THE STAR

THE NEWSLETTER OF THE
MOUNT CUBA ASTRONOMICAL GROUP
VOL. 3 NUM. 4

CONTACT US AT
DAVE GROSKI
David.M.Groski@Dupont.com

OR
HANK BOUCHELLE
hbouchelle@live.com
302-983-7830

OUR PROGRAMS ARE HELD THE SECOND TUESDAY OF EACH MONTH AT 7:30 P.M. UNLESS INDICATED OTHERWISE
MOUNT CUBA ASTRONOMICAL OBSERVATORY
1610 HILLSIDE MILL ROAD
GREENVILLE, DE
FOR DIRECTIONS PLEASE VISIT
www.mountcuba.org

PLEASE SEND ALL PHOTOS AND ARTICLES TO
pestrattonmcag@gmail.com

<u>DECEMBER'S MEETING</u>
<u>TUESDAY THE 9TH 7:30 p.m.</u>

Meet the A.I. DuPont Middle School Planetarium and
The Mysteries of the Star of Bethlehem
Hosts: Jerry Smith, A.I. Middle School Science Teacher and
Hank Bouchelle, Shiftless Ne'er Do Well to the Stars

Please Note: Special Meeting Place:

A. I. DuPont Middle School
3130 Kennett Pike, Wilmington, DE 19807

Traveling from Wilmington to Greenville, Pennsylvania Avenue assumes various names such as Kennett Pike and Route 52. A.I. DuPont Middle School is on the northeast side of Kennett Pike between Rte. 141 and Tower Hill School.
Upon arrival at the school, take the lane on the left side, which takes you to a parking area, and passes the door to the Planetarium, at an interior corner.

<u>NOVEMBER'S MEETING REVIEW:</u>

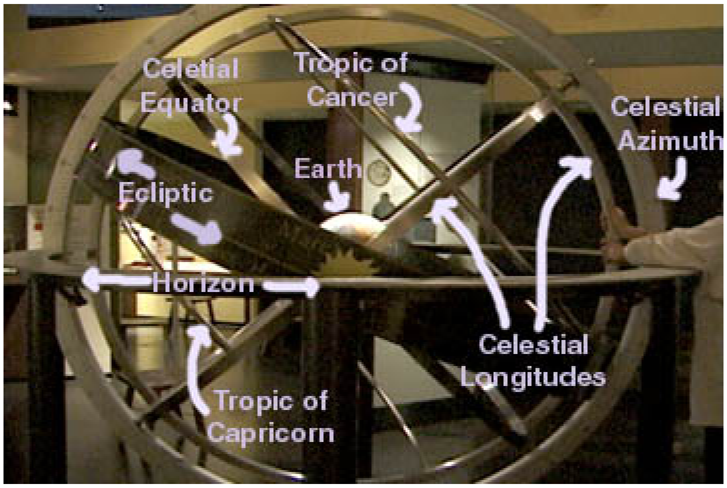
Hank Bouchelle gave a talk on Albedo. Albedo is the fraction of solar energy (shortwave radiation) reflected from the Earth back into space. It is a measure of the reflectivity of the earth's surface. Ice, especially with snow on top of it, has a high albedo: most sunlight hitting the surface bounces back towards space. Water is much more absorbent and less reflective. So, if there is a lot of water, more solar radiation is absorbed by the ocean than when ice dominates.

Albedo is not important at high latitudes in winter: there is hardly any incoming sunlight to worry about. It becomes important in spring and summer when the radiation entering can greatly increase the melt rate of the sea ice.

Scott Jackson demonstrated his home made Armillary or as sometimes referred to as a spherical astrolabe, **armilla**, **or armil.**

It is a model of objects in the sky (in the celestial sphere), consisting of a spherical framework of rings, centered on Earth, that represent lines of celestial longitude and latitude and other astronomically important features such as the ecliptic. As such, it differs from a celestial globe, which is a smooth sphere whose principal purpose is to map the constellations.

How to use an Armillary and it's parts.



Read the marks of the azimuth where it intersects the band of the horizon at 0 degrees (north) to determine for which degree of latitude the model is set. This information helps currents astronomers determine where one of the historical armillary spheres may have been made or used.

