Volume 16, No. 4

Fourth Quarter

Winter 2006

PSF NEWS

Planetary Studies Foundation

PSF would like to wish Everyone a Happy Holidays and a Prosperous New Year!

Astronaut Jack Lousma

Confirmed to Speak at 18th Annual Benefit Dinner

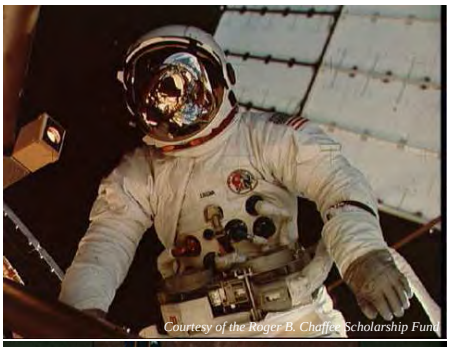
On March 10, 2007, PSF will be hosting it's 18th Annual Benefit Dinner in Hoffman Estates. PSF is honored to announce that this year's guest speaker will be astronaut Jack Lousma.

Lousma is most recognized for his participation in Skylab-3 and Columbia STS-3. He became involved with the space program in 1966 and his list of accomplishments is very impressive. Lousma served in support roles on the missions of Apollo 9 and 10. He also played a historic part in the near-tragic flight of Apollo 13 while he was acting as capsule communicator (or "cap-com" as it is known). Jack was manning the cap-com position when an oxygen tank exploded and nearly destroyed the Odyssey command service module. For many long and cold hours, Jack's voice was the only link Apollo 13's crew had with earth. It was his calm and controlled instructions that carried the crew safely home.

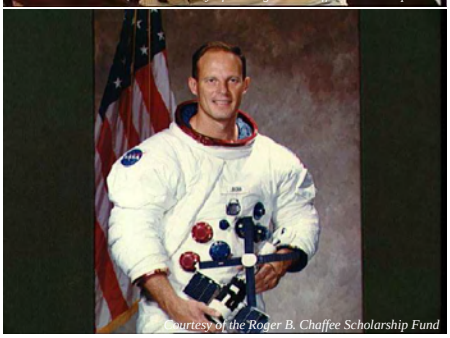
After his influence and support for so many space missions, Lousma was ready to head to space himself. He became one of the first "space residents" when he spent 59 days aboard Skylab-3. He was the pilot of Skylab-3 and later became the spacecraft commander on STS-3. Lousma logged over 1,619 hours in space and 11 hours on two space walks outside the Skylab space station.

Before leaving NASA in 1983, Lousma helped with one last mission as a backup docking module pilot for the Apollo-Soyuz Test Project mission which was completed successfully in July 1975. In 1997, Colonel Jack Lousma was inducted into the US Astronaut Hall of Fame.

PSF is proud to host this incredible man as our guest speaker for this year's dinner. For more information on this year's dinner, see page 11.



Courtesy of the Roger B. Chaffee Scholarship Fund



Courtesy of the Roger B. Chaffee Scholarship Fund

President's Message

This is the time of year when we all sit back and reflect on the events of this past year, and I am no exception! The year began in January with our first public event at the Challenger Learning Center in Woodstock, Illinois honoring the astronauts who have given their lives for space exploration. That was quickly followed in March with the opening of a three month meteorite exhibit at the Lizzadro Museum of Lapidary Art in Elmhurst, Illinois and our Annual Dinner featuring astronaut Al Worden. May and June saw the PSF supporting a NASA educational exhibit in Dubuque, Iowa with StarLab presentations by Diane Spiera and a visit by astronaut Walt Cunningham. During this nine week exhibition tens of thousands of people learned about past, present, and future of NASA space programs as well as learning about the stars and seeing meteorites for the first time. PSF was advertised in flyers, newspaper articles, and radio spots. It was a wonderful opportunity for PSF to get the word out about who we are and what we do. July saw us commemorate the 30th anniversary of the Viking Mars landings with a program at the Challenger Learning Center. July also saw our Austrian colleague Dr. Birgit Sattler off to Spitzbergen to continue her efforts in polar microbiology. This was her third trip to the distant north with PSF support. Her efforts have led to numerous scientific journal articles along with both professional meetings and public presentations. She also represented Austria, and PSF, at the international Antarctic Treaty meeting in Scotland. PSF fall activities were geared toward preparations for opening the new PSF meteorite and space exploration exhibit at the Challenger Learning Center. The official opening took place on October 17th with Space Shuttle astronaut Ken Reightler and the mayor of Woodstock sharing in the ribbon cutting ceremony. It was an evening charged with excitement as children had their pictures taken with our large and heavy Gibeon meteorite which sits on the floor in the center of the exhibition hall. On November 8th PSF members Gary Kutina, Larry Pavell and myself joined over a hundred students at the Karl G. Henize Observatory at Harper College to view the planet Mercury as it passed between the Earth and Sun. It was extremely exciting to see that little black dot move across the face of the Sun in less than five hours. The next time this will happen is in 2016. Throughout the year PSF members presented numerous programs for libraries, community organizations, and various educational institutions. It was an extremely productive year.

