Brown dwarf pair mystifies astronomers

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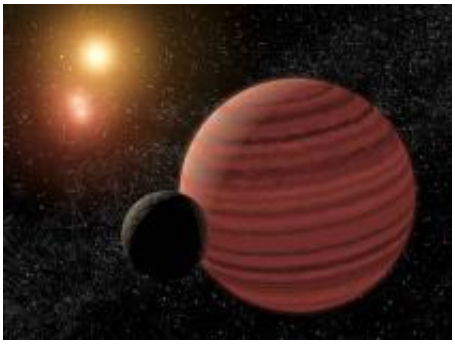

Artist's rendition of a brown dwarf and its moon orbiting a triple star system. Image: NASA

(PhysOrg.com) -- Two brown dwarf-sized objects orbiting a giant old star show that planets may assemble around stars more quickly and efficiently than anyone thought possible, according to an international team of astronomers.

"We have found two brown dwarf-sized masses around an ordinary star, which is very rare," said Alex Wolszczan, Evan Pugh professor of astronomy and astrophysics, Penn State and lead scientist on the project.

The star, BD +20 2457, is a K2 giant -- an old bloated star nearing the end of its life. Seeing a pair of brown dwarfs around a K-type giant is a first for astronomers and offers a unique window into how they can be produced. The researchers from the Torun Center for Astronomy, Poland and the Center for Exoplanets and Habitable Worlds, Penn State

report their findings in the current issue of the *Astrophysical Journal*.

Brown dwarfs are dim, elusive objects that straddle the dividing line between planets and stars. They are too massive to be planets, but not massive enough to generate the fusion-powered energy of a star. These stellar cousins represent a kind of "missing link" between planets and stars, but little is known about how they are made.

"If we find one brown dwarf, we are not sure where it came from," Wolszczan explained. "It could be either from the process of planet formation or it could be a direct product of star formation."

Seeing two of them around a parent star means they must have originally formed from the enormous supply of raw materials that surrounded the star when it was young. Astronomers call this thick, solar system-sized pancake of gas and dust the "circumstellar disk."

"If that is the case," he continued, "then if we add up the minimum masses of these two objects, we know the disk had to be extremely massive."

To find these faint companions, the astronomers used the High Resolution Spectrograph on the Hobby-Eberly Telescope in west Texas to split up the light of BD +20 2457. This technique is similar to the way a prism breaks light into a rainbow -- spectrum -- of colors. They looked for shifts in color of certain features in the spectrum, called spectral lines, as the dwarfs moved around the star and caused the star to wobble back and forth from their gravitational tugs.

When the brown dwarfs' gravitational influence causes BD +20 2457 to move towards Earth slightly, its spectral lines decrease in wavelength, becoming slightly bluer. As it moves away, the wavelengths increase, becoming slightly redder. By noting how quickly and strongly the

spectral lines shift, astronomers can infer the objects' masses, as well as the sizes and shapes of their orbits.

The scientists determined that the two companions are at least 21 and 13 times the mass of Jupiter. Therefore, they are likely to exceed the minimum mass of a brown dwarf, 13 times the mass of Jupiter. They are separated from their star by about 1.5 and 2 times the distance between the Earth and the sun and complete a "year" in 380 and 622 days, respectively.

What is even more unusual is the timescale involved in making these brown dwarfs.

Several million years ago, BD +20 2457 was on the "main sequence," the stage in stellar evolution where the star produced light by burning its hydrogen fuel, much like our sun does now. Except this star, three times the mass of the sun, was much hotter and more luminous.

"The intense radiation of this star would have heated up and evaporated anything that was still forming around it," Wolszczan said. "The fact that these dwarfs are still here means that they had to accumulate a lot of material very quickly and be fully formed by the time the star 'switched on.' "

A star like BD +20 2457 takes about 10 million years to form and enter the main sequence. As a rough estimate, in order keep up with their parent star, the dwarfs would have to accrue as much mass as the Earth's moon every year.

"The lesson from this is that a combination of physical mechanisms may be responsible for making brown dwarfs," Wolszsczan said. "Instead of just growth by accretion (the steady accumulation of material), the dwarfs' own gravity may help them gather more mass and speed up their

formation."

Provided by Pennsylvania State University