Astronomers Find Tiny Planet Orbiting Tiny Star

An international team of astronomers led by David Bennett of the University of Notre Dame has discovered an extra-solar planet of about three Earth masses orbiting a star with a mass so low that its core may not be massive enough to maintain nuclear reactions. This result is being presented in a press conference at the AAS meeting in St. Louis, MO.

The planet, referred to as MOA-2007-BLG-192Lb, establishes a new record for the lowest mass planet to orbit a normal star. The star, MOA-2007-BLG-192L, is at a distance of 3000 light years and the lowest mass host star to have a companion with a planetary mass ratio. The mass of the host is about 6% of the mass of the Sun. Such a star is called a brown dwarf, because this is slight below the mass needed to sustain nuclear reactions in the core. But the measurement uncertainty also permits a host mass slightly above 8% of a solar mass, which would make MOA-2007-BLG-192L a very low-mass Hydrogen burning star.

“Our discovery indicates that that even the lowest mass stars can host planets” says Bennett. No planets have previously been found to orbit stars with masses less than about 20% of that of the Sun, but this finding suggests that we should expect very low-mass stars near the Sun to have planets with a mass similar to that of the Earth. This is of particular interest because it may be possible use NASA’s planned James Webb Space Telescope to search for signs of life on Earth-mass planets orbiting low-mass stars in the vicinity of the Sun.

This discovery of the MOA-2007-BLG-192L star-planet system was made by the Microlensing Observations in Astrophysics (MOA), which includes Bennett, and the Optical Gravitational Lensing Experiment (OGLE) collaborations using the gravitational microlensing method.

Gravitational microlensing takes advantage of the fact that light is bent as the rays pass close to a massive object, like a star. The gravity from the mass of the intervening object, or lens star, warps surrounding space and acts like a giant magnifying glass. As predicted by Albert Einstein and later confirmed, this phenomena causes an apparent brightening of the light from a background “source” star. The effect is seen only if the astronomer’s telescope lies in almost perfect alignment with the source star and the lens star.

Astronomers are then able to detect planets orbiting the lens star if the light from the background star also is warped by one or more planets.
The primary challenge of the microlensing method is that the precise alignments needed for the planetary microlensing signals are quite rare and brief, often lasting less than a day. This new discovery was made possible by the new MOA-II telescope at New Zealand’s Mt. John Observatory, using the MOA-cam3 camera, which is able to image an area of sky 13 times larger than the area of the full moon in a single image. Bennett explains, “The new MOA telescope-camera system allows us to monitor virtually all of the known microlensing events for planetary signals. We would not have made this discovery without it.”

The microlensing observations provided evidence that the host star has a mass of about 6% of the mass of the Sun. This was confirmed by high angular resolution adaptive optics images with the Very Large Telescope (VLT) at the European Southern Observatory in Chile. These images confirm that the planetary host is either a brown dwarf or a very low-mass star.

The planet orbits its host star or brown dwarf with an orbital radius similar to that of Venus. But the host is likely to be between three thousand and 1 million times fainter than the Sun, so the top of the planet’s atmosphere is likely to be colder than Pluto. However, the planet is likely to maintain a massive atmosphere that would allow warmer temperatures at lower altitudes. It is even possible that interior heating by radioactive decays would be sufficient to make the surface as warm as the Earth, but theory suggests that the surface may be completely covered by a very deep ocean.

This result also supports the 1996 prediction by Bennett and Sun Hong Rhie that the microlensing method should be sensitive to Earth-mass planets. “I’ll hazard a prediction that the first extra-solar Earth-mass planet will be found by microlensing. But we’ll have to be very quick to beat the radial velocity programs and NASA’s Kepler mission, which will be launched in early 2009.”

A paper describing this result has been accepted for publication in the Astrophysical Journal, and it is scheduled to be published in the September 1 issue. Bennett’s work is funded by the National Science Foundation and the National Aeronautics and Space Administration.

In addition to Bennett, the MOA group is made up of astronomers from Nagoya University, Konan University, Nagano National College of Technology, and Tokyo Metropolitan College of Aeronautics in Japan, as well as Massey University, the University of Auckland, Mt. John Observatory, the University of Canterbury, and Victoria University in New Zealand. The OGLE group is comprised of astronomers from Warsaw University Observatory in Poland, the Universidad de Concepción in Chile, and the University of Cambridge in England. Additional collaborators who provided the VLT data and analysis are from the Institut d’Astrophysique de Paris, the Observatoire Midi-Pyrénées, and the Observatoire de Paris in France, the European Southern Observatory in Chile, and Heidelberg University in Germany.
Artist’s conception of the newly discovered planet MOA-2007-BLG-192Lb orbiting a brown dwarf “star” with a mass of only 6% of that of the Sun. Theory suggests that the 3-earth-mass planet is made primarily of rock and ice. Observational and theoretical studies of brown dwarfs reveal that they have a magenta color due to absorption by elements such as Sodium and Potassium in their atmospheres.

An alternate artist’s conception of the planet MOA-2007-BLG-192Lb, under the assumption that the host star has a mass of 9% of that of the Sun, which is also consistent with the microlensing data. This would be a red dwarf star about 100 times brighter than the brown dwarf, but 1000 times fainter than the Sun.
Images credit: NASA's Exoplanet Exploration Program

Contact: David Bennett, (574) 315-6621 or (574) 631-8298; bennett@nd.edu

From: William G. Gilroy, assistant director of news and information

The scientific paper accepted for publication by the Astrophysical Journal and high-resolution versions of the artist’s conception pictures are available at [http://www.nd.edu/~bennett/moa07blg192/](http://www.nd.edu/~bennett/moa07blg192/)

Previous National Science Foundation press releases include general information about the microlensing method:

**Closer to Home** (Jan., 2006):

**A Newly Discovered Solar System Contains Scaled-Down Versions of Saturn and Jupiter** (Feb., 2008):