Looking ahead to 2007, the PSF will join in the celebration of the International Polar Year by first participating in a joint research project with the British Antarctic Survey and the University of Innsbruck at Port Lockroy on the Antarctic Peninsula. PSF member Dr. Birgit Sattler will join British researchers in her continuing studies of polar microbial communities and the effects of global warming. In addition, if PSF can find the necessary financial support, we will be returning to Patriot Hills, Antarctica to complete the Lake Paula project which began in 2002. This will be a great opportunity to showcase PSF s contributions to polar research. But, let s not forget our meteorites. In December the PSF entered into a partnership agreement with the University of Washington in Seattle to conduct collaborative meteorite research to study the hundreds of unclassified meteorites begging for attention. This will all begin with the new year. So in closing, I have had the pleasure to report on one of the most productive years in our long history.

On behalf of myself and my family I would like to wish all of our members and friends a very happy holiday season and a very successful new year.

Paul P. Spiera

Donor's Spotlight

Thank you for your generous contributions!

$1,000 - $1,999

Violetta J. DuPont

$500 - $999

Paul & Diane Sipiera

Renewing Members

Jerry Clemens

Cecilia Cooper

Member's Corner

Congratulations:

To **Paula F. Sipiera** who was awarded a second place Youth Essay
Certificate of Merit for her junior high essay on what citizenship means to her. Her award reads "In recognition of excellence in the Patriot's Pen Youth Essay Competition, you have been designated AN OUTSTANDING YOUNG SPOKESPERSON OF THE FUTURE". The competition was sponsored by the Veteran's of Foreign Wars and its Ladies Auxiliary.

To **James A. Lovell** on the 40th anniversary of his Gemini 12 flight with **Buzz Aldrin**. Together they spent 14 days orbiting the Earth in a very cramped and ting capsule. That capsule is now on display at the Adler Planetarium in Chicago as part of its new Shoot for the Moon exhibit which features Jim Lovell. This exhibit is very informative and quite entertaining through its use of several interactive displays. It is definitely worth the trip to downtown Chicago to see it.

To **John Hardy** on his joining the faculty at St. Viator High School in Arlington Heights, Illinois. Although he currently teaches German, John still maintains his interest in Astronomy. His students will certainly benefit from his enthusiasm for the German language and culture.

To **Jim Schwade** on the publication of his book The Schwade Meteorite Collection. His book features many exceptional photos of rare meteorites along with interesting facts that make these specimens more than just display pieces. Jim's collection ranks among the world's finest and is a tribute to his many years of meteorite collecting. This book is a must for every meteorite collector!

On the travel scene, Galena member **Lary Sommers** recently returned from a trip to Dublin, Ireland where he represented The Chicago Athenaeum, a Galena-based firm that sponsors awards in architecture and architectural designs. They presented their New World Architecture Exhibit to the Professional Royal Institute of Architecture of Ireland.

Member's Spotlight: Richard Hoover

On August 15, 2006 Miriam and I celebrated our 36th Anniversary by having a wonderful dinner in San Diego with Gil Levin and his wife. Gil was the Principal Investigator for the Viking Labeled Release Experiment, which may well have discovered Life on Mars in 1976. Miriam joked that it was amazing that we were together since we usually are not even on the same continent when our Anniversary comes around. I am interested in minerals and fossils and we have a nice collection of ammonites, trilobites and crinoids and well as microfossils. Miriam and I enjoy hunting quail with our two Brittanies, Sasha and Brandy, on a cool, crisp morning in early winter. Even if we get no birds, watching the dogs work and enjoying the walk in the fields and the beauty of nature is exhilarating and refreshing. I have always been a collector—in childhood it was Rocks, Stamps, and Baseball Cards -- now it is Diatoms, Fossils, Microscopes, Minerals, Artifacts, and Fine Books.

