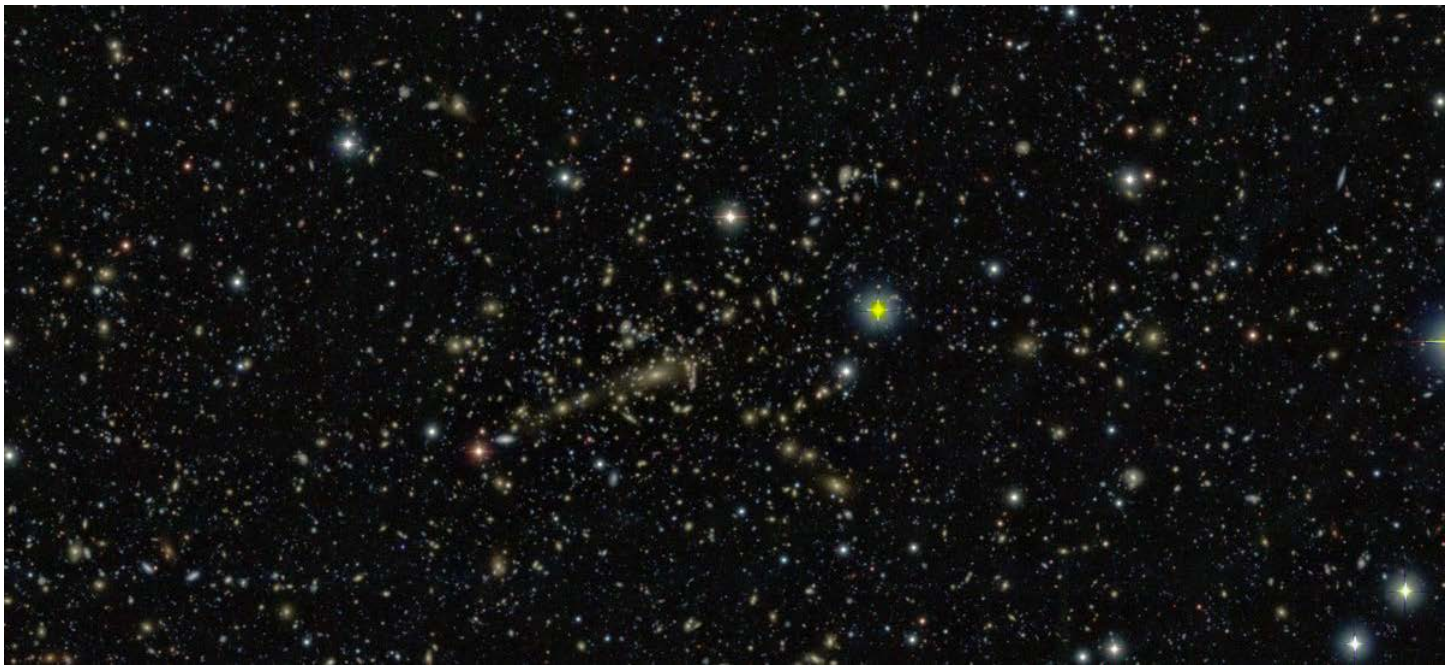
Space News Update

— April 24, 2018 —

Contents

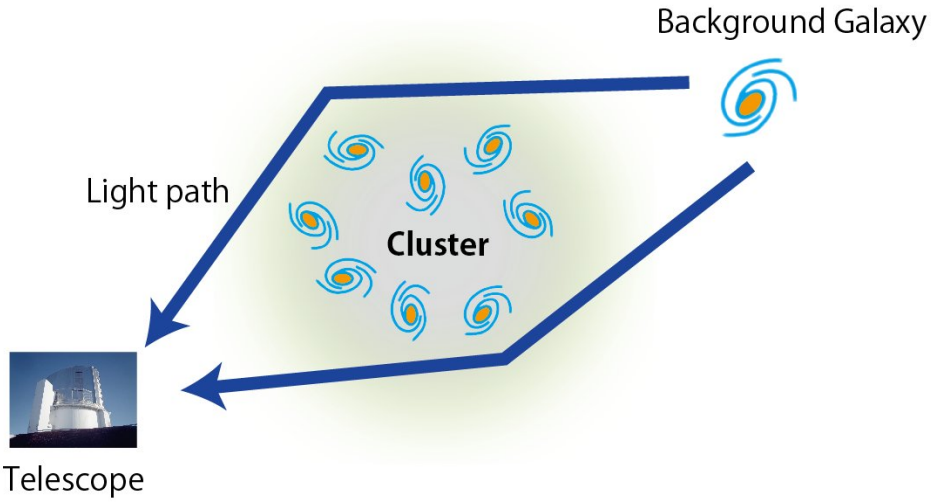
1. Uncovering the secret law of the evolution of galaxy clusters



