Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Cosmos 1.*

Cosmos 1 represented several important firsts. It was to be the first ever solar sail and it was also going to be the ever first citizen driven – or to use the Planetary Society's terminology – space advocacy driven spacecraft.

Before I start raising too many expectations, it's best to tell you that *Cosmos 1*'s launch rocket suffering a staging failure, so the whole mission plan never happened and the spacecraft was destroyed. But plans are already underway for *Cosmos 2*, so hopefully all this thinking will come to fruition sometime soon.

Cosmos 1 was aboard a rocket launched from a Delta 3 class submarine – which, adding the Cheap Astronomy's growing list of poorly pronounced Russian names – was called Borisoglebsk.

The launch took place off the coast of Norway on the 21st of June 2005. The rocket had two stages with Cosmos 1 sitting atop with its own small booster rocket intended to give a final kick up to an altitude of 840 kilometres before the 100 kilogram *Cosmos 1* set sail. Its sail, made of eight triangular segments of Mylar foil would have unfurled, looking like a set of closely fitting windmill blades – creating a total surface area of 600 metres squared – which is about the area of a basketball court.

Each of the 15 metre long Mylar segments of the sail could be swivelled like a rudder that turned the whole spacecraft – so that it might sail with the solar wind directly behind it – or tack across the wind stream – and even sail into the wind to slow the craft down.

It was anticipated that with the sail unfurled, the spacecraft would sail in low Earth orbit, keeping the Sun at its back when not in shadow and this would increase its velocity so that it would rise to a higher earth orbit – to at least 100 kilometres altitude over the expected 30 day life of the mission.

The craft would have been gradually accelerating as a result of the radiation pressure of photons colliding with the sails – and as there would be almost no air resistance, the spacecraft would experience a close to linear acceleration minus the gravitational drag as it rose to a higher orbit.

Assuming the first stage of the mission had been successful, the next phase was to test flying *Cosmos 1* on a microwave beam, fired up from the 70 metre Goldstone dish in California – a part of NASA's Deep Space Network. This would have been a particularly interesting part of the mission for reasons I'll explain now.

See - there's some limitations to solar sailing. Photons from the Sun radiate outwards in an expanding sphere so the further away from the Sun you get, the lower the density of photons become and so the weaker the force pushing against your sail becomes. In the vicinity of Earth, the density of photons would be sufficient to add about 160 kilometres an hour to *Cosmos 1*'s orbital speed within a day – and could add maybe 1,600 kilometres an hour to its speed within a hundred days – and so on.

But as a solar sail increases in speed, it also has to move to a higher orbit – which means it starts moving away from the Sun, so the amount of acceleration force available to it begins to decline – and eventually the spacecraft will reach a maximum, although constant, velocity.

Just where the Sun's push effectively run outs and what speed the craft would be flying by then is dependent on factors like the mass of the spacecraft and the surface area of the sail. Unlike the experimental *Cosmos 1*, the real point of doing all this would be to carry a payload of some sort, at least some scientific instruments and a camera.

Moving this sort of mass means you would definitely need a bigger sail which means more mass itself – suggesting there's a need for some kind of formula to tell you what kind of sail you might need to carry what kind of payload in order to meet different mission objectives.

So for now, what we really want is some data on the functional performance of a solar sail – perhaps through the proposed *Cosmos 2* mission. As well as needing a better understanding of sail surface area to mass ratios, there are issues around the tolerance of light surface sail materials to extended periods in space.

An ideal solar sail should be highly reflective – as this will result in it experiencing twice as much radiation pressure as, say a black, surface that just absorbs the photons. The anticipated thirty day lifespan of *Cosmos 1*'s Mylar sails before they began degrading from the effects of solar radiation would need to be greatly improved upon if the solar sail concept has a practical future.

But nonetheless, it seems reasonable to assume that one day solar sail craft might be able to ferry light payloads from Earth orbit – perhaps to the Moon and perhaps even to Mars or Venus.

If you want it to go to Venus, you sail it into the solar wind, which will reduce your velocity so that you fall in a decelerating solar orbit towards that cloudy, greenhouse-gone-crazy planet.

But, if you want to go to Mars, you are going to sail with the wind at your back, enjoying an exhilarating and accelerating orbital trajectory up the side of the Sun's gravity well until you catch up with the orbit with that red, dead, or-is-it? planet.

More theoretical is the idea of extending the range of the solar sail spacecraft by sailing it on a microwave beam, fired from a dish like Goldstone, though perhaps we would build one out in space or on the Moon – but even this beam would loose its punch with distance as it slowly gets scattered and spread out through space – but it could conceivably maintain a solar sail craft's acceleration well beyond the edge of the solar system – so that even when it did loose its punch, the craft will continue at a constant and impressively high velocity out into interstellar space.

So the technology does offer some capacity to send multiple low mass spacecraft to nearby star systems – a trip that might still take hundreds or even thousands of years, but might get those spacecraft to a new star system, economically – or dare I say it cheaply – where they could once again start sailing around a strange new gravity well investigating an alien star system – and any extra solar planets that might be there.

Anyway – poor old *Cosmos 1* was hopefully just a first faltering step in a technology with a bright future. Sailing on the seas of space-time has got to be worth another try.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website where cheap is just another word for accessible. No ads, no profit, just good science. Bye.