Volume 48 Number 8 August 2022

The Celestial Mechanic

The Official Newsletter of the Astronomy Associates of Lawrence

Coming Events

Monthly Meeting
August 28, 2022, 7:00PM
Baker Wetlands Discovery Center

Public Observing
August 28, 2022, 8:00PM
Baker Wetlands Discovery Center

Club Officers

President
Rick Heschmeyer email

AICOR
William Winkler email

NSN Coordinator
Howard Edin email

Faculty Advisor
Dr. Jennifer Delgado email.

Newsletter Editor
Chuck Wehner email

Inside This Issue

Report From the Officers

By Rick Heschmeyer

As the saying goes, third (and fourth) time's a charm. On June 29th and July 13th we concluded our summer observing schedule after the City Band Concerts. We were greeted with clear skies and pleasant temperatures as Bill Wachspress and Rick Heschmeyer hosted about a dozen people at each session.

July's Telescope Night at KU took place on Thursday, July 14th. Dr. Bruce Twarog, a familiar face to AAL members, started the evening with a presentation entitled "Star Clusters: Test-beds for Stellar Evolution". As always, his presentation was informative and entertaining. Public observing took place on the hill behind Malott following the presentation. There will be no Telescope Night scheduled for August.

As summer draws to a close, we will resume our normal schedule of meetings, followed by observing, at Baker Wetlands Discovery Center. All meetings will start at 7:00PM to be followed by observing following the meeting, weather permitting. The schedule for meetings for the remainder of 2022 is as follows.

Sunday, August 28

Sunday, September 25

Sunday, October 30

Sunday, December 4

Three bright planets will show themselves in the evening sky during the second half of 2022. The first visible, Saturn, will be at opposition on August 14. Jupiter and Mars will follow later in the year.

Looking forward to seeing everyone at the end of August. Clear skies to all!

The Large Hadron Collider Is About to Ramp Up to Unprecedented Energy Levels

By Pierre Celerier
SCIENCEALERT, JULY 4, 2022

Ten years after it discovered the Higgs boson, the Large Hadron Collider is about to start smashing protons together at unprecedented energy levels in its quest to reveal more secrets about how the universe works.

The world's largest and most powerful particle collider started back up in April after a three-year break for upgrades in preparation for its third run.

From Tuesday it will run around the clock for nearly four years at a record energy of 13.6 trillion electronvolts, the European Organisation for Nuclear Research (CERN) announced at a press briefing last week.

It will send two beams of protons – particles in the nucleus of an atom – in opposite directions at nearly the speed of light around a 27-kilometre (17-mile) ring buried 100 meters under the Swiss-French border.

The resulting collisions will be recorded and analyzed by thousands of scientists as part of a raft of experiments, including ATLAS, CMS, ALICE and LHCb, which will use the enhanced power to probe dark matter, dark energy and other fundamental mysteries.

1.6 billion collisions a second

"We aim to be delivering 1.6 billion proton-proton collisions per second" for the ATLAS and CMS experiments, CERN's head of accelerators and technology Mike Lamont said.

This time around the proton beams will be narrowed to less than 10 microns – a human hair is around 70 microns thick – to increase the collision rate, he added.

The new energy rate will allow them to further investigate the Higgs boson, which the Large Hadron Collider first observed on 4 July 2012.

The discovery revolutionized physics in part because the boson fit within the Standard Model – the mainstream theory of all the fundamental particles that make up matter and the forces that govern them.

However several recent findings have raised questions about the Standard Model, and the newly upgraded collider will look at the Higgs boson in more depth.

"The Higgs boson is related to some of the most profound open questions in fundamental physics today," said CERN director-general Fabiola Gianotti, who first announced the boson's discovery a decade ago.

Compared to the collider's first run that discovered the boson, this time around there will be 20 times more collisions.

"This is a significant increase, paving the way for new discoveries," Lamont said.

Joachim Mnich, CERN's head of research and computing, said there was still much more to learn about the boson.

"Is the Higgs boson really a fundamental particle or is it a composite?" he asked.

"Is it the only Higgs-like particle that exists – or are there others?”

'New physics season'

Past experiments have determined the mass of the Higgs boson, as well as more than 60 composite particles predicted by the Standard Model, such as the tetraquark.

But Gian Giudice, head of CERN's theoretical physics department, said observing particles is only part of the job.

"Particle physics does not simply want to understand the how – our goal is to understand the why," he said.

Among the Large Hadron Collider's nine experiments is ALICE, which probes the matter that existed in the first 10 microseconds after the Big Bang, and LHCf, which uses the collisions to simulate cosmic rays.

