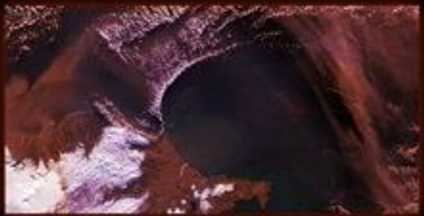
National Aeronautics and Space Administration

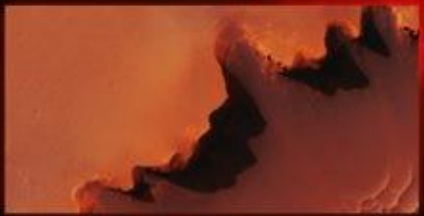
NASA Science

Weekly Highlights
March 29, 2013



EARTH SCIENCE

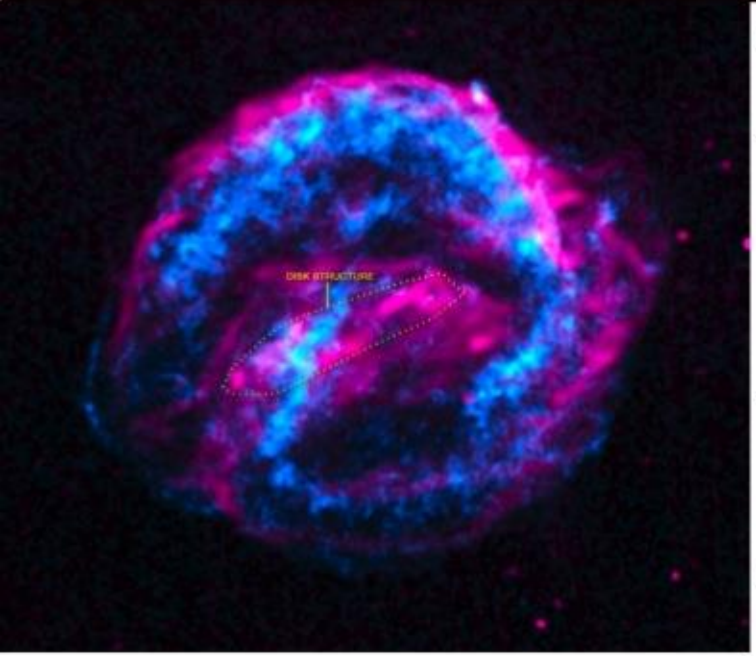
HELIOPHYSICS



PLANETARY SCIENCE

ASTROPHYSICS

Kepler's Supernova Remnant Reveals Clues about Crucial Cosmic Distance Markers



Credits: X-ray: NASA/CXC/NCSU/M.Burkey et al; Infrared: NASA/JPL-Caltech.

This composite image shows Spitzer infrared emission in pink and Chandra X-ray emission from iron in blue. The infrared emission is very similar in shape and location to X-ray emission (not shown here) from material that was expelled by the giant star companion to the white dwarf before the latter exploded. This material forms a disk around the center of the explosion.

- This is the remnant of Kepler's supernova, the famous explosion that was discovered by Johannes Kepler in 1604.
- A new study has used the Chandra X-ray Observatory to identify what triggered this explosion. It had already been shown that the type of explosion was a so-called Type Ia supernova, the thermonuclear explosion of a white dwarf star. These supernovas are important cosmic distance markers for tracking the accelerated expansion of the Universe.
- However, there is an ongoing controversy about Type Ia supernovas. Are they caused by a white dwarf pulling so much material from a companion star that it becomes unstable and explodes? Or do they result from the merger of two white dwarfs?
- The new Chandra analysis shows that the Kepler supernova was triggered by an interaction between a white dwarf and a red giant star. The crucial evidence from Chandra was a disk-shaped structure near the center of the remnant. The researchers interpret this X-ray emission to be caused by the collision between supernova debris and disk-shaped material that the giant star expelled before the explosion. Another possibility was that the structure is just debris from the explosion.
- This composite figure also shows a remarkably large and puzzling concentration of iron on one side of the center of the remnant but not the other. The authors speculate that the cause of this asymmetry might be the "shadow" in iron that was cast by the companion star, which blocked the ejection of material. Previously, theoretical work has suggested this shadowing is possible for Type Ia supernova remnants.

