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REVIEW

SPACE JUNK: IS IT A DISASTER WAITING TO HAPPEN?

Many experts are calling for urgent action before debris floating in orbit around the Earth triggers the domino-like Kessler syndrome

"Estimates suggest there are currently half a million pieces of debris the size of a marble or larger, and 100 million pieces of debris more than one millimetre across"

BBC *Visit the BBC's* Reality Check *website at* ***bit.ly/reality_check_*** *or follow them on Twitter* ***@BBCRealityCheck***

This year, in May, a hole was found in a robotic arm aboard the International Space Station (ISS). The suspected culprit was a piece of space junk. While thankfully no astronauts were injured, it has re-focused attention on the growing problem of orbital debris.

HOW DID WE GET HERE?

It's easy to forget that just seven decades ago the Moon was the only thing orbiting the Earth. On 1 January 2021 there were 6,542 satellites in orbit. Tellingly, only just over half of them were active. That's a lot of useless metal careering around the planet at 28,000km/h – 10 times faster than a bullet. Jan Wörner, the former director general of the European Space Agency (ESA), put it this way: "Imagine how dangerous sailing the high seas would be if all the ships ever lost in history were still drifting on top of the water."

Even the smallest fragments, including stray nuts and bolts, and frozen particles of rocket fuel, can still cause immense amounts of damage. Even flecks of paint are a threat – they forced NASA to replace several damaged windows in the old Space Shuttle. According to NASA, millimetre-sized orbital debris represents the highest mission-ending risk to most robotic spacecraft operating in low Earth orbit.

HOW BAD IS THE PROBLEM?

It's very bad and getting worse. Estimates suggest there are currently half a million pieces of debris the size of a marble or larger, and 100 million pieces of debris more than one millimetre across. Yet only 27,000 pieces are actively tracked by the US Department of Defense.

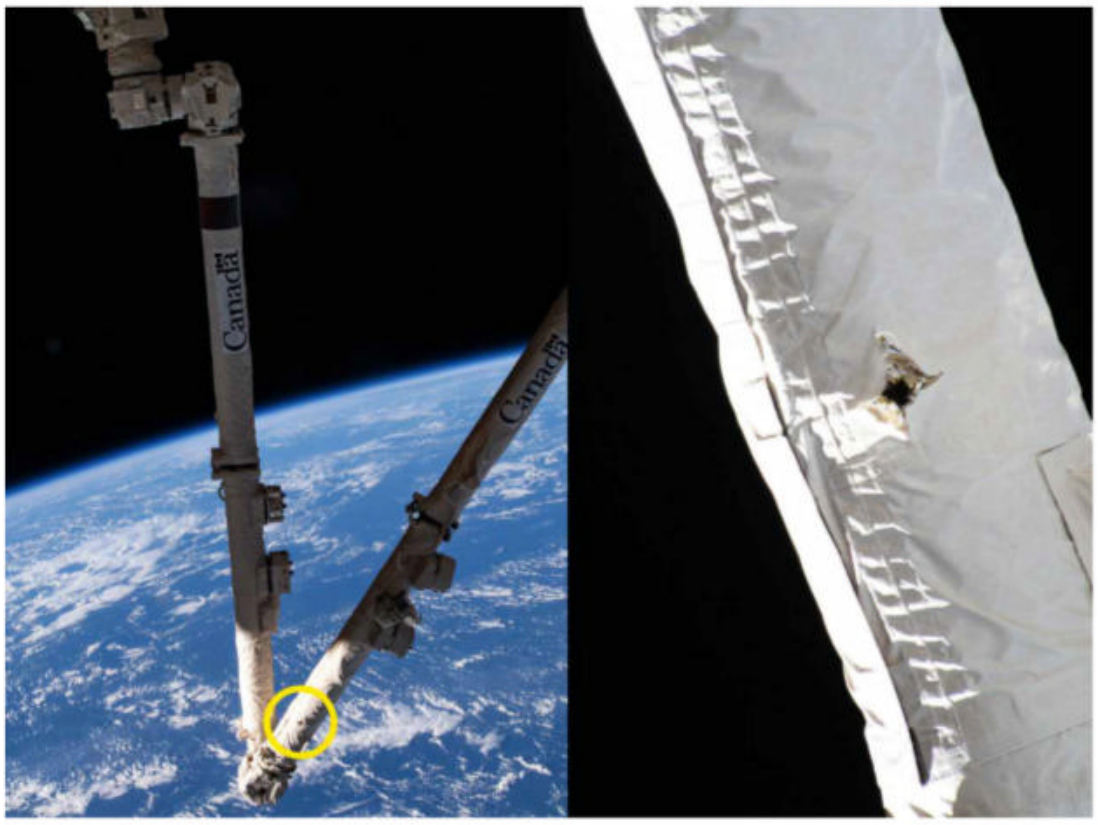
The ISS has had to conduct 29 debris avoidance manoeuvres since 1999, including three in 2020 alone. It doesn't help that some countries have decided to deliberately blow up their satellites with missiles as part of military test manoeuvres. Such a move by India in 2019 produced 400 shards of space debris.

