



Space 201: Orbits (plural)

Just like a cannonball, where there's one flying, there will be others

Let's discuss satellite orbits. In the Space 101 article, we started with Newton's Cannon analogy (if you haven't read the 1-pager, go ahead and take a moment to do that). We snuck the word 'friction' in at the end of 101 for a reason, it was a hook, kind of like at the end of a binge-worthy series season finale. We're adding friction, and distance, and just a tiny bit of Relativity into the mix as we explore various orbits. We'll limit this discussion to two general orbits, but there are many more established. These two ('Low Earth' & 'Geosynchronous') will illustrate why some satellites don't appear to move, while others zip across the fresh night sky. And, it'll help explain why some rockets are bigger than others. (We might have to break our self-imposed 1-page limit for all this!)

The Narcissistic Layer (Low-Earth Orbit)

The vast majority of satellites are not exploring space, they are serving a function back on Earth in real time. And, as humans are visual creatures, a significant portion of those satellites were built to show pictures of our planet and send them back to us. The 'cameras' on these satellites still must contend with concepts like 'focal length' so the closer they are to the planet, the better the image quality. And, since it's relatively close to the surface (~500-1,000 km altitude) the launch costs are lower. It simply takes less fuel to get there. The rub is, that there is still a hint of the Earth's atmosphere at that elevation, so these satellites still experience friction (or drag) which eventually slows them down enough that they de-orbit and fall back to Earth, fulfilling their cannonball destiny.

Subset: The sun worshippers (Sun synchronous Orbits)

Visually it's easy to imagine satellites orbiting like a belt around the Earth, basically following the equator at a higher elevation. But if you take one of those orbits and turn left 90 degrees (so you're facing North or South) and orbit over the Earth's poles, then you have a special kind of orbit. A satellite on a north-south orbit spends half its time in sunlight, and half in shadow, as the Earth rotates underneath it. The satellite's position, relative to the Sun, doesn't change. Here on Earth these satellites appear to be constantly moving, from the satellite's perspective, the Earth is spinning underneath it as the satellite keeps its back to the sun.

Go Big, or go Home (Geosynchronous)

Tired of watching Newton's cannonball crash back to Earth in multiple attempts at orbiting, our intrepid rocket engineer decided to send the cannonball much farther away. This time, not only was the curve of the Earth dropping away faster than the cannonball was falling, but the cannonball was so far away that the Earth's rotation itself started to play a factor. These distances are massive; at roughly 40,000 km (23,000 miles) satellites orbit at the



same speed that the Earth rotates. This means that *Relative* to the Earth, the satellites appear to be **stationary!** They move in sync with the planet on which we stand and maintain position relative to the Earth. Dish Network and Hughes Net are a few examples of everyday communication satellites in geosynchronous orbits. That's why the satellite dish can be mounted to the side of a house, aimed, and left in position. It receives a signal from a satellite that is stationary, relative to that spot on the Earth.

Fun Fact - Satellites don't have lights

Satellites don't have caution lights like airplanes do, and they don't emit light visible to the human eye, so how can we see them in the early night sky? The short answer is that the satellite is still in sunlight, high above the surface, while you (the observer) are in the shadow of the planet. It's nighttime for you, but still daytime for the satellite. You're seeing the sun's light reflected off the satellite. This only works with the naked eye for satellites in Low Earth orbit (with the exception of the Moon, a rather LARGE satellite), for a few hours after sunset.

Your kids probably don't know this bit of trivia, so feel free to tell them that you called the satellite company and asked them to turn on the lights for a short period IF your kids agree to go to bed after they see one.

Still Curious?

Getting a feel for this and still a bit curious? Go dig on your own a bit and discover something. You might start with *Molniya orbits*, *cis-Lunar orbits*, or even just the cool existence of *Lagrange Points*. It won't take twenty years to enjoy the fruits of your efforts; enjoy the journey!