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Issue 3

The Newsletter of AIAA Houston Section
The American Institute of Aeronautics and Astronautics

November / December 2012
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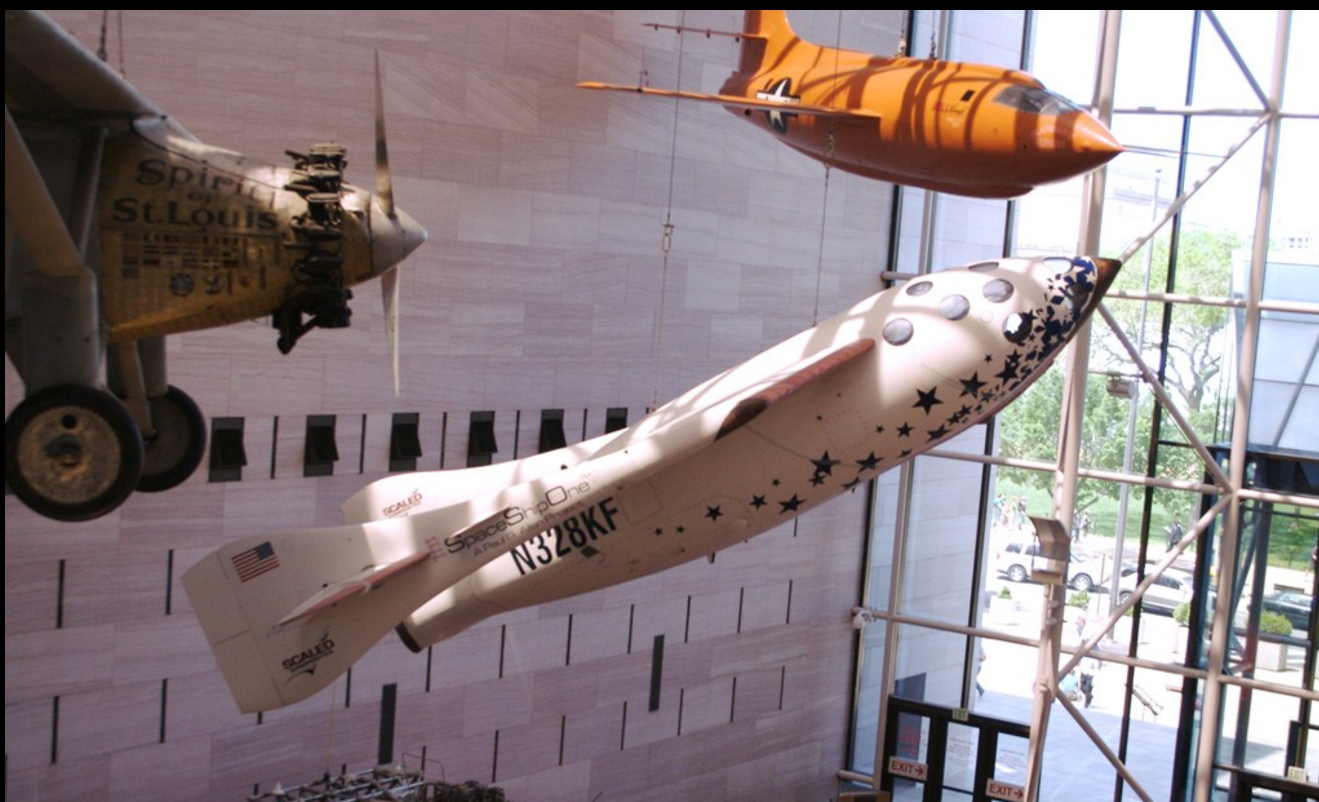
The UP Experience - Houston 2012

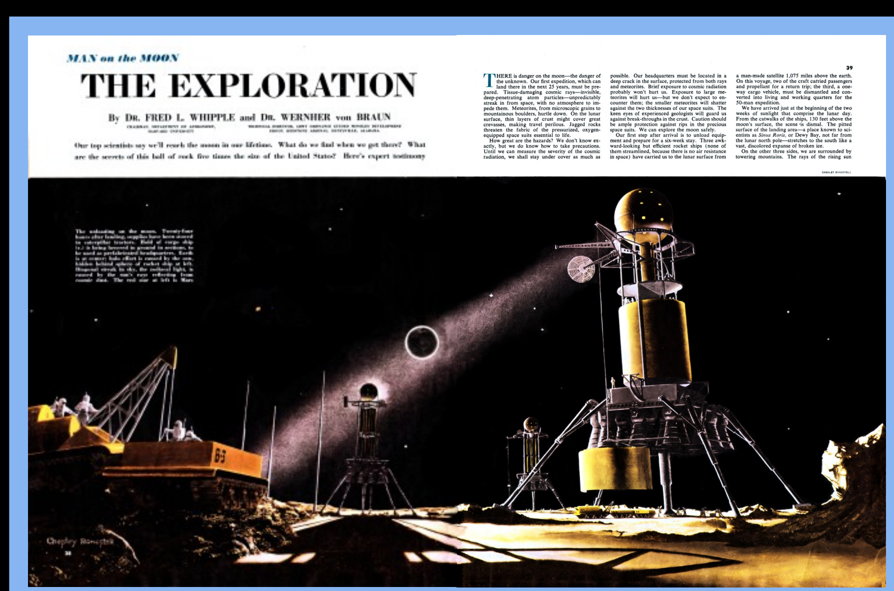
Featuring Burt Rutan & his Interview with Horizons



Also, Continuing in this Issue!
Part 3 of 8:

Man Will Conquer Space Soon!

(Collier's 1952-54)



MAN on the MOON

THE EXPLORATION

By DR. FRED L. WHIPPLE and DR. WERNHER von BRAUN

Our top scientists say we'll reach the moon in our lifetime. What do we find when we get there? What are the secrets of this ball of rock five times the size of the United States? Here's expert testimony

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THERE is danger on the moon—the danger of the unknown. Our first expedition, which can land there in the next 25 years, must be prepared. Tissue-damaging cosmic rays—invisible, deep-penetrating atom particles—unpredictably streak in from space, with no atmosphere to impede them. Meteorites, from microscopic grains to mountainous boulders, hurtle down. On the lunar surface, thin layers of crust might cover great crevasses, making travel perilous. Jagged rocks threaten the fabric of the pressurized, oxygen-equipped space suits essential to life.

How great are the hazards? We don't know exactly, but we do know how to take precautions. Until we can measure the severity of the cosmic radiation, we shall stay under cover as much as possible. Our headquarters must be located in a deep crack in the surface, protected from both rays and meteorites. Brief exposure to cosmic radiation probably won't hurt us. Exposure to large meteorites will hurt us—but we don't expect to encounter them; the smaller meteorites will shatter against the two thicknesses of our space suits. The keen eyes of experienced geologists will guard us against break-throughs in the crust. Caution should be ample protection against rips in the precious space suits. We can explore the moon safely.

Our first step after arrival is to unload equipment and prepare for a six-week stay. Three awkward-looking but efficient rocket ships (none of them streamlined, because there is no air resistance in space) have carried us to the lunar surface from a man-made satellite 1,075 miles above the earth. On this voyage, two of the craft carried passengers and propellant for a return trip; the third, a one-way cargo vehicle, must be dismantled and converted into living and working quarters for the 50-man expedition.

We have arrived just at the beginning of the two weeks of sunlight that comprise the lunar day. From the catwalks of the ships, 130 feet above the moon's surface, the scene is dismal. The pitted surface of the landing area—a place known to scientists as *Sinus Roris*, or Dewy Bay, not far from the lunar north pole—stretches to the south like a vast, discolored expanse of broken ice.

On the other three sides, we are surrounded by towering mountains. The rays of the rising sun

CHESLEY BONESTELL

November / December 2012
Horizons, Newsletter of AIAA Houston Section

Horizons is a bimonthly publication of the Houston Section of The American Institute of Aeronautics and Astronautics.

Douglas Yazell, Editor

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Cover: Photo of SpaceShipOne in the Smithsonian in Washington DC. Image credit: ZnU. "The Exploration" is from the Collier's series in this issue. Table of contents page: part of Vincent van Gogh's 1889 painting The Starry Night.

Congratulations to Dr. Ellen Ochoa, AIAA Fellow

DANIEL NOBLES, CHAIR

While it is sad to see Director Coats retiring after so many years of strong leadership, it is with great pleasure that the Houston AIAA can look forward to the leadership of Deputy Director Ellen Ochoa. Dr. Ochoa has flown on four missions (STS-56, 66, 96, & 110), has a PhD from Stanford, three patents, and will be the first Hispanic director of the Johnson Space Center. She has an extremely technical background in research and development, and is sure to be an asset as the NASA Johnson Space Center's mission grows. I have great hope that we will receive strong support from Dr. Ochoa as center director. Indeed she recently earned the prestigious title of AIAA Fellow. I also recently learned that there are numerous biographies that have been written about her life and accomplishments (25 were identified on a popular online bookstore's website).

From the Chair

chair2012@aiaahouston.org
(Daniel A. Nobles)
Links:
https://people.nasa.gov

Above: For more information about Dr. Ochoa, check out her official NASA biography at: http://www.jsc.nasa.gov/Bios/htmlbios/ochoa.html. Image credit: NASA.

Above: Early warning publicity flyer for our Section's Annual Technical Symposium of Friday, May 17, 2013.

From the Editor

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www.aiaahouston.org
An archive for Horizons on a national AIAA web site is here.

Submissions deadline: February 7, 2012, for the January / February 2013 issue, to be published by February 28, 2013.

The Late James C. McLane, Jr.

DOUGLAS YAZELL, EDITOR

James C. McLane, Jr. initiated and co-founded our sister section relationship with the Shanghai Astronautical Society in 1987. His first visit there was made as part of a delegation of professionals in the footsteps of Eisenhower's citizen-to-citizen diplomacy initiative. Jim wrote in Horizons long ago that in China they are Chinese first and communist second. Jim led our Section's delegations to China in 1988 (We have great photos!) and 1992 (We will soon have great photos from that visit.), and a Chinese delegation visited us in the NASA/JSC community in 1990. Marlo Graves volunteered in about 2008 as our sister section contact person. She continues to do a great job in that role today. She had completed a summer session at International Space University (ISU) in Strasbourg, France. The following year, she had worked for ISU for that same summer session, but it took place in Beijing, not Strasbourg. She traveled once more to China with some help from AIAA and AIAA Houston Section. She visited both Beijing and Shanghai. Her role in our Section is now with our Chinese colleagues in Beijing, not in Shanghai. Franklin Zhang and Marlo accepted our request to write an article in this issue. Our June 2008 issue has articles about this work by Jim and Marlo on its pages 13 through 19.

Jim McLane was our Section's 1971-1972 Chair. Our newsletter started in that year when a JSC contractor company volunteered to produce it. It was initially named Newsletter (AIAA Houston Section Newsletter), and the name Horizons was selected much later, maybe in 1990. Jim McLane later filled regional and national AIAA roles, including direction of technical activities and professional development. He was a great friend though we met rarely. It was a pleasure visiting with him and his son James C. McLane III in the Heroes & Legends tent during the 2011 *Wings Over Houston* air show, where Jim was one of the featured guests of honor. Jim stepped up and delivered for AIAA. He provided decades of high-quality AIAA service and leadership.

This issue's cover story is possible thanks to the generosity of the people at The UP Experience, Houston's signature event since 2008. Shen Ge and I attended this year with press credentials. Shen took the initiative to ask for an interview with Burt Rutan. Shen prepared the questions and conducted the interview while I recorded sound on my iPad and recorded video with my digital still camera. It was great to talk with this legendary aerospace vehicle designer.

Thanks go to Wes Kelly for accepting our invitation to write in this issue about that major discovery, exoplanet α Centauri Bb. Shen Ge suggested the article in this issue from Dr. Martin Elvis, Creating an Economically Robust Space Policy, and we thank Dr. Elvis. The Collier's series is historic and inspiring. It continues in this issue with part 3 of 8, and with some introductory material starting a few pages earlier. Thanks go to Councilor Ellen Gillespie for this issue's article reporting on the 2012 Wings Over Houston air show. Astrodynamics consultant Daniel R. Adamo authored two articles in this issue, one about Near Earth Object (NEO) TC_4, and one about *A Newly Discovered and Highly Accessible NEO*. Dr. Patrick E. Rodi writes in this issue about NEO Asteroid 2012 DA14. All three are timely articles. Scott Lowther does important ongoing work with our scans for the Collier's series. He also provides his regular column in this issue, Aerospace Projects Review (APR Corner). Our lunch-and-learn summary article in this issue is very timely, and we thank Norman Chaffee, NASA/JSC retired, for adding to our reporting.

Until next issue (about February 28, 2013), happy landings!

Above: Map of the five space / military sites visited in China by our 1992 delegation. We will find those 1988 and 1992 trip reports and restore them to our web site. Right: Li Furong (left) and Jim McLane (right) exchanging and receiving gifts at a technical interchange meeting in China in 1988 or 1992. Image credits: The McLane family. Image source: Pages 15 and 16 of our June 2008 issue.

Right: Astronauts for Hire (www.astronauts4hire.org) published their third quarterly newsletter.

Houston's The UP Experience 2012 featuring Burt Rutan

Cover Story

SHEN GE, CONTRIBUTOR, DOUGLAS YAZELL, EDITOR

The UP Experience, similar to TED talks, brought together sixteen of the world's brightest and interesting minds to Houston, Texas USA for one day of talks on Thursday, October 25, 2012. There are many free online video examples of presentations from past years of The UP Experience, such as the memorable 2009 presentation by Neil deGrasse Tyson, Director of the Hayden Planetarium.

Legendary aerospace engineer Burt Rutan gave a talk on the necessity of going back into space. He reminded the audience that no one born after 1935 has been to the Moon. This is quite sad for the space industry when one looks at the aviation industry in comparison. In early 1908, there were only twelve pilots while five years later in 1913, there were hundreds of aircrafts and pilots in 39 countries. For space, there are only five manned space systems developed over a period of 42 years, from 1980 to 2012. *They are the Space Shuttle, Shenzhou, SpaceShipOne, the soon to be available SpaceShipTwo and planned Dragon (the capsule) from SpaceX. At the short interview after his talk, Burt revealed to us that he worked on SpaceShipOne even before there was an X-Prize competition and did covert work on that for two years. He competed for and won the X-Prize hoping that this would spur a revolution in more spacecraft being designed and fabricated. The lack of an upsurge in new and private spacecraft is surprising to him since he thought his X-Prize success would have spurred an explosion in activity. Finally, he believes the next revolution in technology will come from more virtual presences allowing people to interact with each other regardless of where they are. National

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[Starting below we present our Horizons interview with Burt Rutan. It took place immediately after his presentation. The presentation will probably be available for free online eventually. After the two of us were granted press credentials, Shen requested an interview with Burt Rutan, a great idea! Shen prepared the questions and asked most of the questions. For brevity, this is not an exact transcript.]

The American federal government played a wonderful historic role in the 1960s with NASA from the time NASA formed until Apollo and Skylab were done. Absolutely phenomenal work was done, and that kind of work is not being done now. NASA follows the President's direction from White House, and in the 1960s, NASA [was doing no] **Muslim outreach and [had no initiatives related to] ethnic diversity. In the 1960s, NASA was acting like a space research company. [NASA was doing what it should] with taxpayer money. ***[Horizons: How did we arrive in this painful situation with NASA now and since 2010?]*** [That started with the] Clinton years and the Shuttle-Mir program. It was political. It was not science at all. It was not about science experiments in space. It was about the political goals of our interface with Russia. I am not saying that is bad, it is just different from the 1960s. It is a change in political direction.

[How can we encourage the current generation to come into our aerospace profession?] In 2004, we learned that a private company can do manned spaceflight, thanks to the Ansari X-Prize. That provides inspiration like the Wright brothers coming out of bicycle shop to be the first in powered flight. I thought whole world would [follow our example of a private company sending people into space]. [The situation is] not near what I expected after 2004. Nobody else has flown. I don't know why not. Ask them. I really don't know. I was predicting [many more following in our footsteps]. Remember, there were 27 competitors for the Ansari X-Prize. I thought five or six of them would have done what I did. My whole program was 3.5 years, and more than two years were covert. No one knew what we were doing for two years. [Why has no one else followed in our footsteps?] That is a good question for you as a journalist to research.

[What will you be doing in the future?] Conduct a Google search for our Scaled Composites to find that answer, but a lot what Scaled Composite is doing is secret. The biggest Scaled Compo-

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www.burtrutan.com

[Editor's note: Other crewed space systems are in the works, NASA's Orion, Boeing's CST-100, Sierra Nevada's Dream-Chaser and Blue Origin's New Shepard.]

**July 6, 2010, ABC News

White House, NASA, Defend Comments About NASA Outreach to Muslim World Criticized by Conservatives

…In response to criticism, White House spokesman Nick Shapiro said in a statement that "The President has always said that he wants NASA to engage with the world's best scientists and engineers as we work together to push the boundaries of exploration. Meeting that mandate requires NASA to partner with countries around the world like Russia and Japan, as well as collaboration with Israel and with many Muslim-majority countries. The space race began as a global competition, but, today, it is a global collaboration."

Above: Burt Rutan (left) and Shen Ge at The UP Experience 2012 in Houston, Texas USA, Thursday, October 25, 2012. Image credit: Douglas Yazell.

The UP Experience

Above: 1930 Collier Trophy. Image credit: FlugKerl2.

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boundaries will be less and less relevant as cultural geography defines who we are.

Dr. Boaz Almog of Tel Aviv University gave a talk on quantum levitation with live demonstration of how a superconducting disk maintains various initial orientations while, once it is given an initial push, it follows the path just above or just below a circular ring of magnets (about three feet in diameter) or a line of magnets, a "rail." The "line" of magnets was a bit like a roller coaster, a U-shaped line which the disk followed back and forth whether it was above or below these magnets. He dipped the disk in liquid nitrogen (readily available and cheaper than milk) before starting a 30 or 60-second demonstration, or he poured liquid nitrogen on top of the disk. He mentioned these magnets can only be made in China since one ingredient is rare. The disk components are mostly not superconducting with only a 0.5 micrometer thickness of the material being a superconductor. This device can levitate more than 70,000 times its own weight. This is not magnetic levitation. This is quantum locking, also called quantum levitation. The ramifications of further development will be tremendous. For instance, current MRI machines are huge since they need liquid helium to cool their superconductors, so he is working to reduce the size of MRI machines by using to-be-developerd superconducting wires. A subway train using these principles might travel at speeds up to 6,500 km/hour. Applications include large motors, accelerators, power cables and energy storage.

Editor's notes from the audio file:

Magnetic field lines behave like quantum objects. Magnetic field lines behave like particles. The superconductor does not like to have field lines moving around. When we cool it, we get quantum locking, three dimensional locking. We get frictionless

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sites projects with press releases are two space-related things. One is SpaceShipTwo with Virgin Galactic, and in mid-December of 2011, Stratolaunch was announced. Scaled Composites now has 430 employees, two 747-400s and is building the world's largest airplane.

[What exciting emerging technologies do you see coming soon?] Virtual reality. We don't have to do travel. E-mail and PowerPoint are the reasons the need for business travel is only about a quarter of what it used to be. Last year our company had a travel bill of only about 20% of what it [had the prior year]. You have a document in front of you, you make a few clicks and you send it to people to review on their own time. In the past you had to fly and be together in a meeting. Telephone is poor communication compared to e-mail. You have to want to talk at exactly the same time as the other person. Kurds live in separate countries, not their own country. A Kurd country in cyberspace can be created. People don't have to move there. People don't have to form a country. America could have conservatives and progressives [in two separate cyber cultures]. There would be no need for silly political fights. You could belong to a country that shares your beliefs. Why does a CEO have a Gulfstream V ready to use at any time? The CEO would answer that maybe just one meeting per year will occur where the CEO can get there fast enough and beat the competition to a deal. So the CEO maintains a fleet of six corporate jets. But if you fly to a meeting now, you get there last. Virtual reality can kill that industry. [For space travel, we can view other planets with virtual reality, but we cannot] float around a room without going to space. It is difficult to make that happen. We could put a collapsed star just above the room [to enable us to float around the room due to gravitational effects]. That was a joke.

[Why are you so creative?] Large advances [in aviation, space and science] were being made when I was a child, [and as a consequence] I had courage and inspiration. I had the courage to try hard things.

[Horizons is reprinting the Collier's series from 1952 to 1954, Man Will Conquer Space Soon! We conclude we are the first to reprint that series of space magazine articles page by page in high resolution.] At my new home, in North Idaho, I have two Collier trophies and two Doolittle trophies. I am very proud of that. I am the only one alive that has two [Collier Trophies]. Glenn Curtiss and Kelly Johnson have two Colliers.

[You are lecturing and staying active. What next?] I am developing a little airplane to let me explore the lakes and rivers where I live. I do very little traveling. I had a talk to give to IBM at Maui, a large audience, and I took the redeye flight to go home after my presentation, so you can see I don't like to travel. I travel very little. But this is a wonderful audience here in Houston today, and I am enjoying this very much. Have they closed that [NASA/JSC]? Is it still open? Why weren't there more people here at this event

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The UP Experience

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motion except for air friction. We use a sapphire disk, and we grow superconducting material on it if we have the right recipe. The magnetic field is the same along this rail. The amount of energy needed to move this, to start this motion, is minimal because there is no friction except for air friction. The disk will keep going until it warms up [and loses its superconductivity]. There is no magnetic repulsion. Forget everything you know about classical physics. Quantum locking and frictionless motion combine when storing mechanical energy.

Neuroscientist and author Dr. David Eagleman started with a talk on the perception of time. Apparently, cause and effect can be mistaken which leads to the interesting theory that schizophrenia may be a disorder of time perception, not knowing which of two nearly simultaneous events occurred first. To test aspects of time perception, an experiment was conducted by dropping 23 people from 150 feet high into a safety net. The observer recorded the time length of fall while the test subject estimated the time length of fall. On average, the test subject estimated the time passage to be 36% longer. Apparently, time and memory

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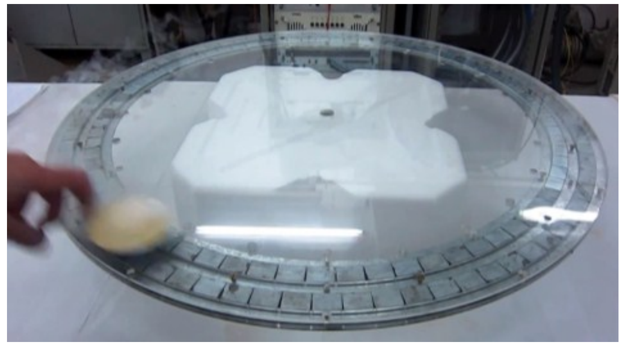

Above: Once cooled with liquid nitrogen, the disk floats via quantum locking (levitation), not magnetic levitation, above or below the rail of magnets. Image credit: www.quantumlevitation.com.

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today from NASA/JSC? I only saw a couple of hands when I asked the audience members today to raise a hand if they work at NASA/JSC. It's weird.

The following paragraphs about the Collier Trophy and the James H. Doolittle Award are taken from Wikipedia. Horizons is reprinting *Man Will Conquer Space Soon!* from the weekly magazine Collier's, a series of manned space articles from 1952 to 1954. Since the same Mr. Collier owned the magazine Collier's and commissioned the Collier Trophy, and Burt Rutan is the only living person to win the Collier Trophy twice, we add a few details here.

The Collier Trophy is an annual aviation award administered by the U.S. National Aeronautic Association (NAA), presented to those who have made "the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency, and safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year."

Robert J. Collier, publisher of *Collier's Weekly* magazine, was an air sports pioneer and president of the Aero Club of America. He commissioned the 525 pound (240 kg) trophy in 1911, originally named the *Aero Club of America Trophy*. Collier also was the owner of a Wright Model B biplane which he purchased in 1911. After presenting it several times, Collier died in 1918 after the end of World War I.

It was renamed in his honor in 1922 when the Aero Club dissolved, and the award was taken over by the NAA. The name became official in 1944, and the award presented once a year by the NAA president, with the trophy on permanent display at the U.S. National Air and Space Museum. As such, the trophy was in the custody of its 1969 co-recipient, Michael Collins during his directorship of the museum.

1911 Glenn Curtiss, for successful development of the hydro-aeroplane. The first award of the Collier Trophy.

1912 Glenn H. Curtiss, for the invention of the single-pontoon seaplane and development of the flying boat.

1958 Clarence "Kelly" Johnson of Lockheed Skunk Works, and Gerhard Neumann and Neil Burgess of GE, for leadership in the development of the F-104 Starfighter (1958) and its J79 engine.

1963 Clarence "Kelly" Johnson, for his leadership at Lockheed's Skunk Works in the development of the SR-71 Blackbird.

1986 Dick Rutan, Jeana Yeager, Burt Rutan and the team of the non-stop unrefueled circumnavigation of the Rutan Voyager

2004 Burt Rutan and his SpaceShipOne team for designing and launching the first commercial manned launch vehicle

The James H. Doolittle Award is an honor presented annually by the Society of Experimental Test Pilots (SETP). It is an award for "outstanding accomplishment in technical management or engineering achievement in aerospace technology." The award consists of a perpetual trophy on permanent display at SETP headquarters, and a smaller replica presented to the recipient. It is named after General James Doolittle, famous for the Doolittle Raid on Tokyo during World War II.

1987 - Burt Rutan, Scaled Composites

2004 – Burt Rutan

The UP Experience

The videos from The UP Experience 2012 are now online and free for anyone to view. Just use that link or start at www.theupexperience.net. We missed Dr. Wade Adam's presentation while we interviewed Burt Rutan. Dr. Adams, Associate Dean of the George R. Brown School of Engineering at Rice University in Houston, Texas USA, spoke about, "Nanotechnology and the Future of Energy." His video is a great one, and it includes getting rid of cancer tumors, a new process already working well with mice.

Above: Game designer and author Jane McGonigal on stage at Meet the Media Guru in Milan, Italy, May 2011. Image credit: Paolo Sacchi / Meet the media Guru.

are intertwined and more memories imply that time appears longer. The solution to make life longer is to make it seem longer by presenting it with more novel experiences. Wear your watch on your other wrist today! Take a different route to work tomorrow!

Biochemist Dr. Gregory Petsko presented on the rising life expectancy and the concurrent rise in Alzheimer's. While the cost for care in time and money is over $200 billion annually, the research on Alzheimer's is a pitiful $0.6 billion. Compare this to something like AIDS research which has received much attention and receives $2.6 billion annually to develop new treatments. The simple reason is that Alzheimer's patients cannot promote research themselves. Dr. Petsko presented a novel technique on overcoming Alzheimer's.

Game designer Jane McGonigal described the power of games to do analysis of real-world problems and to help people overall. She suffered a serious concussion in 2009 after hitting her head on a cabinet door. While in bed, she played a game to heal her brain where she was "Jane the Concussion Slayer," the heroine that slayed her concussion. Through this experience, she created the game *SuperBetter* to help people improve their health by increasing resilience physically, mentally, emotionally and socially. She also created the game *Evoke* as a social entrepreneurship game for the World Bank.

Marcus Luttrell, the ex-Navy seal and best-selling author, talked about his experiences in the military. He jokingly referred to Navy as an acronym, Never Again Volunteer Yourself. He was in a four-man team on a capture-or-kill-a-man-in-Afghanistan mission where his three friends died. The helicopter sent to rescue him was shot down by a 12-year-old boy with a Rocket Propelled Grenade (RPG), killing all onboard. To survive, he stayed five days in a village while the Taliban were hunting him down. He was finally rescued and remained with the SEALs until 2007 when his knees were blown out. Throughout his life, his dogged persistence stemmed from his strict family discipline and his first (ex-SEAL) trainer when he was just a teenager. He says, "There'll be plenty of people who can tell you, 'You can't do it.' You don't need to tell yourself that."

Dr. Donald Sadoway, MIT professor and inventor, presented his invention, the liquid metal battery. Though the electricity grid is the greatest machine ever made, the grid lacks the ability to store charge. Pumped hydroelectric power has low dollars per kilowatt hour (kWh), but unfortunately, it has severe geographic constraints. Today's lithium ion battery has terrible cost-storage efficiency. The batteries he's currently testing had over 800 cells tested. Some cost $100/kWh for electrodes and electrolytes. He created a company called Ambridge for this purpose. This battery has no moving parts and is designed to the market price point without subsidy. Furthermore, it's simple to fabricate. The commercial version of these products is expected to be out in the first part of 2014. Dr. Sadoway made the joke that "What I showed you is one cell. When you put many cells together, it's a battery. If I hit you once, it's assault. If I hit you many times, it's battery." At the question and answer session later, he mentioned that since part of Texas is not part of the national grid, it'll be a good place for testing innovations. Someone asked him about fuel cells and he said they require a lot of platinum which is currently not feasible since the price of platinum is as much as $1,600/ounce. Someone else asked him about competition from a large company such as General Electric. He answered that he was not worried since they're investing in 40-year-old technology such as the GE Zebra battery.

Edward Conard, a best-selling author on economics and former Managing Director of Bain Capital, LLC, talked about what's needed for the government to avoid financial crashes. He says that we should either invest or consume with no hoarding. We shouldn't increase government spending but instead increase equity. Increasing taxes just leads to private sector spending less. The government is consuming equity without making equity for the long run.

Koen Olthuis, a Dutch architect, talked about his company Waterstudio and his idea related to floats, flexible land on aquatic territory. Just as the elevator made more space possible in an urban environment, the float will make more space possible for cities near water. Cities can then be dynamic instead of static. For example, technology used by oil companies can be repopulated as sea trees where a diverse ecosystem ranging from fishes in the water and birds in the air is constructed. This can also be an excellent promoter of oil companies as more ecologically friendly. He is currently working with the Maldives on building floating islands and hotels. Imagine floating hotels that

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can be combined to form islands. He also talked about wet slums that can be helped with floating agriculture, sanitation, energy and architecture.

Barbara Corcoran, an energetic real estate mogul and Shark Tank investor, presented on her experience being fooled by a real estate businessman named Ramon. She thought she loved him. He later married their secretary. When Barbara finally left to start her own business, he told her she would never succeed without him. This kindness / insult motivated her while she built her own multimillion dollar real estate business. Through this process, she learned many business lessons she shared with the audience. For one, perception creates reality. By using the media, she became who she pretended to be. Furthermore, always believe that you have the right to be here. Sometimes, you have to walk through the door even without knowing the answer. Finally, she offered some fun family advice such as how her children brought her a lot more joy than her husband.

Charlie Todd, a YouTube comedian, talked about his various antics around New York. He's the founder of Improv Everywhere and his videos on YouTube have been seen over 250 million times. In one of his first videos, a man in boxer shorts underwear wearing no pants, his bare legs visible on a cold day, gets on the subway followed by another guy that gets onboard dressed the same way for seven consecutive subway stops. The reactions of passengers are filmed via a hidden camera. There are other antics in later videos such as choreographed dancing in seventy windows of stores without permission. There are "site-specific ideas," such as Operation Best Buy where a large number of folks dressed in blue polo shirts and khaki pants and go into a Best Buy to just stand around. The employees found this very funny but the managers and security guards didn't and called 911. There are numerous other cases and his fame has reached a point where in 2006 he pitched a pilot for NBC. Charlie's dream is that "I hope by the time I'm 78, I'm still being asked to leave."

David R. Dow, a law professor from University of Houston, discussed death row inmates. Last year, there were 43 executions with 13 executions taking place in Texas. One reason for the argument against the death penalty is that each death penalty requires vast resources, primarily due to the first stage of the process called trial. The lawyer must learn everything about the client including interviewing every person and looking at all records. This can take weeks and months before a trial. Though the death penalty applies to less than 1% of homicide cases, it costs $600 million per year.

Dambisa Moyo, economist and best-selling author, discussed her latest book on resource scarcity and China's reach across the globe for resources. China has over 100 cities with over 1 million people whereas the United States has 9 such cities and Europe has 18 such cities. Yet China has only 7% arable land and is consuming resources rapidly. China is following three strategies including symbiosis, deep pockets and monopsony. Symbiosis refers to the fact that China is going to the Axis of the Unloved, i.e., places in Eastern Europe, Africa, and South America, and building up local infrastructure while acquiring resources. Deep pockets refers to the fact that China can afford to spend $1 billion a week on commodity investments and is willing to overpay for mines which no private company can compete with. Finally, monopsony refers to the fact that China has power as the key buyer where there are many sellers but only one main buyer. For instance, in 2007, China bought a Peruvian mountain. The road from Cape Town to Cairo through 15 countries was built by China in another example of this monopsony. Dambisa also stressed that whereas many developing nations will prefer the democracy and private capitalism promoted by the United States, China is currently offering these nations wealth and development, whereas the United States either ignores them or gives them donations instead of building up infrastructure.

Gary Vaynerchuk, the social media guru and wine guy, launched into his talk with vivid enthusiasm. He first asked the audience how many people knew who he was which only elicited a few hand raises. He wasn't terribly offended but he did joke that it hurt. He threw around funny offensive comments such as "We used to pay $3/minute to get on Internet. AOL. Those [idiots]." Aside from these tirades, he offered some legitimate comments such as how reaching your consumers is dependent on both content and context. Just posting up there doesn't generate that. He jokingly said that "Every business online is acting like a 19-year-old on a date. They're trying to close on their first move."

The UP Experience

Tony Danza, the famous TV actor from *Taxi* and *Who's the Boss?*, was the last to talk. Surprisingly, he didn't talk about his acting career, but rather his brief teaching career. He only taught for a year. For the first semester, it was more of a TV series than actual classroom teaching. The cameras left at the end of the first semester due to low ratings, but this was good since what was good for the show was not always good for the class.

The UP Experience for 2012 was enlightening. Interesting and successful people shared their stories and projects with us. The opportunity to talk with almost all of the speakers after their talks was a bonus. I would very much like to attend The UP Experience 2013.

Above: Barbara Corcoran. Image credit: Press release kit.

