National Aeronautics and
Space Administration

Science Mission Directorate

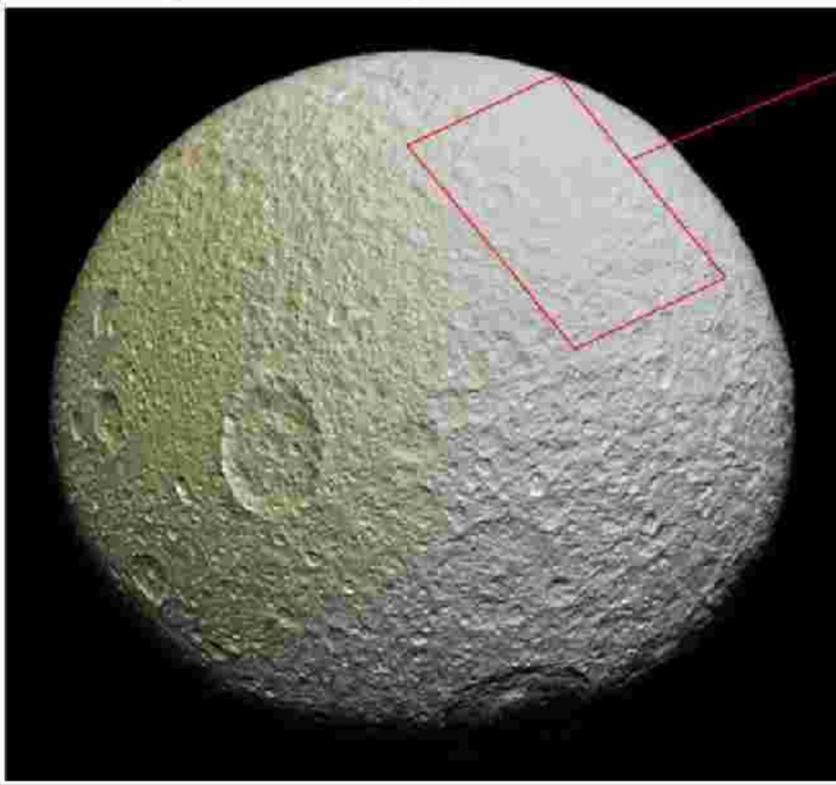
Weekly Highlights

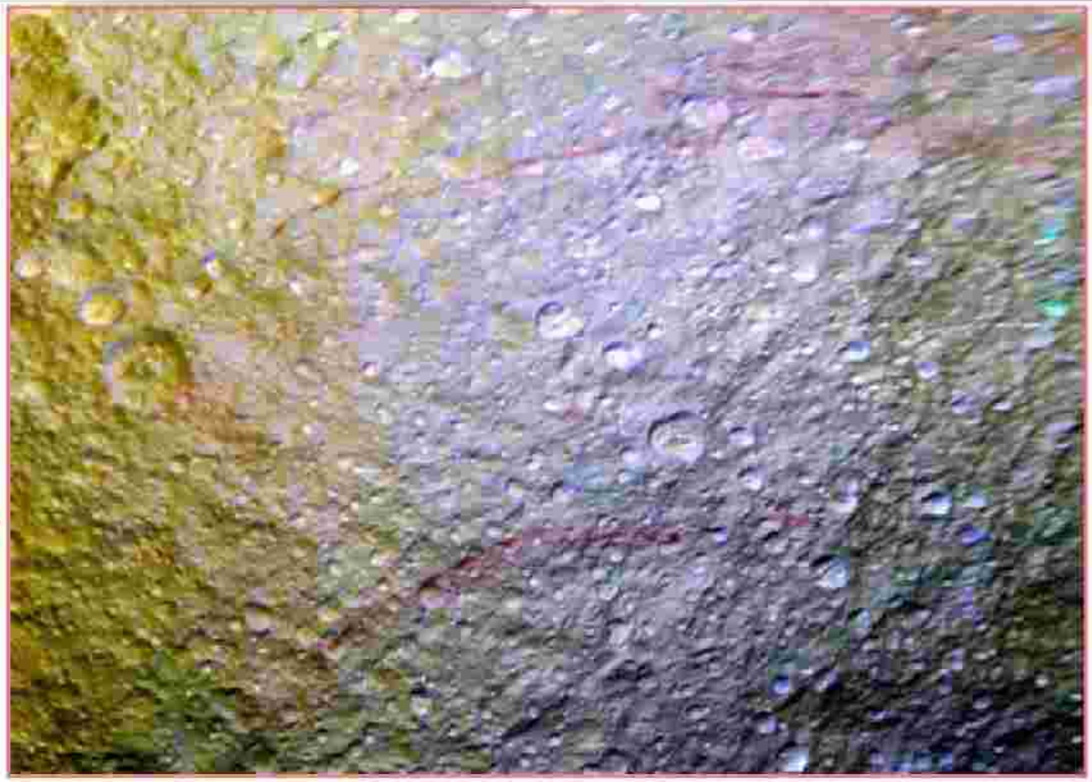
August 28, 2015

Mysterious Red Streaks on Tethys

Newly discovered red arcs on Saturn's moon Tethys are mystifying because they are not linked to any obvious geologic features.

- Reddish arcs are illustrated in this magnified, infrared-enhanced color image (right). The graffiti-like arcs were found in enhanced-color images taken by the Cassini spacecraft April 11, 2015. The next opportunity to observe them even closer will be November 11, 2015 during a 8,300 km flyby.





