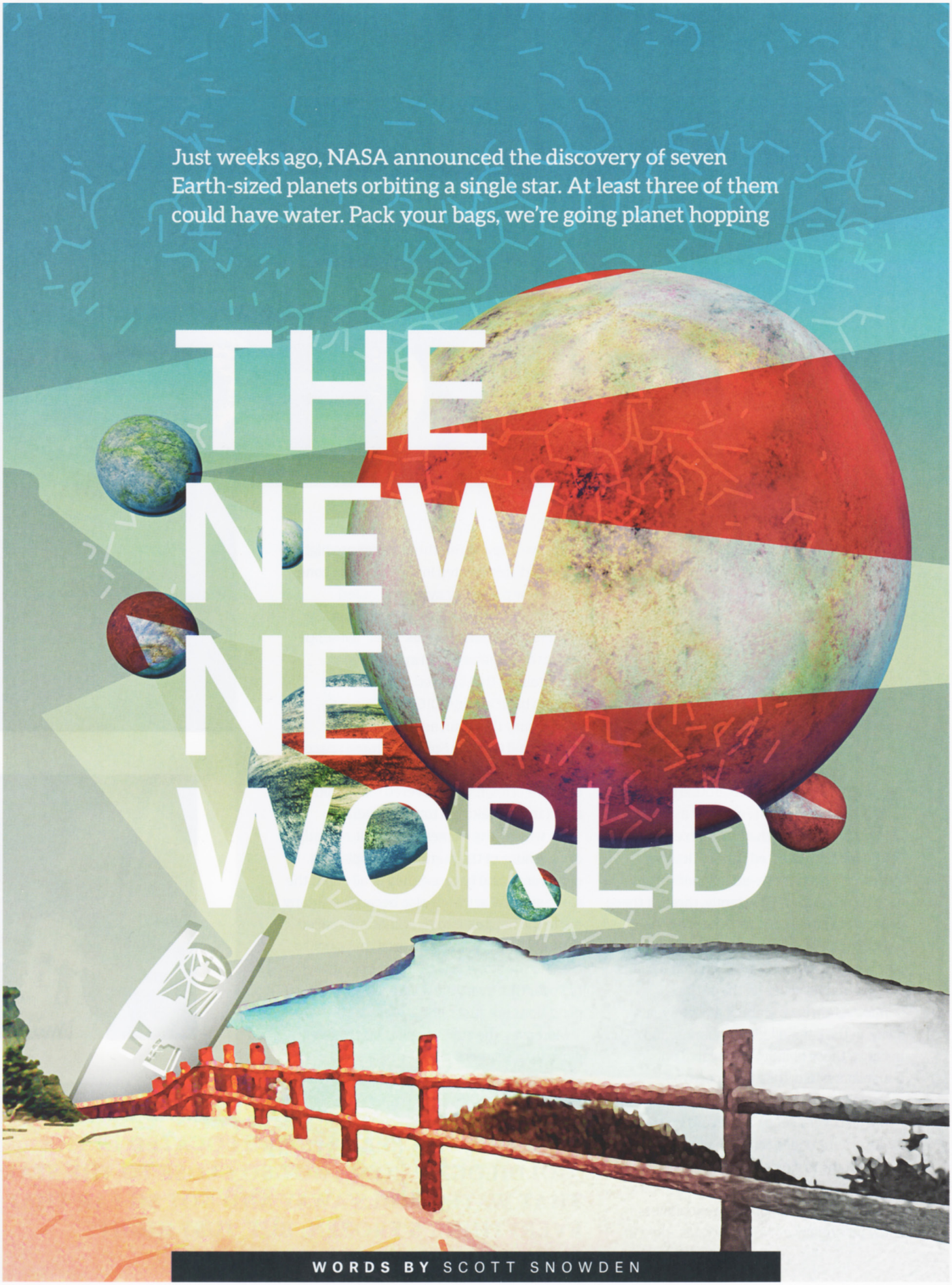
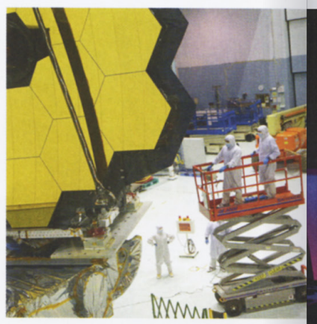


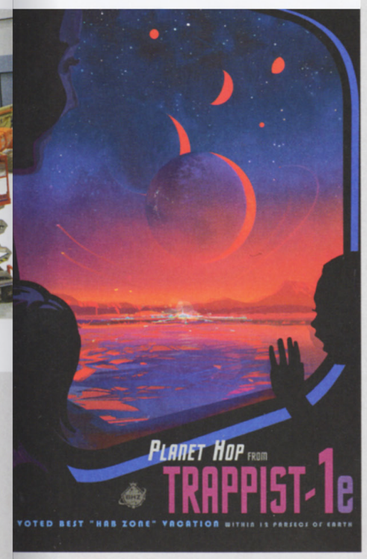
Just weeks ago, NASA announced the discovery of seven Earth-sized planets orbiting a single star. At least three of them could have water. Pack your bags, we're going planet hopping

THE NEW NEW WORLD

WORDS BY SCOTT SNOWDEN

The fourth, fifth and sixth distant planets in the Trappist-1 system dwell in their star's habitable zone. **Below left:** NASA is building the James Webb Space Telescope to study the planets in more detail. **Below:** could we one day be taking exoplanet vacations?