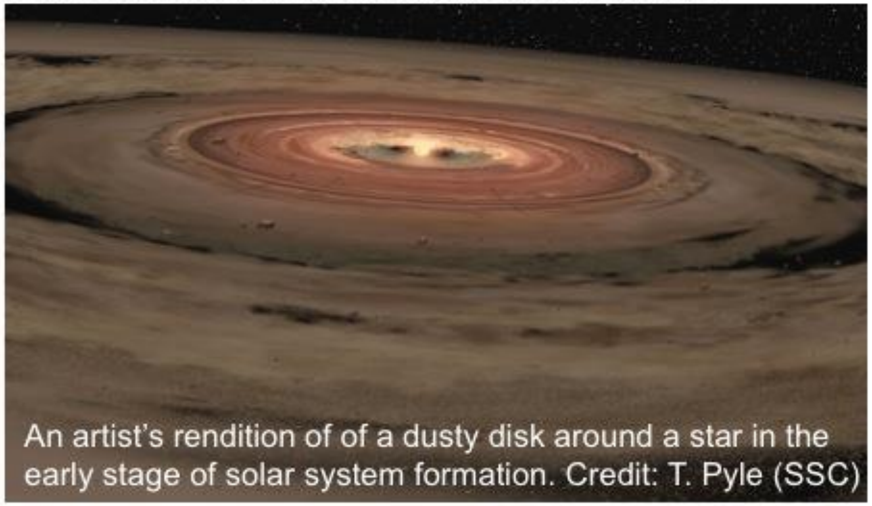
Solving Puzzles About Icy Comets Like Wild 2

Comets and asteroids preserve the building blocks of our solar system and should help explain its origin. But there are unsolved puzzles. For example, how did icy comets obtain particles that formed at high temperatures, and how did these refractory particles acquire rims with different compositions?

Astrobiologists at the Carnegie Institution and Tel Aviv University have created models that shows the early solar nebula could have experienced powerful outbursts that tossed particles great distances – far out of the hot, inner region of the disk.

These models show that several puzzles may have been solved -- an unstable disk can explain both large-scale outward transport of refractory particles, as well as the peculiar rim compositions acquired during their journeys.

Comet Wild 2 imaged just after the flyby of the Stardust spacecraft. Credit: *NASA/JPL*



An artist's rendition of of a dusty disk around a star in the early stage of solar system formation. Credit: T. Pyle (SSC)

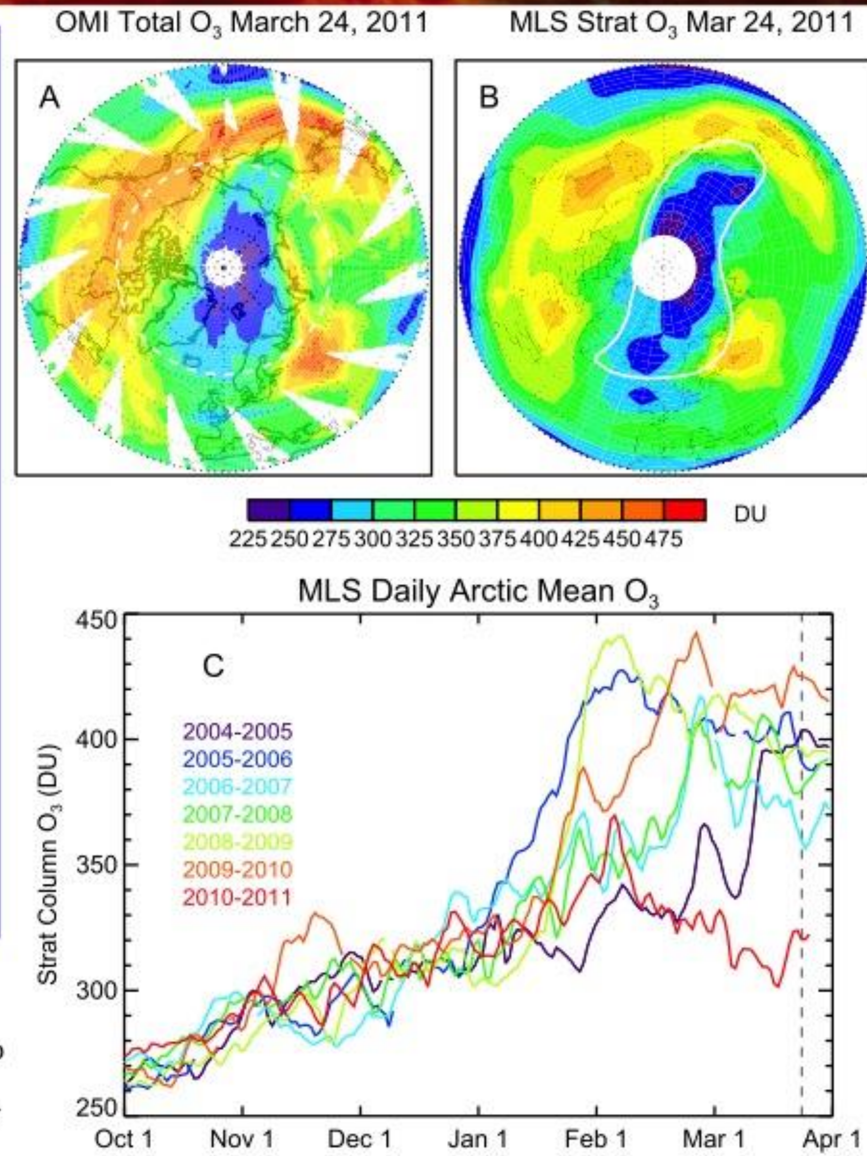
Studying how comets formed and evolved is of value to astrobiologists because many scientists believe that these icy objects from space could have played a role in the origin of life by delivering water and molecules vital for life's origin to the early Earth.

