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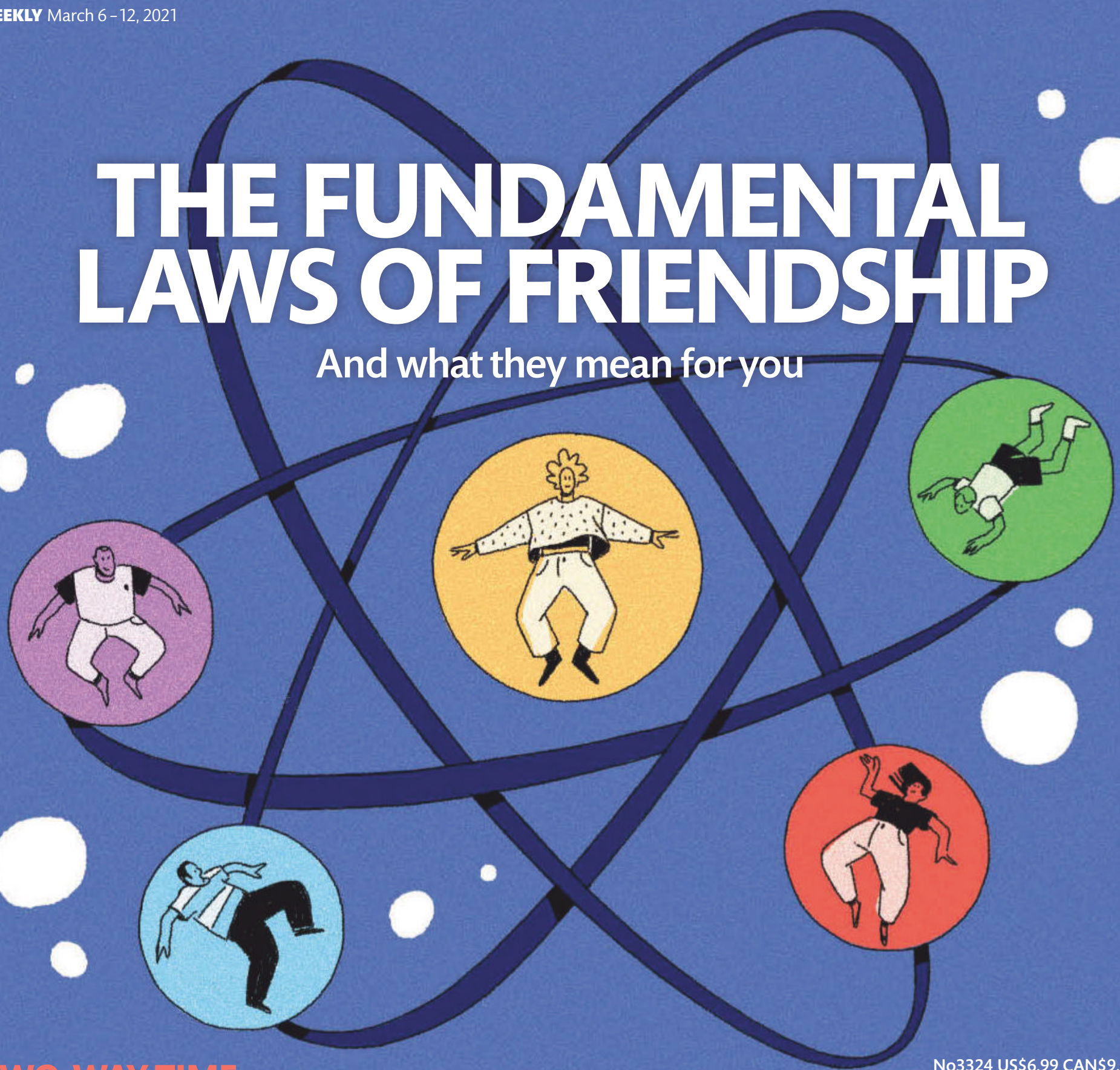

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Space travel

A warp drive that doesn't break the laws of physics

Leah Crane

WARP drives may be on the road to reality. Previous ideas about how to make these hypothetical devices have required exotic forms of matter and energy that may not exist, but a new idea for a warp drive that doesn't break the laws of physics may be theoretically possible. However, it may not be practical in the foreseeable future because it requires ultra dense materials.

