ECLIPSE
NEWSLETTER

The Eclipse Newsletter is by-monthly newsletter dedicated to increasing the reader's knowledge of Astronomy, Astrophysics, Cosmology and related subjects.

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November – December 2016

PLEASE SEND ALL COMENTS, PHOTOS, ARTICLES AND REQUEST FOR ARTICLES TO

eclipseastronews@gmail.com

Special Note:

The STAR is alive and well. I will be using it to support the MCAG's programs designed to help maintain teacher certification. Teachers, who receive ECLIPSE, keep your eyes on your emails for the STAR containing details about the Teachers Certification Program offered by the Mount Cuba Astronomical Group.

<u>THIS ISSUE CONTENTS:</u>

ASTRONOMICAL TERMS AND NAMES DEFINED:

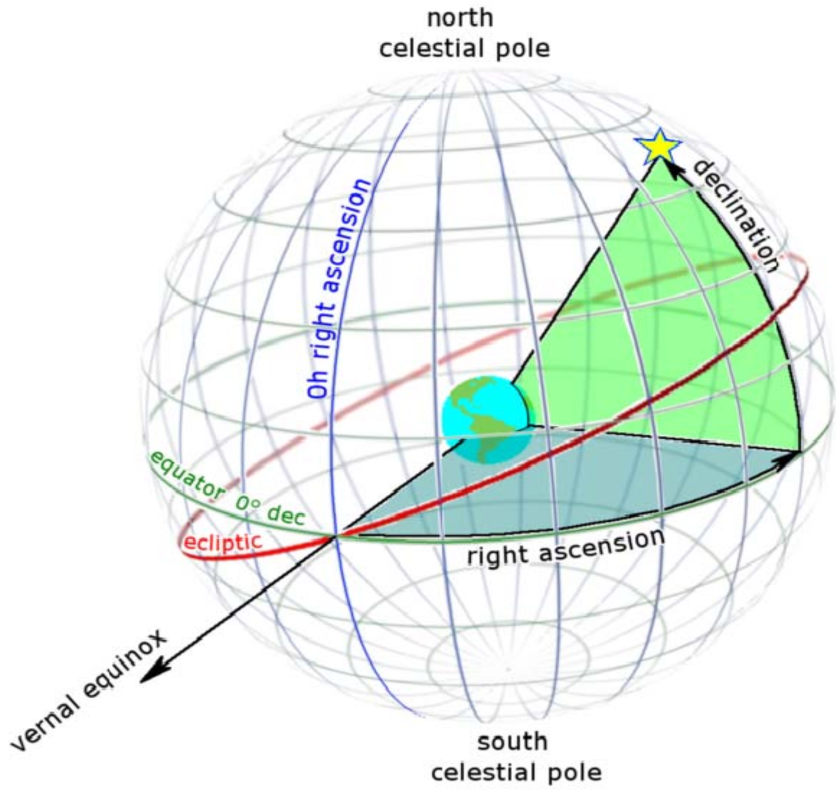
When reading the articles in the STAR, you will come across various terms and names of objects you may not be familiar with. Therefore, in each edition of the STAR, we will review terms as well as objects related to Astronomy and related technologies. These topics are presented on a level that the general public can appreciated.

A Cepheid variable is a type of star that pulsates radically, varying in both diameter and temperature and producing changes in brightness with a well-defined stable period and amplitude.

Reionization - In Big Bang cosmology, reionization is the process that reionized the matter in the universe after the "dark ages", and is the second of two major phase transitions of gas in the universe. As the majority of baryonic matter is in the form of hydrogen, reionization usually refers to the reionization of hydrogen gas. The primordial helium in the universe experienced the same phase changes, but at different points in the history of the universe, and is usually referred to as helium reionization.

That name—dwarf planet—Massive enough to assume a spherical shape due to its own gravitational force, but not quite big enough to control the region of space it inhabits. It must also circle a sun.

When reading about various Constellations or Stars, you will come across names used to help locate them. Hopefully, the following will help the reader better understand the means of each.



