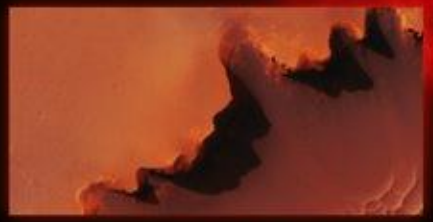
National Aeronautics and Space Administration

NASA Science

Weekly Highlights
October 25, 2013

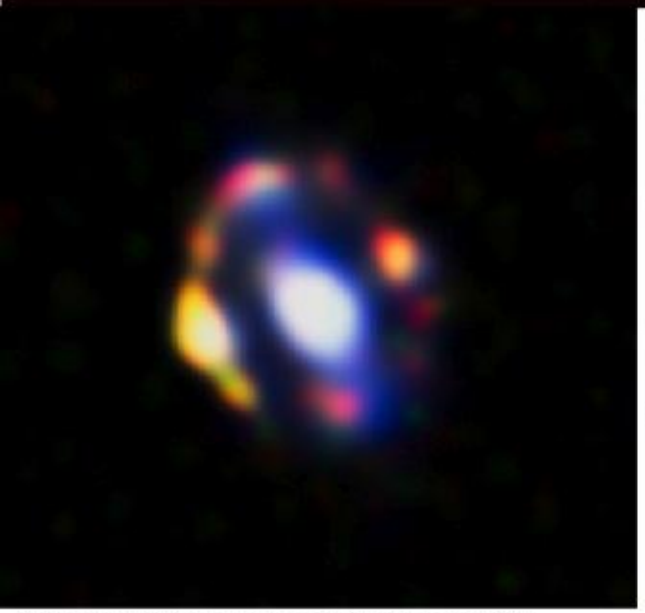

EARTH SCIENCE


HELIOPHYSICS


PLANETARY SCIENCE


ASTROPHYSICS

Most Distant Gravitational Lens

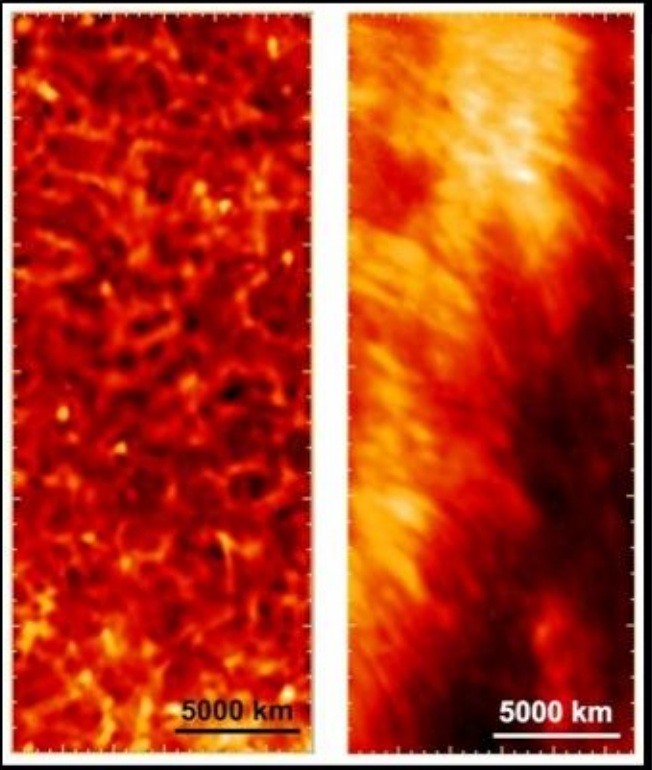


Credit: NASA, ESA, and A. van der Wel (Max Planck Institute for Astronomy)

An international team of astronomers, including several from the U.S., has found the most distant gravitational lens yet — a galaxy that deflects and intensifies the light of an even more distant object. The discovery provides a rare opportunity to directly measure the mass of a distant galaxy. But it also poses a mystery: lenses of this kind should be exceedingly rare.