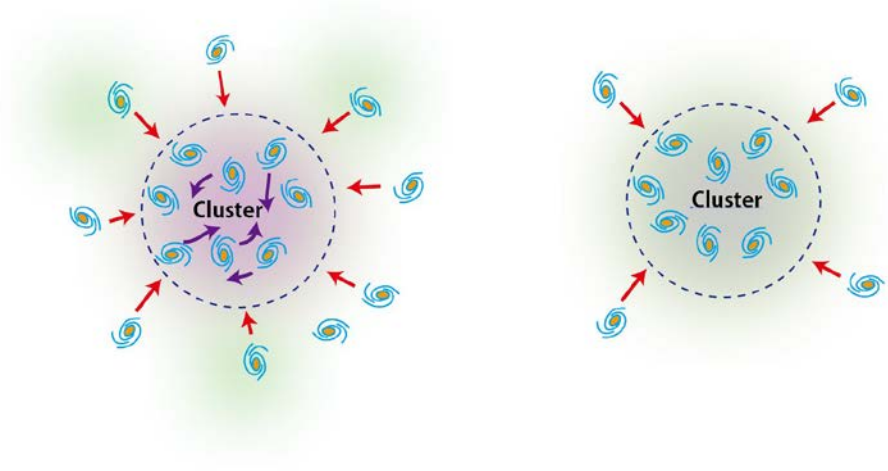
As science enthusiasts around the world bid farewell to legendary cosmologist Stephen Hawking, researchers continue to make important discoveries about the evolution of galaxy clusters that capture the imagination.

Now, an international collaboration between Yutaka Fujita at Osaka University and researchers from Taiwan, Italy, Japan, and the United States found a new fundamental law that stipulates the evolution of galaxy clusters. They recently reported the study in The *Astrophysical Journal*.

Galaxy clusters are the largest celestial body in the Universe (Fig.1 above). However, it has been difficult to measure their size and mass accurately because they mainly consist of dark matter that we cannot observe directly. One way to observe the dark matter indirectly is to use the gravitational lensing effect based on Einstein's theory of relativity. Light rays from a galaxy behind a cluster are pulled by the gravity of the cluster as they pass through it, and their paths are bent (Fig.2 right). This is exactly the same effect as a lens, focusing the light of the distant galaxy and distorting its shape. If we can measure the distortion of the shape for many background galaxies, we can reveal the gravitational field of the cluster, and as a result, we can accurately measure its size and mass.



"One difficulty in our research," explains Keiichi Umetsu at Academia Sinica in Taiwan, "was that accurate measurements of the distortion were necessary." To overcome this problem, the research team has used precise observational data from NASA's Hubble Space Telescope and the Subaru Telescope operated by the National Astronomical Observatory of Japan.



Combining with gas temperature data from the Chandra X-ray satellite, the research group statistically examined those latest data and found that they conform to a simple law represented only by the size, mass, and gas temperature of clusters. Moreover, by making full use of computer simulations, they showed that clusters have grown over 4 to 8 billion years according to the law. Theoretically, the law means that those gigantic clusters are still in adolescence, growing by drawing a large amount of surrounding substances with their strong gravity (Fig.3).

"We've discovered the law that regulates the growth of clusters of galaxies," Fujita says. "Clusters have an internal structure uniquely created in an early growth spurt."

The law is so simple that we can use it to calibrate cluster mass-observable relations, which are a key ingredient for studying the cosmological laws of the Universe.

"Our research draws us closer to explaining the evolutionary history of clusters and the Universe," Fujita adds.

Source: Phys.org

Return to Contents

2. The DARKNESS instrument sill block stars to reveal their planets

The hunt for planets beyond our Solar System has led to the discovery of thousands of candidates in the past few decades. Most of these have been gas giants that range in size from being Super-Jupiters to Neptune-sized planets. However, several have also been determined to be "Earth-like" in nature, meaning that they are rocky and orbit within their stars' respective habitable zones.