Right Ascension - Right Ascension is measured in hours (h), minutes (m) and seconds (s) and is similar to longitude on Earth. As the Earth rotates, stars appear to rise in the East and set in the West just like the Sun. For example, the constellation Orion has a Right Ascension (RA) of 4 hours, which is where the center of the constellation appears directly overhead. The constellation Cancer has a RA of 9h (9 hrs). If you wait 3 hours, Cancer will be directly overhead (9 hrs - 4 hrs). 0 hours RA is by convention the right ascension of the Sun on March 21, the vernal equinox.

Declination - Declination is measured in degrees, arc-minutes and arc-seconds, and is similar to latitude on Earth. There are 60 arc-minutes in a degree and 60 arc-seconds in an arc-minute. Declination measures how far overhead an object will rise in the sky, and is measured as 0° at the equator, +90° at the North Pole and -90° at the South Pole.

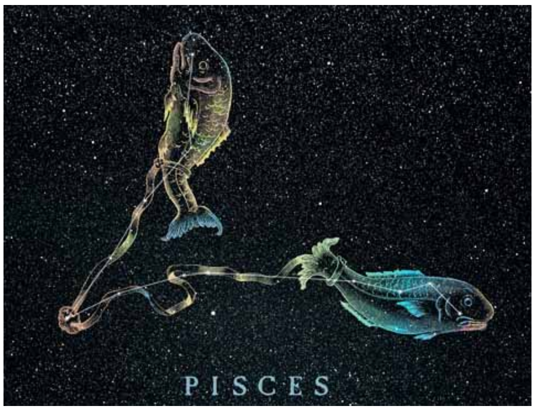
Vernal Equinox - the equinox in spring, on about March 20 in the northern hemisphere and September 22 in the southern hemisphere.

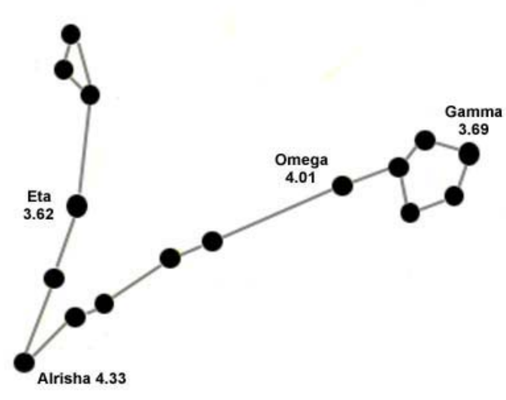
Ecliptic - a great circle on the celestial sphere representing the sun's apparent path during the year, so called because lunar and solar eclipses can occur only when the moon crosses it.

Celestial Pole - the point on the celestial sphere directly above either of the earth's geographic poles, around which the stars and planets appear to rotate during the course of the night. The north celestial pole is currently within one degree of the star Polaris.

For November - Constellation Pisces

Pisces is a constellation of the zodiac. Its name is the Latin plural for fish. It lies between Aquarius to the west and Aries to the east. The ecliptic and the celestial equator intersect within this constellation and in Virgo.





Locating Pisces

Pisces is in the first quadrant of the Northern Hemisphere and covers a large V-shaped region. Its large area, coupled with its dim stars, makes it hard to pick out in the night sky. Northern Hemisphere observers are able to see Pisces most clearly in early autumn.

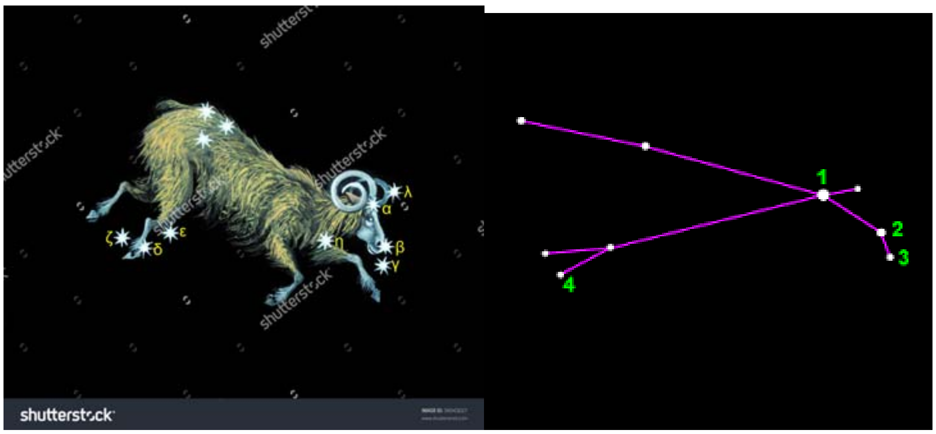
- **Right Ascension: 0.85 hours**
- **Declination: 11.08 degrees**
- **Visible: Between latitudes 90 degrees and minus 65 degrees.**
- **Best viewed: at 9 p.m. between Nov. 6 and Nov. 9.**