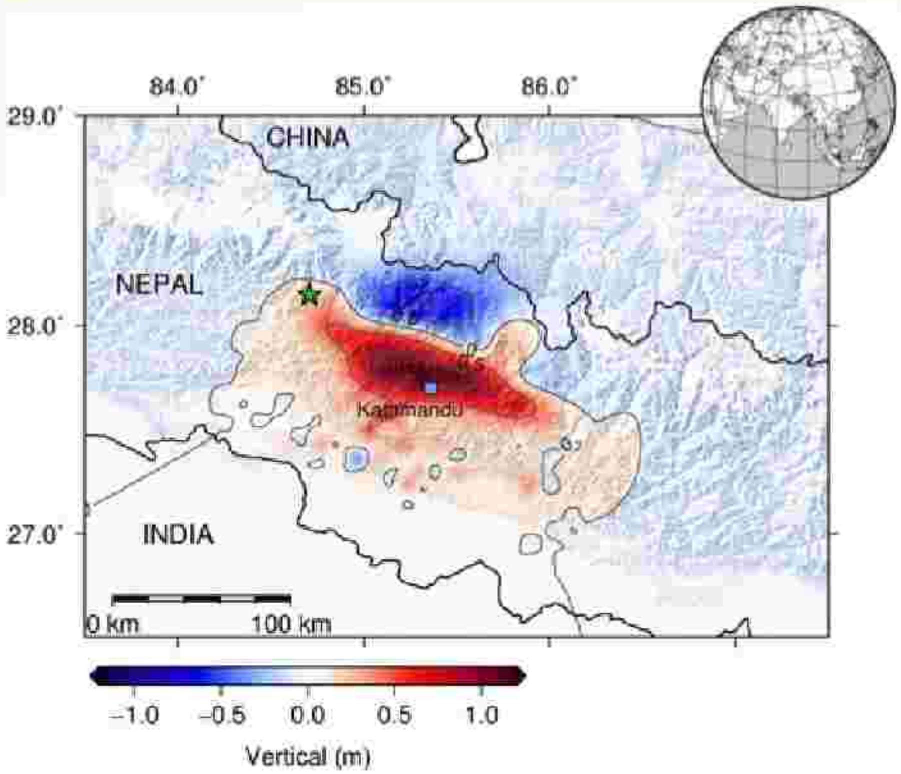
- In the enhanced-color image (left) one hemisphere is stained by Saturn's radiation belts while the other is spray-painted white by water ice particles orbiting the planet. The presence of the red streaks on the hemisphere coated by recent water-ice grains from Saturn's E ring suggests that the features are young or reddish material is being resupplied.
- The origin and composition of the red arcs are unknown, but may be analogous to the reddish-tinted bands observed on Jupiter's moon, Europa. On that moon, the red bands contain water ice mixed with salts and may be sourced from a subsurface ocean.

