Science Mission Directorate

Weekly Highlights

December 16, 2016

The Cyclone Global Navigation Satellite System (CYGNSS) Successfully Launched!

http://www.nasa.gov/cygnss

A constellation of eight microsatellites, called NASA's Cyclone Global Navigation Satellite System mission, or CYGNSS, got a boost into Earth orbit at 8:37 a.m. EST Dec. 15, 2016, aboard an Orbital ATK Pegasus XL rocket. The unique, air-launched vehicle was carried aloft by Orbital's modified L-1011 aircraft, "Stargazer," which took off from the Skid Strip runway at Cape Canaveral Air Force Station in Florida and deployed the three-stage Pegasus XL rocket at a predetermined drop point 39,000 feet above the Atlantic Ocean and about 110 nautical miles east-northeast of Daytona Beach.
NASA's F-18 support aircraft was used to provide live coverage of the Orbital ATK L-1011 air-launch of its Pegasus XL rocket carrying CYGNSS.

Above: View of NASA's CYGNSS Hurricane Mission Launch From Chase Plane. This photo was taken as the AFRC F-18 chased Orbital's L-1011 carrier aircraft.

Above: Flying over the Atlantic Ocean offshore from Daytona Beach, Florida, a Pegasus XL rocket with eight Cyclone Global Navigation Satellite System, or CYGNSS, spacecraft is released from the Orbital ATK L-1011 Stargazer aircraft

The CYGNSS mission will use eight micro-satellites to measure wind speeds over Earth's oceans, increasing the ability of scientists to understand and predict hurricanes. Each satellite will take information based on the signals from four GPS satellites.

The use of eight satellites will also increase the area on Earth that can be measured. The instruments will be deployed separately around the planet, with successive satellites passing over the same region every 12 minutes. As the CYGNSS and GPS constellations move around the earth, the interaction of the two systems will result in a new image of wind speed over the entire tropics every few hours, compared to every few days for a single satellite.

Spinning Black Hole Swallowing Star Explains Superluminous Event

Published in the December 12, 2016 issue of Nature Astronomy

Artist's Impression: ESA/Hubble, ESO, M. Kornmesser

The rapidly spinning supermassive black hole has changed its shape into an oblate sphere, It bends the light from stars and the gas behind it. The gravitational pull rips the star apart.

