You don't exist in an infinite number of places, say scientists

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Infinite repetition, the idea that planets and living beings must be repeated an infinite number of times, cannot be logically deduced from current physics and cosmology theories. Credit: NASA/Apollo 17

(Phys.org)—If you've read about how modern cosmology may imply that, in an infinite universe, the existence of planets and the life forms that live on them must be repeated an infinite number of times, you may have been just a little bit skeptical. So are a couple scientists from Spain, who have posted a paper at arXiv.org criticizing the concept of the infinite repetition of histories in space, an idea closely related to the concepts of "alternate histories," "parallel universes," and the "many worlds interpretation," among others.

Francisco José Soler Gil at the University of Sevilla and Manuel Alfonseca at the Autonomous University of Madrid have looked at two different proposals – one based on classical cosmology and the other on quantum mechanics – that contend that we live in an infinite universe in which history is repeated an infinite number of times in space. They

have picked apart both proposals and argue that both are highly speculative, despite often being presented as plausible ideas. Moreover, they argue that we really don't know whether we live in an infinite universe, as a finite one seems equally likely.

The basic idea of the infinite repetition of histories in space is that, if you take yourself right now and change one thing (say make your red shirt a blue one), then there's another you somewhere who is exactly the same except for that one difference. Change your shirt to purple, and that's a third you. Change the drink in your hand from soda to tea, and there's another one. Plus, there are copies of all of these universes – an infinite number of copies. In their paper, Soler Gil and Alfonseca quote the popular science book "The Music of the Big Bang, The Cosmic Microwave Background, and the New Cosmology" by Amedeo Balbi: "In an infinite universe, every possible event does happen. Not just that: it happens an infinite number of times."

This infinite repetition idea can be found in early philosophy, ancient mythology, and today's sci-fi literature. But can it be derived from physical theories about the universe, and does it have a place in science?

In the first proposal that Soler Gil and Alfonseca analyze, Ellis and Brundrit argue that infinite repetition logically arises from classic relativistic physics. A more detailed summary can be found in the arXiv paper, but the general argument is as follows. If the universe, the number of planets and galaxies, and the number of possible histories (the one we're familiar with is our 13.7-billion-year history) are all infinite; and if the probability of DNA-based life is greater than zero; and if the number of types of DNA-based living things is finite (because the size of the DNA molecules cannot be arbitrarily large); then an infinite universe must contain an infinite number of copies of the finite number of DNA-based living things, and some of these living things will follow very similar and even identical history lines. In other words, infinite histories

plus finite types of living things means that those living things' histories are infinitely repeated.

Soler Gil and Alfonseca take issue with several of these assumptions. One of their main counterarguments at first seems odd: they say that we can't be sure that the probability of DNA-based life is greater than zero. Neither our existence nor our discovery of a finite number of cases of life on other planets can, at least in the logical sense, be used to deduce that the probability is greater than zero. As a result, the infinity of histories is larger than the infinity of living individuals, so each planet compatible with life could have its own unique history.

"If there is an infinite number of possible histories, the fact that there is a given history (or a finite number) leading to life does not make that history probable: its probability would be 1 divided by infinity, which is zero," Alfonseca explained to *Phys.org*. "To have a greater-than-zero probability, you need an infinite number of approaches. But in any case, with this scenario, the number of histories would always be larger than the number of beings, so the same beings infinitely repeated would still have different histories."

The second proposal, by Garriga and Vilenkin, does involve a finite number of histories, but is rooted on the idea in quantum theory that discrete regions of space have finite amounts of energy. In the decoherent histories (DH) interpretation of quantum mechanics, the infinite universe can be divided into an infinite number of regions that cannot influence one another (i.e., they're causally disconnected) because they are separated by event horizons. Then Garriga and Vilenkin deduce that the number of possible histories in each region is finite because the energy in each region is finite and, according to quantum mechanics, energy is quantified. To put it briefly, an infinite number of regions plus a finite number of possible histories in each region means that every history must be repeated an infinite number of times.

Soler Gil and Alfonseca criticize almost all of the assumptions in this proposal, starting with the application of quantum theory to cosmology, which is currently mere conjecture without evidence. Other problems arise when considering the gravitational effects of black holes and the expansion of the universe, which can potentially increase the number of possible histories indefinitely, preventing repetitions.

But the scientists' biggest criticism of the idea of infinite repetition in both proposals is the assumption that the universe is infinite. Whether the universe is infinite or finite is a big open-ended question in cosmology that scientists may never answer. Soler Gil and Alfonseca note that, looking back at the history of physics, situations emerged where infinities seemed impossible to avoid, yet improved theories eliminated the infinities. Currently the two basic theories in physics, general relativity and quantum theory, both predict infinities. In relativity, it's gravity singularities in black holes and the big bang. In quantum theory, it's vacuum energy and certain parts of quantum field theory. Perhaps both theories are simple approximations of a third more general theory without infinities. Soler Gil and Alfonseca also note that, Paul Dirac once stated that the most important challenge in physics was "to get rid of infinity."

While Soler Gil and Alfonseca can't disprove the proposals of infinite repetition, they emphasize that the point of their critique is to show that the idea remains in the realm of philosophy, mythology, and sci-fi tales, not modern cosmology. They call the speculation "ironic science," a term used by science journalist John Horgan to describe options that do not converge on truth but are at best "interesting." Despite the accounts of many popular science books, the idea that our lives are being repeated an infinite number of times somewhere out in the universe is in no way certain and far from either probable or plausible.

More information: Francisco José Soler Gil and Manuel Alfonseca.

"About the Infinite Repetition of Histories in Space." arXiv:1301.5295 [physics.hist-ph]