1. Where did you attend school and what did you study?

I attended Jr. and Sr. High School in Clarksville, Arkansas (1954-1960) where my interest was in science developed. I was intensely interested in Chemistry, Microscopy, Minerals, and Astronomy. By the ninth grade, I had obtained a fairly good library and a nicely outfitted Chemistry Lab - complete with Bunsen Burners, Erlenmeyer Flasks, Beakers, and a fine assortment of chemicals. I obtained many of my books and supplies from Prof. I. T. Beech, who was my Scoutmaster and Head of the Chemistry Dept. of the College of the Ozarks. Dr. Beech advised me on many science related merit badges and profoundly influenced my early love for Science. I later graduated from Henderson State University in Arkadelphia, Arkansas (Majoring in Mathematics, Physics, and French). I then studied theoretical mathematics at Duke University (NSF Fellow) and Physics at University of Arkansas, UCLA (Optics) and the University of Alabama in Huntsville.

2. What is your current profession and what inspired you into that career?

My current profession is Astrobiology, which I began in 1996 shortly after David McKay announced his discovery of possible microfossils in the ALH84001 meteorite from Mars. My work in Astrobiology has been devoted to the study of living microbial extremophiles and microfossils in ancient rocks from Earth and microfossils in carbonaceous meteorites. This was a dramatic transition, since I had spent my first three decades working for NASA in X-Ray Optical Systems and Solar X-Ray Astronomy. My transition from Solar Physics to Astrobiology was greatly facilitated inspired by the fact that for several decades I had been engaged in the study of diatoms, cyanobacteria, and other unicellular microorganisms. Diatoms are single-celled golden brown algae that build exquisitely intricate shells of opaline silica. My study of diatoms began in 1968 when I met Miriam, who became my wife in 1970. She had inherited a wonderful collection of microscope slides of diatoms that had been prepared in the late 1800's by Cornelius Onderdonk (her great grandfather). Miriam still tells friends that I just married her to get her diatoms. Diatoms are truly wonderful as they are not only beautiful but they are also the most important plants on Earth. Diatoms and cyanobacteria are at the base of the marine food chain and contribute much more than 60% of the oxygen replenished to the Earth's atmosphere.

These microbes are of great interest to Astrobiologists as they are extremophiles which might be capable of living on other icy bodies of the Solar System. Diatoms are the dominant forms of plant life of the Sea Ice, Glaciers, and the Polar Ice sheets but they also grow in hot springs, geysers and highly alkaline soda lakes like Mono Lake in California. Some diatoms are also extremely resistant to radiation. A diatom bloom was found growing in the water near Eniwetok Atoll, only a few days after the first Hydrogen Bomb explosion vaporized the island on Nov. 1, 1952

My research on diatoms resulted in the invitation in 1973 to Inventory the diatoms of Henri van Heurck Museum for the Royal Society of Zoology of Antwerp, Belgium. For the next several years, my vacations from NASA were spent in Antwerp. I loved the wonderful food and culture of Europe and enjoyed the exquisite microscopes, scientific library, and the type specimens and magnificent arranged slides of diatoms in this wonderful museum. Photos of some of these slides appeared in June, 1979 in my *National Geographic* article *"Those Marvelous Myriad Diatoms."* As a result of this *National Geographic* article on diatoms, I received a phone call in 1985 from my childhood hero - the noted Astronomer Sir Fred Hoyle. Hoyle had become famous for his scientific work on the origin of elements within stars (Nucleosynthesis), the Steady-State Cosmology, and for his numerous Astronomy texts and Science Fiction books. Professor Hoyle had called me to discuss diatoms rather than Astronomy. He had become interested in diatoms because of experimental and theoretical studies that he had carried out with his colleague, Prof. N. C. Wickramasinghe. This research had found that the infrared spectrum of Interstellar Dust grains toward the center of the galaxy more closely matched that of bacteria and polymeric silica (such as is found in diatom shells) than by carbon coated grains of ice and inorganic silicates (such as olivine and sand grains). This conversation about diatoms ultimately led to a lengthy collaboration with Sir Fred Hoyle. Fred and his lovely wife Lady Barbara came to Huntsville and spent a week as our houseguests and my wife and I still cherish the memory of that week. This research resulted in the publication of our paper "Diatoms on Earth, Comets, Europa and in Interstellar Space." *Earth, Moon, and Planets,* **35,** 19-45, 1986, This paper considered the possibility of microbial life on comets and in the oceans underneath the frozen crust of Europa and provided data showing that the infrared spectrum of bacteria and diatoms microbes matches that of Interstellar Dust grains in the Trapezium nebula and the galactic center source GC-IRS-7. This very early Astrobiology paper appeared a full decade before the 1996 report by David McKay and co-workers of the discovery of possible microfossils in the Mars meteorite ALH84001 that instigated modern Astrobiology research.

Diatoms continue to play a significant role in my life. Last week, I returned from Brussels, Belgium where the van Heurck diatom collection now resides. While in Belgium, I spent several days visiting with Philippe van Heurck, the great, great, grandson of the brilliant scientist. Philippe and I then met with the President of the Royal Academy of Science of Belgium and several other noted Belgian scientists to discuss diatoms, cyanobacteria and the latest results of my studies of well-preserved microfossils of filamentous prokaryotes embedded in carbonaceous meteorites.

