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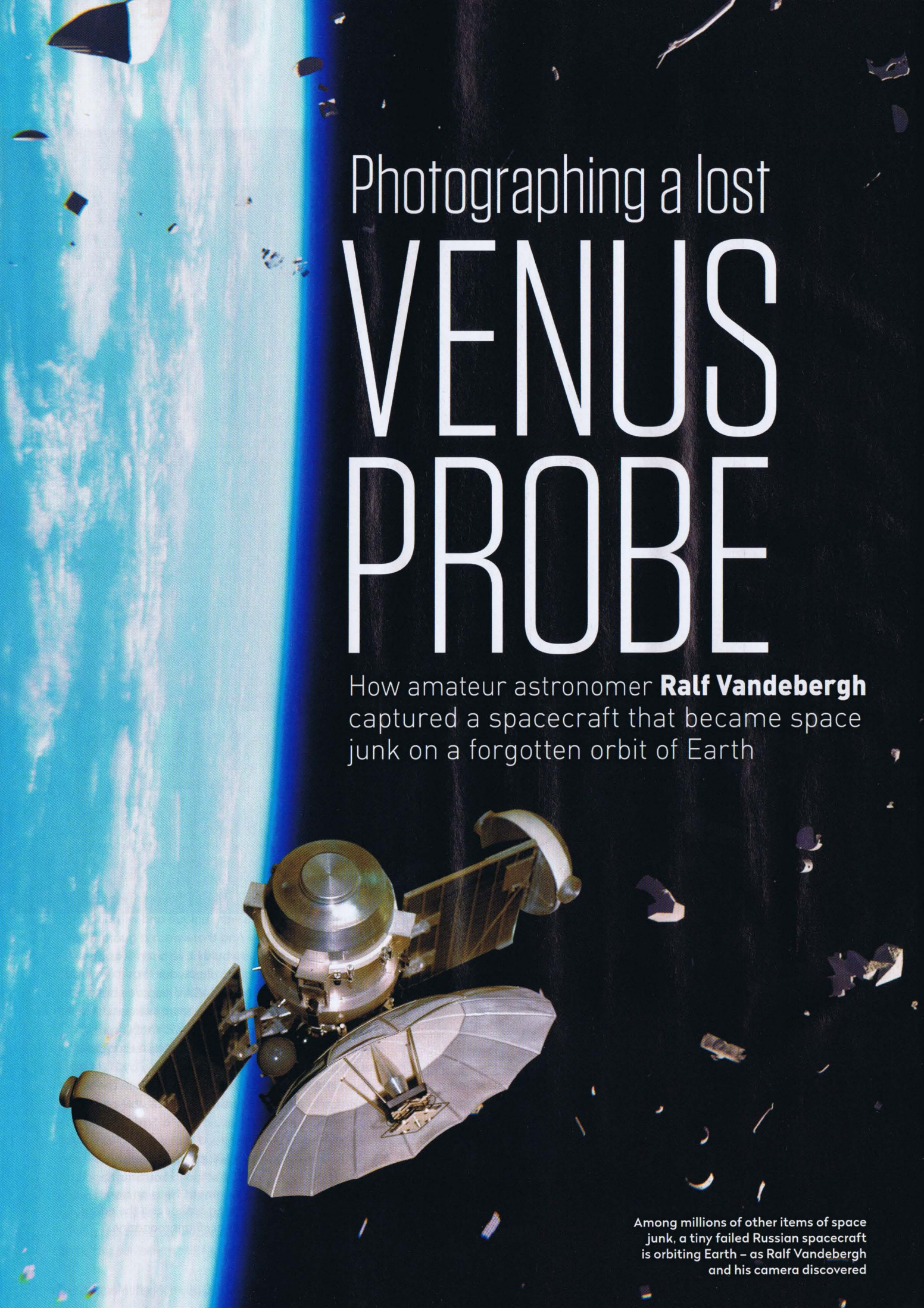
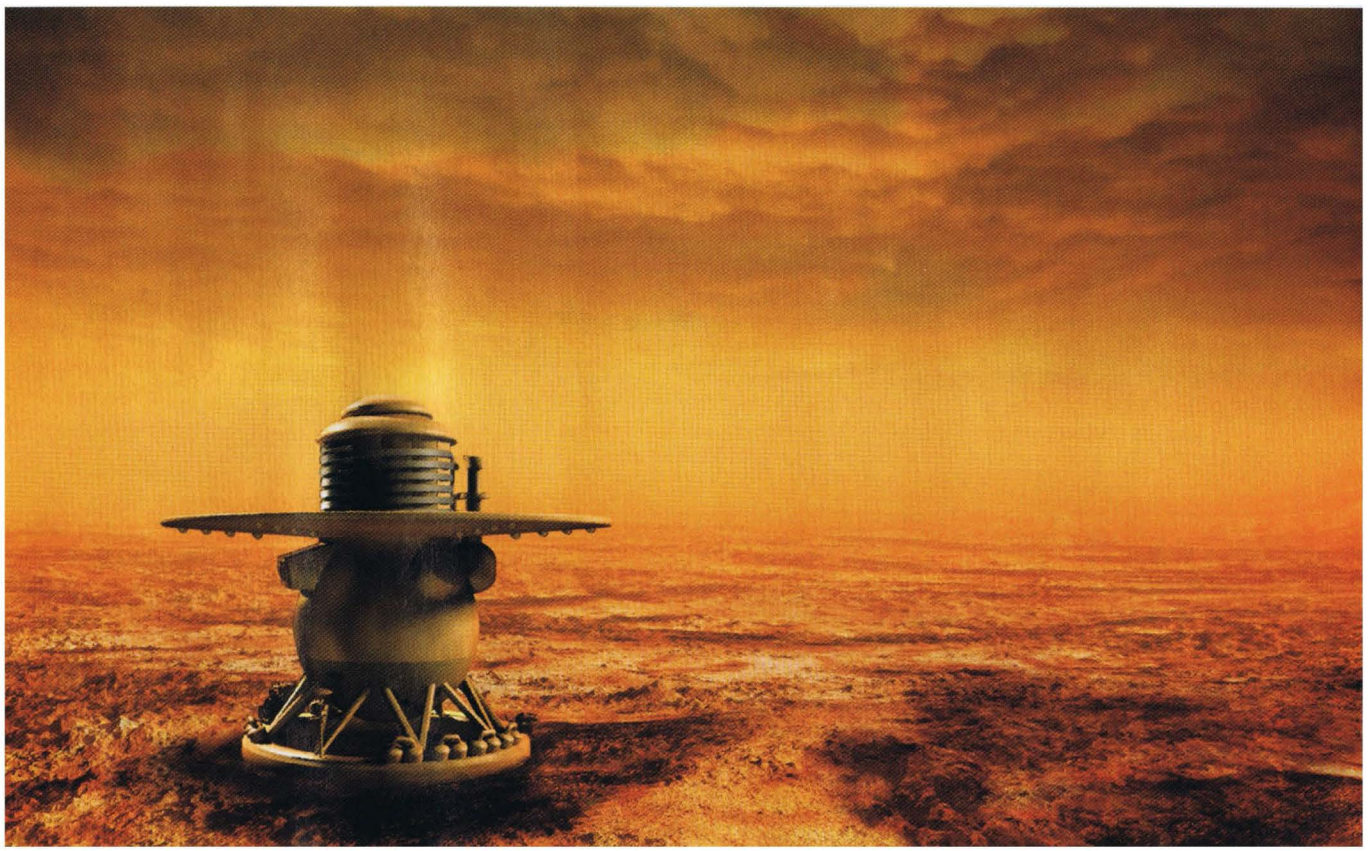
How amateur astronomer **Ralf Vandebergh** captured a spacecraft that became space junk on a forgotten orbit of Earth