Slip Pulse and Resonance of Kathmandu Basin During the 2015 Mw 7.8 Gorkha Earthquake, Nepal Imaged with Geodesy

J. Galetzka, D. Melgar, J. F. Genrich, J. Geng, S. Owen, E. O. Lindsey, X. Xu, Y. Bock, J.-P. Avouac, L. B. Adhikari, B. N. Upreti, B. Pratt-Sitaula, T. N. Bhattarai, B. P. Sitaula, A. Moore, K. W. Hudnut, W. Szeliga, J. Normandeau, M. Fend, M. Flouzat, L. Bollinger, P. Shrestha, B. Koirala, U. Gautam, M. Bhatterai, R. Gupta, T. Kandel, C. Timsina, S. N. Sapkota, S. Rajaure, N. Maharjan | Science | AUGUST 2015 | doi: 10.1126/science.aac6383

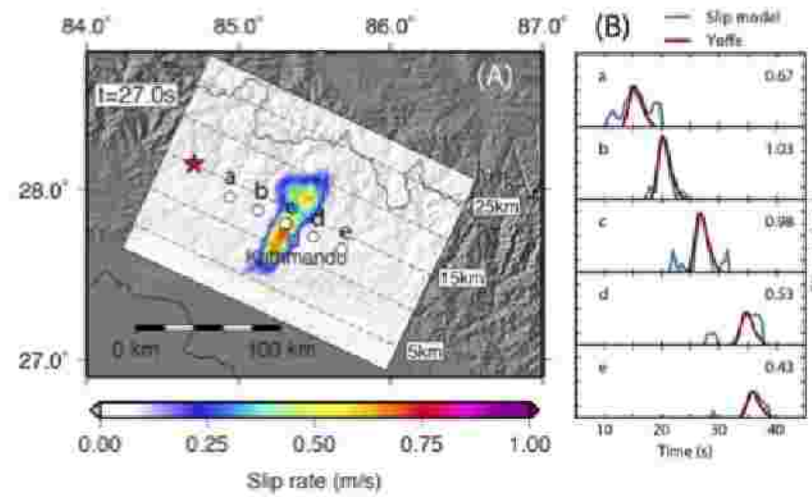
NASA scientists and collaborators used detailed geodetic imaging of earthquake rupture to enhance our understanding of earthquake physics and induced ground shaking. The April 25, 2015 Mw 7.8 Gorkha, Nepal earthquake is the first example of a large continental megathrust rupture beneath a high-rate (5 Hz) GPS network. The researchers used GPS and InSAR data (from PALSAR-2 on JAXA's ALOS-2) to model the earthquake rupture as a slip pulse of ~20 km width, ~6 s duration, and with peak sliding velocity of 1.1 m/s that propagated toward Kathmandu basin at ~3.3 km/s over ~140 km. The smooth slip onset, indicating a large ~5 m slip-weakening distance, caused moderate ground shaking at high >1Hz frequencies and limited damage to regular dwellings. Whole basin resonance at 4-5 s period caused collapse of tall structures, including cultural artifacts.

The shape of the slip-rate time function (STF) during seismic rupture provides critical information about the intensity of near-field ground motion. This study provides insight into the main factors that determined damage sustained during the Gorkha earthquake. While the hypocenter was ~80 km away from the city, the main asperity that radiated most of the energy was much closer, just north of the basin and at relatively shallow depth.



