

New Scientist

WEEKLY 20 January 2024

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Space flight

Rocket engine burns itself up for fuel

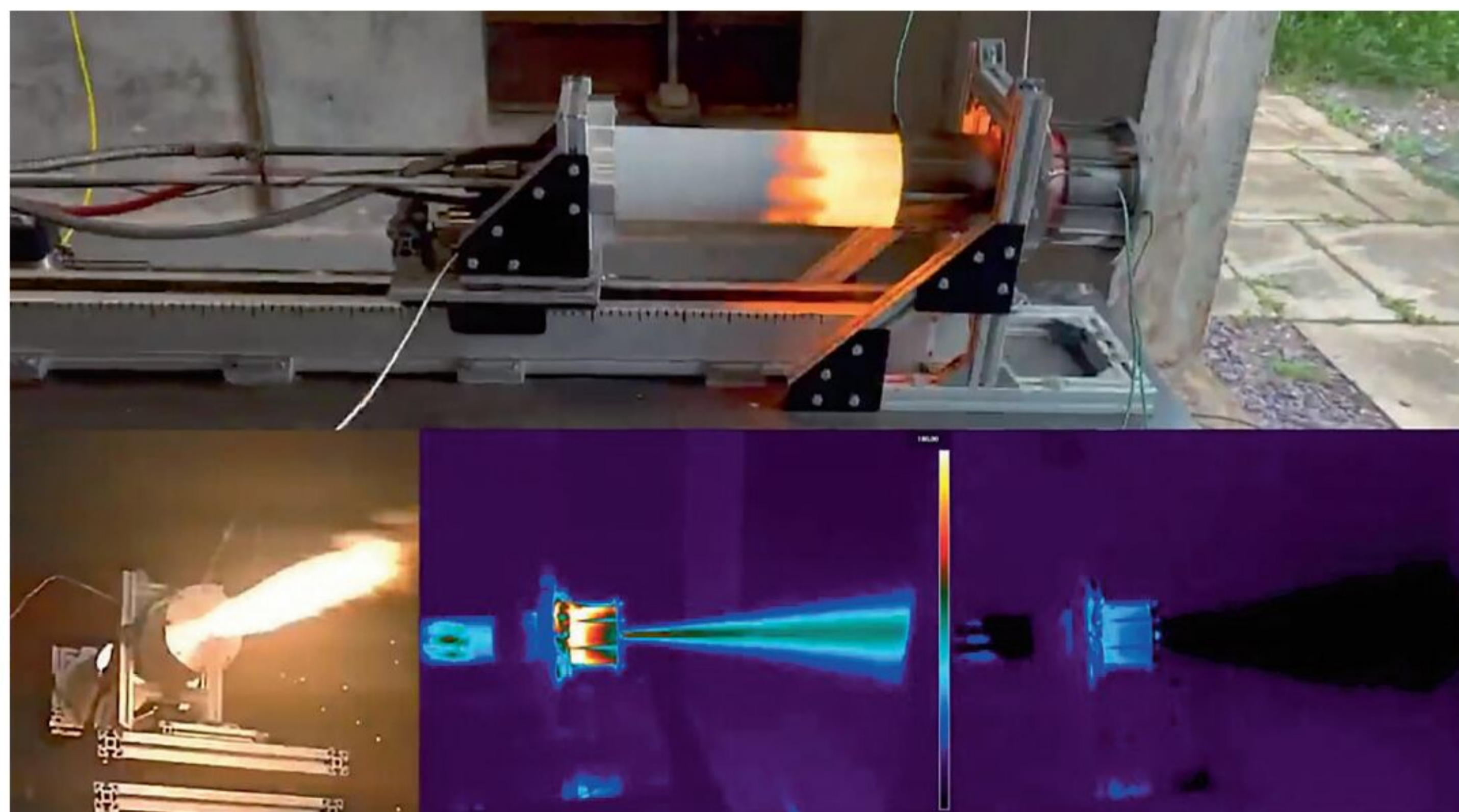
A prototype rocket uses its own fuselage as propellant to avoid carrying dead weight

Leah Crane

ROCKETS that eat themselves may be on the way. To reach orbit, a rocket must hoist its own mass and the mass of its propellant, as well as whatever payload it is carrying. But if a rocket could burn its own parts as fuel, it could free up capacity to transport more crucial cargo. A team of engineers has now built a prototype of one of these “autophage engines”.