After this run, the collider will come back in 2029 as the High-Luminosity LHC, increasing the number of detectable events by a factor of 10.

Beyond that, the scientists are planning a Future Circular Collider – a 100-kilometre ring that aims to reach energies of a whopping 100 trillion electronvolts.

But for now, physicists are keenly awaiting results from the Large Hadron Collider's third run.

"A new physics season is starting," CERN said. ☀

Capturing the onset of galaxy rotation in the early universe

SCIENCE NEWS, JULY 1, 2022

As telescopes have become more advanced and powerful, astronomers have been able to detect more and more distant galaxies. These are some of the earliest galaxies to form in our universe that began to recede away from us as the universe expanded. In fact, the more the distance, the faster a galaxy appears to move away from us. Interestingly, we can estimate how fast a galaxy is moving, and in turn, when it was formed based on how "redshifted" its emission appears. This is similar to a phenomenon called "Doppler effect," where objects moving away from an observer emit the light that appears shifted towards longer wavelengths (hence the term "redshift") to the observer.

The Atacama Large Millimeter/submillimeter Array (ALMA) telescope located in the midst of the Atacama Desert in Chile is particularly well-suited for observing such redshifts in galaxy emissions. Recently, a team of international researchers including Professor Akio Inoue and graduate student Tsuyoshi Tokuoka from Waseda University, Japan, Dr. Takuya Hashimoto at University of Tsukuba, Japan, Professor Richard S. Ellis at University College London, and Dr. Nicolas Laporte, a research fellow at the University of Cambridge, UK, has observed redshifted emissions of a distant galaxy, MACS1149-JD1 (hereafter JD1), which has led them to some interesting conclusions. "Beyond finding high-redshift, namely very distant, galaxies, studying their internal motion of gas and stars provides motivation for understanding the process of galaxy formation in the earliest possible universe," explains Ellis. The findings of their study have been published in *The Astrophysical Journal Letters*.

Galaxy formation begins with the accumulation of gas and proceeds with the formation of stars from that gas. With time, star formation progresses from the center outward, a galactic disk develops, and the galaxy acquires a particular shape. As star formation continues, newer stars form in the rotating disk while older stars remain in the central part. By studying the age of the stellar objects and the motion of the stars and gas in the galaxy, it is possible to determine the stage of evolution the galaxy has reached.

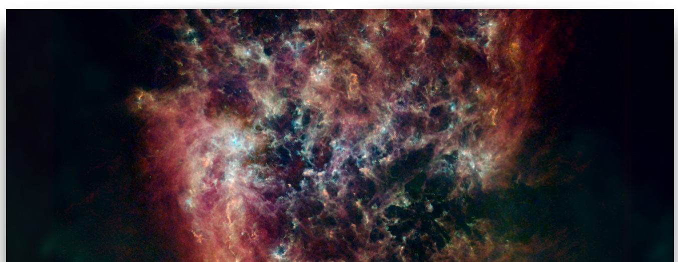
Conducting a series of observations over a period of two months, the astronomers successfully measured small differences in the "redshift" from position to position inside the galaxy and found that JD1 satisfied the criterion for a galaxy dominated by rotation. Next, they modeled the galaxy as a rotating disk and found that it reproduced the observations very well. The calculated rotational speed was about 50 kilometers per second, which was compared to the rotational speed of the Milky Way disk of 220 kilometers per second. The team also measured the diameter of JD1 at only 3,000 light-years, much smaller than that of the Milky Way at 100,000 light-years across.

The significance of their result is that JD1 is by far the most distant and, therefore, earliest source yet found that has a rotating disk of gas and stars. Together with similar measurements of nearer systems in the research literature, this has allowed the team to delineate the gradual development of rotating galaxies over more than 95% of our cosmic history.

Furthermore, the mass estimated from the rotational speed of the galaxy was in line with the stellar mass previously estimated from the galaxy's spectral signature, and came predominantly from that of "mature" stars that formed about 300 million years ago. "This shows that the stellar population in JD1 formed at an even earlier epoch of the cosmic age," says Hashimoto.

"The rotation speed of JD1 is much slower than those found in galaxies in later epochs and our Galaxy and it is likely that JD1 is at an initial stage of developing a rotational motion," says Inoue. With the recently launched James Webb Space Telescope, the astronomers now plan to identify the locations of young and older stars in the galaxy to verify and update their scenario of galaxy formation. ☀

New Images using Data from Retired Telescopes Reveal Hidden Features



For additional images go here.