Among millions of other items of space junk, a tiny failed Russian spacecraft is orbiting Earth – as Ralf Vandebergh and his camera discovered



▲ An artist's impression of a Venera probe successfully landing on Venus

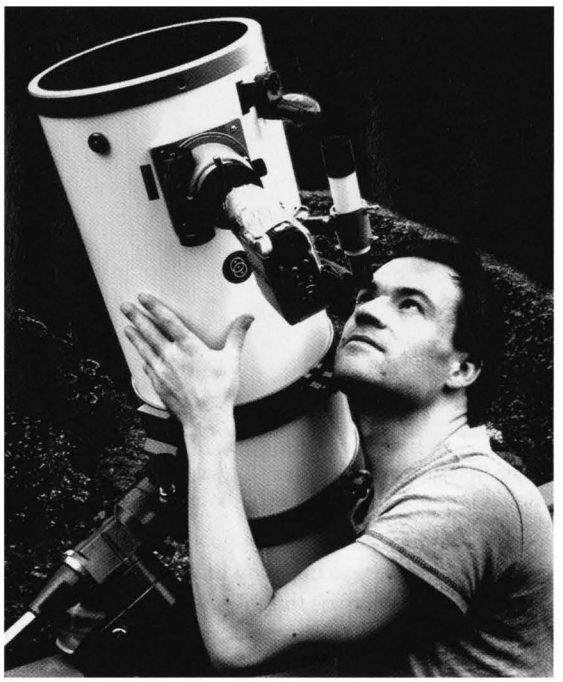
Ralf Vandebergh specialises in high resolution imaging of spacecraft from the ground and is a freelance spaceflight journalist

Around 2010, after years of observing planets and the International Space Station (ISS), I was looking for a new challenge – hunting down satellites in low-Earth orbit. While out watching different satellites pass over my observing location in the Netherlands, I spotted an extremely fast-moving object with 7x50 binoculars, and searched on my satellite list for what the object could be. There are many satellites and space debris items in the night sky, ranging from weather satellites to spying spaceplanes, but this particular object seemed even more interesting.

It turned out to be a remnant of an old planetary probe that was intended to visit Venus, one of the Soviet Union's Venera programme which failed while still in low-Earth orbit. These spacecraft were launched between 1961 and 1984, studying the planet and even landing on its surface, but not all of the craft made it. Those that failed while still in Earth orbit were given the designation Cosmos – and I had found Cosmos 482.

Knowing that Cosmos 482 was an intended Venus probe, or at least a part of one, piqued my interest. I had to try capturing it with the imaging equipment I used for the ISS. To have any chance of success I needed to wait until Cosmos 482 reached its perigee point, where it passes closest to the ground.

Before the digital era, it was completely impossible to obtain high resolution images of orbiting satellites through telescopes, due mainly to the insensitivity of photographic emulsions used at that time. The invention of the charge-coupled device (CCD)



▲ The author with his imaging setup, taken around the start of the Cosmos 482 campaign in 2011

has made it possible to work with extremely short exposure times and small imaging scales, required to freeze the movement of objects at high angular speeds. My setup consisted of an Orion Optics 10-inch aperture Newtonian reflector on an equatorial mount with an ordinary JVC camcorder. The video camera is attached to an eyepiece, so I can quickly ▸

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A history of failure

Like all space junk, Cosmos 482's story can be mapped out

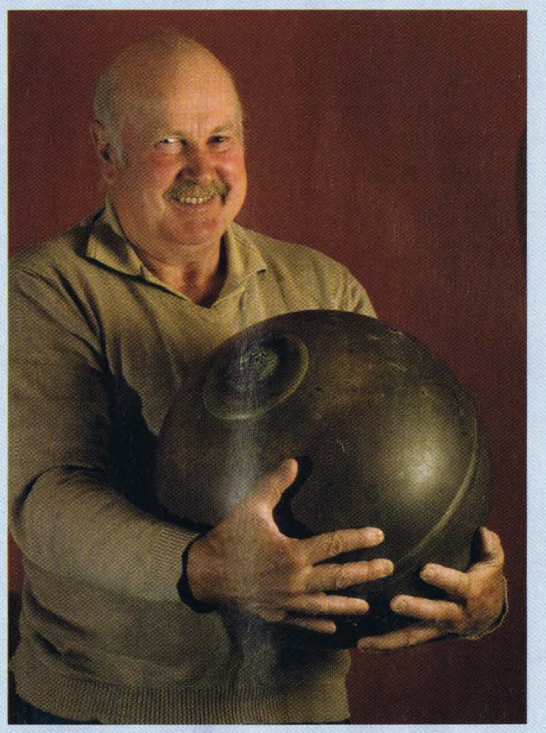
The Venera programme was a series of probes built to study Venus both from orbit and on its surface. Venera 7 made the first successful landing in 1970. The probes were launched in pairs, as rocket launches frequently failed back then. The move proved wise, as when Venera 8 launched in 1972, its sister probe exploded while in Earth orbit.

