EMBARGOED UNTIL 11 January 2012, 19:00 CET
Every Milky Way Star has a Planet!

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Over the past 16 years, astronomers have detected more than 700 confirmed exoplanets [1] and have started to probe the characteristics of these worlds. While studying the properties of individual exoplanets is undeniably valuable, a much more basic question remains: how commonplace are planets in the Milky Way?

Most currently known exoplanets have been found either by detecting the effect of the gravitational pull of the planet on its host star or by catching the planet as it passes in front of its star and slightly dims it. Both of these techniques are much more sensitive to planets that are either massive or close to their stars, or both, and many planets will be overlooked.

The international team of astronomers has searched for exoplanets using a totally different method – gravitational microlensing – that can detect planets over a wide range of mass and those that lie much further from their stars.

The astronomers used observations, supplied by the PLANET [2] and OGLE [3] groups, in which exoplanets are detected by the way that the gravitational field of their host stars, combined with that of possible planets, acts like a lens, magnifying the light of a background star. If the star that acts as a lens has a planet in orbit around it, the planet can make a detectable contribution to the brightening effect of the background star.

Jean-Philippe Beaulieu (Institut d'Astrophysique de Paris), leader of the PLANET collaboration adds: "The PLANET collaboration was established to follow up promising microlensing events with a round-the-world network of telescopes located in the southern hemisphere, from Australia and South Africa to Chile."

The PLANET collaboration relies heavily on data from the 1.0 metre telescope at the Sutherland field station of SAAO. Its representative at SAAO, John Menzies, says "We exploited the geographical advantage of the Sutherland site to fill the time gap between our Australian and Chilean telescopes to provide a full 24-hour/day coverage of the microlensing events."

Microlensing is a very powerful tool, with the potential to detect exoplanets that could never be found any other way. But a very rare chance alignment of a background star and a lensing star is required for a mi-

crolensing event to be seen at all. And to spot a planet during an event an additional chance alignment of the planet's orbit is also needed.

Although, for these reasons, finding a planet by microlensing is a far from easy task, three exoplanets have actually been detected in the PLANET and OGLE searches in the six years' worth of data discussed in the paper: one super-Earth [4], one with a mass comparable to Neptune's and one like Jupiter. By microlensing standards, this is an impressive haul. In detecting three planets, either the astronomers were incredibly lucky and had hit the jackpot despite huge odds against them, or planets are so abundant in the Milky Way that it was almost inevitable [5].

The astronomers then combined information about the three positive exoplanet detections with seven additional detections from earlier work, as well as the huge numbers of non-detections in the six years' worth of data – non-detections are just as important for the statistical analysis and are much more numerous. The conclusion was that one in six of the stars studied hosts a planet of similar mass to that of Jupiter, half have Neptune-mass planets and two thirds have super-Earths. The survey was sensitive to planets at distances of 75 million kilometres to 1.5 billion kilometres from their stars (in the Solar System this range would include all the planets from Venus to Saturn) and with masses ranging from five times that of the Earth up to ten times Jupiter's mass.

Combining the results suggests strongly that the average number of planets around a star is greater than one. They are the rule rather than the exception.

Notes:

[1] Exoplanets are planets associated with stars other than our Sun. The Kepler mission is discovering huge numbers of "candidate exoplanets" (http://kepler.nasa.gov/Mission/discoveries/candidates/) that are not included in the total reported here.

[2] Probing Lensing Anomalies NETwork.

[3] Optical Gravitational Lensing Experiment.

[4] A super-Earth has a mass between two and ten times that of the Earth. The discoveries, using various observational strategies, of 12 microlensing planets have been published so far,

[5] The astronomers surveyed millions of stars looking for microlensing events. Only 3247 such events were spotted in the period, 2002-2007 – the precise alignment needed is very unlikely. A representative subset of 440 light curves, including detections and non-detections, was used to derive the statistical results reported in the paper.