THE STAR

THE NEWSLETTER OF THE
MOUNT CUBA ASTRONOMICAL GROUP
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OUR PROGRAMS ARE HELD THE SECOND TUESDAY OF EACH MONTH AT 7:30 P.M. UNLESS INDICATED OTHERWISE
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The Mission of the Mt. Cuba Astronomy Group is to increase knowledge and expand awareness of the science of astronomy and related technologies.

OUR NEXT MEETING
TUESDAY FEBUARY 9th
7:30 p.m. MT. CUBA ASTRONOMICAL OBSERVATORY

OBSERVATIONS FROM THE CONFORTABLE CHAIR
Hank Bouchelle Co-Chair MCAG

ASTRONOMICAL TERMS AND NAMES OF THE MONTH:

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

Asteroseismology also known as stellar seismology is the science that studies the internal structure of pulsating stars by the interpretation of their frequency spectra.

FROM THE WORLD OF ASTRONOMY:

The 2 most dangerous numbers in the universe are threatening the end of physics.

A deeply disturbing and controversial line of thinking has emerged within the physics community.

It's the idea that we are reaching the absolute limit of what we can understand about the world around us through science.

"The next few years may tell us whether we'll be able to continue to increase our understanding of nature or whether maybe, for the first time in the history of science, we could be facing questions that we cannot answer," Harry Cliff, a particle physicist at the European Organization for Nuclear Research — better known as CERN — said during a recent TED talk in Geneva, Switzerland.

Equally frightening is the reason for this approaching limit, which Cliff says is because "the laws of physics forbid it."

At the core of Cliff's argument is what he calls the two most dangerous numbers in the universe. These numbers are responsible for all the matter, structure, and life that we witness across the cosmos.

And if these two numbers were even slightly different, says Cliff, the universe would be an empty, lifeless place.

Dangerous No. 1: The strength of the Higgs field.

The first dangerous number on Cliff's list is a value that represents the strength of what physicists call the Higgs field, an invisible energy field not entirely unlike other magnetic fields that permeates the cosmos.

As particles swim through the Higgs field, they gain mass to eventually become the protons, neutrons, and electrons comprising all of the atoms that make up you, me, and everything we see around us.

Without it, we wouldn't be here.

We know with near certainty that the Higgs field exists because of a groundbreaking discovery in 2012, when CERN physicists detected a new elementary particle called the Higgs boson. According to theory, you can't have a Higgs boson without a Higgs field.

But there's something mysterious about the Higgs field that continues to perturb physicists like Cliff.

According to Einstein's theory of general relativity and the theory of quantum mechanics — the two theories in physics that drive our understanding of the cosmos on incredibly large and extremely small scales — the Higgs field should be performing one of two tasks, says Cliff.

Either it should be turned off, meaning it would have a strength value of zero and wouldn't be working to give particles mass, or it should be turned on, and, as the theory goes, this "on value" is "absolutely enormous," Cliff says. But neither of those two scenarios are what physicists observed.

"In reality, the Higgs field is just slightly on," says Cliff. "It's not zero, but it's ten-thousand-trillion times weaker than it's fully on value — a bit like a light switch that got stuck just before the 'off' position. And this value is crucial. If it were a tiny bit different, then there would be no physical structure in the universe."

Why the strength of the Higgs field is so ridiculously weak defies understanding. Physicists hope to find an answer to this question by detecting brand-new particles at the newly upgraded particle accelerator at CERN. So far, though, they're still hunting.

Dangerous No. 2: The strength of dark energy

The distribution of dark matter is shown in blue and the gas distribution in orange. This simulation is for the current state of the universe and is centered on a massive galaxy cluster. The region shown is about 300 million light-years across.

Cliff's second dangerous number doubles as what physicists have called "the worst theoretical prediction in the history of physics."

This perilous number deals in the depths of deep space and a mind-meltingly complex phenomenon called dark energy.

Dark energy, a repulsive force that's responsible for the accelerating expansion of our universe, was first measured in 1998.

Still, "we don't know what dark energy is," Cliff admits. "But the best idea is that it's the energy of empty space itself — the energy of the vacuum."

If this is true, you should be able to sum up all the energy of empty space to get a value representing the strength of dark energy. And although theoretical physicists have done so, there's one gigantic problem with their answer:

"Dark energy should be 10120 times stronger than the value we observe from astronomy," Cliff said. "This is a number so mind-boggling huge that it's impossible to get your head around ... this number is bigger than any number in astronomy — it's a thousand-trillion-trillion-trillion times bigger than the number of atoms in the universe. That's a pretty bad prediction."

On the bright side, we're lucky that dark energy is smaller than theorists predict. If it followed our theoretical models, then the repulsive force of dark energy would be so huge that it would literally rip our universe apart. The fundamental forces that bind atoms together would be powerless against it and nothing could ever form — galaxies, stars, planets, and life as we know it would not exist.

