New definition could further limit habitable zones around distant suns

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As astronomers gaze toward nearby planetary systems in search of life, they are focusing their attention on each system's habitable zone, where heat radiated from the star is just right to keep a planet's water in liquid form.

A number of planets have been discovered orbiting red dwarf stars, which make up about three-quarters of the stars close to our solar system. Potentially habitable planets must orbit close to those stars - perhaps one-fiftieth the distance of Earth to the sun - since those stars are smaller and generate less heat than our sun.

But new calculations indicate that, with planets so close, tidal forces exerted on planets by the parent star's gravity could limit what is regarded as a star's habitable zone and change the criteria for planets where life could potentially take root.

Scientists believe liquid water is essential for life. But a planet also must have plate tectonics to pull excess carbon from its atmosphere and confine it in rocks to prevent runaway greenhouse warming. Tectonics, or the movement of the plates that make up a planet's surface, typically is driven by radioactive decay in the planet's core, but a star's gravity can cause tides in the planet, which creates more energy to drive plate tectonics.

"If you have plate tectonics, then you can have long-term climate stability, which we think is a prerequisite for life," said Rory Barnes, a

University of Washington postdoctoral researcher in astronomy.

However, tectonic forces cannot be so severe that geologic events quickly repave a planet's surface and destroy life that might have gotten a foothold, he said. The planet must be at a distance where tugging from the star's gravitational field generates tectonics without setting off extreme volcanic activity that resurfaces the planet in too short a time for life to prosper.

Barnes is lead author of a paper to be published by The *Astrophysical Journal Letters* that uses new calculations from computer modeling to define a "tidal habitable zone." Co-authors are Brian Jackson and Richard Greenberg from the University of Arizona and Sean Raymond from the University of Colorado. The research was funded by NASA.

"Overall, the effect of this work is to reduce the number of habitable environments in the universe, or at least what we have thought of as habitable environments," Barnes said. "The best places to look for habitability are where this new definition and the old definition overlap."

The new calculations have implications for planets previously considered too small for habitability. An example is Mars, which used to experience tectonics but that activity ceased as heat from the planet's decaying inner core dissipated.

But as planets get closer to their suns, the gravitational pull gets stronger, tidal forces increase and more energy is released. If Mars were to move closer to the sun, the sun's tidal tugs could possibly restart the tectonics, releasing gases from the core to provide more atmosphere. If Mars harbors liquid water, at that point it could be habitable for life as we know it.

Various moons of Jupiter have long been considered as potentially

harboring life. But one of them, Io, has so much volcanic activity, the result of tidal forces from Jupiter, that it is not regarded as a good candidate. Tectonic activity remakes Io's surface in less than 1 million years.

"If that were to happen on Earth, it would be hard to imagine how life would develop," Barnes said.

A potential Earth-like planet, but eight times more massive, called Gliese 581d was discovered in 2007 about 20 light years away in the constellation Libra. At first it was thought the planet was too far from its sun, Gliese 581, to have liquid water, but recent observations have determined the orbit is within the habitable zone for liquid water. However, the planet is outside the habitable zone for its sun's tidal forces, which the authors believe drastically limits the possibility of life.

"Our model predicts that tides may contribute only one-quarter of the heating required to make the planet habitable, so a lot of heat from decay of radioactive isotopes may be required to make up the difference," Jackson said.

Barnes added, "The bottom line is that tidal forcing is an important factor that we are going to have to consider when looking for habitable planets."

Source: University of Washington (news : web)