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Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - **University of Sharjah**
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مركز الشارقة لعلوم الفضاء والفلك
Sharjah Center for Astronomy & Space Sciences

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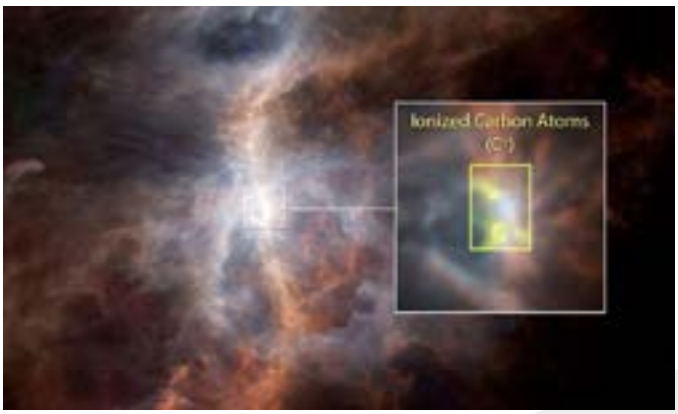
Building blocks of life's building blocks come from starlight



The dusty side of the Sword of Orion is illuminated in this striking infrared image from ESA's Hershel Space Observatory. Within the inset image, the emission from ionized carbon atoms (C+) is overlaid in yellow. Credit: ESA/NASA/JPL-Caltech

Life exists in a myriad of wondrous forms, but if you break any organism down to its most basic parts, it's all the same stuff: carbon atoms connected to hydrogen, oxygen, nitrogen and other elements. But how these fundamental substances are created in space has been a longstanding mystery.

Now, astronomers better understand how molecules form that are necessary for building other chemicals essential for life. Thanks to data from the European Space Agency's Herschel Space Observatory, scientists have found that ultraviolet light from stars plays a key role in creating these molecules, rather than "shock" events that create turbulence, as was previously thought.

Scientists studied the ingredients of carbon chemistry in the Orion Nebula, the closest star-forming region to Earth that forms massive stars. They mapped the amount, temperature and motions of the carbon-hydrogen molecule (CH, or "methylidyne" to chemists), the carbon-hydrogen positive ion (CH+) and their parent: the carbon ion (C+). An ion is an atom or molecule with an imbalance of protons and electrons, resulting in a net charge.

"On Earth, the sun is the driving source of almost all the life on Earth. Now, we have learned that starlight drives the formation of chemicals that are precursors to chemicals that we need to make life," said Patrick Morris, first author of the paper and researcher at the Infrared Processing and Analysis Center at Caltech in Pasadena.

In the early 1940s, CH and CH+ were two of the first three molecules ever discovered in interstellar space. In examining molecular clouds—assemblies of gas and dust—in Orion with Herschel, scientists were surprised to find that CH+ is emitting rather than absorbing light, meaning it is warmer than the background gas. The CH+ molecule ...Read More...

Observable Universe contains ten times more galaxies than previously thought

Among other data, scientists used the galaxies visible in the Great Observatories Origins Deep Survey (GOODS) to recalculate the total number of galaxies in the observable Universe. The image was taken by the NASA/ESA Hubble Space Telescope and covers a portion of the southern field of GOODS. This is a large galaxy census, a deep-sky study by several observatories to trace the formation and evolution of galaxies. Credit: NASA, ESA/Hubble

Astronomers using data from the NASA/ESA Hubble Space Telescopes and other telescopes have performed an accurate census of the number of galaxies in the Universe. The group came to the surprising conclusion that there are at least 10 times as many galaxies in the observable Universe as previously thought. The results have clear implications for our understanding of galaxy formation, and also help solve an ancient astronomical paradox—why is the sky dark at night?

One of the most fundamental questions in astronomy is that of just how many galaxies the Universe contains. The Hubble Deep Field images, captured in the mid 1990s, gave the first real insight into this. Myriad faint galaxies were revealed, and it was estimated that the observable Universe contains about 100 billion galaxies. Now, an international team, led by Christopher Conselice from the University of Nottingham, UK, have shown that this figure is at least ten times too low.