On the other hand, it's extremely frustrating that we can't use our current theories of the universe to develop a better measurement of dark energy that agrees with existing observations. Even better than improving our theories would be to find a way that we can understand why the strength of dark energy and the Higgs field is what it is.

Getting answers could be impossible.

Cliff said there is one possible way to get some answers, but we might never have the ability to prove it.

If we could somehow confirm that our universe is just one in a vast multiverse of billions of other universes, then "suddenly we can understand the weirdly fine-tuned values of these two dangerous numbers [because] in most of the multiverse dark energy is so strong that the universe gets torn apart, or the Higgs field is so weak that no atoms can form," Cliff said.

To prove this, physicists need to discover new particles that would uphold radical theories like string theory, which predicts the existence of a multiverse. Right now,

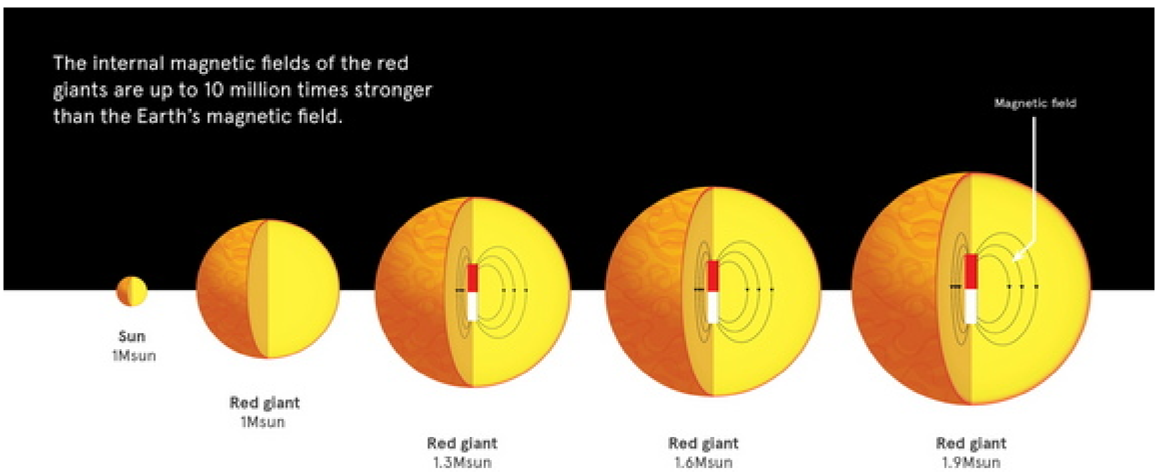
there's only one place in the world that could possibly produce these particles, if they exist, and that's the Large Hadron Collider at CERN.

And physicists only have two to three years before CERN shuts the LHC down for upgrades. If we haven't found anything by then, Cliff said, it could signal the beginning of the end.

"We may be entering a new era in physics. An era where there are weird features in the universe that we cannot explain. An era where we have hints that we live in a multiverse that lies frustratingly beyond our reach. An era where we will never be able to answer the question why is there something rather than nothing."

Ultra strong Magnetic Fields Beat at the Heart of Dying Stars

By Sarah Lewin, Space.com



KISSIMMEE, Fla. — Many dying stars just a little bit more massive than the sun have super powerful magnetic fields hidden away inside that likely play an important role in how such stars change over time, scientists say.

The stellar findings, unveiled here at the 227th Meeting of the American Astronomy Society (AAS), identified strong magnetic fields near the cores of stars in the final stages of their lifecycle. And those intense magnetic forces are much more common than previously thought, the researchers found.

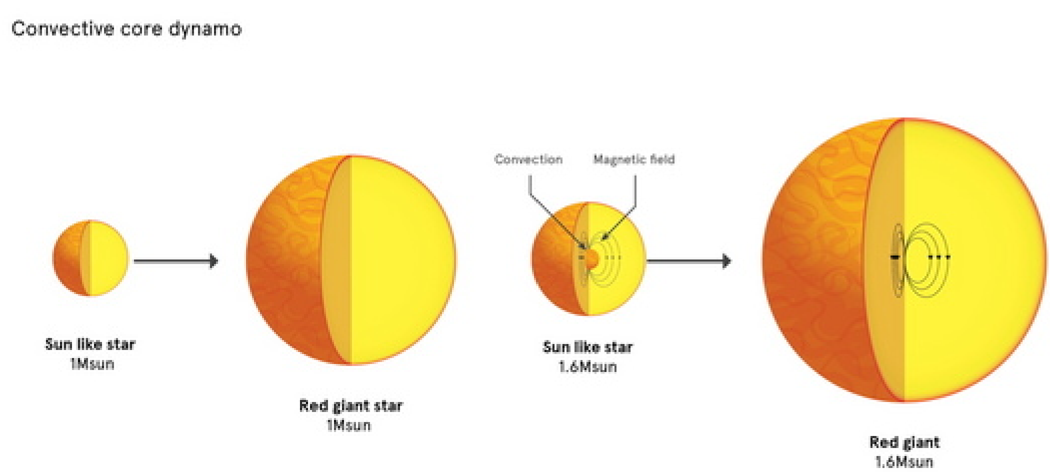
"Today, for the first time, we have the ability to map the demographics of magnetic fields inside of stars," Jim Fuller, a researcher at the California Institute of Technology, said during a presentation at the AAS meeting.

