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Science Focus

Why you find
SLIME ABSOLUTELY EVERYWHERE

Something strange is
GOING ON WITH EARTH'S INNER CORE

Are prescription
WEIGHT-LOSS DRUGS SAFE?

THE HUNT FOR ULTRAMASSIVE BLACK HOLES

What happens when these cosmic monsters reach their limits?

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ABOVE The *Cordyceps* fungus infects an unlucky insect, then erupts out through its body

→ symptoms, it's already made it to the brain. We don't quite understand how that happens, but we think the fungus gets into the blood and then makes its way into the brain. A lot of the symptoms you see are typical of meningitis – vision loss, seizures, memory problems. Even people who survive the infection are often left with neurological impairments. Other fungi like *Candida* yeasts and *Aspergillus* can also cause significant brain infections, although that tends to only happen in patients who have been left untreated for one reason or another.

HOW DO FUNGAL INFECTIONS SPREAD?

We tend to get fungal infections from breathing in spores. Most fungal spores are airborne and we breathe them in all the time, every single time we go outside. But it's only when the immune system is damaged that a spore might not get destroyed and germinates inside your lung. Then the fungus can shapeshift into a yeast or a mycelium, a long, thin type of cell, and that's when you get the infection.

There's not much evidence that fungi are infectious diseases like viruses, where if you're near an infected person you might catch it. You tend to get fungal infections from the environment instead.

HOW DO WE TREAT FUNGAL INFECTIONS?

We have limited numbers of antifungal drugs. So when fungi start causing infections it's hard for us to get rid of them. The reason is that their biochemistry is similar to ours. If you're trying to make a drug that's going to be toxic to the fungus you have to make sure you're not targeting the same biochemical processes that occur in our cells. That's why we're much more limited in comparison to antibiotics, for example, where we have hundreds of different types.

by **DR REBECCA DRUMMOND**
Rebecca is a fungal immunologist based at the University of Birmingham.

ANALYSIS

SOLARIS: ESA'S PLAN TO GENERATE POWER IN SPACE

Could building a network of orbital power stations help us solve the energy crisis?

Some of Europe's science ministers met in Paris in late November 2022, to decide on the priority list for the European Space Agency (ESA) for the next three years. One of the decisions they took could help wean Europe off fossil fuels and provide ESA's member states, which includes the UK, with their own secure source of energy. The decision was to green-light Solaris, a bold project to investigate the feasibility of building commercial power stations in orbit.

These power stations would run on sunlight. They would be equipped with extraordinarily large solar panels to soak up the Sun's energy and convert it into electrical power that would be beamed down to Earth as microwaves. On the ground, huge antennas would receive these microwaves and feed the resulting power directly into the electricity grid.

It sounds like science fiction but, as ESA's Dr Sanjay Vijendran points out, we've been doing something very similar for the past 60 years. "Every telecommunication satellite since the 1960s is basically a space-based solar-power satellite in a small format," he says.

