A formula for life? New model calculates chances of intelligent beings in our universe and beyond

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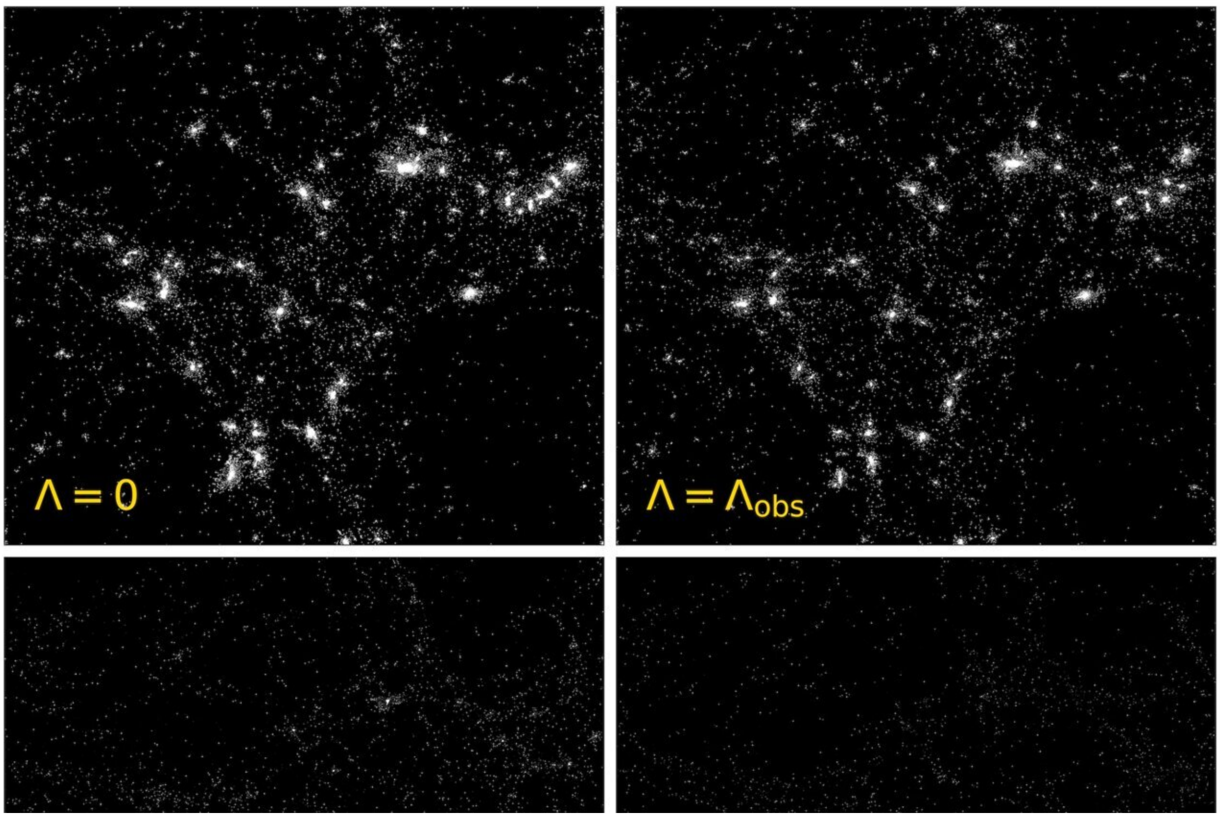

How the same region of the universe would look in terms of the amount of stars for different values of the dark energy density. Clockwise, from top left, no dark energy, same dark energy density as in our universe, 30 and 10 times the dark energy density in our universe. The images are generated from a suite of cosmological simulations. Credit: Oscar Veenema

The chances of intelligent life emerging in our universe—and in any hypothetical ones beyond it—can be estimated by a new theoretical model which has echoes of the famous Drake Equation.

This was the formula that American astronomer Dr. Frank Drake came up with in the 1960s to calculate the number of detectable extraterrestrial civilizations in our Milky Way galaxy.

More than 60 years on, astrophysicists led by Durham University have produced a different model which instead focuses on the conditions created by the acceleration of the universe's expansion and the amount of stars formed.

It is thought this expansion is being driven by a mysterious force called dark energy that makes up more than two thirds of the universe.

What is the calculation?

Since stars are a precondition for the emergence of life as we know it, the model could therefore be used to estimate the probability of generating intelligent life in our universe, and in a multiverse scenario of different hypothetical universes.

The new research does not attempt to calculate the absolute number of observers (i.e. intelligent life) in the universe but instead considers the relative probability of a randomly chosen observer inhabiting a universe with particular properties. The study has been published in *Monthly Notices of the Royal Astronomical Society*.

It concludes that a typical observer would expect to experience a substantially larger density of dark energy than is seen in our own universe—suggesting the ingredients it possesses make it a rare and unusual case in the multiverse.

The approach presented in the paper involves calculating the fraction of ordinary matter converted into stars over the entire history of the universe, for different dark energy densities.

The model predicts this fraction would be approximately 27% in a universe that is most efficient at forming stars, compared to 23% in our own universe.

This means we don't live in the hypothetical universe with the highest odds of forming intelligent life forms. Or in other words, the value of dark energy density we observe in our universe is not the one that would maximize the chances of life, according to the model.

This Hubble Space Telescope image captures a triple-star system, which can host potentially-habitable planets. Our nearest stellar neighbor, the Alpha Centauri system, includes three stars. Credit: NASA, ESA, G. Duchene (Universite de Grenoble I); Image Processing: Gladys Kober (NASA/Catholic University of America)

Dark energy's impact on our existence

Lead researcher Dr. Daniele Sorini, of Durham University's Institute for Computational Cosmology, said, "Understanding dark energy and the impact on our universe is one of the biggest challenges in cosmology and fundamental physics.

"The parameters that govern our universe, including the density of dark energy, could explain our own existence.

"Surprisingly, though, we found that even a significantly higher dark energy density would still be compatible with life, suggesting we may not live in the most likely of universes."

The new model could allow scientists to understand the effects of differing densities of dark energy on the formation of structures in the universe and the conditions for life to develop in the cosmos.

Dark energy makes the universe expand faster, balancing gravity's pull and creating a universe where both expansion and structure formation are possible.

However, for life to develop, there would need to be regions where matter can clump together to form stars and planets, and it would need to remain stable for billions of years to allow life to evolve.

Crucially, the research suggests that the astrophysics of star formation and the evolution of the large-scale structure of the universe combine in a subtle way to determine the optimal value of the dark energy density needed for the generation of intelligent life.

Professor Lucas Lombriser, Université de Genève and co-author of the study, added, "It will be exciting to employ the model to explore the emergence of life across different universes and see whether some fundamental questions we ask ourselves about our own universe must be reinterpreted."

Drake equation explained

Dr. Drake's equation was more of a guide for scientists on how to go about searching for life, rather than an estimating tool or serious attempt to determine an accurate result.

Its parameters included the rate of yearly star formation in the Milky Way, the fraction of stars with planets orbiting them and the number of worlds that could potentially support life.

By comparison, the new model connects the rate of yearly star formation in the universe with its fundamental ingredients, such as the aforementioned dark energy density.

The study involved scientists at the University of Edinburgh and the Université de Genève.

More information: Daniele Sorini et al, The impact of the cosmological constant on past and future star formation, *Monthly Notices of the Royal Astronomical Society* (2024). DOI: 10.1093/mnras/stae2236. academic.oup.com/mnras/article … .1093/mnras/stae2236

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