Place an image of the sun (or moon or planets) on the ecliptic on the date we want to watch. Rotate the sphere until the sun "rises" and "sets" where the ecliptic crosses the horizon on that day. Read the compass marks engraved on the steel horizon band at that point to find out the compass heading where the sun will rise and set in the sky on that date. (To check the accuracy of the reading, wait until that date, take your compass, go to the Chicago shore of Lake Michigan, and look in the direction that the armillary sphere told you to look. If it's not cloudy, the sun will be there.)

As an added exercise, notice where all of the circular bars of the model cross each other. Each crossing of the ecliptic with a celestial longitude and the celestial equator or tropics marks a solstice or an equinox.

Although determining the location of sunrises and sunsets is our main demonstration of the armillary sphere, you can also watch how the ecliptic moves north to south and higher and lower in the model to get a sense of how the sun appears to behave throughout the year.

Finally, imagine tipping the armillary sphere to a different latitude on the azimuth. You would push the axis of the earth where it comes out of the north pole down and eventually upside down to move further south and up approximately 48 degrees to set the model for the north pole. Then try to picture how the ecliptic would act. It's not easy to imagine, is it. For a better understand go to Utube and enter Armillary Sphere for several videos of how it works and what you can learn by using it.

OBSERVATIONS FROM THE CONFORTABLE CHAIR

Have you ever visited a planetarium where you were NOT required to sit down and look up? Where you could raise your hand and expect the show to pause for a moment while you asked a question? And a real person would answer that question and then ask if the answer revealed what you wanted to know? And offered to clarify the answer if you needed more?

That kind of planetarium program is rare, but on Tuesday evening, December 9 at 7:30 pm at the A. I. DuPont Middle School Planetarium that is precisely the kind of program in which you will be participating.

Our host is Jerry Hill, whose nearly single-handed and tireless efforts led to the restoration of an instrument that had lain for many decades hidden under forgotten rock collections, broken desks and particles of dust that would require scientific notation to number.

This evening will be the first major meeting/program in that facility. Jerry will describe what he had found so recently, and how the planetarium instrument does what it does. In the remainder of the evening Jerry and I will address a few of the many mysteries attending the ancient apparition of the Star of Bethlehem or Christmas Star, whose appearance two millennia ago becomes a current topic.

ASTRONOMICAL TERMS AND NAMES OF THE MONTH:

The Mission of the Mt. Cuba Astronomy Group is to increase knowledge and expand awareness of the science of astronomy and related technologies.

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.

Magnetosphere

A magnetosphere is the area of space near an astronomical object in which charged particles are controlled by that object's magnetic field. Near the surface of the object, the magnetic field lines resemble those of a magnetic dipole. Farther away from the surface, the field lines are significantly distorted by electric currents flowing in the plasma (e.g. in ionosphere or solar wind). When speaking about Earth, magnetosphere is typically used to refer to the outer layer of the ionosphere, although some sources consider the ionosphere and magnetosphere to be separate.

Messier Objects

The Messier objects are a set of astronomical objects catalogued by the French astronomer Charles Messier in his "Catalogue des Nébuleuses et des Amas d'Étoiles" ("Catalogue of Nebulae and Star Clusters"), originally published in 1771, with the last addition (based on Messier's observations) made in 1966

Because Messier was interested in finding only comets, he created a list of non-comet objects that frustrated his hunt for them. The compilation of this list, in collaboration with his assistant Pierre Méchain, is known as the Messier catalogue. This catalogue of objects is one of the most famous lists of astronomical objects, and many Messier objects are still referenced by their Messier number.

The first edition included 45 objects, with Messier's final list totaling 103 objects. However, Messier 102 was not reported correctly, bringing the total to 102 objects. Other astronomers, using side notes in Messier's texts, eventually filled out the list to 110 objects.

CONSTILLATIONS:

The following should apply to all constellations when locating and studying them.

Explanation of Constellation Position Notation

The coordinates given in the description are from the appendix of "Explorations: an Introduction to Astronomy" by Thomas T. Arny.

