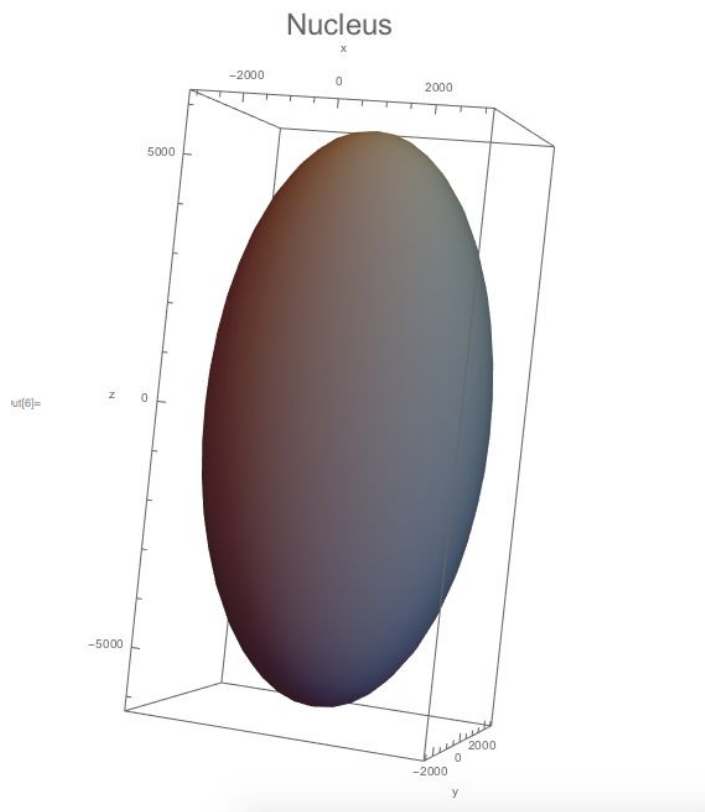


1. Introduction:

Space exploration is in high demand, as we learn new properties about our planet and solar system. It is important that we study objects to reveal our past and what the future of our planet could hold. Our mission for this project is to study properties of a comet. We will explore things like mass, potential gravitational energy and so on. As well as studying properties we will analyze sending a lander to the nucleus of a comet and sending an orbiter around the comet to collect coma dust.

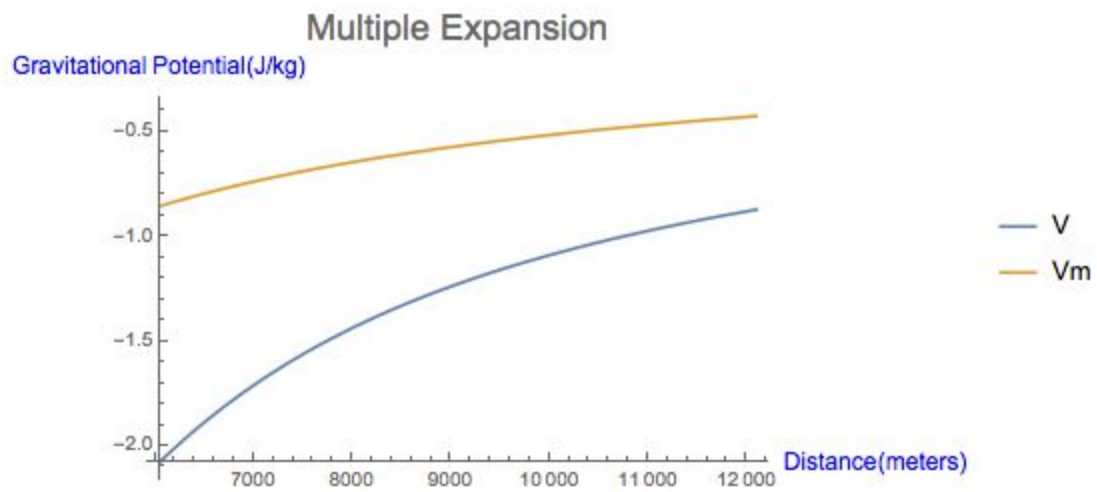
2. Comet Properties:



