Horizons

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The Newsletter of AIAA Houston Section
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GAIA Leaps Past Hipparcos

Wes Kelly, Triton Systems LLC

January / February 2014

Horizons, Newsletter of AIAA Houston Section

T A B L E O F C O N T E N T S

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

Horizons team: Douglas Yazell, Editor, Dr. Steven E. Everett, Shen Ge, Ellen Gillespie, Ryan Miller (& Don Kulba & Alan Simon)
Regular contributors: Philippe Mairet, Wes Kelly, Triton Systems LLC (Kelly's Corner), Dr. Steven E. Everett (Cranium Crunchers)
Contributors this issue: Dr. Patrick E. Rodi

Congratulations!
Horizons and AIAA Houston Section Website
Section Chair Daniel Nobles
AIAA 2013 National Communications Third Place Award Winner

Front cover image: Date: December 14, 2013. Satellite: GAIA. Location: Soyuz launch pad, Centre Spatial Guyanais, Kourou, French Guiana. The GAIA spacecraft - mated with the Fregat stage and enclosed by the fairing - is lowered onto the Soyuz launcher, using an overhead crane inside the mobile gantry on the launch pad. The Soyuz launcher is below the platform inside the 53-meter tall mobile gantry and not visible in this photo. Image credit: ESA-CNES-Arianespace / Optique Vidéo du CSG - S. Martin. This page: The 1889 van Gogh painting, The Starry Night.

Leadership. Responsibility. Dedication.

Chair's Corner

Michael Frostad

The American Institute of Aeronautics and Astronautics (AIAA) was *formed* in 1963 by the merger of two organizations: the American Rocket Society and the Institute of the Aerospace Sciences. Its purpose: to bring all interested parties together to learn from each other's experiences, celebrate successes, foster collaboration, and push the limits of human ingenuity. This tradition continues to this day and AIAA Houston is a part of it!

Through a series of yearly events AIAA Houston brings the Houston Aerospace community together in all spheres of the aerospace profession – whether technical, educational, or professional. Every year we host dinner meetings with important topics, lunch-and-learns to share knowledge, and an Annual Technical Symposium to give people an opportunity to share their work without the need to travel far. In addition we participate in many local Science, Technology, Engineering and Mathematics (STEM) activities, have a scholarship program for early college students, and participate in a Regional Student Paper Conference every year for students of Region IV (Texas, New Mexico, Oklahoma, and Arkansas).

All of the activities above only happen because people step forward. They do so for multiple reasons, yet each one that has done so, who has demonstrated dedication to the task, has learned from the experience. They have communicated beyond their normal circles, sustained and pushed the aerospace field, grown their networks, and practiced actual leadership. They have not waited for things to happen, they have made things happen.

Every year brings new opportunities to take responsibility for the future, practice leadership, and dedicate oneself to a cause - and this year is no different. With this in mind I invite all those interested in taking responsibility for the health and future of the aerospace community to volunteer, to either be or help a chairperson of the AIAA Houston Section. We are putting together the Executive Council for next year (July 1, 2014 – June 30, 2015), some of which must be elected and others appointed, and we are looking for interested parties. It is an opportunity to move the aerospace field forward both technically and socially, to grow as a leader in the aerospace field, and to expand your network beyond your immediate contacts.

For all of these reasons and more I encourage you to review the AIAA Houston Section 45-person organization chart on our website and look for a position in which you could provide assistance. Then, and this is the key part, email our elections coordinator with your interest, your AIAA member number, how you would like to help, and a short paragraph describing your aerospace experience.

We look forward to hearing from you and helping each other grow. Let's take responsibility for the future of aerospace, dedicate ourselves to it, and lead it.

The World's Forum for Aerospace Leadership

Our organization chart: *http://www.aiaahouston.org/OrgChart.pdf*
Our elections coordinator: *councilor7-2013@aiaahouston.org*

Editor's Corner

New Software, New Formats & New Subjects

Douglas Yazell

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

Submissions deadline:
April 9, 2014, for the March / April 2014 issue (online by March 31, 2014).

Advertising:
Please contact us about rates.

Our thanks go to Wes Kelly for the GAIA cover story, as well as his second installment of Kelly's Corner. Our Horizons team grew much stronger recently thanks to our two new members, Ryan Miller and Wes Kelly.