Short Instructions:

> **Is your latitude in the range listed? You can look up the latitude of various cities at MIT's Geography Page.**
>
> **What time are you looking? For every hour after 9:00 PM, the best date to see a constellation moves ahead half a month. For every hour before 9:00 PM, the best date moves back half a month.**
>
> **Northern Hemisphere: The larger the Declination of a constellation (the closer it is to 90 degrees), the larger the fraction of the year it will be visible. For example, Polaris (Dec=89 degrees) is visible all year.**
>
> **Southern Hemisphere: The smaller the Declination of a constellation (the closer it is to -90 degrees), the larger the fraction of the year it will be visible.**

Longer Instructions:

Right Ascension (RA) and Declination (Dec)
These are the coordinates that astronomers use to precisely locate stars in the sky. They are very similar to longitude and latitude on the Earth, except that RA is measured from 0 to 24 hours instead of 0 to 360 degrees, like longitude.

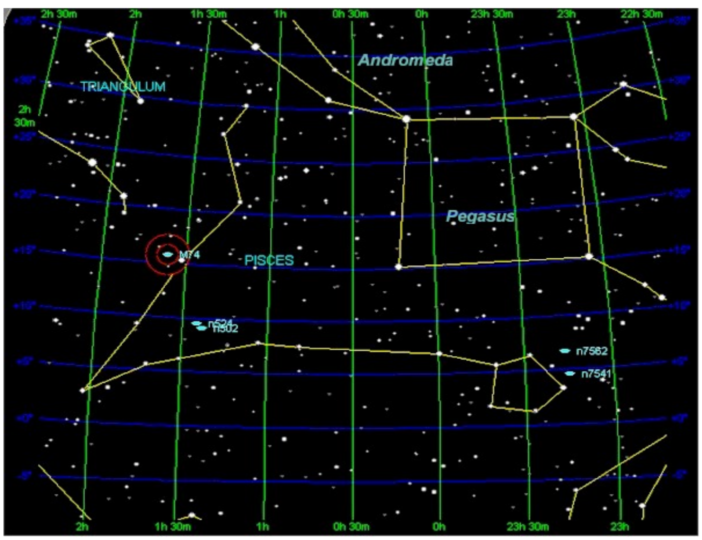
Almost all astronomy textbooks explain RA and Dec, but if you aren't interested in the technical details, just use the explanations below.

When is the best time to look for a particular constellation?
For each constellation, I have included where on the Earth it is visible from and what month is beast for viewing it. First of all, some constellations are never visible from

certain places on the Earth. For example, people in the Southern Hemisphere can't see the North Star (Polaris) because the Earth is always in the way. If your latitude is between the two numbers listed on the constellation pages, then that constellation will be visible at SOME time during the year. (If you don't know your latitude, you can look it up by city on MIT's geography page).

Technical Note: It is easy to figure out which constellations are visible for you. The Declination is very closely related to your latitude on the Earth. All I have done to figure out the maximum and minimum latitudes is add and subtract 80 degrees from the declination.

Figuring out which month a constellation is visible is a little trickier. The month listed is the month when the constellation is highest in the sky. However, each constellation is visible for a range of months, depending on your latitude and its Declination. In addition, the constellations rise and set like the Sun and the planets so, as explained in the Short Instructions above, the time of night that you are out stargazing also matters.



Pisces

Abbreviation: Psc Genitive: Piscium Translation: The Fishes. Position in the Sky

Right Ascension: 1 hour Declination: 15 degrees Visible between latitudes 90 and -65 degrees Best seen in November (at 9:00 PM)

Named Stars

Alrisha (Alpha Psc) Fum al Samakah (Beta Psc) Torcularis Septentrionalis (Omicron Psc)

Messier Objects

M74 (spiral galaxy)

FROM THE WORLD OF ASTRONOMY, PHYSICS AND RELATED FIELDS:

Why a Physics Revolution Might Be on Its Way

The field of physics may be turned on its head soon, said renowned physicist Nima Arkani-Hamed during a live lecture from the Perimeter Institute for Theoretical Physics in Waterloo, Canada.

For one, he said, the tried and true physics of relativity and quantum mechanics don't get along well. The problem is that in some sense, the principles behind these theories seem to be impossible when physicists dig a little deeper into them, Arkani-Hamed said. Scientists run into a lot of problems when they try to apply these theories to the entirety of space and time.