Exoplanet
Earth 2

Interstellar First Stop? Doppler Detection of an Earth-Sized Planet at Alpha Centauri B

WES KELLY, TRITON SYSTEMS, LLC

A Major Discovery

Exoplanet Alpha Centauri Bb

On October 16, 2012, shortly after the September adjournment of the 100 Year Starship public symposium in Houston, a team of European astronomers announced the detection of the nearest extra-solar planet to date, a hot "ingot" orbiting the star Alpha Centauri B (often written α Centauri B), the somewhat dimmer of the two Sun-like binaries (stars in the binary or two-star star system α Centauri, orbiting a common point, with stars named α Centauri A and α Centauri B) 4.3 light years away in the southern celestial sphere. Aside from Proxima Centauri, a dim red dwarf star adjacent to the binary system, these are our nearest stellar neighbors. The detected planet of roughly Earth mass orbits Alpha Centauri B once about every 3.25 days, less than 100th of a terrestrial year. Finding this exoplanet is a major discovery. This Earth-sized planet's name is Alpha Centauri Bb (often written α Centauri Bb).

Unlike the recent discoveries of extra-solar planets with the Kepler Observatory (reported in earlier Horizons), detection was not obtained by watching for a planetary transit. Instead, detection came with prolonged search for Doppler spectral line shifts in the visible stellar spectrum, shifts indicative of a planet perturbing the motion of the stellar primary. With a single star and planet, this analysis is difficult enough. In a binary stellar system like this one the target star also is moving much like the planet. Examining Doppler shifts, the easiest detections are close-in planets of Jupiter mass or greater – and that's what most extra solar detections since the mid 1990s were. Here we have an Earth mass object orbiting a high priority target– and the difficulty of discovery is worthy of note.

Saying that the Alpha Centauri binary star system is the nearest set of Sun-like stars understates the hold this southern sky bright object has on the imagination. Countless science fiction stories of arrival there have been written, including the 2009 film depiction "Avatar." Decades ago, in a collection of aerospace essays, former AIAA president Jerry Grey looked toward the as yet unnamed and un-built Hubble Space Telescope discovering planets orbiting the Alpha Centauri binary star system. Subsequently, when computer simulation tools were widely enough available, many as-

(Continued on page 11)

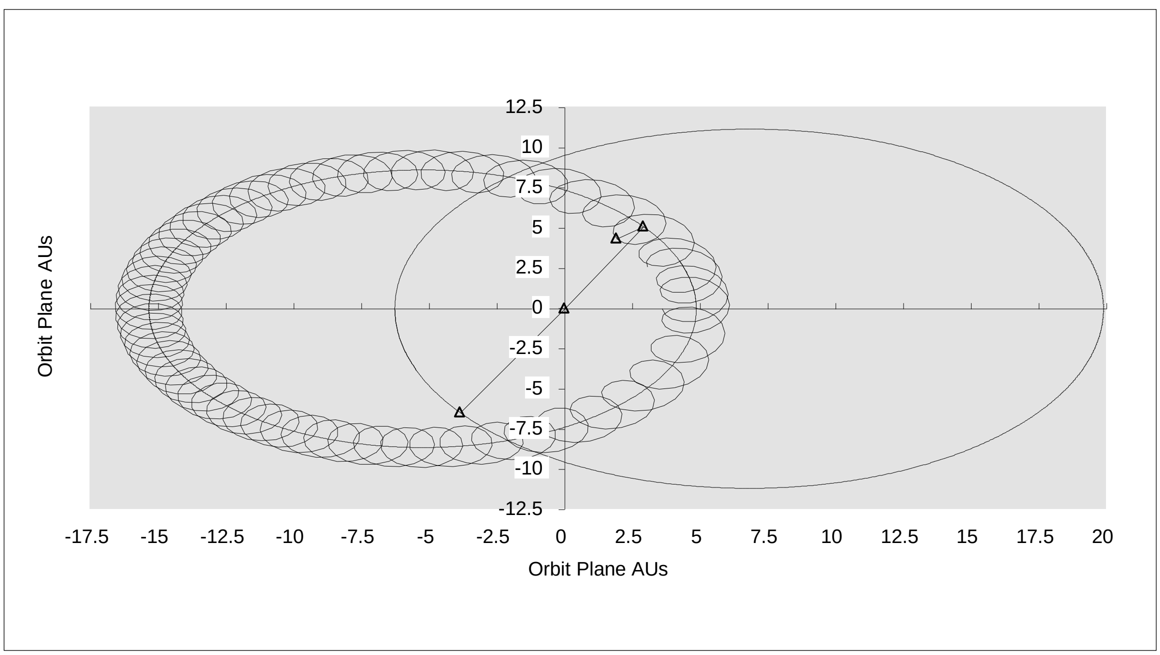


Figure 1 α Centauri A & B with Planetary Track, Epoch =1,500 Days, Origin at Barycenter, Inertial Coordinates, Mean Separation a* = 23.4 AU, e* = .52, P* = 79.9 yrs, Planetary Track about A at 1.25 AU circular orbit

Exoplanet Earth 2

(Continued from page 10)
tronomers and astrodynamicists (even this writer) began to analyze the stability of imagined planets in such systems, obtaining intriguing results for terrestrial analogs.

Two years ago here in Houston, a visiting Israeli-Russian folk singer gave a concert from his recent CD dedicated to his daughter. In the whimsical title song there was the Russian refrain: "*Davaj*, let's head out to α Centauri, … I don't guarantee a royal reception…" How close to the truth this is! At the 100 Year Starship public sympsosium, in the sessions devoted to *Destinations and Habitations*, α Centauri was discussed as a shot in the dark for the starship destination. No planets were known to exist in the system or at the nearby faint red dwarf star Proxima Centauri.

As the investigators report "High-precision measurements have been obtained for Alpha Centauri B between February 2008 and July 2011 using the HARPS spectrograph." HARPS stands for the High Accuracy Radial velocity Planet Searcher at the European Space Observatory at La Silla Chile, a 3.6 meter telescope dedicated to the discovery of extrasolar planets with a high-resolution echelle spectrograph. Beside location in the southern hemisphere, "this instrument has demonstrated a long-term precision of 0.8 meters per second", to date the most powerful instrument available for Doppler shift search for exo-planets.

The discoverers' report leaves an impression that signal is perilously close to the environmental noise. Signal processing becomes a significant part of this story once one compares planet induced stellar velocities with HARPS resolution. In the ensuing months we might expect continued investigation to validate the results against this concern – and also a search for additional α Centauri planets within or closer to the habitable zones of either star, objects possessing greater allure.

Since this binary system has a mean star separation of less than 25 astronomical units (AUs), we must wonder how the circumstellar disks from which planets form could have sustained a process allowing terrestrial or gas giant planets to coalesce and remain closely bound to their primaries. Multi-body simulations give some answers to how planets behave after they form, but as readers of Horizons will recall from William Bottke's discussion of solar system formation studies, large planets interacting with circumstellar disks of gas and dust clear stellar environs either by hurling matter out into deep space or closer and closer to the primary star. In all likelihood "the ingot" is a victim of this process. But does its existence point to other remaining bodies; or is it the last vestige of a train of planets dispensed with by these two stars in their six billion year existence?

Our own early studies, similar to others in the 1990s, employing a restricted elliptic 3-body model for planet and stellar motions, illustrated the behavior of planetary bodies after they formed. In the absence of 4th bodies (e.g., other massive planets), an Earth-like planet in a temperature band near Alpha Centauri A or B would experience cyclic changes in their eccentricity (see table) which would be bounded within regions within 2.0 AU's of each of the suns. As with others, we noticed less dynamic disturbance in the temperate zone in orbit about B than A, even though A resembles the sun more closely in mass and luminosity.

Further away, interaction with the other star would tear the planet away from its steady orbit. But should an "Earth" be accompanied in one of these zones by a Venus or a Mars, there would be further disturbance, especially if one of these neighbors were as big as Neptune or a super Earth. And that's why it might be well worth examining our capabilities to detect planets further out from either star.

Possibly this initial detection could turn out to be a ghost similar to other promising observations in the past. But suggesting this is not a bet against the discoverers; this suggestion is an introduction to difficulties facing the relevant detection technology, interpreting stellar absorption lines.

When you look at individual lines of hydrogen or other element lines in a star's atmosphere, the speed of sound broadening from receding and approaching emissions is considerable; then there is the rotation of the star on its axis, the added difficulty of a binary system and the stochastic nature of processes.

To sort this out, look at a series of ratios for orbital velocities, radii, mass and wavelength *(See the box below, then the article continues on the next page.)*:

$$V_P / V_S = R_S / R_P = M_P / M_S \qquad \Delta\lambda_S / \lambda = V_G/c$$

Where subscripts P and S stand for planet and star and G stands for a gas species in the stellar atmosphere. The planetary and stellar circular orbital velocities are based on radii from the centers of mass and gravitational constants. But in this case, as with many binary systems, there is substantial eccentricity to address as well. The α Centauri system eccentricity is 0.52, much akin to short period comets or disrupted asteroids!

$$V_P = (\mu_1/R)^{1/2} \text{ and } V_S = (\mu_2/R)^{1/2} \quad \tau = 2\pi R/v = 2\pi R^{3/2}/\mu^{1/2}$$

$$\mu_1 = G(M_P+M_S) \qquad \mu_2=G(M_A+M_B) \qquad \text{Luminosity} = L / L_0 \quad L_0 = 4\pi\, \sigma\, R_0^2 T_0^4$$

Exoplanet Earth 2

(Continued from prior page)

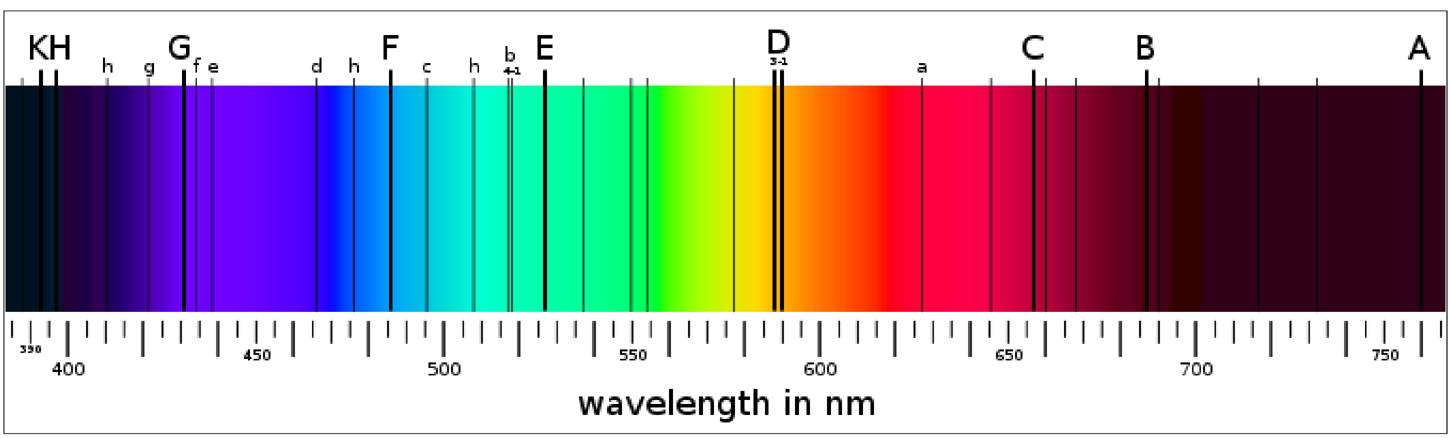
You can extract what an Earth-like temperature planet might provide as a signal with a lengthened period owing to Kepler's law (formula above for period τ). For stars as bright and massive as the Sun, that habitable zone is in the vicinity of 1 AU, the Earth's distance from the Sun. The Sun's effective surface temperature diffused out to 1 AU is about 400° K. Similar calculations can be made for α Centauri's binary system stars.

The constant μ is the gravitational constant for the binary system of interest, the universal gravitational constant multiplying the mass of the two bodies. In the case of binary stars, such as α Centauri A and B, these are masses of 1.1 and 0.9 the mass of the Sun respectively. But the Earth is only 1/330,000th the mass of the Sun. For calculations of the Earth's motion around the Sun (about 29.785 km/sec), we ignore its contribution to solar μ, but if we are calculating the corresponding motion of the Sun in reaction to the Earth in a rotation about the system barycenter, we derive a radius of 1/330,000th of an AU over a period of 365.24 days, a path 453 km in radius and a corresponding speed of 0.0902 meters/sec.

If the mass of α Centauri B is 0.9 solar (Table 1) and the period of the new-found planet is about 100th, we infer a higher Doppler shift. A 365 day orbit around B would require a radius of 0.9654 AU, and a period 1/100th of this would be at 0.045 AUs from the primary, based on Kepler's law. Every 3.65 days α Centauri B would revolve in reaction to the close-by planet of terrestrial mass about an axis of 23.17 km at a rate of 0.46 meters per second. But since α Centauri B is less luminous than the sun, largely due to its lower effective surface temperature and the fact that the luminosity is sensitive to temperature to the 4th power, a terrestrial analog to Earth would be located closer and with a shorter period. From our 1997 results in Table 2, that would be about 2/3 of an AU and a period of 200 days – with some further adjustment for the increased estimates of B's calculated mass in the intervening years. This position and period resembles that of Venus more than Earth in our solar system owing to the differences in stellar brightness.

As for absorption lines in the visible spectrum of a Sun-like star, discrete lines are based on photon transitions in individual atoms in a star's upper atmospheric layers. For the Sun, the effective temperature is about 5800 degrees Kelvin. To first order in aerospace applications such as combustion, we relate thermal energy and velocity with the speed of sound. There is, of course, a larger statistical distribution of velocities in a gas as the Bell-like curves of Maxwell and Boltzmann indicate. And then, of course, even if all the atoms were of uniform velocity, the directions would project velocities between plus and minus the sonic velocities from the perspective of the astronomer viewing the Doppler effect. As a result, a sup-

(Continued on page 13)



K	H	h	G	G	f	e	d	F	c	b_4	b_4	b_2	b_1	E	D_2	D_1	a	C	B		A
Ca+	Ca+	Hδ	Ca	Fe	H	Fe	Fe	Hβ	Fe	Mg	Fe	Mg	Mg	Fe	Na	Na	O_2	Hα	O_2	H_2O	O_2
393.368	396.847	410.175	430.774	430.790	434.0	438.355	466.814	486.134	495.761	516.733	516.891	517.270	518.362	527.0	588.995	589.592	627.661	656.281	686.719	720.0	759.370

Figure 2 Visible Solar Spectrum with Prominent Absorption Lines
Singly ionized calcium atoms (atomic weight 20 vs. 1 for hydrogen) provide a couple of "sharp" near violet lines at 396.9 and 393.4 nanometers. Balmer series supplies transitions in the visual range, the lowest energy being from level 3 to level 2 at 656.3 nanometers (Hα); level 4 to level 2 at 486.1 nanometers (Hβ) etc.

Exoplanet Earth 2

(Continued from page 12)

posed absorption line in the visible range between 400-700 nanometers (4000-7000 Angstroms) would have a bandwidth proportional to the speed of sound and the contribution of the observed atoms in which the transitions occurred. If the speed of sound of a gas in the α Centauri B upper atmosphere has a temperature of 5000° K, and the species is atomic hydrogen, than the width of the observed absorption band is roughly as wide as the Δλ based on the speed of sound. The same would be true of a magnesium or sodium atom transition, but with larger nucleus mass, the atoms would be proportionately slower – and absorption bands accordingly narrower.

Electron energy state transitions involve both emission and absorption of photons, but in Doppler studies to date in search of extra-solar planets, absorption lines have played a larger role. If we adopt the simplified Bohr model of the nucleus and electrons, somewhat akin to a star and solar system, we could describe absorption transitions to first order by shifts back from high to low (closely bound) states. Shifts to and from the lowest hydrogen orbit are known as the Lyman series, playing out in the ultraviolet range. But shifts from the second energy level, the Balmer series supplies transitions in the visual range, the lowest energy being from level 3 to level 2, 6563 angstroms (Hα); level 4 to level 2, 4861 angstroms (Hβ) etc. Singly ionized calcium atoms (atomic weight 20 vs. 1 for hydrogen) provide a couple of "sharp" near violet lines at 3969 and 3934 angstroms.

Yet still, these velocities are measured in kilometers per second, not fractions of meters/second. And other disturbances are still to be addressed. Alpha Centauri B surely rotates on its axis just as our own Sun does, and neither as a rigid uniform ball. That gives a bias to absorption band features as well. Then there is simply the issue of stellar noise. The atmospheres of other stars are at least as noisy as the Sun's, with sunspots, flares, cellular formations on their surfaces – numerous phenomena that can make extraction of this signal from an absorption band literally as difficult as hunting for a game animal in shoulder high grass.

Amid harmonics associated stellar processes, discovery of α Centauri Bb had to occur via spotting the same periodic shift in absorption lies of several species of gas based on elaborate signal processing.

Search for extra-solar planets by visual Doppler methods began near two decades before the Kepler (transit) Observatory mission was launched with the first results published in 1995. Typically these bodies were described in terms of Jupiter mass whether they were as close to their primary as the α Centauri planet or several times the distance of the Earth from the Sun. Remarkably, Jupiter is about the same density as the Sun with diameter about 1/10th as wide – which means that Jupiter is a 1000 times less massive, but 330 times more massive than Earth. So, we would be able to detect a Jupiter mass planet in orbit about the stars of Alpha Centauri based simply on precedent – if a Doppler shift could be observed in the line of sight; but to confirm its existence, several cycles of motion would have to be observed, an Earth-based process of several years. For the current discovery, one year would yield over 100 cycles.

Variation in planet mass changes the radial lengths about which the sun and planet revolve about their common center of mass. The stellar radius of revolution becomes proportionately wider and its velocity over the corresponding orbit grows proportionately as well. Thus far, Doppler signals for Jovian mass planets anywhere in this system have thus far been undetected; perhaps planets with the mass of Neptune (~17 x Earth) could be detected in the near future within the temperate belts of α Centauri A or B? This brings us back to another achievement of the HARPS investigators.

Back in 2006 a 3-Neptune system was detected with HARPS at HD69830, a star very similar to α Centauri B, with the farthest of the three objects located in its temperate belt in a near circular orbit. Three overlaid Doppler signals for periods of 8.67, 31.6 and 197 days were detected with signal amplitudes of about 4, 3 and 2 meters/second, respectively. Just prior to this, in 2005, the Spitzer (infrared) Space Observatory detected a luminous debris disk associated with an asteroid belt outside the orbit of HD69830 d, centered around 1 AU. This star is also known as 285 G Puppis, a K0V star half as luminous as the Sun, of lower metallicity and 41 light years away, but about the same age as the stars of the Centauri system.

We will cross our fingers. *(This article continues on the next two pages.)*

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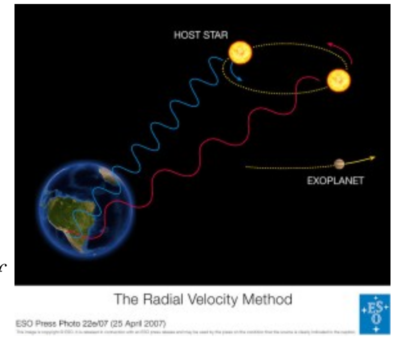
Exoplanet Earth 2

HARPS is the ESO facility for the measurement of radial velocities with the highest accuracy currently available. It is fibre-fed by the Cassegrain focus of the 3.6m telescope in La Silla. Built to obtain very high, long term radial velocity accuracy (~1 m/sec) and mechanical stability, the HARPS instrument is fiber optically fed by the Cassegrain focus of the 3.6m telescope in La Silla. The HARPS echelle spectrograph is contained in a vacuum vessel to avoid spectral drift due to temperature and air pressure variations. One of two fiber optic cables collects star light; the second records simultaneously either a Th-Ar reference spectrum or the background sky. The two HARPS fibers have an aperture on the sky of 1 arc second, producing a spectrograph resolving power of 115,000 in the 378-691-nm range.

Below: High Accuracy Radial Velocity Planet Searcher (HARPS) 3.6 Meter Telescope at the La Silla, Chile Observatory Site With HARPS Spectrograph Below. Image source: Wikipedia. Image credit: HARPS. Image credit: European Southern Observatory.



Right: The radial velocity method to detect exoplanet is based on the detection of variations in the velocity of the central star, due to the changing direction of the gravitational pull from an (unseen) exoplanet as it orbits the star. When the star moves towards us, its spectrum is blueshifted, while it is redshifted when it moves away from us. By regularly looking at the spectrum of a star - and so, measure its velocity - one can see if it moves periodically due to the influence of a companion. Image credit: ESO.

Table 1 Alpha Centauri System Component Characteristics

		Alpha Centauri A	Alpha Centauri B
Right ascension		14h 39m 36.4951s	14h 39m 35.0803s
Declination		–60° 50′ 02.308″	–60° 50′ 13.761″
Spectral type		G2 V	K1 v
Mass	**M⊙**	1.100	0.907
Radius	**R⊙**	1.227	0.865
Luminosity	**L⊙**	1.519	0.500
Temperature	**° K**	5790	5260
Metallicity	**% Sun**	151	160
Rotation	**days**	22	47
Apparent magnitude (V)		-0.01	+1.33
U−B color index		+0.23	+0.63
B−V color index		+0.69	+0.90
Age	**Giga-year**	6 ± 1	6 ± 1
		Alpha Centauri A-B Binary System	
		Orbit	
Period	**(P)**	79.91 ± 0.011 yr	
Semimajor axis	**(a)**	17.57 ± 0.022"	
Eccentricity	**(e)**	0.5179 ± 0.00076	
Inclination	**(i)**	79.205 ± 0.041°	
Longitude of the node	**(Ω)**	204.85 ± 0.084°	
Periastron epoch	**(T)**	1875.66 ± 0.012 days	
Argument of periastron	**(ω)**	231.65 ± 0.076°	
		Astrometry	
Radial velocity	**(Rv)**	−21.6	kilometers/second
Proper motion (μ)	**RA:**	−3678.19	milli-arcseconds/year
	Dec.:	481.84	milli-arcseconds/year
Parallax	**(π)**	747.1 ± 1.2[5]	milli-arcseconds
Distance	**(ly)**	4.366 ± 0.007	(1.339 ± 0.002 parsecs)
Absolute magnitude	**(MV)**	4.38 / 5.71	

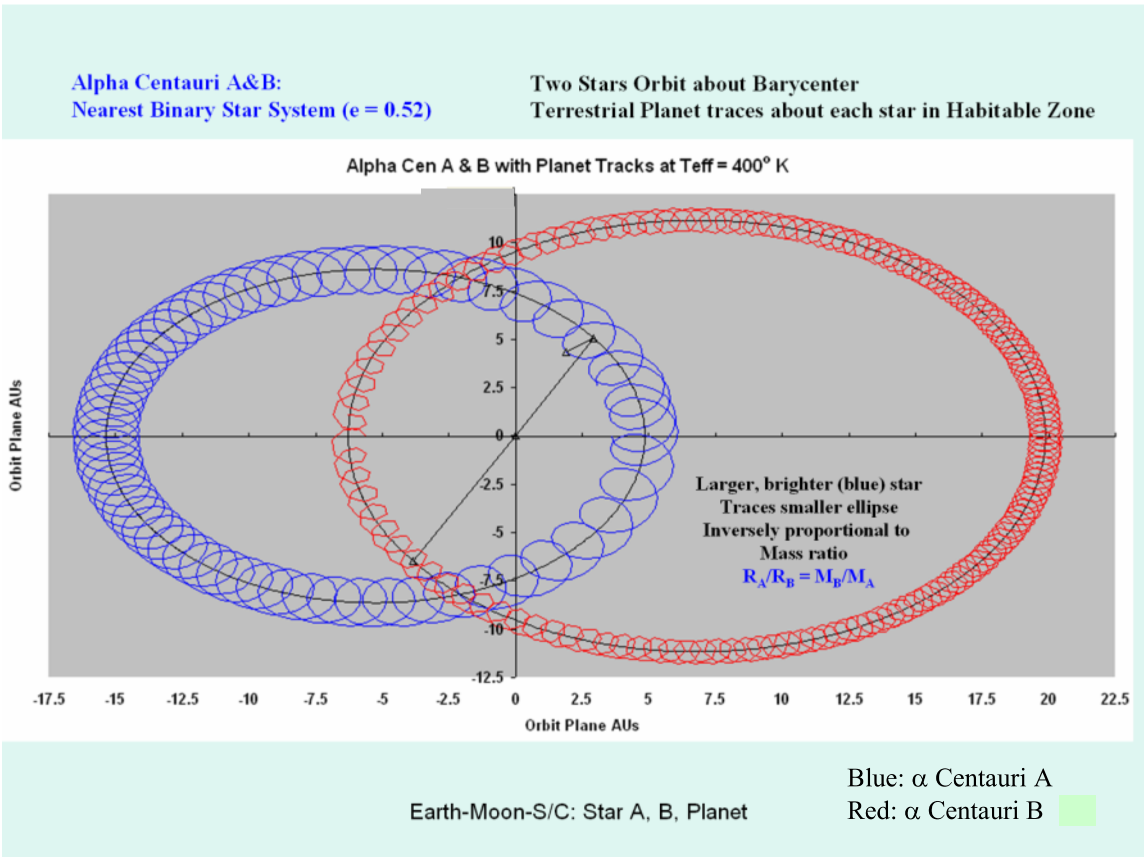
Table 2 Alpha Centauri system Companion "b", Exoplanet Alpha Centauri Bb.

Mass (M⊕)	1.13 ± 0.09
Semimajor axis (AU)	0.04
Orbital period (days)	3.2357 ± 0.0008
Eccentricity	—
Radius	—

Speed of sound (a) for stellar atmosphere absorption bandwidth estimates:

$a = (\gamma R/m_g T_{eff})^{1/2}$

R - Universal gas constant,
m_g - gas molecular weight,
T_{eff} - effective temperature of visible gas.



Left: Figure 3. Exoplanet α Centauri Bb is a major discovery since it is Earth-sized and orbiting the sun / star α Centauri B, a star in the nearest star system to our Sun, but exoplanet α Centauri Bb is not in the habitable zone around the star α Centauri B. This figure shows orbits of two hypothetical terrestrial planets, one orbiting in α Centauri A's habitable zone and one orbiting in α Centauri B's habitable zone. Those two stars orbit their common center of mass. Both stars are similar to our Sun, and Earth-sized exoplanets may yet be discovered in those two habitable zones. Image credit: Wes Kelly.

Table -3 Elliptic Restricted 3-Body Problem Results

Star System Component	$T_{eff}(R_o)$ Temperature (°K)	Nominal Radius R_o (AUs)	2-Body Period (days)	Ejection Period (yrs)	Eccentricity Magnitude (10^3yrs)	Cycle (ΔR/Ro)
α Centauri A	400	1.2468	484		8.0	**0.08, -0.09**
α Centauri A	350	1.6285	724		5.0	0.11, -0.12
α Centauri A	300	2.2165	1,149		2.6	0.12, -0.15
α Centauri A	275	2.6368	1,492	-	1.8	0.13
α Centauri A	250	3.1918	1,985	-	-	-
α Centauri A	225	3.9405	2,724	2,500	-	-
α Centauri B	400	0.6438	204	-	15.8	**0.05, -0.05**

Airshow

Wings Over Houston Airshow 2012

Ellen Gillespie, Councilor

The AIAA Houston Section had a social on the flight line at the Wings Over Houston Airshow on Saturday October 27, 2012. AIAA Houston Section was honored to share space with the Experimental Aircraft Association (EAA).

AIAA Houston booth volunteers (Clay Stangle, Douglas Yazell, and Ellen Gillespie) set up a canopy and AIAA Houston banner alongside EAA. We enjoyed food, company and a great airshow on a sunny, cool and windy day. AIAA members were encouraged to stop by to join us during their time at the airshow. Our canopy provided shade to anyone who wished it, though high winds forced us to take it down in the early afternoon.

(Continued on page 17)

Image credits: Ellen Gillespie, Councilor, except the Blue Angels, Clay Stangle, Treasurer.

(Continued from page 16)

Airshow

The airshow is always a great time. We'd like to thank our EAA friends for sharing space and a great day.

Image credits: Ellen Gillespie, Councilor, except the Osprey, Douglas Yazell, Editor.

Astrodynamics

A 2012 TC_4 Gravity Assist From Earth

DANIEL R. ADAMO, ASTRODYNAMICS CONSULTANT

Yet another recently discovered near-Earth object (NEO) glided past Earth on 12 October 2012, approaching to about 25% of the Moon's distance when it reached perigee at 05:29 UT. Dubbed 2012 TC_4 shortly after it was first detected on 4 October, this NEO is a member of the Apollo group whose orbits cross Earth's and whose orbit periods exceed Earth's.

In the case of this close flyby, 2012 TC_4 crosses Earth's orbit travelling inbound toward perihelion on 25.0 November 2012 UT, when it will be about 91% of Earth's distance from the Sun. As illustrated by the shaded nighttime hemisphere in Figure 1, this inbound geometry places 2012 TC_4 in Earth's night sky before its flyby, facilitating discovery with optical telescopes. After perigee, however, 2012 TC_4 rapidly moves into Earth's daytime sky, and optical observations will become all but impossible. An attempt was made to track 2012 TC_4 prior to perigee with the DSS-14 planetary radar antenna at Goldstone, CA, but it appears no useful data were obtained.

Consequently, the diameter of 2012 TC_4 must be estimated from its absolute magnitude $H = 26.525$. Most NEOs range in albedo (reflectivity) from 0.60 to 0.03. Assuming this range places the diameter of 2012 TC_4 anywhere from 8.5 m up to 38 m. Depending to some degree on 2012 TC_4 shape and composition, this size range spans a sobering spectrum of potential Earth collision hazards. Such a collision might be just a "boom in the sky", possibly followed by a harmless shower of gravel, or it could resemble an event which leveled 2000 km^2 of Siberian forest in 1908 (reference http://science.nasa.gov/science-news/science-at-nasa/2008/30jun_tunguska/).

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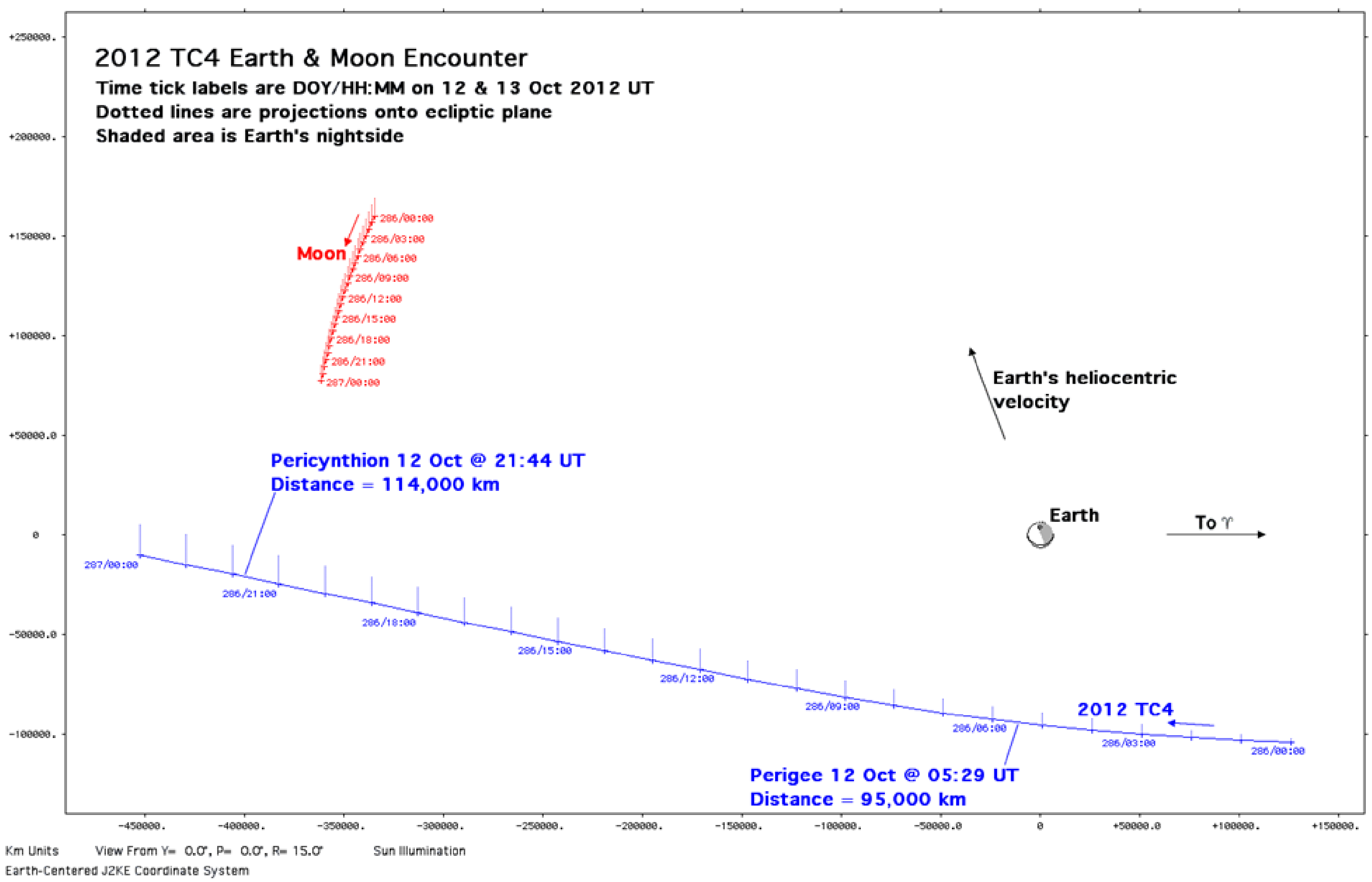

Figure 1. Geocentric motion of 2012 TC_4 and the Moon are plotted during 12 October 2012 UT. Plot perspective is from 75° north of the ecliptic plane.

