"Gravity"-style space debris threat from giant satellite explored in student paper

February 19 2014

Artist's impression of Envisat. Credits: ESA

Physics students at the University of Leicester have pointed out that the huge observational satellite Envisat – which lost contact with Earth in 2012 – could potentially pose a threat similar to the events which plague Sandra Bullock in the Oscar-nominated sci-fi thriller Gravity.

What's more, the task of bringing the satellite back to Earth may be too costly and complex to be feasible, according to their final year paper for the *Journal of Physics Special Topics*, a peer-reviewed student journal run by the University's Department of Physics and Astronomy.

Envisat, an £1.8 billion, 9 metre-long behemoth, was launched by the European Space Agency (ESA) in 2002, and used ten sophisticated

sensors to observe and monitor Earth's land, atmosphere, oceans and ice caps.

However, ESA lost contact with the satellite in April, 2012 – and declared the end of the mission soon after. The satellite now orbits the Earth free from human control at an altitude of 790km - where the amount of space debris around the planet is greatest.

This means there is a chance of collision with other satellites and debris during the 150 years it is expected to remain in space. Each year, two objects are expected to pass Envisat to within about 200m and other spacecraft have had to move out of Envisat's path.

It is possible – though unlikely - that a collision with Envisat could lead to a chain reaction effect, known as the Kessler Syndrome, where a cloud of fast-moving debris causes other collisions with orbiting bodies around the Earth.

This would not be good news for the many essential satellites and spacecraft in orbit. It could also make it difficult for future space missions to pass through the region of Envisat's altitude, if the region becomes congested with space debris.

The fourth-year MPhys students' paper, *De-orbiting Envisat*, suggests that around 140kg of fuel would be required to move the satellite to a point where it would naturally return to Earth within 25 years.

Based on the object's cross-sectional area and its mass, the students calculated that the satellite would need to be moved to an altitude of 700km from its current position in order to return to the planet in 25 years.

The students calculated that the energy required to move the satellite

90km closer to the Earth was 2.7 billion joules – equivalent to an extra 143.1kg of hydrazine fuel. This could be quite feasible, according to the students, if two of the craft's 80kg fuel tanks were replaced.

But actually getting this fuel to the satellite in orbit would be a pretty tall order due to the costs involved of such a mission – which has never been attempted for a satellite which wasn't designed to be refuelled.

An average satellite launch costs hundreds of millions of pounds – with each kilogram of the satellite's costing tens of thousands of pounds.

"In the film, the cloud of space debris is caused by a missile which was supposed to destroy a non-operational satellite and sparks the chain reaction which eventually collides with Clooney and Bullock's spacecraft. In real life this is very unlikely to happen," said physics student Katie Raymer, 22, from Whitstable.

"It is even more unlikely that ESA's Envisat could cause one of these chain reactions. However, each year two objects are expected to pass Envisat to within about 200m and other spacecraft have had to manoeuvre themselves out of Envisat's path. Also Envisat orbits at an altitude where the amount of debris is greatest. So although it is unlikely to happen, de-orbiting Envisat is certainly worth considering.

"Unfortunately, it would be very unlikely we could move Envisat to the right altitude due to how much it would cost. Envisat was not designed to be refuelled, so another method of de-orbiting Envisat may be a better option."

The students suggest it may be possible to use NASA's Robotic Refuelling Mission (RRM) which has been designed to refuel and repair non-operational satellites, but is still in its earliest stages of testing.

Professor George Fraser, Director of the University's Space Research Centre, commented: "The Special Projects paper highlights the huge area and mass of Envisat as the major risk factors for space debris. The fact that Envisat is in a near-polar orbit doesn't help either, since its path intersects most satellites' orbits nearly at right angles. Imagine driving down the motorway and every so often a large truck cuts right across all four lanes right in front of you!"

The team stressed that the calculations used in the paper should be taken as an estimate, as a full treatment would be very complicated and beyond the scope of a *Journal of Physics Special Topics* paper.

The *Journal of Physics Special Topics* is published every year, and features original short papers written by students in the final year of their four-year Master's of Physics degree.

Course tutor Dr Mervyn Roy, a lecturer in the University of Leicester's Department of Physics and Astronomy, said: "The aim of the module is for the students to learn about peer review and scientific publishing. The students are encouraged to be imaginative with their topics, and find ways to apply basic physics to the weird, the wonderful and the everyday."

More information: "De-orbiting Envisat." K. Raymer, T. Morris, O. Youle, B. Jordan, Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH. physics.le.ac.uk/journals/inde … cle/viewFile/621/424

Provided by University of Leicester