

Triton Fun Company

Science Newsletter June 2009

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June 2009

Interstellar Ice Clouds and Star Formation

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Special points of interest:

Ice clouds

Triton Fun stuff

Superfluous questions

Macroastronomy, the study of the celestial heavens on a large scale, composes many subfields including the study of the subset of molecular clouds known as ice clouds. Recent decades have provided the knowledge that the universe is filled with matter of various kinds. Molecular clouds with hydrogen densities 10-1,000 atoms per cubic centimeter were determined in the 1980's to be very common. Many clouds are made mostly of hydrogen, both neutral and ionized; currently it is known that molecular clouds also have various types of less abundant ices such as carbon dioxide and water which occur as a coating on grains of dust or silicates.

Cold clouds appear to be the most numerous in the universe just like other dark objects, all of which significantly outnumber the luminous, or hotter objects. They occur in our own Milky Way Galaxy and in other galaxies, mostly in the interstellar medium. They are predominantly located in the spiral arms of galaxies which are known to be regions of intense star formation.

Molecular ices, both monolayered and multilayered, aggregate around carbon grains of cosmic dust just as raindrops of water develop on Earth around dust or soil particles. The creation of new molecules occurs from the interaction of the

water ice with stellar photons, cosmic rays, and the occasional energy transfer and reaction caused by stellar and supernovae shockwaves. They can be further affected by energy provided by magnetic fields. This can occur on the cosmic scale of interstellar space down to localized interplanetary dust clouds or planetary systems.

Hydrogen, helium, oxygen, and carbon are the most abundant elements in the universe. The elements as raw materials in turn form vast cold and hot molecular cloud networks in interstellar space, along with nebulae of stellar nurseries. The study of chemical transformation in space is called *astrochemistry* or *cosmochemistry*.

Molecular clouds come in all sizes, large and small. Large clouds can be many light-years across; an example is a large H II region (ionized hydrogen atoms) such as the **Orion Nebula (M42)**. Examples of small clouds with overall mass densities just larger than our Sun would be the **Burnham-Herbig-Haro objects**, denser **Bok Globules** (which form double and multiple stars), **Thackeray's Globules** such as **IC 2944 in Centaurus**, or the **Okroy Cloud**. Later evolution can result in a protoplanetary disk cloud.



The Horsehead Nebula:

An example of a molecular cloud

Molecular clouds can be either quiescent and cold, or active and warm (or hot) through gravitational infall which later may form galaxies and stars. The **W31 Region** on the other side of our galaxy is an example of a "hot" cloud. Some regions like W31 can have active subareas such as the **star cluster 1806-20** or the **Becklin-Neugebauer Object in M42**. Examples of giant molecular clouds are the **Taurus Molecular Cloud** and the **Orion Molecular Cloud Complex**.

Stellar lifespans include material starstreams, stellar decay and explosions, and redistribution of processed star material into future stars; this leads to the development of heavier elements, simple diatomic and triatomic molecules, and to larger, more complex molecules.

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We are always looking for **contributors** to the Science Newsletter. If you would like to write an article about a science subject you are excited about, or contribute a superfluous question, or if you would like to be on our **mailing list** for future newsletters, please e-mail us at:

info@tritonfun.com

Ice Clouds in Space: *continued*

Photos/Info: NASA/APOD/Hubble Space Telescope Heritage series images/STSci/Wikipedia

Over the eons of star formation, star generations first consist of *Population III stars*, the oldest theorized but not yet observed which are free of metal [such as the ancient star HE 0107-5240]; *Population II stars*, which are younger stars such as **Barnard's Star**, **Cayrel's Star** or **Snedden's Star**; and *Population I stars*, youngest stars with the highest *metallicity* like our Sun (Sol). The numbering seems backwards but depicts the order of discovery as the sensitivity of instruments and technology has improved.

Large molecular clouds can be dark and cold, with temperatures of only 10-20 degrees Kelvin. The cosmic microwave background radiation temperature is only 2.7 degrees Kelvin (-454 degrees Fahrenheit!), just above absolute zero where atoms have no activity. These clouds can be opaque (primarily from dark carbon grains inside) such as **Lynds Dark Nebula LDN 57 (L57)** or **Barnard 168**. They can be illuminated from brightening caused by stellar interaction, reflectance, or visibility through **Strömgren spheres** (spherical cavities around a star) caused by clearing stellar winds.

Our galaxy has a massive collection of molecular clouds known as the **Sagittarius B2 Complex** and numerous smaller local clouds, many icy cold, forming the **Gould Belt galactic ring**.

Cold clouds are best seen through holes in our galactic disk where dust obscuration is absent, as in both the **Taurus Anticenter** and within the bowl of the **Big Dipper** (Ursa Major). These more clear regions have allowed for the discovery of filamentary clouds or galactic infrared cirrus at high galactic latitudes.

The recent discovery announced in the last few weeks of *Type Ia supernovae* as more accurate distance markers will allow for the finding of additional cold icy molecular clouds.