3. What is your most memorable achievement?

My most memorable achievement was undoubtedly the discovery in late 1996 of well-preserved microfossils of filamentous prokaryotic microorganisms embedded in freshly fractured interior surfaces of the Murchison meteorite. I immediately realized the significance of indigenous microfossils in meteorites. Environmental and Field Emission Scanning Electron Microscope Studies that I have carried out during the past decade, have revealed a complex suite of large filamentous microfossils does exist in some of the CI (Orgueil & Ivuna) and CM (Murchison) and CO (Rainbow) carbonaceous meteorites. However, I have never detected similar filamentous forms in other carbonaceous (CR, CV, and CK) meteorites. I have also failed to find them in any of the ordinary chondrites, achondrites of iron meteorites that I have examined. These discover that many of these filaments exhibited detailed characteristics of many ensheathed prokaryotic microorganisms led me to an intensive study of living and fossil cyanobacteria and filamentous prokaryotes. Unlike many bacteria that appear as small, simple and indistinct cocci or bacillar forms, the filamentous cyanobacteria are sufficiently large and so highly differentiated that for over 200 years they have been classified to genus and species on the basis of their distinctive morphologies and the sizes and size ranges of the cells, filaments and sheath. It is well known that many ancient cyanobacteria (over 3.2 billion years old) are virtually indistinguishable from their modern counterparts. Fossil cyanobacteria are routinely identified and classified based on the observable morphologies of the cells and filaments and these ancient fossils are frequently given names reflecting the modern species. I am convinced that the filamentous remains that I have found in the meteorites are not the result of recent contamination. The Energy Dispersive X-ray studies I have carried out reveal that many of them are mineralized or carbonized and they often exhibit an absence of Nitrogen and have Oxygen/Carbon ratios that are similar to bituminous coal (entirely unlike living or dead microorganisms).

4. How did you become involved with the PSF?

Jim Lovell and Richard Hoover at the Thiel Mountain Range

I became involved in the Planetary Studies Foundation when Paul Sipiera visited NASA in 1999 and invited me to join him and several of his distinguished colleagues to serve as Science Team Lead for the Antarctica 2000 Expedition that he was organizing. This important Expedition included Cdr. James A. Lovell, Jr. (GEMINI 7, GEMINI 12, APOLLO 8, and APOLLO13) and Astronaut Owen Garriott (SKYLAB and Spacelab-1), Paul Sipiera (Expedition Leader), James Pritzker, William Gruber, David Butts, Sharon Hooper, Amanda Onion and Adam Petlin joined the team to document the Expedition to Southern Patagonia, and Antarctica's Patriot Hills, Thiel Mountains, and the South Pole for Fox News. http://science.nasa.gov/headlines/y2000/ast03may_1m.htm The Antarctica 2000 Expedition was tremendously successful; twenty meteorites were recovered from the Blue Ice Fields of the Thiel Mountains and I collected some very interesting microbial extremophiles from Patagonia and from the ice, snow and rocks of Antarctica.

Due to weather we had to abort our landing just as we were about to touch down at the Patriot Hills. The fact that our first flight to Antarctica was aborted turned out to be extremely fortuitous for me. Since we were forced to wait in Chile for 72 hours before our pilot could again attempt a return flight to the Patriot Hills of Antarctica, we decided to take a day trip to visit the Seno Ottway Magellanic Penguin Colony at the southern tip of Chile. I found what I was searching for and while I was on my knees scooping up a sample of Magellanic Penguin Guano into a sterile sample tube, Jim Lovell walked up and asked me what I was doing. Without looking up, I replied, "Don't look, Jim, this is really good stuff." This single sample of penguin guano turned out to be extremely exciting. It produced one new genus and one new species of microbial extremophiles. The paper describing the new species (which we named *Trichococcus patagoniensis)* was just published in the September 2006 issue the *International Journal of Systematic and Evolutionary Microbiology (IJSEM).*

5. What area of science interests you the most and what advancements would you like to see in the future?

I am most interested in Astrobiology, which is devoted to the study of life in the Cosmos. Observations of quasars, galaxies, molecular clouds, distant stars, planets, comets and moons have clearly shown that the same suite of chemical elements, compounds, molecules and organic chemicals that are found on Earth are common elsewhere in the Cosmos. The laws of chemistry and physics appear to be Universal. The evidence for microfossils in meteorites suggests that the laws and principles of biochemistry, molecular biology and microbiology may also be Universal and Life may very well be a common component of the Universe. I think it would be truly astonishing if we were to discover that life, which exists in great abundance in every possible niche on Earth, was present only on Earth and nowhere else in the Cosmos. For this reason, the greatest advancement I would like to see in the future would be the development of spacecraft, instruments and missions designed specifically to actively search for evidence of extant life on comets, Mars, or the icy moons of Jupiter and Saturn with liquid water oceans (Europa & Enceladus). The discovery of living organisms (and the recovery of extraterrestrial life forms in living state -- so that they could be extensively investigated either on Earth or at Space Station or base on the moon) could provide tremendously valuable insights to the nature of Life Itself. Such knowledge could conceivably help us develop novel enzymes, proteins, antibiotics and advanced medicines that might afford new treatments and cures for disease.