Conselice and his team reached this conclusion using deep space images from Hubble, data from his team's previous work, and other published data. They painstakingly converted the images into 3-D, in order to make accurate measurements of the number of galaxies at different times in the Universe's history. In addition, they used new mathematical models which allowed them to infer the existence of galaxies which the current generation of telescopes cannot observe. This led to the surprising realisation that in order for the numbers to add up, some 90% of the galaxies in the observable Universe are actually too faint and too far away to be seen—yet.

"It boggles the mind that over 90% of the galaxies in the Universe have yet to be studied. Who knows what interesting properties we will find when we ...Read More...

New method for making effective calculations in 'high-dimensional space'

Projection of a 9-dimensional cube. High-dimensional spaces pose considerable problems when trying to make calculations and predictions – something that the new method devised by researchers aims to address. Credit: Tom Ruen via Wikimedia Commons

Researchers have developed a new method for making effective calculations in "high-dimensional space" – and proved its worth by using it to solve a 93-dimensional problem.

Researchers have developed a new technique for making calculations in "high-dimensional space" – mathematical problems so wide-ranging in their scope, that they seem at first to be beyond the limits of human calculation.

In what sounds like the title of a rejected script for an Indiana Jones movie, the method improves on existing approaches to beat a well-known problem known as "The Curse Of Dimensionality". It was devised by a team of researchers at the University of Cambridge.

In rough terms, the "Curse", refers to the apparent impossibility of making calculations in situations where the number of variables, attributes, and possible outcomes is so large that it seems futile even to try to comprehend the problem in the first place.

A simple example is this: Imagine that you have a cup containing 100 grains of rice. You pick it up, shake it, and put it down again. The arrangement within the cup changes, but what are the chances of that arrangement occurring, relative to all other possibilities?

While most people would reasonably consider that problem not just impossible, but largely pointless, it illustrates the type of maths needed to make predictions about much bigger – and more meaningful – issues.

Those include, for example, trying to model the likely shape and impact of a decaying ecosystem, such as a developing area of deforestation, or the potential effect of different levels of demand on a power grid. ...Read More...

UC physicists join collaborative efforts in search for new ghost neutrinos

One of the Daya Bay Experimental Halls (L) and the MINOS Far Detector (R). Image courtesy Alexandre B. Sousa, physicist on the joint project.

University of Cincinnati physicists have joined forces in a major international collaboration to shed new light on one of the most pressing questions in particle physics - "do sterile neutrinos exist?"

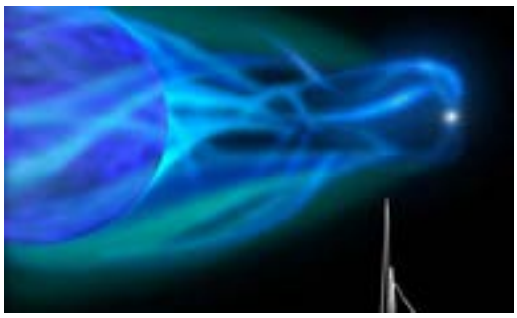
After looking at how the three known neutrino types behave and interact - classified as electron, muon and tau 'flavors' - a new research collaboration between the U.S.-based MINOS accelerator neutrino experiment and China's Daya Bay reactor neutrino experiment has looked for an elusive new light sterile neutrino that may resolve some outstanding puzzles in astrophysics and cosmology.

"Neutrinos are almost nothing at all, as they have almost no mass and no electric charge, but these itty-bitty ghost particles that can travel at near light speeds are all around us, from those created at the Big Bang to those originating in nuclear fusion at the center of the sun - the same process that produces sunlight," says Alexandre B. Sousa, University of Cincinnati assistant professor of physics and part of the MINOS experiment. "And they play an essential role in our fundamental understanding of how the universe works."

Back in the 1990s, scientists working on the Liquid Scintillator Neutrino Detector (LSND) experiment at Los Alamos announced evidence of muon neutrinos oscillating into electron neutrinos. However, the oscillation was occurring much faster than the neutrino oscillations discovered by the Super-Kamiokande experiment that led to the 2015 Nobel Prize in Physics.

According to the researchers, if the LSND results are correct and due to neutrino oscillations, the most likely explanation is the existence of a new, fourth type of neutrino. But this new neutrino would have to be much stranger than anything seen before, being sterile, meaning that it does not interact with matter except through gravity. Over the last twenty years, a number of experiments have tried to confirm or refute the LSND findings, but ...Read More...