"Magnetic fields have been neglected in [the study of] stellar evolution for a long time — now we see that they're common, and they can be very strong and can have a very important influence on stellar evolution," he added.

The researchers used data from the orbiting Kepler Space Telescope to investigate thousands of red-giant stars— the stage of stellar evolution where stars like the sun begin fusing helium into carbon and balloon out into a much larger, cooler state. To look inside, they used a technique called asteroseismology: examining how sound waves ricochet around inside the star to determine its internal shape. Similar techniques can reveal the interiors of our own sun or even large planets with rings.

"Their interior is essentially ringing like a bell," lead author Dennis Stello, an astrophysicist from the University of Sydney in Australia, said in a statement. "And like a bell, or a musical instrument, the sound they produce can reveal their physical properties."

That "ringing" causes subtle changes in brightness picked up by Kepler, and the researchers saw that for many of the stars, certain frequencies were suppressed as they passed through the star — indicating a strong magnetic field.



Pin it Red-giant stars just slightly more massive than the sun hide strong magnetic fields in their cores because of the way convection operates.
Credit: Credit: University of Sydney
View full size image

They found that red-giant stars as small as 1.1 times the sun's size could harbor the powerful magnetic fields, and that they became more likely the larger the star was — roughly half of stars 1.5 times the size of the sun or greater had the strong fields, Fuller said at the meeting session. The field is likely a remnant of an earlier stage of the stars' evolution, when those stars had strong flows of material within their cores that could

have generated such a field. Stars the sun's size lack that internal movement, so those stars would have never had that magnetic power.

"It looks like this effect, which had only been theoretically speculated about, is actually very, very common inside of slightly more massive stars than the sun," Fuller said. As they learn to detect the fields in the cores of different types of stars, he added, they can incorporate what they see into models of stars' interiors.

"We've known for a very long time that magnetic fields can have a profound influence on the way stars live, the way they evolve and the way they die, but we've had very, very few observational constraints about [the kinds of magnetic fields] actually present inside the center regions or the cores of stars," Fuller said. "Now, we can start to learn about these magnetic fields using aster seismology."

Why a rumor about the discovery of something Einstein predicted 100 years ago is going viral

On Monday January 11th, theoretical physicist Laurence Krauss sent the scientific community on Twitter reeling when he suggested that researchers may have detected, for the first time, an astrophysical phenomenon called gravitational waves.

Right now, the rumor is just that. The scientists to which the rumor refers work at the Laser Interferometer Gravitational-Wave Observatory (LIGO). They told Business Insider that there is no basis for such a claim, yet.

"We are still taking data, and we won't finish analyzing and reviewing results until at least a month or two later," Gabriela Gonzalez, LIGO spokesperson and Louisiana State University physics and astronomy professor, told Business Insider.

She added: "The instruments are working great, but ... I don't have any news with analysis results to share, yet."

But what if the rumor turns out to be real? Well, the prospect of what that would mean for science is what earned Krauss's Tweet 4,250% more retweets than his usual 40 or so — overnight.

Albert Einstein first predicted the existence of gravitational waves in 1916.

According to his theory of general relativity, a number of incredibly powerful cosmic systems across the universe will generate measurable ripples in the fabric of space-time called gravitational waves.

One example is two black holes orbiting one another that are eventually destined to collide.

When a smaller black hole meets a larger one, the two attract one another through tremendous gravitational forces. As the smaller black hole inches toward its invariable

doom, is accelerates through space at an ever-increasing rate toward the larger black hole, and, in so doing, generates gravitational waves.

Over 30 years ago, a pair of scientists using the radio telescope in Puerto Rico made the first indirect detection of gravitational waves by observing the behavior of a distant pulsar binary — a pair of rapidly rotating neutron stars (the densest objects in the universe next to black holes). This indirect detection gave fuel for larger projects, like LIGO and the BICEP2 telescope.

In 2014, the BICEP2 team reported the discovery of gravitational waves, but the discovery was later disproved.

To this day, scientists have yet to confirm the existence of gravitational waves with direct, observational evidence, which is why projects like LIGO are so important.

"The detection of gravitational waves would be a game changer for astronomers in the field," Clifford Will, a distinguished profess of physics at the University of Florida who studied under famed astrophysicist Kip Thorne told Business Insider in 2015. "We would be able to test aspects of general relativity that have not been tested."

