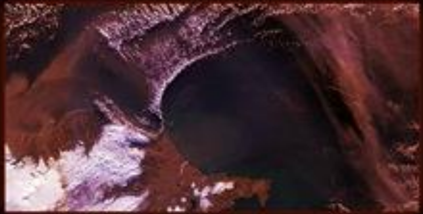
National Aeronautics and Space Administration

NASA Science

Weekly Highlights
July 19, 2013

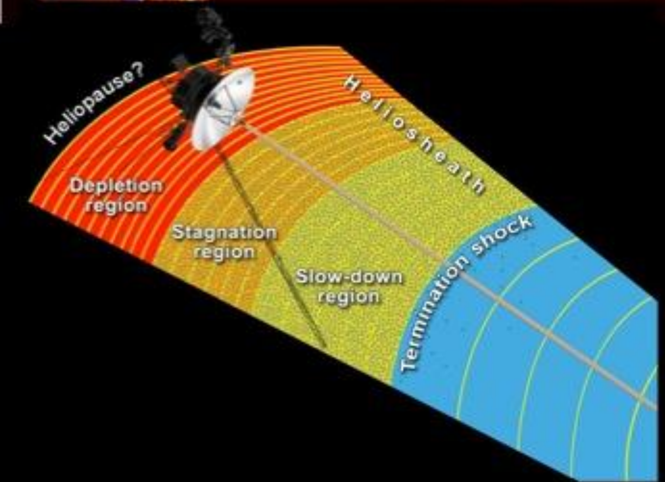

EARTH SCIENCE


HELIOPHYSICS


PLANETARY SCIENCE


ASTROPHYSICS

Voyager 1 Explores the Final Frontier of Our Heliosphere



Transitional Regions at the Heliosphere's Outer Limits: This artist's concept shows NASA's Voyager 1 spacecraft exploring a region called the "depletion region" or "magnetic highway" at the outer limits of our heliosphere, the bubble the sun blows around itself. Credit: NASA/JPL

- Voyager 1, now more than 11 billion miles from the sun, is closer to becoming the first human-made object to reach interstellar space.

- Research using Voyager 1 data and published in the journal Science on June 27, 2013 provides new details on the last region the spacecraft will cross before it leaves the heliosphere, or the bubble around our sun, and enters interstellar space. Three papers describe how Voyager 1's entry into a region called the magnetic highway resulted in simultaneous observations of the highest rate so far of charged particles from outside heliosphere and the disappearance of charged particles from inside the heliosphere.

- Scientists have seen two of the three signs of interstellar arrival they expected to see: charged particles disappearing as they zoom out along the solar magnetic field, and cosmic rays from far outside zooming in. Scientists have not yet seen the third sign, an abrupt change in the direction of the magnetic field, which would indicate the presence of the interstellar magnetic field.

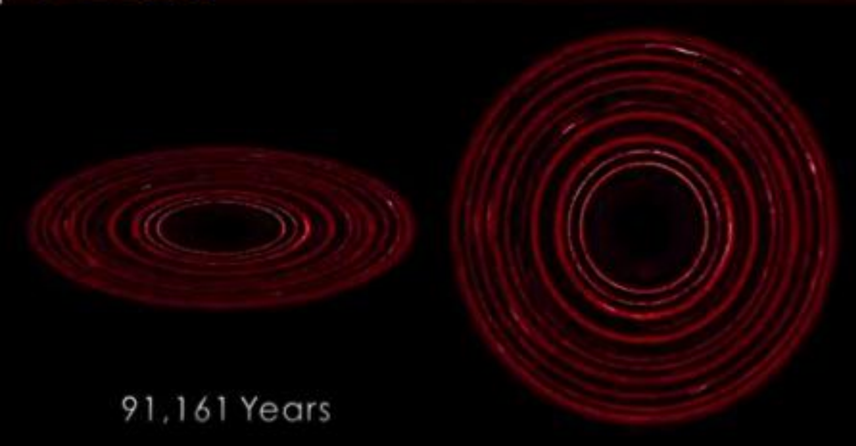
- The magnetic highway allows charged particles to travel into and out of the heliosphere along a smooth magnetic field line, instead of bouncing around in all directions as if trapped on local roads. For the first time in this region, scientists could detect low-energy cosmic rays that originate from dying stars. In the span of about 24 hours, data indicated that the magnetic field originating from the sun also began piling up, like cars backed up on a freeway exit ramp. But scientists were able to quantify that the magnetic field barely changed direction -- by no more than 2 degrees.

