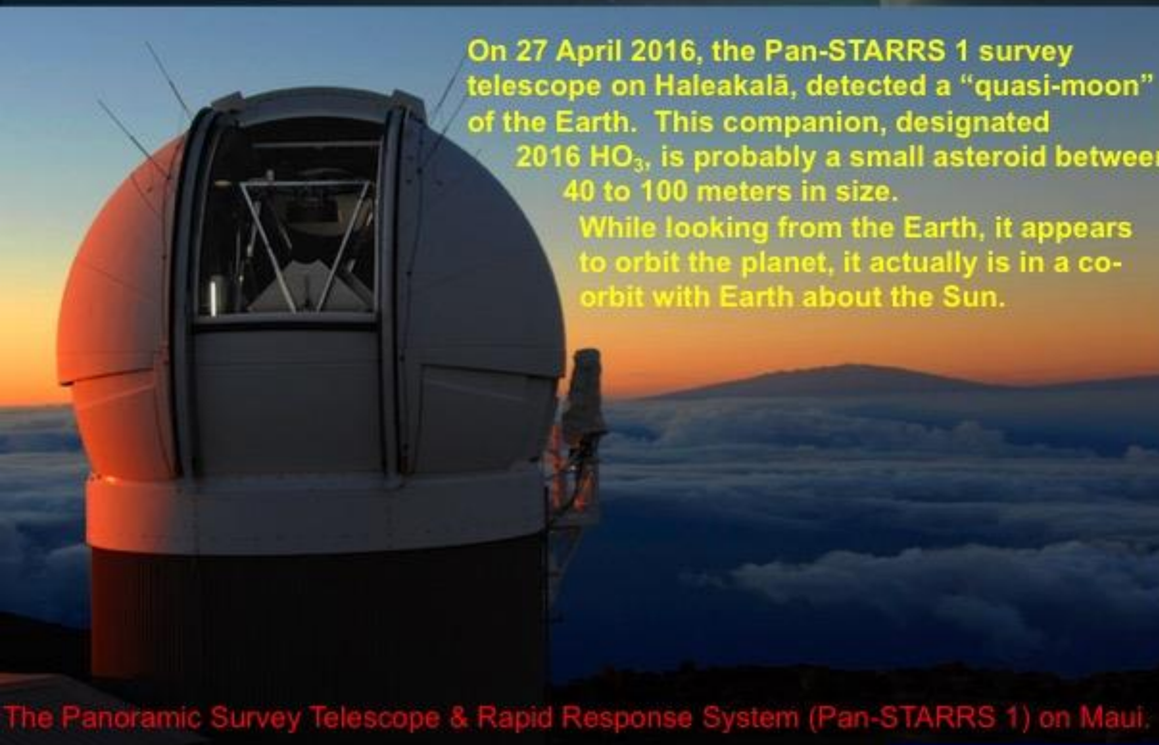
National Aeronautics and
Space Administration

