

The background of the entire cover is a composite image. The upper two-thirds show a deep night sky with a dense field of stars and the prominent, glowing band of the Milky Way galaxy stretching diagonally from the upper left towards the center. The lower third of the image shows a dark, rugged mountain range with significant snow cover, silhouetted against the lighter, starry sky.

# **Secrets of the Universe**

**Edited by  
Nicholas Trevino**

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# Secrets of the Universe

## Exploring Space

Collection of Essays

Edited By Nicholas Trevino

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## Welcome To The Wonderful World Of Science!

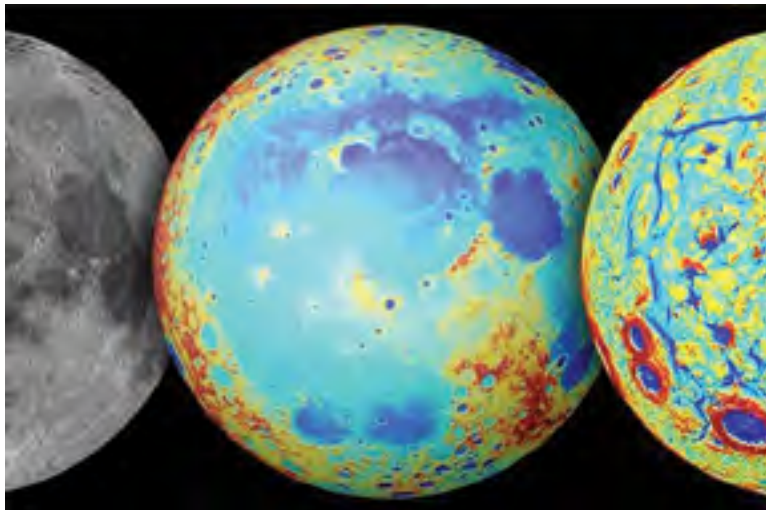
### Introduction

Here, we will explore amazing new discoveries, inventions and explain rare phenomena that happens all around us. We understand that not everyone is familiar with scientific mumbo jumbo, so we'll try our best to keep the terminology as close to plain English as possible. The goal here is to enlighten our readers, such as you, with fascinating information on the world around us! With that mind, we wish you an exciting journey as you read and learn about the many facets of nature and reality.

## Scientists Solve Decades Old Lunar Mystery

By Lisa Winter

For ages, people have looked up at the craters in the Procellarum region of the moon and imagined different shapes within the features; a man's face in particular. But where did these features come from? Hotly debated, the prevailing theory has been that the "man in the moon" was formed by an impact event with a massive asteroid. However, a team using NASA's Gravity Recovery and Interior Laboratory (GRAIL) has discovered that the trademark lunar topography is actually due to a



*Photo credit: NASA/Colorado School of Mines/MIT/JPL/Goddard Space Flight Center*



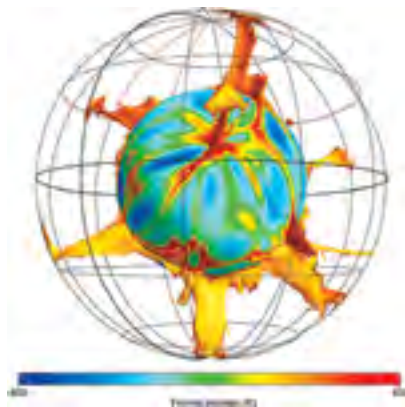
*Artist's rendition of the surface of the moon.*

massive ancient plume of magma. The research was led by Maria Zuber of MIT and the results were published in *Nature* with Jeff Andrews-Hanna as the first author. Zuber's team analyzed data obtained by two probes during the GRAIL

mission in 2012. Variations in the density of the lunar surface caused very slight dips in gravity, which caused one probe to slow down and the second one to slightly catch up. When the trailing probe passed over the same area, it also slowed down. These various differences in distance between the probes were recorded, charting where variations in the gravitational field were. The probes mapped the entire lunar surface using this inchworm-like method.

The Procellarum region is a not quite circular area almost as wide as the United States. Topography readings made it a fairly plausible assumption that the moon was struck by a massive asteroid, with smaller collisions occurring later, deforming the large crater's circular shape. However, gravity field readings have indicated that the crater isn't circular at all; it has sharp 120-degree angles that rule out an asteroid collision. "A lot of things in science are really complicated, but I've always loved to

answer simple questions,” Zuber said in a press release. “How many people have looked up at the moon and wondered what produced the pattern we see — let me tell you, I’ve wanted to solve that one!”



*Magmatic activity inside the moon, where magma plumes are dormant.*

Instead, Zuber and her team believe that a large plume of magma built up beneath the surface of the moon. This pressure caused the surface to crack and the magma to cool at the surface, forming the sharp angles that are seen around the basin.