Astrodynamics

(Continued from page 18)

The direction of Earth's heliocentric motion is annotated in Figure 1. Because 2012 TC_4 reaches perigee at a point behind Earth in its heliocentric orbit, the NEO receives a gravity assist in the direction of Earth's heliocentric motion. This perturbation is evident in Figure 1 as a slight upward bend in the geocentric path taken by 2012 TC_4. Since 2012 TC_4 is moving about the Sun in generally the same direction as Earth on 12 October 2012, the gravity assist it receives increases its heliocentric speed slightly. This also increases the orbit period of 2012 TC_4, ensuring it remains in the Apollo group.

Effects of the 12 October 2012 Earth gravity assist on 2012 TC_4's heliocentric orbit are evident in Figure 2. This plot begins in late May 2011 and ends in late January 2014. A significant increase in 2012 TC_4 aphelion is evident when the portion of its orbit beyond that of Mars is compared before and after 12 October 2012's Earth encounter.

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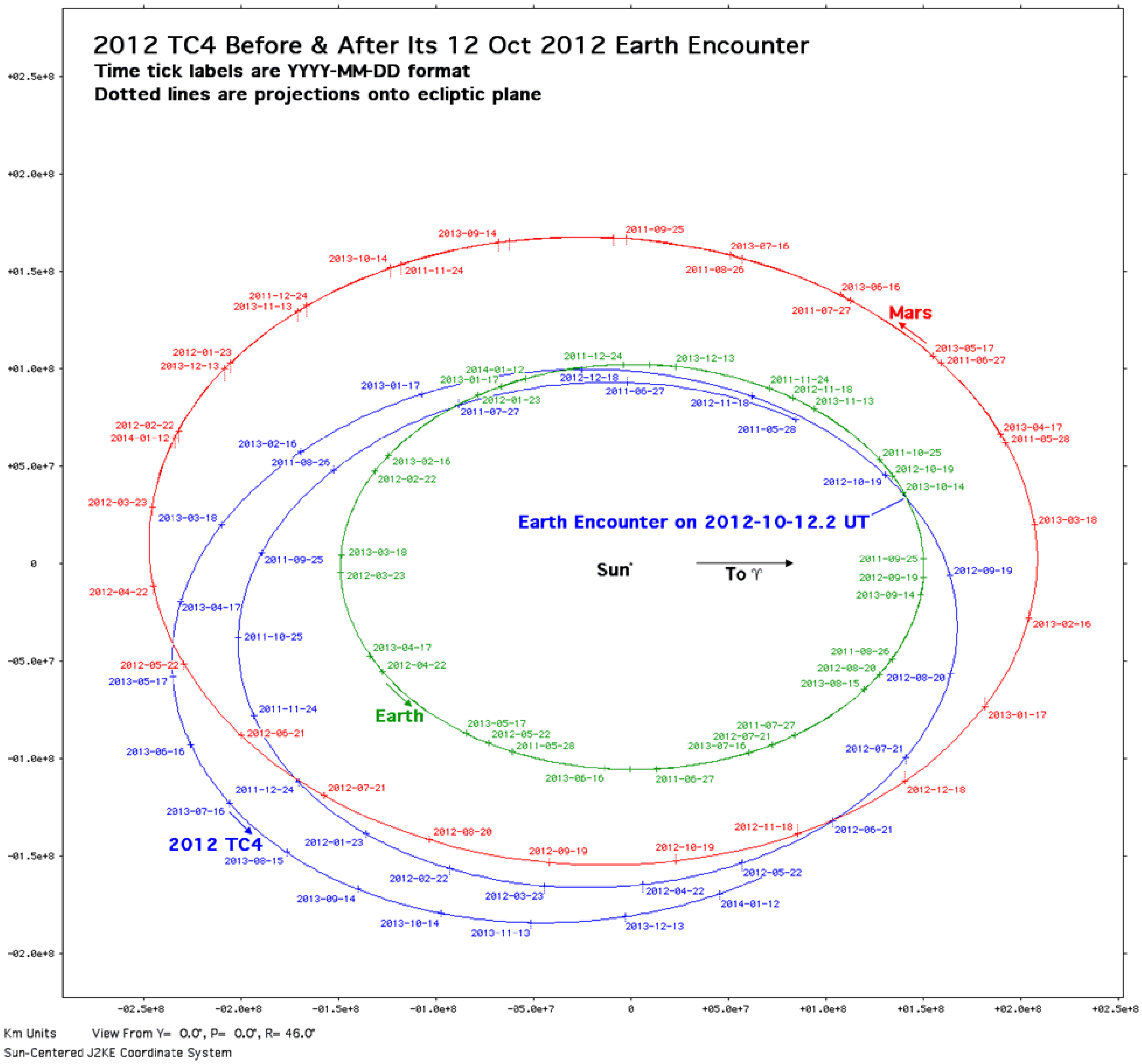


Figure 2. Heliocentric motion of 2012 TC_4, the Earth, and Mars are plotted from late May 2011 until late January 2014 to illustrate effects of the NEO's Earth encounter on 12 October 2012. Plot perspective is from 44° north of the ecliptic plane.

Astrodynamics

(Continued from page 19)

Earth-crossing NEOs whose orbit periods are less than Earth's are members of the Aten group. How closely Apollos and Atens approach Earth is typically a critical matter of timing. In the case illustrated by Figure 1, an Earth collision would have occurred if 2012 TC_4 had crossed Earth's orbit approximately 95,000/v_E seconds earlier, where v_E = 29.8 km/s is Earth's heliocentric speed. This approximation assumes 2012 TC_4 geocentric motion is transverse to Earth's heliocentric motion, a condition roughly applicable to Figure 1 geometry. The approximate time skew required for collision is therefore 3190 s = 53.1 min earlier. If 2012 TC_4 had crossed Earth's orbit slightly earlier than the time skew necessary for collision, perigee would have been above Earth's leading hemisphere with respect to its heliocentric motion. The resulting gravity assist would then have *reduced* 2012 TC_4 heliocentric speed and orbit period. In this manner, 2012 TC_4 could be transformed from an Apollo to an Aten.

Transformations between Apollos and Atens can occur with surprisingly high frequency. For example, consider a linear analysis of 2012 TC_4 position uncertainty in the recent past based on its JPL#17 orbit elements as obtained from the *Horizons* ephemeris server at http://ssd.jpl.nasa.gov/?horizons on 13 October 2012. Working backward in time, 2012 TC_4 position uncertainty increments at a greater rate before Mars is encountered on 24 January 2011 at a periapsis distance near 13 million km. This encounter occurs near the 2012 TC_4 aphelion before Figure 2's plot begins. As a consequence of 2011's Mars encounter, the previous 2012 TC_4 Earth encounter on 12 October 1996 has a 3-standard-deviations (3σ) perigee distance ranging from 4000 km (a statistical collision we know did not occur) to 2.35 million km. Not surprisingly, the time of perigee associated with this Earth encounter has a 3σ uncertainty of ±3085.1 min (±2.14 *days*). Prior to 12 October 1996, 2012 TC_4 might have been an Apollo or an Aten.

Finally, we must all be grateful for any knowledge of 2012 TC_4. An object this small approaching Earth *after* perihelion is not observable until after perigee and can easily escape detection as it recedes into interplanetary space and dims beyond reach of instrumentation confined to Earth or its vicinity.

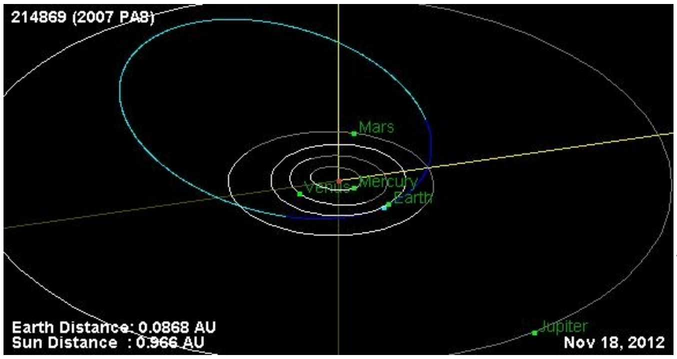
List of Record-Setting Asteroid Close Approaches to Earth

From Wikipedia, the free encyclopedia, excerpts prepared by Douglas Yazell, Editor, 10/17/12:

List of record-setting asteroid close approaches to Earth is a list of events where an asteroid or meteoroid travels close to the Earth. [Another useful web site is http://neo.jpl.nasa.gov, NASA's Near Earth Object Program.]

Near-Earth-object detection technology greatly improved around the turn of the 21st century, so objects being detected as of 2004 could have been missed only a decade earlier. By some definitions, an asteroid must be at least 50 meters in diameter; so the table lists objects smaller than this size separately, but this should not be taken as an endorsement of this particular definition of meteoroids vs. asteroids. Also, objects that enter and then leave Earth's atmosphere, so-called 'Earth-grazers', are separated, as entering the lower atmosphere can constitute an impact event rather than a close pass.

The distances shown are approximate and from the surface of the Earth.

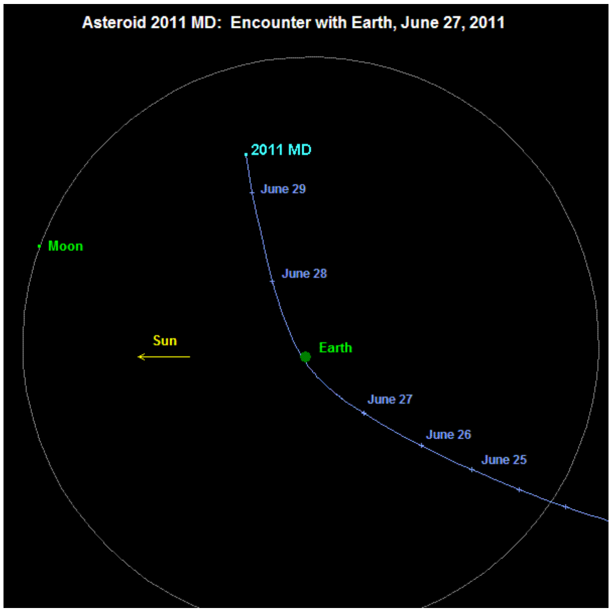


Left: Image credit: NASA. These two images are the closest (12.3k km at right) and farthest (6.5M km at left) from the list.

Date - Name - Distance - Size

(Sorted by Date)

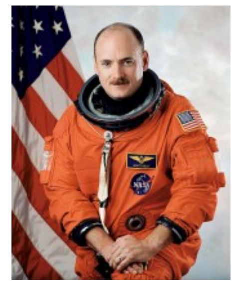
1) November 5, 2012 - 2007 PA8 - 6,500,000 km (17 ld) - 1.5-1.7 km
2) October 12, 2012 - 2012 TC4 - 88,000 km - 17-30 m
3) June 14, 2012 - 2012 LZ1 - 5,300,000 km (14 Ld) - 1000 m
4) May 29, 2012 - 2012 KT42 - 14,440 km - 4-10 m
5) May 28, 2012 - 2012 KP24 - 51,000 km - 25 m
6) January 27, 2012 - 2012 BX34 - 65,390 km - 8 m
7) November 8, 2011 - 2005 YU55 - 324,900 km - 400 m
8) June 27, 2011 - 2011 MD - 12,300 km - 10 m



Above: Trajectory of 2011 MD projected onto the Earth's orbital plane. Note from this viewing angle, the asteroid passes underneath the Earth. (NASA)

NASA, Roscosmos Assign Veteran Crew to Yearlong Space Station Mission

NASA PRESS RELEASE, 11/26/12



WASHINGTON -- NASA, the Russian Federal Space Agency (Roscosmos), and their international partners have selected two veteran spacefarers for a one-year mission aboard the International Space Station in 2015. This mission will include collecting scientific data important to future human exploration of our solar system. NASA has selected Scott Kelly and Roscosmos has chosen Mikhail Kornienko.

Kelly and Kornienko will launch aboard a Russian Soyuz spacecraft from the Baikonur Cosmodrome in Kazakhstan in spring 2015 and will land in Kazakhstan in spring 2016. Kelly and Kornienko already have a connection; Kelly was a backup crew member for the station's Expedition 23/24 crews, where Kornienko served as a flight engineer.

The goal of their yearlong expedition aboard the orbiting laboratory is to understand better how the human body reacts and adapts to the harsh environment of space. Data from the 12-month expedition will help inform current assessments of crew performance and health and will determine better and validate countermeasures to reduce the risks associated with future exploration as NASA plans for missions around the moon, an asteroid and ultimately Mars.

"Congratulations to Scott and Mikhail on their selection for this important mission," said William Gerstenmaier, associate administrator for Human Exploration and Operations at NASA Headquarters in Washington. "Their skills and previous experience aboard the space station align with the mission's requirements. The one-year increment will expand the bounds of how we live and work in space and will increase our knowledge regarding the effects of microgravity on humans as we prepare for future missions beyond low-Earth orbit."

"Selection of the candidate for the one year mission was thorough and difficult due to the number of suitable candidates from the Cosmonaut corps," said head of Russian Federal Space Agency, Vladimir Popovkin. "We have chosen the most responsible, skilled and enthusiastic crew members to expand space exploration, and we have full confidence in them."

Kelly, a retired captain in the U.S. Navy, is from West Orange, N.J. He has degrees from the State University of New York Maritime College and the University of Tennessee, Knoxville. He served as a pilot on space shuttle mission STS-103 in 1999, commander on STS-118 in 2007, flight engineer on the International Space Station Expedition 25 in 2010 and commander of Expedition 26 in 2011. Kelly has logged more than 180 days in space.

Kornienko is from the Syzran, Kuibyshev region of Russia. He is a former paratrooper officer and graduated from the Moscow Aviation Institute as a specialist in airborne systems. He has worked in the space industry since 1986 when he worked at Rocket and Space Corporation-Energia as a spacewalk handbook specialist. He was selected as an Energia test cosmonaut candidate in 1998 and trained as an International Space Station Expedition 8 backup crew member. Kornienko served as a flight engineer on the station's Expedition 23/24 crews in 2010 and has logged more than 176 days in space.

During the 12 years of permanent human presence aboard the International Space Station, scientists and researchers have gained valuable, and often surprising, data on the effects of microgravity on bone density, muscle mass, strength, vision and other aspects of human physiology. This yearlong stay will allow for greater analysis of these effects and trends.

Kelly and Kornienko will begin a two-year training program in the United States, Russia and other partner nations starting early next year.

Image credits: Top: Mikhail Kornienko. Image credit: NASA, Bill Stafford. Bottom: Scott Kelly, Image credit: NASA.

For Kelly's biographical information, visit:
http://go.nasa.gov/SKelly
For Kornienko's biographical information, visit:
http://go.nasa.gov/MKornienko
For more information about the Russian Federal Space Agency, visit:
http://www.roscosmos.ru/
For more information about the International Space Station, visit:
http://www.nasa.gov/station
Join the conversation on Twitter by following the hashtag #ISS. To learn more about all the ways to Connect and Collaborate with NASA, visit:
http://www.nasa.gov/connect
http://www.nasa.gov/home/hqnews/2012/nov/HQ_12-406_ISS_1-Year_Crew.html

Lunch & Learn

Voyages: Charting the Course for Sustainable Human Space Exploration: A Review

DR. KUMAR KRISHEN, FELLOW, SPDS, FELLOW, IETE, REPORTED BY DOUGLAS YAZELL, EDITOR

Above: Dr. Kumar Krishen. Image credit: NASA/JSC.

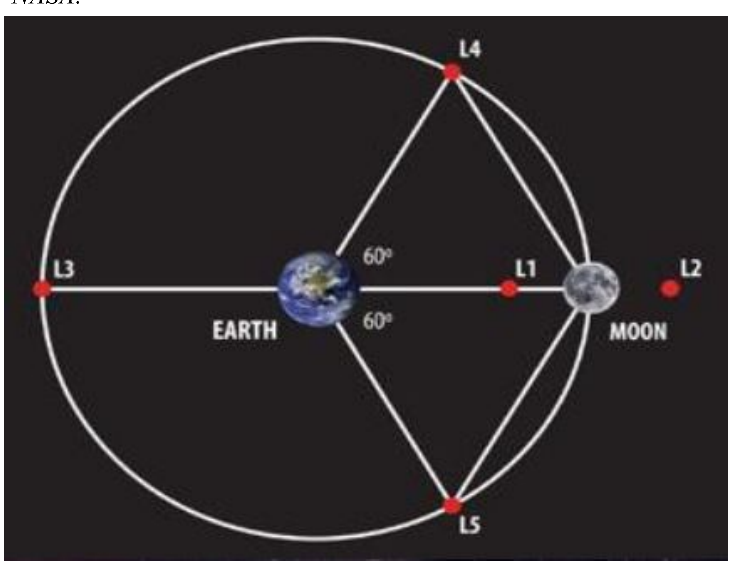
A crowd of about thirty badged NASA/JSC civil servants and JSC contractors, including retired NASA/JSC manager Norman Chaffee, attended this event of Thursday, November 15, 2012, in the Building 30A auditorium. The event organizer was Dr. Satya Pilla, Chair of the AIAA Houston Section Program Management and Integration technical committee shown on our 45-person organization chart on our web site. Ron Sostaric, NASA/JSC, filled in as host for Dr. Pilla at the last minute due to the sudden health troubles of a member of Dr. Pilla's family.

The following two paragraphs from the event flyer present a short speaker biography and a short preview of the presentation.

"Dr. Kumar Krishen is the ST (federal grade) / Senior Scientist / Lead Technologist for the Technology Transfer & Commercialization Office, NASA Johnson Space Center (JSC), Houston, Texas, responsible for developing strategies for joint research and technology projects and plans with industries, universities, other NASA centers, and government agencies. Dr. Krishen has served at Virginia Tech as University Fellow for Technology Transfer, Office of Special Initiatives and Visiting Professor on a special NASA assignment. He also served as Adjunct Professor at Rice University. Currently, he holds the appointment of Honorary Professor for Delhi Technological University.

"The future of human presence in space beyond Earth orbit has been the focus of NASA strategic planning efforts for more than four decades. In the recent past, a report [36 pages, June 4, 2012] titled, *Voyages, Charting the Course for Sustainable Human Space Exploration* was issued by NASA, which identifies a capability-driven approach. This presentation will critically examine the implications of the destinations on technology development and capability enhancement to show what developments should receive priority in the future to enable safe and affordable human space missions. It will identify a set of questions that can lead to a successful prioritization of the technology development. In this context each destination and technology identified in this report will be discussed and rationale for the technology prioritization provided."

Below: The five Earth-Moon Lagrange points. Image credit: NASA.



Two documents referenced at the start of this event are (1) the October 2009 report of 157 pages, *Review of Human Spaceflight Plans Committee, Seeking a Human Spaceflight Program Worthy of a Great Nation*, and (2) the 18-page June 2010 report titled *National Space Policy of the United States of America*.

This first and maybe final draft of this article is based only on prepared remarks from Dr. Krishen.

Voyages is quoted as saying, "The foundation of NASA's new approach, and future human space exploration, is the capabilities." Three categories of capabilities are listed, transportation (LEO crew and cargo access, beyond Earth orbit crew and cargo access and in-space propulsion), mission operations (ground and in-space) and habitation and destination (long-duration habitation, mobile exploration module, EVA systems, precursor robotics, human-robotic interfaces and destination systems.

Page 4 of *Voyages* suggests exploration centered around cislunar space, particularly the Lagrange points, but Dr. Krishen expresses concern about costs for those operations as opposed to ISS operations or being on the Moon, even though the crew operations near the L2 Lagrange point can allow robotic equipment tele-operation on the far side of the Moon.

Voyages page 5 presents three types of benefits, technologies that benefit Earth (help the economy), engaging and inspiring new generations of explorers, and fueling the hu-

(Continued on page 23)

Lunch & Learn

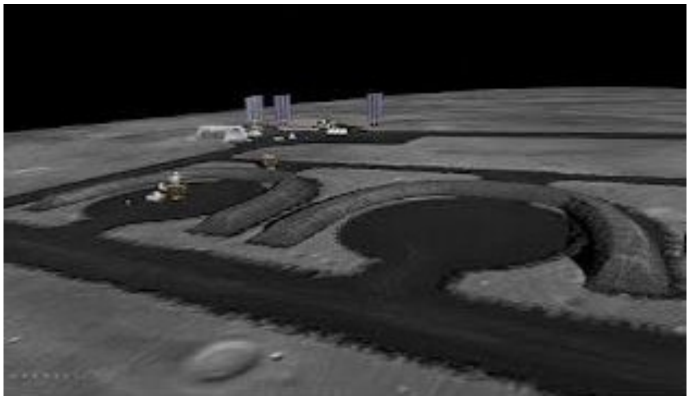
(Continued from page 22)

man spirit via our curiosity (present conveniences being products of past explorations). Dr. Krishen's comments include worker-voyagers and Earth & space monitoring. He mentions populating environmentally unfriendly places on Earth, including deep sea habitats, and states that the Earth's environment is changing. He also mentions harvesting planetary resources for use on Earth.

Voyages page 7 mentions four destinations, the Moon, Mars (and its moons), cislunar space and Near Earth Asteroids (NEAs). Dr. Krishen's remarks include, "There is no priority, sequence or schedule for these destinations. Without this, there can be no mission by mission plan developed, nor can there be the ability to effectively establish a program-level or project level budget to accomplish these missions." He also writes, "For reasons of affordability, development of core capabilities should not all necessarily be accomplished by NASA but divided among global partners with specific responsibilities."

Addressing *Voyages* pages 8-9, he directs our attention to the concept of the International Lunar Research Park (ILRP), recommending it as an extension of the ISS research park. He continues to recommend ILRP as he addressed *Voyages* page 10.

While *Voyages* pages 12-13 addresses the benefits of exploring NEAs, Dr. Krishen continues to recommend the ILRP instead of NEA exploration. Dr. Krishen's prepared remarks then show general comments recommending extended stays on the Moon and a human mission to Mars rather than exploration of NEAs and habitation in cislunar space. Another general comment states, "*Voyages* is a good encyclopedia of exploration options and opportunities, but a prioritized plan for capabilities keyed to missions is needed right away!"



Left: ILRP Phase 3, Long Term Human Settlement Begins. Image credit: Google.

Left: ILRP Phase 2, Lunar Robotic Village. Image credit: Google.

Norman Chaffee, NASA/JSC retired, wrote that he agrees with the conclusions of Dr. Krishen, and Norman writes that our capability-driven approach is new, since we used design reference missions focusing on specific goals in the past. Norman tells us that he fears that the capability-driven approach, such as the NASA/MSFC Space Launch System (SLS), may not be best, since this heavy-lift rocket does not optimally address any specific mission and all possible missions are therefore compromised to some extent. Norman continued his conversation with us by saying, "That can be overcome to a good level by doing a series of design reference missions for the individual proposed applications to understand the compromises involved in accomplishment of each of them imposed by a single launch vehicle design. I was also interested in the authorship of the "Voyages" report [the focus of the lunch-and-learn]- it seems to be from the NASA Chief Engineer's Office at Langley and it is not clear what input was sought or given from NASA/ JSC, MSFC, and KSC. Nor do I recognize the name of the contractor group who apparently prepared the report. We need a lot more "meat" on these bones to decide what a reasonable set of programs would be, considering benefits to be achieved, cost required, schedule required, and international partnerships that might be possible."

3AF MP

Creative Time Launches a New Work by Artist Trevor Paglen into Outer Space for Fall 2012

CREATIVE TIME PRESS RELEASE

Our French sister section is 3AF MP, l'Association Aéronautique et Astronautique de France, Midi-Pyrénées chapter, www.3af-mp.fr. See the Section News pages for the 3AF MP organization chart. More information is soon to be placed on our web site at www.aiaahouston.org, but that has not yet been transferred from our former web site, www.aiaa-houston.org.

The relevant committee is in the technical branch of AIAA Houston Section, the International Space Activities Committee (ISAC), as shown on our organization chart. The ISAC is chaired by Ludmila Dmitriev-Odier.

This article was created by Philippe Mairet, 3AF MP, and Douglas Yazell, AIAA Houston Section. We thank Jessica Shaefer, Creative Time Director of Communications.

The Last Pictures will Enter Perpetual Orbit and Remain on View Five Billion Years, Becoming a Cultural Artifact of Our Time

New York, NY — July 9, 2012 — This fall, Creative Time will launch The Last Pictures, an archival disc created by artist Trevor Paglen, into outer space, where it will orbit the earth for billions of years affixed to the exterior of the communications satellite EchoStar XVI. To create the artifact, Paglen micro-etched one hundred photographs selected to represent modern human history onto a silicon disc encased in a gold-plated shell, designed at the Massachusetts Institute of Technology (MIT) and Carleton College. The Last Pictures is both a message to the future and a poetic meditation on the legacy of our civilization. The images contained in the artifact constitute what the artist describes as "cave paintings from the 21st-century," as they will become one of the longest-lasting material remnants of contemporary civilization. Following its launch from Kazakhstan in fall 2012, the artifact will remain in the Earth's geosynchronous orbit in virtual perpetuity. Audiences on earth will be able to experience the project through a series of public events and programs held in New York City, across the country, and around the world.

Paglen developed The Last Pictures through years of research and consultation with leading philosophers, scientists, engineers, artists, and historians and through a residency sponsored by the Visiting Artists Program at MIT. The project originates from the idea that the communications satellites in Earth's orbit will ultimately become the cultural and material ruins of the late 20th and early 21st centuries, far outlasting anything else humans have created. These geostationary satellites, located above the equator at an altitude of 24,000 miles, experience no atmospheric drag, and will remain in orbit until our sun expands into a red giant and engulfs the earth about 4.5 billion years from now. The Last Pictures imagines a future Earth where there is no evidence of human civilization beyond the derelict spacecraft we have left behind in our planet's orbit.

Creative Time Chief Curator Nato Thompson says, "In essence Copernicus used the skills of representation to transform our ideas of where the earth existed in the universe. In that spirit, Trevor Paglen's project might just do the same for us, only by giving us a sense of the radically astonishing small space we hold in time. "

While the satellite-mounted

(Continued on page 25)

Right: Cherry blossoms. Courtesy of Al Jazeera English.

(Continued from page 24)
artifact of The Last Pictures awaits deciphering by future civilizations, the project will also be shared with audiences on Earth. A display of a gold-plated disc at the Museum of Modern Art (MoMA) in New York City is planned for fall 2012, and Paglen and Creative Time will present a series of artist talks, a website, and an accompanying book co-published by University of California Press and Creative Time Books. In partnership with The New York Public Library's LIVE from the NYPL program, Paglen and Creative Time will also present an evening of performances and conversations with leading scientists and philosophers to debut the project in New York City's Bryant Park, coinciding with the EchoStar XVI satellite launch in fall 2012.

Left: Dust storm, Stratford, Texas. NOAA/Department of Commerce.

Left: Grinnell Glacier, Glacier National Park, Montana, 1940. Glacier National Park Archives.

Left: Grinnell Glacier, Glacier National Park, Montana, 2006. U.S. Geological Survey.

"For almost forty years, Creative Time has been taking artists and publics to unexpected, exciting, thought-provoking places around New York City, the nation, and the world — and now, into outer space," says Anne Pasternak, Creative Time's President and Artistic Director. "As much as The Last Pictures is an opportunity for Creative Time to further its programs beyond our Earth, it is also an opportunity for artist Trevor Paglen to push his artistic practice into new realms. Trevor is known for stunning photographs that force us to rethink our environment in profound, historic ways. Now, with The Last Pictures, Trevor has created an artwork that will likely be a part of our skyscape for billions of years—even longer than multi-celled organisms have been on Earth. It is a timescale so vast, it is difficult for us to comprehend."

Joao Ribas, Curator of MIT's List Visual Arts Center, says, "As human beings we're used to thinking about time in terms of hours or years. The Last Pictures asks: how we do think about a deeper time beyond the human? Combining the metaphysical with the scientific, ecological, and

(Continued on page 26)

3AF MP

(Continued from page 25)

technological, Trevor Paglen forces us to think about our relation to time in a deep way, by encoding information about our presence on earth in materials that can last for very long time. A “cosmic message in a bottle,” the artifact he produced as an artist in residence through the MIT List Visual Arts Center continues his interest in the sky as a place where the past and future meet."

The Last Pictures is part of a long tradition of public intersections of art and space, with direct reference to NASA and Carl Sagan’s Golden Record of 1977, a project that attached to space probes phonograph records containing sounds and images portraying the diversity of life on earth and suggesting the possibility of communicating with extraterrestrial life forms and/or future humans. As much as Paglen’s project draws on past attempts at universal communication beyond the confines of time, it also recognizes the inevitable impossibility of this task—that such communication can only be partial, fragmentary, and quasi-intelligible. Aware that The Last Pictures may never be discovered, Paglen also intends this project to serve as a stark reminder of humanity’s fragility and as a meditation on our ultimate fate.

Find out more at www.creativetime.org/thelastpictures.

ABOUT THE ARTIST

Trevor Paglen has earned international renown for uniting disparate disciplines – including science, contemporary art, and journalism – to explore and document hidden worlds. He uses photography, video, data, and other sources to create artworks that reveal the unexpected and the profound. Paglen’s work has been exhibited at The Metropolitan Museum of Art, New York; the Tate Modern, London; The Andy Warhol Museum, Pittsburgh; Institute for

(Continued on page 27)

Right: Earthrise. NASA/ William Anders.

Right: Glimpses of America, American National Exhibition, Moscow World’s Fair. Copyright 2012, Eames Office, LLC (www.eamesoffice.com).

Right: Waterspout, Florida Keys. NOAA/Department of Commerce.

(Continued from page 26)
Contemporary Art, Philadelphia; San Francisco Museum of Modern Art; and the Massachusetts Museum of Contemporary Art, North Adams. Paglen is the author of three books. His first, Torture Taxi: On the Trail of the CIA's Rendition Flights (co-authored with AC Thompson; Melville House, 2006) was the first book to systematically describe the CIA's "extraordinary rendition" program. His second book, I Could Tell You But Then You Would Have to be Destroyed by Me (Melville House, 2007), was an examination of the visual culture of "black" military programs. His third book, Blank Spots on a Map, was published by Dutton/Penguin in early 2009. Paglen has held residencies at both the Massachusetts Institute of Technology as well as the Smithsonian Institution, and he received a B.A. from UC Berkeley, an M.F.A. from the School of the Art Institute of Chicago, and a Ph.D. in Geography from UC Berkeley.

ABOUT CREATIVE TIME

Since 1974, Creative Time has presented the most innovative art in the public realm. The New York-based nonprofit has worked with over 2,000 artists to produce more than 335 groundbreaking public art projects that have ignited the public's imagination, explored ideas that shape society, and engaged millions of people around the globe.

For more information on Creative Time's programming, please visit www.creativetime.org.

ABOUT ECHOSTAR CORPORATION

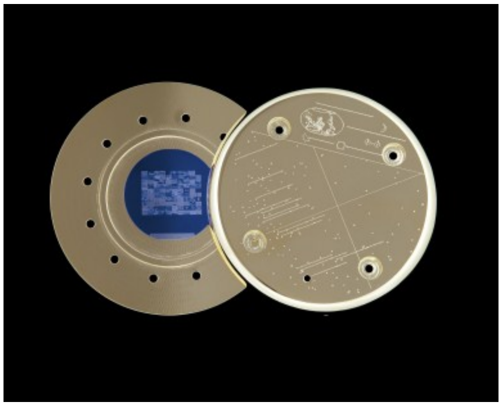
EchoStar Corporation, which donated both the services of its engineers and space on its next satellite, is the premier global provider of satellite operations, delivering innovative network technologies and managed network services for private and government customers in more than 100 countries. As a multiple Emmy Award-winning company that has pioneered advancements in the TV industry and video technology for nearly 30 years, EchoStar has had a major influence on the ways in which consumers interact with visual information.

ABOUT THE MIT COLLABORATION

Visiting Artist Trevor Paglen was in residence at MIT in 2011 to research and develop a new artwork designed to last billions of years in an extreme environment: geostationary space orbit around the earth. Paglen sought out MIT researchers Professor Karl. K. Berggren of the MIT Research Lab for Electronics, Associate Professor Brian L. Wardle from the Department of Aeronautics and Astronautics, and graduate student Adam McCaughan from the Quantum Nanostructure and Nanofabrication Group to explore materials and fabricate a lightweight, encodable, ultra durable silicon wafer etched with images using specialized equipment in the Quantum Nanostructure and Nanofabrication lab at MIT. Paglen's residency was co-sponsored by the MIT Visiting Artist Program and the MIT List Visual Arts Center.

ABOUT THE CARLETON COLLEGE COLLABORATION

Carleton College Astrophysicist Joel Weisberg collaborated with Trevor Paglen on the design of the scientific messages to potential discoverers etched into the artifact's cover. These messages were inspired by the first communications sent into deep space aboard interplanetary spacecraft in the 1970s, and have been updated in light of advances in human knowledge and understanding in the intervening decades. Weisberg and Paglen have written a refereed scientific article, accepted for publication in Astronomical Journal, describing in detail the contents of the artifact cover and the reasons for the choices made in its creation. The article, "A Temporal Map in Geostationary Orbit: The Cover Etching on the EchoStar XVI Artifact," is also available on the scientific preprint server on the web at arXiv.org.



Above: The disks containing the images.

Left to right: Nato Thompson, Chief Curator, Creative Time, artist Trevor Paglen, poet Tracy K. Smith, at the September 19, 2012 The Last Pictures event at Bryant Park, Upper Terrace, New York City. Photograph by Sam Horine, courtesy of Creative Time.

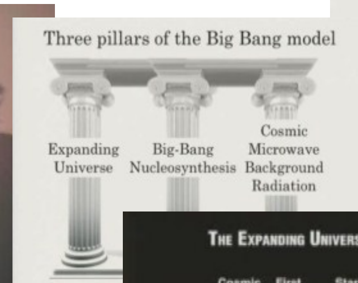
Staying Informed

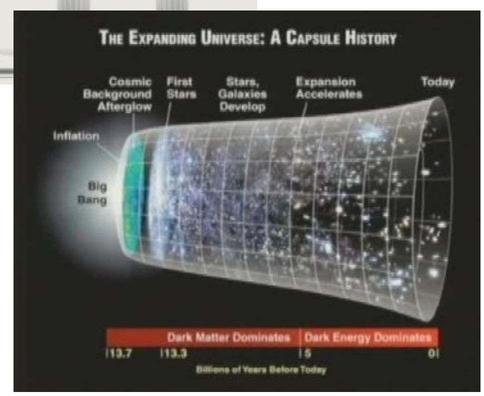
Free [Video](#) Now Availalble!

