National Aeronautics and
Space Administration

Science Mission Directorate

Weekly Highlights

May 6, 2016

Three NASA Heliophysics Missions will Observe a Rare Astronomical Event: A Mercury Transit on May 9th

Three NASA Heliophysics missions will observe a once-in-a-decade astronomical event, called a planetary transit, this Monday, May 9th. Mercury will pass between Earth and our home star, which only happens about 13 times a century. Although Mercury zooms around the sun every 88 days, Earth, the sun and Mercury rarely align. Mercury orbits in a plane that is tilted from Earth's orbit, meaning it usually moves above or below our line of sight to the sun. Mercury will appear as a tiny black dot as it glides in front of the sun's blazing disk over a period of seven and a half hours. Three NASA satellites will be providing images of the transit and one of them will have a near-live feed.

Credits: NASA

Mercury transits have been key to helping astronomers throughout history: In 1631, astronomers first observed a Mercury transit. Those observations allowed astronomers to measure the apparent size of Mercury's disk, as well as helped them estimate the distance from Earth to the sun.

Transits provide a great opportunity to study the way planets and stars move in space – information that has been used throughout the ages to better understand the solar system, and still helps scientists today calibrate their instruments. The utter darkness of the planet provides an opportunity to study effects on the observations of stray light within the instrument. The Earth-facing side of Mercury should appear black as it moves across the face of the sun. But because instruments scatter some light internally, Mercury will look slightly illuminated.

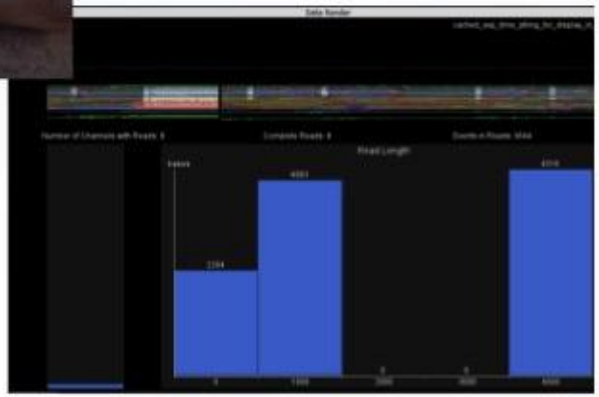
The instruments aboard the Solar Dynamics Observatory (SDO) and the SOlar and Heliophysics Observatory (SOHO) will take transit measurements that will help us to better determine the solar rotation axis. And, because scientists know so precisely where Mercury should be in relationship to the sun, these transit measurements will help scientists better align the instruments themselves as they can use the measurements as markers to fine tune exactly how their instruments should be pointed. Two of the twelve instruments aboard SOHO —– the Extreme ultraviolet Imaging Telescope and the Michelson Doppler Imager — will be brought back into full operation during the transit after five years of quiescence. Hinode, a collaboration between the space agencies of Japan, the United States, the United Kingdom and Europe led by the Japan Aerospace Exploration Agency, will also observe the transit.

For those of us down on the ground, it is worth trying to find a local astronomy club with a solar telescope to see if you can witness this rare event. Alternatively, a near-live feed of SDO images will be available at www.nasa.gov/transit.

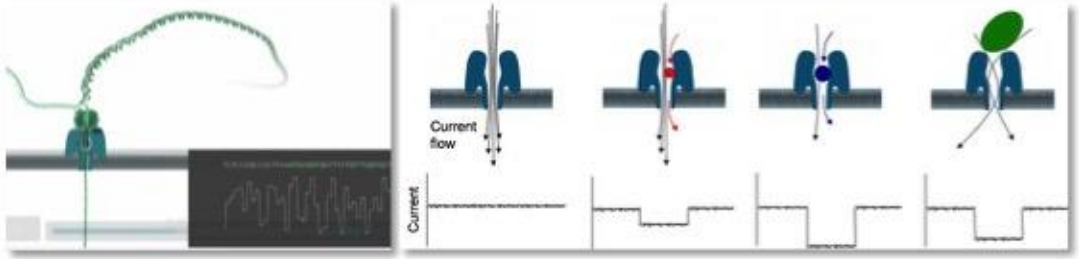
In-Situ Life and Biosignature Detection in the Atacama with the Nanopore MinION Sequencer

A new nanopore flow-cell technology has been demonstrated to identify DNA in situ in Atacama field testing and will later this year be deployed by ISS astronauts for on-orbit sequencing.

- The MinION is a novel, miniature, off-the-shelf instrument capable of detecting biological polymers such as DNA, RNA and proteins, without the need for bulky sequencing equipment, amplification (requiring selection and mixing of chemical solvents), or centrifuges.