Pisces is located northeast of Aquarius and to the northwest of the constellation Cetus the Sea-monster. Other constellations bordering Pisces are Triangulum, Andromeda, Pegasus and Aries.

One of the key ways to identify Pisces is to find the Circlet of Pisces — also known as the head of the Western Fish — to the south of the Square of Pegasus. The Eastern Fish can be seen leaping upward to the east of the Square of Pegasus.

The vernal (autumnal) equinox — the point at which the sun crosses the equator and moves to the Northern Hemisphere each year, has shifted from running through Aries to slicing through Pisces.

For December - Constellation Aries



November and December are especially good months for viewing Aries the Ram in all his starlit majesty, for this constellation shines above the eastern horizon at nightfall and stays out for most of the night. Aries *culminates* – reaches its highest point in the sky – at about 10 p.m. local time (the time in all time zones) in late November, 8 p.m. local time in late December and 6 p.m. local time in late January.

Aries is not a particularly prominent constellation, so a dark country sky absent of moonlight is most desirable for viewing the Ram at its finest. The three stars depicting the Ram's bust – Hamal, Sheratan and Mesartim – suddenly brighten in a dark sky, as if someone had turned up the dimmer switch. By the way, a small telescope reveals that Mesartim is a double star.

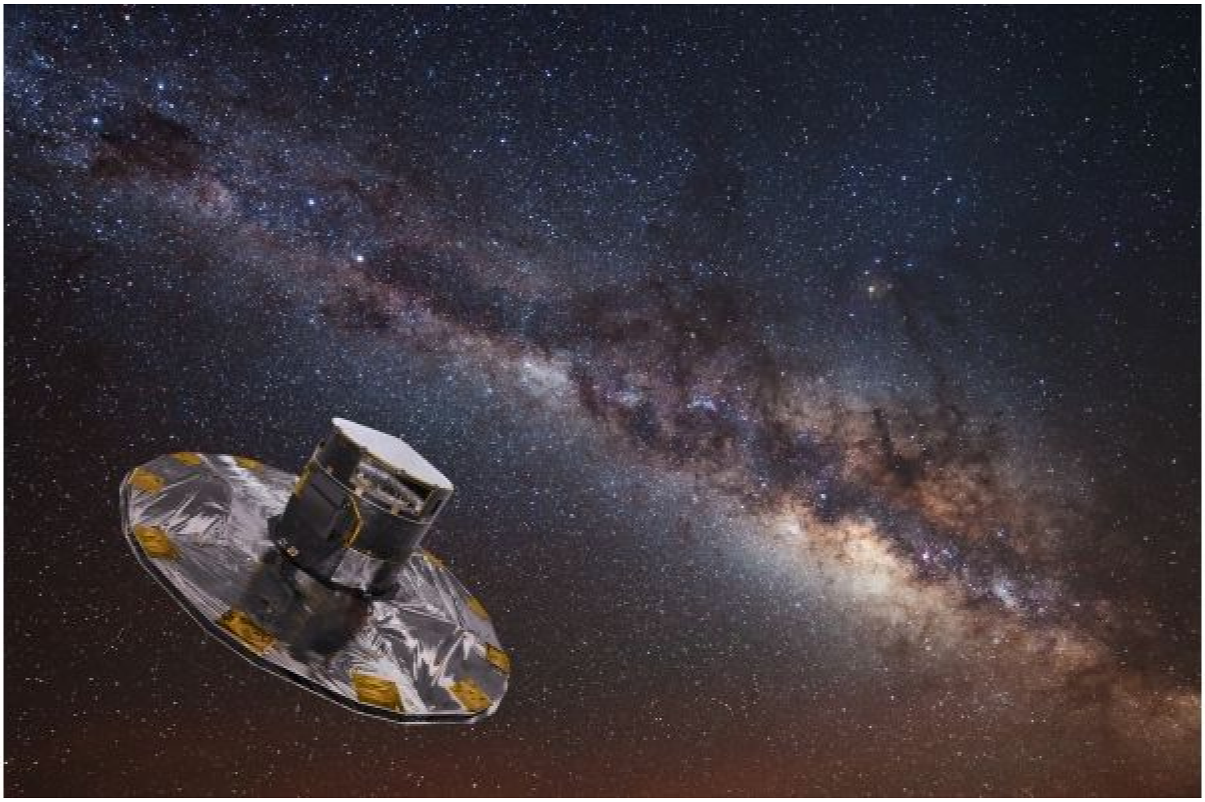
Fortunately, the head of the Ram is fairly easy to locate. You'll find it midway between these two signposts: the Pleiades star cluster to the east and the Square of Pegasus to the west. The Ram's head is actually turned backward, as if admiring the Pleiades – or perhaps his own golden fleece.