Science Mission Directorate

Weekly Highlights

July 8, 2016

2016 HO_3: A Quasi-moon for Earth

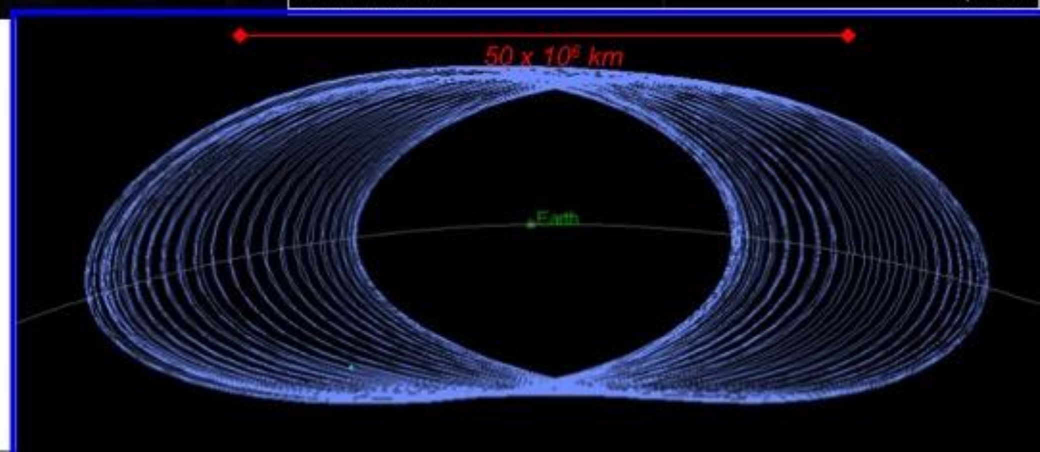


On 27 April 2016, the Pan-STARRS 1 survey telescope on Haleakalā, detected a "quasi-moon" of the Earth. This companion, designated 2016 HO_3, is probably a small asteroid between 40 to 100 meters in size.

While looking from the Earth, it appears to orbit the planet, it actually is in a co-orbit with Earth about the Sun.

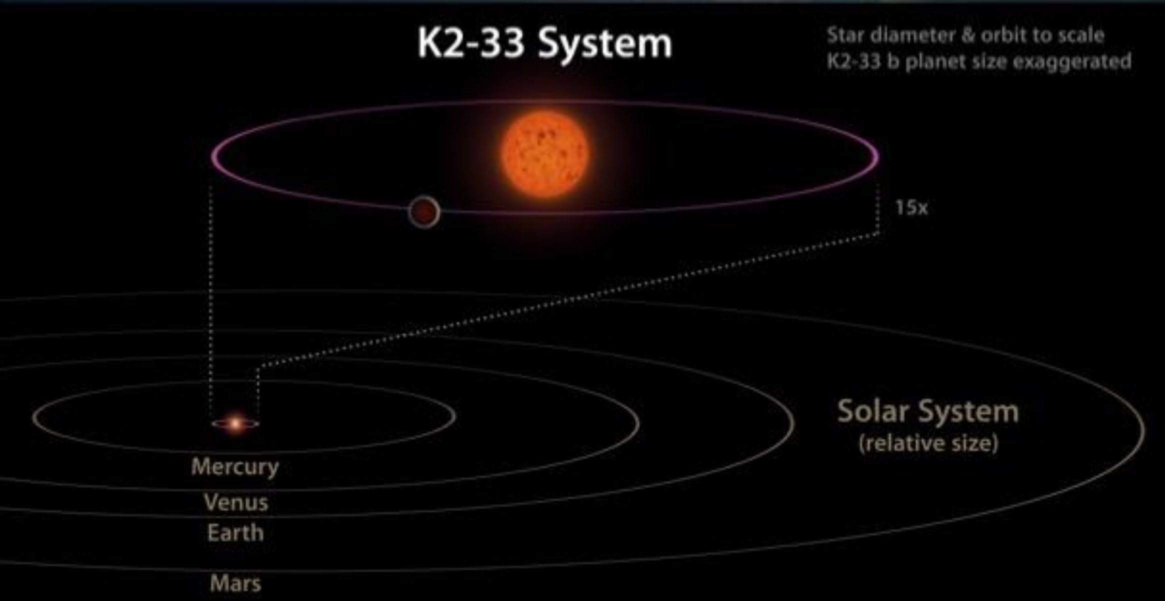
The Panoramic Survey Telescope & Rapid Response System (Pan-STARRS 1) on Maui.

Plot of the librating orbit of 2016 HO_3 over 60 years (1960-2020) relative to the Earth, presented in a rotating frame centered on the Earth and projected onto the ecliptic plane. From this perspective, this near-Earth asteroid appears to orbit the Earth; however, it actually orbits the Sun on a path very close to the Earth's. 2016 HO_3 never approaches closer than 14 million km nor ventures further than 40 million km away. It takes the Earth 365.24 days to orbit the Sun. 2016 HO_3 makes one circuit in 365.93 days (just 16-½ hours longer than Earth). In terms of Δv [the energy required to launch and rendevous a spacecraft], 2016 HO_3 might make an interesting target to visit, as it is accessible every year at less than 7 km/sec despite a 7.7°inclination with respect to the ecliptic.