Unfortunately, determining what conditions might be like on their surfaces is difficult, since astronomers are unable to study these planets directly. Luckily, an international team led by UC Santa Barbara physicist Benjamin Mazin has developed a new instrument known as DARKNESS. This superconducting camera, which is the world's largest and most sophisticated, will allow astronomers to detect planets around nearby stars.

The team's study which details their instrument, titled "DARKNESS: A Microwave Kinetic Inductance Detector Integral Field Spectrograph for High-contrast Astronomy", recently appeared in the *Publications of the Astronomy Society of the Pacific.* The team was led by Benjamin Mazin, the Worster Chair in Experimental Physics at UCSB, and also includes members from NASA's Jet Propulsion Laboratory, the California Institute of Technology, the Fermi National Accelerator Laboratory, and multiple universities.

Essentially, it is extremely difficult for scientists to study exoplanets directly because of the interference caused by their stars. As Mazin explained in a recent UCSB press release, "Taking a picture of an exoplanet is extremely challenging because the star is much brighter than the planet, and the planet is very close to the star." As such, astronomers are often unable to analyze the light being reflected off of a planet's atmosphere to determine its composition.

These studies would help place additional constraints on whether or not a planet is potentially habitable. At present, scientists are forced to determine if a planet could support life based on its size, mass, and distance from its star. In addition, studies have been conducted that have determined whether or not water exists on a planet's surface based on how its atmosphere loses hydrogen to space.

The DARK-speckle Near-infrared Energy-resolved Superconducting Spectrophotometer (aka. DARKNESS), the first 10,000-pixel integral field spectrograph, seeks to correct this. In conjunction with a large telescope and

adaptive optics, it uses Microwave Kinetic Inductance Detectors to quickly measure the light coming from a distant star, then sends a signal back to a rubber mirror that can form into a new shape 2,000 times a second.

MKIDs allow astronomers to determine the energy and arrival time of individual photons, which is important when it comes to distinguishing a planet from scattered or refracted light. This process also eliminates read noise and dark current – the primary sources of error in other instruments – and cleans up the atmospheric distortion by suppressing the starlight.

Mazin and his colleagues have been exploring MKIDs technology for years through the Mazin Lab, which is part of the UCSB's Department of Physics. As Mazin explained:

"This technology will lower the contrast floor so that we can detect fainter planets. We hope to approach the photon noise limit, which will give us contrast ratios close to 10^{-8}, allowing us to see planets 100 million times fainter than the star. At those contrast levels, we can see some planets in reflected light, which opens up a whole new domain of planets to explore. The really exciting thing is that this is a technology pathfinder for the next generation of telescopes."

DARKNESS is now operational on the 200-inch Hale Telescope at the Palomar Observatory near San Diego, California, where it is part of the PALM-3000 extreme adaptive optics system and the Stellar Double Coronagraph. During the past year and a half, the team has conducted four runs with the DARKNESS camera to test its contrast ratio and make sure it is working properly.

In May, the team will return to gather more data on nearby planets and demonstrate their progress. If all goes well, DARKNESS will become the first of many cameras designed to image planets around nearby M-type (red dwarf) stars, where many rocky planets have been discovered in recent years. The most notable example is Proxima b, which orbits the nearest star system to our own (Proxima Centauri, roughly 4.25 light years away).

"Our hope is that one day we will be able to build an instrument for the Thirty Meter Telescope planned for Mauna Kea on the island of Hawaii or La Palma," Mazin said. "With that, we'll be able to take pictures of planets in the habitable zones of nearby low mass stars and look for life in their atmospheres. That's the long-term goal and this is an important step toward that."

In addition to the study of nearby rocky planets, this technology will also allow astronomers to study pulsars in greater detail and determine the redshift of billions of galaxies, allowing for more accurate measurements of how fast the Universe is expanding. This, in turn, will allow for more detailed studies of how our Universe has evolved over time and the role played by Dark Energy.

These and other technologies, such as NASA's proposed Starshade spacecraft and Stanford's mDot occulter, will revolutionize exoplanet studies in the coming years. Paired with next-generation telescopes – such as the *James Webb Space Telescope* and the *Transiting Exoplanet Survey Satellite*(TESS), which recently launched – astronomers will not only be able to discover more in the way exoplanets, but will be able to characterize them like never before.