Right: Image credits: The Lunar and Planetary Institute web site screen capture images.

The Latest Lecture (Thursday, November 15, 2012) in the Public Lecture Series
Cosmic Explorations: A Speaker Series
from The Lunar and Planetary Institute

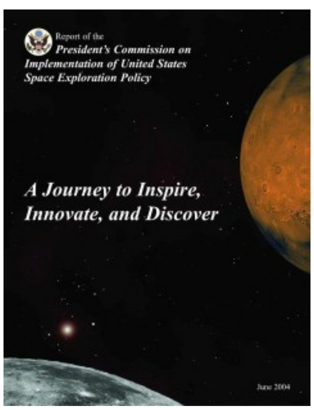
http://www.lpi.usra.edu/education/lectures/videos/Huterer/
http://www.lpi.usra.edu/education/lectures/flyers/111512/bigBang.pdf





Scheduled

2014?



Above: The cover of the Aldridge Commission report. Image credit: Wikipedia.

The Vision for Space Exploration: A Brief History by Paul Spudis in blog entries one through five at his blog, Spudis Lunar Resources. This is a history written by an insider. It starts in January of 2004 with the announcement of the Vision for Space Exploration (VSE) by President George W. Bush, then brings us up to date in November of 2012. Included are the 2004 Aldridge Commission (Paul Spudis was a member.), Michael Griffin's 2005 Exploration Systems Architecture Study (ESAS), Constellation, and the 2010 cancellation of Constellation.

As for the space shuttle program, "It was formally scheduled for mandatory retirement in 2010 in accord with the directives President George W. Bush issued on January 14, 2004 in his Vision for Space Exploration." [Wikipedia] From the Paul Spudis blog entry part three of five, *"The VSE concept of an incremental and sustainable space program had been abandoned. The architecture chosen was an answer to a question that had not been asked. If the mission was to be one of "go to Mars, like we did to the Moon," ESAS served the purpose intended. The retirement of the Shuttle, like Cortez burning his ships, was meant to have left the crew "motivated." No President or Congress would ever take the drastic and presumably wildly unpopular step of terminating the human spaceflight program once the Shuttles were gone – would they?"*

AIAA Daily Launch

NASA Scientists Find Most Accurate Climate Models

Alabama Live (11/12, Roop) reported, "In what NASA says could be 'a breakthrough in the longstanding quest to narrow the range of global warming expected in the coming decades,' scientists in a new analysis ***say they have found the most accurate climate models***. Those models, ***unfortunately, show temperature increases in the coming century on the high side of the range now considered most likely.*** ... Scientists led by John Fasullo and Kevin Trenberth compared how well 16 leading climate models reproduced relative humidity recorded in the tropics and subtropics. They used NASA satellites and a NASA data analysis."

The Minneapolis Star Tribune (11/10, Vastag) reported, "Looking back at 10 years of atmospheric humidity data from NASA satellites, the pair examined two dozen of the world's most sophisticated climate simulations. They found the ***simulations that most closely matched humidity measurements were also the ones that predicted the most extreme global warming***."

Staying Informed

Left: Image credit: PBS.

Free Video
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Above: 201211190020hq (19 Nov. 2012) --- Expedition 33 crew members; Commander Sunita Williams of NASA, Flight Engineers Akihiko Hoshide of Japan Aerospace Exploration Agency (JAXA), and Yuri Malenchenko of Russian Federal Space Agency (Roscosmos) are driven from Russian search and rescue helicopters to the main terminal at the Kustanay Airport in Kazakhstan a few hours after they landed their Soyuz spacecraft in a remote area outside the town of Arkalyk, Kazakhstan on Nov. 19, 2012 (Kazakhstan time). Williams, Hoshide and Malenchenko returned from four months onboard the International Space Station. Photo credit: NASA/Bill Ingalls.

Above: A model of the NASA Mars rover Curiosity at the Rice University public Space Frontiers Lecture by Curiosity engineers Ravi Prakash and Bobak Ferdowsi. Karin and Steve attended with their son Eagle. The hands of Steve and Eagle are visible in the picture. Image credit: Douglas Yazell.

Above: December 3, 2012. Artist's concept of an Orion spacecraft and the European-built module. Image source: Huntsville Times, Lee Roop reporting. Image credit: The European Space Agency (ESA). Huntsville Times headline: Europe will help build key Space Launch System Component, NASA Official Says (Updated).

Science (an AIAA subject) & Religion: A blog entry from SciGuy Eric Berger in the Houston Chronicle, November 30, 2012. Pat Robertson: "If you fight science, you are going to lose your children."

Left and below: Three screen capture images from the Rice University web site and YouTube video:
http://youtu.be/o2IiATREYDM
Ravi Prakash and Bobak Ferdowsi of the Mars Curiosity team, based at NASA's Jet Propulsion Laboratory, spent Nov. 1 at Rice University, where they met with engineering students and gave a public Space Frontiers Lecture. More information at the Rice Space Institute, http://rsi.rice.edu.

Astrodynamics

A Newly Discovered "Highly Accessible" NEO

DANIEL R. ADAMO, ASTRODYNAMICS CONSULTANT

The Minor Planet Center reported discovery of near-Earth object (NEO) 2012 UV_{136} on 24 October 2012. Orbit data inferred from initial 2012 UV_{136} observations are available from the Jet Propulsion Laboratory's (JPL's) *Horizons* ephemeris service at http://ssd.jpl.nasa.gov/?horizons and are used throughout this report. *Horizons* data indicate closest approach to Earth will occur 10.3 November 2012 UT at a distance of 2.2 million km. At that time, 2012 UV_{136} is crossing Earth's orbit inbound toward perihelion at 87% Earth's distance from the Sun on 26 January 2013.

In lieu of any planetary radar observations for 2012 UV_{136}, its effective spherical diameter d must be estimated based on *Horizons* absolute magnitude H = 25.57. These estimates produce d = 13 m to 59 m, assuming a plausible albedo ranging from 60% to 3%, respectively. While 2012 UV_{136} has unremarkable dimensions, its orbit is arguably the third most accessible among known NEOs. An authoritative, if subjective, accessibility metric is provided by the NEO Human Space Flight Accessible Targets Study (NHATS, pronounced "gnats") website at http://neo.jpl.nasa.gov/nhats/. In a cooperative arrangement between the Goddard Space Flight Center and JPL, NHATS data are generated and posted to this website on a daily basis. Using default accessibility criteria, NHATS tallies the number of compliant round-trip trajectories to 2012 UV_{136} with launch dates from 2015 through 2040, arriving at the sum n = 2,105,050 using data available on 1 November 2012. This value is exceeded only by NEOs 2000 SG_{344}, (n = 3,302,718; d = 19 m to 85 m) and 1991 VG (n = 2,737,560; d = 4 m to 16 m) under the same default NHATS criteria.

Both 2000 SG_{344} and 1991 VG have an orbit condition code OCC = 2, meaning their respective orbit solutions are stable, even over decades of position prediction into the past or future. Consequently, we could hope to reliably plan human or robotic missions to these highly accessible NEOs when opportunities arise. With only 49 observations extending over a 9-day interval, 2012 UV_{136} has OCC = 5 as of 1 November 2012. Although a minimal number of observations with poor quality can drive OCC values as high as 9, a few nominal-quality observations will typically achieve OCC = 6. Additional observations over a more extended period will be necessary before 2012 UV_{136} OCC can be reduced to 3 or less. At OCC > 3, this NEO's recovery after passing into Earth's daytime sky during mid-November 2012 may be problematic.

There is real hope for further 2012 UV_{136} OCC reduction because its orbit period is currently less than 2% longer than Earth's. In October 2013, this NEO should therefore be just about as observable as at its discovery. These two observing windows, with 2012 UV_{136} crossing Earth's orbit inbound towards perihelion, are illustrated in Figure 1. Dotted projection lines onto Earth's orbit plane (the ecliptic) in Figure 1 indicate 2012 UV_{136} is slightly below/south of the ecliptic when Earth's orbit is crossed inbound before perihelion and slightly above/north of the ecliptic when Earth's orbit is crossed outbound after perihelion. Small position deviations from the ecliptic by 2012 UV_{136} are due to its 2.3° orbit inclination with respect to that plane.

Inbound Earth orbit crossings are at an ecliptic longitude corresponding to November in Earth's orbit, and Earth happens to be very nearly in-phase with 2012 UV_{136} at these crossings in 2012 and 2013. Outbound crossings of Earth's orbit occur at ecliptic longitudes corresponding to April/May, and reasonably in-phase approaches with Earth will not occur there until 2019. Assuming 2012 UV_{136} OCC is low enough for reliable planning, any of these in-phase Earth orbit crossings offers a human mission opportunity with relatively short duration and low propulsion requirements.

Phasing trends for 2012 UV_{136} with respect to Earth over multiple heliocentric revolutions are best inferred using a relative motion coordinate system rotating with the Earth/Sun line. Figure 2 utilizes such a system, called Local Vertical Curvilinear (LVC), to illustrate 2012 UV_{136} geocentric relative motion over the 3-year interval centered near its discovery date. Locations to the right of Earth in Figure 2 are ahead of Earth in its heliocentric orbit, and locations to the left are behind. Direction towards the Sun is downward throughout Figure 2 because the horizontal LVC axis running through Earth (called the Vbar) maps a heliocentric circular arc. Consequently, 2012 UV_{136} tends to move rightward when located below the Vbar in Figure 2 and move leftward when located above the Vbar. Perihelion for 2012 UV_{136} occurs near the bottom of each Figure 2 LVC loop, and aphelion occurs near the top of each loop.

The gross phasing trend over one or more LVC loops in Figure 2 is leftward, indicating 2012 UV_{136} spends more time outside Earth's orbit than inside it. An Earth orbit crossing by 2012 UV_{136} in Figure 2 corresponds to a Vbar crossing. Because 2012 UV_{136} tends to phase behind Earth and also crosses its orbit, it is a member of the Apollo class of NEOs.

Phasing trend variations are most easily perceived among the 4 Vbar crossings with 2012 UV_{136} inbound toward the Sun at the left of Figure 2. Note particularly the spacing of these November crossings

(Continued on page 31)

Astrodynamics

(Continued from page 30)
along the Vbar in years 2011 through 2014. The greatest phase rate occurs between the 2011 and 2012 inbound Vbar crossings. Because the close Earth approach in November 2012 occurs with 2012 UV_{136} *leading* Earth in its heliocentric orbit, gravity perturbations from Earth lower both aphelion and perihelion. As a result, phase rate from November 2012 until the next Earth close approach in November 2013 is reduced with respect to the preceding year. The more distant Earth approach in November 2013 occurs with 2012 UV_{136} *trailing* Earth in its heliocentric orbit, partially neutralizing Earth perturbations accumulated in 2012. An intermediate phase rate is therefore apparent in Figure 2 from November 2013 until November 2014.

After the November 2013 Earth approach, 2012 UV_{136} phase rate remains reasonably constant until additional outbound Vbar crossings in April/May approach Earth closely beginning in 2019. Additional Earth perturbations will be accumulated by 2012 UV_{136} over the ensuing several years. *Horizons* predictions into the mid-2020s indicate 2012 UV_{136} will have an orbit period of 370 days after Earth perturbations from outbound Vbar crossings have run their course. Approximate heliocentric angular rates for Earth and 2012 UV_{136} can be computed as the quotients ω_1 = 360/365 = 0.9863°/day and ω_2 = 360/370 = 0.9730°/day, respectively.

(Continued on page 32)

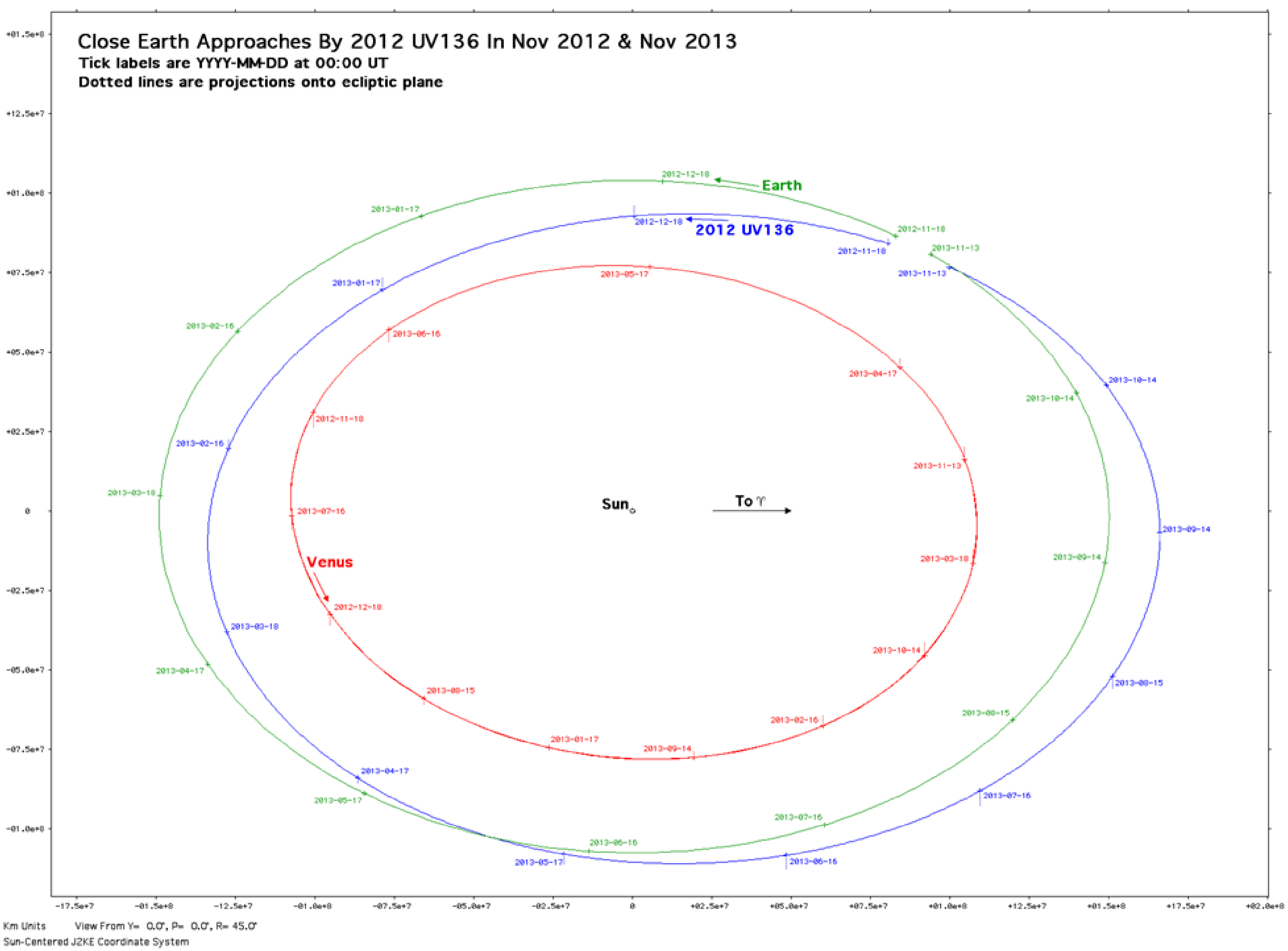


Figure 1. This heliocentric inertial plot shows the motion of Venus (red), Earth (green), and 2012 UV_{136} (blue) during the year following this NEO's discovery. Perspective is from 45° above/north of the ecliptic.

Astrodynamics

(Continued from page 31)

The difference ω_1 - ω_2 = 0.0133°/day approximates 2012 UV_{136} average heliocentric phase rate with respect to Earth. Ignoring further perturbations, this phase rate permits Earth to catch up with 2012 UV_{136} and begin additional close approaches (along with human mission opportunities) after one synodic period T_S = 360/0.0133 = 27,068 days = 74 years.

The "boom and bust" variation in 2012 UV_{136} human mission opportunities over the coming years is illustrated in Figure 3's pork chop chart (PCC). Coloration of each pixel in the PCC represents total mission change-in-velocity (Δv_{TOT}, the sum of impulses required to depart a circular Earth orbit at 400 km height targeting 2012 UV_{136} intercept, rendezvous with 2012 UV_{136}, depart 2012 UV_{136} for Earth and, if necessary, ensure Earth's atmosphere is entered at a speed less than 12.0 km/s) according to the vertical scale at right in Figure 3. This PCC maps Δv_{TOT}-colored pixels in a 2-dimensional array with Earth departure date being the hori-

(Continued on page 33)

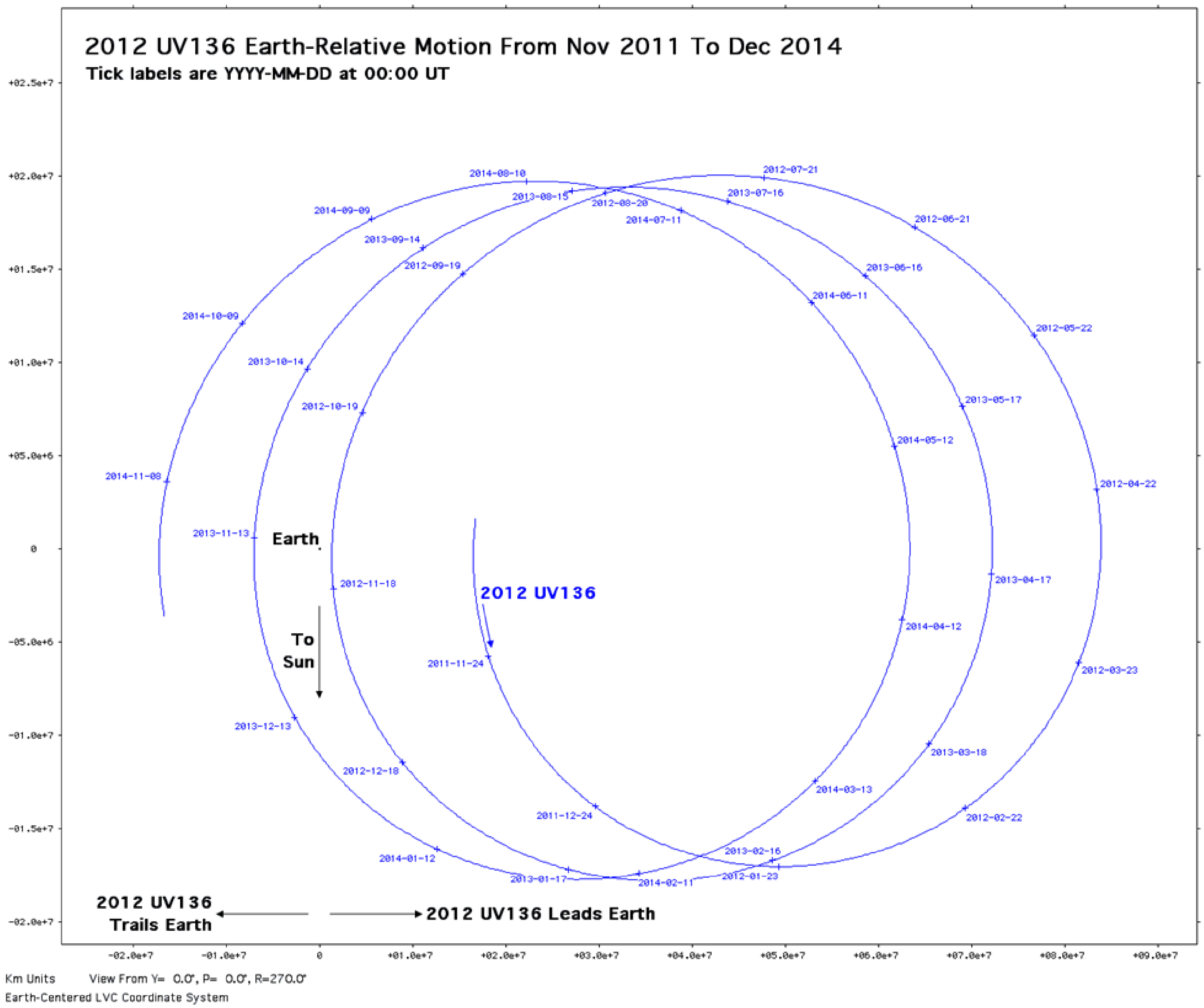


Figure 2. This geocentric plot of 2012 UV_{136} motion projected onto the ecliptic plane is in a coordinate system rotating with the Earth/Sun line. It permits detailed study of Earth perturbations accumulated by this NEO over multiple orbits.

(Continued from page 32)

zontal coordinate and roundtrip mission duration being the vertical coordinate. Note how prolific mission opportunities with a roundtrip flight time less than 450 days prior to an Earth departure date in 2020 fall off dramatically thereafter. By 2030, none exist, and T_S for 2012 UV_{136} suggests no mission opportunities satisfying NHATS criteria will be encountered for decades to follow.

Despite having an Earthlike orbit, 2012 UV_{136} could also have abysmally low NHATS accessibility as measured by n if missions are constrained to launch at times other than the default interval from 2015 through 2040. Launch date constraints are but one of many subjective aspects relating to NEO accessibility for human space flight. An orbit period similar to Earth's may facilitate a NEO's observation from Earth over an extended time interval, but this condition may also place an otherwise accessible NEO on the other side of the solar system from Earth during a programmatically convenient launch season.

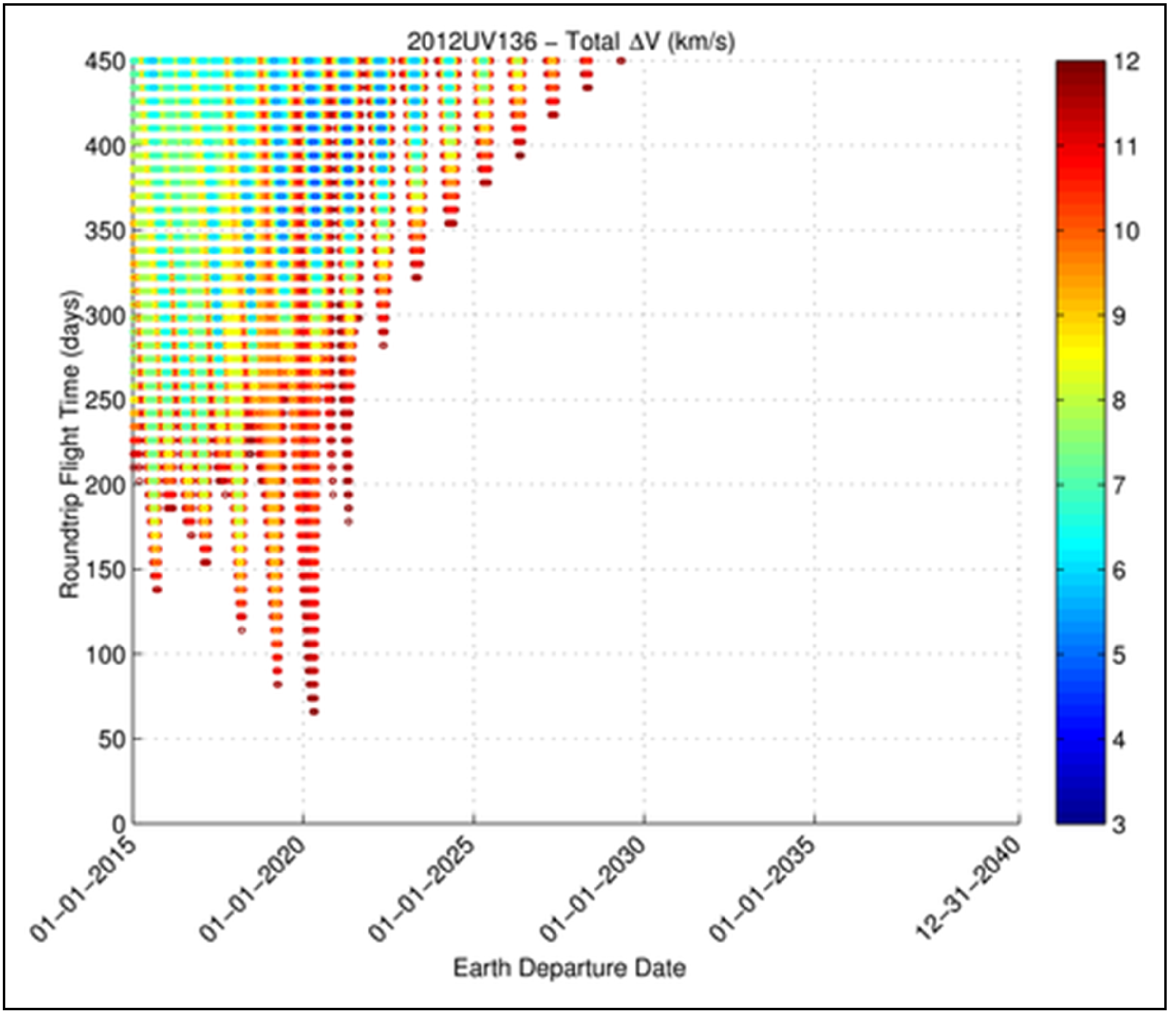


Figure 3. A PCC computed for 2012 UV_{136} according to NHATS mission viability criteria is reproduced as posted to the NHATS website. Note the dearth of NHATS-compliant mission opportunities from 2030 through 2040.

Astrodynamics

Asteroid 2012 DA14's February 2013 Fly-By

DR. PATRICK E. RODI

Above: Dr. Patrick E. Rodi at the AIAA Houston Section 2012 Annual Technical Symposium, as reported on page 14 in the May / June 2012 issue of Horizons. Image credit: Douglas Yazell.

With all the apprehension surrounding December 21st, 2012, there is another date to consider in mid-February, 2013. A 40 meter diameter asteroid will make a very close pass to the Earth on Friday, February 15th, but there is no danger of a collision. The object is known as 2012 DA14 and was first observed by the OLM Observatory at La Sagra, Spain. This pass will have a perigee of about 14,000 miles or about 3.5 Earth radii above the Earth's surface. As a result, this asteroid is expected to travel within the ring of the Clarke orbit (i.e. within GEO).

The asteroid will pass Earth on the night side of the planet. Just before passing into the shadow of the Earth, the asteroid's brightness will reach approximately magnitude 7, which is just beyond the range observable with the unaided eye. A small telescope should be able to image this object passing through a field of stars. With a relative velocity of 7.8 km/sec, 2012 DA14 will travel from the southern hemisphere to the northern hemisphere very quickly.

More details on 2012 DA14 and its upcoming close approach to Earth can be found at JPL's Small-Body Database Browser at, http://ssd.jpl.nasa.gov/sbdb.cgi?sstr=2012+DA14&orb=1

An animation of the fly-by has been created in Cosmographia, and is available on YouTube at, http://www.youtube.com/watch?v=S7YTmS6U8WM .

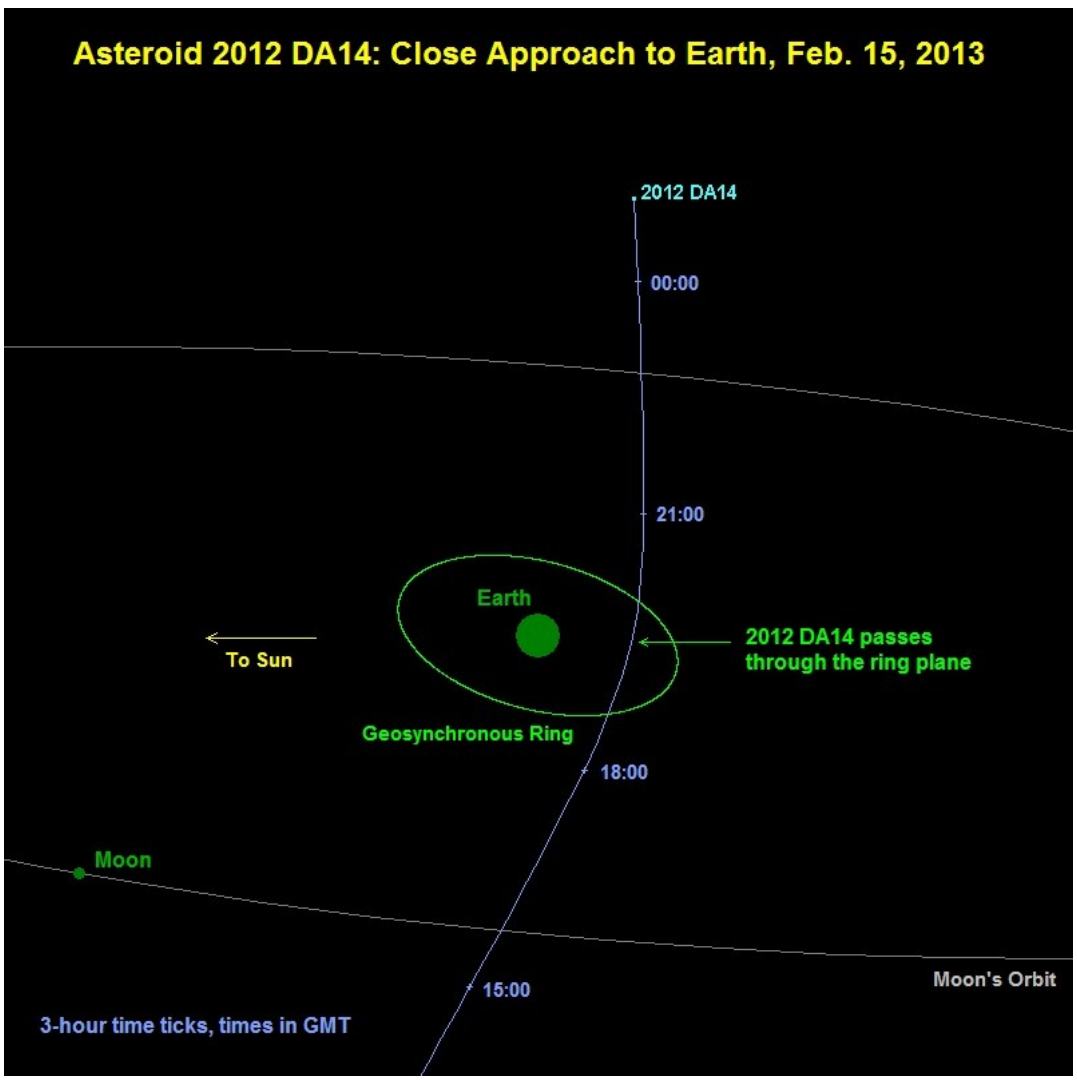


Figure 1. Sketch Showing the 2012 DA14 Pass on February 15th, 2013.

The Experimental Aircraft Association (EAA) Chapter 12 (Houston)

Mission

The EAA's Chapter 12, located at Ellington Field in Houston, Texas, is an organization that promotes all forms of recreational aviation. The organization includes interest in homebuilt, experimental, antique and classic, warbirds, aerobatic aircraft, ultra lights, helicopters and commercially manufactured aircraft and the associated technologies.

This organization brings people together with an interest in recreational aviation, facilitating social interaction and information sharing between aviation enthusiasts. Many of the services that EAA offers provide valuable support resources for those that wish to develop and improve various skills related to aircraft construction and restoration, piloting, aviation safety and aviation education.

Every individual and organization with an interest in aviation and aviation technology is encouraged to participate. (EAA membership is not required, but encouraged.) Meetings are generally from 6:30 PM to 9:00 PM at Ellington Field in Houston Texas. We welcome everyone. Come as you are and bring a guest; we are an all-aviation friendly organization!

In our May 2011 issue we started our series "EAA/AIAA profiles in general and experimental aviation" with Lance Borden, who is rebuilding his Inland Sport airplane, an aircraft manufactured by his grandfather's 1929 - 1932 company. The second in this series was a profile of Paul F. Dye. The third profile will appear as soon as possible. This series was suggested by Richard Sessions of EAA Chapter 12.

Ideas for a meeting? Contact Richard at rtsessions[at]earthlink.net, Chapter 12 web site: www.eaa12.org. Another email contact: eaachapt12[at]gmail.com. As of April 13, 2012, EAA Chapter 12 is meeting on the first Tuesday of month, based on the calendar on the web site. Experimental Aircraft Association (EAA) web site: www.eaa.org

Scheduled/Preliminary Chapter 12 Event/Meeting Ideas and Recurring Events:

1st Saturday of each month – La Grange TX BBQ Fly-In, Fayette Regional (3T5)
1st Saturdays – Waco/Macgregor TX (KPWG), Far East Side of Field, Chap 59, Pancake Breakfast with all the goodies 8-10 AM, Dale Breedlove, jdbvmt[at]netscape.com
2nd Saturdays – Conroe TX Chapter 302 10 AM Lone Star Builder's Ctr, Lone Star Executive
2nd Saturdays – Lufkin TX Fajita Fly-In (LFK)
2nd Saturdays – New Braunfels TX Pancake Fly-In
3rd Saturdays – Wings & Wheels, 1941 Air Terminal Museum, Hobby Airport, Houston TX
3rd Saturdays – Jasper TX BBQ Lunch Fly-In (JAS)
3rd Saturdays – Tyler TX Breakfast Fly-In, 8-11, Pounds Field (TYR)
4th Saturdays – Denton TX Tex-Mex Fly-In
4th Saturdays – Leesville LA Lunch Fly-In (L39)
4th Saturdays – Shreveport LA Lunch Fly-In (DTN)
Last Saturdays – Denton Fly-In 11AM-2 PM (KDTO)

Above: The Long-EZ belonging to Richard Sessions at the Wings Over Houston 2012 airshow. Image credit: Douglas Yazell.

Left: The blue airplane belongs to Louise Hose, and the airplane next to it belongs to Paul Dye. Paul is profiled in an earlier issue of Horizons (the July / August 2011 issue). Those two aircraft contribute nicely to a great EAA display (including two gyrocopters) at the Wings Over Houston 2012 airshow. Image credit: Douglas Yazell.

Museum

1940 Air Terminal Museum at Hobby Airport An AIAA Historic Aerospace Site

DOUGLAS YAZELL, EDITOR

This is a bimonthly column about the 1940 Air Terminal Museum, a 2008 addition to the list of AIAA Historic Aerospace Sites. The museum is restored and operated by the non-profit Houston Aeronautical Heritage Society.

