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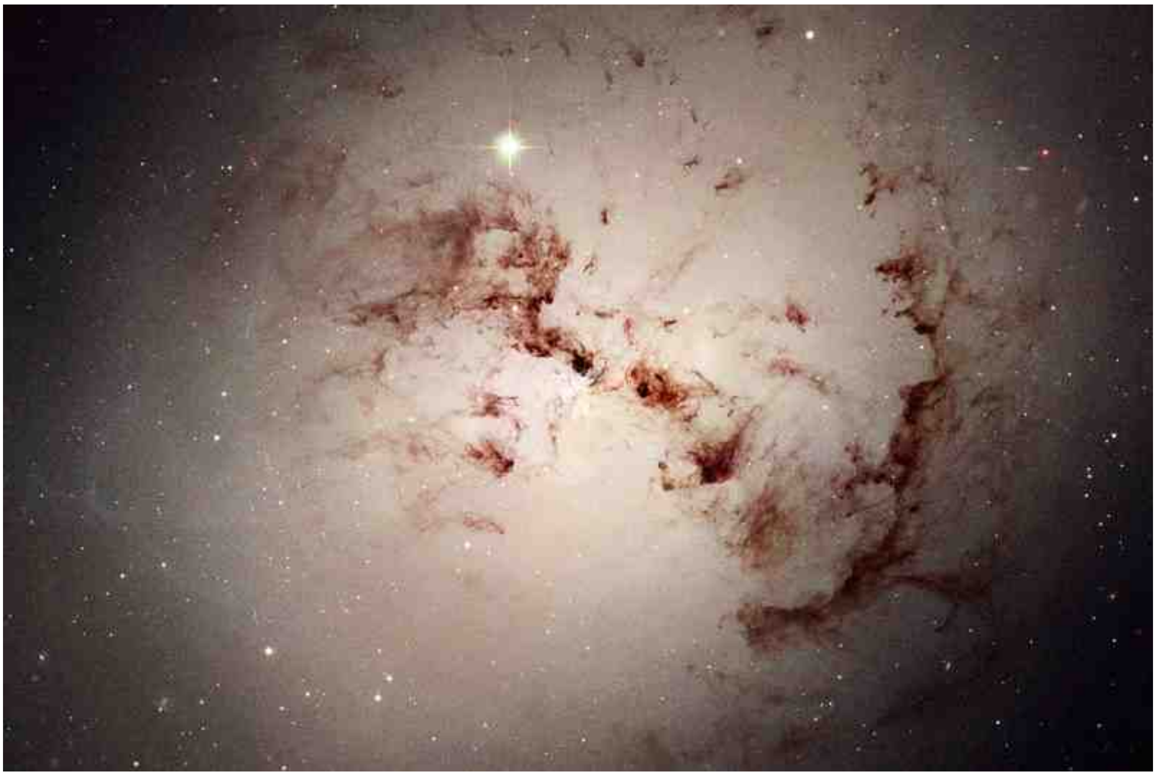
Giant old galaxies, not Milky Ways, are best for life to thrive



Giant elliptical galaxies like NGC 1316 might be good for harbouring life (Image: NASA, ESA, and The Hubble Heritage Team (STScI/AURA))

The cosmos may have good and bad neighbourhoods. Life is most likely to evolve in giant elliptical galaxies whereas dwarf galaxies are thought to be the least hospitable – with the spiral Milky Way falling somewhere in between.

The idea that the universe might have more and less hospitable regions is speculative, especially since we have yet to find any instances of alien life. But "habitable zones" – where water should be stable and Earth-like creatures have a fighting chance of surviving – have been proposed for alien solar systems and regions within galaxies.

Now two studies have zoomed out even further in an attempt to identify the most habitable types of galaxies.

"If we can look at regions around stars that are benign, and regions around galaxies that are benign, then why don't we look at the cosmic volume?" says Duncan Forgan at the University of St Andrews in the UK.

One approach, led by Pratika Dayal at the University of Durham, UK, compares different galaxies to the one known example of an inhabited galaxy, the Milky Way. Dayal proposes that life-friendly galaxies need lots of stars that can host planets, but a low rate of star formation to cut down on the number of supernovae.

Ticking time bombs

That's because supernovae's violent explosions – which occur when massive stars die after only a few million years – may lead to mass extinctions on nearby worlds. So a low rate of recent star formation would mean there are fewer of these ticking time bombs waiting to go off.