The two ideas are also incredibly constraining, and they make it challenging for physicists to think outside the box and develop new ideas and theories, Arkani-Hamed said. [The 9 Biggest Unsolved Mysteries in Physics]

"It's almost impossible to monkey around with the rules and not be wrong immediately," Arkani-Hamed said.

Physicists have known about this disparity for a while, but progress on fundamental questions in physics takes a long time. Scientists proposed the existence of the Higgs boson particle, for example, decades before it was actually discovered.

An unexplained macroscopic universe

One problem is that conventional physics doesn't really account for why the universe is so large, Arkani-Hamed said.

Albert Einstein's theory of relativity showed that a huge amount of energy exists in the vacuum of space, and it should curve space and time. In fact, there should be so much curvature that the universe is a tiny, crumpled ball.

"That should make the universe horrendously different than what it is," Arkani-Hamed said.

But quantum mechanics also poses a problem. The theory is good at describing the very small realm of particle physics, but it breaks down when physicists try to apply it to the universe as a whole.

"Everything that quantum mechanics is, is violated by our universe because we're accelerating (referring to the idea that the universe is expanding) – we don't know what the rules are," Arkani-Hamed said. "When you try to apply quantum mechanics to the entire universe, quantum mechanics cries 'uncle.'"

Physics frontiers

One possible way to solve the problem is with an entirely new theory beyond the Standard Model, the reigning theory of particle physics, the physicist said. [Sparticles to Neutrinos: The Coolest Little Particles in the Universe]

One idea is called string theory, which proposes that particles aren't actually fundamentally particles. Instead, the particles and all the matter in the universe they make up are composed of tiny, vibrating strings. The equations that support string theory appear to work, but that doesn't mean there are no other viable formulas or explanations, Arkani-Hamed said.

Supersymmetry is another possible "new physics" explanation. Under this idea, all subatomic particles have a "superpartner" particle that physicists have yet to discover. Supersymmetry would also open up extra directions that the particles can move in. The discovery of supersymmetry would bolster the Standard Model of physics, scientists have said.

"It's the last thing nature can do to make itself compatible with the general principles of physics that already exist," Arkani-Hamed said.

When the world's largest atom smasher, the Large Hadron Collider (LHC), is up and running again next year, physicists will be looking for the extra particles that supersymmetry suggests should exist.

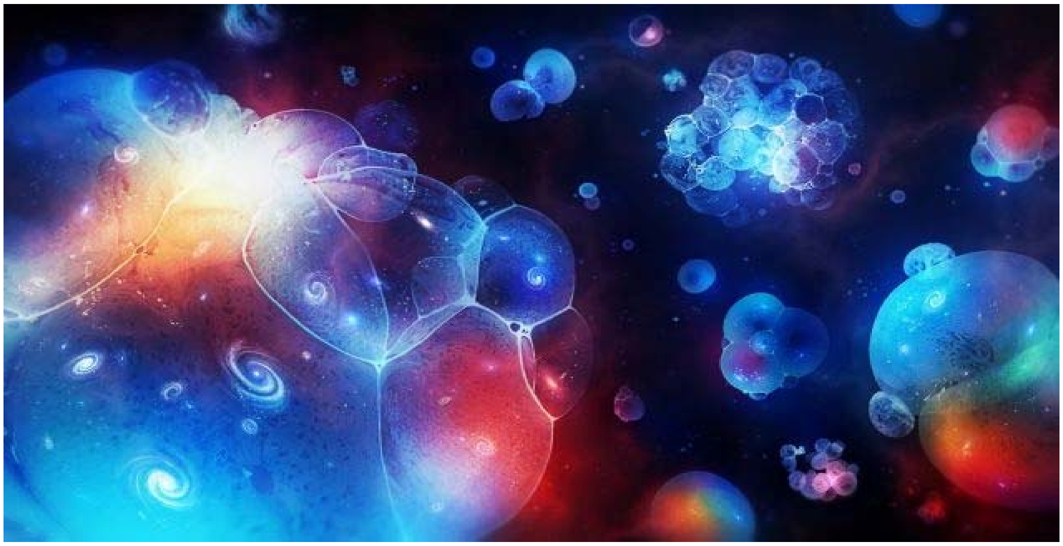
Either way, after a year or two of running the LHC, the question of whether supersymmetry exists should be answered, Arkani-Hamed said.