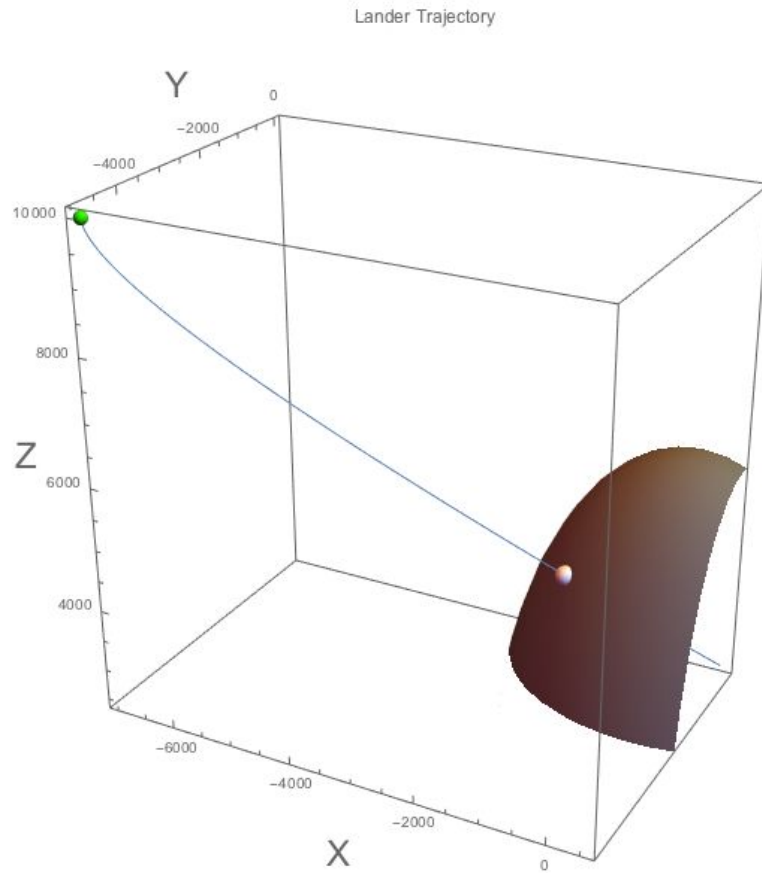
Looking through a telescope one found a comet with its nucleus in the shape of an ellipsoid. The equation of the ellipsoid looks like the following: $x^2/a^2 + y^2/b^2 + z^2/c^2 \leq 1$. The variable 'a' is equal to 3035 meters, the variable 'b' is equal to 2520 meters, and the variable 'c' is equal to 6065 meters. The calculated mass of the nucleus yields to $24,678,192,000,000 \pi$ meters squared. The inertia along the x-axis yields to $13,744,928,000 \pi/3$ kilogram meters squared. The inertia along the y-axis yields to $14,660,392,000 \pi/3$ kilogram meters squared. The inertia along the z-axis yields to $4,979,720,000 \pi/3$ kilogram meters squared. The surface area of the nucleus calculates to 1.78648×10^8 meters squared.

3. Multiple Expansion:

The graph below shows the difference of gravitational potential(V) and of gravitational potential energy(V_m).