You can also star-hop to Aries by drawing an imaginary line from Polaris, the North Star, and through a certain star in the constellation Cassiopeia: Segin (Epsilon Cassiopeiae). You're seeking for the star at the east end of the famed starlit W or M, as shown on the sky chart at right. It's a very long hop, more than twice the Polairs/Segin distance. Jump until you land between the Pleiades cluster and the Square of Pegasus.

100,000 light-years across the Milky Way.

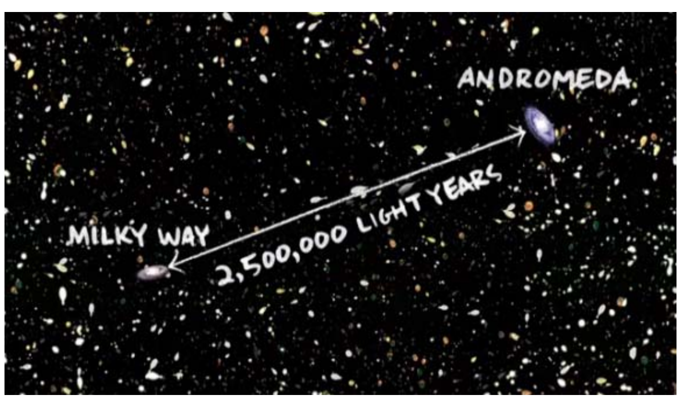
A first-of-its-kind map shows a billion stars shining in the Milky Way.

It's the work of the European Space Agency's Gaia space telescope, which has been scanning the cosmos to create the largest and most accurate 3-D map of our galaxy.



Most of the Milky Way's stars reside in the so-called Galactic Plane, shown as a bright, horizontal strip about 100,000 light-years across and about 1,000 light-years deep. In addition to providing the position and brightness of more than 1.1 billion stars, Gaia also charted the movements of more than 2 million of those stars.

How do astronomers measure extreme distances?



Astronomers have developed several techniques to indirectly measure the vast distances between Earth and the stars and galaxies. In many cases, these methods are mathematically complex and involve extensive computer modeling.

Parallax is the visual effect produced when, as an observer moves, nearby objects appear to shift position relative to more-distant objects. This common event is easily reproduced; hold your finger out at arm's length, and look at your fingertip first with one eye closed, then the other. The "motion" of your fingertip as seen against background objects is caused by the change in your viewing position -- about three inches from one eye to the other.

As Earth orbits the Sun, astronomers invoke this same principle to determine the distance to nearby stars. Just like your fingertip, stars that are closer to us shift positions relative to more-distant stars, which appear fixed. By carefully measuring the angle through which the stars appear to move over the course of the year, and knowing how far Earth has moved, astronomers are able to use basic high-school geometry to calculate the star's distance.

Parallax serves as the first "inch" on the yardstick with which astronomers measure distances to objects that are even farther.

