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Sky at Night

JULY 2017

ASTEROID DAY

DID LIFE COME FROM SPACE?

The evidence bringing us closer to discovering whether asteroids sparked Earth's biosphere

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JULY'S NIGHT SKY

17 PAGES OF OBSERVING

- Image noctilucent clouds
- Tour the Veil Nebula region
- See a bright comet in Aries

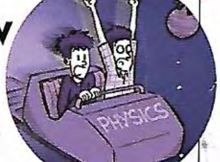
EXTRA ONLINE

CLASSIC EPISODE

Patrick investigates the origins of life in a 1978 *Sky at Night* episode

BOOK PREVIEW

A comic creator and a physicist explore the Univ…



VIDEO INTERVIEW

Richard Darvill, the UK engineer building a new …

This month's contributors include...

Ainsley Bennett
Award-winning imager

Ainsley explains how he used Lightroom to create his IAPY 2016 Skyscape category winner, Binary Haze. *Page 84*

Jasmine Fox-Skelly
Science writer

Jasmin helps us make sense of asteroids: like the planets themselves, they show wonderous variety. *Page 78*

Emily Lakdawalla
Planetary geologist

Amateurs have been processing data from Juno to create exciting new images; Emily examines some of the best. *Page 66*

Mark Parrish
Astronomy craftsman

Mark shares an easy method for adding a red light illuminator to a finder, to make it easier to find bright celestial targets. *Page 81*

Welcome

Dig deeper into the secrets, surprises and dangers of asteroids

The question of how our planet came to host such a unique abundance of life is one that many branches of science have sought to answer. Within astronomy there's one theory that life didn't begin on Earth at all, but was brought here from elsewhere in space by impacting comets and asteroids. This hypothesis – known as panspermia – is not new: it was first put forward in the 19th century. Now there's fresh evidence, which Nick Spall assesses on page 32.

Those asteroids that could have delivered life in the past can certainly end it in the present, which is why we mark Asteroid Day this month. On page 78, you'll find a guide to the types of asteroid lurking out there in the Solar System. It's a stark reminder of the dangers we face – there are close to 800 near-Earth asteroids over a kilometre in diameter whose impact would be an extinction-level event. The good news is amateur astronomers can do something about the risk: on page 44 find out how you can observe, track and even discover space rocks for yourself.

If asteroids aren't your thing, July is peak season for noctilucent clouds, and we've got guides to imaging them on page 64 as well as creating a timelapse to show their movement on page 38. Our 17-page *Sky Guide* is packed with many more observing targets, including a challenge to find the closest double you can split with binoculars.

And if light nights, weather or a combination of both conspire against you this month, take a look at the Jupiter image gallery on page 66. These were processed by amateurs using photo data from NASA's Juno probe and can be done at any time!

Enjoy the issue.

Chris Bramley Editor

PS Our next issue goes on sale 20 July.

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JULY'S BONUS CONTENT

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Highlights

Classic Episode:
Where Did Life Begin?

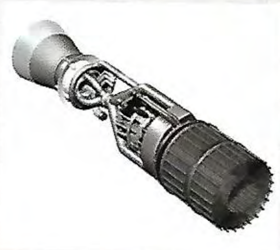
Many of us take it for granted that life on Earth began on Earth. But what if it began somewhere else in the Universe? In this classic *The Sky at Night* episode from 11 October 1978, Patrick Moore explores this very conundrum, turning to the help of astronomers Fred Hoyle and Chandra Wickramasinghe.

and much more...

- ▷ Hotshots gallery
- ▷ Eye on the sky
- ▷ Extra EQMOD files
- ▷ Binocular tour
- ▷ Equipment review guide
- ▷ Desktop wallpaper
- ▷ Observing forms
- ▷ Deep-sky tour chart

Interview: UK's 'Air-Breathing Rocket'

We speak to Richard Varvill, the British engineer whose new rocket engine could revolutionise spaceflight.