After the failure, different objects were spotted in Earth orbit, the largest of which became known as Cosmos 482, which is the part I imaged.

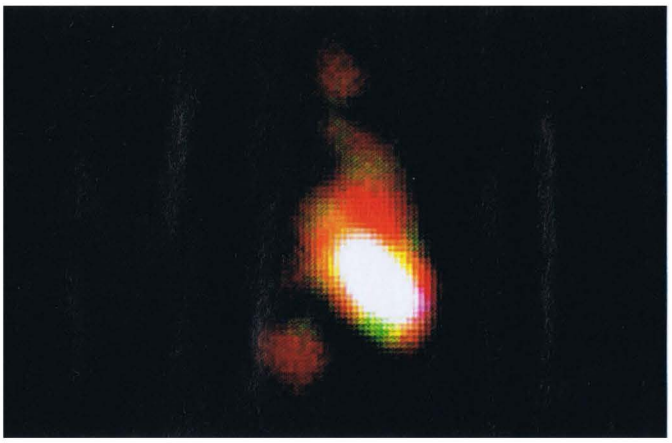
Cosmos 482 is a prime example of space junk – old spacecraft parts that are increasingly cluttering up low-Earth orbit. In the years after the explosion, much of the spacecraft fell back to Earth. Some parts took just 48 hours to re-enter Earth's atmosphere. In 1978, the fuel tanks fell near Ashburton, New Zealand and were called 'space balls' due to their shape.

The remaining part of the spacecraft is expected to re-enter the Earth's atmosphere sometime in the next 15 years, perhaps as early as late 2019. As this is thought to be the landing capsule, which was constructed to withstand the extreme conditions of Venus, the capsule could survive its return to Earth. This is why ground-based imaging of objects like Cosmos 482 can be useful: to find out what the actual condition of the object is.

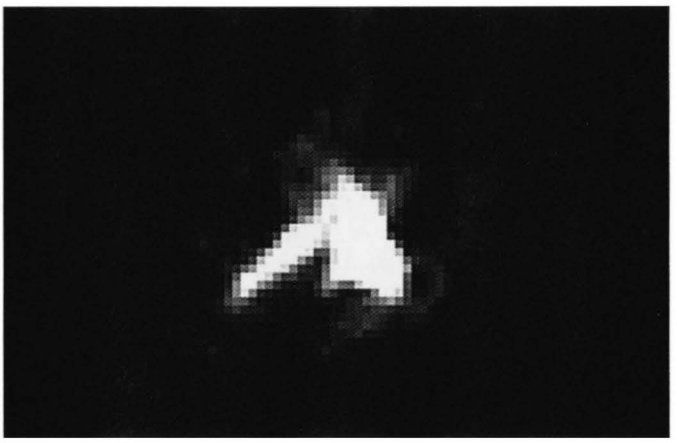
But space debris is not only a threat for people on the ground – orbiting debris can be dangerous for spacecraft in low Earth orbit too. In April 2011, debris from a weather satellite that was intentionally destroyed by a Chinese anti-satellite missile test, passed only 6km from the International Space Station, risking the lives of those on the station.