These giant tension cracks then formed a network, which Zuber referred to as a “plumbing system” for magma within the moon, providing access to the surface. The surface magma filled in the basins and created darker regions. These darker regions are also more dense, contributing to the alteration in gravity. What is less clear, however, is how the magma did this in the first place.

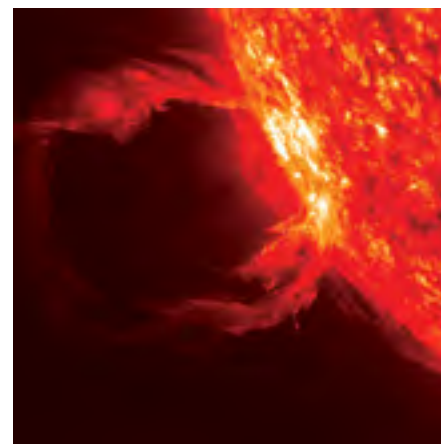
“How such a plume arose remains a mystery,” Zuber continued. “It could be due to radioactive decay of heat-producing elements in the deep interior. Or, conceivably, a very early large impact triggered the plume. But in the latter case, all evidence

for such an impact has been completely erased. People who thought that all this volcanism was related to a gigantic impact need to go back and think some more about that.” In order to thoroughly investigate the origin of this magma plume, the researchers believe it might require a specialized mission by a probe able to take seismic and heat readings from far below the lunar surface. If such a mission did occur, it would likely further supplement, and not replace, the data obtained by the GRAIL mission.

## Dwarf Star Emits Flare 10k More Than The Sun

By Lisa Winter

Astronomers using NASA's Swift satellite spotted a massive solar flare coming from a tiny star on April 23. The explosion was over 10,000 times more intense than anything that has been recorded from our Sun. The star, DG CVn, is an M class star located about 26 light years away in the constellation Canes Venatici. Its radius and mass are about a third of that of our Sun and it's about 1/1000 less luminous. DG CVn is a young star at only about 35 million years old, and like most young stars, it spins rather quickly. While this spinning does contribute to an increased level of activity, DG CVn's flares surpass anything astronomers had predicted. "We used to think major flaring episodes from red dwarfs lasted no more than a day, but Swift detected at least seven powerful eruptions over a period of about two weeks," Goddard's Stephen Drake said in August at a meeting of American Astronomical Society's High Energy Astrophysics Division. "This was a very complex event." Solar flares are triggered by a buildup of charged particles in the



*Solar flare emitting energy into space, recorded by NASA.*

star's plasma. That energy is sometimes released in huge explosions of radiation, spanning the electromagnetic spectrum. Some stars are known as flare stars, as they have predictable activity levels. Astronomers at NASA study these stars in order

to learn more about the phenomenon. However, DG CVn's flare came as quite a shock. "This system is poorly studied because it wasn't on our watch list of stars capable of producing large flares," added astronomer Rachel Osten of the Space Telescope Science Institute in Baltimore. "We had no idea DG CVn had this in it."

Interestingly, Swift is typically used to identify gamma ray bursts, which are brief explosions of radiation stemming from certain supernova events or interactions between neutron stars. A solar flare must have occurred from a small star that was so large, the high level of gamma radiation triggered Swift's Burst Alert Telescope (BAT) and alerted astronomers of its presence. "For about three minutes after the BAT trigger, the superflare's X-ray brightness was greater than the combined luminosity of both stars at all wavelengths under normal conditions," explained





*Graphic artist's interpretation of dwarf star's solar flare.*

Goddard's Adam Kowalski, who is heading up the research into this event. "Flares this large from red dwarfs are exceedingly rare." Solar flare events are classified based on intensity. B class flares are the weakest and X class are the most powerful. Within the classes, the solar flare is given a numerical value to describe how powerful it is, relative to other events within the same class. "The biggest flare we've ever seen from the sun occurred in November 2003 and is rated as X 45," Drake continued. "The flare on DG CVn, if viewed from a planet the same distance as Earth is from the sun, would have been roughly 10,000 times greater than this, with a rating of about X 100,000."

## Unbelievable Facts About Our Universe

By Lisa Winter

Gliese 436 b is a Neptune-sized exoplanet located about 33 light-years away in the constellation Leo. Astronomers believe that it embodies exotic states of water that causes its surface to be covered in burning ice. The pressure on the planet forces the ice to stay solid, but the extreme surface temperature of 570° F (300° C) superheats the water, causing it to come off as steam.