- Gravitational lenses consist of two objects: one is further away and supplies the light, and the other, the lensing mass or gravitational lens, which sits between us and the distant light source, and whose gravity deflects the light. When the observer, the lens, and the distant light source are precisely aligned, the observer sees an Einstein ring: a perfect circle of light that is the projected and greatly magnified image of the distant light source.
- Now, astronomers have found the most distant gravitational lens yet. Lead author Arjen van der Wel (Max Planck Institute for Astronomy, Heidelberg, Germany) explains: "The discovery was completely by chance. I had been reviewing observations from an earlier project when I noticed a galaxy that was decidedly odd. It looked like an extremely young galaxy, but it seemed to be at a much larger distance than expected. It shouldn't even have been part of our observing programme!"
- Van der Wel wanted to find out more and started to study images taken with the Hubble Space Telescope as part of the CANDELS and COSMOS surveys. In these pictures the mystery object looked like an old galaxy, a plausible target for the original observing program, but with some irregular features which, he suspected, meant that he was looking at a gravitational lens. Combining the available images and removing the haze of the lensing galaxy's collection of stars, the result was very clear: an almost perfect Einstein ring, indicating a gravitational lens with very precise alignment of the lens and the background light source.
- The lensing mass is so distant that the light, after deflection, has travelled 9.4 billion years to reach us. Not only is this a new record, the object also serves an important purpose: the amount of distortion caused by the lensing galaxy allows a direct measurement of its mass. This provides an independent test for astronomers' usual methods of estimating distant galaxy masses — which rely on extrapolation from their nearby cousins. Fortunately for astronomers, their usual methods pass the test.
- But the discovery also poses a puzzle. Gravitational lenses are the result of a chance alignment. In this case, the alignment is very precise. To make matters worse, the magnified object is a starbursting dwarf galaxy: a comparatively light galaxy (it has only about 100 million solar masses in the form of stars), but extremely young (about 10-40 million years old) and producing new stars at an enormous rate. The chances that such a peculiar galaxy would be gravitationally lensed is very small. Yet this is the second starbursting dwarf galaxy that has been found to be lensed. Either astronomers have been phenomenally lucky, or starbursting dwarf galaxies are much more common than previously thought, forcing astronomers to re-think their models of galaxy evolution.

Sunrise Balloon Offers New Insight on Sun's Atmosphere



Right: An image from the Sunrise balloon-borne telescope of a region of the chromosphere in close proximity to two sunspots taken on July 16, 2013. The Sunrise image serves as a close up of the image on the left from NASA's Solar Dynamics Observatory. Credit: NASA/SDO/MPS

- Three months after the flight of the solar observatory Sunrise – carried aloft by a NASA scientific balloon in early June 2013 -- scientists from the Max Planck Institute for Solar System Research in Germany have presented unique insights into a layer on the sun called the chromosphere. Sunrise provided the highest-resolution images to date in ultraviolet light of this thin corrugated layer, which lies between the sun's visible surface and the sun's outer atmosphere, the corona.

- With its one-meter mirror, Sunrise is the largest solar telescope to fly above the atmosphere. The telescope weighed in at almost 7,000 pounds and flew some 20 miles up in the air. Sunrise was launched from Kiruna in the north of Sweden and, after five days drifting over the Atlantic, it landed on the remote Boothia Peninsula in northern Canada, gathering information throughout its journey.

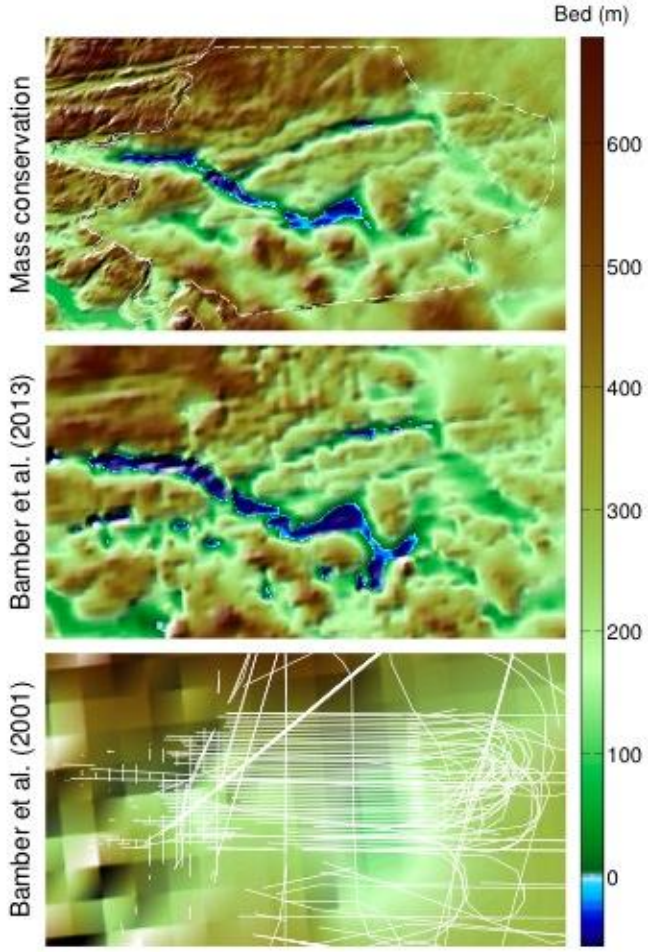
- The temperature in the chromosphere rises from 10,000 F at the surface of the sun to about 35,000 F. It's an area that's constantly in motion, with different temperatures of hot material mixed over a range of heights, stretching from the sun's surface to many thousands of miles up. The temperatures continue to rise further into the corona and no one knows exactly what powers the heating.