Above - MinION in the halite field at the Yungay site in the Atacama Desert, Chile. Right – MinION field detection of DNA from Atacama halite sample, February 2016



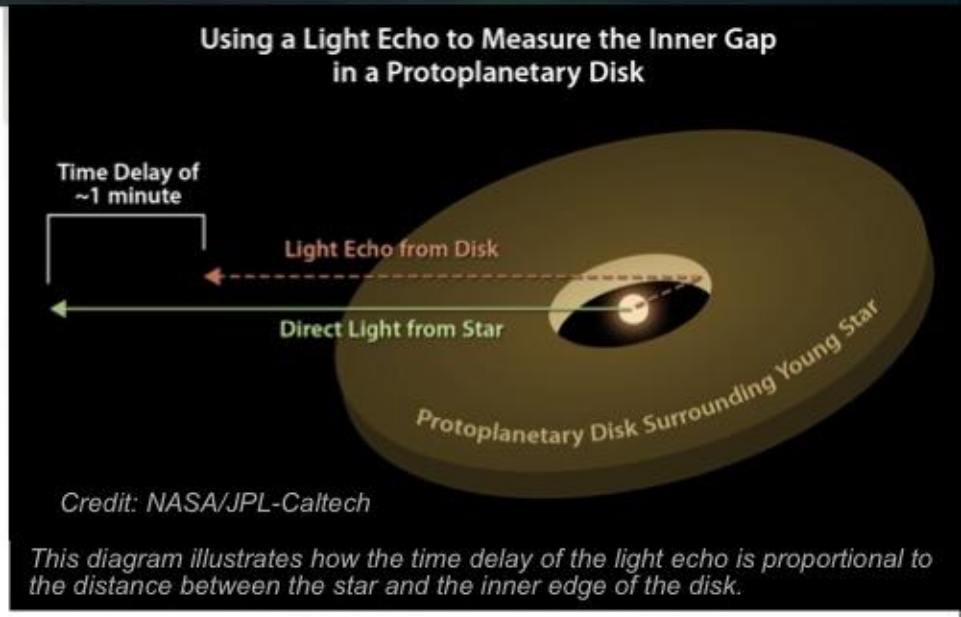
The MinION measures the changes in the current as a biomolecule passes through a protein nanopore, allowing the structural identification of DNA, RNA and proteins.

- The portable MinION device was designed by Oxford Nanopore Technologies and uses consumable flow cells that contain a sensor array of several hundred pores. For output, the devise plugs directly into a computer USB port.
- Preliminary opportunistic testing of a device in conjunction with PSTAR field deployment (ARADS, B. Glass) in Chile in February 2016 showed that the MinION can detect and sequence DNA in salt samples from the hyper-arid Atacama Desert.
- Additionally, groups from two NASA centers are collaborating to launch a MinION to the ISS in June.

Light Echoes Give Clues to Protoplanetary Disk

Accepted for publication in The Astrophysical Journal.

- Imagine you want to measure the size of a room, but it's completely dark. If you shout, you can tell if the space you're in is relatively big or small, depending on how long it takes to hear the echo after it bounces off the wall.
- Astronomers use this principle to study objects so distant they can't be seen as more than points. Researchers determined the distance from a star to the inner rim of its surrounding protoplanetary disk using a method called "photo-reverberation," also known as "light echoes."
- When the central star brightens, some of the light hits the surrounding disk, causing a delayed "echo." Scientists measured the time it took for light coming directly from the star to reach Earth, then waited for its echo to arrive.
- Scientists needed to find a star with variable emission -- that is, a star that emits radiation in an unpredictable, uneven manner. Young stars, which have variable emission, are the best candidates. The star used in this study is YLW 16B which lies about 400 light-years from Earth. YLW 16B has about the same mass as our sun, but is just one million years old.



This diagram illustrates how the time delay of the light echo is proportional to the distance between the star and the inner edge of the disk.

- Astronomers combined data from the Spitzer Space Telescope with observations from ground-based telescopes: the Mayall telescope at Kitt Peak National Observatory in Arizona; the SOAR and SMARTS telescopes in Chile; and the Harold L. Johnson telescope in Mexico.
- During two nights of observation, researchers saw consistent time lags between the stellar emissions and their echoes in the surrounding disk. The ground-based observatories detected the shorter-wavelength infrared light emitted directly from the star, and Spitzer observed the longer-wavelength infrared light from the disk's echo. Because of thick interstellar clouds that block the view from Earth, astronomers could not use visible light to monitor the star.
- Researchers then calculated how far this light must have traveled during that time lag: about 0.08 astronomical units. This was slightly smaller than previous estimates with indirect techniques, but consistent with theoretical expectations. Although this method did not directly measure the height of the disk, researchers were able to determine that the inner edge is relatively thick.
- The Spitzer study marks the first time the light echo method was used in the context of protoplanetary disks.

