Aude Alapini

Born in Cotonou, Benin

Biography

Half Beninese, half Belgian, Aude was born in Cotonou, Benin in 1983. She grew up in Benin, and attended the French Ecole EFE Montaigne. In 2001 she went to the Universite Paris XI in Orsay, France, to study for a DEUG de Physique, followed by a Magistere de Physique. For her Master's degree Aude studied at the University of Manchester in the United Kingdom and at the Observatoire de Paris–Meudon in France, specialising in astrophysics. She is currently completing a PhD at the University of Exeter in the United Kingdom. Her preferred topic is the detection and characterisation of exoplanets. In her spare time, Aude enjoys travelling, scuba-diving, hiking, movies, and spending time with family and friends. She is very interested in the practical applications of physics, such as medicine, energy production, and nanotechnology.

School of Physics, University of Exeter

The School of Physics of the University of Exeter performs world-leading research in astrophysics, biomedical physics, electromagnetic materials, quantum systems and nanomaterials. The astrophysics group at Exeter specialises in star formation and both the observational and theoretical aspects of exoplanets. Astrophysicists in Exeter design advanced star and planet formation simulations, perform millimetre, submillimetre, optical and infrared observations of star- and planet-forming regions and exoplanets using first class telescopes on the ground and in space, and are involved in the development of intelligent telescopes that observe with the minimum of human intervention.

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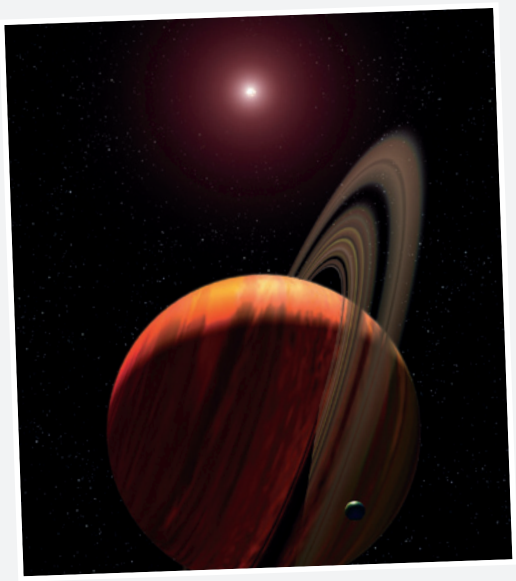
Other Planets in the Milky Way

It is one of humanity's ultimate quests: to find other planets around other stars, beyond our own Solar System. Thanks to new technology and ingenious astronomers, we now know that there are countless worlds in our Milky Way and beyond. But as they are so far away, how can we know for sure that they are really there? And can we see what it's like on these far-flung worlds? Read on for the answers Aude Alapini gives us!



So far, astronomers have mostly found large planets around other stars, such as the one in this artist's impression.

Needle in a haystack

Trying to detect exoplanets is a challenging task. Unlike the nearby planets in our Solar System, exoplanets are very difficult to observe directly. Planets are millions of times fainter than their star, and seen from hundreds of light-years away — a light-year is a year travelling at the speed of light, which is more than a million times faster than an aeroplane! — they appear so close to their star that they are hidden from us in the glare. So far only ten or so exoplanets have been directly imaged using careful techniques that cancel out the light from the star to see the fainter object in orbit. These planets are bigger than Jupiter and in large orbits.

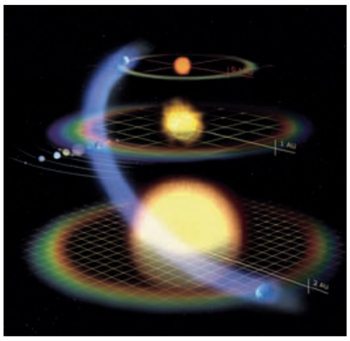
Scientists have developed several other methods to detect exoplanets. Instead of trying to see the planet directly, these methods aim at detecting the planet indirectly, such as through its influence on its star or on stars far behind it.