Millions gathered around their monitors in February as NASA revealed that the Spitzer Space Telescope had detected the first known system of seven Earth-size planets orbiting a single star. Most importantly, three of these planets are situated in what's called the habitable zone – the distance from the parent star where conditions are such that a planet can have liquid water on the surface.

This system is only about 40 light years away, in the constellation Aquarius, and because these planets are located outside our solar system, they are known as extrasolar planets or exoplanets.

The discovery set a new record for the largest number of habitable-zone planets found around a single star outside our own solar system. Under the right atmospheric conditions, all seven of these exoplanets could potentially have liquid water – key to life as we know it. But the chances are highest with the three located in the habitable zone.

The new planetary system is called Trappist-1, named after the Transiting Planets and Planetesimals Small Telescope – at an observatory high in the Chilean mountains – that spotted the first three planets back in May 2016. More recently, in February this year, astronomers announced that the Spitzer infrared space telescope, assisted by several ground-based observatories, had discovered four additional exoplanets, making a total of seven.

So, why all the excitement? Well, not only is it because of the number of exoplanets discovered, and because they're all about the same size as Earth, but also because so many are in the habitable zone. Sometimes called the Goldilocks zone, it's an area that's not so close to the star that water just boils away, or so far that everything's frozen – it's where conditions are 'just right'.

Moreover, the star Trappist-1 is relatively close to us in interstellar terms and it's a red dwarf, which means it's small and dim. This in turn means telescopes on Earth and in orbit can study the system more effectively than if it were a big, bright star, which opens up opportunities to discover more about the planets' atmospheres. Add all that up and it's got astronomers working overtime.

THREE OF THE PLANETS ARE LOCATED IN THE 'GOLDILOCKS' ZONE, NOT SO CLOSE TO THE STAR THAT WATER BOILS AWAY AND NOT SO FAR THAT EVERYTHING'S FROZEN, BUT 'JUST RIGHT'

MIXED SIGNALS

While we expect the first alien transmission detected to be based around a universal scientific concept (see over the page), one different scenario is that we might receive the popular TV broadcasts of an alien civilisation. Yes, forget mathematical constants and instead imagine we stumble on the alien equivalent of *EastEnders*, a cosmic *Coronation Street* or an intergalactic *Top Gear*. This is the notion behind a brand-new podcast called *Transmission*.

'We know we are no longer alone in the universe as we begin to receive the popular broadcasts of an alien civilisation 4.25 light years away,' explains the show's creator, Ian Garret. 'A new shared space race begins as we work to decipher the broadcasts and send a delegation on the most amazing journey ever.'

All TV signals leave Earth and travel into space at the speed of light, dating all the way back to coverage of the opening ceremony of the 1936 Olympic Games, which was the first television broadcast of significant power that went into space. And a hilarious interpretation of this notion of receiving alien broadcasts was used in the movie *Galaxy Quest*.

Incorporating interviews with high-profile members of the scientific community, all 15 episodes of *Transmission*'s first season will be available to download after its premiere at the Edinburgh Festival in August, and a live recording of a new episode will take place at the Edinburgh International Science Festival in April. More details will be available from the website transmiss.io/n soon.

UP IN THE AIR

NASA says that the next phase of research – the hunt for key gases like oxygen and methane in the planets' atmospheres – has already begun. This will provide evidence about whatever is happening on the surface.

'We know how big [these planets] are from how much light they blocked from their host star as they passed in front of it, called a transit,' astrophysicist Phil Plait told *BBC Earth*. 'We can get their orbital period from how long the transit took and that also tells us how far they are from the star. After that, we can only guess what they're like. Some are probably too hot and some too cold, there's still so much to discover.'

Simple things that we take for granted, such as gravity, atmosphere and even our moon, have had a significant effect on how life has evolved on Earth. Biologist D'Arcy Wentworth Thompson has speculated about the effects of gravity on evolution: 'Were the force of gravity to be doubled, our bipedal form would be a failure, and the majority of terrestrial animals would resemble short-legged saurians [lizards], or else serpents,' he said. 'Birds and insects would suffer likewise, though with some compensation in the increased density of the air. On the other hand, if gravity were halved, we should get a lighter, slenderer, more active type, needing less energy, less heat, less heart, less lungs, less blood. Gravity not only controls the actions but also influences the forms of all save the least of organisms.'

And that's why it's such a big deal that these exoplanets are Earth-size, because that means gravity will be similar to here.