Space is only going to get more crowded, with the number of satellite launches set to quintuple in the next decade. In January 2021, 143 satellites were launched into space on a single SpaceX Falcon rocket alone. SpaceX's satellite internet venture – Starlink – wants to put 12,000 satellites in orbit over the next five years. All this additional hardware significantly ramps up the chances of collisions and the dreaded Kessler syndrome.

WHAT IS KESSLER SYNDROME?

Kessler syndrome is a catastrophic chain of events in which a satellite is shattered by a piece of space junk (or a collision with another satellite) and the resulting debris destroys more satellites creating more junk and so on in a neverending cascade. It's a domino effect – one piece falls and then takes the rest with it – and is named after the NASA scientist Donald Kessler who outlined the dangers back in 1978.

According to a 2020 Space Sustainability report by the Organisation for Economic Co-operation and Development (OECD), Kessler syndrome has the potential to render certain orbits unusable for human activities. The report states that ▶



GETTY IMAGE, CANADIAN SPACE AGENCY/GOVERNMENT OF CANADA

BELOW LEFT Circled in yellow is the hole that was punctured in a robotic arm on the ISS by a piece of space junk

BELOW RIGHT Close-up of the small hole, where the extent of the damage can be seen

internet, weather and communication services are the most likely to be disrupted.

HOW CLOSE ARE WE TO TRIGGERING KESSLER SYNDROME?

A UN report from 2013 projected that catastrophic collisions may occur once every five to nine years over the next two centuries. It's already happening. In 2009 an Iridium communications satellite collided with the derelict Russian Kosmos 2251 satellite, destroying both spacecraft. That event happened at about the same altitude as one of the biggest dangers: the eight-tonne Earth observation satellite Envisat. Envisat will remain in orbit for the next 150 years and there's a 15 to 30 per cent chance that it will collide with a piece of space junk in that time. Kessler syndrome doesn't necessarily have to play out quickly. These impacts could be the first domino, with crashes ramping up significantly over time.

WHAT CAN WE DO ABOUT IT?

Better regulation of new launches would help, as right now it's a bit of a free-for-all. There are existing regulations in place to try and mitigate the dangers, such as a 25-year de-orbit rule for missions in low-Earth orbit. However, ESA's Space Debris Environment Report says that less than 60 per cent of those flying in low-Earth orbit currently stick to the rules. Penalties for rule-breakers should be stiffer. Deliberately blowing up satellites needs to stop. Increased monitoring of existing space junk helps because active satellites can be moved off a collision course by firing small thrusters. Yet dead satellites are sitting ducks and there's nothing we can do to avert a collision. That's why many are calling for a clean-up job. In 2018, the British-built RemoveDEBRIS mission tested a space junk harpoon in orbit. Meanwhile, ESA has commissioned the world's first space debris removal mission. Called ClearSpace-1, it will launch in 2025 and attempt to de-orbit the upper stage of a rocket left in space back in 2013.

by **COLIN STUART** *(@skyponderer)*
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ANALYSIS

BILLIONAIRE SPACE RACE: WHAT DOES IT MEAN FOR THE CLIMATE?

New regulations regarding the environmental impacts from space travel must be put in place to prevent the emergence of a 'Wild West' attitude, experts say

Space travel made international headlines in July as both Amazon founder Jeff Bezos and Virgin boss Richard Branson flew to space in craft made by their own companies. Not to be outdone, Elon Musk's SpaceX plans to launch an all-civilian crew into orbit in September.

Commercial space travel is clearly firing up, and is predicted to become big business. Branson's Virgin