HUBBLESITE, JUNE 16, 2022

New images using data from European Space Agency (ESA) and NASA missions showcase the gas and dust that fill the space between stars in four of the galaxies closest to our own Milky Way. More than striking, the snapshots are also a scientific trove, lending insight into how dramatically the density of dust clouds can vary within a galaxy.

With a consistency similar to smoke, dust is created by dying stars and is one of the materials that forms new stars. The dust clouds observed by space telescopes are constantly shaped and molded by exploding stars, stellar winds, and the effects of gravity. Almost half of all the starlight in the universe is absorbed by dust. Many of the heavy chemical elements essential to forming planets like Earth are locked up in dust grains in interstellar space. Understanding dust is an essential part of understanding our universe.

The observations were made possible through the work of ESA's Herschel Space Observatory, which operated from 2009 to 2013. Herschel's super-cold instruments were able to detect the thermal glow of dust, which is emitted as far-infrared light, a range of wavelengths longer than what human eyes can detect.

Herschel's images of interstellar dust provide high-resolution views of fine details in these clouds, revealing intricate substructures. But the way the space telescope was designed meant that it often couldn't detect light from clouds that are more spread out and diffuse, especially in the outer regions of galaxies, where the gas and dust become sparse and thus fainter. For some nearby galaxies, that meant Herschel missed up to 30% of all the light given off by dust. With such a significant gap, astronomers struggled to use the Herschel data to understand how dust and gas behaved in these environments. To fill out the Herschel dust maps, the new images combine data from three other missions: ESA's retired Planck observatory, along with two retired NASA missions, the Infrared Astronomical Satellite (IRAS) and Cosmic Background Explorer (COBE).

The images show the Andromeda galaxy, also known as M31; the Triangulum galaxy, or M33; and the Large and Small Magellanic Clouds – dwarf galaxies orbiting the Milky Way that do not have the spiral structure of the Andromeda and Triangulum galaxies. All four are within 3 million light-years of Earth.

In the images, red indicates hydrogen gas, the most common element in the universe. The image of the Large Magellanic Cloud shows a red tail coming off the bottom left of the galaxy that was likely created when it collided with the Small Magellanic Cloud about 100 million years ago. Bubbles of empty space indicate regions where stars have recently formed, because intense winds from the newborn stars blow away the surrounding dust and gas. The green light around the edges of those bubbles indicates the presence of cold dust that has piled up as a result of those winds. Warmer dust, shown in blue, indicates where stars are forming or other processes have heated the dust.

Many heavy elements in nature – like carbon, oxygen, and iron – can get stuck to dust grains, and the presence of different elements changes the way dust absorbs starlight. This in turn affects the view astronomers get of events like star formation. In the densest dust clouds, almost all the heavy elements can get locked up in dust grains, which increases the dust-to-gas ratio. But in less dense regions, the destructive radiation from newborn stars or shockwaves from exploding stars will smash the dust grains and return some of those locked-up heavy elements back into the gas, changing the ratio once again. Scientists who study interstellar space and star formation want to better understand this ongoing cycle. The Herschel images show that the dust-to-gas ratio can vary within a single galaxy by up to a factor of 20, far more than previously estimated.

“These improved Herschel images show us that the dust ‘ecosystems’ in these galaxies are very dynamic,” said Christopher Clark, an astronomer at the Space Science Telescope Institute in Baltimore, Maryland, who led the work to create the new images.

First Images from the James Webb Space Telescope

NASA.GOV, JULY 12, 2022

The dawn of a new era in astronomy has begun as the world gets its first look at the full capabilities of NASA’s James Webb Space Telescope, a partnership with ESA (European Space Agency) and CSA (Canadian Space Agency). The telescope’s first full-color images and spectroscopic data were released during a televised broadcast at 10:30 a.m. EDT (14:30 UTC) on Tuesday, July 12, 2022, from NASA’s Goddard Space Flight Center in Greenbelt, Maryland. These listed targets below represent the first wave of full-color scientific images and spectra the observatory has gathered, and the official beginning of Webb’s general science operations. They were selected by an international committee of representatives from NASA, ESA, CSA, and the Space Telescope Science Institute.