Video: The Majesty of the Milky Way

Watch astrophotographer Adrien Mauduit's galactic tribute. How many deep-sky objects can you spot?

Audiobook Preview: We Have No Idea

What happens when an illustrator meets a particle physicist? Download a chapter of their new book.

EVERY MONTH
Virtual Planetarium

With Pete Lawrence and Paul Abel

Explore July's night-sky highlights with Pete and Paul.

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LIFE FROM SPACE

The debate continues

Could simple life travel across space to seed suitable planets? **Nick Spall** considers whether we are closer to discovering the truth behind the extraordinary concept of panspermia

The search for extraterrestrial life is now a fundamental driver for space research and astronomy. We now know of almost 3,500 confirmed exoplanets and it seems like new candidates are being identified daily. One recent find could be a water world: GJ 1132b, which is 1.4 times the size of Earth, is thought to have an atmosphere of either water or methane. While it is likely to be too hot for life to exist there, eventually astronomers expect to find a really promising world that could support life – a real Earth-type exoplanet in the perfect goldilocks zone around its star.

On a benign planet like that, we theorise that life could arise independently – a process known as abiogenesis. But there is another hypothesis, that life could arrive from afar, carried by meteorites, comets or asteroids, an idea we call panspermia.

Exobiologists have traditionally focussed on the possibility of life occurring on Mars and within the subsurface oceans of the icy moons Europa and Enceladus, but could simple life forms such as bacteria and extremeophiles be – as panspermia proposes – much more widespread? Could life be drifting through interplanetary space right now, in the form of dormant spores and bacteria?

A seed of an idea

The concept of panspermia began in a basic form from the work of researchers such as Jöns Jacob Berzelius, Hermann Richter and Svante Arrhenius from the 1830s through to the early 1900s. In more recent years it has been promoted by Prof Chandra Wickramasinghe, a former colleague of the famous cosmologist Sir Fred Hoyle. His views also include the idea that pandemics and outbreaks ▸

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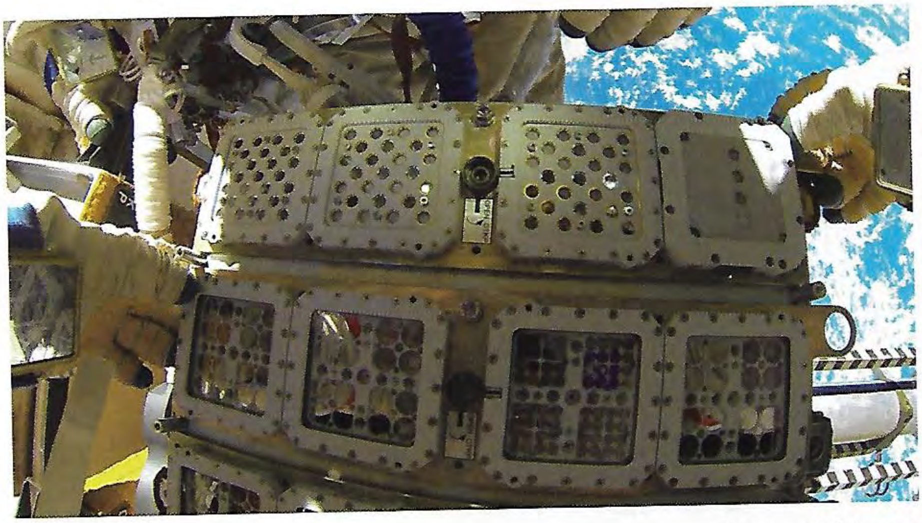
ABOUT THE WRITER
Nick Spall is a freelance space writer. He's interviewed astronauts, and experienced zero-G and parabolic flights.

It's an unresolved question, even on Earth – does life have to begin on a planet, or could it arrive as a stowaway on a space rock?



▲ **The EXPOSE-R2 facility during installment on the outside of the ISS in August 2014**

▸ of illness have occurred as a result of active spores travelling across the vacuum of interplanetary space and arriving in the atmosphere.