Newborn Exoplanet Found Around a Young Star

Published in the June 20, 2016 edition of the journal Nature.



This image shows the K2-33 system, and its planet K2-33b, compared to our own solar system. The planet has a five-day orbit, whereas Mercury orbits our sun in 88 days.
Credits: NASA/JPL-Caltech

- Astronomers have discovered the youngest fully formed exoplanet ever detected. The discovery was made using NASA's Kepler Space Telescope and its extended K2 mission, as well as the W. M. Keck Observatory on Mauna Kea, Hawaii.
- The newfound planet, K2-33b, is a bit larger than Neptune and whips tightly around its star every five days. It is only 5 to 10 million years old, making it one of a very few newborn planets found to date.
- Planet formation is a complex and tumultuous process that remains shrouded in mystery. Astronomers have discovered and confirmed roughly 3,000 exoplanets so far; however, nearly all of them are hosted by middle-aged stars, with ages of a billion years or more.
- The first signals of the planet's existence were measured by Kepler. The telescope's camera detected a periodic dimming of the light emitted by the planet's host star, a sign that an orbiting planet could be regularly passing in front of the star and blocking the light. Data from the Keck Observatory validated that the dimming was indeed caused by a planet, and also helped confirm its youthful age.
- Infrared measurements from NASA's Spitzer Space Telescope showed that the system's star is surrounded by a thin disk of planetary debris, indicating that its planet-formation phase is wrapping up. Planets form out of thick disks of gas and dust, called protoplanetary disks, that surround young stars.
- A surprising feature in the discovery of K2-33b is how close the newborn planet lies to its star. The planet is nearly 10 times closer to its star than Mercury is to our sun, making it hot. While numerous older exoplanets have been found orbiting very tightly to their stars, astronomers have long struggled to understand how more massive planets like this one wind up in such small orbits. Some theories propose that it takes hundreds of millions of years to bring a planet from a more distant orbit into a close one -- and therefore cannot explain K2-33b, which is quite a bit younger.
- The science team says there are two main theories that may explain how K2-33b wound up so close to its star. It could have migrated there in a process called disk migration that takes hundreds of thousands of years. Or, the planet could have formed "in situ" -- right where it is. The discovery of K2-33b therefore gives theorists a new data point to ponder.

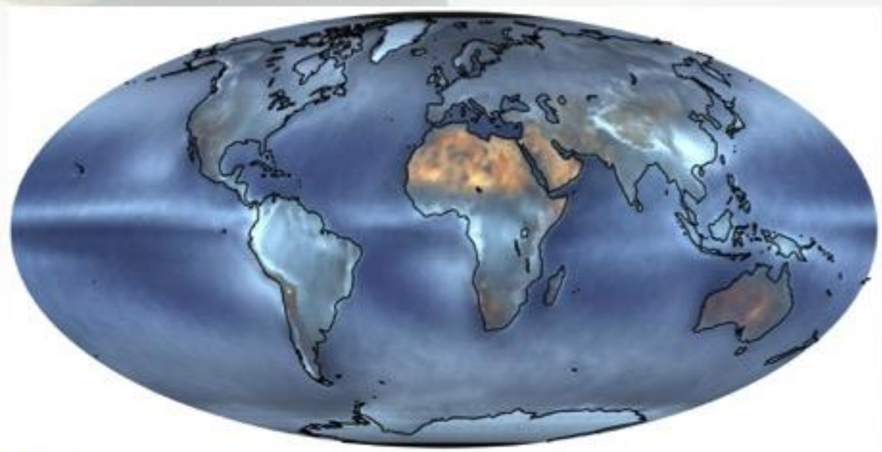
Regional Changes in Earth's Color and Texture as Observed From Space Over a 15-Year Period