The experiments over the next few years will likely tell physicists if they need to fine-tune existing theories or if the field of physics is due for a much deeper and more dramatic paradigm shift.

The questions on the table now are the underpinnings of space and time, and the origin and fate of the universe, Arkani-Hamed said.

"Today we finally have the theoretical framework in place to ask these kinds of big questions," Arkani-Hamed said. "The next step will likely be a revolution."

It's Looking More and More Likely That We Live in a Multiverse



Could our massive universe be just one of many, like a bubble in a frothy stream of cosmos-spawning stuff? It sounds like something out of a 1970s British scifi novel, but it's become a popular explanation for the origin of our universe. But how can we test this hypothesis, when we're stuck in just one universe?

Image by Olena Shmahalo / Quanta Magazine

Physicists who were once wary of the multiverse hypothesis have started to come around to this radical new way of thinking. This is partly because it helps explain why our universe just happens to have the right physical ingredients to make life possible.

In a fascinating two-part article about the multiverse over at Quanta, Natalie Wolchover and Peter Byrne write:

Many physicists loathe the multiverse hypothesis, deeming it a cop-out of infinite proportions. But as attempts to paint our universe as an inevitable, self-contained structure falter, the multiverse camp is growing.

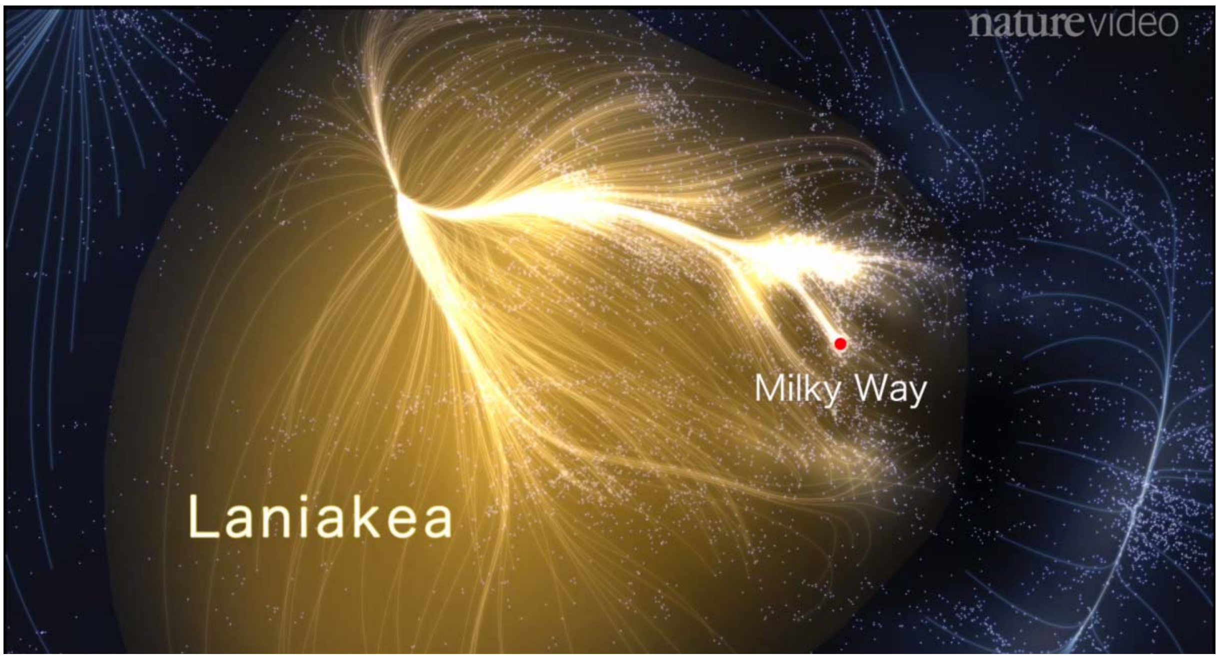
The problem remains how to test the hypothesis. Proponents of the multiverse idea must show that, among the rare universes that support life, ours is statistically typical. The exact dose of vacuum energy, the precise mass of our underweight Higgs boson, and other anomalies must have high odds within the subset of habitable universes. If the properties of this universe still seem atypical even in the habitable subset, then the multiverse explanation fails.

