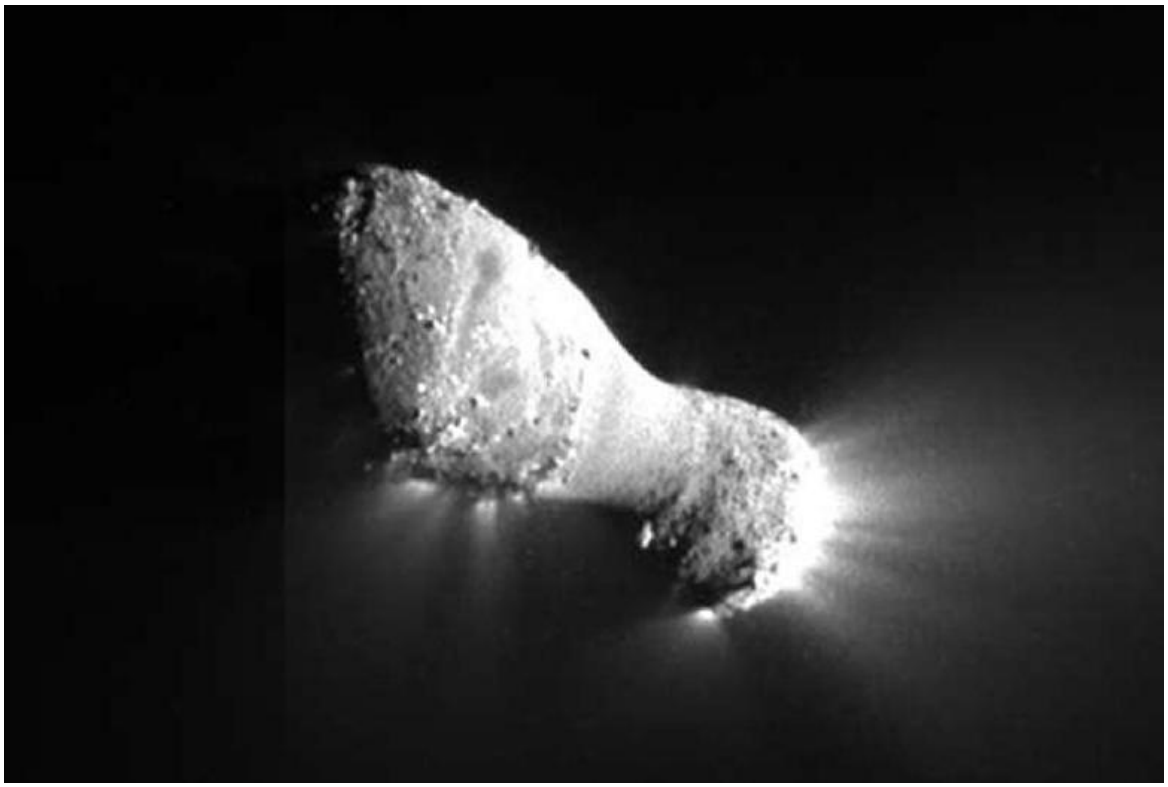


Comet Hartley 2 is seen in this spectacular image taken by the Deep Impact/EPOXI Medium-Resolution Instrument on November 4, 2010 as it flew by the nucleus at a distance of 700 kilometers. The pitted surface, free of large craters, shows a complex texture in regions where gas plumes are actively ejecting gas. The potato-shaped nucleus is 2 kilometers long and 0.4 kilometers wide at its narrowest location. (Credit: NASA/JPL-Caltech/UMD).

