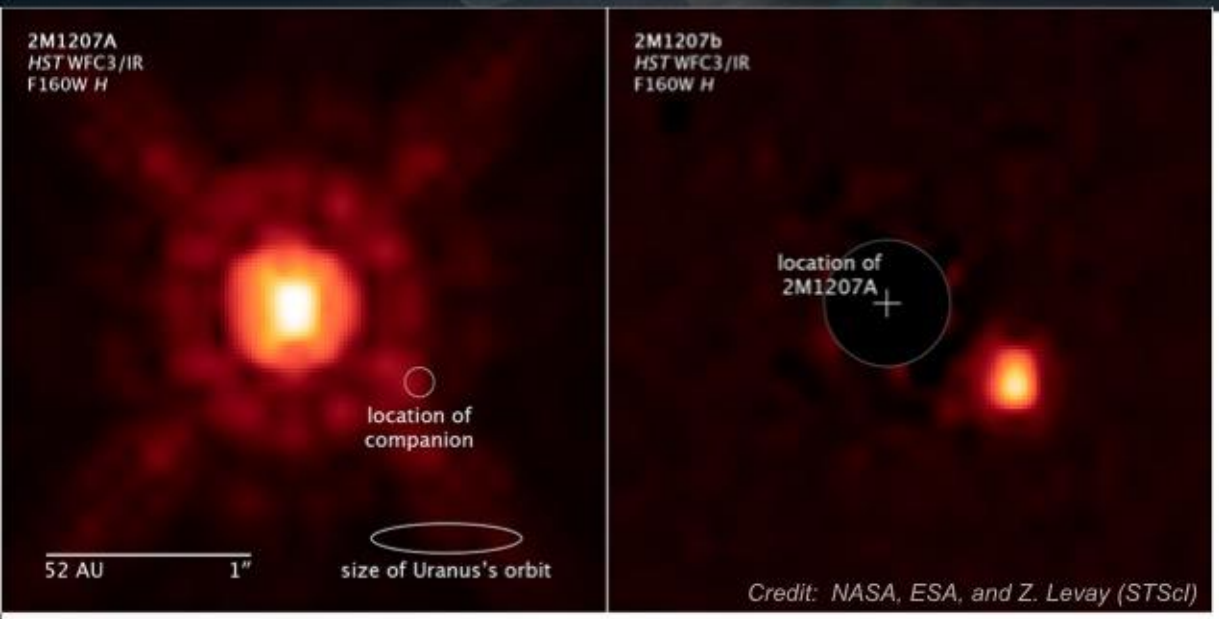
Science Mission Directorate

Weekly Highlights

February 26, 2016

Brown Dwarf 2M1207A and Companion

Published in the February 18, 2016 edition of The Astrophysical Journal.

