

National Aeronautics and
Space Administration



Science Mission Directorate

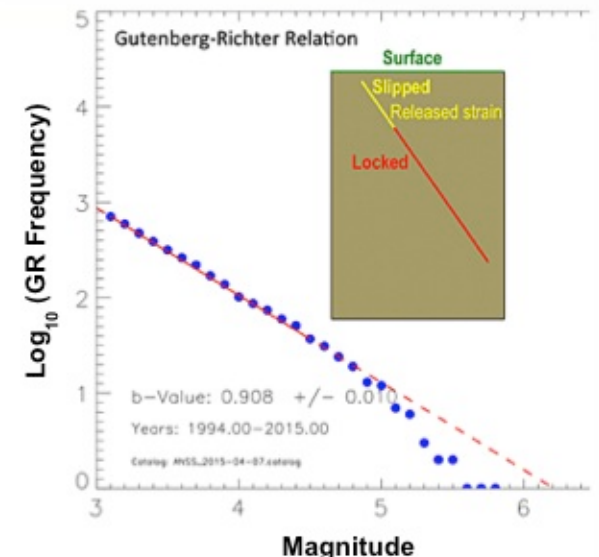
Weekly Highlights

October 23, 2015



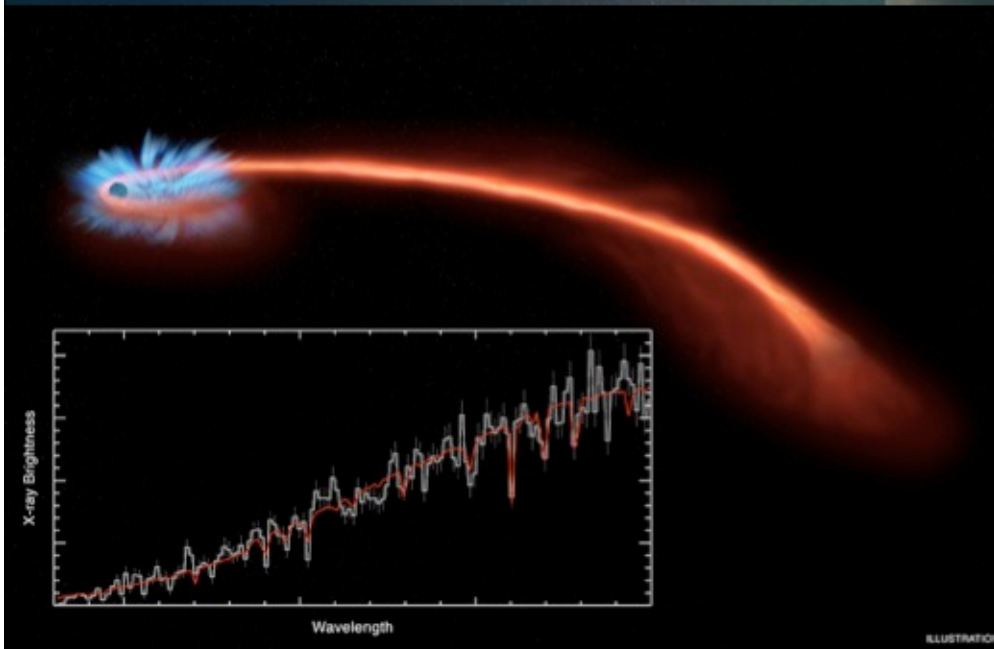
Donnellan, Andrea, Lisa Grant Ludwig, Jay W. Parker, John B. Rundle, Jun Wang, Marlon Pierce, Geoffrey Blewitt, and Scott Hensley | Earth and Space Science | OCTOBER 2015 | doi:10.1002/2015EA000113

Above: Displacements at the time of the La Habra earthquake for GPS stations within a 50 km radius of the epicenter. The M5.1 main shock, M4.1 aftershock, and M5.4 Chino Hills earthquake are noted by red circles around a black dot. **Right:** Gutenberg-Richter relation for a 100 km radius circle from the La Habra earthquake epicenter since the 1994 M6.7 Northridge earthquake.



ASASSn-14li: Destroyed Star Rains onto Black Hole, Winds Blow it Back

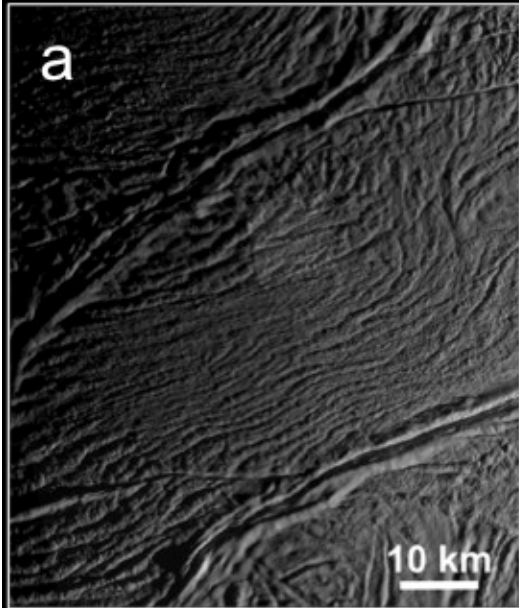
Published in the October 22, 2015 issue of Nature.