▲ New Zealand farmer Denis O'Sullivan shows off his 'space ball', a fuel tank from the Russian probe Cosmos 482 which landed in his turnip field in 1972



▲ The first image of Cosmos 482, taken on 1 August 2011, reveals a bright compact element and a fainter, elongated one



▲ Cosmos 482 imaged on 26 June 2014 during a different pass. Again, we see comparable details, including an elongated element

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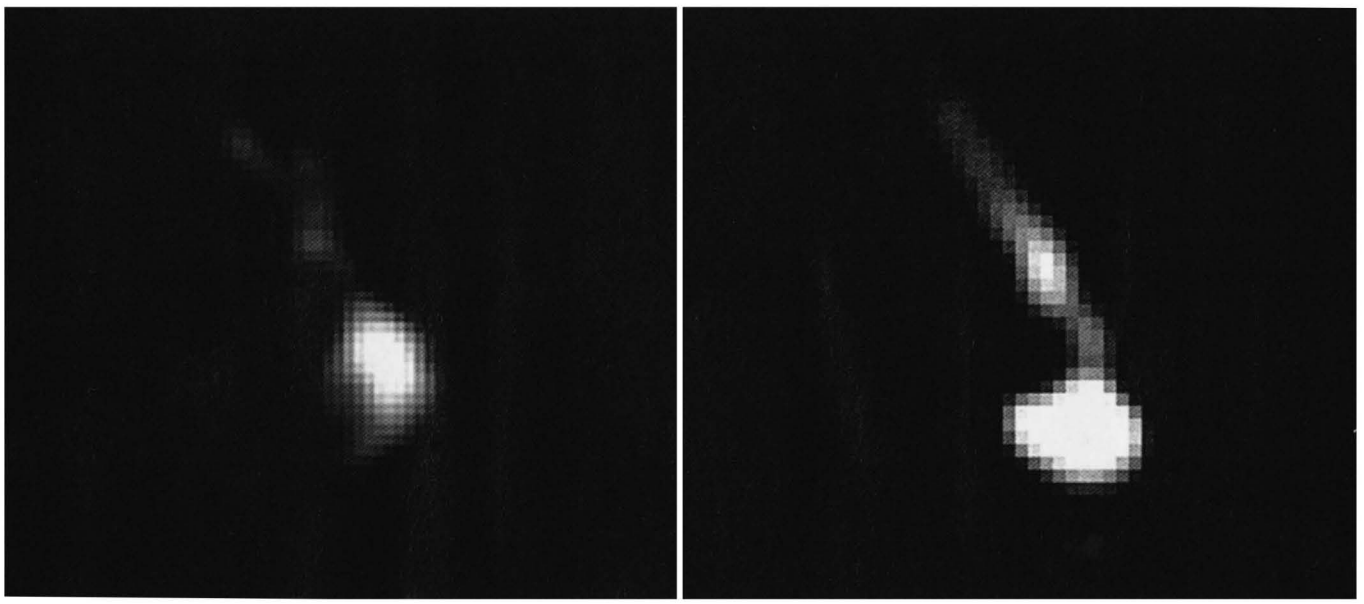
▸ put it into place and be ready to image in seconds. Initially the camera was rough focused at a fixed point, but then I would precise focus on a star close to the path of the object shortly before it approached.

At the ready

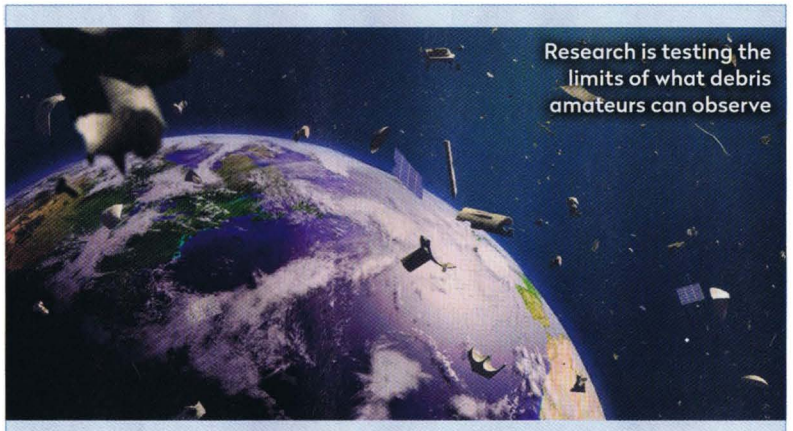
To obtain an image of the ISS or another satellite, I manually track the spacecraft using a small tracking scope and keep the object centred in the crosshairs while recording everything with the camcorder. This is much cheaper than automatic tracking, doesn't require computer software and means I can be ready to capture an image in just a few seconds.