For example, they use a class of variable known as Cepheids, which pulsate in and out like beating hearts. There is a direct relationship between the length of a Cepheid's pulsation and its true brightness. Measuring a Cepheid's apparent brightness -- how bright it looks from Earth -- allows astronomers to calculate its true brightness, which in turn reveals its distance. For this technique to work correctly, though, astronomers must first use the parallax method to get the distances to some of the closer Cepheids. This allows them to calibrate a Cepheid's true brightness, which then can be used to calculate its distance. Cepheids are especially bright stars, so they are visible in galaxies that are tens of millions of light-years away.

For more-distant galaxies, astronomers rely on the exploding stars known as supernovae. Like Cepheids, the rate at which a certain class of supernovae brighten and fade reveals their true brightness, which then can be used to calculate their distance. But this technique also requires good calibration using parallax and Cepheids. Without knowing the precise distances to a few supernovae, there is no **way to determine their absolute brightness, so the technique would not work.**

A Friend For Pluto:

Astronomers Find New Dwarf Planet In Our Solar System.

Scientists in Michigan have found a new dwarf planet in our solar system.

It's about 330 miles across and some 8.5 billion miles from the sun. It takes 1,100 years to complete one orbit.

But one of the most interesting things about the new object, known for the time being as 2014 UZ224, is the way astronomers found it.

David Gerdes of the University of Michigan led the team that found the new dwarf planet. Gerdes describes himself as "an adult-onset astronomer," having started his scientific career as a particle physicist.

He helped develop a special camera called the Dark Energy Camera that the U.S. Department of Energy commissioned to make a map of distant galaxies.

A few years ago, Gerdes had some undergraduates visiting him for the summer. He decided to give them a project: He asked them if they could find some solar system objects lurking in the galaxy map.

How do you find solar system objects in pictures taken of the sky looking for galaxies? Well, you look for things that move: "Objects in the solar system, when you observe them at one instant and then a little while later, they appear to be in a different place in the sky," Gerdes says.

Stars and galaxies are so far away, they're basically stationary. But a planet or asteroid will be in a slightly different position from night to night. It will appear as a dot of light that seems to be moving across the stationary backdrop of stars.

Connect the dots night after night and you can begin to calculate the object's orbit around the sun.

But the images Gerdes had from his galaxy map weren't taken night after night.

"We often just have a single observation of the thing, on one night," he says. "And then two weeks later one observation, and then five nights later another observation, and four months later another observation. So the connecting-the-dots problem is much more challenging."

But they were able to develop software that can do just that.

The dwarf planet that Gerdes and his colleagues have found isn't the first distant dwarf planet astronomers have found in recent years. Sedna, Eris and Makemake

have all been discovered in the past decade or so. Add to that Pluto, which used to be a planet until it was demoted when the definition changed.

It's also possible some astronomers might argue that the object Gerdes found is too small to be considered a dwarf planet, but for now, he says the term applies.

This new dwarf planet is pretty exciting if you're into dwarf planets, but there's a much bigger prize astronomers are searching for. They think there's a planet 10 times more massive than Earth hiding in the outer reaches of the solar system.

A scientific paper earlier this year described the orbit of this so-called Planet Nine. Astronomers have since been scouring the parts of sky where the orbit says Planet Nine might be, but so far, no one has seen it.

Gerdes says it's quite possible that one of the images taken for his galaxy map may actually contain a picture of it.

"I'm excited about our chances of finding it," he told me when we me last month in a conference room along with several of his student collaborators. I asked him if "our" meant him and his team, or astronomers in general.

"I'm excited about the chances of the people in this room finding it. Of course I'm happy for humanity if someone else finds it, it would be the most exciting astronomical discovery in our lifetime, I think."

No luck so far, but as Gerdes says: "The hunt is on."

Read More about Pluto at Pluto: Facts & Information About the Dwarf Planet Pluto - Space.com

The Higgs Boson Explained in Layman's Terms

How can you explain Higgs Boson to a layman? Originally appeared on Quora - the knowledge sharing network where compelling questions are answered by people with unique insights.

Answer by Richard Muller, professor of physics at UC Berkeley, author of Now: The Physics of Time, on Quora.

