National Aeronautics and
Space Administration

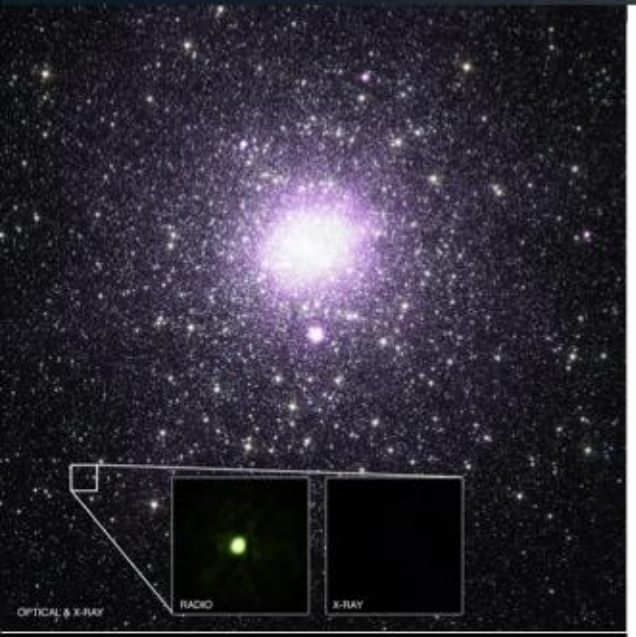
Science Mission Directorate

Weekly Highlights

July 1, 2016

Clandestine Black Hole May Represent New Population

These results appeared in the June 27, 2016 issue of The Astrophysical Journal.



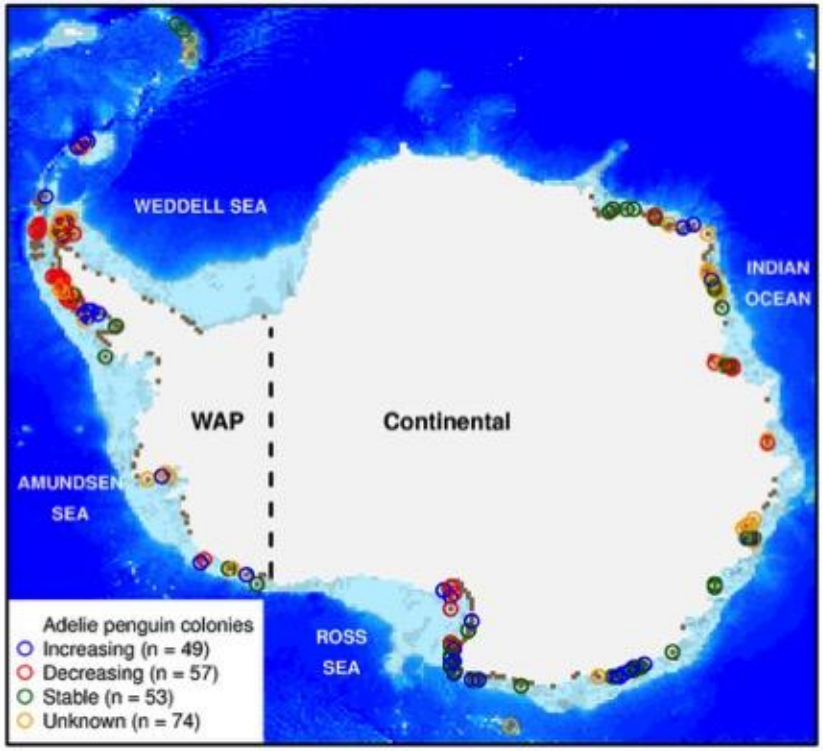
Credit: X-ray: NASA/CXC/Univ. of Alberta/B.Tetarenko et al; Optical: NASA/STScI; Radio: NSF/AUI/NRAO/ Curtin Univ./J. Miller-Jones