But infinity sabotages statistical analysis. In an eternally inflating multiverse, where any bubble that can form does so infinitely many times, how do you measure "typical"?

Guth, a professor of physics at the Massachusetts Institute of Technology, resorts to freaks of nature to pose this "measure problem." "In a single universe, cows born with two heads are rarer than cows born with one head," he said. But in an infinitely branching multiverse, "there are an infinite number of one-headed cows and an infinite number of two-headed cows. What happens to the ratio?"

For years, the inability to calculate ratios of infinite quantities has prevented the multiverse hypothesis from making testable predictions about the properties of this universe. For the hypothesis to mature into a full-fledged theory of physics, the two-headed-cow question demands an answer.

LANIAKEA:



Consider the entire Milky Way galaxy is a tiny speck on the outskirts of a super cluster of galaxies.

The Earth is the only world for us — for now at least. But our planet is dwarfed by the stars and galaxies that make up the universe.

Even our galaxy is a mere speck in a larger structure, which was just revealed for the first time by a group of scientists who created a map of more than 8,000 galaxies in an effort to understand where they fit in the universe.

The team placed the Milky Way on the outskirts of a massive, previously unknown galaxy super cluster scientists have named Laniakea, from the Hawaiian words for "immeasurable heaven."

The finding, reported in this week's issue of the journal Nature, stems from a new mapping technique that combines not only the distances between more than 8,000 nearby galaxies, but also their motion as the universe expands and galaxies are pulled through space by gravity.

As a video by Nature explains, the universe can be understood as a network of galaxies — a cosmic web. That leaves a void of vast, empty space in some areas, but super clusters of galaxies in other places. These clusters are the largest structures in existence.

The technique enables astronomers for the first time to clearly delineate where one super cluster of galaxies ends and another begins.

The new maps show that the Milky Way galaxy, along with the Virgo cluster and some 100,000 other galaxies, is gravitationally sailing in the same gigantic cosmic pool, named Laniakea.

Most galaxies are pulled toward the heart of a super cluster, a dense center called the great attractor. In Laniakea, even though our galaxy is far, far away on the edge of the system, we're still being pulled by the great attractor's gravity.

The super cluster spans some 520 million light-years in diameter. One light-year is the distance that light, which moves at about 186,000 miles per second (300,000 km/s), travels in one year, or roughly 5.88 trillion miles (9.46 trillion km).

Scientists previously believed the Milky Way galaxy, which is where Earth and the rest of the solar system reside, was part of a cluster measuring about 100 million light-years in diameter. The new study shows that structure is just an appendage of the larger Laniakea.

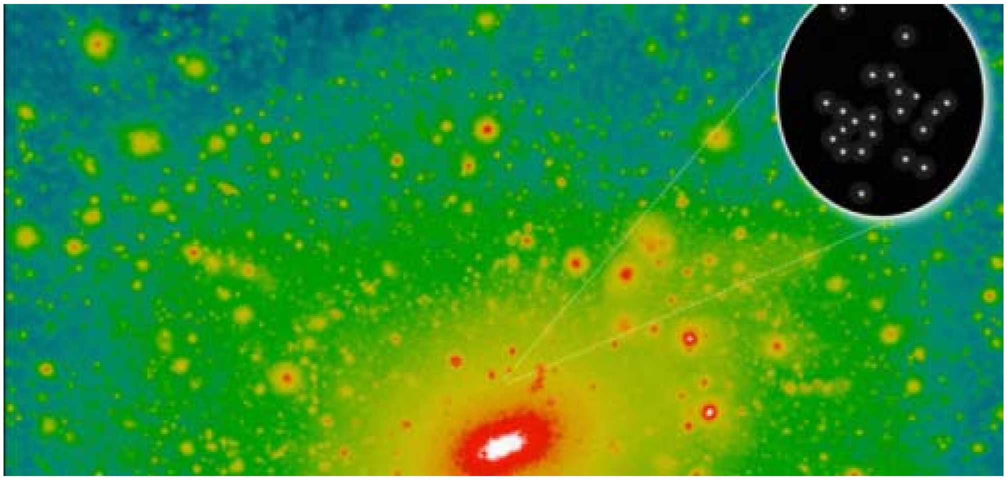
Bordering Laniakea are the Shapley, Hercules, Coma, and Perseus-Pieces super-clusters, though the far edges of the neighboring galaxy complexes have not yet been determined. Thousands more distance measurements will be needed for that, said astronomer and lead researcher Brent Tully, with the University of Hawaii.

