Dying Stars Article

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**Dying stars source of life?**

**Future evidence for extraterrestrial life might come from dying stars**

Harvard-Smithsonian Center for Astrophysics

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Illustration by David A. Aguilar/CfA

A new study finds that researchers can detect oxygen in the atmosphere of a habitable planet orbiting a white dwarf (as shown in this artist’s illustration). Here the ghostly blue ring is a planetary nebula — hydrogen gas the star ejected as it evolved from a red giant to a white dwarf.

Even dying stars could host planets with life — and if such life exists, we might be able to detect it within the next decade.

This encouraging result comes from a new theoretical study of Earth-like planets orbiting white dwarf stars. Researchers found that oxygen in the atmosphere of a white dwarf’s planet could be detected much more easily than in an Earth-like planet orbiting a sunlike star.

“In the quest for extraterrestrial biological signatures, the first stars we study should be white dwarfs,” said [Avi Loeb](https://www.cfa.harvard.edu/~loeb/), theorist at the [Harvard-Smithsonian Center for Astrophysics](http://www.cfa.harvard.edu/) (CfA) and director of the [Institute for Theory and Computation](http://www.cfa.harvard.edu/itc/).

When a star like the sun dies, it puffs off its outer layers, leaving behind a hot core called a white dwarf. A typical white dwarf is about the size of Earth. It slowly cools and fades over time, but it can retain heat long enough to warm a nearby world for billions of years.

Before a star becomes a white dwarf it swells into a red giant, engulfing and destroying any nearby planets, so a planet would have to arrive in the habitable zone after the star evolved into a white dwarf. A planet could form from leftover dust and gas (making it a second-generation world), or migrate inward from farther away.

The abundance of heavy elements on the surface of white dwarfs suggests that a significant fraction of them have rocky planets in their orbit. Loeb and his colleague Dan Maoz of Tel Aviv University estimate that a survey of the 500 closest white dwarfs could reveal one or more habitable Earths.

The best method for finding such planets is a transit search — looking for a star that dims as an orbiting planet crosses in front of it. Since a white dwarf is about the same size as Earth, an Earth-sized planet would block a large fraction of its light and create an obvious signal.

Researchers can study the atmospheres of transiting planets because as the white dwarf’s light shines through the ring of air that surrounds the planet’s silhouetted disk, the atmosphere absorbs some starlight. This leaves chemical fingerprints that indicate whether that air contains water vapor, or even signatures of life, such as oxygen.

Astronomers are particularly interested in finding oxygen because the oxygen in the Earth’s atmosphere is continuously replenished, through photosynthesis, by plant life.

Thus, the presence of large quantities of oxygen in the atmosphere of a distant planet would signal the likely presence of life there.

NASA’s [James Webb Space Telescope](http://www.jwst.nasa.gov/) (JWST), scheduled for launch by the end of this decade, promises to sniff out the gases of these alien worlds. Loeb and Maoz created a synthetic spectrum replicating what JWST would see if it examined a habitable planet orbiting a white dwarf. They found that both oxygen and water vapor would be detectable with only a few hours of total observation time.

“JWST offers the best hope of finding an inhabited planet in the near future,” said Maoz.

Their paper was accepted for publication in the Monthly Notices of the Royal Astronomical Society and will be available online.