In the theory of the Big Bang, it proved difficult to include particles that had mass, so some theorists looked to see what would happen if all particles had zero mass. The theory worked. Wow! But it didn't represent reality.

Then Peter Higgs and his colleagues came up with a fascinating way to handle it: what if electrons, quarks, and all the elementary particles were indeed massless?

Maybe they are! But that contradicts reality. We can measure the mass of an electron.

They knew that the apparent mass of the electron changes when it moves through a crystal, like silicon or quartz. So maybe the mass of the electron is an illusion. Electrons behave as if they have mass, but they don't really. It's just that they are moving through a crystal-like substance. This crystal-like substance was eventually called the Higgs field. It fills all of space, which is why particles behave as if they have mass.

What about the early universe? Theorists had already speculated about the creation of new fields, and the Higgs field fit right into their theories. In the early universe, the Higgs field was zero; it was everywhere. Then there was a phase transition in which through spontaneous symmetry breaking the Higgs field would rapidly grow and reach a constant value - the value it has now. So from that time onward, all particles would have an apparent mass.

Can this theory be tested? Yes! In quantum physics, any field will have particle properties. That means that we should be able to create a Higgs particle in the laboratory. It would have well-defined properties. The critical one would be that it would decay primarily into very heavy particles, which would then also decay.

The "discovery" of the Higgs boson verified this prediction.

Read more at: Physicists Are Desperate to Be Wrong About the Higgs Boson | WIRED

The Untold Story of the First Atoms in the Universe

Exactly when and how were the original hydrogen atoms destroyed? A new telescope may provide an answer.

When our universe first blasted into existence with a Big Bang almost 14 billion years ago, it looked much different than it does today. Instead of planets, stars and galaxies, there was an inflating ball of hot plasma.

The universe cooled as it expanded, and over time the different ingredients of our universe froze out as temperatures plummeted. Quarks froze out first, then protons and neutrons, followed by electrons. Finally, after about 380,000 years, hydrogen – the first atoms – started to form. Some of these atoms were pulled together into stars, where they fused into carbon, oxygen, nitrogen, iron and all of the other elements from which planets and life are built.

However, when our universe was about one billion years old, it appears that nine out of every 10 of those original hydrogen atoms were destroyed before they ever found their way into galaxies. Exactly when and how were those first atoms in

the universe destroyed? Astronomers have puzzled over these questions for decades. I'm leading a new experiment – known as the Hydrogen Epoch of Reionization Array (HERA) – that we hope will help answer what happened.

With the formation of those first hydrogen atoms – each made of one negatively charged electron and one positively charged proton – the universe entered a period cosmologists call the Dark Ages. During this time, the universe quietly waited for clouds of hydrogen to obey the influence of gravity and collapse into the very first stars and galaxies. The ignition of the first stars marks the end of the Dark Ages and the beginning of our "Cosmic Dawn," some 100 million years after the Big Bang. For the first time, our universe began shining with a light other than the afterglow of the Big Bang.

Leading up to our Cosmic Dawn, the entire universe was filled with hydrogen. However, starlight consists of photons with enough energy to split hydrogen apart, reionizing it back into protons and electrons. As more and more stars lit up, larger and larger holes of ionization got carved out of the primordial hydrogen clouds.

Other, more exotic objects also began forming inside galaxies. As stars exhausted their hydrogen fuel, they'd explode in spectacular supernovae. Some stars left behind black holes that devoured nearby stars and generated powerful x-ray jets. In the centers of galaxies, supermassive black holes were growing, with the masses of millions of suns.

These events injected huge amounts of energy into the surrounding hydrogen clouds, heating and ionizing them, until, as we look out today, we see that all of the intergalactic hydrogen has been destroyed – reionized into its component particles, protons and electrons.

We astronomers are still struggling to disentangle all of the complex processes that led to the formation of stars and galaxies and the simultaneous destruction of the universe's hydrogen.

Using our most powerful optical telescopes, we are finding galaxies so far away that their light, emitted when the universe was only one billion years old, is just now getting to us. The glimpse we get of these galaxies in the final throes of reionization is as the last remnants of intergalactic hydrogen are being burned away. Yet as we try to look deeper, the hydrogen itself confounds us. It absorbs the very starlight that we use to observe distant galaxies, acting as a blanketing fog that conceals the chaos behind it.