Zhao, G., Di Girolamo, L., Diner, D. J., Bruegge, C. J., Mueller, K. J., & Wu, D. L| EEE Transactions on Geoscience and Remote Sensing | June 2016 | doi: 10.1109/TGRS.2016.2538723

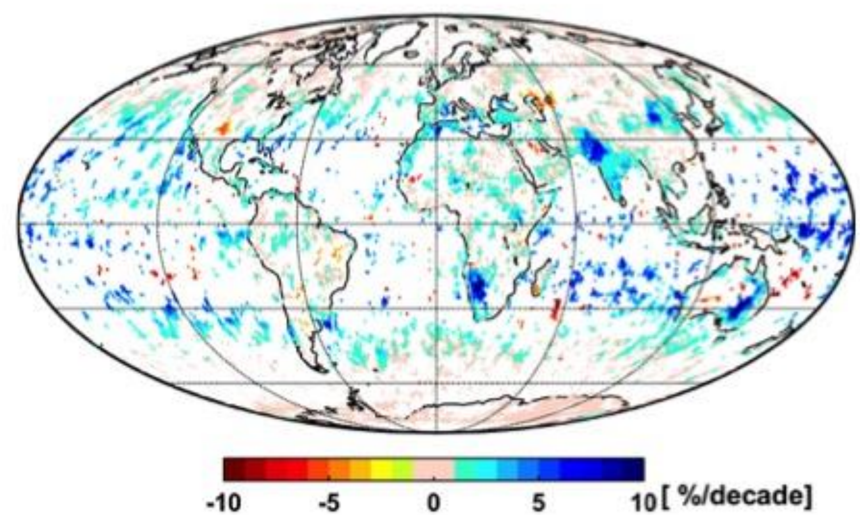
JPL scientists and collaborators identified statistically significant trends in the color and spatial texture of the Earth as viewed from multiple directions from NASA's Multi-angle Imaging SpectroRadiometer (MISR), which has been sampling the angular distribution of scattered sunlight (radiance) since 2000. Since MISR observes scattered sunlight in narrow spectral bands where gaseous absorption is small, the observed changes in the Earth's color and texture must be a direct result of changes in cloud, aerosol, or the surface.

Globally, the study results show that the Earth has been appearing relatively bluer from the nadir view and bluer and smoother from the oblique views over the past 15 years, while large regional shifts in color and texture at 1◦×1◦ lat/lon resolution are observed, particularly over polar regions, along the boundaries of the subtropical highs, the tropical western Pacific, Southwestern Asia, Arabia, and Australia. While the global blueing trends border upon the upper bound in band-relative stability of the MISR instrument, the study demonstrates that the large regional trends cannot be explained either by uncertainties in radiometric calibration or variability in total or spectral solar irradiance. They reflect changes internal to the Earth's climate system and include natural and/or anthropogenic variability in the Earth's atmospheric and/or surface properties. Some regional trends in color and texture are consistent with trends in other derived satellite products (i.e., surface albedo, cloud fraction, and aerosol optical depth).

Below: RGB composite image generated using the mean radiance averaged between May 2000 - December 2014 of blue, green, and red bands for the MISR Nadir Camera.



Below: Global distribution of trends of the difference in scaled radiance anomalies between blue and red bands for the Nadir camera.