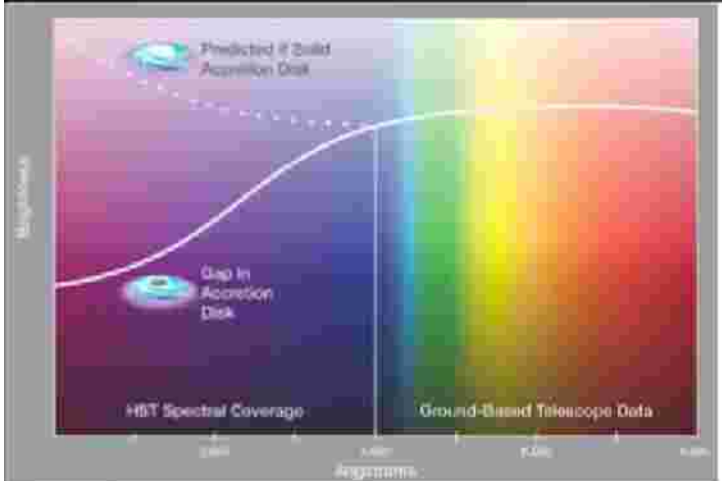
Left: Vertical ground displacements due to the Gorkha earthquake, predicted by the slip model in this paper. Contours are every 0.5 m.

Below: Slip pulse kinematics during the Gorkha earthquake. (A) Snapshot of slip rate on Main Himalayan Thrust at 27s after origin time during propagation of the seismic rupture from the model. The red star is the hypocenter and dashed lines represent the depth to the fault. The white circles are the centers of 5 subfaults used to compare against theoretical source time functions (STFs). (B) STFs at the 5 locations from (A). Plotted are the inverted slip rates. Time is relative to the hypocentral origin.



Hubble Finds That the Nearest Quasar is Powered by a Double Black Hole

Published in the August 14, 2015 edition of The Astrophysical Journal



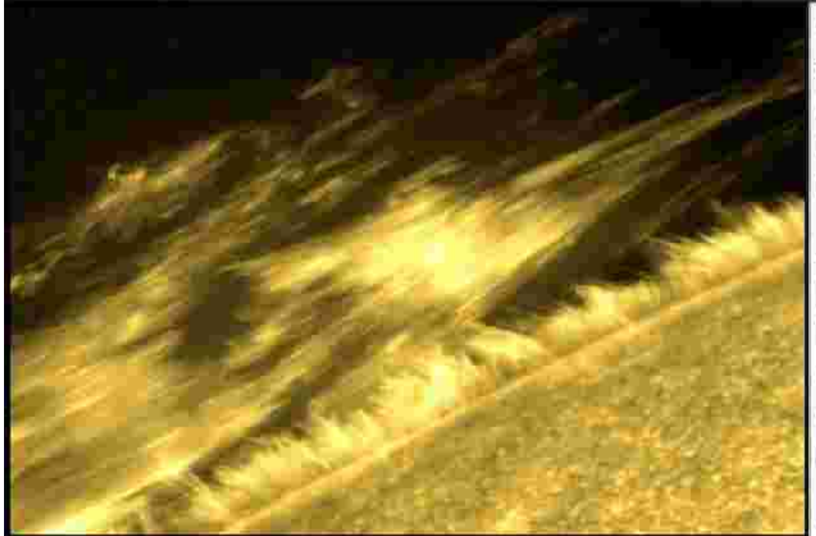
Credit: NASA, ESA, and P. Jeffries (STScI)

The above simplified spectral plot shows the radiation emitted from the center of Mrk 231. Visible and infrared light coming from a disk surrounding a central black hole in the middle of the galaxy is measured. The ultraviolet light from the disk shows a drop in radiation from the disk which is evidence for a large gap in the center of the disk that is likely carved out by a second black hole orbiting the primary black hole.

Credit: NASA, ESA, and G. Bacon (STScI)