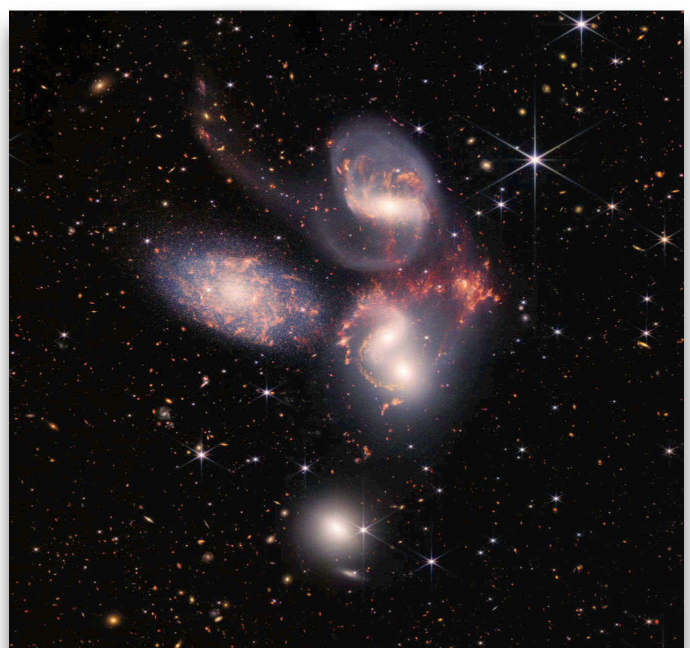
These first images from the world’s largest and most powerful space telescope demonstrate Webb at its full power, ready to begin its mission to unfold the infrared universe.

This landscape of “mountains” and “valleys” speckled with glittering stars is actually the edge of a nearby,

View larger version of this image.

young, star-forming region called NGC 3324 in the Carina Nebula. Captured in infrared light by NASA’s new James Webb Space Telescope, this image reveals for the first time previously invisible areas of star birth.

Called the Cosmic Cliffs, Webb’s seemingly three-dimensional picture looks like craggy mountains on a moonlit evening. In reality, it is the edge of the giant, gaseous cavity within NGC 3324, and the tallest “peaks” in this image are about 7 light-years high. The cavernous area has been carved from the nebula by the intense ultraviolet radiation and stellar winds from extremely massive, hot, young stars located in the center of the bubble, above the area shown in this image.



View larger version of this image.

Stephan's Quintet, a visual grouping of five galaxies, is best known for being prominently featured in the holiday classic film, "It's a Wonderful Life." Today, NASA's James Webb Space Telescope reveals Stephan's Quintet in a new light. This enormous mosaic is Webb's largest image to date, covering about one-fifth of the Moon's diameter. It contains over 150 million pixels and is constructed from almost 1,000 separate image files. The information from Webb provides new insights into how galactic interactions may have driven galaxy evolution in the early universe.

With its powerful, infrared vision and extremely high spatial resolution, Webb shows never-before-seen details in this galaxy group. Sparkling clusters of millions of young stars and starburst regions of fresh star birth grace the image. Sweeping tails of gas, dust and stars are being pulled from several of the galaxies due to gravitational interactions. Most dramatically, Webb captures huge shock waves as one of the galaxies, NGC 7318B, smashes through the cluster.

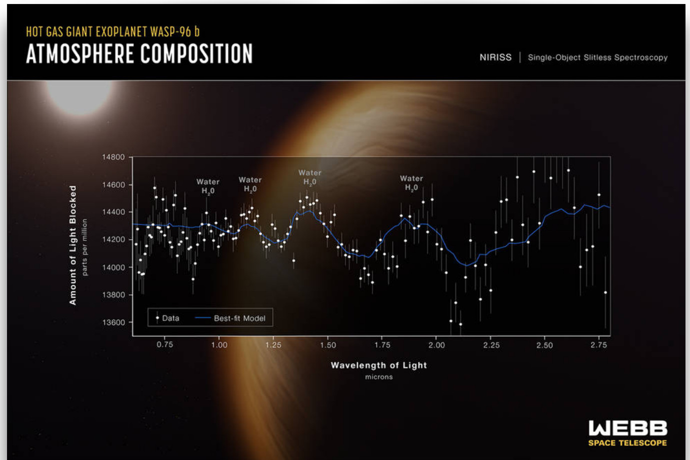
View larger version of this image.

Some stars save the best for last.

The dimmer star at the center of this scene has been sending out rings of gas and dust for thousands of years in all directions, and NASA's James Webb Space Telescope has revealed for the first time that this star is cloaked in dust.

Two cameras aboard Webb captured the latest image of this planetary nebula, cataloged as NGC 3132, and known informally as the Southern Ring Nebula. It is approximately 2,500 light-years away.

Webb will allow astronomers to dig into many more specifics about planetary nebulae like this one – clouds of gas and dust expelled by dying stars. Understanding which molecules are present, and where they lie throughout the shells of gas and dust will help researchers refine their knowledge of these objects.



View larger version of this image.

NASA's James Webb Space Telescope has captured the distinct signature of water, along with evidence for clouds and haze, in the atmosphere surrounding a hot, puffy gas giant planet orbiting a distant Sun-like star.