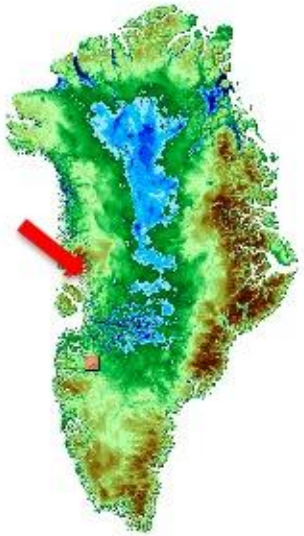
- Sunrise used an instrument that was able to filter particular ultraviolet wavelengths of light that are only emitted from the chromosphere. Sunrise's extremely high-resolution images in this wavelength painted a complex picture of the chromosphere. Where the sun is quiet and inactive, dark regions with a diameter of around 600 miles can be discerned surrounded by bright rims. This pattern is created by the enormous flows of solar material rising up from within the sun, cooling off and sinking down again. Especially eye-catching are bright points that flash up occasionally—much richer in contrast in these ultraviolet images than have been seen before. Scientists believe these bright points are signs of magnetic flux tubes, which are the building blocks of the sun's magnetic field. The magnetic field is of interest since it is ultimately responsible for all the dynamic activity we see on the sun.

- Sunrise researchers are looking forward to a close collaboration with colleagues from NASA's Interface Region Imaging Spectrograph, or IRIS mission. IRIS launched on June 27, only weeks after the end of the Sunrise mission, and also studies the ultraviolet radiation from chromosphere and corona.

High-resolution Bed Topography Mapping of Russell Glacier, Greenland, Inferred from Operation Icebridge Data

