Complex life may be possible in only 10% of all galaxies

Staff Writer

Email Adrian
By
Adrian Cho

The universe may be a lonelier place than previously thought. Of the estimated 100 billion galaxies in the observable universe, only one in 10 can support complex life like that on Earth, a pair of astrophysicists argues. Everywhere else, stellar explosions known as gamma ray bursts would regularly wipe out any life forms more elaborate than microbes. The detonations also kept the universe lifeless for billions of years after the big bang, the researchers say.

"It's kind of surprising that we can have life only in 10% of galaxies and only after 5 billion years," says Brian Thomas, a physicist at Washburn University in Topeka who was not involved in the work. But "my overall impression is that they are probably right" within the uncertainties in a key

parameter in the analysis.

Scientists have long mused over whether a gamma ray burst could harm Earth. The bursts were discovered in 1967 by satellites designed to spot nuclear weapons tests and now turn up at a rate of about one a day. They come in two types. Short gamma ray bursts last less than a second or two; they most likely occur when two neutron stars or black holes spiral into each other. Long gamma ray bursts last for tens of seconds and occur when massive stars burn out, collapse, and explode. They are rarer than the short ones but release roughly 100 times as much energy. A long burst can outshine the rest of the universe in gamma rays, which are highly energetic photons.

That seconds-long flash of radiation itself wouldn't blast away life on a nearby planet. Rather, if the explosion were close enough, the gamma rays would set off a chain of chemical reactions that would destroy the ozone layer in a planet's atmosphere. With that protective gas gone, deadly ultraviolet radiation from a planet's sun would rain down for months or years—long enough to cause a mass die-off.

How likely is that to happen? Tsvi Piran, a theoretical astrophysicist at the Hebrew University of Jerusalem, and Raul Jimenez, a theoretical astrophysicist at the University of Barcelona in Spain, explore that apocalyptic scenario in a paper in press at *Physical Review Letters*.

Astrophysicists once thought gamma ray bursts would be most common in regions of galaxies where stars are forming rapidly from gas clouds. But recent data show that the picture is more complex: Long bursts occur mainly in star-forming regions with relatively low levels of elements heavier than hydrogen and helium—low in "metallicity," in astronomers' jargon.

Using the average metallicity and the rough distribution of stars in our Milky Way galaxy, Piran and Jimenez estimate the rates for long and short bursts across the galaxy. They find that the more-energetic long bursts are the real killers and that the chance Earth has been exposed to a lethal blast in the past billion years is about 50%. Some astrophysicists have suggested a gamma ray burst may have caused the Ordovician extinction, a global cataclysm about 450 million years ago that wiped out 80% of Earth's species, Piran notes.

The researchers then estimate how badly a planet would get fried in different parts of the galaxy. The sheer density of stars in the middle of the galaxy ensures that planets within about 6500 light-years of the galactic center have a greater than 95% chance of having suffered a lethal gamma ray blast in the last billion years, they find. Generally, they conclude, life is possible only in the outer regions of large galaxies. (Our own solar system is about 27,000 light-years from the center.)

Things are even bleaker in other galaxies, the researchers report. Compared with the Milky Way, most galaxies are small and low in metallicity. As a result, 90% of them should have too many long gamma ray bursts to sustain life, they argue. What's more, for about 5 billion years after the big bang, all galaxies were like that, so long gamma ray bursts would have made life impossible anywhere.

But are 90% of the galaxies barren? That may be going too far, Thomas says. The radiation exposures Piran and Jimenez talk about would do great damage, but they likely wouldn't snuff out every microbe, he contends. "Completely wiping out life?" he says. "Maybe not." But Piran says the real issue is the existence of life with the potential for intelligence. "It's almost certain that bacteria

and lower forms of life could survive such an event," he acknowledges. "But [for more complex life] it would be like hitting a reset button. You'd have to start over from scratch."

The analysis could have practical implications for the search for life on other planets, Piran says. For decades, scientists with the SETI Institute in Mountain View, California, have used radio telescopes to search for signals from intelligent life on planets around distant stars. But SETI researchers are looking mostly toward the center of the Milky Way, where the stars are more abundant, Piran says. That's precisely where gamma ray bursts may make intelligent life impossible, he says: "We are saying maybe you should look in the exact opposite direction."

Posted in Physics, Space

Link: http://news.sciencemag.org/physics/2014/11/complex-life-may-be-possible-only-10-all-galaxies