Credit: Spectrum: NASA/CXC/U.Michigan/J.Miller et al.; Illustration: NASA/CXC/M.Weiss

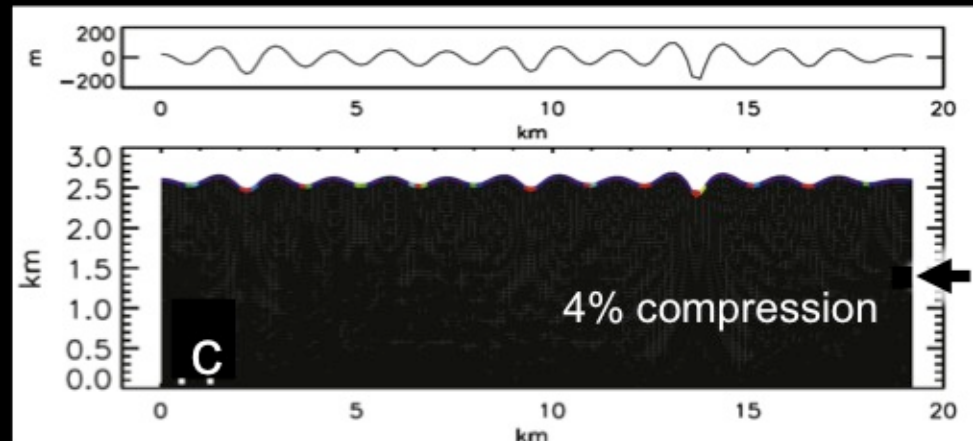
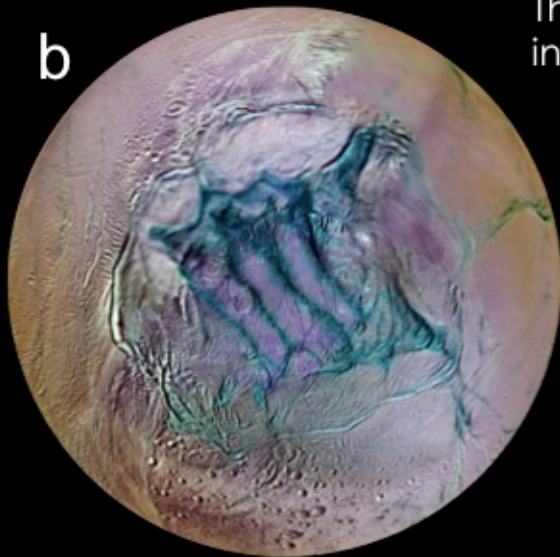
- Astronomers have observed material being blown away from a black hole after it tore a star apart. This event, known as a "tidal disruption," is depicted in the artist's illustration.
- Astronomers used a trio of X-ray telescopes - NASA's Chandra X-ray Observatory, Swift Gamma Ray Burst Explorer, and ESA's XMM-Newton - to observe a tidal disruption located in the center of a galaxy ~290 million light years away. This makes this tidal disruption, dubbed ASASSN-14li, the closest tidal disruption discovered in ten years. The event was discovered in an optical search by the All-Sky Automated Survey for Supernovae (ASAS-SN) in November 2014.
- Theory predicts that early in the evolution of a tidal disruption, material from the shredded star (the reddish-orange streak) should be pulled towards the black hole at a high rate, generating a huge amount of light. The amount of light should decline as the disrupted material falls onto the black hole, shown as the small black circle in the upper left of the illustration. Astronomers estimate the mass of the black hole is a few million times that of the Sun.
- Gas often falls toward black holes by spiraling inward in a disk. But how this process starts has remained a mystery. In ASASSN-14li, astronomers were able to witness the formation of such a disk by looking at the X-ray light at different wavelengths (known as the "X-ray spectrum") and tracking how that changed over time. The researchers determined that the observed X-rays come from material that is either very close to or is actually in the smallest possible stable orbit around the black hole.
- The illustration shows a disk of stellar debris around the black hole in the upper left of the illustration, and a long tail of debris that has been flung away from the black hole. The X-ray spectrum obtained with Chandra (seen in the inset box) and XMM-Newton both show clear evidence for absorption lines, i.e. dips in X-ray intensity over a narrow range of wavelengths. In an X-ray light version of the Doppler Shift, the absorption lines are shifted to bluer wavelengths than expected, giving evidence for a wind blowing towards us and away from the black hole.
- The presence of a wind moving away from the black hole is shown as the bluish white lines in the artist's illustration. The wind is not moving fast enough to escape the black hole's gravitational grasp. An alternative explanation for the relatively low speed is that gas from the disrupted star is following an elliptical orbit around the black hole and is observed at the greatest distance from the black hole where it is traveling the slowest. These results confirm recent theoretical predictions for the structure and evolution of tidal disruptions events.