- Astronomers have identified the true nature of an unusual source in the Milky Way galaxy. This discovery implies that there could be a much larger number of black holes in the Galaxy that have previously been unaccounted for.
- The result was made by combining data from many different telescopes that detect various forms of light, each providing key pieces of information. These telescopes included NASA's Chandra X-ray Observatory, the Hubble Space Telescope, NSF's Karl G. Jansky Very Large Array (VLA), Green Bank Telescope, Arecibo Observatory, and the European Very Long Baseline Interferometry Network.
- The collaborative nature of this study is depicted in this multi-panel graphic. The large panel shows a composite Chandra and optical image of the globular cluster M15 located in our galaxy, where the X-ray data are purple and the optical data are red, green and blue. The source being studied here is bright in radio waves, as shown in the close-up VLA image, but the Chandra data reveal it can only be giving off a very small amount of X-rays.
- This new study indicates this source, called VLA J213002.08+120904 (VLA J2130+12 for short), contains a black hole a few times the mass of our Sun that is very slowly pulling in material from a companion star. At this feeding rate,
- VLA J2130+12 was not previously flagged as a black hole since it lacks some of the telltale signs that black holes in binary systems typically display.
- Previously, most astronomers thought that VLA J2130+12 was probably a distant galaxy. Precise measurements from the radio telescopes showed that this source was within our Galaxy and about five times closer to us than M15. Hubble data identified the companion star in VLA J2130+12 having only about one-tenth to one-fifth the mass of the Sun.
- The observed radio brightness and the limit on the X-ray brightness from Chandra allowed the researchers to rule out other possible interpretations, such as an ultra-cool dwarf star, a neutron star, or a white dwarf pulling material away from a companion star.
- Because this study only covered a very small patch of sky, the implication is that there should be many of these quiet black holes around the Milky Way. The estimates are that tens of thousands to millions of these black holes could exist within our Galaxy, about three to thousands of times as many as previous studies have suggested.

Projected Asymmetric Response of Adélie Penguins to Antarctic Climate Change

Megan A. Cimino, Heather J. Lynch, Vincent S. Saba & Matthew J. Oliver *| Nature Scientific Reports | June 2016 | doi: 10.1038/srep28785*

NASA-funded scientists used true presence-absence data on Adélie penguin breeding colonies to estimate past and future changes in habitat suitability across Antarctica during the chick-rearing period based on historic satellite observations and future climate model projections. During the contemporary period, declining Adélie penguin populations experienced more years with warm sea surface temperature compared to populations that are increasing. Based on this relationship, the scientists projected that one-third of current Adélie penguin colonies, representing ~20% of their current population, may be in decline by 2060. Climate model projections, however, suggest refugia may exist in continental Antarctica beyond 2099, buffering species-wide declines. The contribution of climate change to shifts in a species' geographic distribution is a critical and often unresolved ecological question. Climate change in Antarctica is asymmetric, with cooling in parts of the continent and warming along the West Antarctic Peninsula (WAP). Climate change impacts on penguins in the Antarctic will likely be highly site specific based on regional climate trends, and a southward contraction in the range of Adélie penguins is likely over the next century.



Climate change in Antarctica is asymmetric with cooling in parts of the continent and warming along the West Antarctic Peninsula (WAP). The Adélie penguin (Pygoscelis adeliae) is a circumpolar meso-predator exposed to the full range of Antarctic climate and is undergoing dramatic population shifts coincident with climate change.

Left: Adélie penguin breeding colonies and population status across Antarctica. Each colored circle represents a colonies' current population trend. The black dashed line separates West Antarctic Peninsula (WAP) from continental Adélie penguin colonies.

Heliophysics Mission Van Allen Probes What Have We Learned?

Kessel, M. (2016). THINGS WE DO NOT YET UNDERSTAND ABOUT SOLAR DRIVING OF THE RADIATION BELTS. *J. Geophys. Res.* 121 doi:10.1002/2016JA022472

Credits: JHU/APL

Our reach into space as a species isn't just about exploration and discovery anymore; we rely on communications infrastructure in near-Earth space to do a large variety of everyday activities from commuting to work to looking up dinner recipes. We need reliable space assets for GPS and communication; disturbances from potentially impactful events like solar storms could affect our satellite communications-based lifestyles in significant ways. Sun-Earth interactions directly impact the region of near-Earth space where our space assets reside, called the magnetosphere. The NASA Heliophysics Van Allen Probes Mission, launched in August of 2012, studies electron behavior in this region of near-Earth space through instruments aboard the mission with sensitivities we haven't seen before.

