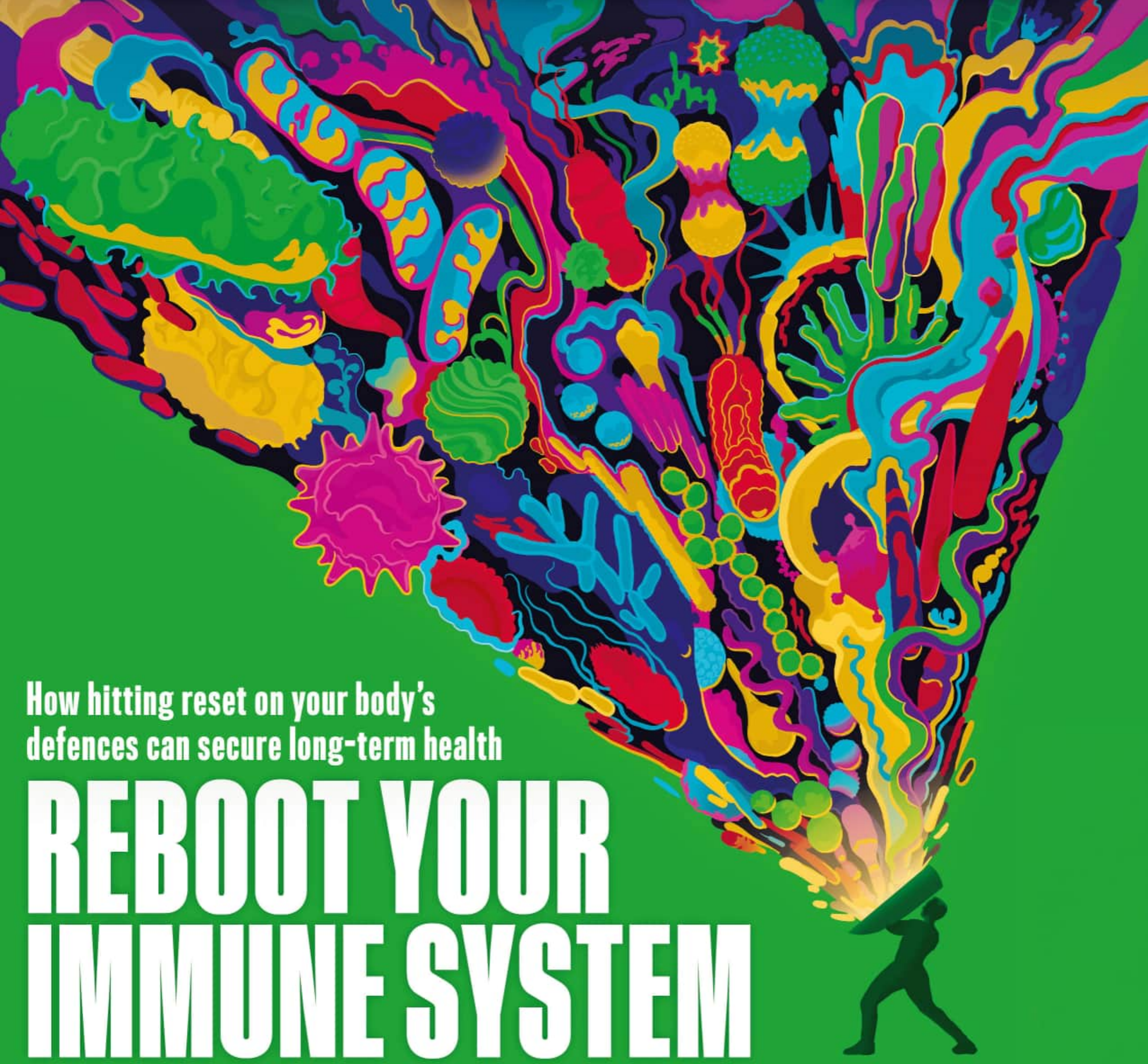
BBC **HOW MEGA-BUILDINGS ARE SLOWING EARTH'S SPIN**

Science Focus

The next-gen drinks
RETHINKING ALCOHOL

The machine that
HUNTS GHOST PARTICLES

Why strange sounds
SOOTHE YOUR BRAIN



How hitting reset on your body's defences can secure long-term health

REBOOT YOUR IMMUNE SYSTEM

IN THIS ISSUE

Tech
How gene-editing could keep your brain young

Space
The solar apocalypse that could destroy Earth

Wildlife
Scientists' bold plan for an 'internet of animals'

COMMENT

Here's how the Sun will end all life on Earth

The Sun isn't going to go supernova. But its demise will cause ripples of stellar devastation that'll be deadly to nearby planets

A few years ago, I walked into my department's weekly coffee club and had an existential crisis about Earth's future.