The observation, which reveals the presence of specific gas molecules based on tiny decreases in the brightness of precise colors of light, is the most detailed of its kind to date, demonstrating Webb's

View larger version of this image.

unprecedented ability to analyze atmospheres hundreds of light-years away.

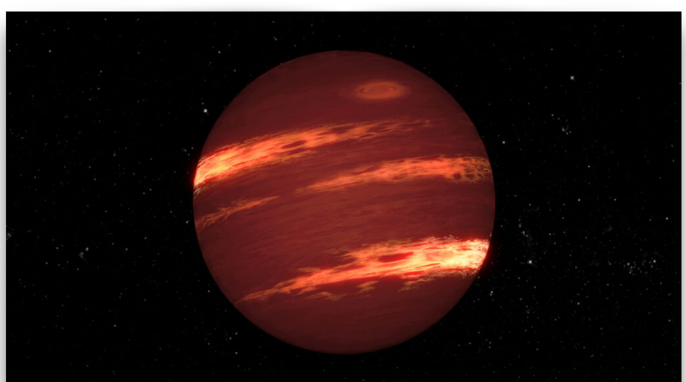
While the Hubble Space Telescope has analyzed numerous exoplanet atmospheres over the past two decades, capturing the first clear detection of water in 2013, Webb's immediate and more detailed observation marks a giant leap forward in the quest to characterize potentially habitable planets beyond Earth.

NASA's James Webb Space Telescope has produced the deepest and sharpest infrared image of the distant universe to date. Known as Webb's First Deep Field, this image of galaxy cluster SMACS 0723 is overflowing with detail.

Thousands of galaxies – including the faintest objects ever observed in the infrared – have appeared in Webb's view for the first time. This slice of the vast universe covers a patch of sky approximately the size of a grain of sand held at arm's length by someone on the ground.

President Joe Biden unveiled this image during a White House event Monday, July 11. ☀

Sand Clouds are Common in Atmospheres of Brown Dwarfs



By Lisa Grossman
SCIENCENEWS, JULY 8, 2022

Clouds of sand can condense, grow and disappear in some extraterrestrial atmospheres. A new look at old data shows that clouds made of hot silicate minerals are common in celestial objects known as brown dwarfs.

"This is the first full contextual understanding of any cloud outside the solar system," says astronomer Stanimir Metchev of the University of Western Ontario in London, Canada. Metchev's colleague Genaro Suárez presented the new work July 4 at the Cool Stars meeting in Toulouse, France.

Clouds come in many flavors in our solar system, from Earth's puffs of water vapor to Jupiter's bands of ammonia. Astronomers have also inferred the presence of "extrasolar clouds" on planets outside the solar system (*SN: 9/11/19*).

But the only extrasolar clouds that have been directly detected were in the skies of brown dwarfs — dim, ruddy orbs that are too large to be planets but too small and cool to be stars. In 2004, astronomers used NASA's Spitzer Space Telescope to observe brown dwarfs and spotted spectral signatures of sand — more specifically, grains of silicate minerals such as quartz and olivine. A few more tentative examples of sand clouds were spotted in 2006 and 2008.

Floating in one of these clouds would feel like being in a sandstorm, says planetary scientist Mark Marley of the University of Arizona in Tucson, who was involved in one of those early discoveries. "If you could take a scoop out of it and bring it home, you would have hot sand."

Astronomers at the time found six examples of these silicate clouds. "I kind of thought that was it," Marley says. Theoretically, there should be a lot more than six brown dwarfs with sandy skies. But part of the Spitzer telescope ran out of coolant in 2009 and was no longer able to measure similar clouds' chemistry.

While Suárez was looking into archived Spitzer data for a different project, he realized there were unpublished or unanalyzed data on dozens of brown dwarfs. So he analyzed all of the low-mass stars and brown dwarfs that Spitzer had ever observed, 113 objects in total, 68 of which had never been published before, the team reports in the July *Monthly Notices of the Royal Astronomical Society.*

"It's very impressive to me that this was hiding in plain sight," Marley says.

Not every brown dwarf in the sample showed strong signs of silicate clouds. But together, the brown dwarfs followed a clear trend. For dwarfs and low-mass stars hotter than about 1700° Celsius, silicates exist as a vapor, and the objects show no signs of clouds. But below that temperature, signs of clouds start to appear, becoming thickest around 1300˚ C. Then the signal disappears for brown dwarfs that are cooler than about 1000˚ C, as the clouds sink deep into the atmospheres.