Astronomers observe a supergiant fast X-ray transient prototype



Artist's impression of a Supergiant Fast X-ray Transient. The light curve at the bottom-right was retrieved by INTEGRAL from the supergiant fast X-ray transient source IGR J17544-2619 on Sept. 17, 2003. Credit: ESA.

A team of astronomers led by Enrico Bozzo of the University of Geneva, Switzerland, has recently studied a prototype of a supergiant fast x-ray transient (SFXT), designated IGR J17544-2619. The researchers investigated its spectral variability during outburst and quiescence, as this source exhibits one of the most extreme levels of X-ray variability among other objects in the same class. The findings were presented in a paper published Oct. 9 on arXiv.org.

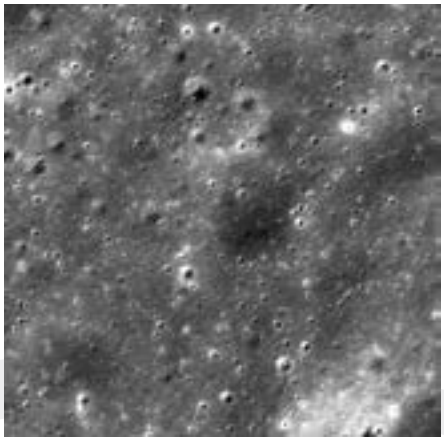
Discovered in 2003 by ESA's International Gamma-Ray Astrophysics Laboratory (INTEGRAL) space observatory, IGR J17544-2619 has a quiescent X-ray luminosity and one of the shortest measured orbital periods among SFXTs – about 4.9 days. The source also showcases the most extreme X-ray variability among all other SFXTs.

In March 2015, Bozzo's team conducted a multi-wavelength observational campaign of IGR J17544-2619, using ESA's X-ray Multi-Mirror Mission (XMM-Newton) and NASA's Nuclear Spectroscopic Telescope Array (NuSTAR) spacecraft. By observing the source simultaneously with both space observatories, the scientists managed to catch it in an initial faint X-ray state and then while undergoing a bright X-ray outburst.

"We report on a 150 ks-long observational campaign performed in the direction of IGR J17544-2619 simultaneously with XMM-Newton and NuSTAR. During these observations, the source remained in a very low quiescent state for most of the time, and then, toward the end of the observations, it underwent a bright outburst comprising three distinct short flares lasting in total about 7 ks," the researchers wrote in the paper.

As was noted by the team, IGR J17544-2619 was initially caught by both telescopes during an extended quiescent period, which covered the first 33 hours and 20 minutes of observations. However, this state of quiescence did not deliver the expected crucial information on the nature of the source, as the statistics of the data were too low to carry out a time-resolved spectral analysis. ...Read More...

Study reveals lunar surface features younger than assumed



Bang! A new moon crater appeared between Oct. 25, 2012, and April 21, 2013. At 12 meters (40 feet) wide, the crater is not hard to spot in the image, but the starburst pattern of ejected debris is elusive to trace. Credit: NASA/GSFC/Arizona State University

The moon's surface is being "gardened"—churned by small impacts—more than 100 times faster than scientists previously thought. This means that surface features believed to be young are perhaps even younger than assumed. It also means that any structures placed on the moon as part of human expeditions will need better protection.

This new discovery comes from more than seven years of high-resolution lunar images studied by a team of scientists from Arizona State University and Cornell University. The team is led by ASU's Emerson Speyerer, who is also the lead author of the scientific paper published Oct. 13 in Nature.

"Before the Lunar Reconnaissance Orbiter was launched in 2009, we thought that it took hundreds of thousands to millions of years to change the lunar surface layer significantly," Speyerer said. "But we've discovered that the moon's uppermost surface materials are completely turned over in something like 80,000 years."

The images used in the discovery come from the Lunar Reconnaissance Orbiter Camera (LROC) on NASA's Lunar Reconnaissance Orbiter spacecraft. LROC is run from the Science Operations Center on ASU's Tempe campus; the instrument's principal investigator is Mark Robinson, a professor in ASU's School of Earth and Space Exploration (SESE). Robinson is a co-author on the paper along with Reinhold Povilaitis and Robert Wagner, both SESE research specialists, and Peter Thomas of Cornell.

