PLANETARY NEWS: PLUTO (2006)

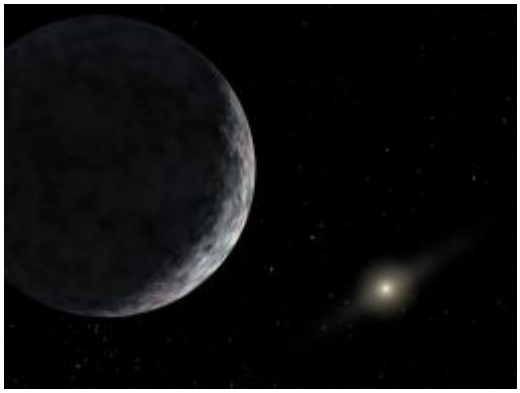
HOW BIG IS 2003 UB313?

RECENT STUDIES PROVIDE DIFFERENT ESTIMATES TO SIZE OF "TENTH PLANET"

By Amir Alexander

February 1, 2006

How big is 2003 UB313 -- the most distant known object in our solar system -- often referred to as the "10th planet"? Ever since its discovery, the exact size of this object, nicknamed "Xena" by its discoverers, has exercised planetary scientists. In the past week, two different announcements gave conflicting answers to this question. One put 2003 UB313's diameter first at almost precisely that of Pluto, the other at 30% greater than Pluto.



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Artist's concept of 2003 UB313

Credit: Robert Hurt (IPAC)

When it was first announced at a press conference in July 2005, Caltech's Michael Brown, who led the team that discovered the object, estimated 2003 UB313's diameter at around 2,700 kilometers (1,620 miles). This implied that it is substantially larger than Pluto, which has a diameter of 2,300 kilometers (1,380 miles), and consequently that it should be considered a "10th planet" in our solar system.

As Brown was quick to note at the time, however, size estimates based on visible light observations are notoriously inaccurate. The reason is that the brightness of an object viewed from Earth is dependent both on its size and its reflectivity, known as the object's "albedo." For a given observed brightness, an object with a higher albedo is smaller than an object with a low albedo. Without an independent measurement of either an object's size or the albedo, there is no way to disentangle the two. Brown's original size estimate was based on the assumption that 2003 UB313's albedo is similar to Pluto's. Since Pluto, which reflects 62% of the Sunlight that comes its way is one of the most reflective known bodies in the solar system, Brown's assumption was, in fact, a conservative one.

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One obvious way of determining the actual size of 2003 UB313 would be to resolve its disk in a telescope and measure it. As reported in the online journal ScienceNOW, in a public talk, Brown said that this was in fact accomplished recently by the Hubble Space Telescope (HST). Preliminary estimates based on this image suggested that 2003 UB313 was smaller than previously thought -- in fact, barely bigger than Pluto. The surprising aspect of this find is that such a small diameter must imply a remarkably high albedo of 92%! Scientists have no idea of how or why the body would be so extraordinarily reflective. However, this report was premature, and Brown has since stated, "Contrary to rumors otherwise, we're just in the preliminary stages of analyzing the HST data. When we are done we should have a very precise measurement. I hope that we will have the HST analysis done within perhaps a month, and I'll be able to say more then."

Indeed, a new study by German scientists seems to point in exactly the opposite direction. In an article published today in the journal *Nature*, a team led by Frank Bertoldi of the

University of Bonn and the Max Planck Institute for Radio Astronomy (MPIfR) and Wilhelm Altenhoff of MPIfR measured the thermal radiation emitted by 2003 UB313. Unlike visible light, thermal radiation is determined almost exclusively by an object's temperature and size, and only marginally by its albedo. Since a body's temperature can be determined with a high degree of accuracy based on its distance from the Sun, measuring its thermal radiation can give a good estimate of its size.

Using the Max Planck Millimeter Bolometer (MAMBO-2) at the IRAM 30-meter telescope in Pico Veleta, Spain, Bertoldi and his colleagues measured 2003 UB313's radiation at the 1.2-millimeter wavelength between August 19 and 27, 2005. Since its surface temperature is about 25 kelvins (-248 degrees Celsius or -414 degrees Fahrenheit), they calculated that its diameter should be 3,094 kilometers (1,856 miles) -- 30% greater than Pluto. This estimate has the additional advantage that it implies an albedo of 55% , very similar to Pluto's 62% . In the *Nature* article, the authors note that the measurement of an object's thermal radiation does depend, to a certain extent, on its rotation rate and the inclination of its orbit as viewed from Earth. But even taking the most "pessimistic" (and unlikely) estimates, Bertoldi's team nevertheless arrived at a size estimate of 2,859 kilometers (1,715 miles) in diameter, still substantially larger than Pluto.

Though the exact diameter of 2003 UB313 is not yet known, the cumulative weight of evidence points to an object larger, perhaps substantially larger, than Pluto. This debate is no help at all to the International Astronomical Union, which is currently weighing the thorny and emotional question: "what is a planet?" If 2003 UB313 is larger than Pluto, is it a planet? If it is, what about other large trans-Neptunian objects? If it isn't, then should its smaller kin Pluto be regarded as a planet? The answers are far from clear. But as evidence accumulates on the variety and complexity of objects in our own and other planetary systems, the old comfortable definitions are being stretched to their limits.

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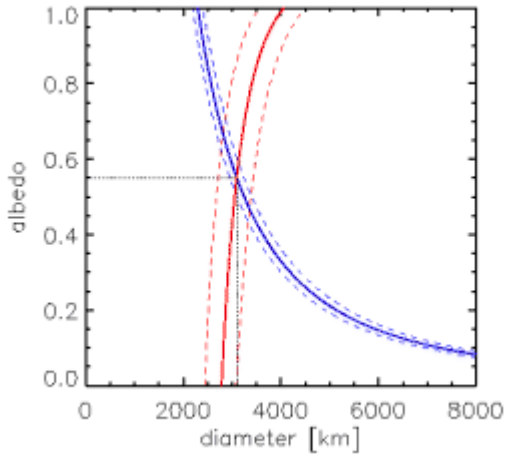
The IRAM 30-meter radio telescope, Pico Veleta, Spain

Credit: Institute for Radio Astronomy at Millimeter wavelengths (IRAM)



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Estimating the diameter of 2003 UB313

Measuring the diameter of faint and distant Kuiper belt objects is a challenge. This diagram shows the state of knowledge of the diameter of 2003 UB313 as of February 2006. The blue curve represents a constraint on the diameter of 2003 UB313 based on its optical brightness. Because the optical brightess is strongly dependent upon the "albedo," or reflectivity, of the surface, the blue curve covers diameters ranging from near Pluto's (2,300 kilometers) out to more than 8,000 kilometers for very low albedo. The red curve represents a constraint given by observations in radio wavelengths, which are dependent upon the temperature of the body. The temperature is only very weakly dependent upon albedo. The intersection of the two curves gives the most likely estimate for the diameter. (Dotted lines give intervals for observational uncertainty in the measurements.) Credit: Frank Bertoldi, MPIfR