6. You enjoy traveling the world, what was your favorite destination and why?

This is a very difficult question as I am somewhat a creature of the planet. I loved Antarctica as it is truly one of the most beautiful places on Earth. Of course, I was there in the sunny summertime when the temperatures (-20 to -40 C) were much more kind that they would have been during the long polar night. Antarctica affords spectacular sights and wonderful treasures for those interested in meteorites and extremophiles.

However, I also loved the Kolyma lowlands of the far Northeastern corner of Siberia. Siberia is a truly vast and beautiful land. When I arrived in Moscow, I discovered that I was still closer to my home in Huntsville than the Lake Yakutskoye - my final destination in Siberia. http://science.nasa.gov/newhome/headlines/ast27may99_1.htm

This region is so immense and can be so hostile to human life that it was considered a separate planet by Stalin's prisoners who were sent to mine gold and platinum from this "pole of cold and cruelty. " It is reported that the prisoners sent to this most hostile land of this Gulag Empire often whispered the phrase "Kolyma means death." In 1999, I spent several weeks working with a team of Russian scientists drilling in the frozen permafrost of the Kolyma lowlands searching for microbes living in cryopegs. These are pools of water trapped in the permafrost with such high salt content that they remain liquid at -20 C. I considered the microbes of these pools to represent analogs for the types of life that might be able to grow in the water of Lake Vostok deep beneath the Central Antarctic ice sheet or in liquid water pools near the crusts of comets or oceans beneath the ice sheets of Europa. A family of wolves lived at the top of the hill just above our drilling site and beautiful little white Ermine with black feet and ears often kept me awake by scampering across the top of my tent. The immense tundra was absolutely spectacular – cliffs at the edge of Lake Yakutskoye had snow banks with red snow algae and ancient ice wedges. The flat tundra was dotted with shallow lakes filled with diatoms and tiny flowers, mosses, and lichens grew everywhere. My trip to Kolyma was in late summer (August) and early winter (September) of 1999 and very soon after I left, the long polar night fell and the flowers vanished under the snow and ice as the Kolyma lowlands were again wracked by frigid polar winds.

I also loved seeing the spectacular sunsets from the Furnace Creek Inn of Death Valley. I remember the beauty of the full moon as it shimmered in the glassy smooth water of the great volcanic crater of Santorini, Greece and rose over the alien world of the tufa columns of Mono Lake, Ca. I was awestruck by the immense power of the interior of the planet as I watched the geysers erupting at Yellowstone and baked from the heat of the red-black molten lava just as it emerged from deep within the Earths crust at the Kilauea Volcano in Hawaii. But I also love the splendor, opulence, and history of the world's great cities, like Moscow, St. Petersburg, and Paris with their fabulous Operas and wonderful museums. I continue to be intrigued by the mysteries of the Pyramids of Egypt and by the ancient archaeological sites I visited in Peru --- the giant precisely fitting stones of Sachsahuaman and Machu Picchu and the spectacular and enigmatic geometrical and animal designs that adorn the perpetually dry plains of Nazca.

7. Have you experienced something scientifically shocking on an adventure of yours?

I was scientifically shocked in 1973 when some of the diatoms that had been lying on a dried herbarium sheet since 1834, began to swim as soon as I added a drop of water to them on a microscope slide at the Henri van Heurck museum. This sense of awe was again repeated in 2000 when ancient bacteria that had been frozen for 32,000 years in the ice of the Fox Tunnel, Alaska also began to swim as soon as the ice thawed. We named this previously unknown organism, a living relic from the Pleistocene - *Carnpbacterium pleistocenium*

http://ijs.sgmjournals.org/cgi/content/abstract/55/1/473
http://www.livescience.com/othernews/050223_arctic_life.html
http://en.wikipedia.org/wiki/Carnobacterium_pleistocenium
http://www.msnbc.msn.com/id/7019473

8. As an active PSF member, where do you see PSF headed?

The Planetary Studies Foundation continues to make extremely important contributions the study of meteorites and in encouraging interest in the sciences. PSF plays an extremely valuable role helping instill into young students an appreciation of the wonders and beauties of the Cosmos. I hope it will continue to grow and carry out this valuable mission as interest in and knowledge of science is crucial to the future of our Nation.