To solve this problem, my colleagues and I designed a new kind of telescope: an array of radio dishes that, instead of searching for distant galaxies, maps the intergalactic hydrogen itself throughout the process of being heated and reionized. Our Hydrogen Epoch of Reionization Array combines cutting-edge supercomputing

hardware with low-cost antenna construction in a unique design that gives it both the sensitivity and precision to create what will be the largest maps in the universe.

HERA is sensitive to a specific kind of radio wave produced when the magnetic fields of the proton and electron inside of hydrogen switch their north-south polarity with respect to each other. Just as two oppositely aligned bar magnets attract each other and release energy in the process, the switching polarity of the electron and proton causes hydrogen to release a small amount of energy. This hyperfine transition produces radio waves with a characteristic wavelength of 21 centimeters.

As a result of the continuing expansion of the universe since the Big Bang, 21-cm radio waves from intergalactic hydrogen have been stretched by different amounts, depending on how old the universe was when they were originally emitted. For example, when the universe was 770 million years old, it was eight times smaller than it is today. A 21-cm radio wave emitted by hydrogen at this time in the history of our universe would be stretched by a factor of eight on its way to us; we would see it with a wavelength of 168 cm. On the other hand, the same radio wave emitted when the universe was 940 million years old would be be stretched only by a factor of seven, appearing to us with a wavelength of 147 cm. By measuring the wavelength of the light, we can know exactly when and where in the universe it was emitted.

By mapping the sky at many wavelengths between 150 and 350 cm, HERA can produce a series of images from the early childhood of our universe. We will be able to watch step by step as the light of the first stars and galaxies destroys the clouds out of which they formed. We expect to see large clouds of hydrogen glowing with 21-cm emission, with dark pinpricks of ionization sprinkled in. As we move to parts of the universe that are closer to us and where more time has elapsed, we should see larger and larger voids where 21-cm emission is missing, until finally, these voids swallow everything and the 21-cm signal that signifies the presence of hydrogen is gone.

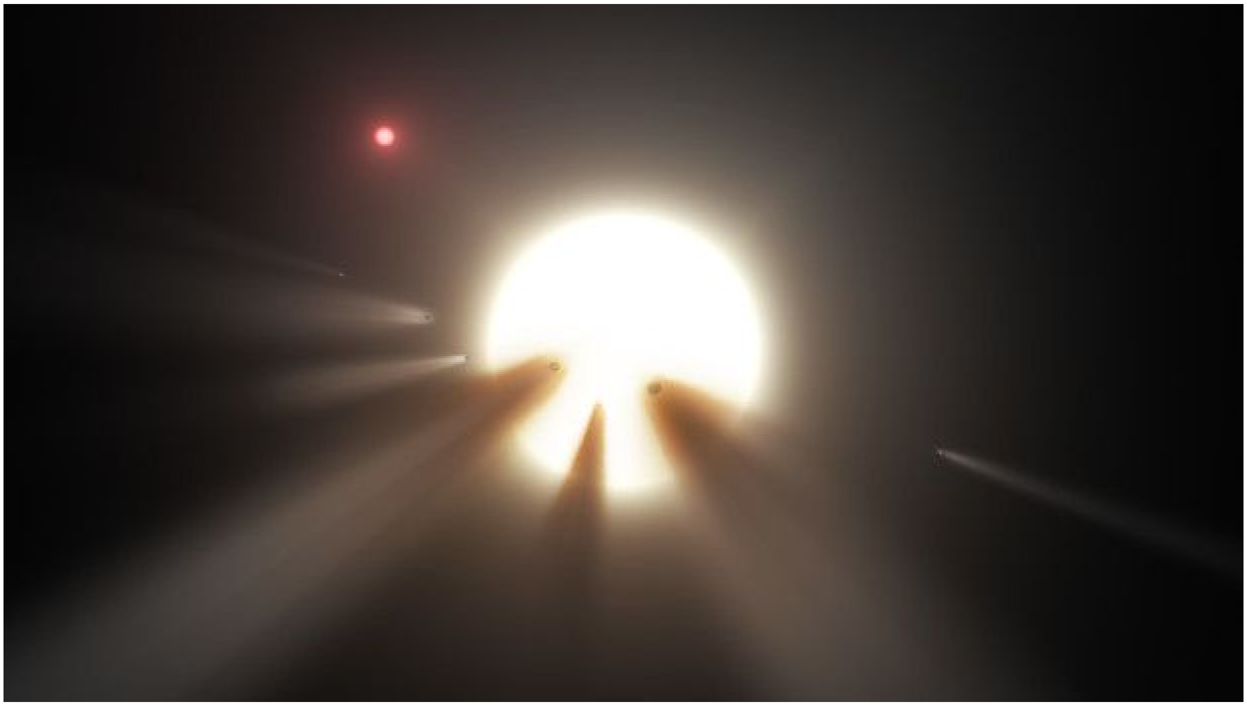
Our HERA team was recently awarded US$9.5 million from the National Science Foundation. We'll use the funds to construct a hexagonal array of 240 14-meter radio dishes in Karoo Radio Reserve of South Africa over the next three years. Our collaborators hail from 16 institutions from around the world. The plan is to work in parallel to conduct the observations that will be used to produce HERA's groundbreaking results.