Before and after

"We used before-and-after images taken by LROC's Narrow Angle Camera," Speyerer said. During the seven years the mission has run so far, he said the team identified 222 new impact craters that formed during the mission. "These range in size from several meters wide ...Read More...

Metamaterial uses light to control its motion

An optically-driven mechanical oscillator fabricated using a plasmomechanical metamaterial. Credit: UC San Diego Jacobs School of Engineering

Researchers have designed a device that uses light to manipulate its mechanical properties. The device, which was fabricated using a plasmomechanical metamaterial, operates through a unique mechanism that couples its optical and mechanical resonances, enabling it to oscillate indefinitely using energy absorbed from light.

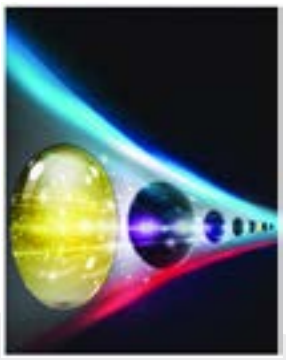
This work demonstrates a metamaterial-based approach to develop an optically-driven mechanical oscillator. The device can potentially be used as a new frequency reference to accurately keep time in GPS, computers, wristwatches and other devices, researchers said. Other potential applications that could be derived from this metamaterial-based platform include high precision sensors and quantum transducers. The research was published Oct. 10 in the journal Nature Photonics.

Researchers engineered the metamaterial-based device by integrating tiny light absorbing nanoantennas onto nanomechanical oscillators. The study was led by Ertugrul Cubukcu, a professor of nanoengineering and electrical engineering at the University of California San Diego. The work, which Cubukcu started as a faculty member at the University of Pennsylvania and is continuing at the Jacobs School of Engineering at UC San Diego, demonstrates how efficient light-matter interactions can be utilized for applications in novel nanoscale devices.

Metamaterials are artificial materials that are engineered to exhibit exotic properties not found in nature. For example, metamaterials can be designed to manipulate light, sound and heat waves in ways that can't typically be done with conventional materials.

Metamaterials are generally considered "lossy" because their metal components absorb light very efficiently. "The lossy trait of metamaterials is considered a nuisance in photonics applications and telecommunications systems, where you have to transmit a lot of power. We're presenting a unique metamaterials approach by taking advantage of this lossy feature," Cubukcu said. ...Read More...

Diamonds aren't forever: Team create first quantum computer bridge



An array of holes (purple) etched in diamond, with two silicon atoms (yellow) placed between the holes. Credit: Sandia National Laboratories

By forcefully embedding two silicon atoms in a diamond matrix, Sandia researchers have demonstrated for the first time on a single chip all the components needed to create a quantum bridge to link "People have already built small quantum computers," says Sandia researcher Ryan Camacho. "Maybe the first useful one won't be a single giant quantum computer but a connected cluster of small ones."

Distributing quantum information on a bridge, or network, could also enable novel forms of quantum sensing, since quantum correlations allow all the atoms in the network to behave as though they were one single atom.

The joint work with Harvard University used a focused ion beam implanter at Sandia's Ion Beam Laboratory designed for blasting single ions into precise locations on a diamond substrate. Sandia researchers Ed Bielejec, Jose Pacheco and Daniel Perry used implantation to replace one carbon atom of the diamond with the larger silicon atom, which causes the two carbon atoms on either side of the silicon atom to feel crowded enough to flee. That leaves the silicon atom a kind of large landowner, buffered against stray electrical currents by the neighboring non-conducting vacancies.

Though the silicon atoms are embedded in a solid, they behave as though floating in a gas, and therefore their electrons' response to quantum stimuli are not clouded by unwanted interactions with other matter.

"What we've done is implant the silicon atoms exactly where we want them," said Camacho. "We can create thousands of implanted locations, which all yield working quantum devices, because we plant the atoms well below the surface of the substrate and anneal them in place. Before this, researchers had to search for emitter atoms among about 1,000 randomly occurring defects—that is, non-carbon atoms—in a diamond substrate of a few microns to find even one that emitted strongly enough to be useful at the single photon level." ...Read More...

How Mars' moon Phobos came to look like the Death Star

Disclaimer: image is for illustration purposes only

Mars' largest moon, Phobos, is well known for its resemblance to the Death Star, the mobile space station and planet-destroying weapon from Star Wars. Now, scientists know how Phobos' unique appearance came to be.