"We haven't seen the edges of our neighbors, and we haven't seen far enough to understand what's causing this full motion of our galaxy," Tully said in an interview.

Having a clear method for identifying super clusters is expected to help scientists piece together a better idea of how galaxies, including the Milky Way, evolve, astronomer Elmo Tempel, with the Tartu Observatory in Estonia, said in a related Nature commentary.

"Hopefully, this will initiate observational programs to carry out additional direct-distance measurements of galaxies," Tempel wrote in an email to Reuters.

How small can galaxies be?



Just how small a star can be, so today let's explore just how small a galaxy can be. Our Milky Way galaxy is about 100,000 light years across, and contains about 200 billion stars. The largest known galaxy (IC 1101) is about 6 million light years across, and has a mass of about 100 trillion solar masses. The smallest galaxy? It has about a thousand stars.

This very faint galaxy is known as Segue 2, and can be seen in the inset of the image above. With only a thousand stars, and a diameter of about 150 light years, you might wonder how it can be considered a galaxy. After all, there are globular clusters surrounding our galaxy that have far more than 1,000 stars.

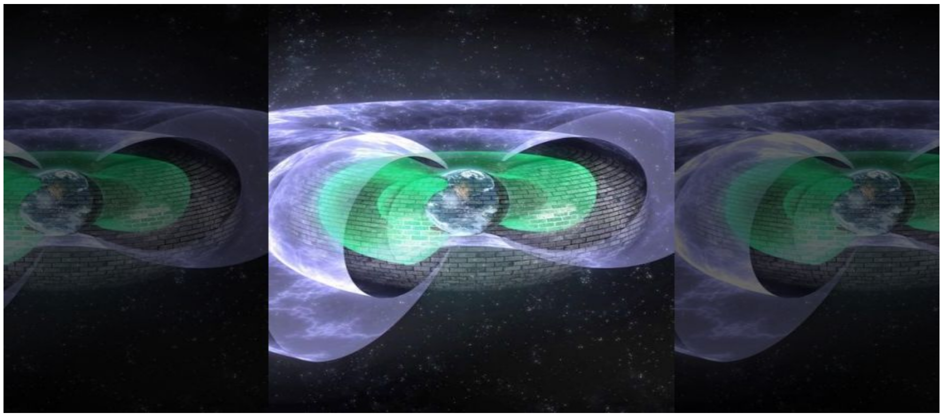
One of the conditions a galaxy must meet is that it must be gravitationally bound. That means the stars must be unable to escape from the gravity of the galaxy. For a mere thousand stars to be gravitationally bound, they would need to have extremely slow motion (no more than about 1 km/s). These stars have speeds about 200 times greater than that limit, and yet they are gravitationally bound.

What makes that possible is dark matter. Although Segue 2 only contains about 1,000 stars, its total mass is about 600,000 solar masses. This means that the vast majority of the cluster's mass is dark matter. In fact, so much of Segue 2 is dark matter that it is basically a clump of dark matter with a few old stars trapped in it. Still, Segue 2 is a gravitationally bound cluster of stars with a dark matter halo. Thus, it is a galaxy.

What's interesting about the Segue 2 galaxy is that it's exactly the type of tiny galaxy predicted by dark matter. Not only does dark matter clumping provide the mechanism necessary to form such a small galaxy, but dark matter actually predicts that a small galaxy such as Segue should be mostly dark matter. That's because the smaller your galaxy, the less material is available for star production, and the more dark matter plays a role in keeping the galaxy gravitationally bound.

Just as the smallest stars help us define what it means to be a star, the smallest galaxies help us define what it means to be a galaxy. What we are finding is that dark matter plays a crucial role in galaxies, particularly the little ones.

Scientists discover Earth's 'Star Trek'-style invisible shield.



A team of scientists led by the University of Colorado Boulder has discovered an invisible "Star Trek"-style shield that blocks so-called "killer electrons" 7,200 miles above Earth.

The electrons, which travel at near light-speed, are capable of damaging space electronics and can put astronauts in danger.

