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Earth May Survive the Sun's Demise

Earth's future is bleak. At best, our planet will become a burned-out cinder as the Sun expands at the end of its life. At worst, it will be engulfed by the Sun, leaving no trace that it ever existed.

Astronomers have found a clue as to which path Earth might follow in a star system about 4,300 light-years away. There, a rocky planet orbits the remains of a once Sun-like star at a distance similar to where Earth could park if it survives our own star's death throes. The system "may offer a glimpse into the possible survival of planet Earth in the distant future," according to a new study published in *Nature Astronomy* (bit.ly/Earth-survival).

The system, KMT-2020-BLG-0414L, was discovered in 2020 by the Korea Microlensing Telescope Network, a set of three automated 1.6-meter telescopes in the Southern Hemisphere.

The network looks for gravitational lensing events, those in which a star or planet passes between Earth and a background star. The gravity of the intervening object acts as a lens, making the background star appear much brighter. The length, intensity, and other details of the event, along with before-and-after observations, allow scientists to calculate the details of the lensing object.

Early analysis suggested that the system (abbreviated as KB200414) consists of a low-mass star, an Earth-mass planet, and a third object many times the mass of Jupiter.

A Lucky Alignment

Astronomers tried to get a clearer look at the system with the 10-meter Keck II Telescope in Hawaii, but those observations did not detect the lensing system's host star.

"This system is part of a larger sample of microlensing planets," said Keming Zhang, an astrophysicist now at the University of California, San Diego and first author of the study. "This is the only one for which we don't detect the expected host brightness."

Zhang and his colleagues considered several scenarios that could explain that finding. They concluded that instead of being a bright main sequence star, the star must be a dimmer white dwarf about half as massive as the Sun. "There is some luck involved, because you would expect only around one in 10 microlensing planets to have white dwarf hosts," Zhang said.

The researchers' analysis also showed that the rocky planet orbiting that star is nearly



An artist's concept depicts what the Earth-analogue planet might look like, with the white dwarf star in the background. Credit: W. M. Keck Observatory/Adam Makarenko

double Earth's mass and more than twice Earth's distance from the Sun. It is the first possible Earth-like world discovered orbiting a white dwarf. Other studies have revealed white dwarfs that host gas giant planets, along with bands of rubble thought to be the remnants of rocky planets, but nothing comparable to Earth.

The third object in the system appears to be a brown dwarf—a "failed star" not massive enough to shine as a true star. It's about 27 times the mass of Jupiter and orbits the white dwarf at about 22 times the Earth-Sun distance, according to the researchers, which would put it beyond Uranus in a comparison with our solar system.

A Glimpse at Earth's Future?

During its time in the main sequence, a star fuses the hydrogen in its core to create helium. As that process ends, the star expands, becoming a red giant. The Sun, which is 4.6 billion years old, is expected to enter that phase in about 6–7 billion years, puffing up to dozens of times its current diameter. It will remain in this red giant phase for a billion years, after which it will expel its outer layers, leaving only its hot, dense, now-dead core: a white dwarf like the one at the center of KB200414.

When the Sun becomes a red giant, it will engulf Mercury and Venus. Mars and the outer planets almost certainly will survive.

Earth's fate is more difficult to foretell, however, because of the complicated nature of the Sun's final days.

"You would expect only around one in 10 microlensing planets to have white dwarf hosts."

One possibility is that as the Sun loses mass and its gravitational grip on Earth weakens, our planet will migrate outward (though its oceans and atmosphere will have boiled away billions of years earlier). As it becomes a white dwarf, the Sun will lose half its mass, and Earth, if it survives, may expand its orbit to twice its current size, Zhang said. That's about as far as KB200414's

rocky planet, suggesting that it met a similar fate.

The scenario will be further complicated by the motions of the other planets, especially Jupiter and Saturn, which can act as wrecking balls.

“Our solar system is relatively boring and stable today,” said Carl Melis, also an astrophysicist at the University of California, San Diego, who was not involved in the study but has collaborated with some of its authors in the past. “But when the Sun begins to die, all bets are off,” he added. “There are many studies of what will happen dynamically, and it’s not pretty.”

In the case of KB200414, the brown dwarf would have “wreaked absolute havoc” on

“Our solar system is relatively boring and stable today. But when the Sun begins to die, all bets are off. There are many studies of what will happen dynamically, and it’s not pretty.”

other planets in the system as it moved away from the red giant, Melis said. “The brown dwarf would excite all kinds of weird things. I can’t even imagine what it would do to the planet.”

For that and other reasons, Melis doesn’t consider the architecture of the system proposed by Zhang and his colleagues settled. “It is a possible solution—even a reasonable solution. But it’s not 100% conclusive,” he said. “My personal take is they need to keep cracking.”