Observations with the new facilities in the next several years are poised to transform our understanding of the first stars, galaxies and black holes, and their role in driving reionization at the end of cosmic dawn. HERA's observations of neutral hydrogen will provide unique insights into this formative period in our universe. Indeed, in the early universe, 21-cm emission provides the only direct way to probe the complex interplay between the first luminous structures and their surroundings. To trace the story of the first atoms in the universe, stay tuned as HERA begins observing over the next few years.

On the Light Side

Astronomers round up the unusual suspects for

'alien megastructure' star.



Comet storm, not alien megastructures

That mysterious "alien megastructure" star is still a mystery, but the most plausible explanations appear to be dense patches of interstellar gas or dust that just happened to pass in front of the star.

That's the upshot of analyses conducted by the astronomer who first raised the idea of an extraterrestrial construction project a year ago.

In the Astrophysical Journal Letters, Penn State's Jason Wright and a co-author, Steinn Sigurdsson, run through a wide range of hypotheses for the behavior of a star called KIC 8462852, also known as Boyajian's Star or Tabby's Star.

Not even the alien hypothesis is ignored.

The mystery has to do with a strange pattern of erratic dimming and brightening that was observed by NASA's Kepler space telescope. That pattern was noted last

September in a study with Yale astronomer Tabetha Boyajian as principal author. (Hence the star's nickname.)

Wright suggested that the dimming could theoretically be caused by shifts in an alien megastructure surrounding the star – perhaps a giant energy-generating Dyson sphere built by an advanced civilization.

Later studies reported that the star, which is located 1,500 light-years from Earth in the constellation Cygnus, had undergone other long-term dips in brightness.

Is it aliens? Wright says the idea is "not completely ruled out, yet" but "very unlikely." In their latest study, Wright and Sigurdsson say stellar observations from the European Space Agency's Gaia satellite could definitively rule out the alien hypothesis or keep it alive.

Many other explanations have been proposed for the observations of Boyajian's Star, including variability in the star, or swarms of comets passing in front of it. But Wright and Sigurdsson favor a scenario in which small-scale density variations crop up in the interstellar medium between us and the star.

Those types of variations – for example, short-lived patches of gas and dust, or small molecular clouds – would have to be rare. "But it turns out rare dense patches are a thing!" Wright says.

Future observations, either of repeated dimming patterns at Boyajian's Star or of similar dimming by other stars, would lend additional support to this hypothesis. The comet swarm hypothesis is also still in the running, plausibility-wise.

For what it's worth, there's talk about even more dramatic patterns of irregular dimming that have been observed in a star called EPIC 204278916.

The observations from Kepler's K2 mission were reported in a paper published last month in the Monthly Notices of the Royal Astronomical Society.
The study could bring additional perspective to the debate over Boyajian's Star.

To get the rundown on the full range of hypotheses for Boyajian's Star, including black holes, check out the research paper as well as the AAS Nova update and Wright's analysis on his AstroWright blog.

MCAO Public Nights

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