9. Any exciting plans for the near future?

I am continuing to do research into microbial extremophiles and microfossils in carbonaceous meteorites. A new genus and new species of bacteria *(Anaerovirgula multivorans)* that I collected in Owens Lake, CA will be published in the next issue of IJSEM. I also have several exciting experiments planned to continue the work with meteorites and living filamentous cyanobacteria underway. I also plan to deliver a Lecture next year on these results to the Royal Society of Belgium and I hope that it may be possible for me to again participate in a future Planetary Studies Foundation Expedition.

A Special Thanks to Richard Hoover!

Getting Better with Time

A look at the Hubble Space Telescope

In the past, the best view of space was from the tallest mountain you could climb. Astronomers would climb to great altitudes for a clear glimpse of what was beyond our atmosphere. Finally, in 1990 the Hubble Space Telescope, the first telescope above Earth's atmosphere, was launched aboard the space shuttle Discovery.

Within it's first ten years, the telescope had made 330,000 exposures and probed 14,000 celestial targets. This large telescope sits outside of the Earth's atmosphere and has whirled around Earth 58,400 times, that is equal to 1.5 billion miles or eight round trips to the Sun! Each day the telescope generates enough data to fill a home computer (3 to 5 gigabytes). Although it is easy to forget about the massive telescope orbiting us everyday, astronomers depend on the daily information to observe, discover and collect new data. Astronomers have published 2, 651 scientific papers on Hubble results.

Although the space program has been relatively "inactive" compared to NASA in the past, the telescope is always probing further into the future. On November 16, 2006, Hubble found evidence for Dark Energy in the young universe. The telescope found that Dark Energy is not new, but has been present for most of the universe's history. This finding was consistent with Albert Einstein's prediction nearly a century ago.

Hubble Statistics

Length: 13.3 meters (43.5 feet)

Weight: 11,110 kilograms (24,500 pounds)

Primary Mirror: 2.4 meters (7 feet 10.5 inches)

Latest Solar Arrays: 36 meters² (384 feet)

1977 — Congress approves budget for a space telescope. Lockheed Missiles and Space Company wins

1979 — Astronauts begin underwater training with telescope mockup.

1981 — The Space Telescope Science Institute is established as the operations center in Baltimore, MD.

1983 — The telescope is named after renowned astronomer, Edwin P. Hubble.

1986 — Hubble launch is delayed after the Challenger accident.

1989 — The telescope is shipped from Lockheed Missiles and Space Company in California to the Kennedy Space

1990 — Hubble is launched aboard the space shuttle, Discovery.

1990 — The telescope resolves a ring of material around the Supernova 1987A.

1992 — Hubble identifies nearby intergalactic clouds.

1993 — First servicing to help fix the telescope's myopic vision.

1994 — Hubble offers definitive confirmation of the existence of super massive black holes.

1995 — Another observation, called the Hubble Deep Field, allows astronomers to see the edge of the universe.

1996 — Hubble resolves the host galaxies of quasars.

1997 — The second servicing mission.

1999 — Hubble's observations allow astronomers to refine the universe's expansion rate to within 10% accuracy. Also

IGNITE YOUR IMAGINATION WITH THE CHALLENGER LEARNING CENTER!

For more information and to register for these and other programs, call the Challenger office at (815) 338-7722 or stop by the center at 222 Church Street in Woodstock. To find out more about the Challenger Learning Center, log onto our website at www.challengerillinois.org.

Family Science Night Series

Join in the most popular series at the Challenger Center that combines families and science with exploratory fun! The first Friday of every month is a family program that focuses on a different theme with activities each member of the family will enjoy!

Program Fee: $10 per person per program. Includes pizza and pop. Pre-registration is required.

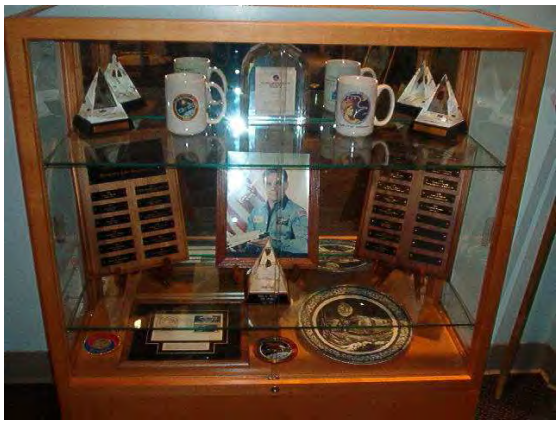
Participants: Ages 5+. Children must be accompanied by an adult.

