The table gives information about one-half of the orbit of the Chandra satellite. A full orbit takes the spacecraft from its farthest distance to its closest distance and back to its farthest distance. The time required for a full orbit is called the orbit period.

A) What is the orbit period, P, for Chandra in hours? Answer: The time between 6/19/2012 10:00AM and 6/20/2012 6:00 PM is 32 hours, so the period is twice this to get back to the minimum distance or **P = 64 hours**.

B) Write an expression that gives the elapsed time, T, in hours when Chandra returns to its closest distance in the table after N orbits. Answer: **T = 64N**.