1940 Air Terminal Museum
8325 Travelair Street
Houston, Texas 77061
(713) 454-1940

A spectacular Wings & Wheels Saturday lunch event took place at the museum on November 17, 2012, one of the monthly (usually the third Saturday of the month) Wings & Wheels events costing only $7 admission (11:00 AM to 3:00 PM). The featured attraction was the WW II B-17G airplane from the Commemorative Air Force (CAF), but there was much more. Museum volunteers already have the event report completed on the museum's web site, including about 100 photographs!

The remainder of this column for this month is taken from the museum web site's report of this November 2012 Wings & Wheels.

Texas Raiders Day!

This month was all about the big green plane, **The Commemorative Air Force's B-17 "Texas Raiders"**!

Joining the B-17 on the ramp were two of the vehicles from the **Sixth Cavalry Historical Association**. The owner, Robert Singer was on hand to show of these beautiful vehicles. A big thanks to Tim Landers and museum volunteer Phil LaBox for arranging their visit.

The CAF folks sold rides to many people and made two trips in and out of our ramp.

In the atrium, we were treated to the sounds of the **Jazz Connection Band** while they played tunes from the 1940s!

Out front, we hosted about fifty of the members of **Houston JeepPeople**. They filled up every bit of our parking lot and then some!

In case you're wondering why the only plane on the ramp the entire day was the B-17, this is because we had some logistical issues with positioning the B-17. Originally it was to operate much farther south than it did, giving it lots more room to turn around. Unfortunately, some trailers were parked in our way and we had to improvise. It was a tight fit, but we were able to get it on the ramp without crossing the line. This is why you saw them park it, then pull out, and park again. The airport also closed down runway 12R and so the B-17 would be operating out of runway 4 most of the day, meaning it would have to taxi out, and turn to the right (instead of the left - as we had originally planned), blasting everything

(Continued on page 37)

(Continued from page 36)
in its wake. This was the reason we decided to park the fly-in planes down at our hangar, along with our raffle plane, and also why we put everyone behind the fence to reduce the effect of the prop wash.

Preview of the Recent Wings & Wheels for Saturday, November 17, 2012

This month we are honored to welcome the B-17G *Texas Raiders* to our ramp, fresh from another great display at Wings Over Hou-
(Continued on page 38)

The Commemorative Air Force presents the Texas Raiders B-17, November 17, 2012, at the 1940 Air Terminal Museum, Hobby Airport, Houston, Texas USA. All images are from the museum's web site. Photographers often include Andrew Broadfoot, Blair McFarlain and Michael Bludworth. Their planespotting photographs are often seen at www.houstonspotters.net.

Museum

(Continued from page 37)

ston! This aircraft is not only a wonderful example of the numerous bombers that helped win the second World War, it is also a wonderful example of the results of the tireless efforts by volunteers such as those in the Commemorative Air Force, Gulf Coast Wing, to preserve and restore these great pieces of aviation history.

Texas Raiders is a very hardworking plane, not only during its service to this country from 1945 to 1955 and its service as a civilian aerial photo platform from 1957 to 1967, but also for its longest tour, from 1967 to today as one of the many historical aircraft the CAF operates. After two major restorations and several awards on the airshow circuit, the *TR* took a much needed breather and was once again disassembled and restored just two hangars down from the 1940 Air Terminal Museum, emerging once again in October of 2009 to rejoin the CAF fleet. We at the Museum were very happy to see *TR* undergoing its taxi tests right down Taxiway Golf!

Texas Raiders will be on display on our ramp and will be selling rides! There are only eleven airworthy B-17s in the world. Don't miss your chance to ride on one! Please visit **www.gulfcoastwing.com** and click on *B-17 Airplane Rides*

(Continued on page 39)

Above: The fly-in airplanes were parked in the hangar in order to avoid prop wash from the B-17.

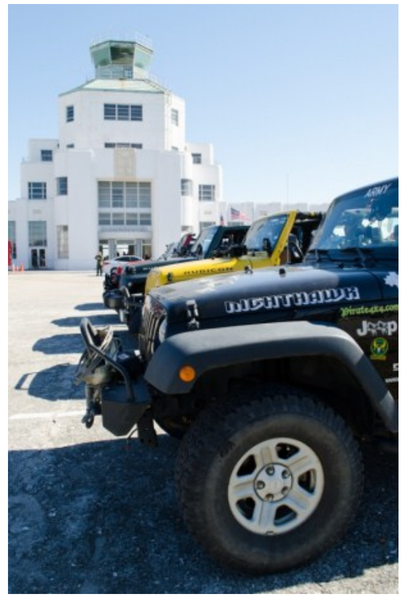
Above: This year's raffle airplane could be yours for $50.

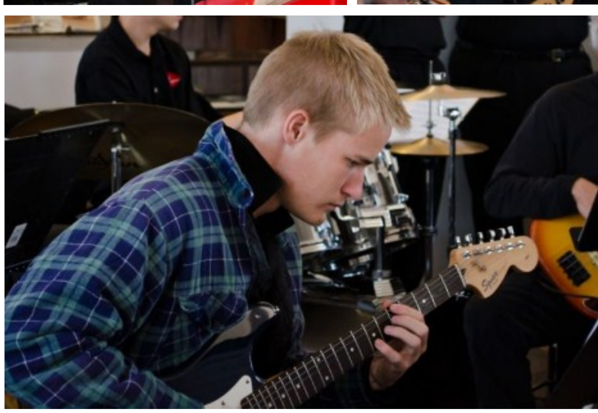
(Continued from page 38)
for more information.

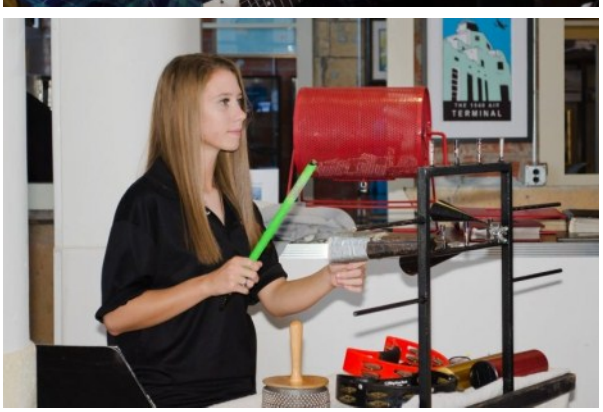
As always, we welcome any and all aircraft to our ramp. Visit our website for updates, or just stop by Houston Hobby Airport on the third Saturday and let's see what flies in!

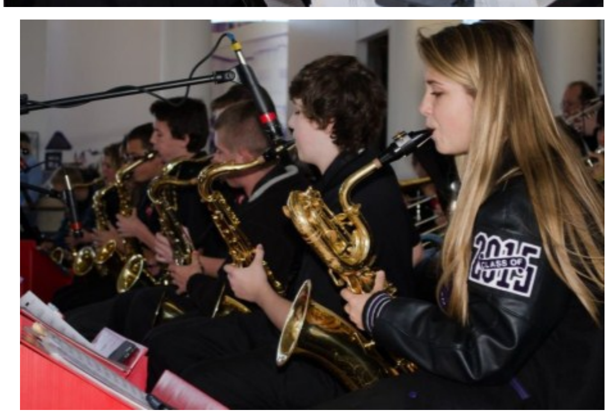
On the car side we're welcoming **Houston JeepPeople**, a family-oriented club that was formed in 2008 dedicated to four-wheeling and enjoying their Jeeps! Among their goals are promoting *Jeeping* as wholesome family fun, practicing ethical, environmentally-conscious use of public and private lands, and supporting the **Tread Lightly** program from the **Texas Motorized Trails Coalition.**

Learn about the great offroad fun that you can find in our wonderful state with these great people! As they say, it's not just about the Jeep, it's about the people!









Calendar

Section events & other events related to aeronautics & astronautics. This November / December 2012 issue of Horizons is scheduled to be online by December 10, 2012. All items are subject to change without notice.

Section council meetings: email secretary2012[at]aiaahouston.org
Time: 5:30 - 6:30 PM usually
Day: First Monday of most months except for holidays.
Location: NASA/JSC Gilruth Center is often used. The room varies.

Recent Section events:

15 November 2012 Lunch and Learn, Dr. Kumar Krishen, NASA/JSC, *Voyages: Charting a Course for Sustainable Human Space Exploration: A Review*, AIAA Houston Section Program Management and Integration technical committee, Chair: Dr. Satya Pilla, Host: Ron Sostaric, NASA/JSC.

Upcoming Section events:

Audiobook in work by Ted Kenny, NASA/JSC, Chair, AIAA Houston Section History technical committee, *Suddenly Tomorrow Came, A History of JSC*

Friday, May 17, 2013: AIAA Houston Section Annual Technical Symposium. See www.aiaahouston.org for more information. The early warning publicity flyer is also presented on page 3 of this issue.
Location: NASA/JSC Gilruth Center.
Time: Approximately 8:00 AM to 4:30 PM.

AIAA & Related National & International Conferences

www.aiaa.org (Events)

2013:

7 - 10 January 2013 Grapevine (Dallas/Ft. Worth Region), Texas, 51st AIAA Aerospace Sciences Meeting
8 January 2013 Grapevine TX, *Engineers as Educators*, Learn to Hold a Workshop in Your Section
9 January 2013 Grapevine TX, *Engineers as Educators* Workshop
28 - 31 January 2013 Orlando, Florida, Annual Reliability and Maintainability Symposium (RAMS)
10 - 14 February 2013 Kauai, Hawaii, AAS/AIAA Space Flight Mechanics Conference
12 - 13 February 2013 Huntsville, Alabama, Civil Space Symposium 2013
23 February 2013 Peoria, AZ, AIAA *Educator Academy*-Phoenix
2 - 9 March 2013 Big Sky, Montana, 2013 IEEE Aerospace Conference
19 - 20 March 2013, Washington, DC, 2013 *Congressional Visits Day*
22 - 23 March 2013 Park City, Utah, Space Weather Community Operations Workshop
25 - 28 March 2013 Daytona Beach, Florida, 22nd AIAA Aerodynamic Decelerator Systems Technology Conference and Co-located Conferences
8 - 11 April 2013 Boston, Massachusetts, 54th Structures, Structural Dynamics, and Materials and Co-located Conferences
10 - 12 April 2013 Delft, The Netherlands, EuroGNC 2013, 2nd CEAS Specialist Conference on Guidance, Navigation and Control
15 - 19 April 2013 Flagstaff, Arizona, 2013 IAA Planetary Defense Conference
23 - 25 April 2013 Herndon, Virginia, Integrated Communications Navigation and Surveillance 2013

Horizons: published bimonthly by the end of February, April, June, August, October & December at www.aiaahouston.org.

Cranium Cruncher

Challenge

DR. STEVEN E. EVERETT

In October, a puzzle was presented of how one of a trio of astronauts determined which helmet he was wearing. Since the man at the back could not determine the color of the stripe on his own helmet, this means that the front two men could not have been wearing helmets with black stripes. Recall that there were only two helmets with black stripes, so if he saw two, he could have deduced that his had a red stripe. Therefore, there must have been at least one helmet with a red stripe on the two front men. Subsequently, the middle man must not have been able to see a helmet with a black stripe. Otherwise he would have known he was wearing a helmet with a red stripe. Therefore the front man must have been wearing a helmet with a red stripe - which finally he deduces. Interestingly, the other two can never determine which helmets they were actually wearing.

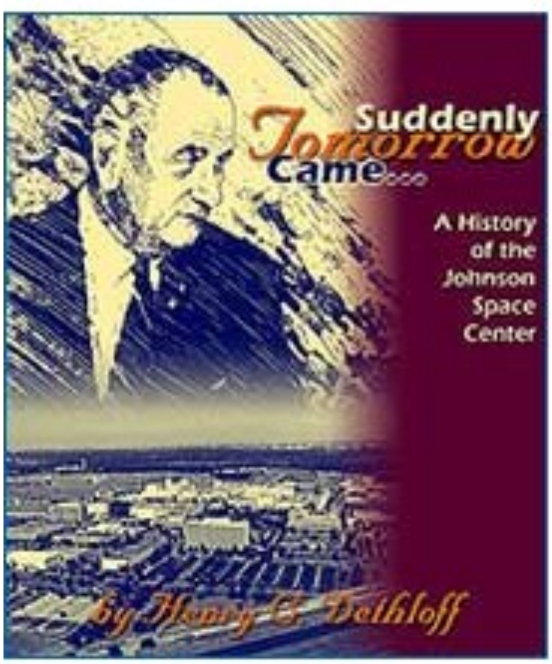
  

This month, the following logic puzzle is posed:

Brown, Clark, Jones, and Smith are the names of four former Shuttle astronauts who held, though not respectively, the positions of Commander, Pilot, Mission Specialist 1 (MS1), and Mission Specialist 2 (MS2) on their shared mission.

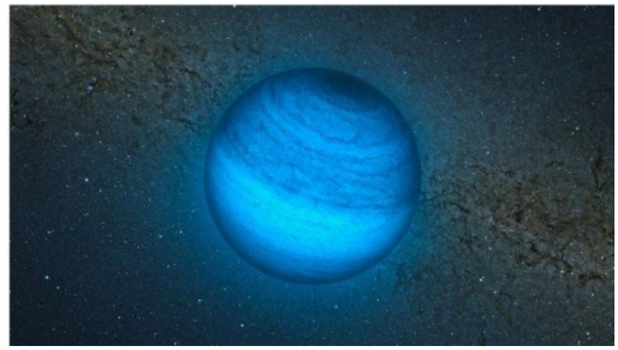
> Although the Pilot beats him consistently, the MS2 will play chess with no one else at NASA.
> Both the MS1 and Pilot are better chess players than the Commander.
> Jones and Smith are next door neighbors, and frequently play chess together in the evening.
> Clark plays a better game of chess than Jones.
> The Commander lives near the MS2 but not near any of the others.

What was each man's position on the group's mission?



Suddenly Tomorrow Came… A History of the Johnson Space Center, the Audiobook! See page 22 of our July / August issue, a 76-page PDF file available in low (23 MB) or high (87 MB) resolution. The original 1993 book is free (PDF with great art!) via NASA.

Section News



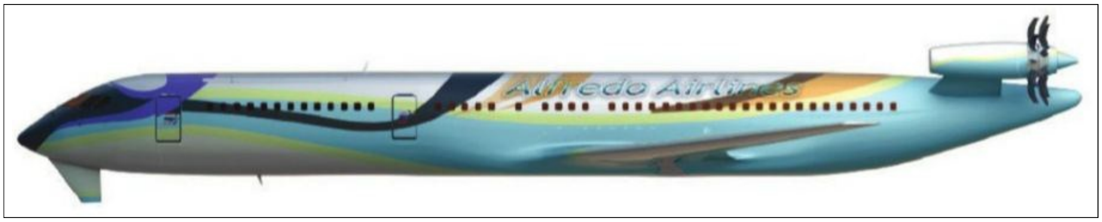
Right: This artist's impression shows the free-floating planet CFBDSIR J214947.2-040308.9. This is the closest such object to the Solar System. It does not orbit a star and hence does not shine by reflected light; the faint glow it emits can only be detected in infrared light. Here we see an artist's impression of an infrared view of the object with an image of the central parts of the Milky Way from the VISTA infrared survey telescope in the background. The object appears blueish in this near-infrared view because much of the light at longer infrared wavelengths is absorbed by methane and other molecules in the planet's atmosphere. In visible light the object is so cool that it would only shine dimly with a deep red color when seen close-up. Credit: L. Calçada, P. Delorme, Nick Risinger, R. Saito, European Southern Observatory/VVV Consortium.

For more information: http://spaceflightchronicles.com/2012/11/14/orphan-jupiters-the-first-confirmation/

Association Aéronautique et Astronautique de France (3AF)

Sister Section of AIAA Houston Section since 2007
Jumelée avec AIAA Houston Section depuis 2007

Section News



Above: A Tale of No Tail from the November 2012 issue of the [AIAA] magazine Aerospace America, page 39. If the tailless concept works, "old technology" airliners will become obsolete. Computational Fluid Dynamics (CFD) studies have shown that a "chin rudder" can counteract sideslip angles with a control gain of two relative to the freestream. Author: Daniel P. Raymer, Conceptual Research.

The American Institute of Aeronautics and Astronautics (AIAA)

Houston Section
Since 1962

Executive Council
July 01, 2012 - June 30, 2013

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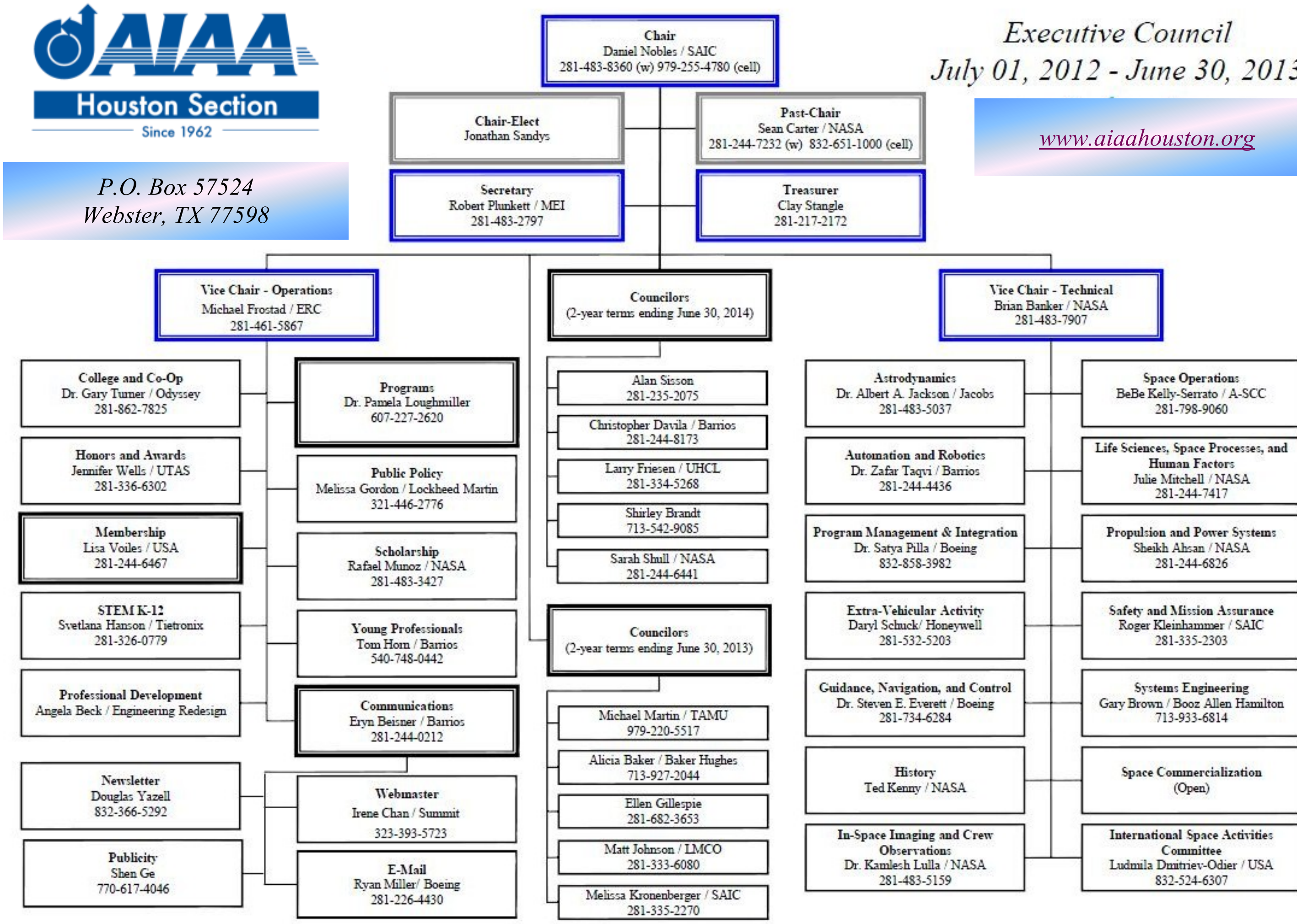

Updated July 31, 2012, Executive Council Voting Members (20) are identified by:

Student Section News

Rice University AIAA Student Section Advisor:
Professor Andrew Meade, *meade[at]rice.edu*
713-348-5880, www.ruf.rice.edu/~meade/

TEXT OF PRESIDENT JOHN KENNEDY'S RICE UNIVERSITY STADIUM MOON SPEECH 9/12/62, Houston, TX USA

...There is no strife, no prejudice, no national conflict in outer space as yet. Its hazards are hostile to us all. Its conquest deserves the best of all mankind, and its opportunity for peaceful cooperation many never come again. But why, some say, the moon? Why choose this as our goal? And they may well ask why climb the highest mountain? Why, 35 years ago, fly the Atlantic? Why does Rice play Texas?

We choose to go to the moon. We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too. It is for these reasons that I regard the decision last year to shift our efforts in space from low to high gear as among the most important decisions that will be made during my incumbency in the office of the Presidency. In the last 24 hours we have seen facilities now being created for the greatest and most complex exploration in man's history. We have felt the ground shake and the air shattered by the testing of a Saturn C-1 booster rocket, many times as powerful as the Atlas which launched John Glenn, generating power equivalent to 10,000 automobiles with their accelerators on the floor. We have seen the site where the F-1 rocket engines, each one as powerful as all eight engines of the Saturn combined, will be clustered together to make the advanced Saturn missile, assembled in a new building to be built at Cape Canaveral as tall as a 48 story structure, as wide as a city block, and as long as two lengths of this field. Within these last 19 months at least 45 satellites have circled the earth. Some 40 of them were "made in the United States of America" and they were far more sophisticated and supplied far more knowledge to the people of the world than those of the Soviet Union. The Mariner spacecraft now on its way to Venus is the most intricate instrument in the history of space science. The accuracy of that shot is comparable to firing a missile from Cape Canaveral and dropping it in this stadium between the 40-yard lines. Transit satellites are helping our ships at sea to steer a safer course. Tiros satellites have given us unprecedented warnings of hurricanes and storms, and will do the same for forest fires and icebergs. We have had our failures, but so have others, even if they do not admit them. And they may be less public. To be sure, we are behind, and will be behind for some time in manned flight. But we do not intend to stay behind, and in this decade, we shall make up and move ahead. The growth of our science and education will be enriched by new knowledge of our universe and environment, by new techniques of learning and mapping and observation, by new tools and computers for industry, medicine, the home as well as the school. Technical institutions, such as Rice, will reap the harvest of these gains.

And finally, the space effort itself, while still in its infancy, has already created a great number of new companies, and tens of thousands of new jobs. Space and related industries are generating new demands in investment and skilled personnel, and this city and this State, and this region, will share greatly in this growth. What was once the furthest outpost on the old frontier of the West will be the furthest outpost on the new frontier of science and space. Houston, your City of Houston, with its Manned Spacecraft Center, will become the heart of a large scientific and engineering community. During the next 5 years the National Aeronautics and Space Administration expects to double the number of scientists and engineers in this area, to increase its outlays for salaries and expenses to $60 million a year; to invest some $200 million in plant and laboratory facilities; and to direct or contract for new space efforts over $1 billion from this Center in this City. To be sure, all this costs us all a good deal of money. This year¹s space budget is three times what it was in January 1961, and it is greater than the space budget of the previous eight years combined. That budget now stands at $5,400 million a year--a staggering sum, though somewhat less than we pay for cigarettes and cigars every year. Space expenditures will soon rise some more, from 40 cents per person per week to more than 50 cents a week for every man, woman and child in the United Stated, for we have given this program a high national priority--even though I realize that this is in some measure an act of faith and vision, for we do not now know what benefits await us. But if I were to say, my fellow citizens, that we shall send to the moon, 240,000 miles away from the control station in Houston, a giant rocket more than 300 feet tall, the length of this football field, made of new metal alloys, some of which have not yet been invented, capable of standing heat and stresses several times more than have ever been experienced, fitted together with a precision better than the finest watch, carrying all the equipment needed for propulsion, guidance, control, communications, food and survival, on an untried mission, to an unknown celestial body, and then return it safely to earth, re-entering the atmosphere at speeds of over 25,000 miles per hour, causing heat about half that of the temperature of the sun--almost as hot as it is here today--and do all this, and do it right, and do it first before this decade is out--then we must be bold. ...However, I think we're going to do it, and I think that we must pay what needs to be paid. I don't think we ought to waste any money, but I think we ought to do the job. And this will be done in the decade of the sixties. It may be done while some of you are still here at school at this college and university. It will be done during the term of office of some of the people who sit here on this platform. But it will be done. And it will be done before the end of this decade.

I am delighted that this university is playing a part in putting a man on the moon as part of a great national effort of the United States of America. Many years ago the great British explorer George Mallory, who was to die on Mount Everest, was asked why did he want to climb it. He said, "Because it is there." Well, space is there, and we're going to climb it, and the moon and the planets are there, and new hopes for knowledge and peace are there. And, therefore, as we set sail we ask God's blessing on the most hazardous and dangerous and greatest adventure on which man has ever embarked. Thank you.

Student Section News

The Texas A&M University AIAA student section started work on its web site for the new year as of August 10, 2012: http://stuorg-sites.tamu.edu/~aiaa/

Faculty advisor: Professor John E. Hurtado, *jehurtado[at]tamu.edu*, 979-845-1659.

Brian Freno '08 Chair	Bob Cline '13 Speaker Chair	Chris Greer Graduate Representative
Rahul Venkatraman '13 Vice Chair	Nhan Phan '14 SEC Chair	Nicholas Ortiz '13 Senior Class Representative
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Erica Lovig '13 Treasurer	Lauryn Hoch '15 Publicity Chair/ Webmaster	Logan Hodge '15 Sophomore Class Representative
		Jacob Shaw '16 Freshman Class Representative

Above: Brian Freno. Image credit: Texas A&M University AIAA student section web site.

Above: Rahul Venkatraman. From: Aberdeen, New Jersey. Career Interests: Flight Engineer, First Male Indian American Astronaut. Something you should know about Rahul: Age 2: I saw Venus for the first time, Age 3: I learned to say the nine planets, Age 10: I earned my third degree black belt in Tae Kwon Do, Age 18: Placed 5th in the 400m dash at State Champs. Favorite quote: "Dare to Dream." Dr. Kalpana Chawla, NASA Astronaut. Image credit: Texas A&M University AIAA student section web site.

Student Section News

Please send inputs to Dr. Gary Turner, our College and Co-Op Chair. His e-mail address is: *collegecoop2012[at]aiaahouston.org*
His backup for this task is Editor Douglas Yazell: *editor2012[at]aiaahouston.org*
We publish most bimonthly issues at www.aiaahouston.org by the last day of each even-numbered month, and the submissions deadline is three weeks earlier. The November / December issue is an exception. It is published by December 10, not December 31.

Essay

After Apollo: Creating an Economically Robust Space Policy by Learning from the American West

Dr. Martin Elvis, Reported by Shen Ge, Contributor

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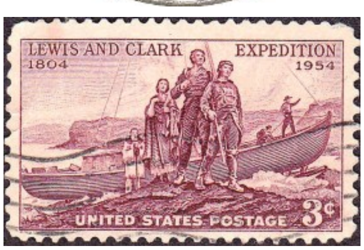

Dr. Martin Elvis is a Senior Astrophysicist at the Smithsonian Astrophysical Observatory, part of the Harvard-Smithsonian Center for Astrophysics. The views presented here are his own, and should not be taken to represent those of the Smithsonian Institution.

Just over two hundred years ago an American president initiated a program of exploration that sent two men to the Pacific Ocean. Fifty years ago, another US president initiated a program of exploration that sent two men to the Sea of Tranquility. Fifty years after Lewis and Clark we had the California Gold Rush, and it was just another 16 years to the completion of the first transcontinental railroad with the Golden Spike. But fifty years after the start of the Apollo Program, the High Frontier of space is trailing far behind the pace of the frontier of the American West. Why the striking contrast?

From the beginning, the effective goal of the US space program was to dominate this new frontier against Soviet incursions. Despite the costs, it worked. Until recently, whether by accident or design, it has suited the United States for space to be expensive. As long as no other country, or regional bloc, could rival US expenditures on space, US supremacy was assured by these high costs. Even after the Cold War, this has been the de facto US strategy for space. In this sense, we are still living in the Apollo era of space policy.

What should our "After Apollo" space policy be? New players are now challenging US dominance is space, with increasing success. Perhaps no new US response is needed. Our pride may be hurt, but realism suggests that space really doesn't matter. After all, space is a small industry. In 2007, the entire global space industry, by its own Space Foundation estimates (even including the GPS chips that are now common in cell phones), amounted to just two -thirds of Walmart's annual turnover. Perhaps the US should simply ignore space.

In fact, US competitiveness is threatened - in space and on Earth - and a new economically oriented space policy is critical for American success in both realms. The US government should respond to this new situation by playing to the nation's strength. The federal government should play the same role in space in the 21st century that it played in the development of the American West in the 19th century: making the frontier safe for capitalism.

Unleashing Capitalism in Space

This is not a Cold War argument, attempting to scare the US into a renewed space program based on military fears. Rather, the US has made a huge investment in space, and it now has a clear technological advantage, but it could easily lose this advantage if the necessary changes are not made. As the Chinese and others catch up, US technological advantages are eroding. At some point, which could be in the near future, the value of space resources will become commercially exploitable. When that happens, will US companies reap the rewards?

The formal goal of the US space program, for nearly 30 years, and under both parties, has been, as George W. Bush clearly stated: "to advance US scientific, security, and economic interests through a robust space exploration program." Considering the three elements of this goal - science, security, and economic growth - NASA has done a great job promoting a robust scientific program in space. Military utilization of space for security, from spy satellites to the GPS system, is

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also robust: the Air Force and National Reconnaissance Office space programs form a $20B-$30B a year enterprise.

The third interest, economic growth in space, has not fared as well. In fact, as Jeff Greason, the president of XCOR, has emphasized, the US has no coherent strategy to achieve this goal. Space resources are vast, and could be harnessed to the great benefit of the nation. These resources will benefit not only American citizens but, through networks of global commerce, all the peoples of the world. A strategy for achieving economic benefit from space must involve both government and industry, as did the development of the American West.

Imagine that the US had ignored the territories acquired in the Louisiana Purchase. At first, this was a hostile territory and much of it was considered a desert. Ignoring the American West might have left Native Americans better off, but the wealth and power of the US would today be radically reduced. Other European nations were then actively exploring the "Wild West," as other nations are now exploring space. In the hostile territory of space there are, fortunately, no indigenous populations to abuse, and we already know that the resources are there.

What are these resources? They have been discussed for years, and are expertly cataloged in John S. Lewis's 1996 book, *Mining the Sky*: beaming solar power to Earth, mining the moon for the helium isotope, helium-3 (for use in fusion reactors), and mining asteroids for many things, including iron to use in construction in space, water for astronauts, and methane for rocket fuel. These are truly vast resources, with trillions of dollars in street value, and capable of solving today's oil-based energy crisis. Policy makers have not paid serious attention to these resources, because they seem more like tales of El Dorado than real opportunities. The possibility that the US may soon lose leadership in space means that American policy makers should reconsider the facts of the matter and make a reasoned choice, lest we cede there bounty by default.

Developing space resources means enabling profits to be made from them. The paeans to the value of space resources have almost all been written by scientists, not by business people. And we scientists are financially naïve. We add up the value of the resource, but ignore the cost of bringing that resource to market, or even the existence of a market. There are, for example, no fusion reactors to fuel with helium-3, nor will there be for at least several decades. In space, the large capital costs and long payback time make it impossible to turn a profit from almost any of these resources, as John Hickman showed in 1999. However, Hickman does point out that if, for example, functioning solar power stations were in orbit, they would be profitable. That positive financial feedback (profit) could then fuel entirely new space-based industries. Getting to that starting point is the problem. Historically, governments have often invested in long term infrastructure development projects to lower cost and risk barriers, and thereby empower private enterprise.

One problem that blocks this virtuous cycle from starting outweighs all others: the forbiddingly expensive cost of access to space. Today it costs US$10,000 to US$20,000 per kilogram, just to get to low Earth orbit (LEO). It is a rare industry that can make a profit with cargo rates this high. This price has barely changed since Apollo, in constant dollars.

Could the cost come down? Space is not inherently expensive. Of the US$50M launch price for a Falcon 9 rocket, from SpaceX, less than one percent is the cost of the fuel. Nor do we need new technologies. Jet airplanes have been around about as long as rockets to orbit, and a ticket from New York to Los Angeles costs about a tenth of what it did in 1960, in constant dollars. Incremental improvements driven by competition drove down the cost. There are some hopeful signs. There is a nascent space tourism industry. Virgin Galactic will soon offer short, sub-orbital flights for US$200,000 a ticket. Early demand is brisk. But the business plan to go from sub-orbital to orbital flights is not obvious. It takes 30 times as much energy to reach orbital velocity as it does to briefly exit Earth's atmosphere going straight up and down. Bigelow Aerospace is developing commercial space stations, in hopes of renting

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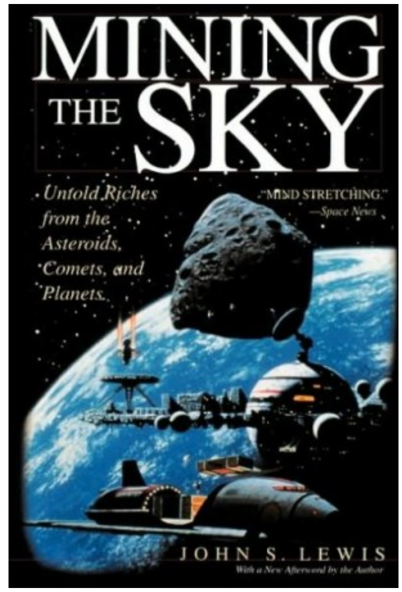
Below: John S. Lewis's book, Mining the Sky, was a seminal work on space resources, as relevant today as in 1966 when it was first published. Image Credit: Barnes and Noble.