M. Morlighem et al. (2013), Journal of Glaciology, 8, 2013 doi: 10.3189/2013JoG12J235.

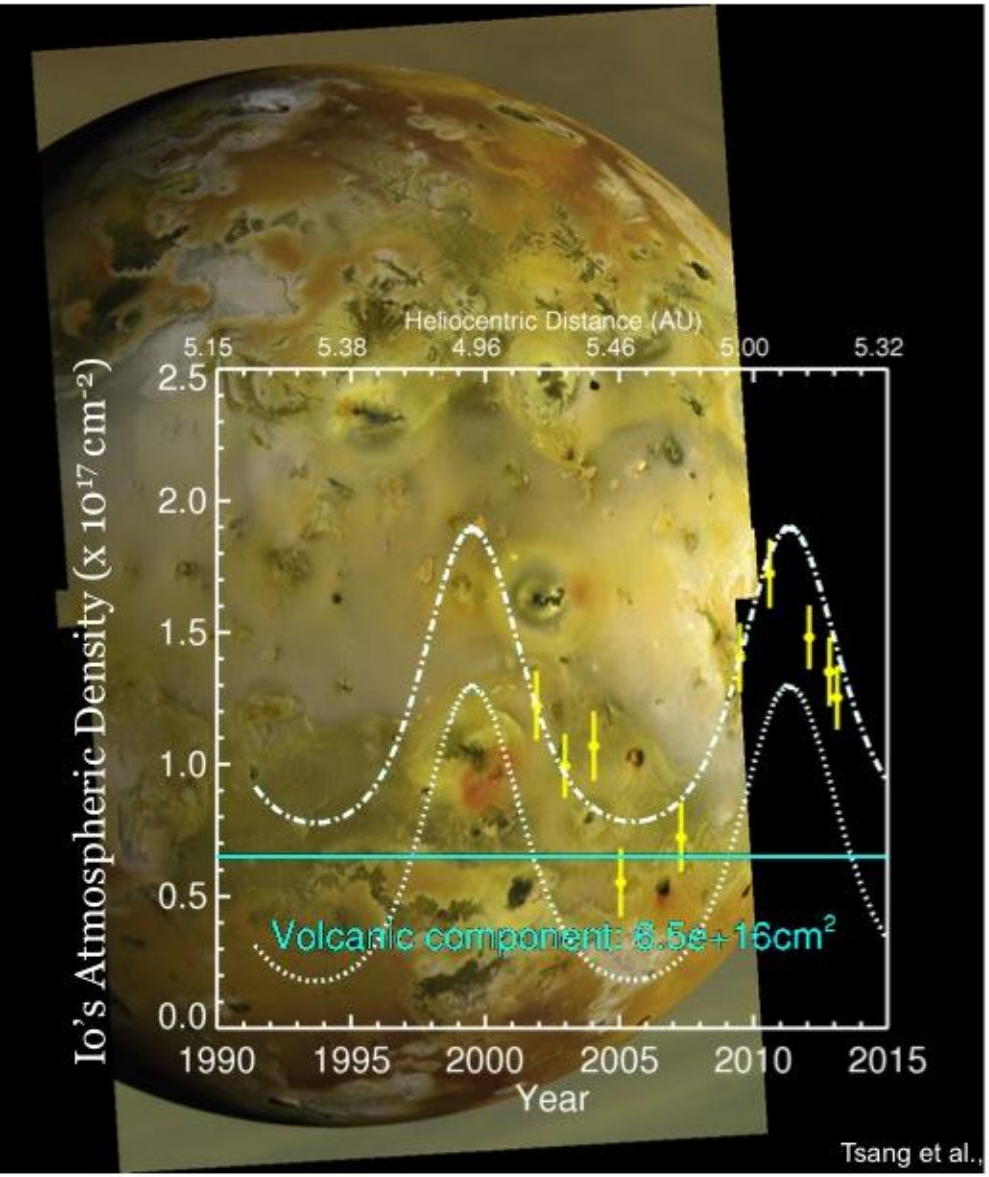




Above, left: Bedrock topography of Russell Glacier, Greenland: **(bottom)** prior to OIB (Bamber et al., 2001); **(middle)** with OIB (Bamber et al., 2013); and **(top)** with mass conservation. Flight lines from OIB 2011 are white lines in the bottom panel. Mass conservation is the only technique resolving glacier valleys. The location of Russell Glacier is identified by the red arrow in the figure on the right.

- Detailed maps of bed elevation and ice thickness are essential for understanding and projecting ice sheet evolution. They are traditionally obtained using airborne radar-sounding profile data interpolated onto regular grids.
- NASA-funded scientists have developed a new technique, using the principles of mass conservation, and compared the resulting map to ones obtained from traditional methods (e.g., kriging and tomography) beneath Russell Glacier, on the southwestern coast of Greenland.
  - They combined surface velocities, derived from satellite InSAR (interferometric synthetic aperture radar) data, with radar-sounding data collected along tracks spaced at 5 km by NASA's Operation IceBridge in 2011.
  - This combination of radar and ice motion data offers significant advantages along coastal sectors.
  - They found that the application of mass conservation constraints revealed bed topographic features that were intimately responsible for the flow structure of the ice toward the ice margin.
  - For Russell Glacier, in particular, the bed topography turned out to be much more complex than anticipated given its relatively smooth surface elevation and uniformity in speed.
  - The mass-conservation method revealed that the ice flow pattern is directly related to the shape of the bed, which is characterized by deeply carved channels.

Io's Atmosphere Expands and Contracts



- Io has an atmosphere of sulfur dioxide from volcanic eruptions. Previous work proposed that when Jupiter is farthest from the Sun in its slightly eccentric orbit, this atmosphere would condense on the surface to form a layer of sulfur dioxide frost. Over a period of many years, as Jupiter approaches the Sun and more sunlight falls on Io, the sunlight would evaporate (sublimate) the frost from the surface and increase the density of Io's atmosphere.
- Observations with NASA's Infrared Telescope Facility in the mid-infrared of Io's atmosphere over a Jupiter year show the atmosphere of Io expanding and then contracting with its distance from the Sun, confirming the model. In essence, Io's atmosphere has "seasons"!

Tsang et al., 2013, Icarus, 226, 1177-1181, http://dx.doi.org/10.1016/j.icarus.2013.06.03

GLOBE Student Art Competition Receives Record Number of Entries

The 2nd Annual GLOBE Student Art Competition received more than 250 entries -- more than double the number from last year -- representing every GLOBE geographic region. The competition called on students to illustrate and write about what makes their local environment unique. Winning entries will be seen around the world in the 2014 GLOBE calendar.

The student art competition is one of many ways that GLOBE is used by teachers to integrate a range of subject areas across the curriculum. Students draw on language, geography, art and science proficiencies to represent their environmental observations.

Members of the GLOBE International Scientist Network and GLOBE Program staff will judge the competition.

Artwork from last year's student art competition is currently on display at the Mesa Lab, National Center for Atmospheric Research (NCAR) in Boulder, Colorado, through December 2013.