A massive crater, spanning nearly half the moon, lends Phobos its Death Star-like appearance. Until now, astronomers couldn't figure out how an impact could leave such a sizable mark without destroying the satellite.

New simulations designed by physicists at Lawrence Livermore National Laboratory have offered some answers.

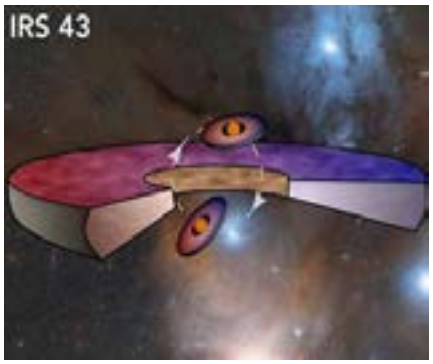
"We've demonstrated that you can create this crater without destroying the moon if you use the proper porosity and resolution in a 3D simulation," Megan Bruck Syal, a researcher with the LLNL planetary defense team, said in a news release. "There aren't many places with the computational resources to accomplish the resolution study we conducted."

The models -- detailed in the journal Geophysical Review Letters -- suggest a range of size and speed combinations, but researchers believe the most likely impact scenario involved an object 250 meters, or 820 feet, across, traveling 6 kilometers per second, roughly 14,000 miles per hour.

To model the Phobos impact, Syal and her colleagues at LLNL used an open source code called Spheral. The code is being developed to simulate the outcomes of various methods for deflecting Earth-bound asteroids.

"Something as big and fast as what caused the Stickney crater would have a devastating effect on Earth," Syal said. "If NASA sees a potentially hazardous asteroid coming our way, it will be essential to make sure we're able to deflect it. We'll only have one shot at it, and the consequences couldn't be higher. We do this type of benchmarking research to make sure our codes are right when they will be needed most." ...Read More...

Stars with Three Planet-Forming Discs of Gas



A graphic illustration of the IRS 43 system showing the relative positions of the planet-forming discs. The two newly formed stars each have a rotating disc of gas and dust and also have a shared disc which is much larger and lies across the other two discs. All three discs are staggered in relation to each other. The red colour indicates the parts of the discs moving away from us, while the blue shows what is moving towards us. Image courtesy Christian Brinch, NBI, KU.

A star with a ring of planets orbiting around it - that is the picture we know from our own solar system and from many of the thousands of exoplanets observed in recent years. But now researchers from the Niels Bohr Institute have discovered a system consisting of two stars with three rotating planet-forming accretion discs around them.

It is a binary star where each star has its own planet-forming disc and in addition, there is one large shared disc. All three planet-forming discs are misaligned in relation to one another. The spectacular results are published in the scientific journal, Astrophysical Journal Letters.

A solar system is formed by a large cloud of gas and dust. The cloud of gas and dust condenses and eventually becomes so compact that it collapses into a ball of gas in the centre. Here the pressure heats up the matter and creates a glowing ball of gas, a star. The remainder of the gas and dust cloud rotates as a disc around the newly formed star. In this rotating disc of gas and dust, the material begins to accumulate and form larger and larger clumps, which finally become planets.

Often it is not just one, but two stars that are formed in the dense cloud of gas and dust. This is called a binary star and they are held together by their mutual gravity and orbit in a path around each other. About half of all stars are binary stars and they can each have a rotating disc of gas and dust.

Never Before Seen

But now the researchers have observed something highly unusual: a binary star with not just two, but three rotating gas discs.

"The two newly formed stars are both the size of our Sun and they each have a rotating disc of gas and dust similar to the size of our solar system. In addition ...Read More...

US relies on industry help to make 'giant leap' to Mars

File Image.

US President Barack Obama said Tuesday the nation is relying on private industry to find ways to make the "giant leap" to Mars, with human missions on the horizon by the 2030s.

The US president's announcement confirmed a long-standing agreement to partner with commercial companies on future missions to deep space, and gave some new details on how such collaborations will play out in the coming years, particularly aboard the International Space Station.

"We have set a clear goal vital to the next chapter of America's story in space: sending humans to Mars by the 2030s and returning them safely to Earth, with the ultimate ambition to one day remain there for an extended time," Obama wrote in an essay posted by CNN.