Contrary to what its name may suggest, a warp drive isn't really an engine. Rather, it is a bubble of space-time protected by a shell of matter in which the fundamental properties inside the shell can differ from those outside. Without an added mode of propulsion, warp drives don't move through space on their own, but, in theory, some types could break the speed of light, moving faster than this by stretching and compressing space-time around them.

"Einstein's relativity only sets limits for things moving in space-time, not the speed of space-time itself," says Sabine Hossenfelder at the Frankfurt Institute for Advanced Studies in Germany. "If you're trying to reach a certain speed by warping space-time, this limit can, in principle, be overcome."

The first method suggested to do just that was proposed by Miguel Alcubierre in 1994, but it would require strange matter with negative energy, rather than the positive energy normal matter has. There is no evidence that such matter exists, so Alexey Bobrick and Gianni Martire at Applied Physics in New York, an independent research institute, have come up with a modification that allows their warp drive to be made of real matter. Without negative energy, it can't beat the speed of light, but its effects on time could still make it useful for long space journeys.

Their idea is based on the fact that in the presence of powerful gravitational fields, the passage of time appears to slow down

"The incredibly dense materials needed for this aren't something we could produce at present"

due to the effects of general relativity. In a warp drive, this effect could allow a person inside a shell of matter to travel enormous distances in what is, from their perspective, a relatively short time.

The strength of that effect is dependent on the mass of the shell – the more massive it is, the slower time moves within it relative to the outside.

"In a sense, a burrito is a warp drive, with the contents as the passenger, but it's not a very interesting one," says Bobrick. That is because the gravitational effect of the tortilla used to wrap the burrito's contents is negligible, so it doesn't deform space-time, and therefore the contents move through time in the normal way. Even if the tortilla used to make the burrito were extremely massive, it would make a far from ideal warp drive. The team found that a flat, circular shape would work best, with the largest side facing forward, like a pie sailing towards a face (*Classical and Quantum Gravity*, doi.org/fxr8).

The mass required for a measurable effect is enormous, higher than that of an entire planet. "If we take the mass of the whole planet Earth and compress it to a shell with a size of 10 metres, then the correction to the rate of time inside it is still very small, just about an extra hour in the year," says Bobrick.

So, an actual warp drive, even a tiny one, is still science fiction. "The densities that you need to get at to make this even measurable are so high that we cannot presently produce them. It's not something that's going to work in the next several hundred years," says Hossenfelder. "But maybe eventually we'll get there." ▮

CINECLASSICO/ALAMY

Warp drives are a staple of the *Star Trek* universe

Ancient humans

Neanderthal hearing was tuned for language like ours

Krista Charles

VIRTUAL reconstructions of Neanderthal ears show that our extinct cousins had the same physical capacity for hearing as modern humans. This implies they could make the sounds we can, although whether they actually spoke a language is still unknown.

"We don't know if they had a language, but at least they had all the anatomical parts needed to have the kind of speech that we have," says Mercedes Conde-Valverde at the University of Alcalá in Spain. "It's not that they had the same language, not English, not Spanish, nothing like this. But if we could hear them, we would recognise that they were humans."

Conde-Valverde and her colleagues used medical imaging software to create virtual reconstructions of Neanderthal external and middle ear cavities, based on CT scans of their skulls. With these models, they could determine the range of sounds that Neanderthals could hear, and thus probably produce as speech.

The team also did this for a group of fossils known as the Sima de los Huesos hominins that are thought to be the immediate ancestors of Neanderthals. The results showed that, unlike these ancestors, Neanderthals had the same capacity for hearing as we do (*Nature Ecology and Evolution*, doi.org/fxrg).

Neanderthal hearing was optimised towards consonants that often appear in modern human languages, such as "s", "k", "t" and "th", in the same way that ours is, says Conde-Valverde.

We don't know if this means they had the mental capacity for language development, but Conde-Valverde says recent archaeological evidence, including stone tool use, jewellery making and art, hints at complex behaviour in Neanderthals that could indicate language ability. ▮