Making Sense of the Universe (part of Chapter 4): Why does the Earth go around the Sun?

Kepler's laws describe planetary motion, but they don't explain planetary motion. Newton's Law of Gravity: Every mass attracts every other mass through the force called gravity. $F = GM_1M_2/d^2$. A cannonball fired horizontally from a high tower falls to Earth if fired at a slow speed, flies away from Earth if fired at a very fast speed, and goes around and around Earth if fired at an intermediate speed. The cannonball goes into orbit.

Newton's Law of Gravity explains each of Kepler's three laws, plus the orbits of comets. The orbit of a planet around the Sun can be used to determine the mass of the Sun, the orbit of a moon around a planet can be used to determine the mass of the planet. Planets actually orbit around the centre of mass of the Sun and the planet. This is not the same as the centre of mass of the Sun, but since the Sun is so much heavier than the planets, it is very close.

High tide occurs on the part of Earth closest to the Moon and on the part furthest away from the Sun simultaneously, giving 2 high tides per day at a fixed location. Tides are caused by differences in the gravitational pull of the Moon from one side of Earth to the other. The Sun has a smaller effect on tides on Earth than the Moon has.

Speed describes how fast you're going. Velocity describes how fast you're going and what direction you're going in. Something is accelerating if its velocity changes. Something that is accelerating can be changing its speed, its direction, or both.

Acceleration due to gravity is 10 m/s^2. All falling objects experience the same acceleration.

Newton also stated three laws of motion. An object moves at a constant velocity if there is no net (overall or total) force acting upon it. Force = mass x acceleration. For any force, there is always an equal and opposite reaction force. These laws explain why your body senses acceleration, but not velocity, why planets orbit forever (unlike motion here on Earth which is always slowed by friction), and lots of other things.

Newton's laws of motion and law of gravity were the first scientific principles to be applied to both the heavens and Earth successfully. They linked familiar falling objects and unfamiliar orbiting planets.

Spacecraft orbiting the Earth still feel Earth's gravity. The reason astronauts don't fall to the bottom of their spacecraft is that the spacecraft and all its contents are experiencing exactly the same gravitational acceleration as they "fall" towards Earth. People in space are in "free-fall", they are not weightless.