

An artist's
impression of the
exoplanet Gliese
581e, with 'd' in
the distance

Homing in on a second Earth

Vincent Whiteman reports on the discovery of a fourth planet around the star Gliese 581, and what it means in the hunt for life in the Universe

You would think that after the many times it's been in the news, the M-class red dwarf star Gliese 581 would be content with its list of achievements. But the attention-seeking star has done it again. Now astronomers say the star, located 20.5 lightyears away in the constellation Libra, is once again home to the lightest known exoplanet. Gliese 581e is the fourth planet to be found orbiting its parent star, and has a mass of just two times that of Earth.

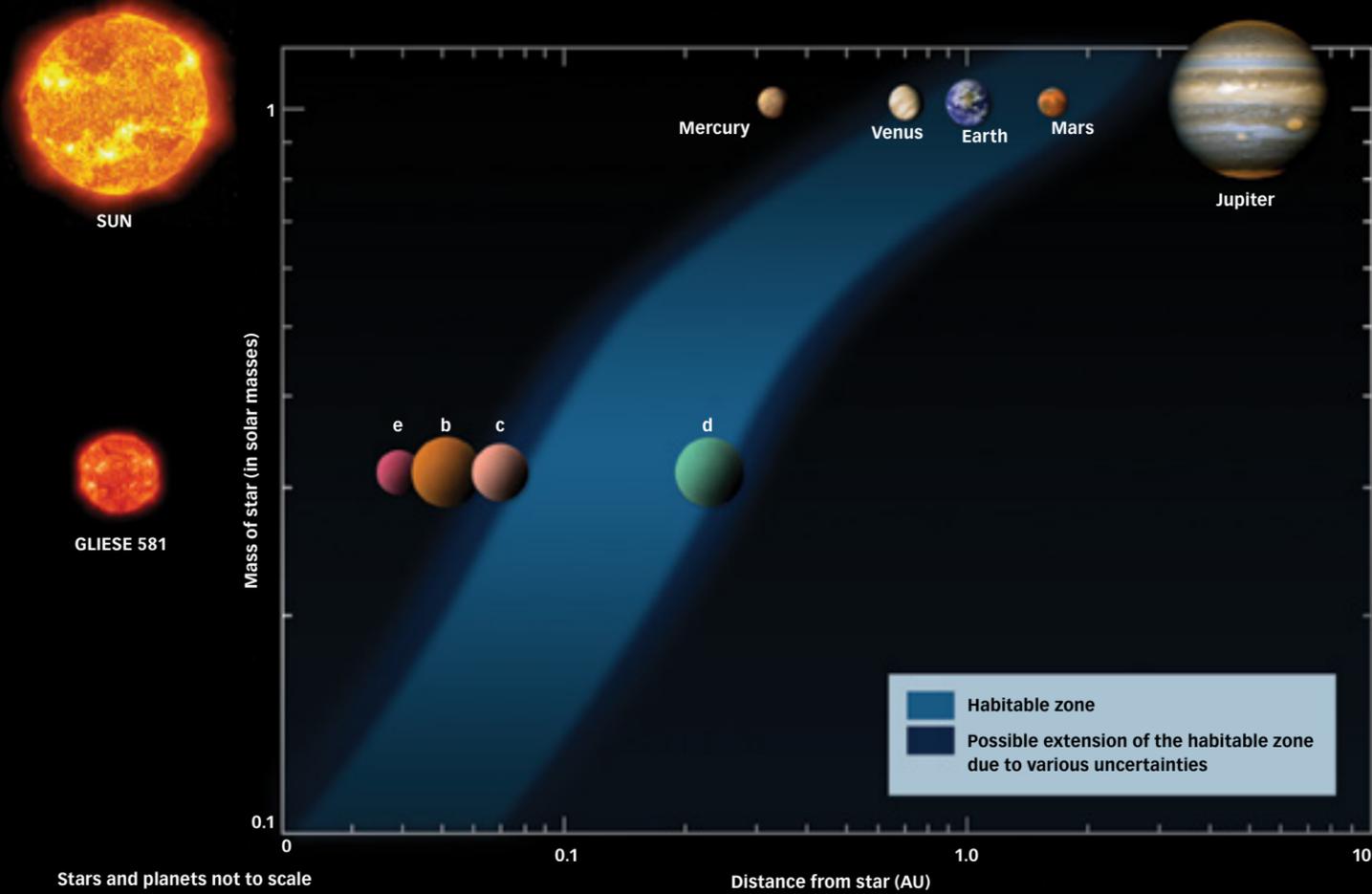
Veteran planet hunter Michel Mayor from the Geneva Observatory announced the findings during the European Week of Astronomy and Space Science (EWASS) at the University of Hertfordshire. The new planet takes only 3.15 days to orbit its parent star and was discovered by Mayor and his pan-European team of astronomers. They used the HARPS (High Accuracy Radial Velocity Planet Searcher) spectrograph and the 3.6m ESO telescope at La Silla, Chile, to record their observations.

"With only 1.9 Earth-masses, it is the least massive exoplanet ever detected and is, very likely, a rocky planet," says co-discoverer Xavier Bonfils from Grenoble Observatory. HARPS is able to detect a planet by measuring a change in wavelength of light coming from the parent star – any change indicates that the star must have a slight 'wobble'. Astronomers therefore don't see or detect an exoplanet directly, but instead observe its gravitational influence on its parent star. The larger the planet, the bigger the star's wobble. This technique is called the radial velocity method.