Type Ia supernova data refinement will cause discoveries relating to dark matter and dark energy. Distances to galaxies will improve. Studies of absorbed light extinction by cold ice and dust clouds between Earth and quasars will progress. The implications to astrometric mapping, nucleocosmochronology, and the Hubble Constant are significant.

The dark parts of the sky are just as exciting as the lighted parts. Ice clouds are a cool part of the universe!

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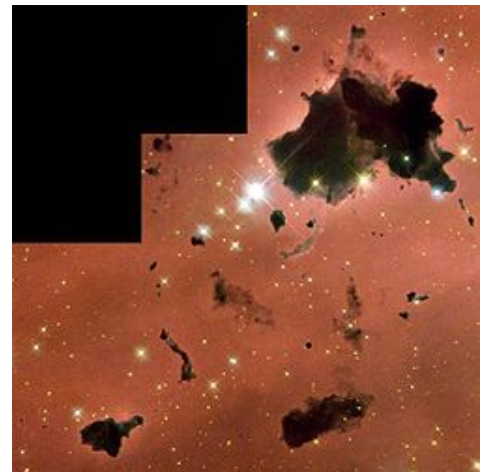
References:

1. Congiu, E, et al., "Laboratory evidence for the non-detection of excited nascent H₂ in dark clouds", *Monthly Notices of the Royal Astronomical Society*, preprint 2009 June 03.
2. Bailey, S., et al., "Using spectral flux ratios to standardize SN Ia luminosities", *Astronomy & Astrophysics*, preprint 2009 May 17.
3. Hollenbach, D., et al., "Water, O₂, and ice in molecular clouds", *Astrophysical Journal*, preprint 2009 March).



The Rosette Nebula

An example of a molecular cloud with a *Stromgren sphere* inside it. The sphere originates from blowing stellar winds that clear out the region near the center, enveloping the star.



Bok Globules

These are dark clouds of gas and dust named after astronomer Bart Bok who discovered them in 1947. Inside these dark recesses, star formation is likely occurring which may produce multiple star systems. The globules obscure objects behind them.



V838 Monoceros

Molecular clouds of dust and gas are lit up around V838 Monoceros (a red supergiant star) from reflected starlight.

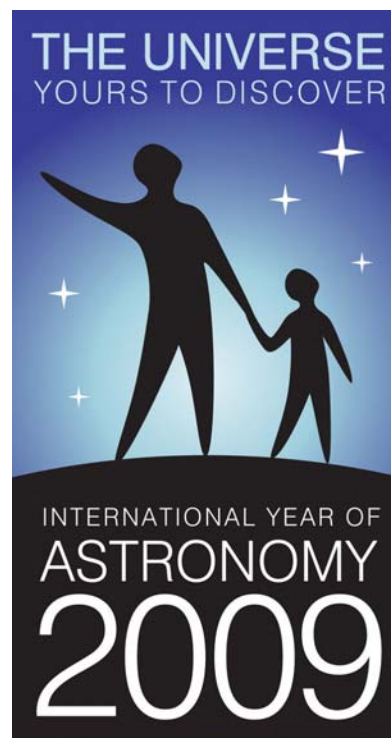
TRITON FUN PRODUCTS

2009 has been declared the "International Year of Astronomy". Events and activities to further the excitement of astronomy are being planned by IYA committees in over 100 countries. The logo for the IYA2009 is shown below. For more info on upcoming IYA2009 events, go to: <http://www.astronomy2009.org>

Triton Fun is an authorized distributor of T-shirts, sweatshirts and long-sleeve tees sporting this new logo. Part of the proceeds from the sale of these shirts will go to support astronomy clubs and astronomy activities connected with IYA2009 in California.

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** Send us your superfluous questions for a future issue ! They can be on any subject. The funnier, the better. M.D., our editor, appreciates the help and will send you a free Triton Fun coffee mug as compensation for your question. Or write an article for us and be read by professional and amateur astronomers and scientists in the U.S. and Canada ! **

Superfluous Questions:

- 1) Who built the first microscope ?
 - a) Zaccharias Janssen
 - b) Robert Hooke
 - c) Antonie van Leeuwenhoek
 - d) Carl Zeiss
- 2) What teams played in the 1943 World Series ?
 - a) White Sox-Giants
 - b) Cardinals-Browns
 - c) Giants-Senators
 - d) Cardinals-Yankees
- 3) In the TV show *The Odd Couple*, Oscar wins a prize in a radio contest. What was the prize ?
 - a) new bowling ball
 - b) new refrigerator
 - c) new car
 - d) canned squid
- 4) Kurt Browning, the Olympic ice skating champion, is from *what* Canadian province ?
 - a) Alberta
 - b) New Brunswick
 - c) British Columbia
 - d) Ontario

→ ANSWERS in next months issue of the Science Newsletter ! ←---

** ANSWERS to May's Superfluous Questions: 1. b) Texas 2. a) Shreveport 3. d) Ivy 4. b) Las Vegas