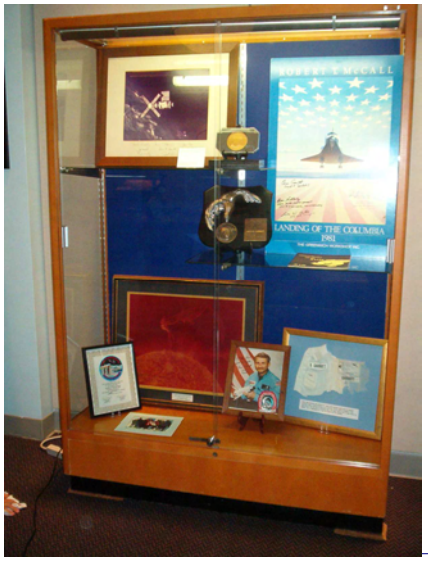
Tallest Tower Competition **Friday, January 5th - 6:00-8:30 p.m.**
Bring your thinking caps and take the challenge! Each family will work together to come up with a plan to create the tallest free-standing tower with a set amount of supplies. It's the ultimate workshop that combines strategy and teamwork.

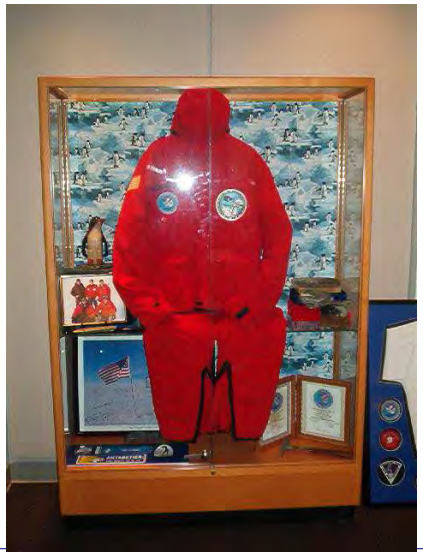
The Great Airplane Race **Friday, February 2nd – 6:00-8:30 p.m.**
There's more than one way to make a paper airplane! Come and learn a few new folds, tricks and techniques followed by a paper airplane toss for prizes.

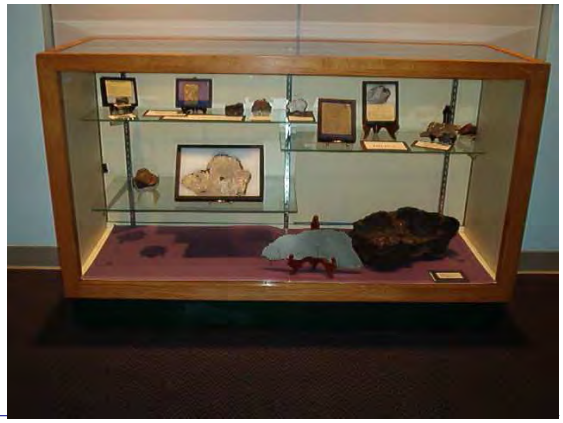
Science Olympics **Friday, March 3rd – 6:00-8:30 p.m.**
Put on your thinking cap for a night filled with scientific challenges! Families will work as teams to brainstorm, problem solve and create works of science doing several different and fun tasks, such as building a catcher for an egg that will be dropped from various heights.

Also visit . . .
The newly opened PSF meteorite & space exploration exhibit at
The Challenger Learning Center









Astronomy 101 by David Kahn

What are…Stars?

On a clear dark night, a few thousand stars are visible to the naked eye. Even though each individual star is unique, all stars share much in common. The Sun, which is the source of virtually all light, heat and energy reaching the Earth, is our nearest star. Today, we know that stars are born from interstellar gas clouds, shine by nuclear fusion, and then die, sometimes in dramatic ways.

Each star has certain basic properties that, when taken together, can be used to categorize them. First, stars can be grouped according to their diameter, which can range from 0.1 times the Sun's diameter to hundreds of times larger. One of the most important properties of a star is its mass, which can range from 0.01 times the Sun's mass to 20 times more massive. Some stars are even up to 100 times more massive than the Sun, but these are thought to be very rare. Next, stars can be classified according to their surface temperature, which can range from about 2,000° K for the coolest stars to 50,000° K for the hottest. These temperatures can be determined through spectral analysis. Further, all stars, including the Sun, have nearly identical compositions. Typically, 73% of a star's mass is hydrogen, 25% is helium and 2% is made up of all other elements.

