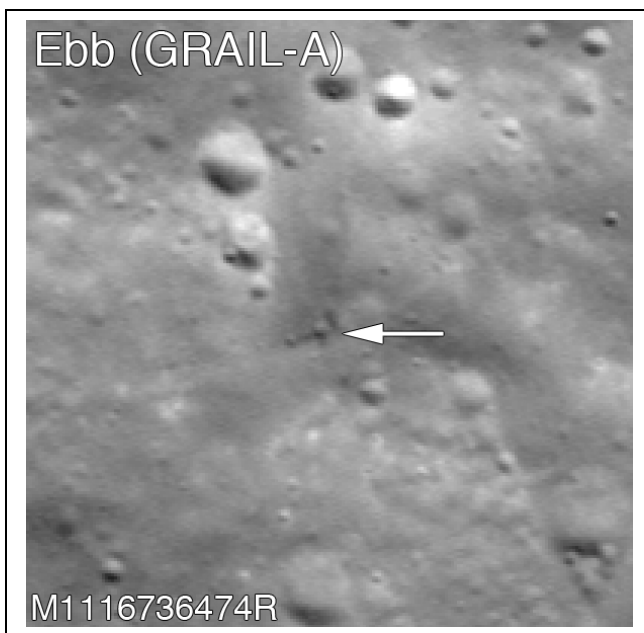


On December 17, 2012 each of the twin Grail spacecraft ended their lunar mapping missions by crashing into the lunar surface. The two images to the left were taken by the Lunar Reconnaissance Orbiter as it flew over the impact site for the Grail-A spacecraft.

The width of each image is 213 meters.

At the moment of impact, each Grail spacecraft was traveling at a speed of 6,070 km/h and carried a mass of 200 kg.



Problem 1 – What was the diameter, in meters and feet, of the crater left behind when Ebb impacted the surface?

Problem 2 – The diameter of the Grail spacecraft was about 1-meter. How many times larger was the crater than the spacecraft?

Problem 3 – For the largest crater in the image, how large would the meteorite have to be to make the crater assuming it has the same density as Grail?

Problem 4 – Assume that the crater was a cylinder with a depth $\frac{1}{4}$ its diameter. If the density of the lunar soil is 2700 kg/m^3 , how many kilograms of lunar soil were excavated by the impact?

Problem 5 – What is the ratio of the excavated mass to the spacecraft mass?

NASA's LRO Sees GRAIL's Explosive Farewell

http://www.nasa.gov/mission_pages/LRO/news/grail-results.html

Problem 1 – What was the diameter, in meters and feet, of the crater left behind when Ebb impacted the surface?

Answer: Use a millimeter ruler to measure the width of the image. You should get about 80 mm .The scale is then 213 meters/80 mm = 2.7 meters/mm. The crater is about 1mm across so this is just **2.7 meters**. Since 3 feet = 1 meter, this is about **8 feet across**.

Problem 2 – The diameter of the Grail spacecraft was about 1-meter. How many times larger was the crater than the spacecraft?

Answer: About **2.7 times larger**.

Problem 3 – For the largest crater in the image, how large would the meteorite have to be to make the crater?

Answer: The largest crater is about 9 mm across or 24 meters. Using Grail, we get 24 meters/2.7 = **8.9 meters across**.

Problem 4 – Assume that the crater was a cylinder with a depth $\frac{1}{4}$ its diameter. If the density of the lunar soil is 2700 kg/m^3 , how many kilograms of lunar soil were excavated by the impact?

Answer: Volume = $\pi R^2 h$ so $V = 3.14 \times (2.7/2)^2 \times (2.7/4) = 3.8 \text{ meters}^3$.
Mass = density x volume so Mass = $2700 \times 3.8 = \mathbf{10,000 \text{ kilograms}}$.

Problem 5 – What is the ratio of the excavated mass to the spacecraft mass?

Answer: 10,000 kilograms/200 kg = **50**.

So the amount of excavated mass is 50 times the mass of the impacting spacecraft.