4. Landing on the Comet:



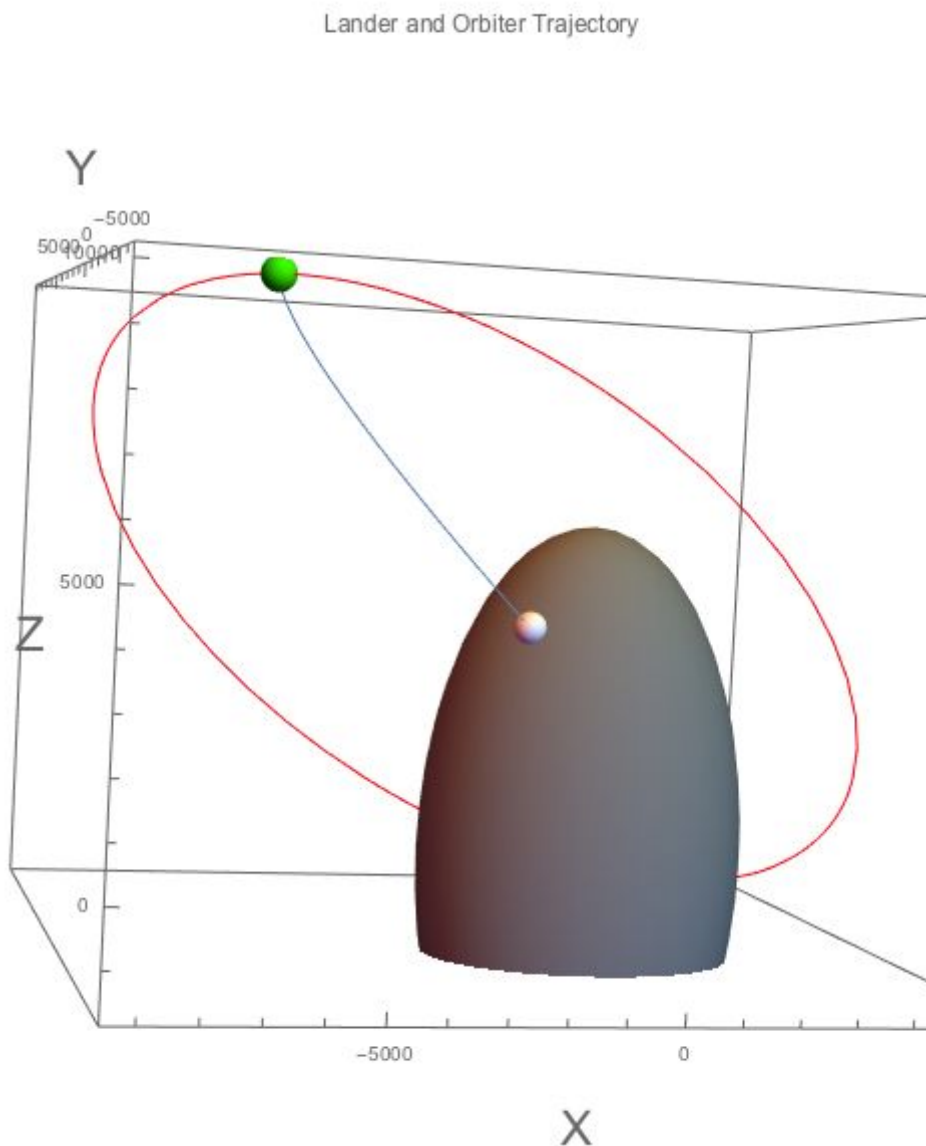
The trajectory of the lander can be described as

$$r_l[t] := \{-7000 + 0.001t + 3 \cdot 10^{-6}t^2, -5000 + 0.001t + 2 \cdot 10^{-6}t^2, 10000 - 0.05t - 2 \cdot 10^{-6}t^2\}$$

. Using this trajectory function we find that at time t equals 42,684.8 seconds the lander will land on the surface of the comet. On the graph above the green sphere is the release location and the white sphere is the landing location. When the lander is released the initial velocity is calculated to be 0.05002 kilometers per second. In order to find the initial force on the lander we must calculate a force function which looks like $F_{onLander}[t] = -(M_{lander}) * gradV[t]$. The initial force yields .000121194 Newtons. The velocity at impact is .369901 meters per second and occurs when the comet has gone 42,684.8 meters. The lander will make a safe landing. The work done on the lander by the comet's gravity is 75.4142 Jules. The work done by the lander's thrusters during its descent comes out to be $\{-71.9437, -73.8658, -72.9873\}$. These are projected to be negative because it is work done against gravity in slowing descent. The velocity at impact will be 1.49 kilometers per second. The lander does not make a safe landing.

5. Orbiting in the coma:

The graph below shows the Lander and the Orbiter trajectory. As stated previously the green sphere shows the starting point of the lander and the white sphere shows the landing spot for the lander. The red oval shows the path of the orbiter around the comet in one time period. It will start and end in the same place the lander starts. The trajectory of the orbiter can be expressed by $ro[t] = \{-1769.42 - 5230.58 \cos[0.0001 t] - 5362.31 \sin[0.0001 t], 1233.56 - 6233.56 \cos[0.0001 t] + 4499.51 \sin[0.0001 t], 4187.62 + 5812.38 \cos[0.0001 t]\}$. While the orbiter is orbiting the comet it will collect dust. The amount of dust the orbiter will collect comes out to be .00417019 kilograms which is approximately 4.17 grams.



6. Conclusion:

After analyzing the data collected, many properties of the comet were found. We concluded that the mass of the comet is $24,678,192,000,000 \pi$ meters squared and the surface area of the comet is 1.78648×10^8 meters squared. Along with mass and surface area, inertias along the x-axis, y-axis, and z-axis were calculated. We then analyzed the flights of the lander and orbiter around the comet. The lander and orbiter will both start at the same location with varying velocities. We found that in order for the lander to land successfully the thrusters must be used or the velocity of the lander will be too high to land safely. Finally as the orbiter orbits the comet it will collect a certain amount of dust. The mass of this dust comes out to be approximately 4.17 grams.