Gliese 581e may be similar in size to Earth, but that's where the similarities end. It lies too close to its parent star, which makes it very hot. "It's not convenient for life," Mayor told *Sky at Night Magazine*.

The holy grail of exoplanet research is the discovery of a rocky, Earth-like world in the 'habitable zone'. This is the region around a star where the ►

A habitable place to live



► conditions are just right for water to be liquid on a planet's surface – see 'A habitable place to live' above. "We have to see this discovery as a very nice step in the search for a rocky planet – the twin of Earth. But it's still not really an equivalent of the Earth."

Water world

The announcement of a newly discovered exoplanet may have been headline news, but the press conference sprung a second surprise. Mayor and his team revealed that they had refined the orbit of a sibling planet Gliese 581d, bringing it closer to its parent star and placing it within the habitable zone. Taking 66.8 days to orbit, 581d is seven times the mass of the Earth and is believed to be an icy planet.

Mayor told *Sky at Night Magazine*: "This is probably the first example of a low mass planet within the habitable zone." Mayor believes there would not have been enough rocky material in the accretion disc during the formation

▲ **Gliese 581d sits just inside the habitable zone, and is closer to its cooler red dwarf parent star than Earth is to the Sun**

of the planetary system to have formed a wholly rocky planet of this size. At Gliese 581d's position, he speculates that the planet is composed of ice and rock and, due to its location, has a liquid upper layer. "It could be the first candidate for a new class of planet called 'ocean planets'. They are planets with huge oceans on their surfaces," he explains.

The team's work is the result of over four years of observations and is an exciting leap forwards in the hunt for Earth-like planets and the possibility of life in the Universe. The detection of Gliese 581e and the refinement of the orbit of Gliese 581d were only made possible by the HARPS spectrograph – currently the most precise instrument of its kind operating in the world today.

Dedicated to finding exoplanets, HARPS, located at the La Silla Observatory, Chile, sits at an altitude of 2,400m where the extremely dry climate provides excellent viewing conditions. The spectrograph achieved

first-light in 2003, and has consistently beaten its rivals to detect exoplanets with the lowest mass. It's found 17 out of the 20 record setters so far.

Of late, the hunt for Earth-like worlds has focused on red dwarf stars like Gliese 581. M-class red dwarfs are less massive than other middle-aged stars like the Sun. So any wobble caused by low-mass planets is more pronounced than it would be around a bigger star, making them easier to detect using the radial velocity method.

Astronomers have so far found many exoplanets closer to their host stars than Earth is to the Sun, but they are typically hot gaseous worlds not in their stars' habitable zone. Because red dwarfs are cooler than other stars, they have habitable zones that are closer to themselves. That means there's the potential to discover a habitable, Earth-like planet capable of supporting life around a red dwarf because rocky planets are generally found close to their parent stars.

Any potentially habitable planets discovered now will be valuable targets for future space projects like NASA's Terrestrial Planet Finder and ESA's Darwin, both under development. Their advanced instrumentation will help astronomers learn much more about what the planets are made of, and consequently their ability to sustain life.

"It is amazing how far we've come since we discovered the first exoplanet around a normal star in 1995 – the one around 51 Pegasi," says Mayor. "The mass of Gliese 581e is 80 times less than that of 51 Pegasi b. This is tremendous progress in just 14 years." ☪

FIND OUT MORE ►

- Watch *Sky at Night Magazine's* Will Gater interview Michel Mayor on the discovery of Gliese 581e in a special vodcast report. You can download the episode from iTunes or from www.skyatnightmagazine.com
- Turn to page 59 to find out how to see the star Gliese 581 through your own telescope

La Silla Observatory in Chile, where the exoplanet Gliese 581e was discovered using the HARPS spectrograph



Super-Earths

So far a handful of planets similar to Earth have been discovered, all made of rock or ice and bigger or more massive than Earth – hence their nickname

GLIESE 581C

This exoplanet is a super-Earth five times more massive than Earth. It was discovered in 2007 using the HARPS spectrograph at La Silla, Chile, by the same team that found Gliese 581e. At the time it was the lightest exoplanet known. It has a radius close to 1.5 times that of Earth, but is too close to its host star to harbour life.

GLIESE 876D

Discovered in 2005 using the WM Keck Observatory, Gliese 876d was the third planet found around the host star, located around 15,000 lightyears away in the constellation Aquarius. It was detected through the radial velocity method and has a mass of 7.5 times that of Earth. It orbits a middle-aged star and, like the others, was the smallest planet discovered at the time.

MOA-2007-BCG-192LB

Believed to be three times the mass of Earth, the planet set a new record for super-Earths. It was discovered in 2007 using the technique of 'gravitational microlensing'. It orbits a brown dwarf star 3,000 lightyears away and was found by an international team led by the University of Notre Dame using the MOA-II (Microlensing Observations in Astrophysics) telescope at Mt John Observatory, New Zealand.

An artist's impression of the exoplanet MOA-2007-BCG-192LB orbiting its brown dwarf star

