Introduction

Space Debris as defined by Nasa is “all man-made objects in orbit about the Earth which no longer serve a useful purpose”. In the last 50 years, the space around earth's orbit went from virtually empty to being completely cluttered with man-made objects and space junk. Space waste is a topic that is usually neglected by STEM magazines and media outlets, it gets overshadowed by the grandeur of the universe and the bigger picture of the age of the universe, distant galaxies, life on other planets and space exploration. However, Space debris is no longer a distant threat, it has become a formidable issue that scientists need to focus on. NASA’s definition of space debris was revisited in the 1990s when they started to observe that the number
of man-made objects in orbit started to increase dramatically and overtook naturally occurring debris such as meteorites and smaller pieces of debris as the real threat to launches, satellites and the ISS.

**What counts as Space Debris and how much is there?**

As mentioned before, space debris is any human-made object in orbit about the Earth that no longer serves a useful function. Space debris size can range from inactive satellites to tiny flecks of paint, any kind of waste that is generated by human activity in space that remains in orbit can be referred to as space debris -or orbital debris- It is estimated that there is more than 27,000 pieces of orbital debris in the near-earth orbital environment. In addition, NASA estimates that there are more than half a million pieces of debris that are smaller than 1 centimetre across, and a million pieces of debris that are smaller than a millimetre across. The amount of orbital debris is only bound to increase in the future as humanity continues to launch rockets and satellites into space. For instance, the private sector alone is planning to launch more than 100,000 satellites into low earth orbit in the upcoming decade, over 5 times as much as what already exists in orbit. There is a concern that grows along with the growth of the amount of debris in orbit that is the concern of the Kessler Syndrome -named after the astrophysicist Donald J. Kessler, who is known for his research on space debris-, a scenario in which the increase in collisions would increase the
number of debris which drives the number of collisions even higher, creating a self-sustaining cycle, as it would keep colliding and expanding the number of debris in the environment.

**What makes Orbital Debris dangerous?**

The inherent danger of orbital debris comes from the incredibly high velocity it travels in and its ability to grow larger in numbers thanks to the Kessler syndrome. Some debris orbits around the earth at astronomical speeds reaching 8 kilometres per second!

Even small flecks of paint can cause damage at these speeds. For example, in 1983, the shuttle Challenger was hit by a 0.2mm wide paint chip which created a 0.4mm wide pit in one of its windows. And later on in the following 63 launches, over 177 impacts were recorded on the windows of the shuttles and overall, 70 shuttle windows had to be replaced in a span of 22 years of shuttle missions. Even the International Space Station faces the threat of colliding with space debris, where it had to be manoeuvred 3 times in 2020 alone, where its last manoeuvre was to avoid the remaining debris of a Japanese satellite that broke up into 77 pieces. Unfortunately, however, not all satellites are able to avoid collisions with orbital debris. In 1996, french rocket
Cerise - French for cherry - collided with a catalogued piece of debris travelling at an astounding 14 kilometres per second, making it the first case of an accidental orbital collision with space debris. In a similar fashion 15 years later, US communications satellite Iridium was taken out by a dysfunctional Russian satellite Kosmos, creating an additional 2300 large pieces of debris.

**How do Scientists protect Satellites and the ISS?**

Satellites are usually equipped with additional fuel that enables them to manoeuvre, but that fuel is reserved for them to be able to perform an orbital burn out - the use of propulsion systems to change the orbit of a spacecraft - that enables them to return back to Earth. Such is the case with the Iridium class satellites discussed earlier. The ISS uses a more complex approach to avoiding possible collisions with space debris. As for the International Space Station, there is a different protocol in place to avoid potential collisions with space debris. The ISS resides in an imaginary “manoeuvre box” which is a 5km x 5km x 2km grid where if a piece of debris would enter, the ISS would have to perform a manual manoeuvre unless it would interfere with a primary mission or payload delivery. Furthermore, the ISS is protected via a Whipple Shield, which consists of 2 layers made of kevlar and aluminium respectively and with a gap that separates them, the kevlar
layer is meant to absorb the initial collision, where the piece of debris would penetrate the layer but would also disintegrate the projectile upon collision, meaning that the second layer would withstand the pressure of the subsequent impact.

**How can scientists “clean up” Orbital Waste?**

Solving the issue of orbital debris has been delayed for the last few decades as it has proven to be difficult and expensive. Almost 2 tonnes of space debris makes it back to earth every week, and since our planet's surface is mostly covered with water bodies, a lot of debris in the near-earth orbit ends up in the bottom of the ocean. Moreover, engineers have begun to realize that not resolving the issue of space debris can be catastrophic, and thus, there are certain measures being taken to make sure that future launches take into consideration the fact that these objects we are putting in space might end up becoming space debris. For instance, Starlink is a satellite constellation that plans on having 42,000 satellites in orbit, all of these satellites will be equipped with extra fuel that enables them to reenter the atmosphere in case of failure, thus alleviating some of the debris issues that might occur. However, one of the bigger obstacles in the way of clearing space debris is not difficulty or cost, but rather the legal barriers. For instance, a preposition to clear out existing space debris was to make use of a laser that would heat up the debris and knock it out of orbit by vaporizing it, but the counterargument was that they might be used to take out operational satellites.
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