A good many exobiologists doubt these conclusions. However, it was Wickramasinghe who first proposed, with Hoyle in 1974, that some dust in interstellar space was largely organic as it is composed of carbon compounds, including silicates, inorganic carbon (such as graphite) and ices of various kinds. Today the scientific community accepts that organic molecules are common in the Galaxy.

To add to the panspermia debate, recent results of the EXPOSE experiments on the International Space Station (ISS) have shown that meteorite-type protection layers around organic biological samples could indeed allow for bacterial endospores and even seeds to survive in the harsh vacuum of space, despite heavy ultraviolet radiation and extremely low temperatures. This material might also withstand an entry into a planetary atmosphere.

From 2008 to 2016, EXPOSE's samples were exposed to space and then returned to Earth from the ISS. Some have survived, even after 1.5 years mounted outside the ISS – in one case 100 per cent of the bacterial endospores placed in Mars-type conditions were viable – still capable of life, in other words. A quarter of the experiment's tobacco seeds survived to be grown as plants back on Earth.

The EXPOSE results represent the first data evidence that basic cryptoendolithic life – organisms that colonise cavities in the structures of rocks – can be hardy enough to survive movement through outer space. This is of key importance to the panspermia debate and future exobiology research directions. It is also of direct relevance to future Mars mission sample analysis, planetary protection sterilisation for lander probes and the future exploration of possible life-bearing environments across the Solar System and beyond.

Types of panspermia

Panspermia addresses the way that life could be distributed across the Galaxy, no how life actually began. Various methods of transport are included in the theory. 'Lithopanspermia' proposes that extremophile-type microscopic life could

NASA X 2, ISTOCK X 2, ESO, PAPILIO/ALAMY STOCK PHOTO

IS PANSPERMIA POSSIBLE? TWO DIFFERENT VIEWS

Prof Chandra Wickramasinghe and Prof Ian Crawford make the case for and against the theory

Yes, definitely

Prof Chandra Wickramasinghe, director of the Buckingham Centre for Astrobiology, University of Buckingham

"When Fred Hoyle and I first proposed the theory of cometary panspermia in the early 1980s, the supportive evidence was very limited compared to what we have today. Our starting point was the unexpected evidence that was obtained in the 1970s for the widespread occurrence of complex organic molecules resembling biological dust in interstellar space. This data was combined with perceived flaws and inadequacies in the standard theories of the origin and evolution of life on the Earth to develop the Hoyle-Wickramasinghe theory of cosmic life.

Many predictions of the H-W theory have since been verified. These include the detection of biomaterial in comet dust collected in the stratosphere, discoveries following from the space exploration of comets and the surprising evidence from DNA sequence studies indicating the role of extrinsic viruse in the evolution of terrestrial life.

The enormous survivability of bacteria a viruses, as well as plant seeds and tardigra under space conditions, powerfully adds to case for panspermia and for life as a cosmi rather than terrestrial phenomenon. In my vi the old primordial soup idea will soon be relegated to the archives of science history. O a period of three decades no data has com to light that contradicts cometary pansperm

No, it has still to be proven

Prof Ian Crawford, professor of planetary science and astrobiology, Birkbeck University of London

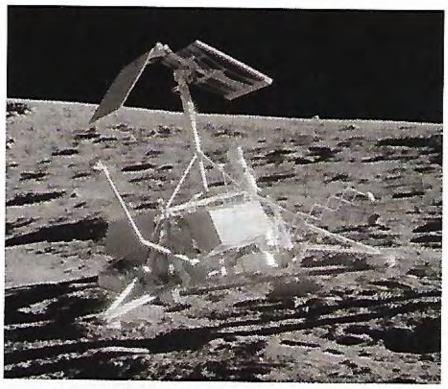
"It is theoretically plausible for microbes to travel between planets in meteorites, but this has not yet been demonstrated. If it proves to be physically possible then it follows that life may have arrived on Earth from elsewhere, perhaps from Mars or another location in the Solar System, although there is no evidence for this.