Gravity isn't the only factor to consider. Trappist-1 itself doesn't emit very much ultraviolet light – instead, its primary luminosity is emitted in the infrared spectrum. 'The star is very red,' says Plait. 'Interestingly, chlorophyll absorbs red light pretty well, so plants there could use that molecule just as ours would. They wouldn't look green, though, since the star doesn't emit any green light. Plants on Earth reflect green light, which is why they look green, so plants on these exoplanets might look black.

'We've seen planets around small red dwarfs before, and planetary systems with lots of exoplanets around other stars – but we've never seen a system with this many planets around a red dwarf star. This is the most common kind of star in the galaxy; there are probably a hundred billion or so

of them. If systems like this are common, then planets orbiting stars like Trappist-1 are far, far more common than ones orbiting stars like our sun,' continues Plait.

We won't have to wait too long to gain further insight into the kind of atmosphere these exoplanets have: once the James Webb Space Telescope launches in October next year, scientists will be able to study them in much more depth. And what will they find? Intelligent and enlightened beings such as those you might see in *Star Trek*, or xenomorphs with acid for blood as in *Alien*?

'We've never found any life beyond our own world, so your guess is as good as mine,' says Plait. 'But for three-quarters of its existence, Earth was covered in simple plants like yeast and cyanobacteria. So probably most planets we find will be like that, too.'

LOOKING FOR LIFE

The Earth is 4.5 billion years old and *homo sapiens* has been around for a couple of hundred thousand years. Trappist-1 is at least 500 million years old, so it's not impossible that we could find intelligent life has already evolved. Perhaps it took a different route and skipped the whole prehistoric/dinosaur thing.

'Yes, we have looked at it,' says Dr Seth Shostak, senior astronomer at the Search for Extraterrestrial Intelligence (SETI) Institute. 'Back when the first three exoplanets were discovered, we spent some time looking over a wide range of the radio dial for signals using the Allen Telescope Array.

'We didn't find anything, but we're going to go back and we're going to refine the experiment, because we now know there are four more planets and we now know how long they take to orbit the star, which makes them easier to scan for any communication signals being transmitted,' he says.

It's generally believed that an alien intelligence would employ scientific reasoning when sending out a message, in order to make it easier for other civilisations to detect. For example, Carl Sagan theorised for his book *Contact* that the message would be transmitted at 4.4623GHz. This is the frequency at which hydrogen readily absorbs and emits energy, times pi (π), a circle's circumference divided by its diameter. It doesn't matter what language you use, or what units you choose, these are both natural constants. An alien civilisation might call this frequency 78.9 SplugiWhiz, it doesn't matter, because it still means the same to us.

'We are looking at the hydrogen frequency, as that is by far the most important number in all of radio astronomy, because three-quarters of the universe, by weight, is hydrogen. Aliens would know about it, so maybe they are broadcasting near that number because they know we'll be looking,' says Dr Shostak.

Since radio waves travel through space at the speed of light, any message would have to travel for 40 years before it reached either Earth or any of the exoplanets in the Trappist-1 system, making the wait for a reply somewhat lengthy. But even with all these hurdles, Shostak is confident that we will find a transmission of alien origin within the next 20 years.

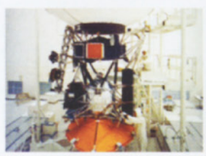
THE EARTH NEXT DOOR

If 40 years is too long to wait for a reply to a message, Proxima b (artist's impression, right) is only about 4.2 light years from Earth, making it the closest known exoplanet to our solar system. The Earth-sized planet, found last year, circles the star Proxima Centauri, and conditions there look promising for life. But is it practical to go looking for it? In 2015, NASA's New Horizons probe completed its 3-billion-mile journey to Pluto after travelling for nearly 10 years at 59,000km/h. At that speed, it would take the craft about 737,000 years to reach Proxima Centauri. And the difficulties don't end there. The SETI Institute only has a few dedicated arrays and is predominantly based in the US, but Proxima b is in the southern hemisphere. 'If we were in Australia we would do it, but we're not,' says SETI's Dr Seth Shostak. 'We can only look at it from time to time.'

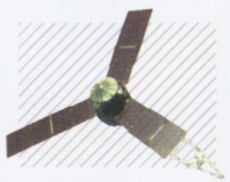
HOW LONG WOULD IT TAKE TO REACH TRAPPIST-1?

WALKING FROM EARTH
(5km/h, without any breaks)
8,653,099,354 years

DRIVING FROM EARTH
(113km/h, without stopping)
383,208,685 years



VOYAGER 1 (61,380km/h, already 11.7 billion miles from Earth) 703,288 years



THE FASTEST SPACECRAFT
currently in the solar system, Juno (which orbits Jupiter with a speed of 257,495km/h relative to Earth) 167,653 years

THE MILLENNIUM FALCON
Star Wars (hyperdrive – faster than speed of light) 27 years

THE USS ENTERPRISE
NCC-1701 (original *Star Trek* series, warp 5.5) 87 days

Photographs: Getty, Shutterstock, Science Photo Library, iStock, Rex Features, Alamy, NASA