- Scientists do not know exactly how far Voyager 1 has to go to reach interstellar space. They estimate it could take several more months, or even years, to get there. The heliosphere extends at least 8 billion miles (13 billion kilometers) beyond all the planets in our solar system. It is dominated by the sun's magnetic field and an ionized wind expanding outward from the sun. Outside the heliosphere, interstellar space is filled with matter from other stars and a magnetic field present in the nearby region of the Milky Way.

- Voyager 1 and its twin spacecraft, Voyager 2, were launched in 1977. They toured Jupiter, Saturn, Uranus and Neptune before embarking on their interstellar mission in 1990. They now aim to leave the heliosphere. The Voyager missions are a part of NASA's Heliophysics System Observatory.

Study Shows Disks Don't Need Planets to Make Patterns

A paper describing the findings was published in the July 11 issue of Nature.



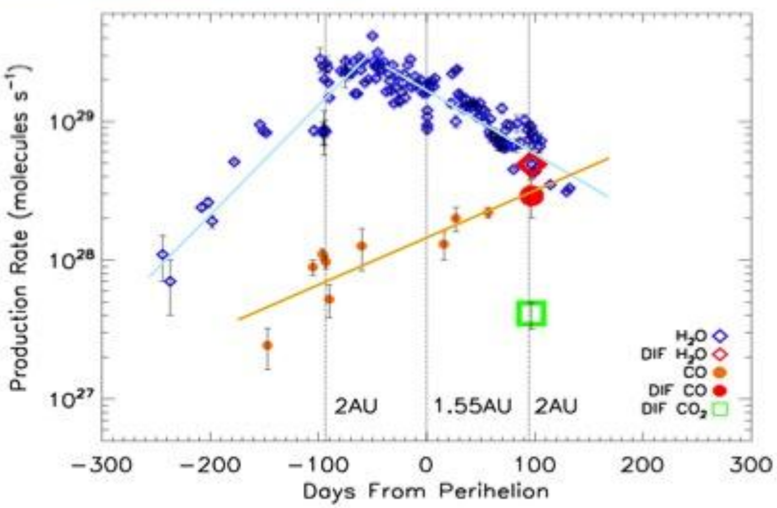
Credit: NASA GSFC/W. Lyra (JPL-Caltech), M. Kuchner (GSFC)

The image is a snapshot from a model simulation. At the left, the disk is seen from a 24-degree angle; at the right, it is face-on. Lighter colors indicate higher dust density.

- Many young stars known to host planets also possess disks containing dust and icy grains, particles produced by collisions among asteroids and comets also orbiting the star. These debris disks often show sharply defined rings or spiral patterns, features that could signal the presence of orbiting planets.
- A new study by NASA scientists sounds a cautionary note in interpreting rings and spiral arms as signposts for new planets. Thanks to interactions between gas and dust, a debris disk may, under the right conditions, produce narrow rings on its own, no planets needed.
- "When the mass of gas is roughly equal to the mass of dust, the two interact in a way that leads to clumping in the dust and the formation of patterns," said lead researcher Wladimir Lyra, a Sagan Fellow at NASA's JPL. "In essence, the gas shepherds the dust into the kinds of structures we would expect to be see if a planet were present."
- The warm dust in debris disks is easy to detect at infrared wavelengths, but estimating the gas content of disks is a much greater challenge. As a result, theoretical studies tend to focus on the role of dust and ice particles, paying little attention to the gas component. Yet icy grains evaporate and collisions produce both gas and dust, so all debris disks must contain some amount of gas.
- When high-energy ultraviolet light from the central star strikes a clump of dust and ice grains, it drives electrons off the particles. These high-speed electrons then collide with and heat nearby gas. The rising gas pressure changes the drag force on the orbiting dust, causing the clump to grow and better heat the gas. This interaction, which the astronomers refer to as the photoelectric instability, continues to cascade. Clumps grow into arcs, rings, and oval features in tens of thousands of years, a relatively short time compared to other forces at work in a young solar system.
- Dense clumps with many times the dust density elsewhere in the disk also form. When a clump in a ring grows too dense, the ring breaks into arcs and the arcs gradually shrink until only a single compact clump remains. In actual debris disks, some of these dense clumps could reflect enough light to be directly observable.
- The researchers conclude that the photoelectric instability provides a simple and plausible explanation for many of the features found in debris disks, making the job of planet-hunting astronomers just a little bit harder.