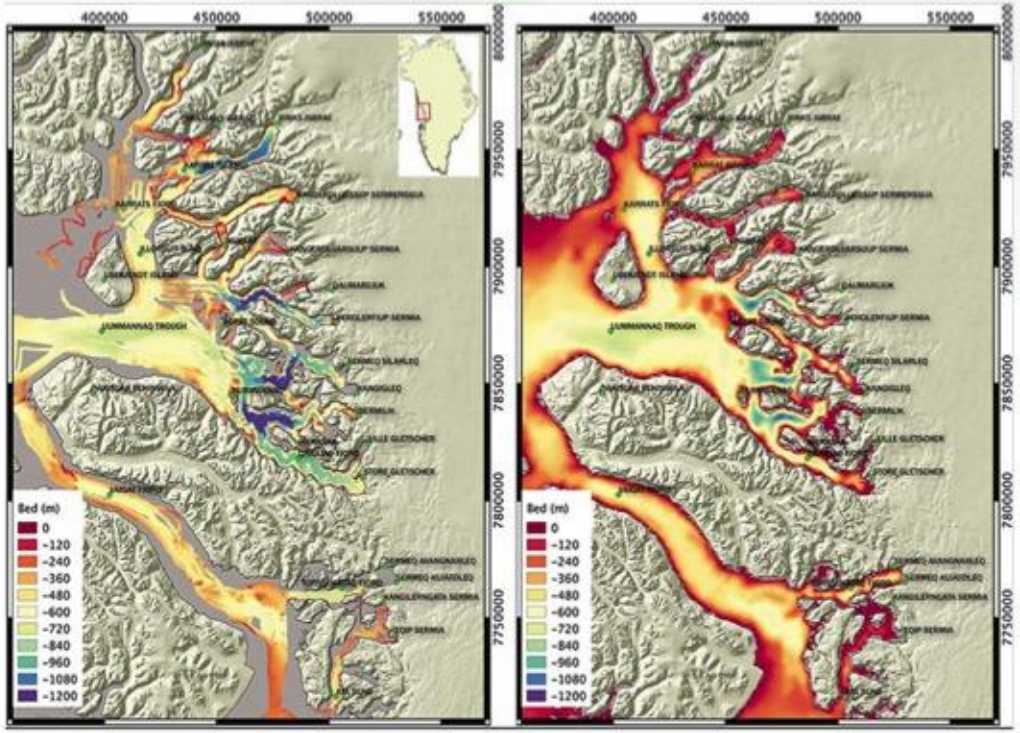
Bathymetry Data Reveal Glaciers Vulnerable to Ice-ocean Interaction in Uummannaq and Vaigat Glacial Fjords, West Greenland

E. Rignot, I. Fenty, Y. Xu, C. Cai, I. Velicogna, C. Ó Cofaigh, J. A. Dowdeswell, W. Weinrebe, G. Catania, and D. Duncan. *| Geophysical Research Letters| March 2016 | doi: 10.1002/2016GL067832*

NASA funded researchers and collaborators presented a multibeam echo sounding survey of 14 glacial fjords in the Uummannaq and Vaigat fjords, west Greenland, which extends from the continental shelf to the glacier fronts. This constitutes the first relatively complete bathymetry mapping of two large fjord systems in west Greenland, which host a number of major outlet glaciers that control nearly 10% of the ice sheet discharge. The data revealed valleys with shallow sills, overdeepenings (>1300 m) from glacial erosion, and seafloor depths 100–1000 m deeper than in existing charts. Where fjords are deep enough, the scientists detected the pervasive presence of warm, salty Atlantic Water (AW) (>2.5°C) with high melt potential, but they also found numerous glaciers grounded on shallow (<200 m) sills, standing in cold (<1°C) waters in otherwise deep fjords, i.e., with reduced melt potential. These results show that actual bathymetry is drastically different from existing charts, especially in the inner fjords which are typically 100 m to 1000 m deeper.

Marine-terminating glaciers play a critical role in controlling Greenland's ice sheet mass balance. Their frontal margins interact vigorously with the ocean, but our understanding of this interaction is limited, in part, by a lack of bathymetry data. Bathymetric observations extending to the glacier fronts are critical to understand the glacier evolution.

Left: The new maps show that the seafloor under Store Glacier is almost 2,000 feet deeper than previously thought.



Above: A comparison of the newly compiled map of the Uummannaq and Vaigat fjords (left) and an older map (right). Red areas indicate shallower depths, blues and purples deeper.

President Barack Obama as Science Channel's Guest Presenter Discusses Pollution Trends

- On April 12, 2016, President Obama appeared on the Science Channel and used multiple images from NASA's Aura and International Space Station missions to explain how pollution affects our planet

  "NASA's Aura satellite has been tracking global pollution transfer the past decade and its initial findings have shown us a lot about the state of our atmosphere."– President Obama

- Visualizations from Goddard's Scientific Visualization Studio (https://svs.gsfc.nasa.gov/index.html) and imagery from the International Space Station were featured
- To view video, see: http://www.sciencechannel.com/tv-shows/science-channel-presents/videos/president-obama-discusses-pollution-trends/