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SPACE

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Long distance weather reports are now a commonality. The report for 2MASSJ22282889-431026 is somewhat unusual. It forecasts wind-driven, planet-sized clouds, with the light varying in time, brightening and dimming about every 90 minutes. The clouds on 2MASSJ22282889-431026 are composed of hot grains of sand, liquid drops of iron, and other exotic compounds. Definitely not the first place to spend a summer holiday.

Not that 2MASSJ22282889-431026 (or 2M2228 as it is known in The Astrophysical Journal Letters) will appear on a travel itinerary anytime soon. For 2M2228 is a brown dwarf, 39.1 light years from earth. Brown dwarves form out of condensing gas, as stars do, but lack the mass to fuse hydrogen atoms and produce energy. Instead, these objects, which some call failed stars, are more similar to gas planets, such as Jupiter and Saturn, with their complex, varied atmospheres. Although brown dwarves are cool relative to other stars, they are actually hot by earthly standards. This particular object is about 600 to 700 degrees Celsius.

The atmosphere of 2M2228

Astronomers using NASA's Spitzer and Hubble space telescopes have probed the stormy atmosphere of this brown dwarf, creating the most detailed "weather map" yet for this class of cool, star-like orbs. "With Hubble and Spitzer, we were able to look at different atmospheric layers of a brown dwarf, similar to the way doctors use medical imaging techniques to study the different tissues in your body," said Daniel Apai, the principal investigator of the research at the University of Arizona in Tucson.

But more surprising, the team also found the timing of this change in brightness depended on whether they looked using different wavelengths of infrared light.

This artist's illustration shows the atmosphere of a brown dwarf called 2MASSJ22282889-431026, which was observed simultaneously by NASA's Spitzer and Hubble space telescopes. The results were unexpected, revealing offset layers of material as indicated in the diagram. For example, the large, bright patch in the outer layer has shifted to the right in the inner layer. The observations indicate this brown dwarf — a ball of gas that "failed" to become a star — is marked by wind-driven, planet-size clouds. The observations were made using different wavelength of light: Hubble sees infrared light from deeper in the object, while Spitzer sees longer-wavelength infrared light from the outermost surface. Both telescopes watched the brown dwarf as it rotated every 1.4 hours, changing in brightness as brighter or darker patches turned into the visible hemisphere. At each observed wavelength, the timing of the changes in brightness was offset, or out of phase, indicating the shifting layers of material. Image credit: NASA/JPL-Caltech.

These variations are the result of different layers or patches of material swirling around the brown dwarf in windy storms as large as Earth itself. Spitzer and Hubble see different atmospheric layers because certain infrared wavelengths are blocked by vapors of water and methane high up, while other infrared wavelengths emerge from much deeper layers.

The new research is a stepping-stone toward a better understanding not only of brown dwarves, but also of the atmospheres of planets beyond our solar system.

Into the red: the Spitzer space telescope

The Spitzer Space Telescope is the final mission in NASA's Great Observatories Program – a family of four space-based observatories, each observing the Universe in a different kind of light. The other missions in the program include the visible-light Hubble Space Telescope, Compton Gamma-Ray Observatory, and the Chandra X-Ray Observatory.

The Spitzer Space Telescope consists of a 0.85-meter diameter telescope and three cryogenically-cooled science instruments which perform imaging and spectroscopy in the 3 – 180 micron wavelength range. Since infrared is primarily heat radiation, detectors are most sensitive to infrared light when they are kept extremely cold. Using the latest in large-format detector arrays, Spitzer is able to make observations that are more sensitive than any previous mission. Spitzer's mission lifetime requirement was 2.5 years, then extended this to 5-years. Spitzer .

Launched on August 25, 2003 Spitzer is now more than 9 years into its mission, and orbits around the sun more than 100-million kilometers behind Earth. It has heated up just a bit – its instruments have warmed up from -271 Celsius to -242 Celsius. This is still way colder than a chunk of ice at 0 Celsius. More importantly, it is still cold enough for some of Spitzer's infrared detectors to keep on probing the cosmos for at least two more years; the project funding has been extended to 2016.