The Unprecedented Behavior of Comet Garrard

A Deep Impact Flyby image of CN (gas) from Comet Garrard on February 21, 2012 (co-added from 66 frames) revealed no strong jets.
(Feaga et al. 2013, Astronomical Journal, in review)



The Deep Impact Flyby (DIF) spacecraft infrared spectrometer observed the dynamically young Oort Cloud comet C/2009 P1 Garrard

- Mar-Apr 2012, 2 AU from the Sun
- 3 months post-perihelion

The DIF spacecraft is a unique observing platform

- Only facility that can observe CO_2
  - Earth's atmosphere never a factor (weather or telluric absorption)
- Different viewing geometries than Earth
- New IR calibration completed in 2012

Volatiles on Garrard behave differently from other comets

- The team compiled all community observations
- H_2O peaked 2 ½ - 3 months pre-perihelion
  - Not unusual in comets
- CO increased monotonically through perihelion
  - ***Never seen before in a comet***
- CO_2 unknown trend – DIF only observed once!

Highest cometary CO/H_2O ratio ever measured at 60%

- *DIF data fit perfectly with a surprising CO trend*
- Previous range measured inside 2.5 AU was 0-35%

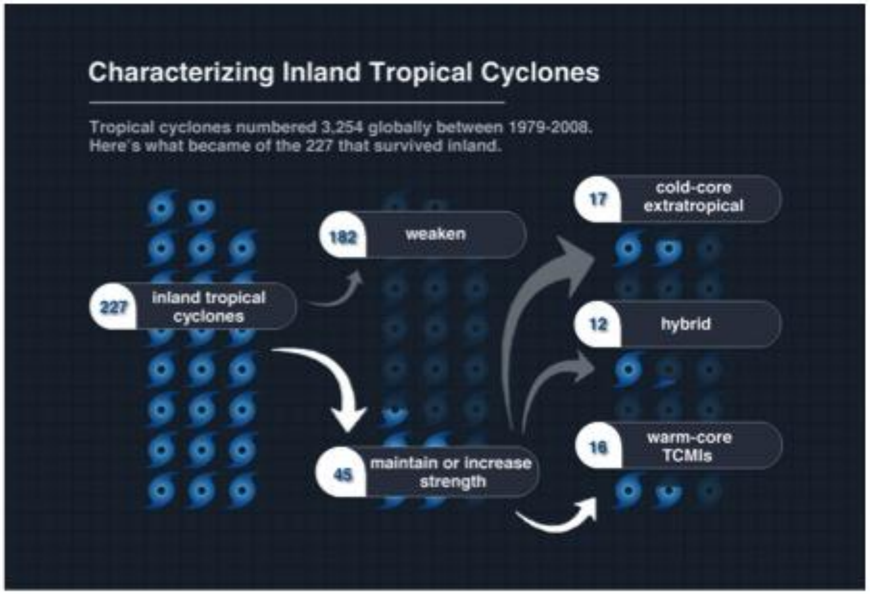
❖ Behavior differences could be due either to a heterogeneous nucleus experiencing a seasonal effect, or to rapid, pre-perihelion water loss globally exposing more primitive material containing more CO