*Artist's interpretation of dwarf star's flare.*

Though it is impossible to smell space directly or through a spacesuit, astronauts report that upon returning from a spacewalk, their gear smells distinctively like seared steak, hot metal, and arc welding fumes. The source of this odor could be byproduct from dying stars, the traces of which can be found throughout the universe. About 10,000 light-years away in the

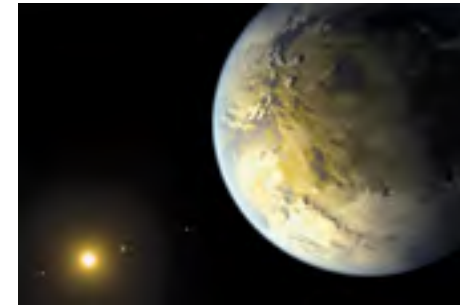
constellation Aquila, there is a cloud of alcohol with a diameter 1,000 times larger than our solar system. The amount of ethyl alcohol present in the cloud could serve up to 400 septillion (400, followed by 24 additional zeros) drinks.



*Image credit: NASA, ESA, and the Hubble SM4 ERO Team.*

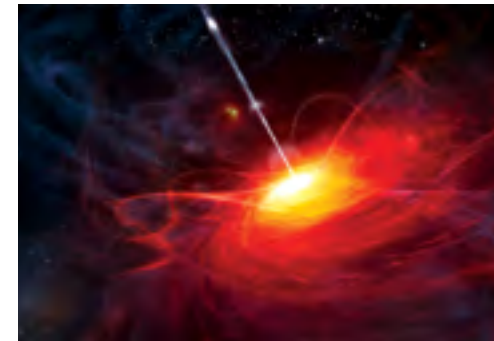
The Andromeda galaxy is our closest galactic neighbor, roughly 2.5 million light-years away. Though it is 140,000 light-years across, it isn't bright enough to be seen in the night sky by our eyes. If it were brighter, it would appear six times larger than the full moon. Black holes are formed when some very large stars collapse and condense all of their mass into a very small area, known as the Schwarzschild radius. Earth's Schwarzschild radius is just below nine mm ( $1/3$  inch), and if it were to be compressed below that size, our planet would become a black hole. For a person to become a black hole, they would have to be compressed smaller than a proton.

Though the birth and death of stars don't happen instantaneously, the process happens fairly frequently. By using observed star formation and supernova events within the Milky Way, astronomers have estimated that 275 million stars are born and die throughout the observable universe each day. This totals more than 100 billion over the course of a year. It takes 24 hours for



*Image credit: NASA Ames/SETI Institute/JPL-Caltech*

Earth to rotate on its axis to make a day, and 365 days to orbit around the sun for a year. It takes around 230 million years for our solar system to complete a single orbit around the Milky Way. The last time it was in its current position, the earliest dinosaurs had just appeared, and flowering plants wouldn't evolve for another 100 million years.



*Image credit: ESO/M. Kornmesser*

Our solar system may smell like hot metal and seared steak, but what about the middle of the Milky Way? According to recent research from the Max Planck Institute, it smells like raspberries and tastes like rum. They found that ethyl formate, a key chemical component for both raspberries and rum, can be readily found at the center of our galaxy. Can't choose between raspberries or rum? Why not just soak the berries in the rum and call it a party? If you have ever wished there were more hours in the day, just be patient. Every century, Earth's rotation slows down by about 1.4 milliseconds. When

the dinosaurs were around, a day lasted about 23 hours. NASA reports that Earth's rotation was exactly 24 hours in 1820, but is now off by 2.5 milliseconds. There are anywhere between 200-400 billion stars in the Milky Way and an estimated 100 billion planets. Around one in five stars are like our sun, and astronomers have estimated that about 22% of them have planets the size of Earth in their habitable zone, where water can exist as a liquid. This means there could be 8.8 billion planets within the galaxy capable of supporting life (not accounting for composition of the planet or its atmosphere). When analog television sets aren't tuned to a channel correctly, it results in static and white noise. Around 1% of that is radiation left over from the Big Bang, better known as the Cosmic Microwave Background (CMB). This interference between overlapping signals actually allowed Arno Penzias and Robert Wilson to discover the CMB in 1965.

Quasars occur when gas swirls around a black hole very quickly, and friction causes it to heat up, emitting light. Astronomers have discovered a group of 73 quasars that are over 6.5 times larger than the average quasar group. This structure is over four billion light-years wide, and actually cannot be explained by the Theory of General Relativity. Theoretically, it shouldn't even exist. Pulsars are magnetized neutron stars that spin incredibly fast and blast out a beam of radiation, kind of like a lighthouse beacon. The fastest known pulsar is PSR J1748-2446ad, located

around 18,000 light-years away in the constellation Sagittarius. Though it is of average size for a neutron star, it spins an astonishing 716 times per second. This is nearly a quarter of the speed of light, and exceeds what theories say is possible.