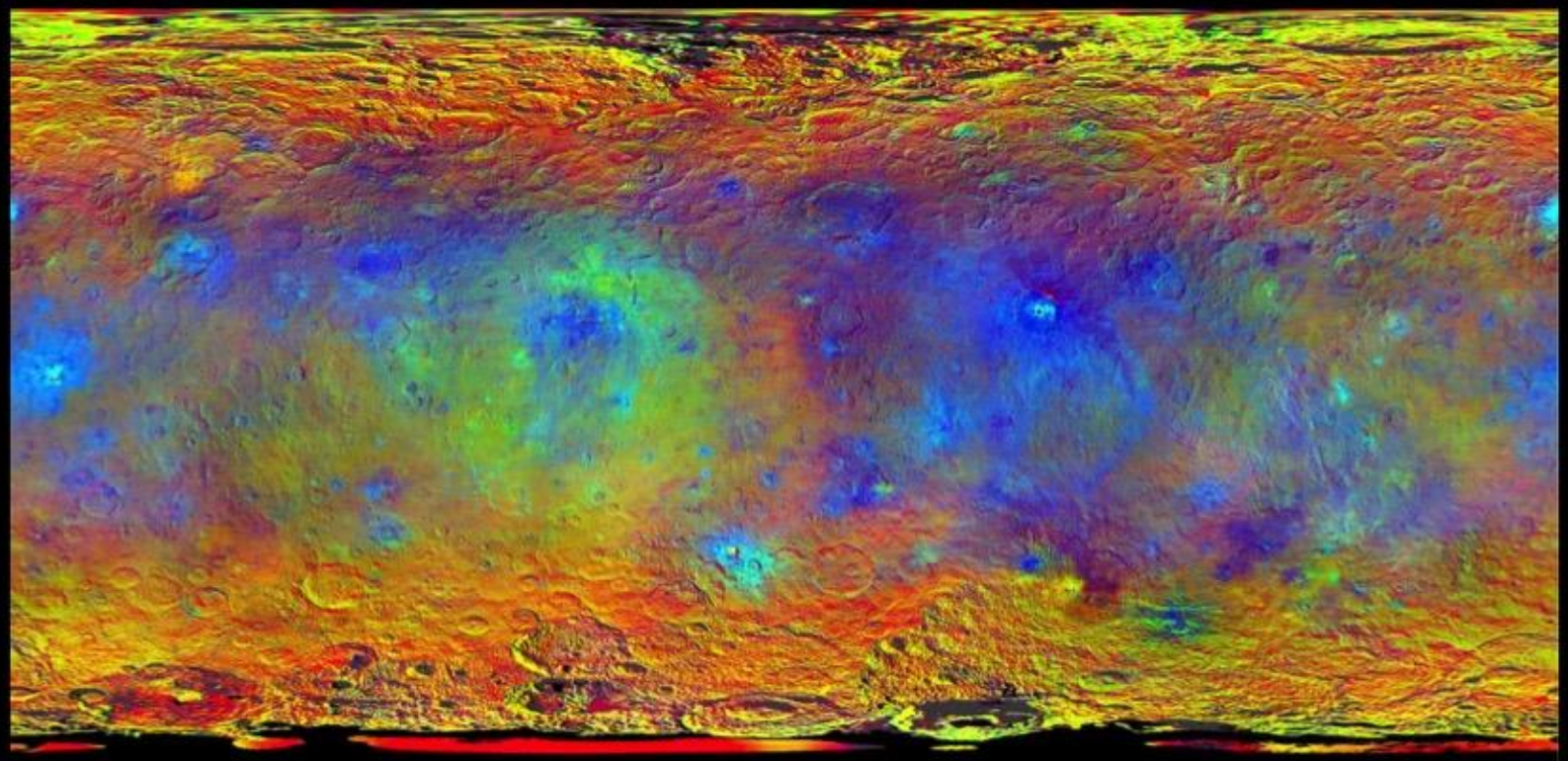
NASA HQ Heliophysics Program Scientist Mona Kessel recently published a commentary in the Journal of Geophysical Research outlining the science so far understood since the launch of the Van Allen Probes Mission:

