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HOW MANY EARTHS?

Ken Tapping, 3rd October, 2017

How many planets in our galaxy are about the size of our world, have atmospheres and are at the right distance from their stars to have liquid water on their surfaces? We call these "earth-like" planets, and have a particular interest in these because, like our planet, they may also host some forms of living creatures. We don't worry at this point about whether their atmospheres contain oxygen because firstly, in most cases it is hard to tell, and secondly, before life appeared on our planet, the atmosphere contained no oxygen. That came along later, thanks to primitive plants. Two additional requirements are that firstly, the radiation from a planet's sun is not so rich in X-rays and ultraviolet that the planets would be sterilized, and secondly, that the planets and their stars would exist long enough for life to evolve. A decade or two ago attempts to address this question would have involved a lot of guessing. Today we can make a reasonably good estimate.

This means we can discount the hot, blue stars because of their intense radiation and also because most of them don't last long enough to provide a stable long-term environment on any of their planets. We can also cross off the list white dwarf stars. Although they are stable for billions of years, they are the ashes of dead stars, which in their final convulsions would have fried their planets. If anyone survived, white dwarfs are so niggardly in their emission of energy those survivors would now be deep-frozen.

Allowing for dark matter – whatever that is – and the amount of material tied up in black holes, our galaxy contains around 200 billion stars. The hot blue stars, white dwarfs and other stars not good for hosting earth-like planets make up about 10% of the total. That leaves some 180 billion suitable stars. However, some of these are members of multiple star systems, where two or more stars orbit one another. There is a scene in the first Star Wars Movie where Luke Skywalker watches a double-star sunset on the planet Tattooine. In reality nobody would bother colonizing such a planet. Any planets orbiting stars in multi-star systems will have chaotic and ever-changing orbits. They would alternately freeze and fry, and almost certainly end up colliding with one of the stars. This brings us down to about 120 billion stellar candidates for hosting earth-like planets.

The recent Kepler space mission has revolutionized our search for planets orbiting other stars, particularly for earth-like planets. This spacecraft monitored many stars at a time, watching for the minute dimmings in a star's light when one of its planets passed in front of it. Out of some 150,000 stars examined, 3500 planets were found, of which 51 were earth-like. Of course only a tiny minority of stars would have their planets in orbits oriented to cross our line of sight. Without that happening we cannot detect the planets. If we assume the orbits are oriented randomly then the number would be closer to 20,000 Earth-like planets. That is about 13% of the number of stars looked at. So, with 120 billion candidate stars in our galaxy, there could be about 15 billion earth-like planets at various points in their evolution.

For possibly life-bearing bodies in space the story does not end here. In our Solar System there is Europa, a moon of Jupiter, and Enceladus, one of Saturn's moons, which, heated by tidal forces from the giant planets they orbit, not by the Sun, have deep oceans lying under thick envelopes of ice. There could be communities of creatures in those oceans like those living around the hydrothermal vents in our oceans. There could be a lot of life out there. It would be hard to imagine a universe that is so big, with so many planets, and yet with just our world having living creatures on it. .

Saturn lies low in the southwest. Brilliant Venus lies close to Mars in the dawn glow. The Moon will be Full on the 5th, the "Harvest Moon".

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