One of the most basic observable properties of a star is its brightness, which can be measured in two distinct ways. The apparent magnitude is the measure of how bright a star appears to be from Earth. It is measured on a scale taken from the ancient Greeks, where brighter stars are given lower numbers (i.e. Sun -26.5; Full Moon -12.5; Venus -4.1; Sirius -1.4; North Star 2.0; limit of naked eye 6; Pluto 15; limit of Hubble Space Telescope 28). Keep in mind that apparent magnitude does not actually indicate how bright a star is, because it does not take into account the star's distance from us. Instead, absolute magnitude can also be measured, which allows the overall brightness of objects to be compared, without regards to distance. This is done by measuring the magnitude that a star would appear to have at a hypothetical distance from us of 10 parsecs (33 light years). It is also important to remember that brightness does not give an actual measure of energy output. Instead, astronomers measure a star's luminosity, or the amount of energy radiated into space per second by a star. In order to determine a star's luminosity, its apparent magnitude and distance must be known.

The properties of mass, luminosity, temperature and diameter are closely related, and can be used to classify stars into their various stellar classifications. Further, the relationships between those properties can be demonstrated on a graph called the Hertzsprung-Russell (H-R) diagram. About 90% of all stars, including the Sun, fall along a broad strip of the H-R diagram known as the main sequence, which runs from the top-left corner (hot, luminous stars) to the bottom-right corner (cool, dim stars). For main sequence stars, it can be demonstrated that luminosity increases with temperature. These stars are now known to be fusing hydrogen into helium at their core.

However, not all stars fall on the main sequence. Stars plotted on the upper right of the H-R diagram are cool, yet very luminous. In order to be that bright and yet cool, they must have a large surface area. These stars are called red giants, which are very large, distended, and relatively cool stars which are in the final stages of their lives. If a typical red giant were at the center of our solar system, it might extend past the orbit of Mars, and its relatively cool temperature (perhaps only 2,000° C as compared to the Sun's 6,000° C) would make it look orange or red instead of yellowish-white. The Sun is predicted to become a red giant about 5 billion years from now. Red giants are not the only stars that do not plot on the main sequence. The dim, hot stars plotted in the lower left of the H-R diagram must be very small; otherwise they would be very luminous. These stars are called white dwarfs, which are collapsed stars with approximately the mass of the Sun crammed into a space the size of the Earth.

All stars form in the same manner as did the Sun. Star formation begins with a cloud of interstellar gas and dust called a nebula, which collapses upon itself due to its own gravity. As this cloud contracts, it begins to rotate, eventually forming a disk shape with a hot, condensed object at the core, called a protostar. This protostar is in its earliest stages of development, shortly before the start of nuclear fusion. Eventually, the temperature inside a protostar becomes hot enough for nuclear fusion to begin, and the protostar ignites, becoming a main sequence star.

What happens during the remaining life of a star depends on its mass. Mass governs a star's temperature, luminosity and diameter. The more massive a star, the more inward pressure (gravity) there is, and the hotter and denser the star becomes to balance that gravity. At the core of a main sequence star, hydrogen atoms are fused into helium atoms (nuclear fusion), releasing incredible energy. Remember that energy (E) = mass (m) times the speed of light (c) squared (or more familiarly, $E=mc^2$). The production of this energy provides the outward pressure that balances against the inward pressure of gravity.

As a star like the Sun converts hydrogen to helium in its core, it gradually become more luminous as the core temperature slowly rises. It takes about 10 billion years for a star with the mass of the Sun to convert all of the hydrogen in its core into helium. At this stage, the star begins expanding; increasing its luminosity, while decreasing its temperature. It becomes a red giant. Eventually, the outer layers of gases are lost and the star returns to near its original size. However, the core is extremely hot (100 million degrees K) and the helium is now converted into carbon. When all of the helium has converted to carbon, the outer layers are again lost. This leaves a small, hot core about the size of the Earth—a white dwarf.

The death of a more massive star is much more dramatic. These star burn through their nuclear fuel much faster, synthesizing heavier elements, with each set of nuclear reactions forming a new layer around the star. As more layers form, the star becomes a supergiant, which is a star that has a mass at least six to ten times greater than the Sun. When the reactions in a supergiant's core have created iron, no further energy-producing reactions can occur, and the core collapses on itself. This collapse is so violent, that protons and electrons in the core merge to form neutrons. As the inward falling material bounces off the hard core, the outer layers are blown off in an explosion known as a supernova. After the outer layers are blown away, the remaining dense core is now called a neutron star. Some neutron stars pulse radio waves into space as they spin. Known as pulsars, these are rotating (30 times/sec.) neutron stars whose radiation is observed as regular pulses. Finally, some stars are even too massive (20 times the Sun) to form neutron stars. These stars have so much gravity that their cores keep collapsing forever, eventually forming a black hole.

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