Source: Universe Today Return to Contents

3. What do Uranus's cloud tops have in common with rotten eggs?

Hydrogen sulfide, the gas that gives rotten eggs their distinctive odor, permeates the upper atmosphere of the planet Uranus - as has been long debated, but never definitively proven. Based on sensitive spectroscopic observations with the Gemini North telescope, astronomers uncovered the noxious gas swirling high in the giant planet's cloud tops. This result resolves a stubborn, long-standing mystery of one of our neighbors in space.

Even after decades of observations, and a visit by the Voyager 2 spacecraft, Uranus held on to one critical secret, the composition of its clouds. Now, one of the key components of the planet's clouds has finally been verified.

Patrick Irwin from the University of Oxford, UK and global collaborators spectroscopically dissected the infrared light from Uranus captured by the 8-meter Gemini North telescope on Hawaii's Maunakea. They found hydrogen sulfide, the odiferous gas that most people avoid, in Uranus's cloud tops. The long-sought evidence is published in the April 23rd issue of the journal *Nature Astronomy*.

The Gemini data, obtained with the Near-Infrared Integral Field Spectrometer (NIFS), sampled reflected sunlight from a region immediately above the main visible cloud layer in Uranus's atmosphere. "While the lines we were trying to detect were just barely there, we were able to detect them unambiguously thanks to the sensitivity of NIFS on Gemini, combined with the exquisite conditions on Maunakea," said Irwin. "Although we knew these lines would be at the edge of detection, I decided to have a crack at looking for them in the Gemini data we had acquired."

"This work is a strikingly innovative use of an instrument originally designed to study the explosive environments around huge black holes at the centers of distant galaxies," said Chris Davis of the United State's National Science Foundation, a leading funder of the Gemini telescope. "To use NIFS to solve a longstanding mystery in our own Solar System is a powerful extension of its use." Davis adds.

Astronomers have long debated the composition of Uranus's clouds and whether hydrogen sulfide or ammonia dominate the cloud deck, but lacked definitive evidence either way. "Now, thanks to improved hydrogen sulfide absorption-line data and the wonderful Gemini spectra, we have the fingerprint which caught the culprit," says Irwin. The spectroscopic absorption lines (where the gas absorbs some of the infrared light from reflected sunlight) are especially weak and challenging to detect according to Irwin.

The detection of hydrogen sulfide high in Uranus's cloud deck (and presumably Neptune's) contrasts sharply with the inner gas giant planets, Jupiter and Saturn, where no hydrogen sulfide is seen above the clouds, but instead ammonia is observed. The bulk of Jupiter and Saturn's upper clouds are comprised of ammonia ice, but it seems this is not the case for Uranus. These differences in atmospheric composition shed light on questions about the planets' formation and history.

Leigh Fletcher, a member of the research team from the University of Leicester in the UK, adds that the differences between the cloud decks of the gas giants (Jupiter and Saturn), and the ice giants (Uranus and Neptune), were likely imprinted way back during the birth of these worlds. "During our Solar System's formation the balance between nitrogen and sulphur (and hence ammonia and Uranus's newly-detected hydrogen sulfide) was determined by the temperature and location of planet's formation."

Another factor in the early formation of Uranus is the strong evidence that our Solar System's giant planets likely migrated from where they initially formed. Therefore, confirming this composition information is invaluable in understanding Uranus' birthplace, evolution and refining models of planetary migrations.

According to Fletcher, when a cloud deck forms by condensation, it locks away the cloud-forming gas in a deep internal reservoir, hidden away beneath the levels that we can usually see with our telescopes. "Only a tiny amount remains above the clouds as a saturated vapour," said Fletcher. "And this is why it is so challenging to capture the signatures of ammonia and hydrogen sulfide above cloud decks of Uranus. The superior capabilities of Gemini finally gave us that lucky break," concludes Fletcher.

Glenn Orton, of NASA's Jet Propulsion Laboratory, and another member of the research team notes, "We've strongly suspected that hydrogen sulfide gas was influencing the millimeter and radio spectrum of Uranus for some time, but we were unable to attribute the absorption needed to identify it positively. Now, that part of the puzzle is falling into place as well."

While the results set a lower limit to the amount of hydrogen sulfide around Uranus, it is interesting to speculate what the effects would be on humans even at these concentrations. "If an unfortunate human were ever to descend through Uranus's clouds, they would be met with very unpleasant and odiferous conditions." But the foul stench wouldn't be the worst of it according to Irwin. "Suffocation and exposure in the negative 200 degrees Celsius atmosphere made of mostly hydrogen, helium, and methane would take its toll long before the smell," concludes Irwin.