The clear winners are giant elliptical galaxies more than twice the mass of the Milky Way, but with less than a tenth the number of volatile young stars. "If the Milky Way is capable of hosting one habitable planet, giant elliptical galaxies would host as many as 10,000 habitable planets," Dayal says, based on the observed supernova rate in our galaxy.

The worst places to find life in the universe might be small, irregular galaxies with lots of newborn stars. Here, regular supernova blasts could sterilise the whole galaxy. There might also be insufficient elements heavier than hydrogen to form planets, Dayal says.

It's not just supernovae we need to consider. Gamma ray bursts – rarer, deadlier cousins of supernova explosions – put similar constraints on life, says Li Ye at the University of Nevada in Las Vegas, who has independently looked at galaxies' habitability.

Earth is thought to have experienced only one gamma ray burst in the last 500 million years, possibly resulting in the Ordovician mass extinction that terrorised trilobites about 440 million years ago. But an Earth-like planet in an active dwarf galaxy might need to weather 100 gamma ray bursts during the same timeframe, according to Ye's calculations.

Dangerous galaxies

Like supernovae, gamma ray bursts are more common when and where stars are being born. They reached their heyday about 11 billion years ago, when star formation across the universe was at its peak and a scarcity of heavy elements made gamma bursts a more likely result of stellar explosions. "Almost all the galaxies were dangerous, whatever their mass," Ye says.

That means the cosmological habitable zone may extend in time as well as space, with advanced life deterred by blasts of intense radiation in the first few billion years of the universe, Dayal adds. “The universe today is a very calm place compared to the chaos we had,” she says.

Forgan, who wasn’t involved in either study, notes that we still know very little about how life evolves. We assume the Earth is representative of life everywhere, but it may not be.

“It’s a very coarse grained approach to the problem, because habitability is this really squishy chemical problem that has to be dealt with at human scales,” Forgan says. “But they are trying to paint a picture at the scale of the universe.”

References: Dayal’s study: arxiv.org/abs/1507.04346; Ye’s study: arxiv.org/abs/1507.05966

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Clusters of living worlds would hint life came from outer space

Panspermia would give rise to some lively stellar neighbourhoods (Image: NASA/JPL-Caltech)

Does life spread like an interstellar infection? If we spot it on clusters of planets, that might suggest it doesn’t stay put wherever it evolves.

The theory that life crosses space to reach new worlds, called panspermia, is hard to test. Life on Earth could have been seeded by just one microbe-laden rock, but there are too many rocks to check, even if we had a foolproof test for extraterrestrial life.

“That’s not a very effective strategy of testing whether life came from outer space,” says Henry Lin of Harvard University. He says the answer lies in mapping life across the galaxy.

Future probes like NASA’S James Webb Space Telescope will scrutinise the atmospheres of planets in other solar systems for possible signs of biological activity. If life spreads between planets, inhabited worlds should clump in space like colonies of bacteria on a Petri dish. Otherwise, Lin says, its signature would be seen on just a few, randomly scattered planets.

Radiating life

Lin argues that if we find 25 worlds with life on one side of the sky and 25 lifeless ones on the other, it might mean the sun sits on the edge of a panspermia bubble – a strong sign that life radiated outward. “We would have smoking-gun evidence that panspermia actually happens,” he says.

But panspermia would be harder to confirm from the bubble’s centre. If there are biosignatures all around as far as we can see, for example, we can’t draw conclusions one way or the other. And if we see only scattered life, Lin says, that could suggest either that panspermia doesn’t happen or that it proceeds so slowly as to be rare.

Sara Seager of the Massachusetts Institute of Technology, an expert on the hypothetical biosignatures the technique relies on, doubts Lin’s scenarios will come in handy any time soon. “It would be great if there’s a time in which we have so many biosignatures that we see clumps throughout the galaxy. But I don’t know when that time will be,” she says. “Until we find biosignatures we can’t actually proceed with any of this work.”

Whether we manage to detect biosignatures or not, Lin thinks his work might have a second life in the distant future, if humans achieve interstellar travel. The spread of humans and other organisms riding our coat-tails would follow the same growth pattern, he says.

“Even if panspermia doesn’t happen, we might be the ones to bring it about. Maybe this paper will be useful a thousand years from now,” he says.

Journal reference: arxiv.org/abs/1507.05614