The finding confirms previous suspicions that silicate clouds are widespread and reveals the conditions under which they form. Because brown dwarfs are born hot and cool down over time, most of them should see each phase of sand cloud evolution as they age. “We are learning how these brown dwarfs live,” Suárez says. Future research can extrapolate the results to better understand atmospheres in planets like Jupiter, he notes.

The recently launched James Webb Space Telescope will also study atmospheric chemistry in exoplanets and brown dwarfs and will specifically look for clouds (*SN: 10/6/21*). Marley looks forward to combining the trends from this study with future results from JWST. “It’s really going to be a renaissance in brown dwarf science,” he says. ☀

A New Method to Detect Exoplanets

ScienceDaily, July 20, 2022

In recent years, a large number of exoplanets have been found around single 'normal' stars. New research shows that there may be exceptions to this trend. Researchers from The Autonomous University of Nuevo León (UANL), The National Autonomous University of Mexico (UNAM), and New York University Abu Dhabi suggest a new way of detecting dim bodies, including planets, orbiting exotic binary stars known as Cataclysmic Variables (CVs).

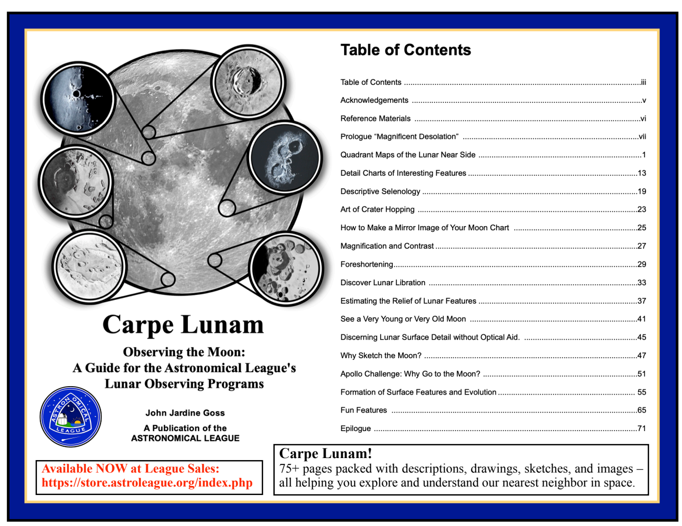
CVs are binary star systems in which the two stars are in extremely close proximity to each other; so close that the less massive object transfers mass to the more massive. CVs are typically formed of a small, cool type of star known as a red dwarf star, and a hot, dense star -- a white dwarf. Red dwarf stars have a mass between 0.07 and 0.30 solar masses and a radius of around 20% of the Sun's, while white dwarf stars have a typical mass of around 0.75 Solar masses and a very small radius similar to that of planet Earth.

In the CV system, the transfer of matter from the small star forms an accretion disk around the compact, more massive star. The brightness of a CV system mainly comes from this disk, and overpowers the light coming from the two stars. A third dim body orbiting a CV can influence the mass transfer rate between the two stars, and hence the brightness of the entire system. The method described in the new work is based on the change of brightness in the accretion disk due to perturbations of the third body that orbits around the inner two stars.

In their research, team leader Dr Carlos Chavez and his collaborators have estimated the mass and distance of a third body orbiting four different CVs using the changes in the brightness of each system. According to calculations carried out by the team, such brightness variations have very long periods in comparison to the orbital periods in the triple system. Two out of the four CVs appear to have bodies resembling planets in orbit around them.

Dr Chavez comments on the new findings, "Our work has proven that a third body can perturb a cataclysmic variable in such a way that can induce changes in brightness in the system. These perturbations can explain both the very long periods that have been observed -- between 42 and 265 days- and the amplitude of those changes in brightness." He adds, "Of the four systems we studied, our observations suggest that two of the four have objects of planetary mass in orbit around them."