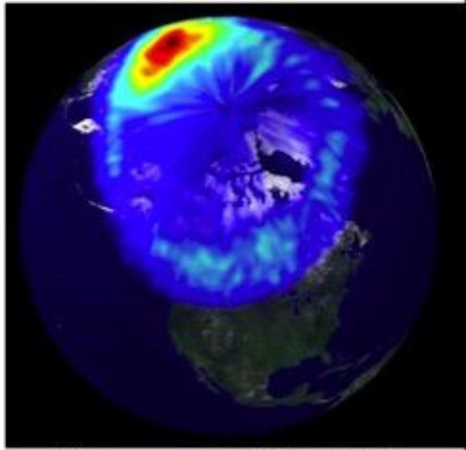
How Auroras on Jupiter Provide an Interdisciplinary Lens to Investigate Heliophysics Science

Kimura, T., R. P. Kraft, R. F. Elsner, G. Branduardi-Raymont, G. R. Gladstone, C. Tao, K. Yoshioka, G. Murakami, A. Yamazaki, F. Tsuchiya, et al. (2016), JUPITER'S X-RAY AND EUV AURORAS MONITORED BY CHANDRA, XMM-NEWTON, AND HISAKI SATELLITE. J. Geophys. Res. Space Physics. 121, 2308–2320. doi:10.1002/2015JA021893.

New images taken by the Hubble Space Telescope reveal captivating ultraviolet and x-ray auroras on Jupiter, which span an area larger than the size of our entire planet. Internal and external plasma sources enter into both Earth's and Jupiter's upper atmospheres and interact with each planet's magnetic fields to produce auroras. How these auroras are created varies greatly based on each planet's atmospheric composition, internal magnetic field strength and the collision chemistry between incoming plasma particles and the particles in each planet's atmosphere. Studying the two systems and applying what we know from one system to another can help us understand more about the strength of each auroral source. Investigating scientific mysteries through an interdisciplinary lens helps us see science from a whole systems approach, which in turn gives us important information about our own Earth-based systems.

On both Earth and Jupiter, auroras are created when high-speed plasma particles (electrons and ions), found in plasma streaming along the planet's magnetic fields, collide with atoms and molecules in each planet's atmosphere. The area influenced by each planet's magnetic field, or magnetosphere, acts as an invisible shield that protects it from the solar wind, the continuous stream of charged particles flowing out from the sun. The solar wind interacts with the magnetosphere by populating it with charged particles and energizing it, accelerating the co-mingled magnetospheric and solar wind particles to such an extent that they precipitate down into a planet's atmosphere. These particles are funneled down by way of the magnetic North and South Poles, which is why auroras are predominately visible in these areas. What we observe as auroras occur after the plasma particles collide with atmospheric particles, and energized photons in the form of light are released as they return to their normal states. Aurora are created by the interaction between the solar wind and the magnetosphere, as well as by magnetospheric processes. Jupiter's moons also contribute to the formation of its auroras, especially its volcanic moon, Io.

Although auroras occur on both our home planet and Jupiter, Jupiter's auroras are hundreds of times more powerful than ours and as such are not visible to the naked eye as they lie in the UV and x-ray portions of the light spectrum. The brilliant auroral displays in Jupiter's atmosphere observed by NASA satellites are a result of incoming oxygen and sulfur ions, moving at nearly the speed of light. Scientists from JAXA wanted to know why these ions moved so fast. They used data collected from NASA's Chandra X-Ray Observatory and concluded that the solar wind contributed to the fast acceleration of these ions, causing them to appear in the x-ray spectrum. On Earth we are able to monitor the solar wind and magnetosphere to study what causes auroras thanks to missions within the Heliophysics System Observatory, such as the ACE, Magnetospheric Multi-Scale (MMS), Van Allen Probes, THEMIS missions. Our understanding from the Heliophysics Systems Observatory helps support the Planetary Science Division's Juno Mission, which successfully entered Jovian orbit on Independence Day of this year, to better compare and contrast the magnetospheric and atmospheric interactions on both planets.



Top left image credit: NASA Hubble Space Telescope. Above image credit: NASA Heliophysics Polar mission (2000) .

As different as our two planetary bodies are, observing the brilliant and beautiful auroras on Jupiter is a reminder of something we enjoy and admire here on Earth. Something we can learn from and something that connects us back home.

Shareables: Explorers Wanted Posters Imagining the Future of Mars Exploration

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