TOP 6 THINGS ABOUT GRAVITY

Gravity does far more than make apples fall from the tree and. It governs the motion of planets around the sun, holds galaxies together and determines the structure of the universe. Gravity is something we don't think about too much, until we stumble on the stairs.

To many ancient thinkers, gravity wasn't even a force – it was just the natural tendency of objects to sink toward the centre of Earth, while planets were subject to other, unrelated supernatural laws.

Of course, we now know that gravity does far more than make things fall down. It makes the Sun shine with life-giving warmth and controls the weather around us. The modern theory of gravity – Einstein's General Theory of Relativity – is one of the most successful theories we have. And yet, at the same time, we still don't know how gravity fits in with the other forces. **But here are six weighty facts we do know about gravity**:

1. Gravity is by far the weakest force we know. Gravity only ever attracts – there is no version of the force to push things apart. And while gravity is powerful enough to hold galaxies together, it is so weak that you overcome it every day. If you pick up a book, you're counteracting the force of gravity on it from all of Earth.
   a. For comparison, the electric force between an electron and a proton inside an atom is roughly one quintillion (that's a one with 30 zeroes after it) times stronger than the gravitational attraction between them. **In fact, gravity is so weak, we don't know exactly how weak it is.**
2. Gravity and weight are not the same thing. Astronauts on the space station float, and sometimes we say they are in zero gravity. But that's not true. The force of gravity on an astronaut is still about 90 percent of the force they would experience on Earth. However, astronauts appear weightless, since they, together with the Space Station, are in permanent free-fall around the Earth, where the centrifugal energy of their speed matches the gravitational attraction of the Earth exactly.
   a. Take a bathroom scale onto an elevator and stand on it while riding up and down. Your weight fluctuates, and you feel the elevator accelerating and decelerating, yet the gravitational force is the same. Einstein used this idea in his General Relativity Theory

NASA astronaut Karen Nyberg uses a fundoscope to image her eye while in orbit. Image credit: NASA

3. General Relativity predicts gravitational waves. If you have two stars or white dwarfs or black holes locked in mutual orbit, they slowly get closer as gravitational waves carry energy away. In fact, Earth also emits gravitational waves as it orbits the sun, but the energy loss is too tiny to notice. The Laser Interferometer Gravitational-wave Observatory (LIGO) confirmed the phenomenon this year, picking up a burst of gravitational waves produced by the collision of black holes a billion light-years away.
   a. One consequence of relativity is that nothing can travel faster than the speed of light in vacuum. We assume that goes for gravity, too. If something drastic happened to the sun, the gravitational effect would reach us only some 8 minutes later, at the same time as the light from the event.
4. Explaining the microscopic behaviour of gravity has thrown researchers for a loop. The other three fundamental forces of nature are described by quantum theories at the smallest of scales, the Standard Model. However, we still don't have a working quantum theory of gravity, though researchers are trying.
   a. One avenue of research is called loop quantum gravity, which uses techniques from quantum physics to describe the structure of space-time. It proposes that space-time is particle-like on the tiniest scales, the same way matter is made of particles.
   b. Another approach is string theory, where particles – including gravitons – are considered to be vibrations of strings that are coiled up in dimensions too small for experiments to reach. Neither theory is currently able to provide testable details about the microscopic behaviour of gravity.
5. Gravity might be carried by massless particles called gravitons. In the Standard Model, particles interact with each other via other force-carrying particles. For example, the photon is the carrier of the electromagnetic force.
   a. **The hypothetical particles for quantum gravity are gravitons, and we have some ideas of how they should work from general relativity. Like photons, gravitons are likely massless.**
6. Quantum gravity appears at the smallest length anything can be. Gravity is very weak, but the closer together two objects are, the stronger it becomes. Ultimately, it may reach the strength of the other forces at a very tiny distance known as the Planck length, many times smaller than the nucleus of an atom.
   a. From the smallest to the largest, gravity keeps attracting scientists' attention. AK from EarthSky Notes