"I'm excited to announce that we are working with our commercial partners to build new habitats that can sustain and transport astronauts on long-duration missions in deep space," he added.

"These missions will teach us how humans can live far from Earth -- something we'll need for the long journey to Mars."

Obama also touted an upcoming conference of top scientists, engineers, innovators and students later this week in Pittsburgh, Pennsylvania, as a chance "to dream up ways to build on our progress and find the next frontiers."

In August, NASA announced that six companies had been selected to work on deep space habitats, and would receive a combined total of $65 million over the next two years.

These companies include Bigelow Aerospace, Boeing, Lockheed Martin, Orbital ATK, Sierra Nevada Corporation, and NanoRacks.

Habitats, or expandable living quarters, may be erected on a planet's surface or used to shelter ...Read More...

X-rays uncover surprising techniques in the creation of art on ancient Greek pottery

A chemical map of Greek art revealed that a calcium-based color additive was used for white, which would have added an additional step. It also raised questions about the firing process due to the absence of zinc in the black regions. It had been assumed that a zinc additive was key to achieving the black figures in the heating process. Credit: SLAC National Accelerator Laboratory

Under beams of X-rays, the colors of art become the colors of chemistry. The mysterious blacks, reds and whites of ancient Greek pottery can be read in elements—iron, potassium, calcium and zinc—and art history may be rewritten.

That's the power of a growing collaboration between the Cantor Arts Center's Art + Science Learning Lab, art and science faculty, and the Stanford Synchrotron Radiation Lightsource (SSRL) at SLAC National Accelerator Laboratory.

Having a facility like SSRL just up the hill from the Cantor's conservation lab lends a unique opportunity for students to probe cultural mysteries with advanced scientific tools, says Susan Roberts-Manganelli, director of the Learning Lab. About two years ago, she started a fellowship for science students interested in studying art conservation. She works closely with SSRL scientific staff to mentor students bringing delicate, valuable art objects to SLAC in search of discoveries that benefit art and science.

"We can do a lot of testing here at the Cantor," Roberts-Manganelli says. "But some studies need more robust collaboration and more powerful X-rays to actually get answers to our questions."

One such study, done by Kevin Chow, BS '13, when he was a senior in collaboration with Stanford, SLAC and the Getty Conservation Institute, took a deeper look at the techniques of the ancient Greek potters, which are difficult to reproduce and not entirely understood. Using a technique called synchrotron X-ray fluorescence, the team was able to uncover surprising steps in the production process that challenge the conventional understanding. ...Read More...

This Week's Sky at a Glance
Oct. 15 - 21

Oct 15 Uranus at opposition (Local Time: 14:00)
Oct 16 Full Moon (08:22) - Meridian passage (23:54) – Altitude: 69°
Oct 17 Moon at perigee: 357860 km (Local Time: 03:36)
Oct 21 Meteor shower Orionids – Parent body: Halley's comet – Active dates: 16-27 Oct

World Tuesday's Lecture - October 18, 2016
14:00 - 15:00

Lecture: Astronomy and Astrology: Science and Superstition
Lecturer: Mr. Mohamed Atoui - SCASS
Date: October 18, 2016
Time: 14:00 - 15:00
Location: SCASS - Auditorium

Gemini Observatory North
Image Credit & Copyright: Joy Pollard (Gemini Observatory)

Explanation: It does look like a flying saucer, but this technologically advanced structure is not here to deliver the wise extraterrestrial from the scifi classic movie The Day the Earth Stood Still. It is here to advance our knowledge of the Universe though. Shown sitting near the top of a mountain in Hawaii, the dome of the Gemini Observatory North houses one of two identical 8.1-meter diameter telescopes. Used with its southern hemisphere twin observatory in Chile, the two can access the entire sky from planet Earth. Constructed from 85 exposures lasting 30 seconds each with camera fixed to a tripod, the image also clearly demonstrates that the Earth did not stand still. Adjusted to be slighter brighter at the ends of their arcs, the concentric star trails centered on the North Celestial Pole are a reflection of Earth's rotation around its axis. Close to the horizon at Hawaiian latitdues, Polaris, the North Star, makes the shortest star trail. The fainter denser forest of star trails toward the right are in the rising Milky Way.