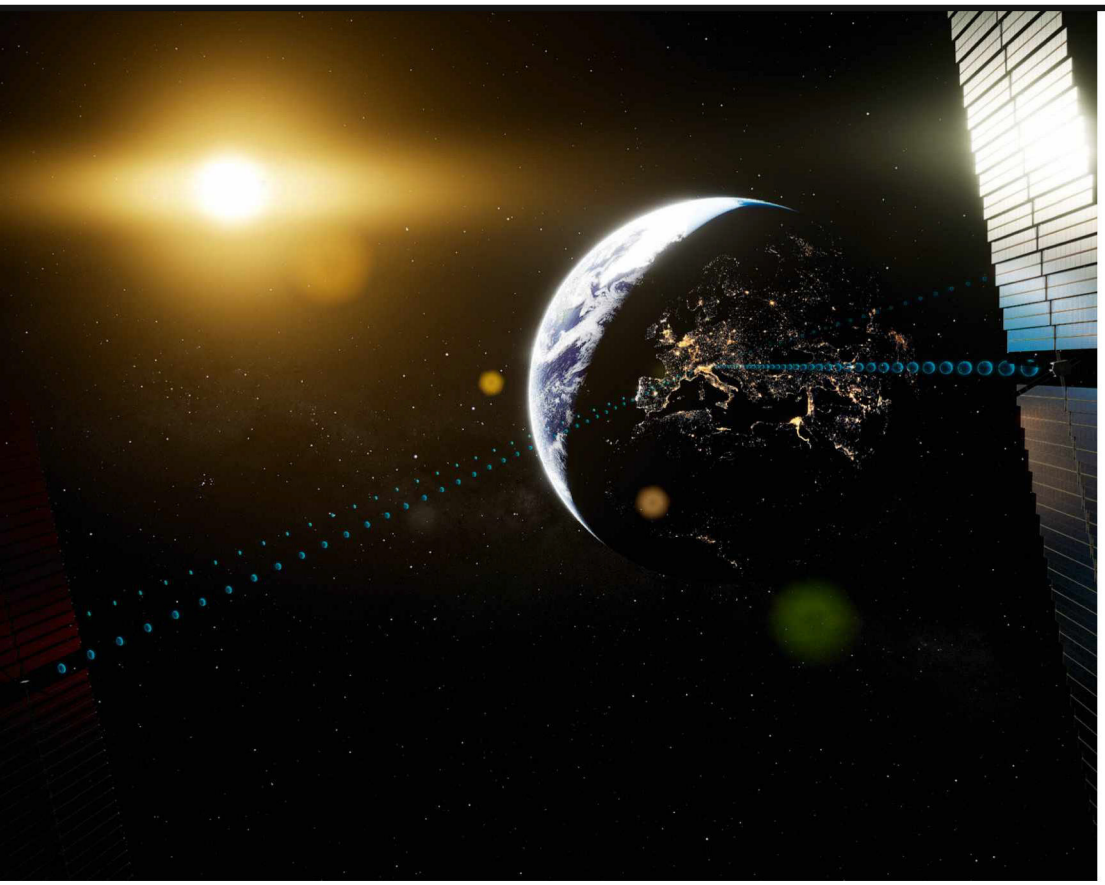
That's because such satellites generate electricity with their solar panels and use it to transmit data to Earth. The transmissions are then converted back into electricity so that the data can be read. "The physics involved in that whole chain is exactly the same for space-based solar power, but the scale of it is completely different," says Vijendran.

The size of the solar panels needed to generate power on a commercial basis would measure kilometres across. That's 10 times longer than the solar panels on the International Space Station. They would need to be constructed 36,000km away from Earth, in the same orbits as the telecommunications satellites, so that they stay above their ground stations. And they would have to be constructed by robots.

As extraordinary as all that sounds, the only thing that has prevented us from building orbiting power stations already is the cost of launching the material into space. Traditionally, it costs about $1,000 (£820 approx) to launch every kilogram into space, but given the size an orbiting power station needs to be, that would make the cost of the electricity a station generates too expensive to be commercially viable.

ALAMY, ESA

"The only thing that has prevented us from building orbiting power stations already is the cost of launching the material into space"



ABOVE Giant satellites would harvest solar energy and transmit it down to Earth and into the electricity grid

But things are changing. With the advent of SpaceX and its reusable rockets, launch costs are falling. "$300 [£250 approx] per kilogram is the holy grail for space solar power," says John Mankins, a former NASA physicist who is now president of Artemis Innovation Management Solutions.

Mankins is a world expert on solar power satellites, having worked on many feasibility studies going back to the 1990s. Each of his previous investigations of the concept have shown that the cost of launch is the prohibitive factor. But not for much longer. "$300 per kilogram is not just possible someday, it's inevitable in the next five or seven years," he says.

Hence, why ESA is now collaborating with European industry to produce two designs for solar power satellites. They're also beginning a technology development programme on solar cells and large-scale antennas, searching for ways to make them lighter and more efficient than today's models.

The great promise of space-based solar power means that it's not just ESA exploring this technology.

In the UK, the Frazer-Nash Consultancy published a report in September 2021 for the government that concluded: "space solar power is technically feasible, affordable, and could bring substantial economic benefits for the UK and support net zero pathways."

The Chinese are also pursuing the technology and plan to show the feasibility of beaming power to Earth from orbit in 2028. This will be a demonstration mission, rather than a commercial power station. But nevertheless, if successful, it would be a significant development.

In the US, the California Institute of Technology launched a demonstration satellite called the Space Solar Power Demonstrator (SSPD) on 3 January 2023, to test the technologies that will be required for a full-blown orbital power station.

"We've clearly got some catching up to do," says Vijendran.

If all goes well with ESA's plan, Solaris will be back on the agenda when Europe's science ministers meet again in three years' time. This time, however, it will be to ask for the money to build the satellites and begin scaling up the technology into something that's commercially viable. "Solaris is a bridge to check that solar power from space is really doable and that it would really help before we ask for billions of euros," says Vijendran.

by **DR STUART CLARK**

Stuart is an astronomer, science journalist and author of several popular science books, the latest of which is Beneath The Night *(£14.99, Guardian Faber).*