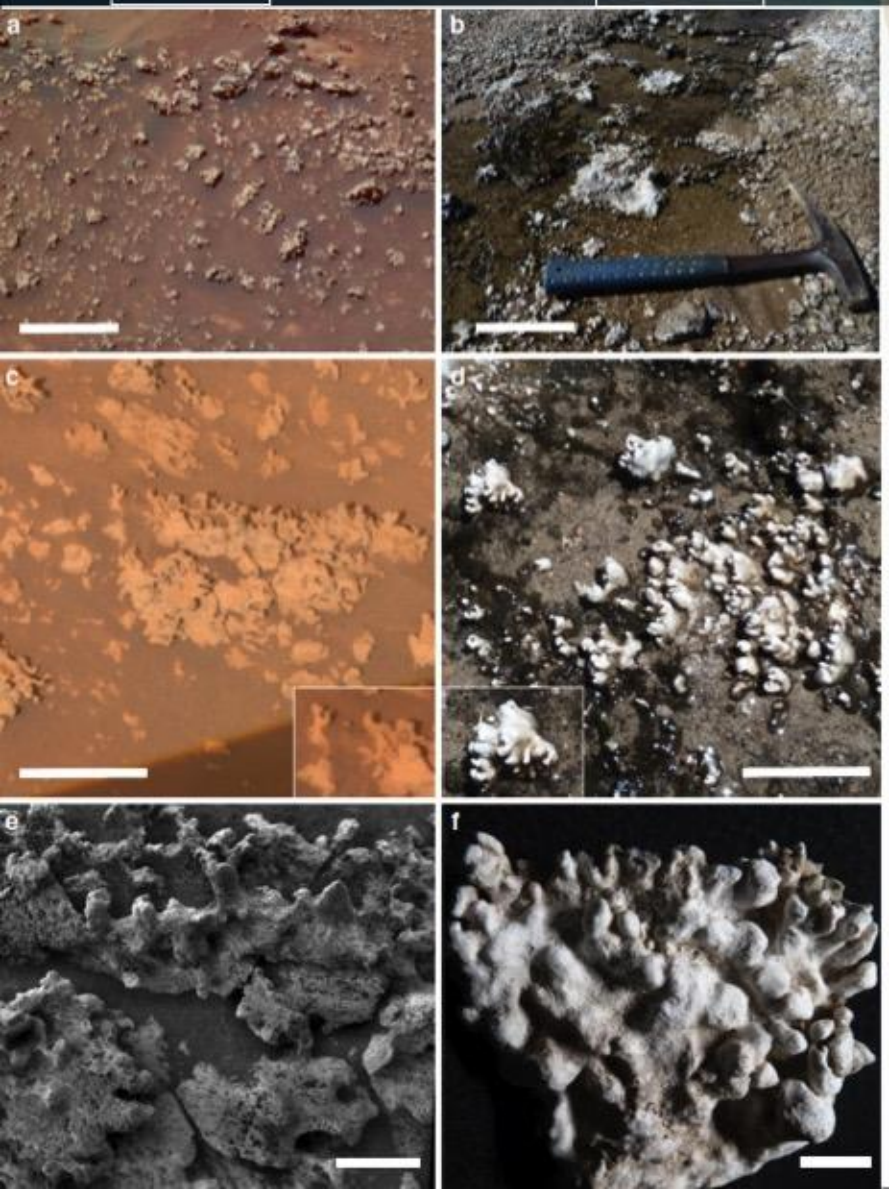
- An extraordinarily brilliant point of light seen in a distant galaxy was thought to be the brightest supernova ever seen. But new observations have now cast doubt on this classification. Instead, a group of astronomers propose that the source was an even more extreme and rare event — a rapidly spinning black hole ripping apart a passing star that came too close.
- In 2015, the All Sky Automated Survey for SuperNovae detected an event, named ASASSN-15lh, that was recorded as the brightest supernova ever — and categorized as a superluminous supernova, the explosion of an extremely massive star at the end of its life. It was twice as bright as the previous record holder, and at its peak was 20 times brighter than the total light output of the entire Milky Way.
- An international team has now made additional observations of the distant galaxy, ~4 billion light-years from Earth, and they have proposed a new explanation for this event. After observing the source for 10 month, scientists have concluded that the event was probably caused by a rapidly spinning supermassive black hole as it destroyed a low-mass star.
- The extreme gravitational forces of a supermassive black hole ripped apart a star that wandered too close — a so-called tidal disruption event, something so far only observed about 10 times. In the process, the star was "spaghettified" and shocks in the colliding debris as well as heat generated in accretion led to a burst of light. This gave the event the appearance of a very bright supernova explosion, even though the star would not have become a supernova on its own as it did not have enough mass.
- The team based their new conclusions on observations from multiple ground and space telescopes including: NASA's Hubble Space Telescope, the Very Large Telescope at ESO's Paranal Observatory, the New Technology Telescope at ESO's La Silla Observatory, NASA's Swift telescope, the Las Cumbres Observatory Global Telescope, the Australia Telescope Compact Array, ESA's XMM-Newton, the Wide-Field Spectrograph and the Magellan Telescope.
- The data revealed that the event went through three distinct phases during the follow-up observations. These data more closely resemble what is expected for a tidal disruption than a superluminous supernova. An observed re-brightening in ultraviolet light as well as a temperature increase further reduce the likelihood of a supernova event. Furthermore, the location of the event — a red, massive and passive galaxy — is not the usual home for a superluminous supernova explosion, which normally occur in blue, star-forming dwarf galaxies.
- The mass of the host galaxy implies that the supermassive black hole at its center has a mass of at least 100 million times that of the Sun. A black hole of this mass would normally be unable to disrupt stars outside of its event horizon. However, if the black hole is a particular kind that happens to be rapidly spinning — a so-called Kerr black hole — the situation changes and this limit no longer applies.

Text credit: ESA Hubble website.

Biosignatures in a Chilean Mars Analog

Mars

Earth



Similarities between features in a hot spring outflow channel in El Tatio, Chile and those identified in the 'Home Plate' feature in the Columbia Hills of Gusev crater suggest that this may be an good place to search for signs of life.

- The Atacama desert is considered a Mars analog, since it is very dry, gets very cold in the winter and at the very high elevation has a stronger UV flux than most surface locations on Earth.
- At El Tatio, microbes in the hot spring environment play a part in the creation of distinctive nodule-like features that are similar in morphology and scale to those seen on Mars (image at left, 'Home Plate' on left, El Tatio on right).
- Similar morphology does not necessarily require similar creation processes, however this research suggests that Columbia Hills may be a promising location to investigate further with the Mars 2020 rover, which has an excellent suite of instruments for detecting biosignatures.

Ruff and Farmer (2016). *Nature Communications*

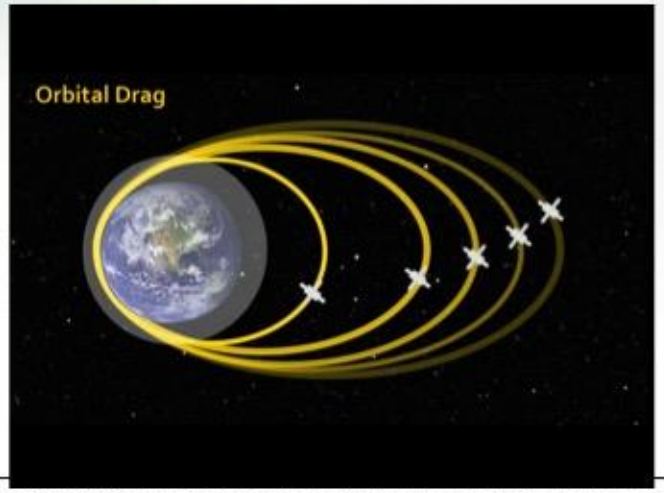
The Thermosphere Fights Back: TIMED Results Reveal Cooling Mechanism Affecting Orbital Drag

D. Knipp, et, al. The Thermosphere Fights Back: Sources of Nitric Oxide Cooling During Geomagnetic Storms (Fall AGU 2016). SA41C-02

In the quest to characterize our space environment both close to home and further away, NASA heliophysics missions provide key observations and research on the closest levels of near-Earth space: Earth's upper atmosphere as well as the charged particles making up Earth's ionosphere. Recent research has used decades of archival data to help improve our understanding of how this region can affect orbital decay.