- ✓ The sudden outward loss of high-energy electrons from the outer radiation belt (termed flux dropout) is usually preceded by sudden inward motion of the magnetopause due to large increases in solar wind pressure
- ✓ A pressure increase in the solar wind can come from Coronal Mass Ejections (CMEs) and High Speed Streams (HSS) from the sun, though these disturbances don't always cause electron loss from the magnetosphere
- ✓ The enhancement of electrons happens through inward radial diffusion by ultra-low-frequency (ULF) waves and also by the local acceleration of particles within the magnetosphere by higher frequency chorus waves. Both processes have been observed by the Van Allen Probes in the heart of the radiation belts
- ✓ The Van Allen Probes have found that outward loss across the magnetopause occurs for trapped electrons initially at greater than 4 Earth radii, as measured at the equatorial plane; for trapped electrons initially inside 4 Earth radii, particles are typically lost into the atmosphere
- ✓ Geomagnetic storms occur when the interplanetary magnetic field turns southward and Van Allen Probes data has shown us that electron loss and enhancement can be initiated by geomagnetic storms caused by solar wind events such as HSS, CMEs, and pressure increases

Although these advancements in our scientific understanding of electron behavior in Earth's magnetosphere are significant, we are still searching for information to help us better predict impactful Sun-Earth interactions. Kessel elaborates on using the flux dropout process, observed by Van Allen Probes, to further understand these important electron processes. Understanding the inward extent of flux dropouts within the magnetosphere may help us in predicting disturbances in ways previous models and research haven't. We do know that solar wind dynamic pressure and a southward pointing Interplanetary Magnetic Field play key roles in the causing flux dropouts.

More exploration and observation into the magnetosphere and electron processes is needed to help us better predict and prepare for Sun-Earth interactions that could affect us here on the ground and our communications assets in space.

Hints at Ceres' Composition from Color



- This view of Ceres was created from images taken by Dawn during its high-altitude mapping orbit, in August and September, 2015.
- Images taken using infrared, red and blue spectral filters were combined to create this false-color view.
  - Redder colors indicate places that reflect light strongly in the infrared, bluish colors indicate enhanced reflectivity at short (bluer) wavelengths; green indicates places where albedo, or overall brightness, is strongly enhanced.
- Once mapped to mineral spectra this map will provide valuable insights into the mineral composition of the surface, as well as the morphology and relative ages of features.

GLOBE Expedition in Antarctica

Laura Schetter, a teacher at Wildwood Academy in Maumee, Ohio, is now entering Global Learning and Observation to Benefit the Environment (GLOBE) data which was collected in Antarctica in March 2016. Ms. Schetter is sharing her experiences on the GLOBE blog. The expedition was part of the 2016 Foundation's Antarctic Expedition with Robert Swan (http://2041foundation.org/expeditions).

To collect water samples from Antarctica, Laura had to abide by the International Antarctic Treaty. She had to obtain a permit to use probes to collect data on water temperature, conductivity, pH, and nitrates. The National Science Foundation, US Environmental Protection Agency, and US Department of State granted her permission to test the water. With Antarctica designated as "a natural reserve, devoted to peace and science," 53 countries have agreed that no one owns Antarctica. In a spirit of international peace and science, leaving no trace, she collected water samples for 10 days: twice from shore, and 8 times from the ship.

Ms. Schetter thanks biologist, Fabrice Genevois (Quark Expeditions, University of Lyon, France), for his academic mentorship in sampling water. Continue reading: GLOBE Blog http://www.globe.gov/web/lauraschetter/blog

Laura Schetter has created a website entitled H2yOu Project (h2youproject.com), where students can share their story about what water is like where they live, after collecting GLOBE water data! Student story-telling adds a literacy layer to students' scientific research.

Fabrice Genevois & Laura Schetter

Whaler's Bay