Hi this is Steve Nerlich from Cheap Astronomy www.cheapastro.com and this is *Spot that planet.*

The most authoritative source for confirmed extrasolar planets – or exoplanets – is the Extrasolar Planets Encyclopedia. At the time of recording this in May 2011, the Encyclopedia contains 548 confirmed exoplanets going around 458 stellar systems – because some systems have multiple planets, in fact 66 of these systems.

But to be clear this is not a door knock census of every star in our neighbourhood. Many of the stellar systems already assessed may have more planets than we can detect – and many stars where we have failed to find any planets, may just be a result of our failure to detect rather than a genuine absence of planets. We are starting to get a lot better at this after what is now 19 years of planet spotting, but the science is still full of false negatives and also false positives.

To avoid false positives, you start by just reporting exoplanet candidates. For example, the fabulous Kepler mission – which is a space-based observatory staring fixedly at 145,000 stars. Kepler has already reported, in February 2011, 1,235 exoplanet candidates, including 54 that may be in a habitable zone.

But these are just candidates. To achieve the status of confirmed exoplanet – and be so entered in the Extrasolar Planets Encyclopedia – candidates identified by space-based – or ground based telescopes must be further assessed – often over several years, if for example we need to allow an exoplanet to complete one of more orbits so that its existence can be confirmed by repeated observations. Or on the other hand, we might confirm the reliability of an exoplanet candidate by checking for it via different detection techniques.

So just what are the planet-spotting techniques that we use to achieve all this fabulous science?

(Commencing list of currently successful exoplanet finding methods)

Pulsar timing – A pulsar is a neutron star with a polar jet roughly aligned with Earth. As the neutron star spins and that jet comes into the line of sight of Earth, we detect an extremely regular pulse of light. Indeed, it is so regular that a slight wobble in the star's motion, due to it possessing planets, is detectable.

Now pulsar planets are rare - only four such pulsar planets have been confirmed to date, none of which could be considered habitable. But these are worth noting, because it is the case that the first extrasolar planets ever found were found in this way – actually three of them, around the pulsar PSR B1257+12 in 1992.

But that's pulsar planets. If we want to look for planets around main sequence stars, we have…

The radial velocity method – This is similar in-principle to the pulsar technique, where we know that a planet or planets will shift their star back and forth as they orbit it, causing tiny changes in the star's apparent velocity relative to Earth. These changes are generally measured as shifts in a star's spectral lines, detectable via Doppler spectrometry, although detection through astrometry (which is a direct detection of minute shifts in a star's position in the sky) may also be possible in the near future.

To date, the radial velocity method has been the most productive method for exoplanet detection (finding 500 of the 548 of those confirmed exoplanets I mentioned), although it'sbest at picking up massive planets in close stellar orbits (i.e. hot Jupiters) – and as a consequence these planets are over-represented in the current confirmed exoplanet population. Also, when used on its own, this method is only effective up to about 160 light years from Earth – and it only gives you the minimum mass, not the size, of the exoplanet.

So, to determine a planet's size, you can use…

The transit method – The transit method is effective at both detecting exoplanets and determining their diameter – although it has a high rate of false positives. This is because a star with a transiting planet, which partially blocks the star's light, makes it by definition a variable star. And, there are a great many reasons why a star may be variable – many of which have nothing to do with a transiting planet.

For this reason, the previously mentioned radial velocity method is quite often used to confirm a transit method finding. Consequently, although we do say 128 of the 548 confirmed exoplanets were found by the transit method – these 128 are also part of the 500 that are attributed to the radial velocity method. In other words, a transit method finding on its own is not currently sufficient to confirm an exoplanet's existence – but the transit method plus the radial velocity method combined is a very powerful confirming technique.

As well as that – since the radial velocity method gives you the exoplanet's mass – and the transit method gives you its size – with both these measures you can calculate the planet's density. You can also calculate the exoplanet's orbital period (by either method) which then gives you the distance of the exoplanet from its star, just by the application of Kepler's Third Law of planetary motion. Putting all this together, we can determine whether an exoplanet is a rocky Earth-sized planet in a star's habitable zone – where water could exist as a fluid.

And it doesn't stop there. When using the transit method, it's also possible to conduct a spectroscopic analysis of the exoplanet's atmosphere. So, we might imagine, in the not-too-distant future, we might find an Earth analogue planet in a star's habitable zone – and proceed to examine its atmosphere and monitor its electromagnetic broadcasts – in other words, scan for life signs.

It is also possible, from consideration of tiny variations in transit periodicity and duration of transit, to identify additional smaller planets that can't otherwise be visualized. Indeed, eight exoplanets have been confirmed via this method – and with future increased sensitivity, it may also become possible to use this approach to identify exomoons.

So, these are to date, the best techniques available to find habitable zone planets. To find planets in wider orbits, you can also try…

Direct imaging – This is a challenging technique since a planet is a faint light source quite close to a very bright light source (that is, its star). Nonetheless, 24 exoplanets have already been found by direct imaging. A technique called nulling interferometry is an effective way to detect a fainter light source normally hidden by a star's light, by conducting two observations and then effectively cancelling out the star's light in a composite image - through what's called destructive interference of the star's waveform.

Gravitational lensing – A star is massive enough to create a gravitational lens and hence magnify a distant light source – and if that star happens to have a planet, particularly one in an outer orbit, which is massive enough to slightly skew this lens effect of the star, then that planet can make its presence known. Such an event is relatively rare – and you might have to wait a long time to get a repeated observation. But nonetheless, this method has detected twelve exoplanets so far.

And that's about it. As I mentioned earlier, these current techniques are not expected to deliver a complete census of all planets, but they do offer us some impression of just how many exoplanets may be out there. It has been speculated from the scant data available so far, that there may be as many as 50 billion planets just within our galaxy - although there are the usual definitional issues of just what a planet is – particularly where you should draw the line between a planet and a brown dwarf. The Extrasolar Planets Encyclopedia currently sets the limit of a planet at 20 Jupiter masses.

Anyhow, 548 confirmed exoplanets for only 19 years of planet spotting is not bad going. And the search continues.

Thanks for listening. This is Steve Nerlich from Cheap Astronomy, www.cheapastro.com. Cheap Astronomy offers an educational website that even aliens on a distant Earth-analogue planet would find surprisingly inexpensive. No ads, no profit, just good science. Bye.