This tenuous and ionized layer around Earth is our interface to space, combining facets of both outer space and our terrestrial atmosphere. It is where one can find radio waves, satellite signals, aurora, geostationary and other satellites, as well as the International Space Station. This region is also highly variable. It changes in response to a myriad of inputs from the sun, from Earth, and from atmospheric chemistry. In addition to interfering with radio communications and GPS signals, such changes can lead to issues with premature orbital decay: When the upper atmosphere swells, it can envelope satellites in denser material, leading to satellite drag. Correctly modeling satellite orbits, therefore, depends on accurate situational awareness of what drives change in this area.

The Heliophysics TIMED mission, which celebrated its 15th anniversary in orbit on Dec. 7, 2016, has been providing critical data on Earth's upper atmosphere since 2001. TIMED SABER data was used to analyze the effect of nitric oxide (NO) in the thermosphere during periods of intense expansion caused by geomagnetic storms. NO was already known to be a cooling agent that could cause swelling in the thermosphere to quickly reduce back to normal – or even further. By comparing over a decade of DoD satellites to the TIMED data, the researchers could correlate what kind of storms led to this overcooling reaction. Most surprisingly, the scientists discovered that the most energetic solar storms are likely to create more NO and provide a net cooling and shrinking effect on the upper atmosphere, rather than intense heating and expanding as previously understood. Learning more about how Earth's upper atmosphere functions during times of intense geomagnetic activity will help us better predict how satellite drag affects satellites in orbit.

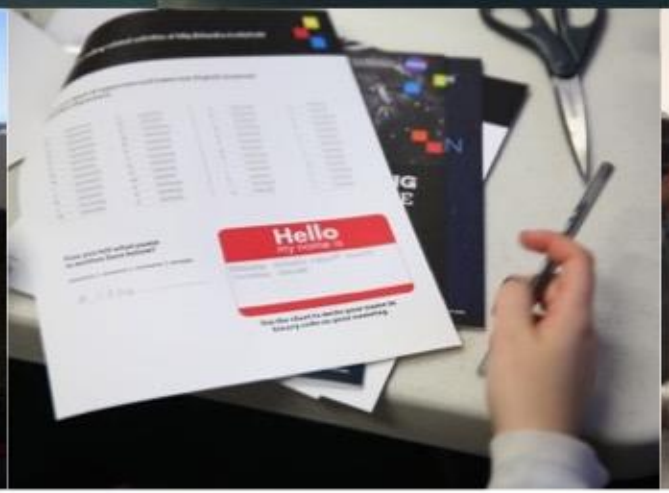


The swelling of Earth's upper atmosphere during geomagnetic storms can alter the orbits of satellites, bringing them lower and lower. Credit: NASA

In addition to making critical use of archival data, heliophysics continues to expand research into this closest region of Earth's space. The missions ICON and GOLD, launching in June and October of 2017, respectively, will provide new data on Earth's upper atmosphere by observing a phenomenon called airglow, which is light emitted by gas that has been excited or ionized by solar radiation. By taking simultaneous measurements of these charged and neutral particles, ICON will give scientists an unprecedented look at how Earth's upper atmosphere behaves and also how it interacts with Earth's terrestrial weather systems. GOLD will take many of the same measurements that ICON will but from a geostationary orbit, which will allow the instrument to observe an unprecedented near-global view of how the upper atmosphere changes.

This research was presented by scientists from NASA GSFC, the Catholic University of America, the University of Colorado Boulder, and the University of California, Berkeley at a press conference on the ionosphere at the Fall meeting of the American Geophysical Union on Dec. 14, 2016, in San Francisco, CA.

“How To Build the Milky Way” Workshop at the World Science Festival Academy in New York City



- On November 29, 2016, at the invitation of the World Science Festival Academy in New York City, Dr. Kim Arcand (Chandra X-ray Observatory/Smithsonian Astrophysical Observatory SAO) launched a pilot 3D modeling and printing workshop built around data-based 3D modeling of celestial objects being done at Chandra and Hubble
- Brian Greene opened the workshop with a demonstration & discussion of Einstein's general theory of relativity
- Dr. Arcand conducted a 90 minute workshop on topics of EMS, binary code, the Milky Way and stellar evolution
- Students looked at how 3D modeling helps scientists understand different objects in space, then used Computer-Aided Design (CAD) software to model & understand the life cycles of stars and galaxies
- Students also toured Columbia University's Maker Space
- Each received a 3D printed object they created in the workshop
- Eleven high school students, 2 educators, & 2 media members attended