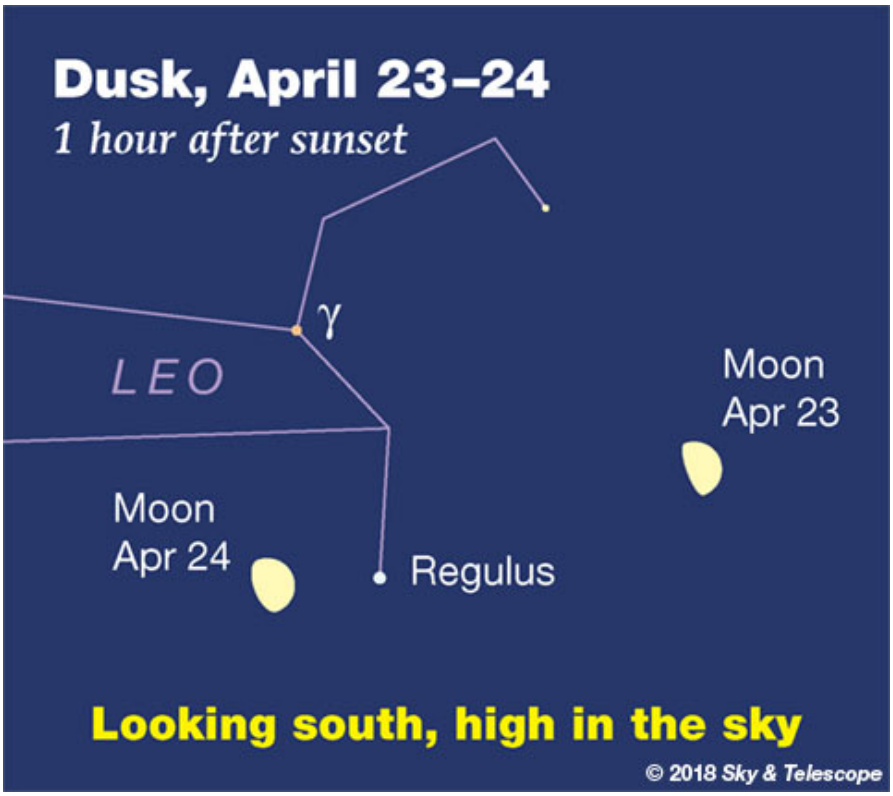
The new findings indicate that although the atmosphere might be unpleasant for humans, this far-flung world is fertile ground for probing the early history of our Solar System and perhaps understanding the physical conditions on other large, icy worlds orbiting the stars beyond our Sun.

Source: EurekAlert Return to Contents

The Night Sky

Tuesday, April 24

• The waxing gibbous Moon shines near Regulus this evening.



Wednesday, April 25

• Arcturus is the brightest star in the east these evenings. Spica shines about three fists at arm's length to its lower right. To the right of Spica by half that distance is the distinctive four-star constellation of Corvus, the Crow of Spring.

Thursday, April 26

• Face north just after nightfall, look very high, and now you'll find the Pointers, the end stars of the Big Dipper's bowl, on the meridian pointing toward Polaris straight down below. From the Pointers to Polaris is about three fists at arm's length.

Friday, April 27

• Look below the bright Moon this evening for Spica. Jupiter rises far to their lower left around the end of twilight.

Source: Sky & Telescope

Return to Contents

ISS Sighting Opportunities

For Denver:

No sightings for Denver through Saturday April 28th.

Sighting information for other cities can be found at NASA's Satellite Sighting Information

NASA-TV Highlights

(all times Eastern Daylight Time)

10:30 a.m., Wednesday, April 25 - ISS Expedition 55 In-Flight Educational Event with the Fairchild Tropical Botanic Gardens in Coral Gables, Florida and NASA Flight Engineers Drew Feustel and Ricky Arnold (Starts at 10:45 a.m.) (all channels)

8 a.m., Thursday, April 26 - ISS Expedition 55 In-Flight Event for JAXA with the Tenku Mirai Project in Tokyo and Flight Engineer Norishige Kanai of the Japan Aerospace Exploration Agency (NTV-1 with English interpretation, NTV-3 in native language) (starts at 8:10 a.m.) (all channels)

10 a.m., Thursday, April 26 - Exploration Progress Update from the Johnson Space Center (all channels)