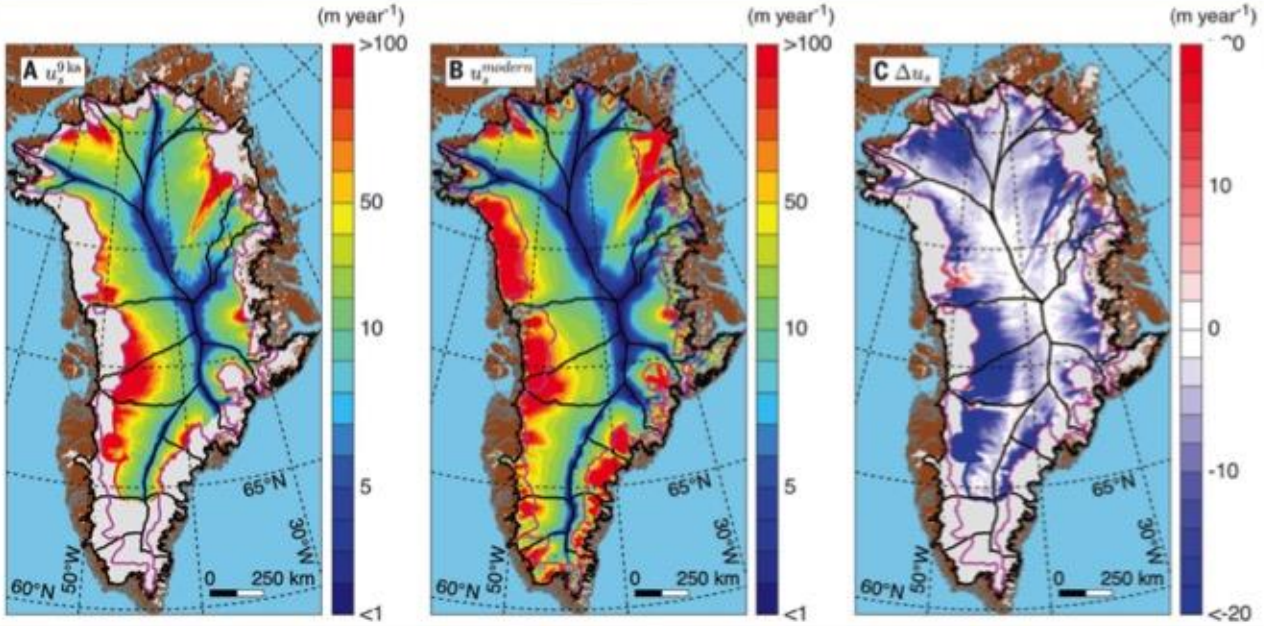


- Astronomers using NASA's Hubble Space Telescope have measured the rotation rate of an extreme exoplanet by observing the varied brightness in its atmosphere. This is the first measurement of the rotation of a massive exoplanet using direct imaging.
- The planet, called 2M1207b, is about four times more massive than Jupiter and is dubbed a "super-Jupiter." It is a companion to a failed star known as a brown dwarf, orbiting the object at a distance of 5 billion miles. By contrast, Jupiter is approximately 500 million miles from the sun. The brown dwarf is known as 2M1207. The system resides 170 light-years away from Earth.
- Hubble allowed astronomers to precisely measure the planet's brightness changes as it spins. The researchers attribute the brightness variation to complex clouds patterns in the planet's atmosphere. The new Hubble measurements not only verify the presence of these clouds, but also show that the cloud layers are patchy and colorless.
- Astronomers first observed the massive exoplanet 10 years ago with Hubble. The observations revealed that the exoplanet's atmosphere is hot enough to have "rain" clouds made of silicates: vaporized rock that cools down to form tiny particles with sizes similar to those in cigarette smoke. Deeper into the atmosphere, iron droplets are forming and falling like rain, eventually evaporating as they enter the lower levels of the atmosphere. The atmospheric temperatures are between about 2,200 to 2,600 degrees Fahrenheit.
- The super-Jupiter is so hot that it appears brightest in infrared light. Astronomers used Hubble's Wide Field Camera 3 to analyze the exoplanet in infrared light to explore the object's cloud cover and measure its rotation rate. The planet is hot because it is only about 10 million years old and is still contracting and cooling. The planet, however, will not maintain these temperatures. Over the next few billion years, the object will cool and fade dramatically. As its temperature decreases, the iron and silicate clouds will also form lower and lower in the atmosphere and will eventually disappear from view.
- Scientists have also determined that the super-Jupiter completes one rotation approximately every 10 hours, spinning at about the same fast rate as Jupiter. This super-Jupiter is only about five to seven times less massive than its brown-dwarf host. By contrast, our sun is about 1,000 times more massive than Jupiter. The planets orbiting our sun formed inside a circumstellar disk through accretion. But the super-Jupiter and its companion may have formed throughout the gravitational collapse of a pair of separate disks.

Holocene Deceleration of the Greenland Ice Sheet

MacGregor, J. A., Colgan, W. T., Fahnestock, M. A., Morlighem, M., Catania, G. A., Paden, J. D., & Gogineni, S. P. | February 2016 | doi: 10.1126/science.aab1702

A NASA and NSF-funded study found that the recent peripheral thinning of the Greenland Ice Sheet (GrIS) is partly offset by thickening of ice in the interior, and is overprinted on its poorly constrained Holocene evolution. The authors used a dated radiostratigraphy to show that ice flow in the interior of the Greenland Ice Sheet is slower now than the average speed over the past nine millennia. They had previously derived this record from approximately 20 years of NASA-funded ground-penetrating radar data, including data from the airborne Operation IceBridge surveys. Generally higher Holocene accumulation rates relative to modern estimates can only partially explain this millennial-scale deceleration. The ice sheet's dynamic response to the decreasing proportion of softer ice from the last glacial period and the deglacial collapse of the ice bridge across Nares Strait also contributed to this pattern. Thus, recent interior thickening of the Greenland Ice Sheet is partly an ongoing dynamic response to the last deglaciation that is large enough to affect interpretation of its mass balance from altimetry. The dynamics of the Greenland Ice Sheet (GrIS) are coupled intimately with the surrounding ocean, overlying atmosphere, and underlying lithosphere. The large range of time scales spanned by these interactions and the GrIS's own internal dynamics challenge our ability to predict GrIS evolution within the context of ongoing Holocene climate change.



Left: **Holocene-averaged and modern surface speed across the GrIS. A.** Averaged surface speed over the last 9,000 years, inferred from ice-sheet radiostratigraphy; **B.** Composite of modern surface speed, 1995-2013; and **C**. Change in surface speed between the present and the Holocene average.

SDO Celebrates it's 6th Year Anniversary!

See "SDO: Year 6" at https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=12144

The Solar Dynamics Observatory (SDO), our first Living with a Star mission, launched in February of 2010 to help us understand where the Sun's energy comes from, how the inside of the Sun works, and how energy is stored and released in the Sun's atmosphere.

- ✓ SDO discovered a new class of solar flares with possible implications on changes in the Earth's atmosphere.
- ✓ SDO data and science results have appeared in almost 2500 refereed publications.
- ✓ Each day, about 1.5 TB flows into the Joint Satellite Operations Center (JSOC) from SDO and 7.5 TB in science data flows out to users around the world.
- ✓ During the extended mission we continue to add about 50 publications a month.