Panspermia, if it occurs, does not solve the problem of the origin of life, but merely relocates that event to somewhere else in the Universe. The main theoretical advantage of panspermia as a concept is that wherever 'somewhere else' was, it may have permitted more time for the pre-biological chemical reactions that led to the origin of life, but we don't currently know that more time was actually required. The only way to determine if panspermia has been operating in the Solar System is to exp other habitable, or past habitable, environm on other planets – such as Mars. If pansper has been operating, it will predict that all l found throughout the Solar System will ha common origin and thus share key biochem characteristics – such as the same genetic c On the other hand, if life did not travel betw planets, we would expect that any life we would be quite different to our own."

Lithopanspermia says that life could be carried into space amongst the planetary ejecta from an asteroid impact

▲ Dust clouds such as those within NGC 6537 could harbour the building blocks of life, a variation known as pseudopanspermia

▲ Tardigrades or 'water bears' are tiny organisms famed for being able to survive in the harshest conditions, even space



▲ Lunar lander Surveyor 3 is said to have been the interplanetary ferry for Earth bacteria, which survived in a dormant state

exist in debris blasted into space from planetary collisions with asteroids and comets. Alternatively, 'radiopanspermia' postulates that organisms might travel through space via radiation pressure from stars – it is argued in this situation that the lethal action of ultraviolet and X-ray radiation, plus the vacuum of space, does not completely destroy all the microorganisms, and that enough may possibly survive to seed a suitable planetary environment. Another variant is 'pseudopanspermia' where, in a relatively soft molecular process, the organic building blocks of life originate in interstellar dust clouds and are transported to the surfaces of planets where life is then developed via abiogenesis.

Many researchers have questioned whether panspermia is really possible. Both Iosif Shklovsky and Carl Sagan noted how the harsh environment of space could seriously damage viable DNA or RNA in spores and microorganisms. In response, Wickramasinghe and others consider that given enough microbes in a dust cloud, some could survive in space in a dormant form.

Experimental evidence

The search for extraterrestrial life and the possibility of organisms surviving the harsh space environment has been investigated with numerous orbital experiments. As well as the ISS's EXPOSE experiments, there has been BIOPAN on Russian Foton capsules and EXOSTACK on the US Long Duration Exposure Facility satellite. These have shown that when given basic protection, spores, lichens and even tiny animals known as tardigrades could survive for a few years in space.

Famously, a piece of the Surveyor 3 lunar lander that was bought back to Earth by the Apollo 12 crew in 1969 was found to contain an Earth bacterium that appeared to have survived unprotected for over two years on the airless surface. Controversy surrounds whether this bacterium came from laboratory contamination on arrival back on Earth, but the excitement it caused gave added concerns over future contamination by ▸

THE SEARCH FOR LIFE CONTINUES

The quest to discover life in the Solar System is a key research objective for future missions

Ongoing
EXPOSE on the ISS will continue to study the survivability of organic material in space until 2024.

2016-2018
NASA's Juno mission to Jupiter will perform close studies of the icy moon Europa.

2018
NASA's Insight lander to Mars is set to carry out interior studies of the Red Planet.

2018
JAXA's Hayabusa 2 will reach asteroid 162173 Ryugu in 2018 and return samples by 2020.

2018
NASA's OSIRIS-REX will bring back 2kg of material from asteroid 101955 Bennu by 2023.

2020
NASA's Mars 2020 rover will look for life past and present, and store samples for a future mission to collect.

2020
ESA's Exomars rover will drill deep below the surface to seek potential past and present life.

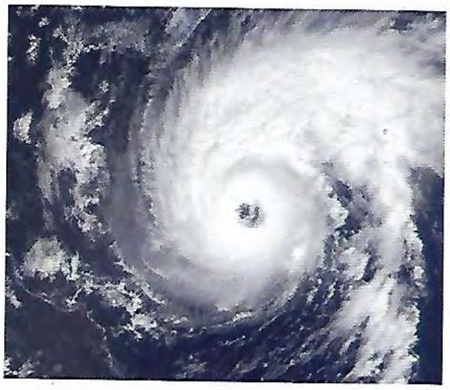
2022
ESA's JUICE mission will send an orbiter to study Jovian moons Europa, Ganymede and Callisto.