To be clear, the discussion wasn't about the future of Earth, per se. We were talking about a newly published paper regarding some interesting features in the spectrum of light from a distant star – technically a 'stellar remnant', or dead star, called a white dwarf.

This white dwarf couldn't possibly have any effect on our planet and nothing in its spectrum was particularly threatening. But what that paper did show us was a glimpse of the future of our Sun and, in a particularly gruesome way, ourselves.

Let me start by reassuring you that the Sun isn't going to explode. One of the most common misconceptions I encounter is the idea that the Sun is fated to go supernova someday, ending its life in a spectacular explosion that'll incinerate the Solar System. But from what we know of stellar evolution, that's not what the Sun's future looks like.

There are two main ways a star can go supernova. One, called a core-collapse supernova, is when a very massive star burns through all its fusion fuel and collapses, rebounding into an extraordinarily intense explosion.

The other is when a stellar remnant, such as a white dwarf, has some unfortunate interaction with a companion star, which obliterates them both. Our Sun isn't massive enough for a core collapse and it doesn't have a stellar companion, so as far as we know, it's safe from either of those outcomes.

That doesn't mean it's immortal, unfortunately. Today, the Sun is essentially a giant fusion reactor, transforming hydrogen to helium in its core and releasing a huge amount of energy in the process. Some of that energy escapes into the Universe as light, but some goes towards making the plasma inside the Sun bounce around at high speed.

This is what causes the pressure that keeps the Sun from collapsing under its own weight, in the same way the air pressure inside a balloon stretches the rubber and keeps it round. For the next five or so billion years, the Sun will carry on like this, but, eventually, its hydrogen supply is going to start running out. At this point, things will start rapidly going wrong.

With fusion slowing down, the pressure support drops and the core starts to compress. As a result,

ILLUSTRATION: CHARLIE PADGETT

"At some point in the red-giant phase, the Sun's puffy outer layers slough off into space"

a bit of the helium inside the core, now much hotter and denser, begins to fuse into heavier elements, releasing energy even faster. The Sun brightens and swells. By this time, the Sun will have long since become bright enough to boil off Earth's oceans, probably ending all terrestrial life. But things get even worse for Mercury and Venus. As the Sun continues to evolve, it puffs up to hundreds of times its current size, engulfing the orbits of the two inner planets and vaporising them completely.

What happens to Earth at this point in the process is a bit unclear. Will it also be engulfed, meeting the same fiery doom? Will it get pushed farther out? Honestly, things don't look great for Earth whichever way you look at it.

At some point in the red-giant phase, the Sun can no longer do fusion of any kind. Its core compresses even further and its puffy outer layers slough off into space. (On the bright side, this is likely to make a very pretty planetary nebula.) Meanwhile, the core compresses into an extremely dense white dwarf star, which is held up not by fusion, but by a strange feature of quantum mechanics that says if you try to pile up too many electrons, some of them will start moving extremely fast, increasing the pressure enough to stop the collapse. All stars like the Sun seem fated to end their lives as dense white dwarfs, slowly cooling and fading forever.

Which brings us back to that department coffee meeting. The researchers behind the paper had been looking at white dwarf spectral lines (the pattern in the light that tells us which elements are present) and noticed a bit of pollution. Where they expected only a few light elements, they found calcium, potassium and sodium. These weren't produced by the stars. They concluded they were debris from rocky planets the stars had recently devoured, showing up as distinctly as blood on the jaws of a predator.

While still reeling from this existential horror, I discovered that astronomers have been studying polluted white dwarf stars for decades and, as far as I know, maintaining emotional composure. And, sure, one could argue that a supernova would be worse. But to me, there was something particularly visceral about looking at those spectral lines and wondering about the poor lost planet that produced them.

Maybe, someday, billions of years from now, some alien astronomer on a far-off planet will look in our direction. Perhaps they'll see a smudge of dirt in the light of a lonely white dwarf star, surrounded by the glow of a nebula, and spare a thought for the beautiful world we once were.

DR KATIE MACK

(@AstroKatie) Katie is a theoretical astrophysicist. She currently holds the position of Hawking Chair in Cosmology and Science Communication at the Perimeter Institute for Theoretical Physics.