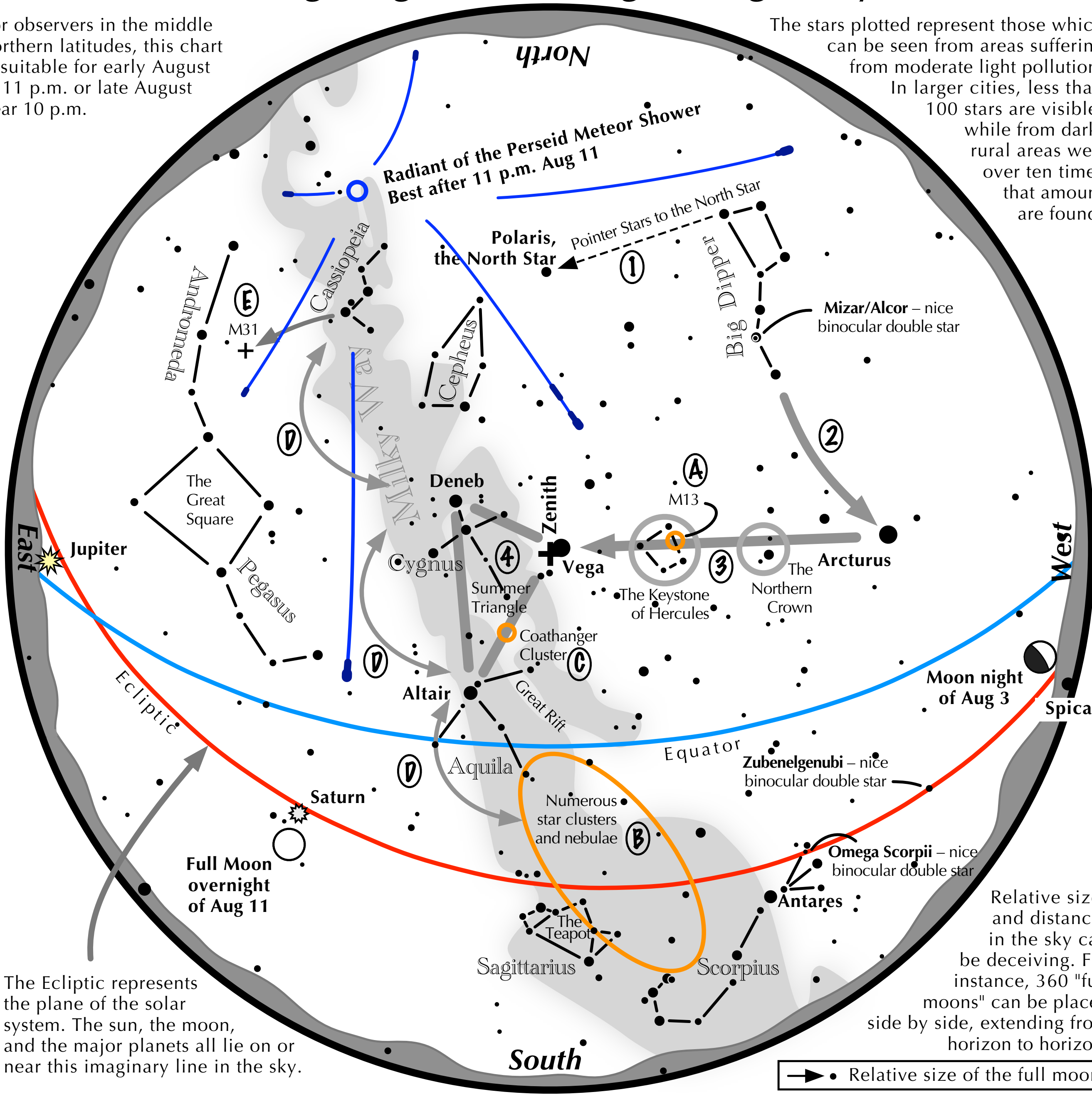
The scientists believe that this is a promising new technique for finding planets in orbit around binary star systems, adding to the thousands already found in the last three decades. ☀



Navigating the mid August Night Sky

For observers in the middle northern latitudes, this chart is suitable for early August at 11 p.m. or late August near 10 p.m.

The stars plotted represent those which can be seen from areas suffering from moderate light pollution. In larger cities, less than 100 stars are visible, while from dark, rural areas well over ten times that amount are found.



The Ecliptic represents the plane of the solar system. The sun, the moon, and the major planets all lie on or near this imaginary line in the sky.

Relative sizes and distances in the sky can be deceiving. For instance, 360 "full moons" can be placed side by side, extending from horizon to horizon.

→• Relative size of the full moon.

Navigating the mid August night sky: Simply start with what you know or with what you can easily find.