The shield, which forms a barrier to particle motion, was found in the Van Allen radiation belts, according to Distinguished Professor Daniel Baker, director of CU-Boulder's Laboratory for Atmospheric and Space Physics, who led the study. The radiation belts, which are held in place by Earth's magnetic field, are two doughnut-shaped rings that are packed with high-energy electrons and protons.

"It's almost like these electrons are running into a glass wall in space," said Baker, in a statement. "Somewhat like the shields created by force fields on Star Trek that were used to repel alien weapons, we are seeing an invisible shield blocking these electrons. It's an extremely puzzling phenomenon."

The scientists discovered an "extremely sharp" boundary at the inner edge of the outer radiation belt, which appears to block electrons from breaking through the shield and moving towards Earth's atmosphere.

The CU-Boulder team previously thought that the electrons drifted into Earth's upper atmosphere, where they would be wiped out by air molecules.

Scientists have gained insight into the Van Allen belts in recent years. In 2012, for example, two NASA probes found that the belts alter more rapidly than previously thought, with particles in the areas undergoing swift changes in energy, time and spatial distribution.

Last year a team led by Daniel Baker used the probes to discover a third, transient "storage ring" between the inner and outer Van Allen belts. The third ring appears to come and go, depending on space weather.

The radiation belts are named after celebrated University of Iowa physicist James Van Allen, who discovered them in 1958. Van Allen, who is widely regarded as a pioneer in magnetospheric space research, died in 2006 at the age of 91.

A paper on UC-Boulder's research will be published Nov.27 in the journal Nature.

Follow James Rogers on Twitter @jamesjrogers

WEB SITES OF INTEREST:

http://curious.astro.cornell.edu

TELESCOPE WORKSHOP:

If we are able to have a workshop, we will notify everyone by email.

DECEMBERS SKY:

December 6 — Full Cold Moon, 7:27 a.m. EST, The visible Moon is fully illuminated by direct sunlight. Though the Moon is only technically in this phase for a few seconds, it is considered "full" for the entire day of the event, and appears full for three days.

December 12 — Moon at apogee (its farthest point from the Earth), 6:00 p.m. EST.

December 13-14 — Geminid meteor shower, best viewing overhead from 1-3 a.m. EST.

December 14 — Last Quarter Moon, 7:51 a.m. EST. One-half of the Moon appears illuminated by direct sunlight while the illuminated part is decreasing.

December 17 — Jupiter rises 9:00 p.m. EST.

December 21 — Winter Solstice, 6:03 p.m. EST. The Sun reaches its farthest point south of the celestial equator. New Moon, 8:36 p.m. EST.

December 22-23 — Ursid meteor shower. Visible from the north all night.

December 24 — Moon at perigee (its closest point from the Earth), 12:00 p.m. EST; Saturn rises at 4:42 a.m. EST

December 27— Sirius meridian 12:23 a.m. EST.

December 28— First Quarter Moon, 1:31 p.m. EST. One-half of the Moon appears illuminated by direct sunlight while the illuminated part is increasing.

December 29— Moon and Uranus very close.

PUBLIC NIGHTS AT MCAO:

15-Dec-14 Judi Provencal The Music of the Stars

If you know of anyone who is interested in Astronomy or someone who would like to learn more, please do not hesitate to extend an invitation to them to attend our meetings. If they have an interest in joining, our application is below.

Mount Cuba Astronomical Group
Membership Form

The Mission of the Mt. Cuba Astronomy Group is to increase knowledge and expand awareness of the science of astronomy and related technologies. Benefits include:

Monthly newsletter that includes details about the groups activities and articles on astronomy as well as other related subjects.

Monthly programs on subjects and topics of astronomical interest.

Free or discounted subscriptions to astronomy related publications.

Free registration to MCAG workshops and classes.

Mention Mount Cuba Astronomical Group and receive a 5% discount at Manor Books in New Castle (http://www.yelp.com/biz/manor-used-books-New Castle)

APPLICATION BELOW

Name____

Email Address____

Home Address____

Phone (optional)_______________________________________

Mail to: Carolyn Stankiewicz
Mount Cuba Astronomical Observatory
1610 Hillside Mill Road
Greenville De. 19807