The problem with small objects like Cosmos 482 is they're mostly not visible with the naked eye, making tracking them a challenge. With the ISS you can see it with the naked eye and point the tracking scope in the right place, but with small objects I find reference stars along the path of the orbiting object across the sky. Keeping those stars in the field, I then wait for the satellite to appear and then hang on to it as soon as it does. If all works well, the resulting video will have at least a few frames with the satellite. This requires a well-adjusted tracking scope and experience, but if you get it right the results can be spectacular.

In August 2011, I managed to take my first images of Cosmos 482. These were the first high-resolution images ever taken of this object – a very exciting thing to do. Only part of the Cosmos 482 spacecraft remains in orbit, and one reason I took these images



▲ **The author has grabbed frames from the video footage he took on 26 June 2014, to produce these two images which, he speculates, could show the bright, spherical shape of the Venera landing capsule. The elongated, somewhat fainter tail is mysterious, but it's possible that this might be the parachute of the lander which was deployed (partially) when the capsule separated from the spacecraft**



Amateurs track space junk

Astronomers are helping to track debris from their back gardens

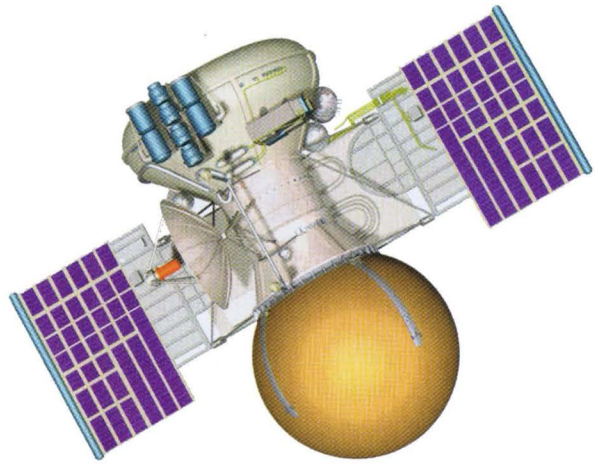
Space debris is a big problem. In the UK, the Defence Science and Technology Laboratory (Dstl) has been leading efforts to mount a mission that will remove dead satellites from orbit. Before they can do that though, Dstl needs to accurately know where they are.

"Professional astronomical facilities tend to be expensive, and state-of-the-art facilities are few and far between," says Will Feline from Dstl. "Amateur astronomers, however, are more widespread and use equipment which is by definition much cheaper."

To test if amateurs could help track space debris, Dstl worked with the Basingstoke Astronomical Society (BAS) on Project Argus – an initiative to find the limits of what amateur equipment could do in detecting and tracking orbiting space junk.

The group used standard DSLRs and CCD cameras to track objects in space, using GPS trackers to accurately time-code their observations. Accurate times are vital for calculating orbital positions, but the group found the basic software unsatisfactory and so wrote their own, which is accurate to 20 milliseconds.

"After months of observations we determined that trailing objects with magnitudes between +7.0 and +9.0, or so could be detected with short exposures on DSLR and CCD cameras," says Trevor Gainey, chair of the BAS. Dstl is currently analysing BAS's hard won data, to see how amateur astronomers could help fight space junk in the future.



▲ **This illustration of a Venera probe clearly shows the spherical section which housed the lander craft**

was to try and find out what part this is. Because you don't know what to expect, there is the excitement about whether you can reveal anything.

The results were surprising. The images showed an elongated shape with a visible bright blob near its centre, flanked by two fainter elements. As the image was still quite blurry at this resolution, I had to remove imaging and tracking errors – such as disturbances from air turbulence or exposures that were too long.

I retook the images in 2014, and confirmed much of the detail, but finding out exactly what parts of the spacecraft are still in orbit has been difficult. That's why I waited until now to publish the results. This perhaps goes against the spirit of astrophotography today: data gets old quickly and everything seems to be posted in real time. But these images of Cosmos 482 demonstrate that it is still possible for amateurs to do new things, and that an element of patience can pay off where long-duration projects are involved.