The concept of a rocket that eats its own parts was first patented in 1938, but a working prototype was never built because it would have been tough to execute with the enormous rockets that have historically performed most launches. In recent years, however, small satellites have risen in popularity, so there is increasing demand for smaller rockets.

Krzysztof Bzdyk at the University of Glasgow, UK, and his colleagues have built a small prototype of a rocket engine that eats its own fuel tank. It isn't powerful enough to loft anything into space, but it successfully demonstrates the concept. The researchers presented their work at the American Institute of Aeronautics and Astronautics



SciTech Forum in Florida on 10 January. The engine is called the Ouroboros-3, named after the ancient symbol of a snake eating its own tail.

Like the emblematic snake, the engine is designed to devour its own back end as it uses up the rocket fuel contained there. “As you burn through your propellants, you have these empty tanks where you’ve got all of this structural mass that’s not being useful,” says Bzdyk. “So what we’re doing is consuming that dead weight so you don’t have to carry it with you on the way up, and that allows you to carry more mass to space.”

In the prototype, as the oxygen and propane that make up the main fuel are burned, the plastic tube that holds that fuel is also fed into the engine. The tube constitutes up to one-fifth of the total propellant, which provides about 100 newtons of thrust – only about four times as much force as it takes to break an egg.

The team is now working on a larger prototype that could provide about 1000 newtons of thrust – around one-sixth as much as the engine will need to make it to suborbital space and about 1/20th as much as it will require to reach orbit.



Krzysztof Bzdyk, Patrick Harkness and Jack Tufft (above) work on the prototype rocket that burns its fuselage (left)

“With added tests, they should be able to scale up the rocket... [but] sometimes scaling up is not trivial, easy or likely,” says Haym Benaroya at Rutgers University in New Jersey.

Challenges will include making sure the plastic fuselage is fed into the engine and burned at a consistent speed, and testing how burning up pieces of the rocket alters its flight path.

Such engines could help ease the problem of space junk by burning up leftover bits of spacecraft rather than leaving them to hurtle around in orbit and possibly endanger other satellites. ■

Marine biology

Some corals change sex each year to boost mating odds

MANY colonies of hammer coral change sex annually. The pattern seems unique among animals.

In 2011, Shinya Shikina at the National Taiwan Ocean University and his colleagues discovered that hammer corals (*Fimbriaphyllia ancora*) in the tropical West Pacific Ocean can change sex. At that time, the only coral group known to change sex was mushroom

corals, which are generally solitary and can move around a reef. But *F. ancora* dwells permanently in single-sex colonies containing individuals that are either all male or all female.

To learn more, Shikina and his colleagues kept tabs on 26 hammer coral colonies in Taiwan's Nanwan Bay over eight years. Nineteen of the colonies – about 73 per cent – shifted between sexes every year. The other seven colonies remained fixed as either female or male (bioRxiv, doi.org/mchk).

The researchers took samples

from the sex-changing colonies and looked at their gonads under a microscope. In the months following sperm or egg release, testes tissue wanes before converting into an ovary and vice versa. This is similar to a process that certain sex-changing fish also undergo.

There are many types of hermaphroditism. Some animals, like slugs, have functional male

73%

Proportion of coral colonies switching sex every year

and female sexual organs at the same time. Clownfish start as male and can become female. But no other species is known to change sex annually. “This new knowledge expands the sexual plasticity of corals beyond what I was expecting,” says Chiara Benvenuto at the University of Salford, UK.

Shikina and his colleagues suggest that if there are colonies in a population that alternate between expelling sperm and eggs, it may increase the overall odds of successful mating. ■

Jake Buehler