

BBC TOO FAST: THE SHOES BANNED AT THE OLYMPICS

Science Focus

THE BIG QUESTIONS

SPECIAL
ISSUE

Do we live in a simulation?

Should we reach out to aliens?

How did life begin?

Is religion dying out?

Should we play with evolution?

What are emotions?

Are we getting happier?

What's inside the fifth dimension?

What happens when we die?

Can we cure old age?



IN THIS ISSUE

Icy plunge

Why doctors think you should try cold-water swimming

Dragon man

Meet the long-lost member of the human family

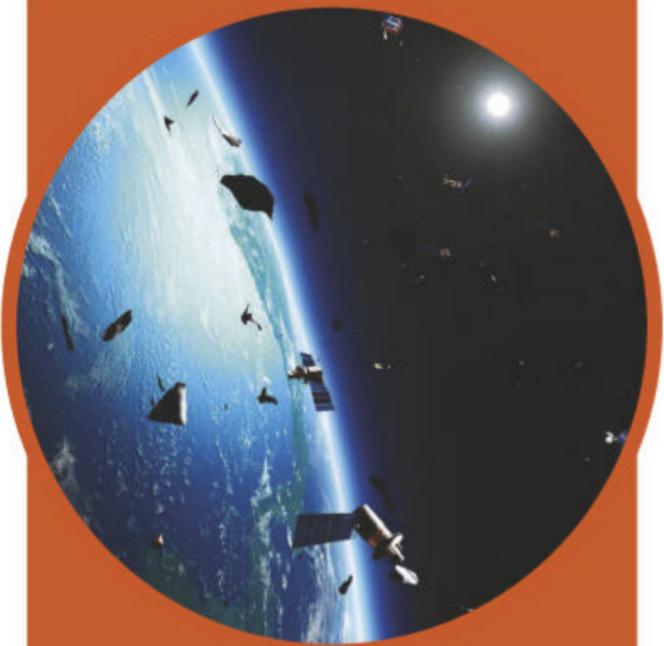
Artificial heart

A machine-based transplant Iron Man would be proud of

QUICKFIRE

WITHOUT ALL THE EMPTY SPACE, HOW BIG WOULD THE UNIVERSE BE?

It's said atoms are largely empty space – protons and neutrons one million-billionth of a metre across with electrons circling in orbits over 100,000 times larger. Quantum theory shows this model is misleading, but ignoring this, astronomers estimate there are roughly 10^{80} atoms in the visible Universe. Crammed together, they'd make a ball that would fit inside the Solar System.



HOW MANY PIECES OF SPACE JUNK ARE ORBITING EARTH?

There are currently 28,600 catalogued pieces being tracked, according to the European Space Agency. But that's only the bits that are large enough (upwards of 5cm) and near enough to register on radar.

Statistical models estimate there could be as many as 900,000 pieces between 1cm and 10cm, and up to 128 million pieces sized 1mm to 1cm.

HOW DO WE KNOW HOW OLD THE UNIVERSE IS?

We deduce the age of the Universe (13.82 billion years old) from observations, coupled with an assumption that the fundamental physical laws of today also operated in the past. We know that the galaxies we observe are receding, so the Universe is expanding. If the rate of expansion were constant, that would give us a point in time when it was zero size, which we could label the beginning: the Big Bang. But the rate of expansion seems to be increasing. This expansion tells us the Universe as we know it hasn't been here forever.

COULD WE BUILD AN ELEVATOR TO THE MOON?

Blasting off in a rocket is an expensive, difficult and dangerous way to get to the Moon. COLIN STUART looks into another way we could travel there and back

What do you see when you look at the Moon? Beauty? Craters? Some people see dollar signs. You'll occasionally see our only natural satellite billed as 'Earth's eighth continent' because it's full of resources that are hard to ignore. A rare form of helium, helium-3, could be used in fusion power stations here on Earth. Rare elements, such as neodymium, could be extracted and returned home for use in smartphones and other electronics.