- Astronomers using NASA's Hubble Space Telescope have found that Markarian 231 (Mrk 231), the nearest galaxy to Earth that hosts a quasar, is powered by two central black holes furiously whirling about each other. Mrk 231 is located 581 million light-years away.
- The finding suggests that quasars — the brilliant cores of active galaxies — may commonly host two central supermassive black holes that fall into orbit about one another as a result of the merger between two galaxies. Like a pair of whirling skaters, the black-hole duo generates tremendous amounts of energy that makes the core of the host galaxy outshine the glow of the galaxy's billions of stars.
- Scientists looked at Hubble archival observations of ultraviolet radiation emitted from the center of Mrk 231 to discover what they describe as "extreme and surprising properties."
- If only one black hole were present in the center of the quasar, the whole accretion disk made of surrounding hot gas would glow in ultraviolet rays. Instead, the ultraviolet glow of the dusty disk abruptly drops off towards the center. This provides observational evidence that the disk has a big donut hole encircling the central black hole. The best explanation for the observational data, based on dynamical models, is that the center of the disk is carved out by the action of two black holes orbiting each other. The second, smaller black hole orbits in the inner edge of the accretion disk, and has its own mini-disk with an ultraviolet glow.
- The central black hole is estimated to be 150 million times the mass of our sun, and the companion weighs in at 4 million solar masses. The dynamic duo completes an orbit around each other every 1.2 years.
- The lower-mass black hole is the remnant of a smaller galaxy that merged with Mrk 231. Evidence of a recent merger comes from the host galaxy's asymmetry, and the long tidal tails of young blue stars.
- The result of the merger has been to make Mrk 231 an energetic starburst galaxy with a star-formation rate 100 times greater than that of our Milky Way galaxy. The infalling gas fuels the black hole "engine," triggering outflows and gas turbulence that incites a firestorm of star birth.
- The binary black holes are predicted to spiral together and collide within a few hundred thousand years.

IRIS and Hinode Reveal Mechanisms of Coronal Heating



This image taken on Oct. 19, 2013, shows a filament on the sun – a giant ribbon of relatively cool solar material threading through the sun's atmosphere, the corona. The individual threads that make up the filament are clearly discernible. This image was captured by the Solar Optical Telescope onboard JAXA/NASA's Hinode solar observatory. Researchers studied this filament to learn more about how material is heated in the solar corona. Credits: JAXA/NASA/Hinode

- The sun produces energy by fusing hydrogen in its core, so the layers surrounding the core generally get cooler as you move outwards—with one exception. Two NASA missions have just made a significant step towards understanding why the corona—the outermost layer of the sun's atmosphere — is hundreds of times hotter than the lower photosphere, the sun's visible surface.

- Researchers have observed a long-hypothesized mechanism for coronal heating, in which magnetic waves are converted into heat energy. Past results have suggested that magnetic waves in the sun -- Alfvén waves – have enough energy to heat up the corona. The question has been how that energy is converted to heat. An essential part of this process is called resonant absorption has now been directly observed for the first time.

- Resonant absorption is a complicated wave process in which repeated waves add energy to the solar material, a charged gas known as plasma, the same way that a perfectly-timed repeated push on a swing can make it go higher. Resonant absorption has signatures that can be seen in material moving side to side and front to back. To see the full range of motions, the team used observations from NASA's Interface Region Imaging Spectrograph, or IRIS, and the Japan Aerospace Exploration Agency (JAXA) / NASA's Hinode solar observatory to successfully identify signatures of the process.

- The researchers then correlated the signatures to material being heated to nearly corona-level temperatures. These observations showed that a certain type of plasma wave was being converted into a more turbulent type of motion, leading to friction and electric currents, thus heating the solar material. The signatures of these motions appear in three dimensions, making them difficult to observe without the teamwork of several missions.

- Using plane-of-sky observations (measurements of motions that appear, from our perspective, to be up-and-down or side-to-side) from Hinode and line-of-sight observations (motions in the third dimension, toward and away from us) from IRIS, researchers observed material heating up in conjunction with the wave motions, further confirming that this process is related to heating in the solar atmosphere and concluding that resonant absorption is an excellent candidate for the role of an energy transport mechanism.

Fermi Gamma-Ray Space Telescope: "Build Your Own Pulsar Activity "

- Lynn Cominsky and Elizabeth Ferrara of Sonoma State University conducted the "build your own pulsar" activity with groups of visiting students during the International Astronomical Union (IAU) 2015 meeting in Honolulu, Hawaii, held August 3-14, 2015

- Students visited the NASA exhibit area during two scheduled sessions to make pulsar models out of batteries, light-emitting diode (LEDs) and modeling clay
- The activity was also featured on the local TV news