Essay

Below: Headquarters of SpaceX in Hawthorne, California. If launch costs are reduced by more than 80% to $2,000/kg, substantial progress will be made in opening the door to economical space development. Image source: Wikipedia. Image credit: Bruno Sanchez-Andrade Nuño (Flickr) from Washington, DC, USA.

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inflatable rooms in space. And Elon Musk's Space-X has announced plans to launch cargo to LEO for just US$2,000/kg. If realized, this would be a substantial price break. But it is not enough to make space based solar power pay off, which requires launch costs closer to US$200/kg. After all, sunlight does come to the ground for free. And while asteroids offer metals and minerals in abundance, until there are in-space markets for iron, water and methane, these resources cannot be profit centers.

We need to find a pump primer. We need some space venture that makes enough profit, on the ground, even at high access costs, to get the ball rolling. The profits will have to be as extreme as those of the luckier Gold Rush pioneers. And it has to pay off right away. It must have a very high price per kilogram. Does space have a "Gold Rush" resource?

The answer is a resounding "Yes! But…" Gold, silver, platinum, and similar heavy metals are rare today because most lie out of reach in the Earth's core, where they settled early on, when the planet was still molten. Only small amounts remain in the Earth's crust, where they can be mined. As a result, some precious metals have prices of US$2000/ounce, or US$70,000/kg. That's a promising number compared with US$20,000/kg to launch, especially as a kilogram of mining equipment should bring back much more than a kilogram of ore.

But why go to space to mine even these most precious metals? Meteorites tell us that among the asteroids there are ores that are far richer than any mines on Earth. If we could find one of the smaller asteroids, just 200 meters diameter, that was as rich in platinum and related metals as the richest meteorite, it would have a value of about US$30B, and provide close to two year's production of platinum at current levels. These are encouraging numbers. The technical difficulties in bringing the ore back to Earth profitably are large, but perhaps not insurmountable. So: Yes. The Platinum Group Metals (PGMs) could be the pump primers we need to build a profitable space economy.

What about rare earths? Strategically, the near-monopoly on rare earth production by China is a concern to other nations, as the recent sharp spike in prices has shown. But rare earths are poorly named. They are not particularly rare, just hard to mine. Normally the most expensive rare earths command only about a tenth the price of platinum, so they would not be profitable as a space venture. However, the strategic lesson is good. If demand for hydrogen fuel cells takes off for powering automobiles, then the demand for platinum could multiply several-fold. (Fuel cells use platinum as a catalyst.) US strategic interests would be well served by ensuring a commercial supply from asteroids. Today, more than 75% of the world's platinum and more than 85% of the rhodium comes from a single geological feature in South Africa.

And yet, US$30B is not really a big enough number, given the costs and risks involved. There have been, over the years, numerous articles studying the problem of mining the asteroids for PGMs. Jeffrey Kargel (1994), Mark Sonter (1997), and others, in a scattered literature, have laid out the technical and economic challenges. Sonter, and Shane Ross (2001), in particular, began to explore the costs to determine whether a profit is possible. More recently, Ricky Lee (2009) examined several legal as well commercial concerns regarding profitable asteroid mining.

High risk, long term, venture capital is likely to require at least a 20% per year return. In that case, for a venture capital fund to invest US$5B today, they will want to see a return of about US$30B in 10 years, with a good chance of success. While US$5B is not an outsized investment for a new terrestrial mine, the risks and rewards are far better known on Earth. As a result, the likely profit from an asteroid mining venture today is negative.

Bringing down this risk and cost barrier is where the US government can play an historic role. As Hickman notes: "Capitalization is a crucial problem for these projects because the total capital investment required is very large and the investment takes a very long time before producing economic returns. Very large space development projects are best understood as massive public works projects which are necessary to open frontiers. Despite the libertarian sentiments in much of the popular science writing on very large space develop-
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ment projects, government would likely have to play a large role in capitalizing such projects."

Strategic government investment could "buy down the risk" over the next decade so that a venture capitalist could reasonably undertake an asteroid mining enterprise. This is a role the US government has played well in the past, notably in the development of the American West. The late historian, William H. Goetzmann laid out the interaction of government and private enterprise in his masterpiece, *Exploration and Empire* (1966). From the Lewis and Clark expedition, through detailed geological surveys, the establishment of legal rights, providing security, offering land grants, and developing infrastructure in the form of railroads, the US government was highly involved in enabling the pioneers and prospectors who developed the American West.

This tells us that the US can best respond to the international challenge it faces in space by playing to its strong suit: it is time to unleash capitalism in space.

Modest efforts along these lines have begun. NASA's commercial crew vehicle program has just awarded US$275M, somewhat over one percent of its budget, to develop private sector launch services. But, because we have lacked a clear strategy, our legislators have not embraced this approach wholeheartedly. One earlier NASA commercialization initiative has already paid off. Space-X developed the Falcon 9 launcher and Dragon capsule for just US$600M, and first launched them in 2010. They now have a NASA contract to resupply the International Space Station, starting in 2012. The prospect of new profits engages creativity in space, as it does everywhere else.

Myriad Details
& Thorny Questions

A program as large as taming a new frontier, be it the American West or space, involves getting many details right, and resolving numerous difficult issues. The economic development of asteroids, and of space resources in general, will take a wide range of skills. Some of these challenges are outlined here, in five categories: technology, economics and markets, issues of law, justice, and policing (including property rights), ethics, and finally the coordination of private and public efforts.

NASA is well positioned to create some of the necessary infrastructure, mostly by developing new technologies. Other agencies, such as the Department of the Interior - via the US Geological Survey - will have expertise to contribute too. Many of the required technologies overlap with NASA's current goal of sending humans to an asteroid, so NASA will need little alteration of its priorities, for the moment. Other technological needs are driven by the specific demands of economically viable asteroid mining; these will be new to NASA. For example, the interest payments on a US$5B loan impose a strong "time is money" imperative on all off-planet activities. Some of this technology development will be able to make use of the International Space Station, injecting new purpose into its mission.

While the technological challenges are many, it is possible to outline a strategy to address them. Initially, astronomers will be needed to map out the territory, as only 10% of the nearby asteroids have been found so far, and even fewer have known mineralogical compositions. Then, even as we map out potentially profitable sites, space and mining engineers will need to test out ways to mine in space economically.

Economists, mining companies, and marketing experts will need to make refined estimates of profitability, in the face of fluctuating prices and changing markets, and likely PGM recovery rates from asteroids. Economic considerations will have technical repercussions. For example, the relative importance of accurate robotic assays will rise.

Diplomats and international lawyers will need to establish a hospitable international legal framework. To Europeans, the Louisiana Purchase gave the US a legal claim to the West. In space no state has any claim. Effective US sovereignty over the Louisiana Purchase was tenuous for quite a while, and was contested over large areas by

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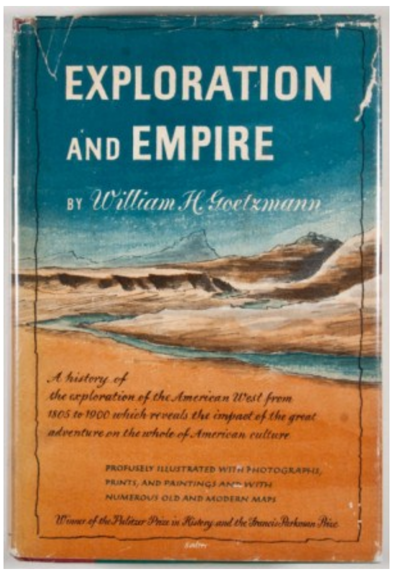
Below: William H. Goetzman's book Exploration and Empire covers in detail how the US government supported exploration of the American west. Image credit: Walkabout Books.



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Spain and Britain. The US response was active and multi-formed, and included, for example, legal licensing of trappers in the territory.

The existing 1963 United Nations "Outer Space Treaty" (officially, the "Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space") is completely oriented toward the principal of a "common heritage of mankind." This means that it is impossible to own a celestial body, at least de jure. This is a major disincentive to any venture capitalist, as their expenditures may be lost if the goods they return are forfeit. In *Who Owns the Moon?* (2009), Virgiliu Pop argues that the "common heritage of mankind" principle prevents the profitable use of space resources, and that establishing ownership de facto is the most likely route that resource development will take. He cites John Locke, the Enlightenment philosopher, who argued that private development of land left "waste in common … does not lessen, but increases the common stock of mankind." Such arguments have become dubious on Earth, as we realize the finiteness of its resources, but in space such limits are very distant indeed.

Once a single profitable asteroid mining venture succeeds, it will start an "asteroid rush." The best ore-bearing asteroids will then suddenly become highly valuable properties, and all the usual legal, policing, and justice issues that apply in a gold rush will necessarily come into play.

Central to a venture capitalist's concerns are property rights. How can a company establish a mining claim? How can anyone own a piece - or all - of a celestial body? Are asteroids even "celestial bodies" under the law? After all, if you can move it, is it still celestial? (A forthcoming Keck Institute for Space Studies report will show that a small asteroid could be moved from its orbit around the Sun to an orbit around the Earth.) Is it enough to do a private survey? To land on an asteroid and plant a flag? (This is how entire terrestrial continents were claimed in the past.) Or is it necessary to return an ore sample to Earth? If so, can an entire asteroid be claimed following the return of a very tiny sample? What if the asteroid is 1000 km across? How can claims be enforced? What if a rival alters the asteroid's orbit to hide it? Is there a penalty? (And who decides, under what jurisdiction, and who enforces such a ruling?) Once there are repair crews, to tend to the expensive mining equipment, there must be safety regulations, and provisions for emergency services. Public safety is also an issue. If an enterprise moves an asteroid towards Earth for more convenient processing, what rules must they follow to avoid an unintended impact with our planet? ("Environmental Impact" indeed!) If a piece of mined material lands in my backyard, do I own it? Who gets to tax asteroid mining, and what are the most societally beneficial taxation regimes?

Establishing these rules will be a busy and necessary occupation for both diplomats and lawyers. Any rules we set up beforehand will surely need to be modified as the exploitation of space resources grows. And remember that platinum group metals are just the pump primer. The "tailings" from PGM mining will include ultra-pure iron, already separated and ground into small grains, which can be used for any number of in-space development projects, such as space based solar power systems, at a low incremental cost.

There are ethical issues too. Asteroid mining will destroy pristine environments containing clues to the early solar system, and possibly to the origins of life. If we grind up these asteroids for profit, will we have lost something as special as the Amazon rainforest or the Arctic wilderness? This is not a purely altruistic consideration. There may be materials on asteroids of great potential value, but of which we are now ignorant. Take for example, quasicrystals. These are strange, newly discovered materials, for which the 2011 Nobel Prize in Chemistry was awarded. The only naturally occurring quasicrystal found to date may well have come from an asteroid. How do we avoid Garret Hardin's "Tragedy of the Commons?" Here the history of the American West is not a good guide. Indian Treaties were routinely discarded,

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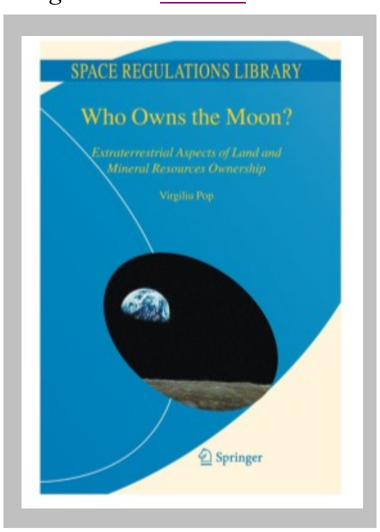
Below: Virgiliu Pop's book, Who Owns the Moon?, outlines in detail the unresolved questions in space ownership in present international space law. Image credit: Amazon.



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as soon as the hint of a valuable resource was discovered on reservation territories. Can we, or should we, try to create the space equivalent of the far more successful National Parks? Who would serve as trustees for these parks? The United Nations? A seemingly mild proposal to reserve the Saha crater on the far side of the Moon for radio astronomy has already proved difficult. As Karen Cramer (1997) notes, "mining, astronomy, geology, solar power, manufacturing, and landing rights are not all compatible."

How will we coordinate the various activities of multiple federal agencies that the commercial utilization of space will elicit in the US government? President Obama's new *National Space Policy* (2010) directs NASA to "pursue capabilities, in cooperation with other departments, agencies, and commercial partners, to detect, track, catalog, and characterize near-Earth objects to ... identify potentially resource-rich planetary objects [emphasis added]." The Department of Commerce has already created a small Office of Space Commercialization. Extending federal interests to asteroids will require, at a minimum, an Interagency Working Group, with participants drawn from several departments, including Commerce, State, Justice, Defense, Interior, Transportation, and, of course, an economically repurposed and re-focused NASA. To involve a wider range of actors, beyond the Federal Government, a Presidential Commission, like the 2004 Aldridge Commission, which defined the G.W. Bush *Vision for Space Exploration*, could be highly beneficial. Such a commission could draw on the expertise developed over the past decade by private US studies. For example, the Colorado School of Mines has held an annual *"Space Resources Roundtable"* since 1999. The creation of permanent institutions to support and regulate this vast new resource regime should, perhaps, wait until its specific needs emerge and are better understood.

Enacting a Capitalist Space Policy

President Obama has called for NASA to send astronauts to an asteroid by 2025. As he said, "in fulfilling this task, we will not only extend humanity's reach in space - we will strengthen America's leadership here on Earth." But the President's call has generated only a lukewarm response. The problem, I believe, is the lack of a compelling "Why?" Why go to an asteroid? The 2009 Augustine report, "Seeking a human spaceflight program worthy of a great nation," argued that the asteroids are valuable as stepping-stones to Mars, better than the Moon in various ways. But putting humans on Mars is so distant, and is only interesting as a prelude to possible settlement. And space settlement is itself not particularly compelling for many people. So the President's program has had only mild appeal. The uncertainty over the value proposition of NASA today - given the end of the Shuttle, the current federal budget crunch, and the ongoing arguments over free market versus public development strategies - undergirds this weak public response. NASA's US$18B budget seems large if it only supports pure science and space spectaculars. But considered as an infrastructure investment that will open up great economic possibilities, it is actually quite modest.

Re-directing NASA's priorities towards a strategy of developing space resources for commerce may have a better chance of engaging the public, and industry. And once profits flow, who needs public enthusiasm? Profitable asteroid mining ventures will be self-propelled. And they will pay taxes. Within a decade or so, the federal government could reduce the cost and risk barriers to commercial exploitation of asteroids to a level that venture capital will be a viable path forward. Once a profit making industrial apparatus is in place, the government can step aside from that aspect, even as its role in the legal and diplomatic side of space capitalism will increase. Put simply, enabling profit should be the centerpiece of any 21st Century national space policy.

Like the Apollo program, the Ming Dynasty fleets of the early 1400s projected sovereign power, but they were costly and they brought no economic bounty. Bureaucrats argued that there were more pressing needs at home, and the fleet was dismantled. The challenges to Chinese seafaring supremacy were far closer than they imagined. We know much more about space today than the Chinese knew about the high seas 600 years ago.
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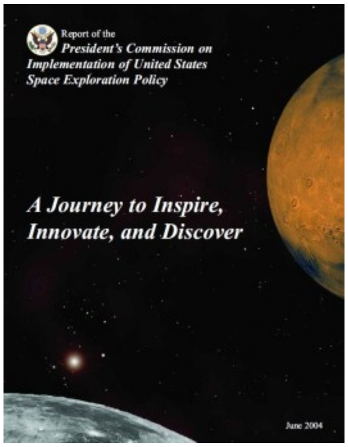
Below: Cover page of report of Aldridge Commission, Report of the President's Commission on Implementation of United States Space Exploration Policy, 2004. Image source: Wikipedia. Image credit: National Space Society & NASA / Aldridge Commission.



Essay

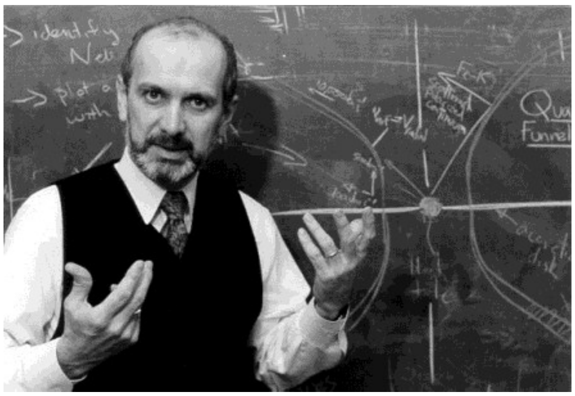
(Continued from page 51)

But we have to change our model.

NASA's primary directive, as already legislated under President Reagan, in a 1985 update to the 1958 Space Act, is to "seek and encourage, to the maximum extent possible, the fullest commercial use of space." With the challenges now arising to the nation's economic leadership in space, the US should organize a strategy around this already established, but under-implemented, goal. US led capitalism in space can bring unprecedented benefits to all of Earth's inhabitants. A far-sighted leveraging of government investment, similar to that pursued by Thomas Jefferson in the historic West, will empower US capitalism to lead the economic development of the space frontier.

I thank BC Crandall of Space Wealth and Jonathan McDowell of planet4589.org for valuable discussions and advice.

[Dr. Martin Elvis]



Above: Dr. Martin Elvis, Astrophysicist, Harvard-Smithsonian Center for Astrophysics. Image credit: Harvard University.

"This article is reprinted from the Harvard International Review, Spring 2012: http://hir.harvard.edu/a-new-empire/after-apollo"

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Racing to the Moon - An Update on the Chinese Space Program

MARLO GRAVES & FRANKLIN ZHANG

All the evidence indicates that the Chinese government will land on the Moon within the next decade. In the second half of 2013 China plans to launch a lunar lander called Chang'e-3. This lander will explore the lunar surface for 15 days and carry out various experiments. This will be China's third lunar lander. The previous satellites were launched in 2007and 2010.

In addition to its unmanned space program, China is pushing forward with its human space program. During the summer of 2013, China will launch another crew into space. This mission will most likely be called Shenzhou 10. Like the previous mission, Shenzhou 9, which launched in June 2012, this mission will be a three-person crew consisting of two men and one woman. China only began launching humans into space in 2003 when they sent the first Chinese national, Yang Liwei, into space. So far, China has launched nine astronauts into space.

China already has an orbiting space lab called Tiangong-1. This space platform allows the Shenzhou spacecraft to test their docking capabilities and is useful for training the Chinese astronauts. Tiangong 1 is scheduled to last two years and will be followed by Tiangong 2 and Tiangong 3. The Chinese plan to launch their first space telescope in about 2015 and then build their own complete space station by 2020.

The successful launches of Shenzhou spacecraft received great attention all over the country, and Chinese people are very proud to be in the forefront in the global space program. The astronauts came back and then were treated as national heroes. During their time in the space, CCTV (China's national television network) reported on their activities, such as their daily life and experiments conducted in Shenzhou 7.

It may just be a decade before China lands on the Moon. What will they do when they get there and what other nations will be there to meet them?

Marlo Graves & Franklin Zhang are active with AIAA Houston Section's Beijing sister section. The purpose of this group is to foster citizen to citizen diplomacy and to increase cultural knowledge among AIAA members.

A PROCLAMATION

issued jointly by the

SHANGHAI ASTRONAUTICAL SOCIETY
CHINESE SOCIETY OF ASTRONAUTICS

and the

HOUSTON SECTION
AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

WHEREAS both the Chinese Society of Astronautics (CSA) and the American Institute of Aeronautics and Astronautics (AIAA) are organizations of learned scientists and engineers working in their respective countries to advance the arts, sciences and technology of astronautics and related fields, and

WHEREAS members of the Shanghai Astronautical Society of the CSA and those of the Houston Section of the AIAA share many technical interests, particularly those closely associated with the study of space sciences, the exploration of space, and its development to the benefit of mankind, and

WHEREAS it is the desire of the members of the Shanghai Astronautical Society and the Houston Section to establish and recognize a special relationship for the purpose of fostering good-will and understanding between their members,

NOW, THEREFORE do they declare themselves to be

SISTER SECTIONS

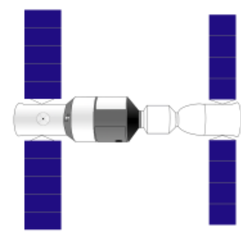
and do extend to each other the hand of friendship, and the pledge of cooperation in all things as befits this special relationship.

梁晋才
Chairman
Shanghai Astronautical Society, CSA

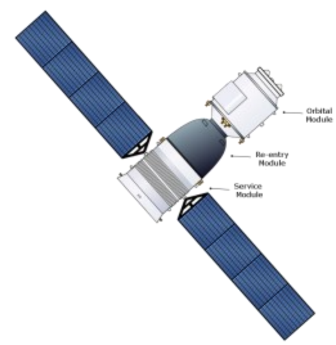
Carl R. Huss AUG. 27, 1987
Chairman
Houston Section, AIAA

8-1

Above: AIAA Houston Section's 1987 sister section proclamation with the Shanghai Astronautical Society (SAS), co-founded by James C. McLane, Jr.



Above: Shenzhou 9 spacecraft (left) docked with Tiangong 1. Image source: Wikipedia. Image author: Craigboy.



Above: Diagram illustrates the post S-7 Shenzhou spacecraft and to some extent is based off of this image. Image source: Wikipedia. Image author: Craigboy.

Above: Mission patch for Shenzhou 9, launch in June 2012. Image source: Wikipedia. Image author: China National Space Agency (CNSA).

Collier's 1952-54

Man Will Conquer Space Soon! (1952-54)

DOUGLAS YAZELL, EDITOR

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John Sisson, Dreams of Space
Arthur M. Dula
Shirazi Jaleel-Khan

Quite a few more people make these articles possible, including the Horizons team listed on page 2. Thanks to all involved!

We reprint in the following pages that part of *Man Will Conquer Space Soon!* which appeared in the third of these eight issues of the weekly magazine Collier's. We can read them already at http://UNZ.org, but the paintings are almost totally blacked out there. These are nine full pages, pages 38 through 48 in the original magazine, where pages 41 and 43 were full page advertisements.

This issue of Collier's was dated October 25, 1952, and it concluded a series of articles in the issue from the prior week dated October 18, 1952. The earlier articles were titled *Man on the Moon*, and these articles were titled *More About Man on the Moon.*

Collier's of December 13, 1952, contained Week's Mail about the issue of October 18, 1952, *Man on the Moon*. That mail appears on pages 4, 6 and 8 as shown at http://UNZ.org. **First** was a very complimentary short letter

(Continued on page 55)

	"Man Will Conquer Space Soon!" in 8 Issues of the Weekly Magazine Collier's 1952-54	Cover Image	Page Count
1	March 22, 1952: Man Will Conquer Space Soon! What are we Waiting For? pp. 22-23, The Editors Crossing the Last Frontier, pp. 24-29, 72, 74, Dr. Wernher von Braun A Station in Space, pp. 30-31, Willy Ley The Heavens Open, pp. 32-33, Dr. Fred L. Whipple This Side of Infinity, pg. 34, Dr. Joseph Kaplan Can We Survive In Space? Pp. 35, 65-67, Dr. Heinz Haber Who Owns the Universe? Pp. 36, 70-71, Oscar Schachter Space Quiz Around the Editor's Desk, pp. 38-39	Yes	25
2	October 18, 1952: Man on the Moon Man on the Moon, p. 51, The Editors The Journey, pp. 52-58, 60, Dr. Wernher von Braun Inside the Moon Ship, pg. 56, Willy Ley	Yes	11
3	October 25, 1952: More About Man on the Moon The Exploration, pp. 38-40, 44-48, Dr. Fred Whipple & Dr. Wernher von Braun Inside the Lunar Base, pg. 46, Willy Ley	No	10
4	February 28, 1953: World's First Space Suit Man's Survival in Space, 10 Contributors & 3 Artists, edited by Cornelius Ryan pp. 40-41 Picking the Men, pp. 42-48	Yes	10
5	March 7, 1953: More About (Continuing) Man's Survival in Space Testing the Men, pp. 56-63	No	8
6	March 14, 1953: How Man Will Meet Emergency in Space Travel Concluding Man's Survival in Space: Emergency! pp. 38-44	Yes	9
7	June 27, 1953: The Baby Space Station: First Step in the Conquest of Space Baby Space Station, pp. 33-35, 40, Dr. Wernher von Braun with Cornelius Ryan	Yes	6
8	April 30, 1954: Can We Get to Mars? / Is There Life on Mars? Is There Life on Mars? pg. 21, Dr. Fred L. Whipple Can We Get to Mars? pp. 22-29, Dr. Wernher von Braun with Cornelius Ryan	Yes	10

This issue

Above: Man Will Conquer Space Soon!, a series of articles from 1952 to 1954, from the weekly magazine Collier's. Source for most of the table: Wikipedia, Man Will Conquer Space Soon!, an article first written by John Sisson.

Collier's 1952-54

(Continued from page 54)
from Albert B. Dickas of Oxford Ohio about the space stories in both of those October 1952 issues. The **second** letter is from Robert M. Meltzer of Auburn, Maine. He compliments everyone for the space stories appearing in all three issue of Collier's to that point. He states that he is happy to know that more such articles are coming soon. He concludes by stating that everyone he talks with about these space projects, hundreds of people from all walks of life where he lives, is supportive. The **third** letter is thankful that the articles published so far support what they believe to be the first high school science fiction club, The Regis High School Science Fiction Society. The two student letter writers are Gerald Albin of Cahill, NY and Hubert James Horan of Flushing NY. The **fourth** letter is a short one from Lee Thomas (aged 12) of Austin, Texas, saying that since the Moon landing ship is not streamlined, a small amount of air on the Moon will cause it trouble, and the editors reply that Collier's scientists state that there is little, if any, air on the Moon. The fourth letter is from Bobby Stewart of Kirbyville, Texas. "...How many people noticed that in Fred Freeman's cutaway illustration of the Moon ship three of the scientists on the ship are Dr. Wernher von Braun (top floor), Willey Ley (entering engineering deck) and Dr. Whipple (navigation deck)?" The editor replies, *"Several, Bobby."* That cutaway illustration of the Moon ship is on page 45 of our last issue, and we identify those three faces and two more (artists Rolf Klep and Fred Freeman) on page 49 of our last issue.

The **fifth** letter is a short note from Eric E. Hale of El Centro, California, stating that he

(Continued on page 56)

Issue 3 of 8:
The cover image
is not related to
*Man Will Conquer
Space Soon!*

Issue 5 of 8:
The cover image
is not related to
*Man Will Conquer
Space Soon!*

Above: Image credits: Scott Lowther, with help from other Horizons Collier's team members.

Collier's 1952-54

(Continued from page 55)

likes the *Man on the Moon* articles and urges Americans to complete the project before the Russians. The **sixth** letter is from Clarence Mathews of Clinton, Illinois. He notes that it was written that the astronauts on the Moon would need to be careful of falling since there is no air to break the fall, so he asks how the spacecraft can brake for landing and takeoff. *The editors answer that the rocket ship is the only engine known to science that not only works in a vacuum but is more efficient there than in air.*

The **seventh** letter is from Thomas Pappan of Owosso, Michigan. He asks how nitric acid, hydrazine and hydrogen peroxide make the rocket go. The editors write, *"The hydrogen peroxide drives the pumps which feed the hydrazine and nitic acid into the rocket motor. These liquids burst into flame when they touch each other; they don't require ignition. Combustion of the gases propels the ship in accordance with Newton's third law of motion."* In the **eighth** letter, Ed Giesselmann of El Cerrito, California asks how heat can be dissipated on the airless, waterless and perhaps soilless Moon, heat from things like tractor engines, and turbogenerators. The editors respond, *"The heat has to be dissipated by radiation. The radiating surfaces would be shielded from the Sun."* The **ninth** letter is from Ing. Ismael Sanchez Pardo of Mexico, D.F., Mexico. He quotes the article, *"...with a gentle shove the reserve tanks will disappear out of sight and eventually they will crash on the Moon."* He concludes that the shove must be strong enough to ensure the tanks are caught by another gravitational field, and if the push is not strong enough, the tanks will return to the side of the ship attracted by its gravitational field. The editors reply, *"Theoretically, the reader is correct. Practically, the gravitational field of the ship would be so slight that it wouldn't matter."*

*Above: Lockheed L-749A Constellation N6022C "Star of Virginia" **TWA** at London (Heathrow) Airport with under-fuselage "Speedpack" freight container. September 12, 1954. Image source: Wikipedia. Image credit: RuthAS.*

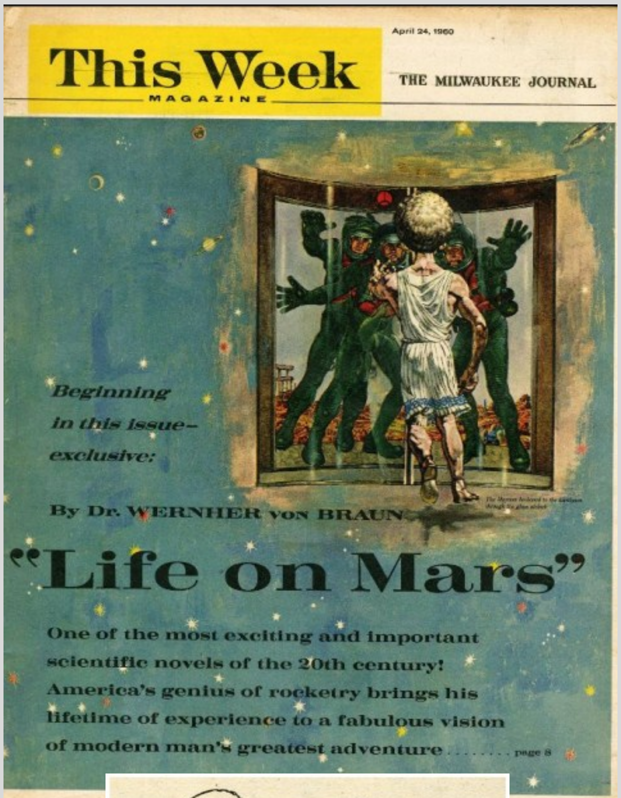
The **tenth** letter is from Ralph S. Damon of New York, N.Y. The Wikipedia article on the Harmon Trophy mentions that Trans World Airlines (**TWA**) CEO Ralph [Shepard] Damon won that prize for 1948. Mr. Damon was also a letter writer for Collier's Week's Mail presented on page 36 of our last issue, and we presented a little more information about him there. Mr. Damon writes that the October [18, 1952] issue of Collier's passed around the world so fast that the day it hit the newsstands in the USA, it was also on display at Nairobi Airport, Kenya, East Africa, traveling on TWA from New York to Cairo, and on Ethiopian Air Lines from Cairo to Nairobi. Below his letter is a photograph (see http://UNZ.org for a grainy black and white reproduction) of Mr. Damon reading that October 18, 1952 issue of Colllier's (its cover showing the Moon ship launching from the Moon) along with two other men. Behind them is a sign, *"East African Airways, Nairobi, Eastleigh Airport…"* The image caption says, *"Mr. Damon (left) is president of TWA. With him are Michael W. Dunford (center), general manager of East Africa Tourist Travel Association, and Malcolm P. Aldrich of New York City."*

The **eleventh** letter is from C. P. Peppard of Excelsior Springs, Missouri. He says he subscribed to Collier's for years but finds Man on the Moon purely silly and worthy of first prize for wasting paper. The **12th** and **last** letter is from Joseph J. Miata of New York, N.Y. *"I marveled over your article by Dr. Wernher von Braun on the breath-taking possibility of "The Journey." The brilliant concepts illustrated by Chesley Bonestell surpassed those that were so amply displayed in Conquest of Space [March 22, 1952].*

"The article refueled my mental faculties. I could vividly see the entire universe as a final working unit striving together to accomplish this major task. Our problems on Earth, largely international controversies, should be dispelled from our minds and focused on the enormous job before us."

Dreams of Space
Books & Ephemera

Non-Fiction Children's Books about Space Flight from 1945 to 1975
http://dreamsofspace.blogspot.fr

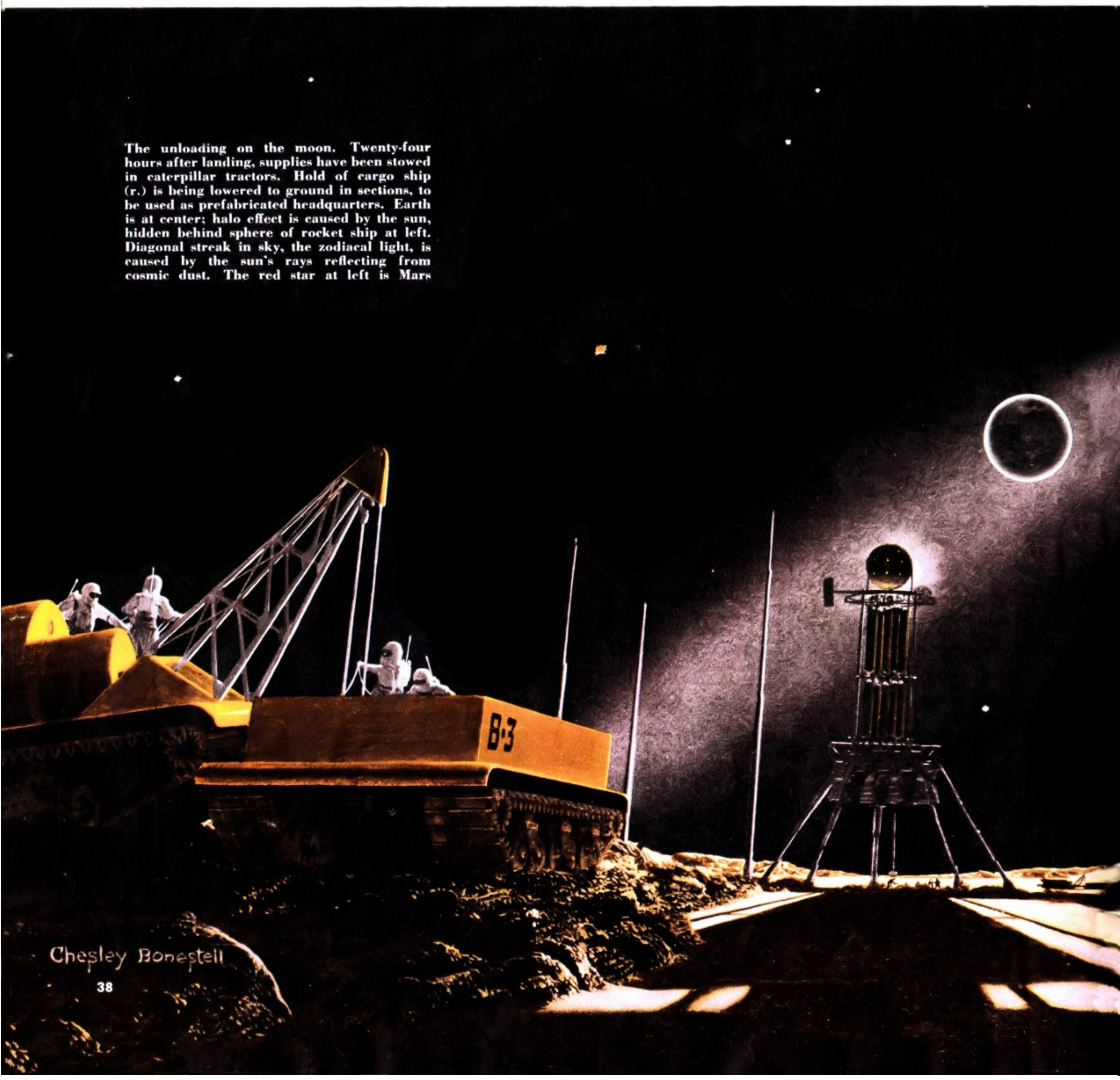


McKay braked the tractor as Sterling exclaimed: "I swear there's a temple up there!"