Mid 2020
NASA's Europa Clipper will perform multiple flybys of Europa to analyse its liquid water ocean.

From 2030s
Human landings on Mars, focused on surface life studies, drilling, and sample analysis and return.

Post 2050s
Future lander and sample-return missions to icy moons could include subsurface ocean probes.

Late 21st century
Human landings and research on Europa, Titan, Enceladus, Ganymede and others.



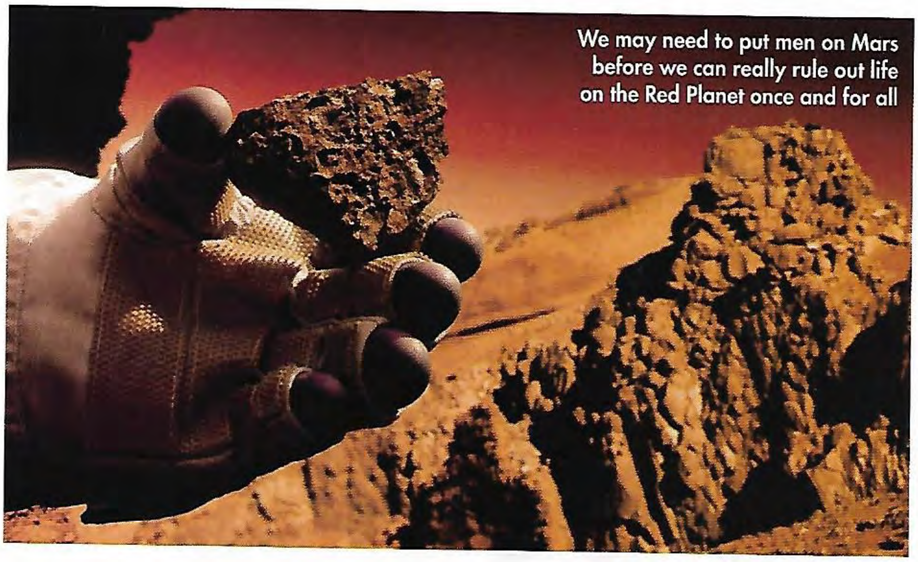
▲ Cells high in a world's atmosphere does not guarantee panspermia – extreme weather systems such as hurricanes could lift them there

▸ lander probes to Mars and destinations such as Titan, Europa and Enceladus.

A search for space microorganisms at stratospheric altitudes was carried out by the Indian Space Research Organisation (ISRO) via balloon flights between 2001 and 2006. The results were considered by Wickramasinghe to indicate that living interplanetary cells existed in air samples taken from above 41km, a level at which air from lower levels of the atmosphere could not normally be transported. However, in 2010 NASA atmospheric sampling before and after hurricanes suggested that large-scale convection could transport Earth bacteria very high into the upper reaches of the atmosphere.

What of future space missions to seek out answers to the question of panspermia? Several orbital and landing missions are planned for Mars, the icy moons, and asteroids and comets. But many believe that it will need the presence of astronaut explorers on the surfaces of Mars and other longer distance targets like Europa and Enceladus to properly solve the question of life in the Solar System.

Comparing any life forms found, be they past or present, with Earth-type life will be a crucial test of panspermia and exobiology researchers have to take the possibility on board when designing life-seeking space missions for the future. Until probes find direct evidence of space-borne life, whether on a planet or moon surface or via deep-space sample collection, the panspermia debate will continue. Ⓢ



We may need to put men on Mars before we can really rule out life on the Red Planet once and for all