9 a.m., Friday, April 27 - ISS Expedition 55 In-Flight Event with WBFF-TV, Baltimore and Flight Engineers Ricky Arnold of NASA and Norishige Kanai of the Japan Aerospace Exploration Agency (JAXA) (starts at 9:10 a.m.) (all channels)

10:30 a.m., Friday, April 27 - ISS Expedition 55 In-Flight Educational Event with the Aransas County Independent School District and the Port Aransas County Independent School District in Aransas Pass, Texas and NASA Flight Engineers Drew Feustel and Scott Tingle (starts at 10:50 a.m.) (all channels)

Watch NASA TV on the Net by going to the NASA website. Return to Contents

Space Calendar

- Apr 23 - Comet 300P/Catalina Closest Approach To Earth (1.563 AU)
- Apr 23 - Comet P/2012 O1 (McNaught) At Opposition (2.177 AU)
- Apr 23 - Comet 147P/Kushida-Muramatsu At Opposition (3.301 AU)
- Apr 23 - NEW [Apr 16] Apollo Asteroid 2018 GG4 Near-Earth Flyby (0.025 AU)
- Apr 23 - Aten Asteroid 2012 XL16 Near-Earth Flyby (0.041 AU)
- Apr 23 - Aten Asteroid 2017 HF1 Near-Earth Flyby (0.061 AU)
- Apr 23 - Apollo Asteroid 2015 XF352 Near-Earth Flyby (0.090 AU)
- Apr 23 - Asteroid 400796 Douglass Closest Approach To Earth (1.803 AU)
- Apr 23 - Asteroid 52301 Qumran Closest Approach To Earth (1.839 AU)
- Apr 23 - Asteroid 6001 Thales Closest Approach To Earth (1.863 AU)
- Apr 23 - Asteroid 5000 IAU Closest Approach To Earth (2.202 AU)
- Apr 23 - Max Planck's 160th Birthday (1858)
- Apr 24 - Moon Occults Regulus
- Apr 24 - Asteroid 4 Vesta Occults 2UCAC 25156525 (12.5 Magnitude Star)
- Apr 24 - Amor Asteroid 2018 GD3 Near-Earth Flyby (0.064 AU)
- Apr 24 - Apollo Asteroid 2018 GF2 Near-Earth Flyby (0.070 AU)
- Apr 24 - Apollo Asteroid 469219 (2016 HO3) Closest Approach To Earth (0.145 AU)
- Apr 24 - Asteroid 7986 Romania Closest Approach To Earth (0.969 AU)
- Apr 24 - Asteroid 232 Russia Closest Approach To Earth (1.113 AU)
- Apr 24 - Asteroid 19367 Pink Floyd Closest Approach To Earth (1.842 AU)
- Apr 24 - Kuiper Belt Object 42355 Typhon At Opposition (20.615 AU)
- Apr 24-26 - Workshop: Managing Rivers, Reservoirs, and Lakes in the Face of Drought, Fort Collins, Colorado
- Apr 25 - Sentinel 3B Rokot-KM Launch
- Apr 25 - Comet 169P/NEAT Closest Approach To Earth (1.604 AU)
- Apr 25 - Comet 222P/LINEAR Closest Approach To Earth (2.885 AU)
- Apr 25 - Comet 33P/Daniel At Opposition (3.393 AU)
- Apr 25 - Comet P/2003 T12 (SOHO) At Opposition (3.582 AU)
- Apr 25 - Comet C/2017 B3 (LINEAR) At Opposition (3.972 AU)
- Apr 25 - Apollo Asteroid 2018 GH Near-Earth Flyby (0.037 AU)
- Apr 25 - Apollo Asteroid 2018 EY3 Near-Earth Flyby (0.088 AU)
- Apr 25 - Apollo Asteroid 4581 Asclepius Closest Approach To Earth (0.293 AU)
- Apr 25 - Asteroid 3350 Scobee Closest Approach To Earth (1.441 AU)
- Apr 25 - Asteroid 17023 Abbott Closest Approach To Earth (1.446 AU)
- Apr 25 - Asteroid 6123 Aristoteles Closest Approach To Earth (1.448 AU)
- Apr 25 - Asteroid 268242 Pebble Closest Approach To Earth (1.497 AU)
- Apr 25 - Asteroid 827 Wolfiana Closest Approach To Earth (1.586 AU)
- Apr 25 - Asteroid 248750 Asteroidday Closest Approach To Earth (2.138 AU)
- Apr 25 - Asteroid 21564 Widmanstatten Closest Approach To Earth (2.664 AU)
- Apr 25 - Teleconference: Exoplanet Science Strategy
- Apr 25-27 - Workshop: Carbon in the Solar System, Denver, Colorado
- Apr 26 - UPDATED [Apr 22] Zhuhai-1 03 & 04 CZ-11 Launch
- Apr 26 - Comet 334P/NEAT Closest Approach To Earth (3.583 AU)
- Apr 26 - Comet C/2017 E3 (PANSTARRS) Closest Approach To Earth (5.356 AU)
- Apr 26 - NEW [Apr 21] Aten Asteroid 2018 HP Near-Earth Flyby (0.030 AU)
- Apr 26 - Amor Asteroid 450648 (2006 UC63) Near-Earth Flyby (0.082 AU)
- Apr 26 - 20th Anniversary (1998), Cassini, Venus Flyby
- Apr 26 - 25th Anniversary (1993), STS-55 Launch (Space Shuttle Columbia, Spacelab-D2)
- Apr 26 - Anro Penzias' 85th Birthday (1933)
- Apr 26 - 170th Anniversary (1848), Andrew Graham's Discovery of Asteroid 9 Metis