THE EXPLORATION

By DR. FRED L. WHIPPLE and DR. WERNHER von BRAUN
CHAIRMAN, DEPARTMENT OF ASTRONOMY, HARVARD UNIVERSITY
TECHNICAL DIRECTOR, ARMY ORDNANCE GUIDED MISSILES DEVELOPMENT GROUP, REDSTONE ARSENAL, HUNTSVILLE, ALABAMA

Our top scientists say we'll reach the moon in our lifetime. What do we find when we get there? What are the secrets of this ball of rock five times the size of the United States? Here's expert testimony



The unloading on the moon. Twenty-four hours after landing, supplies have been stowed in caterpillar tractors. Hold of cargo ship (r.) is being lowered to ground in sections, to be used as prefabricated headquarters. Earth is at center; halo effect is caused by the sun, hidden behind sphere of rocket ship at left. Diagonal streak in sky, the zodiacal light, is caused by the sun's rays reflecting from cosmic dust. The red star at left is Mars

THERE is danger on the moon—the danger of the unknown. Our first expedition, which can land there in the next 25 years, must be prepared. Tissue-damaging cosmic rays—invisible, deep-penetrating atom particles—unpredictably streak in from space, with no atmosphere to impede them. Meteorites, from microscopic grains to mountainous boulders, hurtle down. On the lunar surface, thin layers of crust might cover great crevasses, making travel perilous. Jagged rocks threaten the fabric of the pressurized, oxygen-equipped space suits essential to life.

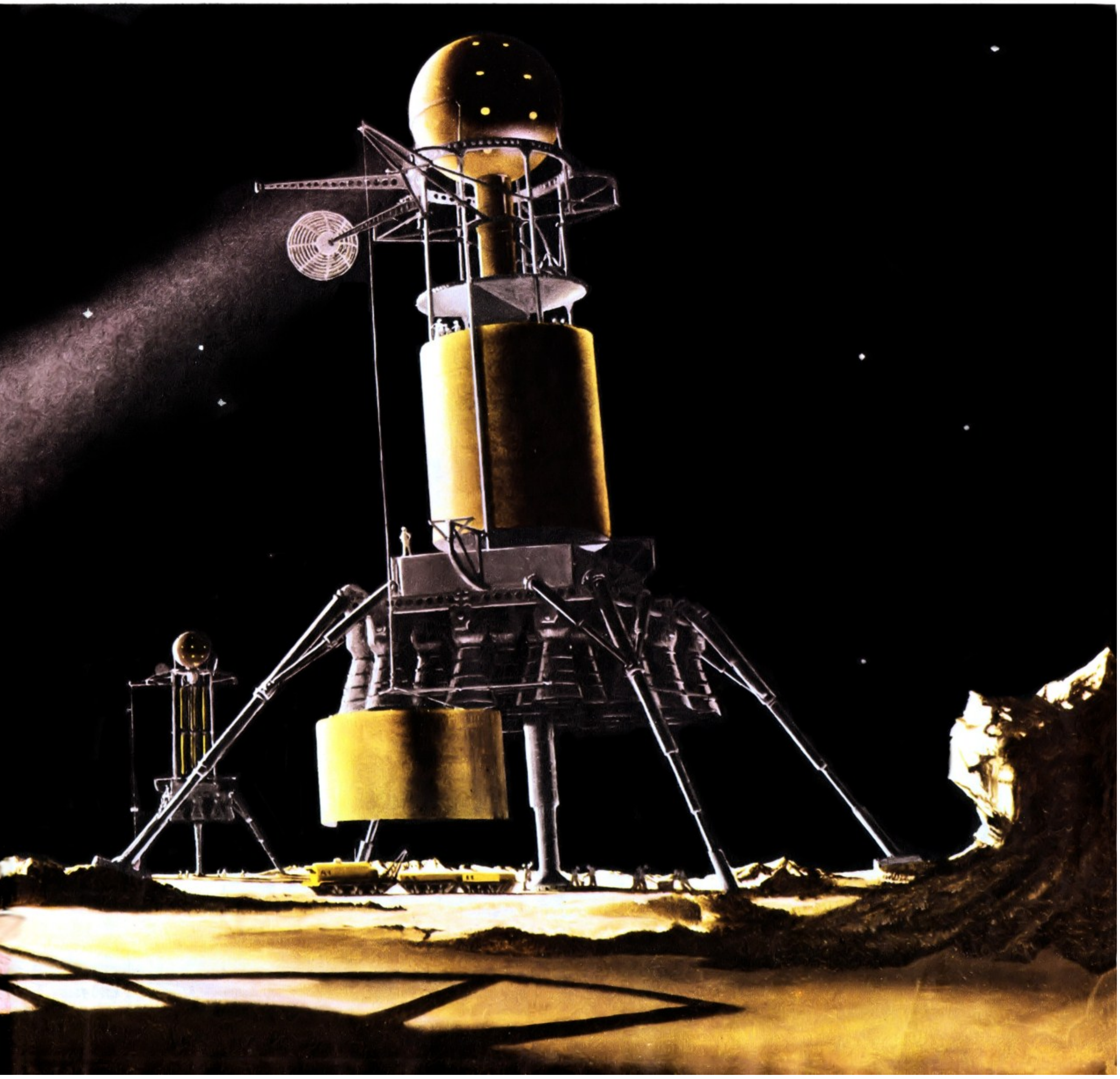
How great are the hazards? We don't know exactly, but we do know how to take precautions. Until we can measure the severity of the cosmic radiation, we shall stay under cover as much as possible. Our headquarters must be located in a deep crack in the surface, protected from both rays and meteorites. Brief exposure to cosmic radiation probably won't hurt us. Exposure to large meteorites will hurt us—but we don't expect to encounter them; the smaller meteorites will shatter against the two thicknesses of our space suits. The keen eyes of experienced geologists will guard us against break-throughs in the crust. Caution should be ample protection against rips in the precious space suits. We can explore the moon safely.

Our first step after arrival is to unload equipment and prepare for a six-week stay. Three awkward-looking but efficient rocket ships (none of them streamlined, because there is no air resistance in space) have carried us to the lunar surface from a man-made satellite 1,075 miles above the earth. On this voyage, two of the craft carried passengers and propellant for a return trip; the third, a one-way cargo vehicle, must be dismantled and converted into living and working quarters for the 50-man expedition.

We have arrived just at the beginning of the two weeks of sunlight that comprise the lunar day. From the catwalks of the ships, 130 feet above the moon's surface, the scene is dismal. The pitted surface of the landing area—a place known to scientists as *Sinus Roris,* or Dewy Bay, not far from the lunar north pole—stretches to the south like a vast, discolored expanse of broken ice.

On the other three sides, we are surrounded by towering mountains. The rays of the rising sun

CHESLEY BONESTELL



have painted the great mountain range a blinding white against the pitch blackness of the sky. But elsewhere, there is none of the brilliant color we are used to on earth—just dull, lifeless browns and grays. There is no cloud cover, no wind, no rain or snow—no weather of any kind. Overhead, pinpoint stars shine steadily; they don't twinkle, for there is no blurring atmosphere, as on earth.

Dust-covered, drab, silent, the panorama has the frozen stillness of a faded backdrop.

Within minutes after the landing, big cranes on the sides of the passenger ships swing out and start lowering expedition members to the ground. In our cumbersome space suits, we plod through the quarter-inch dust layer toward the cargo ship, whose crewmen are already starting the unloading operation. Our movements are restricted by the suits, yet we feel light. The moon's gravity is about one sixth that of the earth; a 180-pound man weighs only 30 pounds now. We wear weighted shoes to help pin us down.

The first equipment brought out of the cargo ship is one of our three surface vehicles, tanklike cars equipped with caterpillar treads for mobility over the moon's rough surface. The pressurized, cylindrical cabins hold seven men, two-way radio equipment, radar for measuring distances and depths, and a 12-hour supply of oxygen, food, water and fuel. Power is provided by an enclosed turbine driven by a combination of hydrogen peroxide and fuel oil (oxygen escaping from the hydrogen peroxide enables the fuel oil to ignite). The vehicle goes 25 miles an hour on flat ground.

As soon as the moon car has been set down and checked, a search party boards it to scout out a suitable crevice for the campsite. They drive off in a spray of dust which settles almost immediately, like the bow wave of a motorboat (there is no air to hold the dust suspended, as on earth).

The area around the cargo ship bustles with activity. Through our earphones, we can hear a stream of orders from the engineer in charge of unloading. All orders are addressed to numbers, rather than names; faces are not visible through the heavy antiglare glass of the helmets, and we wear numerals for identification.

By the time the search party returns, the ground around the cargo ship is littered with supplies: containers of water and liquid oxygen, canned and frozen food, scientific equipment, high explosives, rockets, the other two lunar cars and nine trailers (three per car) also track-equipped.

Ship's Hold Is Converted into Huts

In all, the huge cylindrical cargo hold, 75 feet long and 36 wide, has held 285 tons of supplies (less than 50 tons, moon-weight). But the silolike hold is itself part of the cargo, and must be unloaded from the framework of the ship. Its walls are laced with wiring, air-conditioning ducts, and water and sewage pipes; split lengthwise, the cargo cabin will become two buildings like Quonset huts, and the horizontal floors which separated it into compartments will be vertical partitions. We'll live in one hut; the other will be a laboratory.

Engineers direct the unbolting of the hold from the framework, and cranes lower the huge cylinder in sections onto trailers. Two of the lunar tractors hitch up to three trailers each, and the double convoy moves silently off for the headquarters site. A third convoy, loaded with supplies and personnel, brings up the rear.

The framework of the cargo ship now stands stripped and forlorn on the barren plain, only its personnel sphere left intact. We'll leave it there and use the sphere, with its expensive radio equipment and big disk antenna, as a station for communication with the earth—lonely, but essential, duty for the radio operators.

The crevice picked for the campsite by our search party is deep—we require a depth of 65 to 100 feet for safety—with almost vertical sides. Cranes attached to the rear of the lunar tractors lower an advance squad to the floor of the chasm. It's fairly level down there, but some big chunks of rock may have to be moved to clear the way for the two prefabricated huts; pickaxes and small explosive charges do most of the work, and the cranes do the rest. Now the sections are lowered.

The front ends of the tractors are firmly anchored to the moon's surface, and one by one the hut units are eased down the side of the gully. They are quickly assembled at the bottom; electrical circuits are joined, air conditioning, water and sewage pipes hooked up—and we're ready to move in. A power unit like those on the rocket ships—a solar mirror which heats mercury to produce vapor (like steam) for a turbogenerator—is set up at the lip of the chasm.

We have now been on the moon 48 hours. There has been little sleep for anybody, but the preparatory work is over. Supplies (including our store of high explosives) are now safely out of the way of vagrant meteorites; our living quarters and laboratory are ready to use—and we'll be ready to explore as soon as we've slept.

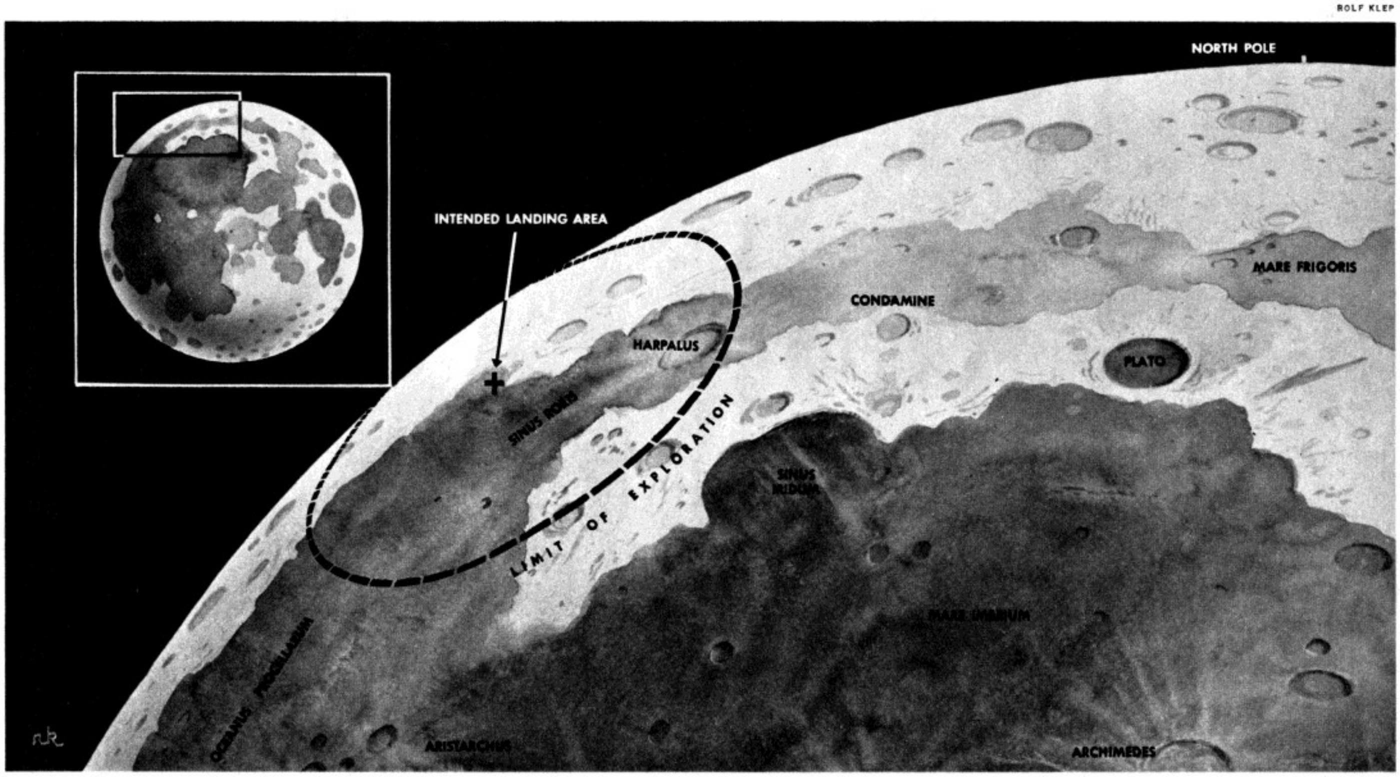
Sinus Roris, our landing area, was selected partly because of the opportunities it offers for exploration, partly because its temperature is livable—40 degrees Fahrenheit during the lunar daytime (at the lunar equator it hits a blistering 220 degrees), and 240 degrees below zero at night. That's mighty cold, but it's bearable on the airless, waterless moon, and we have heaters inside the huts.

From our headquarters site, we can explore any place within a range of 250 miles, and all the lunar features of interest to our scientists fall within that area. It may require some long trips, though—the region involved is approximately as large as the whole northeastern part of the United States, north of Washington, D.C.; in other words, the size of the six New England states, New York, Pennsylvania, New Jersey, Maryland and Delaware. Besides looking over selected sites on the side of the moon visible from the earth, we'll also be able to see a part of the unknown side—the part always turned away from the earth.

What will we be looking for?

To start with, our scientists want to know whether any faint traces of atmosphere are present, what minerals there are (maybe we'll find some rare, useful ones), whether the moon has a magnetic field like the earth and how the temperature varies beneath the lunar crust. Sheer curiosity suggests other questions and will play a large part in our explorations. We're the first people who've ever been here, the first ever to peer into the mys-

ROLF KLEP



Exploration area, within dotted line, covers 195,000 square miles, about equal to New England, New York, New Jersey, Maryland, Pennsylvania, Delaware. It lies in lunar northern hemisphere and can be seen by naked eye from earth at full moon (see inset, left)

Hubble Meets Skylab

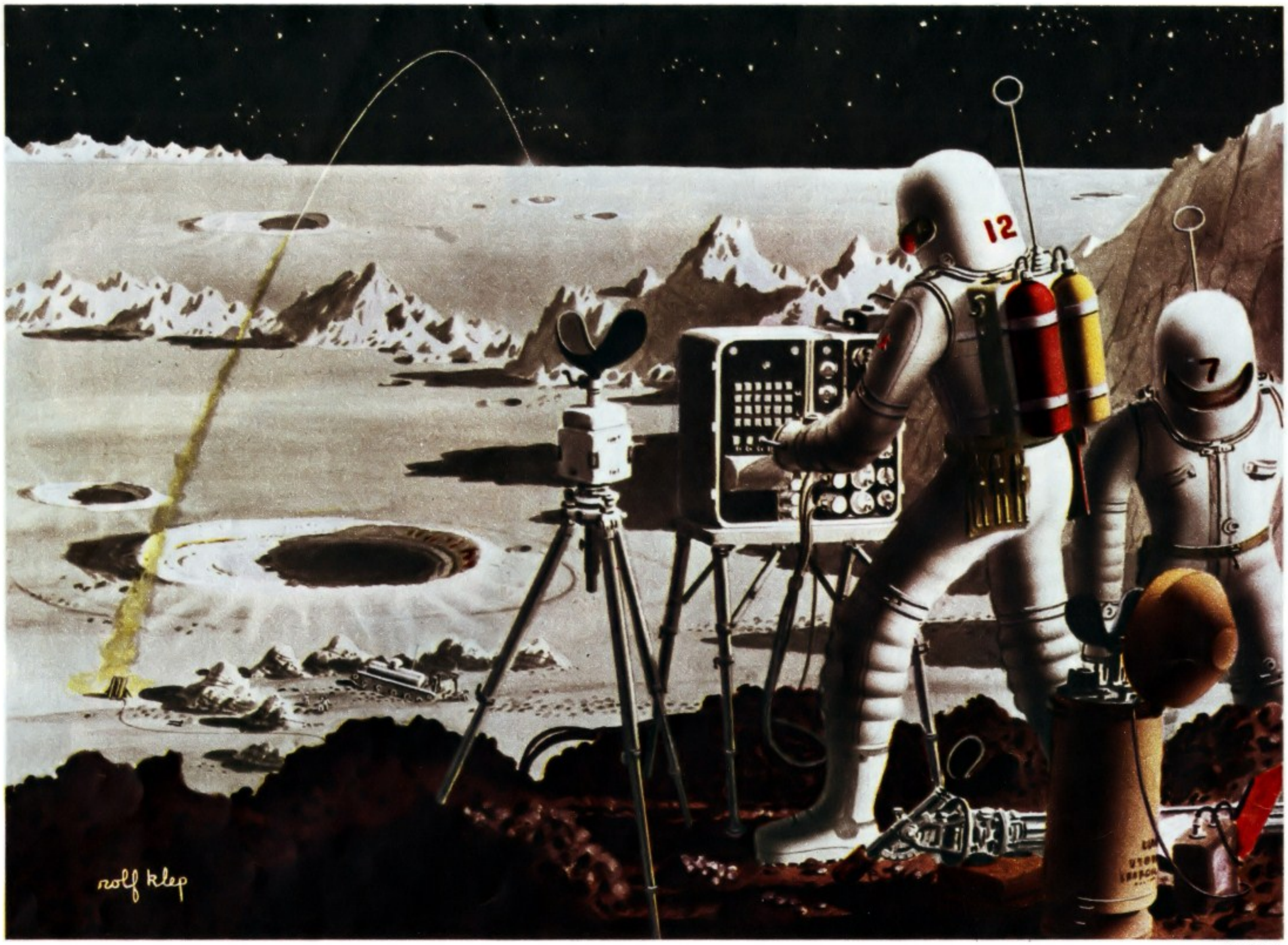
Scott Lowther, Aerospace Projects Review

A number of apparently completely independent space projects have been linked, even if only briefly. Two such programs were Skylab and the Hubble Space Telescope. For a brief period in 1970, there was work on joining the two together.

The idea for a large orbital astronomical telescope originated in the late 1960s as a logical outgrowth of the ongoing growth in orbital telescopes, both astronomical and military. Until well into the 1970's, the only effective ways to return telescope imagery to the surface was via television (which produces grainy low-resolution images in real-time) or via film (which produces high quality images, but very slowly). Since astronomical satellite telescopes have a much greater need of high quality pictures than fast images, large space telescope designs of the late 60's and early 70's tended to utilize film. A number of spy satellites used film that would be dropped to Earth by way of small capsules, but this entailed considerable risk of loss and limited the total

(Continued on page 70)

Aerospace Projects Review



ROLF KLEP

Causing moonquakes. Rockets with explosive war heads are fired off and scientists check vibration waves caused by distant blast, to determine interior composition of the moon. Seismograph in foreground is push-button controlled and surveying instrument to its left has cupped headpiece, to accommodate hand hooks and helmets of expedition members

terious lunar valleys, the first to examine the mountains and craters of the moon close up. Who knows what we may find on this virgin ball of unexplored rock, about five times the size of the United States?

The possibilities are exciting. Suppose we turn up a great store of raw materials; maybe then we'll want to recommend setting up a permanent community. We can make it practically self-supporting, securely encased inside a great plastic dome with its own synthetic atmosphere. Such an establishment could serve as a superb scientific laboratory—especially for astronomy and for research work requiring a vacuum; as a springboard for further ventures into space (if we can manufacture our own fuel on the moon, which is a possibility, we can make tremendous savings in the launching of a space ship); perhaps as a military base (the moon would be fine for launching military rockets, but hard to hit from the earth).

But the principal aim of our expedition during this first lunar exploration will be strictly scientific—and very important. Our investigations will help us unravel the secret of the universe: how the moons and planets were born and what they're made of. Up to now, all our information on that subject has come from examination of the earth and from surveying the heavens from observatories. The moon will give us a new perspective: a different look at the astral bodies and the story of its own birth as a clue to the birth of other satellites, planets and stars.

We know that the moon didn't form in the Pacific Ocean and get hurled into space, as was generally believed 50 years ago. It *is* possible that it was an independent planet which came from outer space, fell into the earth's gravitational field, smashed into the Pacific and then ricocheted back into its present orbit. But the most likely explanation is that the moon originally consisted of a belt of gases and minerals that girdled the earth—much as Saturn's ring surrounds that planet today—and eventually fused into a solid mass.

That's the theory we'll check.

First, if there are faint traces of such heavy gases as xenon and krypton, we'll know the moon was never a completely molten, hot mass (for extreme heat would have dispelled *all* gases), and so could not have been an independent planet. We'll find out by using a rotary pump which will compress whatever gases may exist and capture them in a bottlelike container. It probably will take many days to accumulate enough of whatever gases there may be, but checking them will be fairly simple.

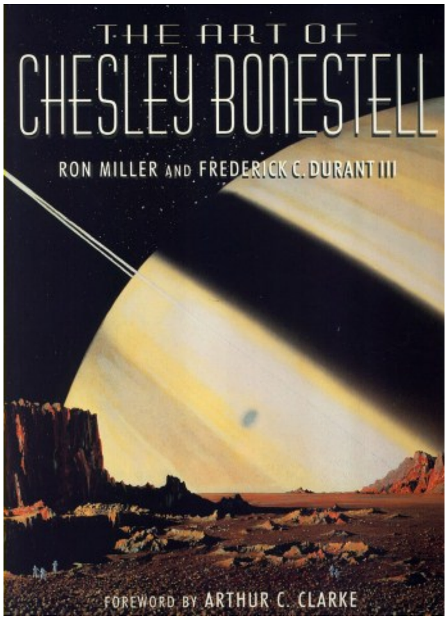
Does the Moon Have an Iron Core?

Then we'll look for a magnetic field. If we don't find it, we'll have another indication that the moon doesn't have an iron core, as an independent planet would. Compasslike magnetometers will do the trick for us; if the moon has magnetic poles as the earth has, they will show up (isolated iron deposits also will register, but they will be easily distinguishable from a core).

We'll also shake up the moon's surface a bit. Scientists have learned a lot about the earth from earthquakes. The vibration waves of a quake travel freely through solids, but some of them cannot pass through liquids—which is how we know that the center of the earth is molten iron. We can't count on having moonquakes, so we'll make some: we'll send off rockets with high-explosive war heads and then read the story of the waves from our seismographs. The explosions, occurring about 100 miles away, will show if the moon's core is molten (in which case, our waves will be stopped), solid (they'll go right through), or a jumble of rocks which never have been molten (muffled waves).

There is another clue to the moon's origin: the scars on its surface. The plains of the moon are rough and scored by fissures. Close examination will disclose whether these score marks are cracks or wrinkles. Wrinkles will indicate that the moon was molten at birth, and has cooled since. Cracks will be evidence that it was cool to begin with and has since been heated, perhaps by radioactivity. Fortunately, these lunar birthmarks have not been washed away by erosion, as has happened on earth.

So much for the moon's past. There are also some facts we want to learn about its present. One of the most important is the exact intensity of the cosmic rays which strike it. As soon as we're settled in our quarters, we set out instruments to measure the rays. Another is the frequency of meteorite hits. Careful measurements also will be kept of the surface temperature caused by the sun, and we'll want to measure the subsurface tempera-



Award winner Ron Miller & Black Cat Studios

Ron Miller, winner of the 2002 Hugo Award (World Science Fiction Society) for Best Related Work: The Art of Chesley Bonestell

The Chesley Bonestell Archives of Melvin H. Schuetz

www.bonestell.com

A former satellite controller in the U.S. Air Force and private industry, Melvin H. Schuetz has researched and collected publications from around the world containing Bonestell's art for more than four decades. His book, A Chesley Bonestell Space Art Chronology, is a unique reference bibliography containing detailed listings of over 750 publications which have included examples of Bonestell's space art.

Space scientist and well-known author of visionary books on spaceflight. Ordway was in charge of space systems information at the Marshall Space Flight Center from 1960 to 1963 and before that performed a similar function for the Army Ballistic Missile Agency. For many years he was a professor at the University of Alabama's School of Graduate Studies and Research. However, his greatest contribution has been to the popularization of space travel through dozens of books that he has authored or coauthored. He was also technical consultant to the film 2001: A Space Odyssey and owns a large collection of original paintings depicting astronautical themes. Ordway was educated at Harvard and completed several years of graduate study at the University of Paris and other universities in Europe.

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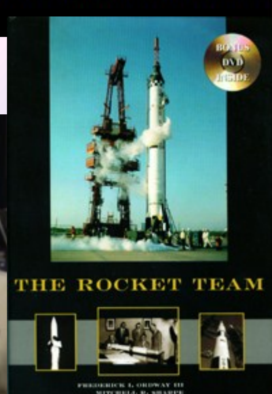


Frederick Ira Ordway III

Co-Author with Mitchell R. Sharpe of The Rocket Team

Dreams of Space, Books & Ephemera

Non-Fiction Children's Books about Space Flight from 1945 to 1975

http://dreamsofspace.blogspot.fr

Classics Illustrated were comic books intended to educate as well as entertain. They often were fictional “classic” books in comic book form such as Moby Dick. They also had a special series called "The World around Us." These were non-fiction comic books about topics of interest.

Classics Illustrated. Illustrated by Gerald McCann, Sam Glanzman and John Tartaglione. The Illustrated Story of Space (80 pages), 26 cm, softcover.

Contains illustrated stories on training for space, the first rocket to the Moon, the history and use of the rocket, the launch of Vanguard 1 and the construction of a space station. "The World Around Us" (#5) January 1959.

At end of two-week-long lunar day, convoy of tractors, each pulling two of its three trailers, moves cautiously across rough terrain near plain

ture at varying depths (it may be considerably warmer than the surface, due to radioactivity).

For two weeks, we devote ourselves to research on these points, past and present. The expedition breaks up into teams, each with its own assignment. Most of the investigating during this period is done within a 10-mile radius of the base. It's difficult, dangerous work. We climb across meteor pits, into chasms, up great rock piles, struggling in our bulky suits, always fearful of snagging ourselves on sharp outcroppings, always nervous about stray meteorites and watchful for thin crust.

Because we'll never be really certain how safe we are on the moon, however long we stay, we keep up a chatter over our walkie-talkie radio transmitters, not to bolster our courage, but for a practical reason: if something happens to us, the people back at headquarters will have a record of our findings.

For the same reason, lunar headquarters maintains constant contact with the earth. Back there, a special panel of scientists remains in constant session, as it will all during our six-week stay. A dozen specialists in fields like astronomy, astrophysics, geophysics, mineralogy and geology follow our every move by radio (as, indeed, does the entire world), keeping track of our findings, suggesting new leads and occasionally asking for the repetition of an experiment. Television transmission is impractical, but every day dozens of photographs are radioed back to earth.

For those of us on the moon, the work is endless and fascinating. We collect samples of everything in sight—dust (where did it come from; what's it composed of?), mineral specimens, rock and lava fragments. Besides scouring the lunar surface, we make test drillings several hundred feet into the moon's ground, and collect more samples that way.

We work in almost frantic haste during these two weeks, trying to make the most of the brilliant sunlight. We eat and sleep in shifts, so that there will be no halt in the research, no break in the flow of information back to the earth.

But soon the sun begins to slip over the horizon. For a while, there's still plenty of light; work slows down, but not entirely. For several days after sunset, we live in a kind of twilight, with a cold, but fairly bright, illumination cast over us by the earth (it reflects about 60 times as much sunlight on the moon as the full moon reflects on the earth). The browns and grays of the lunar day take on a green tint; mountains throw long shadows; craters and chasms appear jet black. The light grows dimmer as the "full earth" becomes a "half earth."

Now comes an exciting moment: the start of our longest expedition. We've had to wait to make it, because all the vehicles have been in constant use for the vital explorations near the base; as a result, we'll have to travel outbound in comparative darkness. That's not desirable, but it's possible, and we have no alternative.

of *Sinus Roris* (Dewy Bay). Glare of mountain range to north is caused by setting sun. Remainder of scene is illuminated by greenish earth light

Our destination is a crater about 195 miles away as the rocket flies, but about 250 miles off by lunar tractor. This crater, called Harpalus, is the most interesting one within reach—24 miles across, with a surrounding ridge 3,100 feet high, and a depth of almost 11,000 feet from peak to bottom.

It must have taken a monstrous meteorite to smash into the moon with such force—or was it a meteorite? That's one of the questions we want answered. All we know before we start is that a meteorite *could* make such a crater—if it were the size of a small mountain, and traveling at a speed of thousands of miles an hour. Another mystery we can solve on this journey is the nature of the great white marks which radiate for tremendous distances from the most perfect (and perhaps the newest) craters. Maybe they're powdered dust, shot out by the impact of meteorite against moon; maybe their origin is volcanic. We'll soon know.

Our expedition consists of two tractors, hauling three trailers each. Ten men are making the trip, and we carry supplies and fuel enough to last about two weeks. The outbound trip should take a little less than five days, the return journey, made in sunlight, perhaps four; we also want to spend a day or two at the crater. That's 10 days. We carry an extra four days' emergency supplies.

The trip is slow and difficult. The two vehicles cautiously pick their way around great rocks and deep pits, making about two miles an hour over the rough ground. Powerful searchlights and radar probe for major obstacles; at suspicious places, a geologist hops out to scan the ground for thin crust and feel his way afoot. When, despite our precautions, one of the tractors gets stuck in a rut, the other hauls it out.

At selected points along our course, we stop and plant explosives—part of our vibration-wave experimentation—which technicians back at headquarters will fire later by remote control (the explosions will be visible from the earth through strong telescopes).

After four days, the perimeter ridge of Harpalus looms ahead. As we press on, the first rays of the sun—marking our second lunar day on the satellite—glare off the side of the ridge and the mountain range to our left. By the time we get to the base of the ridge, full sunlight pours down on us again.

From a few miles away, the crater rim is measured with surveying instruments and photographed with special cameras. As we move closer, lava samples are collected, and holes are drilled for additional specimens. Other members of the expedition take temperature readings, check for magnetism and gather dust specimens.

Scaling the crater wall is a hard job. In some places, where the ridge is rough, we can make slow progress with regular mountain-climbing equipment; elsewhere, steep walls compel us to shoot grappling hooks up the sides by means of rockets;

PAINTING BY CHESLEY BONESTELL

rope ladders then enable us to reach the rim. The party descends as far as it can into the mouth of the crater. When no further progress is possible, we lower one man by rope to examine the floor and gather lava specimens. It's tricky, dangerous work; despite the relatively slight gravitational pull, a tumble would be just as dangerous as on earth, for there's no atmosphere to retard a falling body.

We work swiftly, for our time is limited. After a day or two at the crater, we start back, making a detour to examine the mountain range to the northeast, where there are interesting rock and lava formations and cavelike holes of unknown origin. The trip home is faster than the journey to the crater; the vehicles are heavily laden with specimens, but there is light to drive by. In a few days, we're back at the headquarters crevice.