Making Ropy Terrain at Enceladus' South Pole: High Heat Flow and Insulation Required

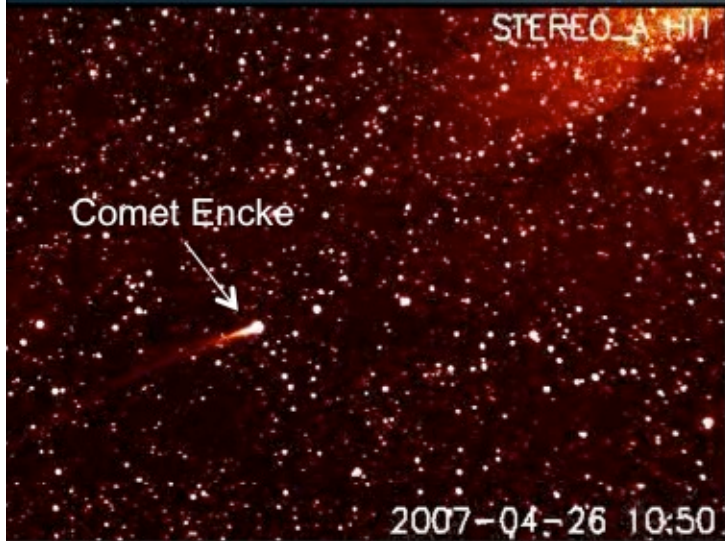


Enceladus' ropy or funiscular terrain is found between tiger stripes (panel a) and has been proposed to form by thin-skinned compression of viscous surface layer similar to "pahoehoe" lava.

- A closer examination of this hypothesis by numerical models (panel c) show that this works if surface ice is warm (>170 K) and heat flow high (100s of mW/m^2). These models would require insulating surface material; either material ejected by the plume falling back on the surface to a thickness of 1-10m or a layer of cracked, low-conductivity surface ice $> 50\text{m}$ thick. The source of the additional heat flow required for this model, however is unclear.
- An additional feature of this ropy terrain is its unusual color (panel b) shows false color of S. hemisphere from Cassini UV, green, and IR filters. The unique magenta color seen between the tiger stripes may be indicative that the heat flux in this region is currently elevated.



Comet Encke: A Solar Windsock Observed by NASA's STEREO



STEREO mission shows the motion of Comet Encke and its tail as it approached the sun in April 2007.
Credit: NASA/STEREO/HI.

- Much like the flapping of a windsock displays the quick changes in wind's speed and direction, called turbulence, comet tails can be used as probes of the solar wind – the constant flowing stream of material that leaves the sun in all directions. According to new studies of a comet tail observed by NASA's Solar and Terrestrial Relations Observatory, or STEREO, the vacuum of interplanetary space is filled with turbulence and swirling vortices similar to gusts of wind on Earth. Such turbulence can help explain two of the wind's most curious features: its variable nature and unexpectedly high temperatures.

- A recent study helped explain these characteristics using the heliospheric imager onboard STEREO. Scientists studied the movements of hundreds of dense chunks of glowing ionized gas within the ribbon of Comet Encke's tail, which passed within STEREO's field of view in 2007. Fluctuations in the solar wind are mirrored in what is seen in the tail, so by tracking these clumps, scientists were able to reconstruct the motion of the solar wind, catching an unprecedented look at the turbulence.

- The solar wind dominates the space environment within our solar system and travels well past Pluto, creating a huge bubble known as the heliosphere. Closer to home, the solar wind also interacts with Earth's magnetic field, sometimes initiating changes in near-Earth space that can disrupt our space technology or cause auroras. So scientists needed to come up with a way to observe something that's invisible—and that's where Comet Encke came in.

- Using the images from STEREO-A, scientists tracked 230 different features as they weaved through Comet Encke's tail over the course of about 9.3 million miles of its journey around the sun. They then compared these motions to how they would expect solid objects to orbit around the sun, finding evidence that these gas clumps were being picked up by drag against the solar wind. They found that, though the gas clumps moved more or less randomly on smaller scales, they exhibited clear patterns on the scale of about 300,000 miles, indicating large-scale swirling eddies are mixing the solar wind—and possibly heating it as well.

- These observations of the solar wind provide a preview of what NASA's Heliophysics Division plans to observe more directly with the Solar Probe Plus, or SPP, mission in 2018. SPP will travel to within nine solar radii of the sun, which is nine times the radius of the sun, or about 3.9 million miles.

2015 White House Astronomy Night

- On October 19, 2015, NASA and Science Mission Directorate leaders participated in Astronomy Night held at the White House and 80 additional locations across the U.S.
- This was the second event held during this Administration, with the first held in 2009
- President Obama addressed a crowd of over 300 students and other attendees
- 20 Telescopes, including those from the Goddard Astronomy Club and the Space Telescope Science Institute, were featured
- Other popular areas were the touchable lunar sample from Apollo 17 astronaut gloves, and a 3D printed Mars Curiosity rover