The research is published in Sept 2012 Earth and Planetary Science Letters.

The Contributions of Chemistry and Transport to Low Arctic Ozone in March 2011 Derived From Aura MLS Observations

S.E. Strahan, A.R. Douglass, and P.A. Newman, JOURNAL OF GEOPHYSICAL RESEARCH: ATMOSPHERES, VOL. 118, 1–14, doi:10.1002/2012JD017821, 2013

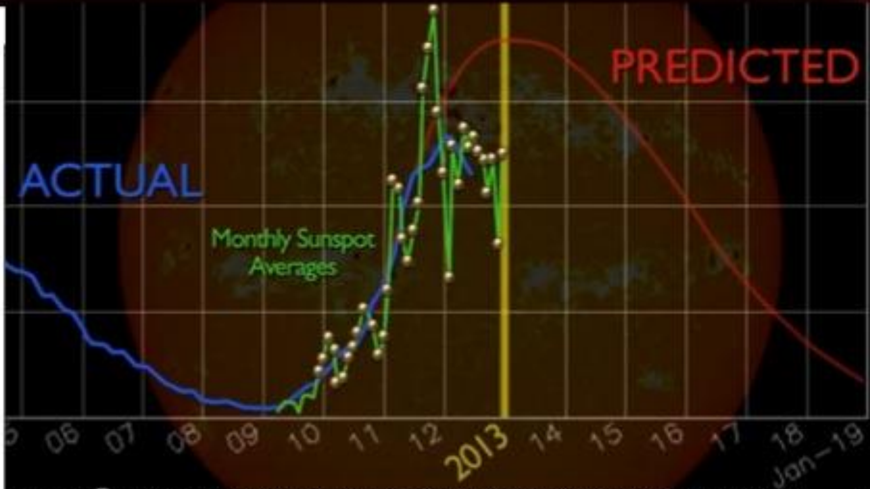
NASA scientists used Aura Microwave Limb Sounder (MLS) Ozone (O_3) observations to quantify the roles of chemistry and transport in the 2011 observed stratospheric and total columns of Arctic O_3 (63–90°N). In late March 2011 they averaged 320 and 349 DU, respectively, 50–100 DU lower than any of the previous 6 years. They found that there are two major reasons for low O_3 in March 2011: heterogeneous chemical loss and a late final warming that delayed the resupply of O_3 until April. Most years, atmospheric waves knock the vortex to lower latitudes in later winter, where it breaks up. In comparison, the Antarctic vortex is very stable and lasts until the middle of spring. But in 2011, an unusually quiescent atmosphere allowed the Arctic vortex to remain strong for four months, maintaining frigid temperatures even after the sun reappeared in March and promoting the chemical processes that deplete ozone. The team ran two simulations: one that included the chemical reactions that occur on polar stratospheric clouds, the ice particles that only form when it's very cold, and one without. They then compared their results to real ozone observations from NASA's Aura satellite. They calculated that the combination of chlorine pollution and extreme cold temperatures were responsible for two thirds of the ozone loss, while the remaining third was due to the atypical atmospheric conditions that blocked ozone resupply.