But how do we get them here without blowing all the profits on rockets? According to a study published in 2019, a lunar elevator could be the answer. A cable anchored to the lunar surface would stretch most of the 400,000km (250,000 miles) home. It couldn't be directly attached to the Earth, due to the relative motions of the two objects, but it could terminate high in Earth orbit. That would have the added benefit of placing it above the bulk of our space junk, a growing problem as we launch ever more satellites. Solar-powered robotic shuttles could move up and down the cable, acting as a conveyor belt to ferry precious resources our way.

GOING UP?

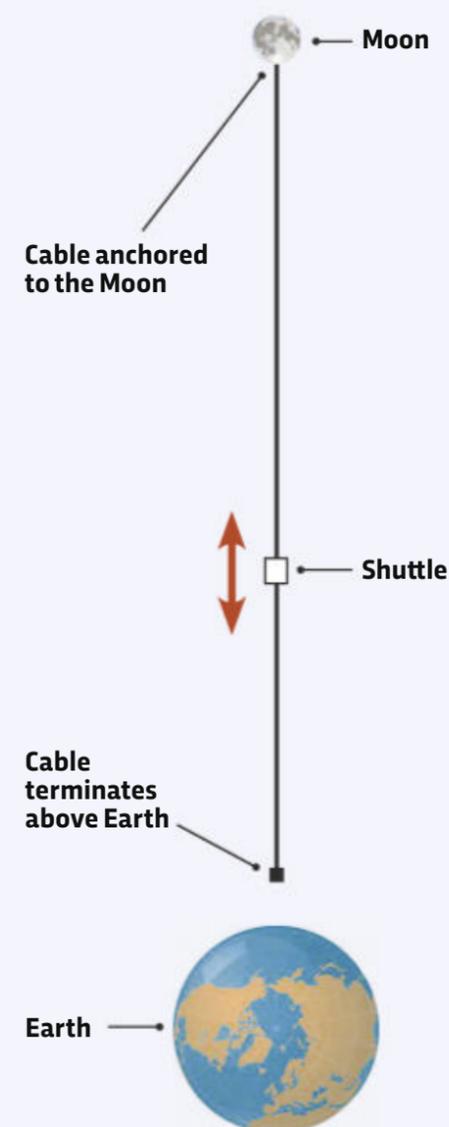
It may sound like an outlandish prospect, but Zephyr Penoyre and Emily Sandford – the two University of Columbia astronomy PhD candidates behind the study – believe we could pull it off for a few billion US dollars. To put that into context, Jeff Bezos liquidates \$1bn (over £700m) of his Amazon stock every year to fund his Blue Origin space tourism company. NASA's Artemis programme, which is sending the first female astronaut and first astronaut of colour to the Moon later this decade, is costing \$86bn (£60bn). Such is the value of the Moon's resources, a separate study estimated that a lunar elevator would pay for itself within just 53 trips.

The cable, which would be no thicker than a pencil, would weigh 40 tonnes – well within the remit of modern rockets,

It's not as dramatic as a rocket launch, but catching a lift would be a more economical method of getting into space in the long term

HOW COULD IT WORK?

According to the University of Columbia study, a cable could be attached to the lunar surface, terminating above Earth. Solar-powered shuttles travelling up and down the cable would ferry goods from the Moon.



such as SpaceX's Starship. Unlike a space elevator that would travel from Earth's surface into space, a lunar elevator stopping slightly shy of our planet wouldn't have to contend with huge gravitational forces. The Moon has no atmosphere either, which simplifies matters. That means the cable could be made from existing materials, such as Kevlar, instead of the yet-to-be-invented super-strong materials needed for an Earth-to-space elevator.

We could also combine the two. In April 2021, Chinese state-run media presented the country's idea for a 'Sky Ladder'. This would see a spacecraft winched up an elevator from Earth's surface to a waiting space station, before being flung towards the Moon where it would meet another elevator that would lower it down to the lunar surface.

The idea of space elevators has been around for over a century without much progress. But if enough people – or, more likely, corporations – become enamoured with the chance of making big bucks, we could see the lunar equivalent of a gold rush in the decades ahead. Elevators could well turn out to be a way to keep costs down and profits literally sky-high. **SF**