The images and data from SDO capture the public's attention in compelling ways. Goddard released a beautiful video showing the entire 6th year on YouTube which received more than 640,000 plays by the end of its first week, **becoming Goddard's most popular video over the last 3 months!** Superlative-laden news coverage came from **Gizmodo/Sploid, Gizmag, Discovery News, Discover Magazine** and others, including a quote from VOX news saying,

"SDO might be the space agency's most **beautiful mission.**"

The three powerful and technologically innovative instruments on SDO:

Helioseismic and Magnetic Imager (HMI) makes high resolution full disk maps of the solar magnetic fields and peers beneath the sun's opaque surface using a technique called helioseismology. A key goal of this experiment is to decipher the physics of the Sun's magnetic dynamo.

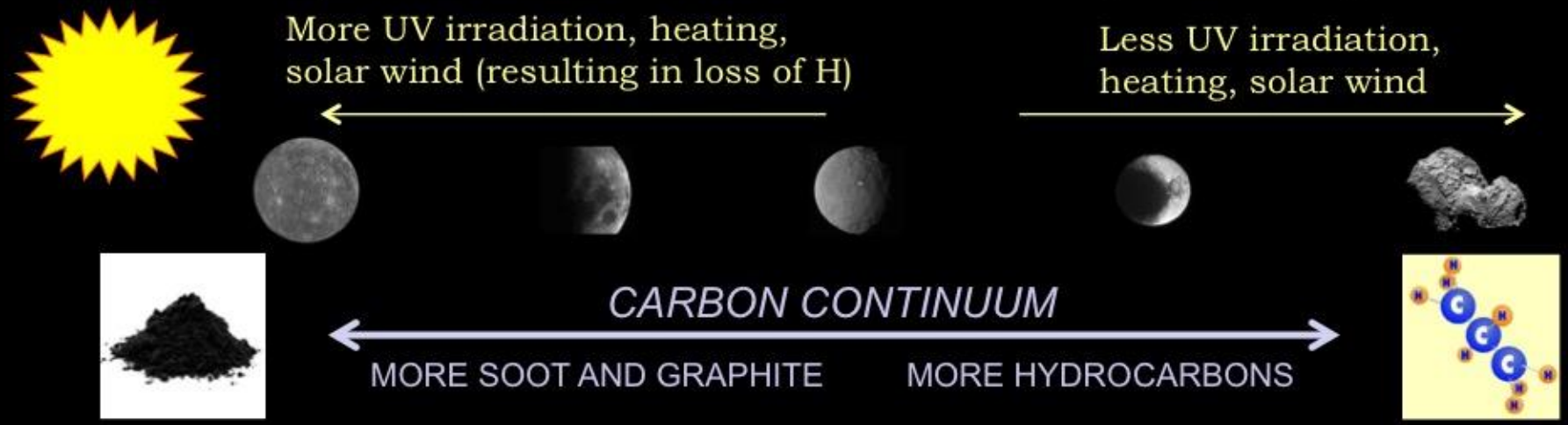
Atmospheric Imaging Assembly (AIA) provides continuous full-disk observations of the sun's surface and atmosphere using a battery of 4 telescopes, with filters that cover 10 different wavelength bands, or colors, selected to reveal key aspects of solar activity, spanning a temperature range from approximately 20,000 Kelvin to above 20 million Kelvin.

Extreme Ultraviolet Variability Experiment (EVE) measures fluctuations in the Sun's extreme ultraviolet output with unprecedented accuracy and timing. EUV radiation from the sun has a direct and powerful effect on Earth's upper atmosphere, heating it, puffing it up, and breaking apart atoms and molecules.

Carbon Distribution Throughout the Solar System

Instruments on spacecraft such as Cassini and the Hubble Space Telescope are providing new insights into the distribution of carbon species in our solar system, made possible by spectral features that are more easily observed at UV wavelengths.

- Two bodies were the focus of this study: Ceres, which lies in the asteroid belt between Mars and Jupiter, and Iapetus, a moon of Saturn. Spacecraft data from these two were compared with models to make predictions about UV characteristics in other regions of solar system.



- Complex carbon molecules on surfaces in the inner solar system tend to get destroyed closer to the Sun, and converted to simpler forms of carbon (e.g., soot or graphite).
- In the outer solar system complex molecules can survive, and many types of hydrocarbons and organics have been detected on surfaces further from the Sun.
- Carbon compounds make up life as we know it, and are found in the interstellar medium as well as early stellar systems outside of our own – so it's important to examine and understand their non-uniform distribution and evolution.

Hendrix et al. (2016)

Northwest Earth & Space Sciences Pipeline

- As a new NASA Science awardee, the kick-off meeting for the Northwest Earth & Space Sciences Pipeline was held January 25-26, 2016 at the Museum of Flight in Seattle, WA.

- More than 40 educators from colleges, museums and K-12 organizations in Montana, Oregon and Washington attended collaborate on formal and informal education projects to increase the number of underrepresented minority students targeted to pursue degrees in science, technology, engineering and math.

- Summer 2016 internships begin for high school students and teachers, summer academies for middle and high school students, and curriculum development.