The snappily named 51 Pegasi b, found in 1995, was the first discovery of a planet around a star similar to the Sun. This exoplanet was discovered by Swiss astronomers using the radial velocity method, which needs a bit of explaining. 51Pegasi b is a planet more than 150 times as massive as the Earth — about half the mass of Jupiter — and 20 times closer to its star than the Earth is to the Sun. It would take us 50 years travelling at the speed of light to reach it. When a planet orbits a star, it causes the star to also move in a small orbit of its own. The radial velocity method consists of measuring the speed at which the star moves towards and away from us due to a planet orbiting around it. This speed is called the radial velocity and is only a few kilometres per hour for small planets like the Earth, less than walking speed. It is measured by studying features in the light coming from the star. With this method, scientists can measure the minimum mass of an exoplanet. So far, almost 500 exoplanets have been discovered with this method, making it the most popular technique. Other successful systems include transits (when the exoplanet moves in front of its host star), and microlensing (when the gravity of the exoplanet briefly enhances and focuses the light from the star).

Which types of exoplanets have we found so far?

Since 51 Pegasi b, astronomers have found almost 500 exoplanets in our galaxy, with new ones being discovered every week. Small planets like the Earth are extremely challenging to detect, as the smaller the exoplanet the weaker its signal. None found so far resemble the Earth in terms of composition or habitability. Most of them are more massive than Jupiter, meaning that they are very different from the Earth. They are also closer to their star than Mercury is to the Sun, meaning that it is extremely hot on their surfaces, often more than ten times hotter than boiling water! These exoplanets are nicknamed “hot Jupiters”.

Among all the exoplanets discovered so far, the one that resembles the Earth most is perhaps Gliese 581 d. Gliese 581 is a star three times smaller than the Sun, 20 light-years away from us. Gliese 581 d is the fourth planet around this star, orbiting slightly closer to its star than the Earth does around the Sun. Its mass is expected to be more than eight times that of the Earth, but its exact mass and radius are still unknown. This means that, for now, it is impossible to know what Gliese581d is made of.

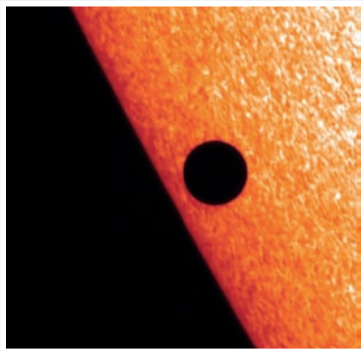


The “habitable zone” around a star is the region where water can exist as a liquid on a planet’s surface. This exact distance depends on the star.

How much can we know about these exoplanets?

