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New Planet for the New Millennium

A team of British scientists has made the first direct sighting of a world beyond our solar system. Using the largest Anglo-Dutch telescope in the Canary Islands and a tailor-made computer programme they have managed to untangle the faint starlight of the distant "millennium" planet from the blinding glare of its parent star.

"The signal is very faint, but it tells us that it's coming from a planet twice the diameter and eight times the mass of Jupiter – a real monster," said Andrew Cameron Collier of the University of St. Andrews, Scotland, the leader of the team.

The planet's parent star, Tau Bootis, is located 55 light years from the Earth. It is easily seen by the naked eye but its' planet has only been suggested at before based on the "wobble" in the light coming from the star as the planet travels around it. Although 28 planets have been indirectly inferred using the "wobble" method none have been confirmed by direct detection of their own actual light until now.

Team member Alan Penny from the Rutherford Appleton Laboratory, Oxfordshire, said," To be one of the first people on Earth to see a completely new planet is an awesome experience, especially on the eve of a new millennium. Our discovery is a major step in finding out what these planets are really like, a step that could lead to finding planets like Earth".

Cameron Collier and colleagues Keith Horne and David James from the University of St Andrews, together with Alan Penny used the 4.2-meter William Herschel Telescope on La Palma, Canary Islands, to detect the planet's starlight.

" This is a tremendous coup for British astronomers", said Ian Halliday, CEO of PPARC the UK's strategic science investment agency and funding body behind the team. Halliday added," UK scientists are continually pushing back the frontiers of knowledge. Cutting edge discoveries like this endorses our investment in science and technology and highlights our IT expertise in developing such powerful computing programmes".

Commenting on this first visible detection Lord Sainsbury, Minister for Science said, "This discovery was made possible by the innovative work of British scientists. It is exciting to be able to look, for the first time, at the light from a planet outside our own solar system. It is another step in the search for life elsewhere in the Universe."

The team's results are to be published in the scientific journal Nature on 16 December 1999.

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Image: An artist's impression of how the "millennium" planet might look based on scientific data from the research team. The moon in the foreground is imaginary, but it is possible that the planet might have a moon.

This image has been sent to your picture desk – file name planet.jpg.
It is also available at http://www.pparc.ac.uk/news from midday on Wednesday 15th December.

Notes to Editors:

- One Light Year is equivalent to 6 million, million miles.

- The new result is the latest in a flurry of discoveries that began 4 years ago when Swiss astronomers Michel Mayor and Didier Queloz found the star 51 Pegasi to be "wobbling" back and forth every 4 days. Similar wobbles, caused by unseen planetary companions, have now been found in a total of 28 nearby Sun-like stars, and the tally is growing fast. The significance of the new discovery is that unlike the Doppler wobble method, it detects the light from the planet itself. This provides independent confirmation that the star wobbles really are caused by planets. It also opens up the prospect of identifying the atmospheric constituents of these bizarre, char-grilled planets within the next few years. Further evidence that the wobbles really are caused by planets came to light last month when two teams in the USA -- one in Colorado, then one in Tennessee -- saw a brief dimming in the light of the star HD 209458, as its planet passed between us and the star.

- The astronomers used the 4.2-m William Herschel Telescope, which is operated on the island of La Palma in the Canary Islands in Spain by the UK's Particle Physics and Astronomy Research Council and its Dutch equivalent, the NWO. Their first attempt, in 1998, produced no clear sign of a planet. "The planet turned out to be more difficult to see than we thought," said Collier Cameron. Meanwhile, another team led by David Charbonneau and Robert Noyes at Harvard University had also failed to detect the planet, using the giant 10-m Keck Telescope on Mauna Kea in Hawaii. Both teams came to the conclusion that the planet was at least 10,000 times fainter than the star.

Fortunately the UK team was given a second chance to push the search to even fainter limits. In the spring of this year, they timed their nights on the telescope to coincide with times when the planet should be on the far side of the star, with its illuminated face turned toward Earth.

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- The team also developed a sensitive new computer programme, which was needed to untangle the faint light of the planet from the blazing glare of its parent star. The scientists likened the problem to picking up a picture from a distant TV station, on the same channel as a local station and using a TV set with no aerial. "There's a danger that if you stare at it for long enough you'll see something that isn't really there. The signal we detect is about 3 times stronger than background interference. This is pretty convincing but it does leave a 1 in 20 chance that we're not there yet," cautions Collier Cameron.

- The computer analysis revealed a faint copy of the star's spectrum, embedded in the starlight and wobbling back and forth in a sense exactly opposite the star's own, smaller wobble (see animation). This is exactly how light reflected from a closely orbiting planet should behave: the planet's light appears slightly bluer when the planet is approaching Earth and redder when it is receding. The wobble was, however, only half the size the team was expecting for a planet in a nearly edge-on orbit. "This told us that the orbit was strongly tilted to the line of sight," said Collier Cameron.

- Knowing the tilt allowed the team to determine that the planet's mass is eight times that of Jupiter, the largest planet in our own system. "Unless the planet is one of the rare variety that passes across the face of its star, our direct detection method is the only unambiguous way to measure the planet's mass," said Collier Cameron.

- The tilt also explains why the planet appears so faint. "Even when it's on the far side of the star, we never get to see the planet's face fully illuminated so it's always at least 30,000 times fainter than the star," said Horne. When the tilt is taken into account, however, the signal is as strong as expected for a planet with a diameter 60 percent to 80 percent bigger than that of Jupiter, or about 20 times the diameter of Earth.

- The method of discovery bears some resemblance to that used to find the planet Neptune in our own solar system. Just over a century and a half ago, John Couch Adams and Urbain Leverrier predicted the presence of the as-yet undiscovered planet Neptune, from irregularities in the orbit of Uranus. In the following year, 1846, Johann Galle and Heinrich Louis d'Arrest used their predictions to obtain the first sighting of Neptune, close to its predicted position. "Knowing the timing of the orbit was the key to success," said Horne. "This enabled us to pick out the times when the planet would be at its brightest, and to use the planet's own wobble to distinguish it from the light of the star."

- Being so close to its star, the planet's atmosphere is expected to be a chemical cauldron at a temperature of about 1700 C. David Sudarsky and his colleagues at the University of Arizona recently predicted an alien environment in which elements like sodium and potassium, which take the form of metals on Earth, are present as trace gases in a hot hydrogen atmosphere above a cloud deck of magnesium silicate droplets. "It's possible that these trace elements in the atmosphere explain the lack of yellow and violet light," says Penny. "It's tremendously exciting that we will soon be able to test these ideas directly."

- The team is now planning even more detailed observations for early next year, using their new-found knowledge of the planet's orbit. They are optimistic that new observations will not only confirm the detection, but will also provide enough spectral information for them to identify the chemical composition of the atmosphere. The same technique should also detect the light reflected from several other bright stars thought to harbour close-in planets. "We've got plenty to keep us occupied in the new millennium," said Collier Cameron.

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