Now the six hectic weeks of exploration draw to a close. At the landing site, electronic engineers set up automatic recording instruments which will radio scientific observations to earth after we've taken off. These stations (not much larger than an office desk) house delicate instruments which record cosmic radiations, tremors caused by the impact of meteorites hitting the surface, temperature changes and other scientific data. They are connected by cables to the skeleton of the cargo ship, which we're leaving behind. The ship's solar mirror generates power for the instruments, and the dishlike antenna will flash the readings to earth. Unless these automatic stations are destroyed by meteorites, they will operate for years without human supervision.

Engineers and technicians clamber over the passenger ships, checking pumps, rocket motors and electrical connections. The day before take-off, specimens for later study, oxygen and any remaining food are loaded onto the trailers at the lunar base. The entrances to the two huts are left open, permitting the synthetic atmosphere to escape; all material in the living quarters and laboratory will now be preserved by the vacuum of space.

During the next few hours, the cranes of the two ships haul up supplies. Each lunar tractor, when finally unloaded, is parked beside the skeleton of the cargo ship, to remain until the next lunar expedition. At last the cranes complete the loading

INSIDE the LUNAR BASE

By WILLY LEY

NOTED ROCKET SCIENTIST AND AUTHOR

THE first visitors to the moon will travel 239,000 miles through space—and then go underground at their destination. For their six-week stay, their home will be in a deep chasm, for protection against meteorites and cosmic rays. The cylindrical hold of the cargo-carrying rocket ship is split into lengthwise halves, 75 feet long and 36 wide, and lowered in sections by the cranes of our lunar tractors. One of the halves becomes a laboratory; we live in the other.

In the picture at right, one tractor is seen at the lip of the crevasse, lowering scientific specimens from the surface. Expedition members may also use the crane to enter the chasm, or they may climb down the light extension ladder at the left. Between the ladder and the tractor is a power plant like those on the rocket ships: a solar mirror focuses the sun's rays on a mercury pipe, creating vapor which drives a turbogenerator.

Each of the two buildings has its own air-conditioning, oxygen and water-recovery systems (the latter captures and cleanses for re-use all the moisture in the synthetic atmosphere we have provided within the huts). The air-conditioning and water-recovery plants of the laboratory building (rear) are visible just behind the ladder, on the first floor. Next is the chemical analysis room, and, to its right, the photographic darkroom. The radio operator works in the compartment next door, keeping in constant touch with fieldworkers, and recording their reports on tape. (The tapes are passed on to the radio operator in the cargo ship for transmission to the earth.) The upper floor at this end of the building is used for supplies and water storage (note the cylindrical water tanks).

The central unit of the hut contains a two-story screen for viewing color photographs, slides and films made in the course of the scientific investigations. At the far side of the room is a physical laboratory; experiments to determine whether the moon has an atmosphere are made here, and mineral samples are checked for magnetism, radioactivity and so forth. The projection room is visible under the pipes; next to it, through the open door, is a small conference room. To the right of the conference room, behind the small ladder, is a dispensary. Records are kept on the balcony above it.

The entire right-hand section of the lab building is an entry chamber, with space suits suspended by pulleys overhead. To get in and out of the huts, we crawl through air locks. A man is shown entering the laboratory air lock; the spring-loaded outer hatch will clap shut behind him, and a twist of wheel will open the inner hatch. (The wheel can be seen in the air lock of the other building, through which a man is about to leave.)

An airtight pipe connects the two huts; in an emergency, it can carry either water or air from one building to the other.

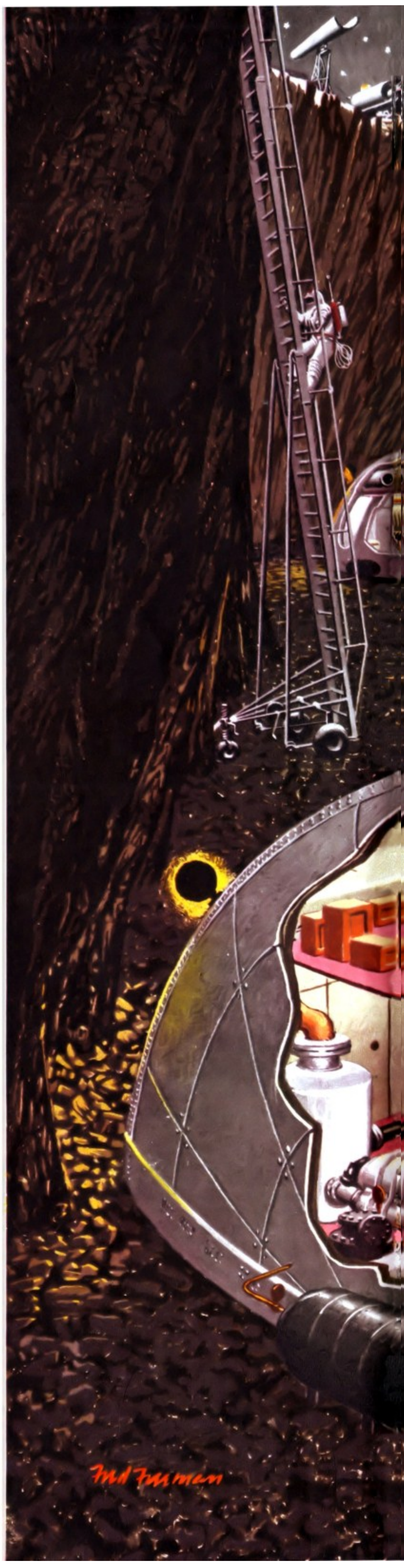
In the foreground of the hut used for living is a close-up view of the air-conditioning and water-recovery systems. The compartment behind it contains berths and lockers for most of the expedition members and, on the right, a washroom. (Bunks for the remaining personnel are on the second floor, which runs the length of the building and is otherwise used mainly for supplies.)

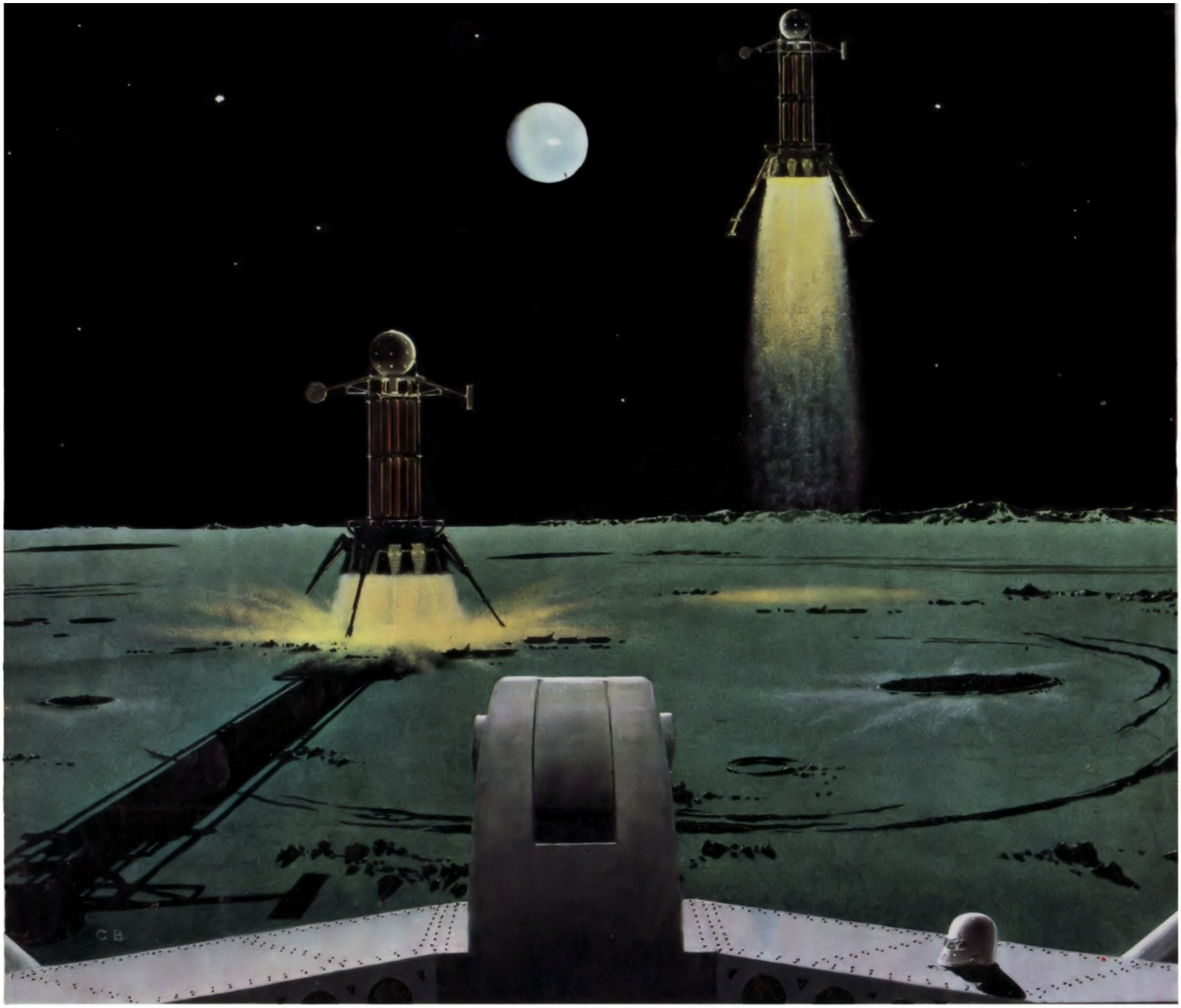
The large middle compartment has the expedition's kitchen and dining room. A dumb-waiter leads to the storehouse on the upper floor. The table-and-bench units in the dining area can be raised to the ceiling when not in use (one is shown in raised position). Against the right-hand wall of this section are washing machines, a hot-air drying room and a shower closet. The rearmost stalls on this wall are clothes lockers.

Oxygen supplies for both buildings are contained in the cylinders shown on the outside walls of the huts (they're placed there to save space). Also on the outer walls are floodlights to illuminate the dark interior of the chasm.

Here, 65 to 100 feet below the surface of the moon, the visitors from the earth spend most of their time during their lunar visit.

PAINTING BY FRED FREEMAN





CHESLEY BONESTELL

Seen from abandoned cargo ship with "full earth" shining in sky, passenger ships take off for return trip from the moon to space station's orbit

of equipment and start hoisting men up to the catwalks of the two rocket ships. Then the cranes are folded against the framework, ready for flight.

Through the intercom, the commander of the fleet counts off the seconds to take-off. At X minus 4 seconds, a thunderous rumble sounds in the passenger spheres: the rocket motors have been started. The turbopumps are switched on, forcing hydrazine and nitric acid into the motors.

One by one, the ships slowly lift from the surface. An automatic pilot performs the complicated take-off maneuvering which will set us precisely on course for the space station circling the earth 239,000 miles away. We have timed our departure so that we shall arrive at the space station at the precise moment when its orbit is lined up with the direction of our travel.

Immediately after leaving the ground, the ship's four spiderlike corner legs are jettisoned to save weight; soon afterward, the central shock-absorbing leg is burned away by the fierce heat of the rocket motors around it.

By now, our earth-weight has returned, and we feel astonishingly heavy. As the ship picks up speed, we are made heavier and heavier by the force of acceleration, until at an altitude of 40 miles from the moon, about 2½ minutes after take-off, we weigh 3½ times normal earth-weight.

We have reached maximum powered speed at this point: 4,200 miles an hour, sufficient to counteract the moon's gravitational pull and its 2,280-mile-an-hour speed in its course around the earth. We can now cut our motors; momentum will carry us beyond the moon's gravity, and from that point on we'll simply fall toward our destination. As the flame of the rocket motors dies away, we become weightless once again.

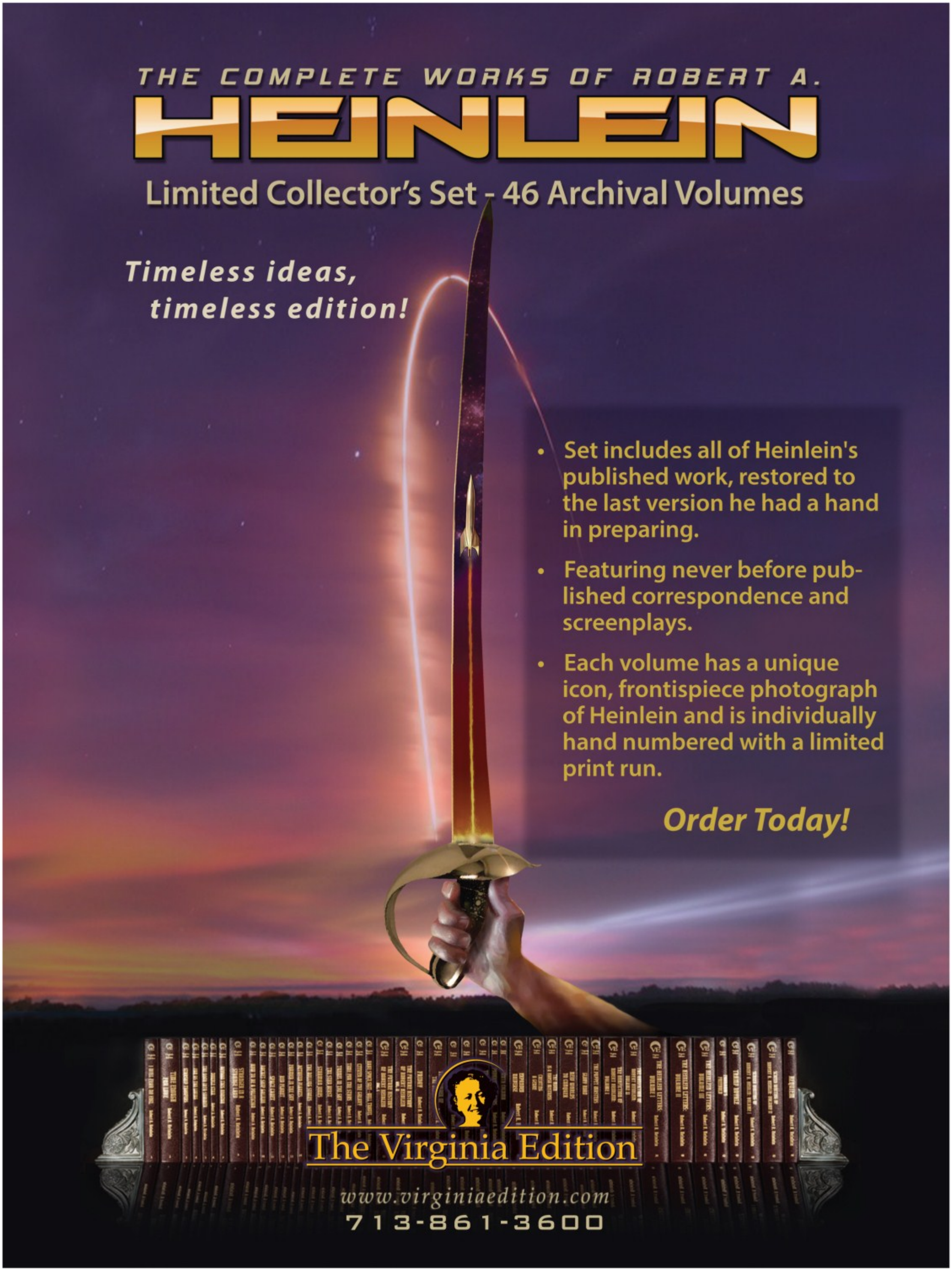
From here on, the flight is routine. The navigators keep constant check on our flight path (we can change course by using our rockets), fixing the position of the ships in relation to star constellations and the steadily growing globe of the earth. Far behind us, and to the right, the moon becomes correspondingly smaller.

Once past the neutral point between the gravitational fields of the moon and the earth, we start our fall, picking up speed constantly. At a distance of 131,000 miles from the space station's orbit with 20 hours of travel to go, we hit a speed of 4,300 miles an hour. Eighteen hours later, a little less than 17,000 miles from the orbit, our speed reaches 10,500 miles an hour, and we start to think about slowing down. We cartwheel our ship (by using a flywheel which, turning in one direction, causes the ship to turn in the other), so the rocket motors point toward the space station. Now we watch our speed carefully. Ahead, the man-made satellite, looking like a bright star, is traveling around the earth at 15,840 miles an hour. When our speed reaches 22,200 miles an hour, we turn on the motors. Because they point in the direction of our movement, they act as brakes.

Gradually we slow down. As we get closer, we cut the motors to half power. The needle of the speed indicator backs across the dial. When it hits 15,840, our motors are off. We are now a satellite of the earth, traveling in the 1,075-mile-high orbit at just the right speed to counteract the earth's gravity. A few miles away is the space station, endlessly circling the earth at the same speed.

We are back at our starting point. Man's first exploration of the moon has ended. Space taxis speed toward us from the station. Other men pour out of the satellite's air lock to greet us.

Our next trip will be a short one: two hours to the earth, aboard one of the sleek rockets parked nearby. There, the members of our scientific panel await us—and, without question, a great crowd of earthlings, come to see the first men ever to set foot on the ancient, mysterious soil of the earth's closest neighbor in the heavens.



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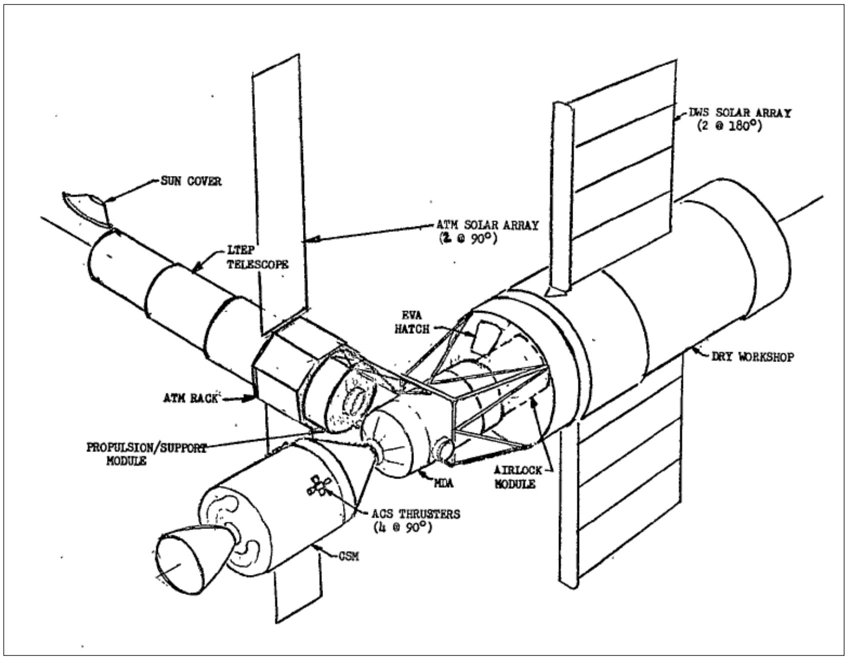
APR Corner

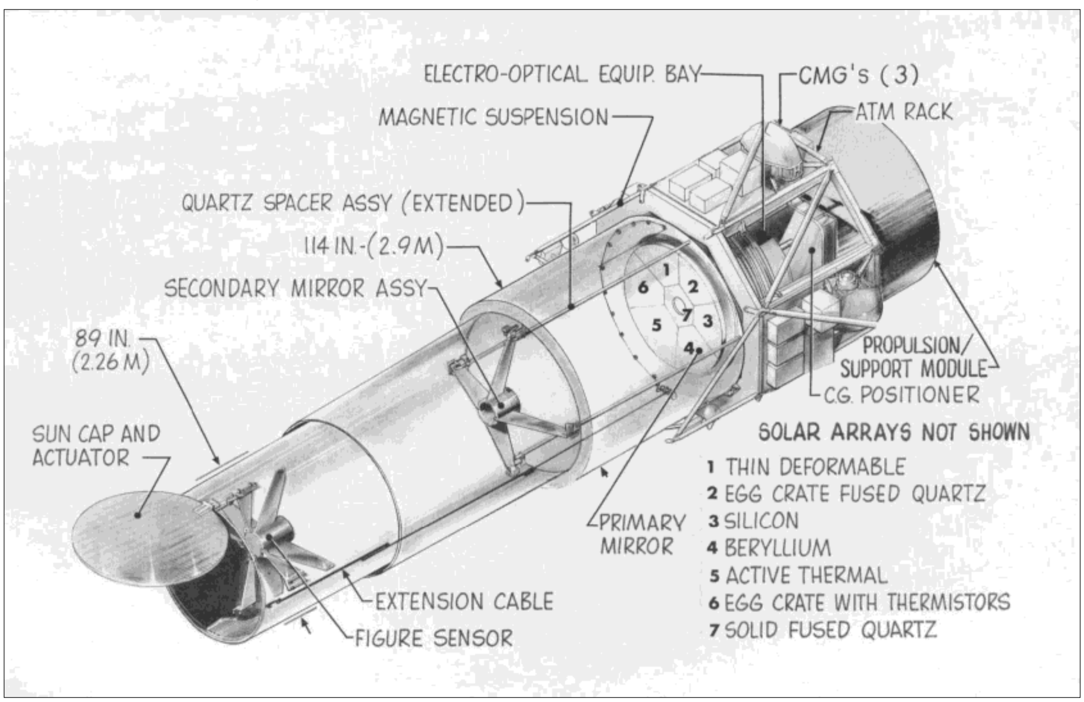
Aerospace Projects Review

(Continued from page 61)
number of photos that could be taken in the space telescopes lifetime. NASA wanted man-tended systems, where trained astronauts could both remove and replace film canisters.

From 1965 to 1967, Lockheed – together with optics manufacturer Perkin-Elmer - worked on the "Optical Technology Experiment System" (OTES) which produced conceptual designs of large (2 - and 3-meter diameter primary mirror) space telescopes. Utilizing leading edge and experimental design features and materials such as laser communications and adaptive optics, the OTES telescopes were to be serviced by astronauts in Apollo spacecraft. The OTES was not intended to be a fully operational space observatory, but instead a testbed for the technologies needed. A follow-on program for a Large Telescope Experiment Program (LTEP) began in 1969 with the same players, building on the OTES design. While outwardly the design was much the same, an important change at NASA had occurred: the Apollo Applications Program was in full swing.



Above: AAP dry-lab orbital workshop with docked LTEP telescope. (Lockheed, 1970). Image credit: Scott Lowther.



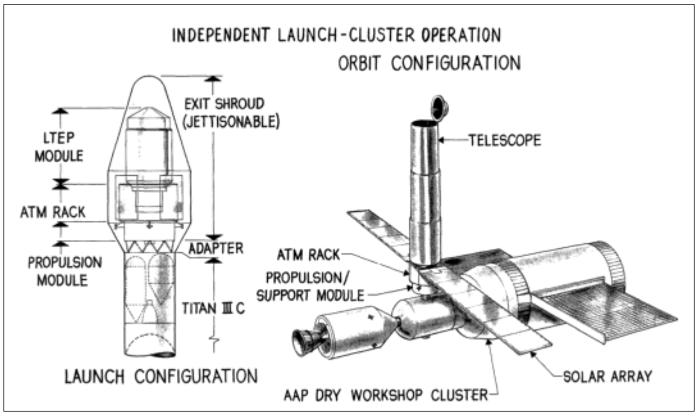
Above: Cutaway sketch of the OTES/LTEP telescope showing major features (Lockheed, 1970). Image credit: Scott Lowther.

From 1965 to 1967, NASA was focused on getting Apollo to the Moon, but by 1969 NASA was ramping down lunar programs and was looking forward to what would follow the Apollo moon missions. While a manned mission to Mars was the final goal, in the near term NASA looked towards the Apollo Applications Program (AAP) to provide opportunities for missions. At the heart of AAP was a dry-lab orbital workshop, a single-launch space station made from a modified Saturn S-IVb upper stage. From the earliest, the AAP orbital workshop was recognizable… it would eventually be built and launched as Skylab.

The AAP workshop was to be equipped with the Apollo Telescope Mount (ATM) for astronomical purposes. This was originally to be built from a greatly modified Lunar Module cabin to save cost and increase commonality. Lockheed and Perkin-Elmer suggested a rather different ATM telescope system: the 2-meter LTP telescope.

The LTEP was designed for several modes, including an independent free-flyer that would only occasionally be visited by an Apollo spacecraft for the purpose of replacing film and experimental modules. But also considered was mounting the telescope to the workshop. While this had the benefit of locating the telescope, with its film and experiment modules, conven-

(Continued on page 71)



Left: LTEP configured for launch by a Titan IIIc, with rendezvous and docking with the AAP workshop. In this mode, the telescope would be equipped with a propulsion module so that it could maneuver to docking with the AAP workshop, much as the Apollo CSM would. (Lockheed, 1970). Image credit: Scott Lowther.

APR Corner

Aerospace Projects Review (APR) is presented by Scott Lowther, whose unique electronic publication is described as a "journal devoted to the untold tales of aerospacecraft design." For more information:

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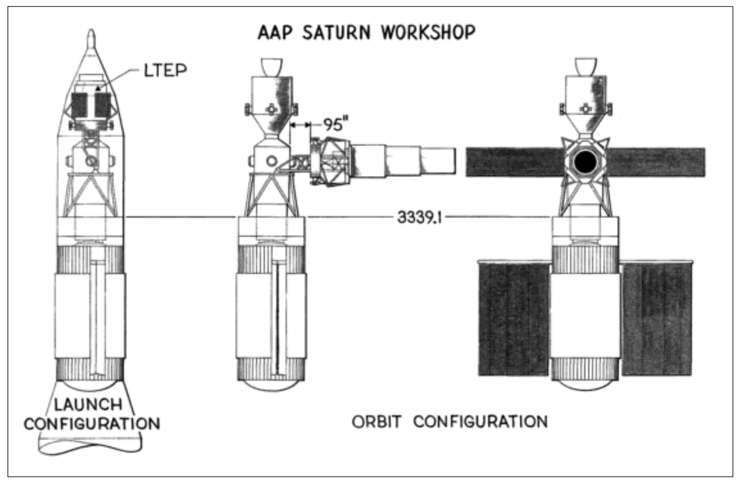
(Continued from page 70)

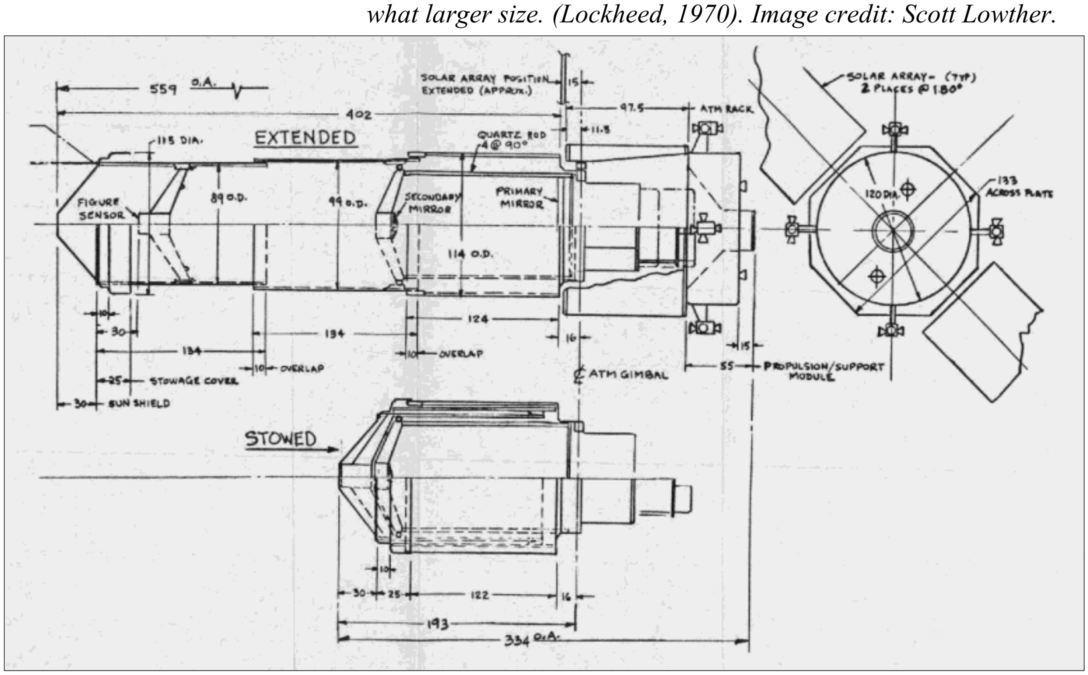
iently close to a trained crew, it had the disadvantage of having the telescope attached to a manned vehicle, with all the vibrations that entails. To deal with that, the telescope could be detached to float nearby during operations, or could be permanently mounted and only operated during unmanned periods on the workshop. For an operational space telescope this would be an unacceptable restriction, but for an experimental telescope meant mostly to prove out materials and technologies, and get done a little astronomy on the side, this would be acceptable.

The OTES/LTEP telescope was clearly an ancestor of the Hubble Space Telescope, though there were a number of clear divergences in design. Most obviously, the OTES/ LTEP had an extendable multi-segment sun shield, where the Hubble's sun shield is a fixed design. This was due to the fact that the Hubble was designed to fit within the 60-foot-long payload bay of the Space Shuttle, while the OTES was designed to be launched by vehicles such as the Saturn Ib, the Saturn V or the Titan IIIc with much shorter payload accommodations. The OTES featured a multi-segment mirror, with each segment made out of a different material (to test how these materials would perform in space), while Hubble has a monolithic mirror. And of course, the OTES had provisions for manual removal and replacement of the film canisters, while Hubble radios down digital imagery.

Aerospace Projects Review



Above: LTEP configured to be launched with the workshop atop a Saturn V. Here the telescope would function much as the Apollo Telescope and Mount did on Skylab, though of course at somewhat larger size. (Lockheed, 1970). Image credit: Scott Lowther.



Above: LTEP general arrangement, launch and orbit configurations. (Lockheed, 1970). Image credit: Scott Lowther.

James C. McLane, Jr., 1923 - 2012

James Calvin McLane Jr., pioneering space program engineer and WW2 fighter pilot died in Webster TX Nov. 7, 2012. James (often called Jim by friends) was born in Newberry S.C. Nov. 16, 1923 to Martha Lathan McLane and James C. McLane. His sister Alice Kemp and Dorothy, his wife of 61 years predeceased him. As a child, James lived in Concepcion Chile, South America where his father was building a highway. Dad's road construction work required frequent family relocations. One year James attended 9 different schools. New environments helped him cultivate a sociable personality, grow intellectually curious and develop excellent mechanical aptitude. During one interesting period, James lived at the City Jail in Abbeville SC with his grandfather, Sheriff Foster McLane. As a teenager James was the second person in South Carolina to build a gasoline powered model airplane. He graduated high school in Newberry and enrolled as a cadet in Clemson College.

In 1942 James left College to join the Army Air Corp. The next year he married Dorothy Dean of Sumter SC. McLane served as an instructor pilot in P-40 aircraft. In 1945 he flew P-51s with the famed 357th Fighter Group in combat over Germany. His Mustang carried words "Dainty Dotty" on its nose in honor of his wife. Later he piloted C-119 and C-130 aircraft with the Air Force Reserve, retiring as a Major.

After WW2, McLane returned to Clemson for a Bachelor of Civil Engineering degree. Beginning in 1948 he worked for the National Advisory Committee for Aeronautics at Langley VA. In 1951 he moved to Tullahoma TN to design wind tunnels for the US Army Corps of Engineers and the Air Force. He worked at Arnold Engineering Development Center with notable engineers, including German specialists brought to the US after WW2 under "Operation Paperclip." While at Arnold Center he wrote his first a major technical paper on large butterfly valves. He obtained licenses to practice Professional Engineering in Tennessee and later in Texas.

In 1962 McLane went to Houston TX for a job with the National Aeronautics and Space Administration (NASA). He spearheaded design of the Lunar Receiving Laboratory that handled the precious rocks brought back from the moon. McLane wrote an article for the February 1967 issue of Science magazine about this facility. During NASA's Apollo program, the joint Apollo-Soyuz project with Russia, the Skylab space station, and Space Shuttle development he was Division Chief in charge of the Space Environmental Simulation Lab at NASA's Johnson Space Center. His work allowed him to personally meet many significant historical figures.

Jim was active in technical societies, most notably the American Institute of Aeronautics and Astronautics (where he was an Associate Fellow and held various offices). He received numerous professional awards and honors.

After retiring from NASA in the Senior Executive Service he consulted with industry on space environment simulation. He and his wife Dorothy shifted their personal focus to travel and made friends in many countries. In particular, they enjoyed China, a place they visited 5 times. On one trip sponsored by the United Nations, McLane presented a course to Chinese technical specialists on ground-based space simulation. Today's successful Chinese manned space program owes a debt of gratitude to Jim for his encouragement.

McLane was named after his father and his great grandfather, Confederate veteran James Calvin McLane, who is buried in Cameron Texas. Jim was interested in genealogy and could trace his ancestry to a Hessian soldier who arrived during the American Revolution and to Scotch-Irish immigrants in the Carolinas. He and Dorothy visited a Scottish Island for an international Clan Maclean reunion. The couple was religiously active and helped charter Lutheran churches in Tullahoma TN, La Porte TX and Clear Lake City TX.

He is survived by son James C. McLane III of Houston TX, an Engineer following his dad's professional footsteps, his loving daughter Patricia Ann Campbell of Tullahoma TN, grandchildren Krystal McLane and Jay Campbell, several great grandchildren and brother-in-law Harold Dean of Myrtle Beach SC.

Jim's ashes were interred in the Houston National (Veterans) Cemetery next to those of his wife Dorothy. In lieu of flowers the family encourages friends to support the 357th Fighter Group museum in Ida Louisiana, a place that maintains memories of a brief, but remarkable chapter in Jim's extraordinary life.

(Below are links to Jim McLane's biography and oral history.)

http://www.jsc.nasa.gov/history/oral_histories/McLaneJC/McLaneJC_Bio.pdf

http://www.jsc.nasa.gov/history/oral_histories/McLaneJC/McLaneJC_11-13-00.pdf