

What would aliens learn if they observed the Earth? A recent study provides an answer

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Earth seen from orbit around the moon. Credit: NASA

Are we alone in the universe? It's a question that fascinates scientists and the public alike. In science, the focus tends to be on our [search for life elsewhere](#). The idea that we might be watched by a distant alien civilization, however, is usually [confined to the realm of science fiction](#).

But if there are other technological civilizations out there, they would probably be significantly more developed than we are. After all, we have

only just emerged as a fledgling technical (industrial) civilization in the last 200 years—other technical civilizations could easily be 1,000 or 10,000 or even 100,000 years more advanced than we are.

And no one can deny that the [pace of our own technological progress is accelerating](#), in some areas at a blistering pace. To paraphrase science fiction author [Arthur C. Clarke's third law](#)—an advanced civilization would appear to us as capable of magic in terms of their technical prowess.

Over the last few years, my colleagues and I have started to think about whether an advanced civilization could detect the technological signatures ("[techno-signatures](#)"), such as [radio emissions](#), from Earth. And if so, what might they detect?

Our [latest study](#) provides a clue.

This isn't the first time such research has been undertaken. But it's now more than 50 years since the topic was [properly considered](#). While a lot has changed since the mid-1970s, by far the biggest change has occurred in the last two decades with the advent of mobile phones. These [devices and the towers that connect them](#) have created a new broadband radio emission techno-signature.

Although 4G [mobile handsets](#) and transmitting towers are relatively low power individually (0.1-200 watt), there are just so many of them—billions of phones and many millions of towers. And the accumulated radio emission from these is beginning to become quite significant. But would it be noticeable to an alien civilization watching from afar? We wanted to find out.

It turns out to be rather difficult to find a [public database](#) that lists the location and transmitting characteristics of all the mobile towers around

the world. But by using the [OpenCellID database](#), with data populated by crowdsourcing, we were able to build a simple model estimating the global distribution of mobile towers.

Our model is no doubt crude and incomplete, but it is our best estimate of the techno-signature mobile towers leak out into space.

Because the Earth rotates on its axis, an advanced civilization located somewhere in our galaxy would measure the radio emission from mobile towers to rise and fall in intensity as different parts of the Earth rotate into view.

The model is complicated by the fact that the transmission of mobile towers is typically beamed towards the horizon. This means that at any given time, towers that are viewed to be setting or rising on the Earth's horizon will contribute most to the measured signal.

Alien conclusions?

An advanced civilization making many precise measurements of this radio leakage over time could probably conclude that our planet is mostly covered by water and is separated into several major land masses. The radio leakage typically come from the land masses rather than the water.

They might also be able to tell that while most of the mobile radio leakage is associated with land masses, the towers (and presumably their intelligent users) tend to be situated along the coastline.

They would also see that mobile tower networks are quite equitably distributed across the planet. That's different to the traditional radio leakage previously recognized as major techno-signatures—in particular, radar and TV transmitters.

Our simulations show that significant contributions to the Earth's mobile leakage radiation is being made by developing regions, such as Africa and Asia. This is no surprise given the [importance of mobile systems](#) in all aspects of society in developing countries.

We calculated the power emitted from Earth—which is about 4 gigawatt (GW) in total at its peak (one GW could power around 750,000 homes for an hour). We estimated the transmission as viewed from three different stars in our galaxy—[HD 95735](#), [Barnard's star](#), and [Alpha Centauri A](#).

We worked out that an alien civilization near these locations would, however, need much better telescopes than we have to detect the Earth's mobile radio leakage. But that would be quite probable, given most technical civilizations are expected to be much more advanced than we are.

There are also other types of emissions they could see, such as military radar systems and deep space communication transmissions to distant spacecraft, such as the Voyager space probes. While these signals would be relatively rare events for an observing alien, they have the advantage of being extremely powerful.

Radio techno-signatures are probably the defining characteristic of our own civilization's existence, at least from an alien's perspective. But an extraterrestrial species would also find leakage radiation across the electromagnetic spectrum (including visible light).

If we continue to increase our energy consumption at the current rate, ["waste-heat"](#)—an unavoidable end-product of energy usage—will also be discharged into space. There it would manifest itself as an anomalous excess at infra-red wavelengths—a telltale sign of an active technical civilization.

Other techno-signatures including [industrial pollutants](#) in the Earth's atmosphere would also be noticeable to aliens equipped with powerful telescopes and spectral analysis systems (which break down light according to wavelength). An advanced alien civilization could no doubt have a good guess at our particular phase of industrialization and our [energy consumption](#).

On Earth, we use the [Kardashev scale](#) for estimating the development of alien civilizations based on their energy usage—on that scale we'd appear as an emerging technical civilization, not yet on the bottom rung of the ladder.

And even if an alien species failed to detect all this at the moment, they might do better very soon. We plan to extend this work to include traditional radio techno-signatures and other emerging sources of radio leakage radiation, including 5G systems, wifi, digital transmissions and deep space communications.

This would also include the cocoon of radio emission that will soon surround the Earth as the growth of huge [satellite constellations](#) such as Starlink and OneWeb provide global wifi coverage.

Who knows? It might even be possible for aliens to decode the complex modulation of our mobile communication systems. Ultimately, as the Earth becomes artificially brighter at all wavelengths, the chances that they detect us before we detect them, cannot be ruled out.

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