New Scientist

WEEKLY 1 February 2025

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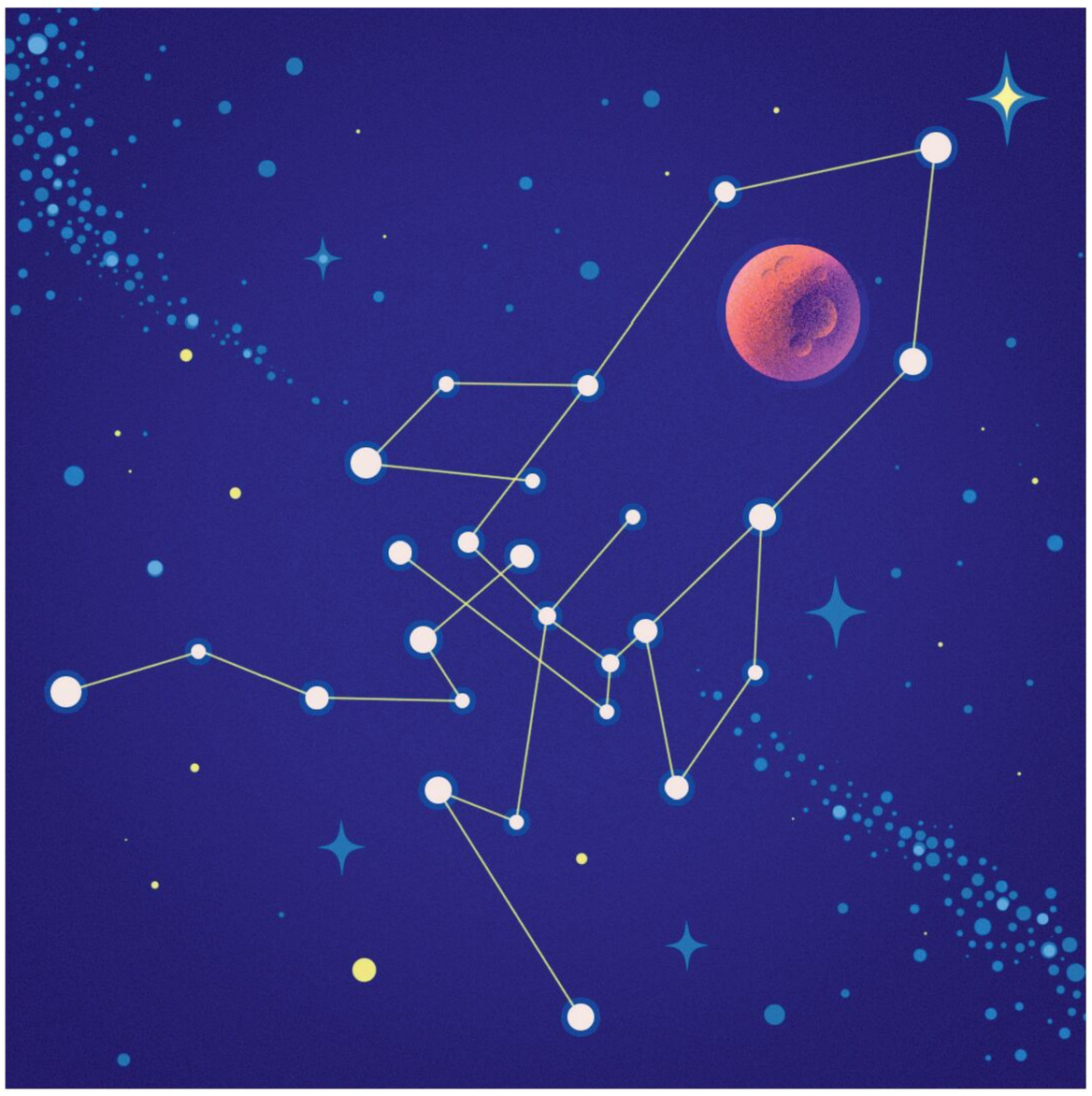
Boldly attempting to go

Scientists' ideas for interstellar spacecraft range from the wholly improbable to the wildly expensive and very difficult, says **Ed Regis**

WHILE researching *Starbound*, my new book on the realities of interstellar travel, I was often surprised by the bizarre, over-the-top spacecraft designs that scientists have proposed in well-regarded academic journals. The best-known of these is Project Orion (1957-1965), whose central idea was to propel an interstellar spacecraft by detonating a series of thermonuclear bombs behind it, giving the craft a succession of powerful kicks through space.

Long after the project ended, Freeman Dyson, who worked on the project, said: "We really were a bit insane, thinking that all these things would work." Amen.

Plenty of other wild starship designs have been offered up, in all seriousness. In 1984, Anthony Martin stated in the *Journal of the British Interplanetary Society* that "the carrying capacity of the largest vehicles proposed is only some 50 million (that is, equivalent to the population of the British Isles)". Only?



ADRIÀ VOLTÀ

That same year, physicist Robert L. Forward published a design for a laser-pushed, 1000-kilometre-diameter interstellar light sail. This, he admitted, had a major drawback: "If we want to provide a constant acceleration, the laser power would have to be increased from 43,000 TW at the start to 75,000 TW or more at the end of the acceleration phase." "TW" stood for terawatts – at that point, 1 terawatt was the total amount of power produced on Earth in one year. By any standard, 75,000 is a lot of terawatts.

In 1996, NASA engineer Thomas McKendree revealed what might be possible if molecular nanotechnology were used to build a spacecraft from material structures made out of diamond. This would allow for a 4610-kilometre-long ship. The habitable area inside it, he wrote in a paper, "yields a possible population for this structure of 99 billion people". (Why not just round up to 100 billion?)

But even more modest designs turn out to probably be unworkable in practice. One of the most popular ideas at present is the "world ship", in which generations of passengers are born and die aboard a spacecraft over hundreds of years of travel. In 2020, Andreas Hein at the University of Luxembourg and his colleagues published a paper defining these craft as "starships with populations of over 100,000 and a velocity below 10% the speed of light".

A spaceship with 100,000 people on board is, by itself, an epic, even heroic, design concept. Its construction would require resources on a scale never before seen on Earth. The authors say the major stumbling block of such a design concerns its consistent operation over time: "World ship reliability is likely to be a major feasibility issue, due to the large number of parts and the long mission duration."

The researchers estimate a failure rate of three component parts per second. Keeping up with this would require a large and autonomous repair capability. Since the facility would also be subject to failure, it must be self-repairing. But the catch is that such a self-repairing system would itself be susceptible to the breakdowns it was designed to prevent or repair. So, in the end, the world ship becomes a self-destructive artefact, one that effectively dooms the craft and its passengers. Surprise!

Even if interstellar travel is out of our reach for the indefinite future, the fact remains that we have the rest of our own solar system to colonise. Possible destinations include the moon and Mars, as well as satellites like Europa and Enceladus. Another option would be to create space colonies in Earth orbit or among the asteroids. Colonising any of these places would be a huge engineering challenge and wildly expensive. But the best thing going for this option is that, while difficult in practice, it isn't preposterous.

Ed Regis's latest book is *Starbound: Interstellar travel and the limits of the possible*