Spitzer seen against the infrared sky. The band of light is the glowing dust emission from the Milky Way galaxy seen at 100 microns (as seen by the IRAS/COBE missions). Image credit NASA/JPL

Spitzer is the largest infrared telescope ever launched into space. Its highly sensitive instruments allow scientists to peer into cosmic regions that are hidden from optical telescopes, including dusty stellar nurseries, the centres of galaxies, and newly forming planetary systems. Spitzer's infrared eyes also allows astronomers see cooler objects in space, like brown dwarves, extrasolar planets, giant molecular clouds, and organic molecules that may hold the secret to life on other planets.

Instead of orbiting Earth itself, the observatory trails behind Earth as it orbits the Sun and drifts away from us at about 1/10th of one astronomical unit per year.

This innovative orbit lets nature cool the telescope, allowing the observatory to operate for around 5.5 years using 360 litres of liquid helium coolant. In comparison, Spitzer's predecessor, the Infrared Astronomical Satellite, used 520 litres of cryogen in only 10 months.

This unique orbital trajectory also keeps the observatory away from much of Earth's heat, which can reach 250 Kelvin (-23 Celsius) for satellites and spacecraft in more conventional near-Earth orbits.

More scientific duets: the asteroid belt of Vega

Like a gracefully aging rock star Spitzer is reveling in duets. It has also teamed up with the European Space Agency's Herschel Space Observatory. Using data from both astronomers have discovered what appears to be a large asteroid belts around the star Vega, the second brightest star in northern night skies.

The data are consistent with the star having an inner, warm belt and outer, cool belt separated by a gap. The discovery of this asteroid belt-like band of debris around Vega makes the star similar to another observed star called Fomalhaut. Again this formation is similar to the asteroid and Kuiper belts in our own solar system.

Astronomers have discovered what appears to be a large asteroid belt around the bright star Vega, as illustrated here at left in brown. The ring of warm, rocky debris was detected using NASA's Spitzer Space Telescope, and the European Space Agency's Herschel Space Observatory. In this diagram, the Vega system, which was already known to have a cooler outer belt of comets (orange), is compared to our solar system with its asteroid and Kuiper belts. The relative size of our solar system compared to Vega is illustrated by the small drawing in the middle. On the right, our solar system is scaled up four times. The comparison illustrates that both systems have inner and outer belts with similar proportions. The gap between the inner and outer debris belts in both systems works out to a ratio of about 1-to-10, with the outer belt 10 times farther away from its host star than the inner belt. Astronomers think that the gap in the Vega system may be filled with planets, as is the case in our solar system. Image credit: NASA/JPL-Caltech.

What is maintaining the gap between the warm and cool belts around Vega and Fomalhaut? The results strongly suggest the answer is multiple planets. Our solar system's asteroid belt, which lies between Mars and Jupiter, is maintained by the gravity of the terrestrial planets and the giant planets, and the outer Kuiper belt is sculpted by the giant planets.

"Our findings (accepted for publication in the Astrophysical Journal) echo recent results showing multiple-planet systems are common beyond our sun," said Kate Su, an astronomer at the Steward Observatory at the University of Arizona, Tucson.

Vega and Fomalhaut are similar in other ways. Both are about twice the mass of our sun and burn a hotter, bluer color in visible light. Both stars are relatively nearby, at about 25 light-years away. Fomalhaut is thought to be around 400 million years old, but Vega could be closer to its 600 millionth birthday. For comparison our sun is 4,600 million years old. Fomalhaut has a single candidate planet orbiting it, Fomalhaut b, which orbits at the inner edge of its cometary belt.

The Herschel and Spitzer telescopes detected infrared light emitted by warm and cold dust in discrete bands around Vega and Fomalhaut, discovering the new asteroid belt around Vega and confirming the existence of the other belts around both stars. Comets and the collisions of rocky chunks replenish the dust in these bands. The inner belts in these systems cannot be seen in visible light because the glare of their stars outshines them.

It would seem that Spitzer has quite a bit more productive and novel scientific life, including duets, left in it yet.

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