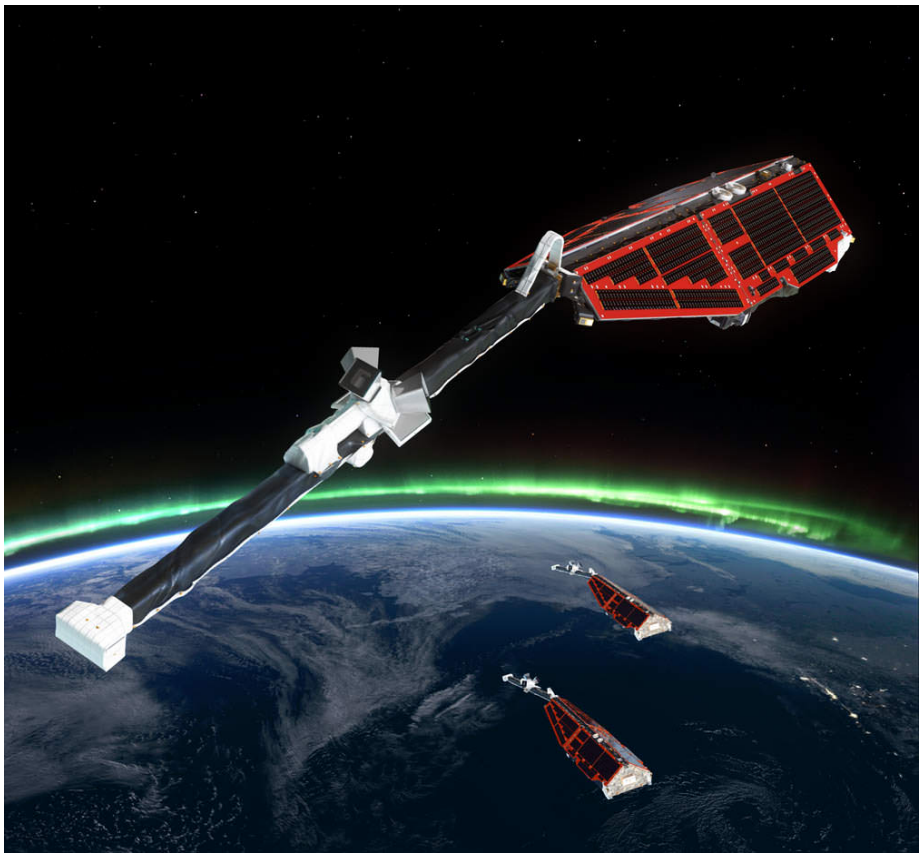
- Apr 26 - 215th Anniversary (1803), L'Aigle Meteorite Shower (Hit House in France)
- Apr 27 - Comet P/2011 CR42 (Catalina) At Opposition (1.539 AU)
- Apr 27 - Comet 313P/Gibbs At Opposition (2.713 AU)
- Apr 27 - NEW [Apr 18] Apollo Asteroid 2018 GH5 Near-Earth Flyby (0.031 AU)
- Apr 27 - Apollo Asteroid 2018 GB2 Near-Earth Flyby (0.044 AU)
- Apr 27 - Apollo Asteroid 444193 (2005 SE71) Near-Earth Flyby (0.062 AU)
- Apr 27 - Amor Asteroid 194126 (2001 SG276) Near-Earth Flyby (0.084 AU)
- Apr 27 - Apollo Asteroid 5786 Talos Closest Approach To Earth (0.792 AU)
- Apr 27 - Asteroid 3773 Smithsonian Closest Approach To Earth (1.423 AU)
- Apr 27 - Asteroid 8146 Jimbell Closest Approach To Earth (1.955 AU)
- Apr 27 - Philip Abelson's 105th Birthday (1913)