Not only that, the ability to observe gravitational waves would open a whole new frontier of astronomy. The same way that astronomers today use light waves to study the universe, they could also use gravitational waves to see cosmic objects — such as colliding black holes — like never before.

How to snag a gravitational wave

LIGO first began sniffing for gravitational waves in 2002. And between 2002 and 2010, the $620 million experiment came up empty handed.

To better the odds, engineers began upgrading LIGO to make it eventually 10 times more sensitive to gravitational waves.

Last September, scientists turned the new-and-improved machine on and began taking data with, what is now called Advanced LIGO.

The way Advanced LIGO works is that it consists of two identical machines that are located 1,865 miles apart — one is in Livingston, Louisiana and the other is in Hanford, Washington.

At each detector, there are two equally-long tunnels with a mirror at the end (one of the mirrors is shown in the image above). Scientists split a laser beam in two and then fire each half down one of the two tunnels. When the beams reflects off the mirror, the two beams should return at the same time, since they're both traveling at the speed of light.

However, if a gravitational wave passes through the detector the same time the laser is traveling through the two tunnels, scientists expect to see a slight difference in time between when the first and second halves of the beam return.

Compared to the length of light waves we see with our eyes, which are micrometers in size (about the width of a human hair), gravitational waves are huge. This is why the distance between each LIGO detector is over 1800 miles, because that's about how long LIGO scientists think the gravitational waves they're searching for should be.

Therefore, if one detector observes a gravitational wave, it should mean the other detector should measure the same signal, offering immediate confirmation that the observation at the first detector isn't a fluke.

Scientists at LIGO aren't taking any chances with this experiment — they don't want another BICEP2 incident. Before they announce a discovery, the data will have been fully vetted twice-over by their expert peers.

But if they do succeed, it will revolutionize astronomy as we know it.

Answer’s to January quiz.

Problem 1
– Earth has a radius of 6378 kilometers. What is the circumference of Earth to the nearest kilometer?
Answer: C = 2
π
R so C = 2 x 3.141 x (6378 km) =
40,067 km.

Problem 2
– At the speed of light, how long would it take for a radio signal to travel once around Earth?
Answer: Time = distance/speed so
Time = 40,067/300,000 =
0.13 seconds. This is about 1/7 of a second
.
Problem 3
– The Moon is located 380,000 kilometers from Earth. During the Apollo-11 mission in 1969, engineers on Earth would communicate with the astronauts walking on the lunar surface. From the time they asked a question, how long did they have to wait to get a reply from the astronauts?
Answer: From the proportion:
0.13 seconds X

------------------ = ---------------- we have X = (380000/40067) x 0.13 = 1.23 seconds.
40067 km 380000 km
This is the one-way time for the signal to get to the moon from Earth, so the round-trip time is
twice this or
2.46 seconds
.
Problem 4
– In the table below, fill in the one-way travel time from the sun to each of the planets. Use that fact that the travel time from the Sun to Earth is 8 ½ minutes. Give your answer to the nearest tenth, in units of minutes or hours, whichever is the most convenient unit.
Answer: Use simple proportions based on 8.5 minutes of time = 1.00 AU of distance.
Planet Distance from Sun in Astronomical Units - Light Travel - Time

Mercury 0.38 3.2 minutes Venus 0.72 6.1 minutes

Earth 1.00 8.5 minutes Mars 1.52 2.9 minutes

Jupiter 5.20 44.2 minutes Saturn 9.58 1.4 hours

Uranus 19.14 2.7 hours Neptune 30.20 4.3 hours

PUBLIC NIGHTS AT MCAO:

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/

Monday Feb. 8th	**8:00 PM**	**Scott Jackson**	**What's New about Exoplanets**
Monday Feb. 22nd	**8:00 PM**	**Rob Lancaster**	**To Be Determined**
Monday Mar. 07th	**8:00 PM**	**Stan Owocki**	**Cosmic Evolution From Big Us.**
Monday Mar. 21st	**8:00 PM**	**Billie Westergard**	**Hubble Ultra Deep Filled-The Most Distant Planets**
Monday April 11th	**8:00 PM**	**Carolyn Stankiewicz**	**To Be Determined**
Monday April 18th	**8:00 PM**	**Lynn King**	**Asterisms, What are They? Where can I find them?**
Monday May 9th	**8:00 PM**	**Hank Bouchelle**	**Light and Stars**
Monday May 23rd	**8:00 PM**	**Hank Bouchelle**	**Motions in the Solar System**
Monday June 13th	**8:00 PM**	**Greg Lee**	**Moonstruck**
Monday June 27th	**8:00 PM**	**Greg Weaver**	**To Be Determined**

Mount Cuba Astronomical Group

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)

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