Right: (A) OMI total column O3 in the Arctic, 24 March 30 2011. The white dashed line is 63°N. (B) MLS stratospheric column O_3 on 24 March 2011. The white solid line shows the vortex edge. The difference between Figures 1a and 1b is the tropospheric column, ~25–35 DU. (C) Daily MLS Arctic Mean (63o–88oN) stratospheric column O3 time series from 1 October to 1 April for seven fall/winter seasons, 2004–2011. 24 March is indicated by the dashed line.

* DU: Dobson Units

2013 Solar Cycle Update



Recent sunspot counts fall short of predictions. Credit: NASA

- 2013 is supposed to be the year of solar maximum, the peak of the 11-year sunspot cycle. Yet 2013 has arrived and solar activity is relatively low. Sunspot numbers are well below their values in 2011, and strong solar flares have been infrequent for many months. The quiet has led some observers to wonder if forecasters missed the mark. Researchers have a different explanation: This is solar maximum, but it looks different from what we expected because it is double peaked.

- Astronomers have been counting sunspots for centuries, and they have seen that the solar cycle is not perfectly regular. For one thing, the back-and-forth swing in sunspot counts can take anywhere from 10 to 13 years to complete; also, the amplitude of the cycle varies. Some solar maxima are very weak, others very strong.

- The last two solar maxima, around 1989 and 2001, had two peaks. Solar activity went up, dipped, then resumed, performing a mini-cycle that lasted about two years. The same thing could be happening now. Sunspot counts jumped in 2011, dipped in 2012, and researchers expect them to rebound again in 2013. Another curiosity of the solar cycle is that the sun's hemispheres do not always peak at the same time. In the current cycle, the south has been lagging behind the north. The second peak, if it occurs, will likely feature the southern hemisphere playing catch-up, with a surge in activity south of the sun's equator.

- A group of solar physicists assembled in 2006 and 2008 to forecast the next solar maximum. At the time, the sun was experiencing its deepest minimum in nearly a hundred years. Recognizing that deep minima are often followed by weak maxima, and pulling together many other threads of predictive evidence, the group issued this statement: *"The Solar Cycle 24 Prediction Panel has reached a consensus. The panel has decided that the next solar cycle (Cycle 24) will be below average in intensity, with a maximum sunspot number of 90. Given the date of solar minimum and the predicted maximum intensity, solar maximum is now expected to occur in May 2013. Note, this is not a unanimous decision, but a supermajority of the panel did agree."*

- Given the current low state of solar activity, a maximum in May 2013 now seems unlikely. Incidentally, there is a similarity between Solar Cycle 24, underway now, and Solar Cycle 14, which had a double-peak during the first decade of the 20th century. If the two cycles are in fact twins, it would mean one peak in late 2013 and another in 2015. No one knows for sure what the sun will do next. It seems likely, though, that the end of 2013 could be a lot livelier than the beginning.

THEMIS/Energy from the Sun (EPOESS)

More than 300 girls in grades 6 through 9 got a peek at possible careers in science, technology, engineering and math (STEM) when they descended on Las Positas College on March 2 for “Expanding Your Horizons.” The THEMIS mission and the Energy from the Sun EPOESS jointly hosted a table at the event, featuring hands-on Sun-related activities such as UV beads, interactive magnetic Sun models, and “solar pizzas.” Expanding Your Horizons is an annual career conference now in its 34th year. The theme for the event this year was "Get Connected with Your Future.” The conference hopes to inspire girls to keep their minds open and explore all of their career options, and to realize that science is a "girl thing," too. These girls seemed to fully embrace that idea with great enthusiasm, interest and knowledge!

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