Source: JPL Space Calendar

Return to Contents

Food for Thought

Did You Know the Earth Has a Second Magnetic Field? Its Ocens



Earth's magnetic field is one of the most mysterious features of our planet. It is also essential to life as we know it, ensuring that our atmosphere is not stripped away by solar wind and shielding life on Earth from harmful radiation. For some time, scientists have theorized that it is the result of a dynamo action in our core, where the liquid outer core revolves around the solid inner core and in the opposite direction of the Earth's rotation.

In addition, Earth's magnetic field is affected by other factors, such as magnetized rocks in the crust and the flow of the ocean. For this reason, the European Space Agency's (ESA) Swarm satellites, which have been continually monitoring Earth's magnetic field since its deployment, recently began monitoring Earth's oceans – the first results of which were presented at this year's European Geosciences Union meeting in Vienna, Austria.

The Swarm mission, which consists of three Earth-observation satellites, was launched in 2013 for the sake of providing high-precision and high-resolution measurements of Earth's magnetic field. The purpose of this mission is not only to determine how Earth's magnetic field is generated and changing, but also to allow us to learn more about Earth's composition and interior processes.

Beyond this, another aim of the mission is to increase our knowledge of atmospheric processes and ocean circulation patterns that affect climate and weather. The ocean is also an important subject of study to the Swarm mission because of the small ways in which it contributes to Earth's magnetic field. Basically, as the ocean's salty water flows through Earth's magnetic field, it generates an electric current that induces a magnetic signal.

Because this field is so small, it is extremely difficult to measure. However, the Swarm mission has managed to do just that in remarkable detail. These results, which were presented at the EGU 2018 meeting, were turned into an animation (shown below), which shows how the tidal magnetic signal changes over a 24 hour period.

As you can see, the animation shows temperature changes in the Earth's oceans over the course of the day, shifting from north to south and ranging from deeper depths to shallower, coastal regions. These changes have a minute effect on Earth's magnetic field, ranging from 2.5 to -2.5 microtesla. As Nils Olsen, from the Technical University of Denmark, explained in a ESA press release:

"We have used Swarm to measure the magnetic signals of tides from the ocean surface to the seabed, which gives us a truly global picture of how the ocean flows at all depths – and this is new. Since oceans absorb heat from the air, tracking how this heat is being distributed and stored, particularly at depth, is important for understanding our changing climate. In addition, because this tidal magnetic signal also induces a weak magnetic response deep under the seabed, these results will be used to learn more about the electrical properties of Earth's lithosphere and upper mantle."

By learning more about Earth's magnetic field, scientists will able to learn more about Earth's internal processes, which are essential to life as we know it. This, in turn, will allow us to learn more about the kinds of geological processes that have shaped other planets, as well as determining what other planets could be capable of supporting life.

Be sure to check out this comic that explains how the Swarm mission works, courtesy of the ESA.

Source: Universe Today Return to Contents

Space Image of the Week

Hubble celebrates 28th anniversary in style with stunning view of Lagoon Nebula

For 28 years, NASA's Hubble Space Telescope has been delivering breathtaking views of the universe. Although the telescope has made more than 1.5 million observations of over 40,000 space objects, it is still uncovering stunning celestial gems.

The latest offering is this image of the Lagoon Nebula to celebrate the telescope's anniversary. Hubble shows this vast stellar nursery in stunning unprecedented detail.

At the center of the photo, a monster young star 200,000 times brighter than our Sun is blasting powerful ultraviolet radiation and hurricane-like stellar winds, carving out a fantasy landscape of ridges, cavities, and mountains of gas and dust. This region epitomizes a typical, raucous stellar nursery full of birth and destruction. Full Story

Source: NASA

Return to Contents