Computing Gravity
(Student)

Discussion:

With your JavaScript simulation, you get to test how different properties of the planets affect the gravitational force between them, observing the outcome. This is great, and for many years, scientists had a similar approach -- observing the motions of the planets and making conclusions about the force interactions between them. In fact, Isaac Newton wasn't able to get much further himself. He determined that the force was related to the mass of the planets and the distance that separated them, but he was not actually able to calculate the magnitude of that force.

It wasn't until almost 100 years later that another English scientist, Henry Cavendish, calculated the gravitational force between two objects in a laboratory setting for the first time. This experiment eventually formalized the equation of the Universal Law of Gravity, which we still use today:

$$F_g = GM_1M_2 / r^2$$

where F_g is the gravitational force in Newtons (N), M_1 is the mass of one object in kilograms (kg), M_2 is the mass of the other object in kilograms (kg), **r** is the distance between those two objects in meters (m), and **G** is the gravitational constant, equal to 6.67×10^{-11} ($m^3kg^{-1}s^{-2}$).

Exercise:

1a) Using the formula above, calculate the strength of the gravitational force between the sun and the earth. The mass of the sun is 1.99×10^{30} kg, the mass of the earth is 5.97×10^{24} kg, and the average distance between them is 1.5×10^{11} m.

1b) Now calculate the strength of the force between the earth and the moon, if the moon's mass is 7.35×10^{22} kg and the average distance between them is 3.85×10^{8} m.

1c) How does the force on the moon compare in size to the force on the earth? Why?

1d) Which has a bigger gravitational force, the earth - sun interaction or the earth - moon interaction? Does this surprise you? Why or why not? How many times bigger is it (divide the bigger force by the smaller force)?

1d) If you were to double the size of the moon, how many times bigger/smaller would the force be acting on the earth?

1e) If you were to double the distance between the earth and the moon, how many times bigger/smaller would the force be acting on both of them?

2a) Time to calculate the gravitational force between you and a friend! To determine how many kilograms of mass you have, divide your weight in pounds by 2.2. If you or your friend is uncomfortable sharing their weight, just use 64 kg. If you are sitting 1.5 m apart (around 5 ft), how strong is the force of gravity between you?

2b) Why don’t you feel this force between you two? Why do you think this is so?