Problem 1 - Suppose that the shape of the comet nucleus can be approximated by the following function

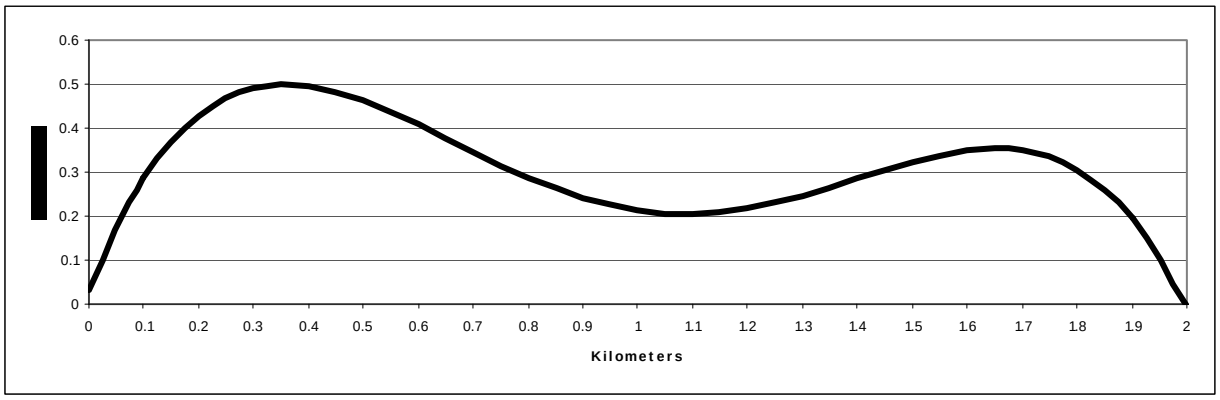
$$y(x) = -1.22x^4 + 5.04x^3 - 6.78x^2 + 3.14x + 0.03$$

rotated about the x-axis between x=0 and x=2.0, where all units are in kilometers.
A) Graph this function;
B) Perform the required volume integration by using the method of circular disks.
C) To two significant figures, what is the total volume of the nucleus in cubic meters?

Problem 2 - Assuming that the density of Comet Hartley-2 is 0.6 grams/cm^3, what is your estimate for the mass of Comet Hartley-2 in megatons? (Note: 1000 kg = 1 metric ton)

Problem 1 - Answer:

A) Graph:



B)

$$V = \int_0^2 \pi y(x)^2 dx \qquad \text{then} \qquad V = \pi \int_0^2 \left(-1.22x^4 + 5.04x^3 - 6.78x^2 + 3.14x + 0.03\right)^2 dx$$

Expand integrand and collect terms (be careful!):

$$V = \pi \int_0^2 \left(1.49x^8 - 12.30x^7 + 41.94x^6 - 76.00x^5 + 77.55x^4 - 42.28x^3 + 9.46x^2 + 0.18x + 0.0009\right) dx$$

Integrate each term:

$$V = \pi \left[0.17x^9 - 1.54x^8 + 5.99x^7 - 12.67x^6 + 15.51x^5 - 10.57x^4 + 3.15x^3 + 0.09x^2 + 0.0009x + c\right]_0^2$$

Now evaluate V(x) at the two limits to get V = V(2) - V(0): Note that the answer for V will be sensitive to the accuracy of the polynomial coefficients, here given to 4 decimal place accuracy:

V=(3.14)[0.1655(2)^9 – 1.5375(2)^8 +5.9914(2)^7 – 12.6667(2)^6 + 15.51(2)^5 – 10.57(2)^4 +3.1533(2)^3 + 0.09(2)^2 + 0.0009(2)]

V = 3.14[0.157]

So **V = 0.49 cubic kilometers**.

Problem 2 - Mass = Density x Volume; First convert the volume to cubic centimeters from cubic kilometers: V = 0.49 km^3 x (10^3 meters/1 km)^3 x (100 cm/1 meter)^3 = 4.9 x 10^{14} cm^3. Then, Mass = 0.6 gm/cm^3 x 4.9 x 10^{14} cm^3 = 2.9 x 10^{14} gm**.** Convert grams to megatons: Mass = 2.9 x 10^{14} gm x (1 kg/1000 gm) x (1 ton/1000 kg) = 2.9 x 10^8 tons or **290 megatons**.