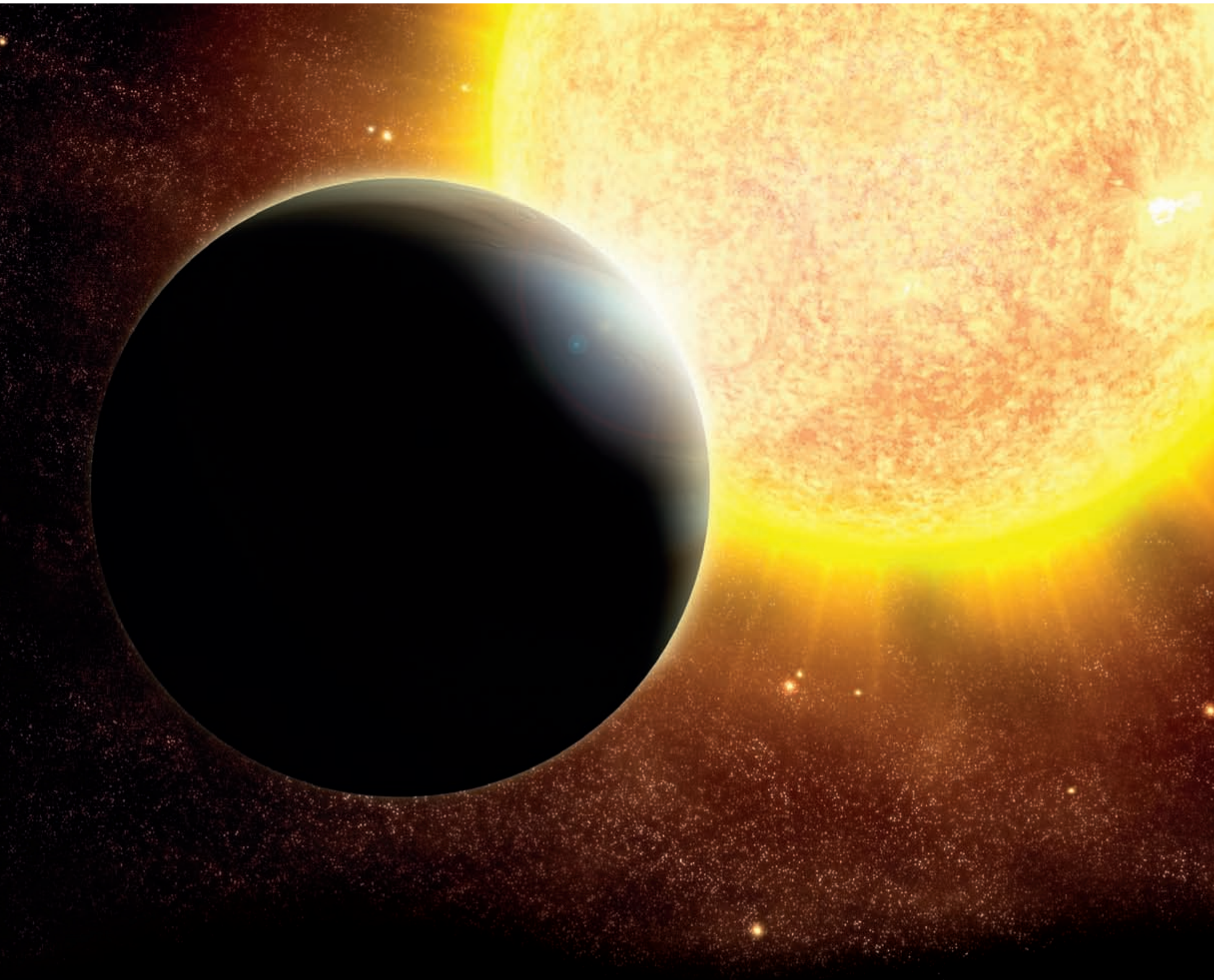
With our current technology, astrophysicists can already do a lot of great science, using ingenious scientific techniques to stretch the performance of available instruments. With the right observations, astrophysics can measure the mass and radius of an exoplanet, the shape of its orbit, and have a rough idea of its composition and atmosphere. The mass and radius of an exoplanet are used to calculate the planet’s density, which gives some information on the composition. The shape of the orbit of an exoplanet gives some information on the temperature and how it might have formed.

Detecting the atmosphere of an exoplanet was meant to be achievable only with the next generation of space telescopes, but clever astrophysicists have developed ingenious methods with the current orbiting observatories Hubble and Spitzer. Detecting the atmosphere of an exoplanet can currently be achieved for transiting planets in two ways. The first is by studying the light from the star that passes through the planet’s atmosphere. The other way is by studying the light from the exoplanet itself by measuring the difference between the light received from both the star and the planet and the light received from only the star when the planet disappears behind it.



During a transit, a planet passes in front of its star as seen from the Earth, meaning that we see the star’s brightness decrease a little. The dark spot in this picture is actually the planet Mercury, during a transit of our own Sun.

In some cases astrophysicists can even detect brightness variations as the planet moves around in its orbit. These give some information



on the presence of clouds in the atmosphere and atmospheric circulation of the exoplanet. We are actually starting to study some kind of "weather" on these worlds!

What's next?

The next generation of space telescopes, Darwin (launch after 2015) and Terrestrial Planet Finder (launch after 2020), are designed to find and study habitable exoplanets with direct imaging. With these telescopes, scientists hope to discover worlds resembling the Earth, and look for chemical signatures of life in the atmosphere of these planets.

Finding and studying exoplanets is really exciting science. It helps us understand how our Solar System was formed and what our place is in the Universe. It is a scientific way of looking for answers to questions such as: "Are there other planets like the Earth in the Universe?" and "Is there life on these planets?"

Artist's impression of a transiting Jupiter-mass exoplanet around a star slightly more massive than the Sun.