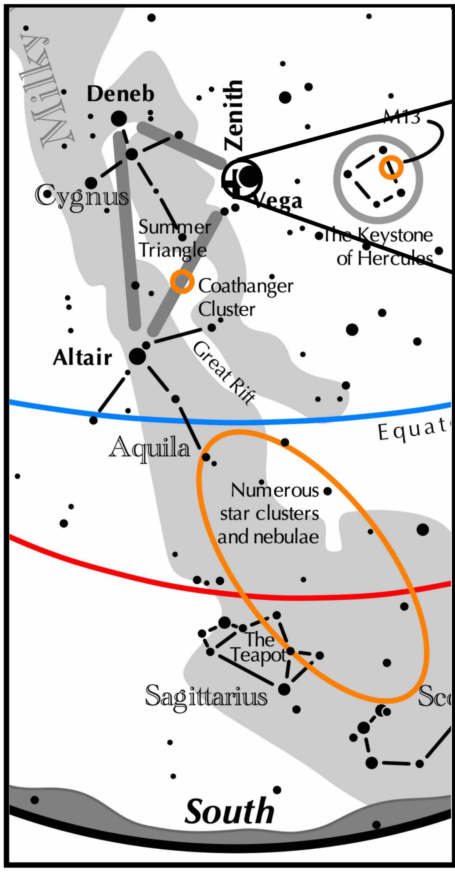
1. Extend a line north from the two stars at the tip of the Big Dipper's bowl. It passes by Polaris, the North Star.
2. Follow the arc of the Dipper's handle. It intersects Arcturus, the brightest star in the June evening sky.
3. To the northeast of Arcturus shines another star of the same brightness, Vega. Draw a line from Arcturus to Vega. It first meets "The Northern Crown," then the "Keystone of Hercules." A dark sky is needed to see these two dim stellar configurations.
4. High in the East lies the summer triangle stars of Vega, Altair, and Deneb.

Binocular Highlights

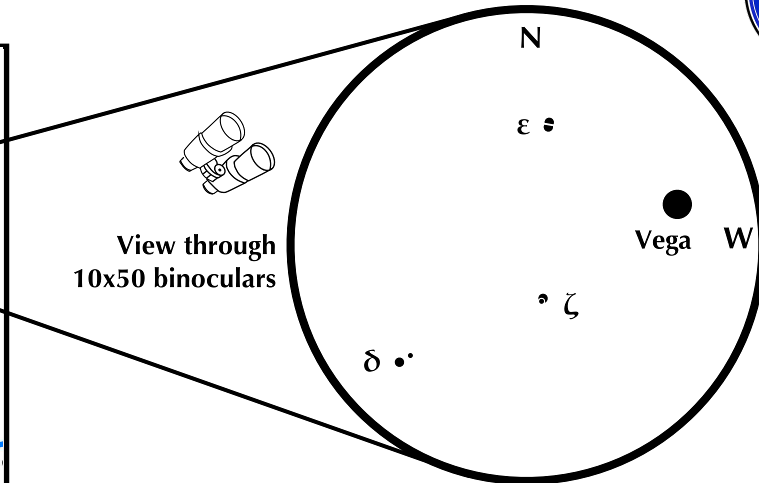
A: On the western side of the Keystone glows the Great Hercules Cluster.
B: Between the bright stars Antares and Altair, hides an area containing many star clusters and nebulae.
C: 40% of the way between Altair and Vega, twinkles the "Coathanger," a group of stars outlining a coathanger.
D: Sweep along the Milky Way for an astounding number of faint glows and dark bays, including the Great Rift.
E: The three westernmost stars of Cassiopeia's "W" point south to M31, the Andromeda Galaxy, a "fuzzy" oval.

Astronomical League *www.astroleague.org/outreach; duplication is allowed and encouraged for all free distribution.*

If you can observe one evening celestial scene this month, consider this one:



Facing south 90 minutes after sunset



3 amazing double plays

Face directly south and look overhead 90 minutes after sunset. (Bright moonlight may interfere August 4 - 14.)

- Lie on your back and look directly overhead at the bright blue-white star Vega.
- Aim a pair of binoculars at Vega, and place it near the western edge of the field.
- In the field's northern half lies Epsilon Lyrae. Hold the glasses steady and its two similarly bright stars can be seen next to each other.
- Look just below the center of the field for Zeta Lyrae. Keen eyed binocular users can discern two stars, one brighter than the other.
- On the southeastern section of the binocular field shines Zeta. Again, steadily held binoculars reveal two stars.

About Astronomy Associates

The club is open to all people interested in sharing their love for astronomy. Monthly meetings are typically on the last Sunday of each month and often feature guest speakers, presentations by club members, and a chance to exchange amateur astronomy tips. These meetings and the public observing sessions that follow are scheduled at the Baker Wetlands Discovery Center, south of Lawrence. All events and meetings are free and open to the public. Periodic star parties are scheduled as well.

Because of the flexibility of the schedule due to holidays and alternate events, it is always best to check the Web site for the exact Sundays when events are scheduled.

Copies of the Celestial Mechanic can also be found on the web at newsletter.
Annual Dues for the club are: $12 for regular members; $6 for students Membership forms can be accessed at the club website form.