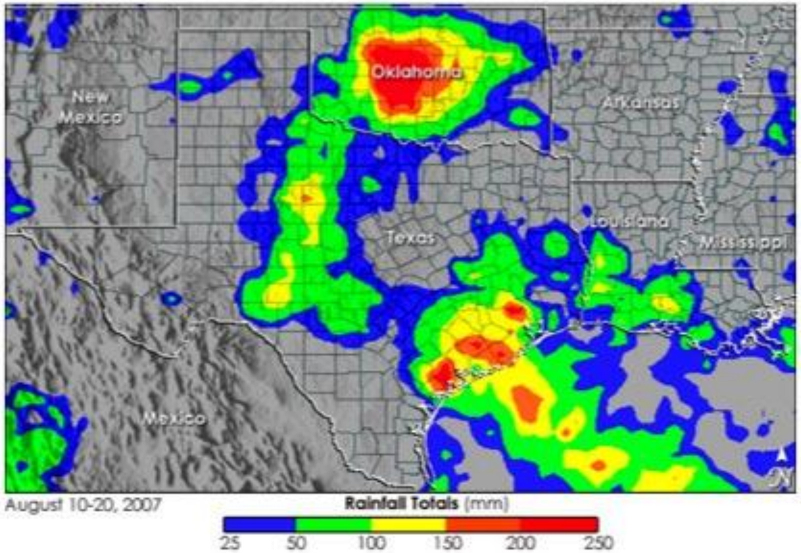
❖ Frequent monitoring of relative abundances is needed to understand if different layers in the comet exist

A Global Spatiotemporal Analysis Of Inland Tropical Cyclone Maintenance Or Intensification

Theresa K. Andersen and J. Marshall Shepherd, INTERNATIONAL JOURNAL OF CLIMATOLOGY *Int. J. Climatol.* (2013) Published online in Wiley Online Library (wileyonlinelibrary.com) DOI: 10.1002/joc.3693

NASA funded study identifies the environments and characteristics of "tropical cyclone maintenance or intensification" (TCMIs), and explores physical processes that may produce an atmosphere conducive for tropical systems. A compilation of an inland tropical cyclone (TC) dataset over a 30-year period is used to quantify TC traits that may relate to maximum strength over land, and analyze surface and atmospheric conditions leading up to intensification. Of 227 inland TCs globally, 45 maintained or increased strength inland: 17 cold-core (ET), 16 warm-core (TCMI), and 12 hybrid cases. Analysis of synoptic conditions indicates that TCs persist when low-level temperature gradients are weak. Soil moisture gradients were in the vicinity of the cyclones at the time of intensification and may be forcing the TCMIs via increased surface latent heat flux (LHF). In the 2 weeks leading up to each TCMI, the LHF tends to be higher than average over the intensification regions and provides further evidence of land surface forcing.





Above: schematic to categorize inland tropical cyclones, highlighting a newly described sub-category called tropical cyclone maintenance and intensification events, or TCMIs. ***Left***: Tropical Storm Erin in 2007 was a warm-core TCMI, which can deliver much more rainfall than their extratropical counterparts. The newly described storm type derives energy over land from the evaporation of abundant soil moisture.

Forecasting tropical cyclone (TC) intensity changes over land is complicated by interactions of various surface and atmospheric features. Due to generally unfavorable conditions, many TCs weaken and decay soon after landfall. In some cases, TCs may also transition to extratropical cyclones (ETs). Despite the absence of oceanic forcing, a number of TCs have been observed to maintain or increase strength inland, termed "tropical cyclone maintenance or intensification" (TCMIs).

POLAR SCIENCE WEEKEND

at **Pacific Science Center**: **Eight Years of Outreach and Partnership**

Polar Science Weekend is featured in the Spring 2013 issue of ***Witness the Arctic***, the newsletter of the ***Arctic Research Consortium of the U.S. (ARCUS)***

Polar Science Weekend is an annual four-day event in which scientists present hands-on activities about their research to the public

Polar Science Weekend is held at Seattle's *Pacific Science Center*, the most well-attended museum in the Pacific Northwest

The article emphasizes the eight-year partnership between a research institution (the *Polar Science Center* at the University of Washington) and an informal science education institution (*Pacific Science Center*)

This "research weekend" model has won national awards (from ASTC and IMLS)

Polar Science Weekend has been funded by a major grant from NASA since 2010

WEB: http://www.arcus.org/witness-the-arctic/2013/2/article/19955

PDF: http://www.arcus.org/files/witness-the-arctic/2013/2/pdf/wta2013_v17i2.pdf