Extremely large ground-based telescopes, which are expected to come online early in the next decade, should reveal the white dwarf itself, allowing astronomers to confirm their scenario, Zhang said. And NASA’s Nancy Grace Roman Space Telescope, due to launch in 2027, should find many additional white dwarf planetary systems, he said. Those discoveries could provide additional clues to the bleak fate of Earth.

By **Damond Benningfield**, Science Writer

Torrents of Sediment-Laden Water Worsened Disastrous Libyan Floods

Africa’s deadliest flood in a century didn’t happen in the continent’s rain-soaked equatorial jungles or along the mighty Nile, Congo, and Niger rivers. It happened in Libya, along its dry northern coast.

“The deadliest flood happened in the driest country in all Africa, the only nation that has no rivers at all,” said remote sensing scientist Essam Heggy of the University of Southern California and the NASA Jet Propulsion Laboratory.

When Storm Daniel slunk down from Greece to strike Libya’s northern coast in September 2023, it unleashed flash floods that took thousands of lives and left some 45,000 people displaced.

Now, new research from Heggy and his colleagues shows that enhanced soil erosion in Libya loaded Storm Daniel’s floodwaters with sediments, increasing their destructive power.

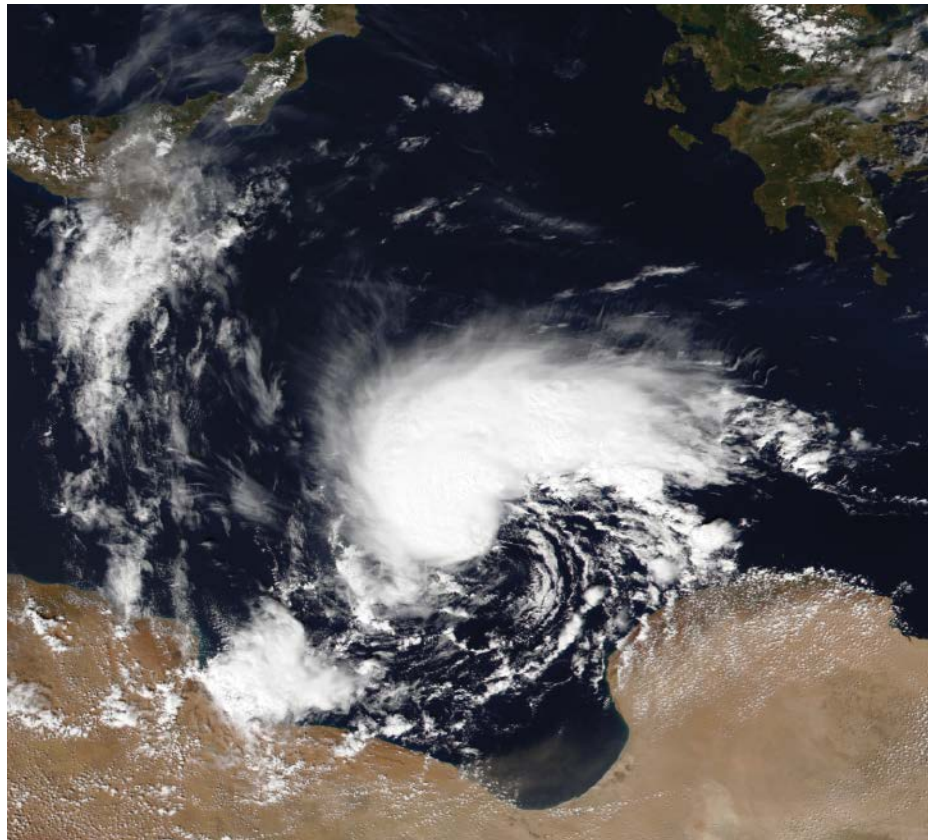
By analyzing satellite radar images, the researchers mapped storm damage and tracked sediments washed out by the storm. The data show that 66% and 48% of the cities of Derna and Susah, respectively, were moderately or severely damaged.

The results, published in *Nature Communications*, point to a looming threat in the Mediterranean: increasingly catastrophic floods in arid regions driven by intensifying cycles of drought and deluge (bit.ly/Libya-floods).

Drought and Deluge

Storm Daniel spun up over the Ionian Sea in early September 2023, fueled by lingering high sea temperatures after a sweltering summer in southern Europe. Storms like Daniel, sometimes called medicanes, are expected to get more intense as the Mediterranean warms.

Rain fell in torrents over southeastern Europe and Türkiye, flooding towns and tak-



Storm Daniel struck Libya in September 2023. Credit: VIIRS imagery from the NOAA-20 satellite