We successfully created our first issue (this January / February 2014 issue) using Adobe InDesign (the Creative Suite 6 version). InDesign is the industry standard and will allow us more flexibility in our output format. Horizons used Microsoft Publisher (part of the Office Professional Suite) since our November 2004 issue. That was a major upgrade for Horizons, our newsletter which started in 1971. Jon Berndt was the new Horizons editor for that November 2004 issue. He upgraded the cover format for the September 2005 issue (featuring the Stellar-J cover story by Wes Kelly, Triton Systems LLC). Those were big steps forward for Horizons, but the Horizons look and feel did not change much since then.

We hoped to add animated figures to our PDF files starting in this issue, and we succeeded. We thank Dr. Patrick E. Rodi for the article featuring two animated images. However, our animations have a few bugs (looping instead of playing only once when clicked, for example), and the animations (using the Adobe Flash SWF format in a PDF file) will not play on iPhones or iPads. But we are off to a good start with our new software.

Our newsletter website contains our current and and quite a few back issues as noted at left, but its oldest issue is the January 2005 issue. Since the first issue featuring Jon Berndt as Editor was the prior issue, the November 2011 issue, we will add that issue to this archive.

We will also add the April 2002 issue of Horizons to that archive. Its cover story is the Ugly Spaceship and the Astounding Dream by Albert Jackson. That celebrated the 50th anniversary of the Collier's series, Man Will Conquer Space Soon! Horizons readers know that we recently completed the first page-by-page, high resolution reprint of that series, about 89 pages. We used eight issues of our bimonthly Horizons, corresponding to eight issues of the weekly magazine Collier's (1952-1954).

Please allow us to share a recent email note about that series of reprints:

[February 24, 2014] "I want to express my appreciation to you and your editorial team for making this series available and for the high quality of the reproductions in your newsletters. My parents were subscribers to Collier's, and I was 6 years old when these were first published. I was utterly fascinated by the illustrations (and the related Disney "Man in Space" episodes [on television]) and having learned to read at the age of four, was able to read them even though I didn't always comprehend everything I read. They stimulated an interest in spaceflight and science that has remained with me to this day. I saved the copies and would frequently re-read them, but over the years and through several moves they gradually fell apart or crumbled to dust. I've searched for copies at used book stores and on eBay but have never been able to amass a complete collection until now, thanks to your reprints. They are a reminder of a vision and a spirit of innovation and a sense of wonder that seems to be missing today.

"Best wishes to the entire Houston Section."
Michael McMurtrey
Carrollton, Texas USA
Former Editor, Squadron/Signal Publications

[*Wikipedia*: "*Man in Space*" is an episode of *Disneyland* which originally aired on March 9, 1955. … This Disneyland episode (set in Tomorrowland), was narrated … by … Dr. Willy Ley, Dr. Heinz Haber, Dr. Wernher von Braun and Dick Tufeld of *Lost in Space* fame. The show talks briefly about the lighthearted history of rockets and is followed by discussions of satellites, a practical look (through humorous animation) at what spacemen will have to face in a rocket (both physically and psychologically, such as momentum, weightlessness, radiation, even space sickness) and a rocket takeoff into space.]

Climate Change
Science & Public Policy

"Nobody has a monopoly on what is a very hard problem, but I don't have much patience for anyone who denies that this challenge is real." That quote is from President Obama, June 25, 2013. Horizons seeks climate change articles, and that quote is a good guide for our choices. On the other hand, a recent national magazine's cover story claimed on its cover to feature new satellites that could cool the debate. That language might imply that without more data, we cannot know that this challenge is real. ■

GAIA Leaps Past Hipparcos

Feature Story

Wes Kelly, Triton Systems LLC

In the March / April 2013 edition of Horizons where we covered the Lunar and Planetary Science Conference (LPSC), we omitted mention of books offered at the conference from scientific publishing houses, difficult to find at local bookstores and difficult to assess from descriptive data provided by online bookstores. Among the books available was a 2011 publication titled, *The Exoplanet Handbook* by Michael Perryman (**Ref. 1**). Despite lacking descriptions of the Kepler Observatory's more recent and remarkable planetary discoveries, the handbook provides a detailed summary of extrasolar planets, plus the instrumental means for detecting them. Dr. Perryman devoted his career largely to spacecraft astronomy in the United Kingdom and in Europe with the European Space Agency. Remarkably he has been a principal investigator for both the Hipparcos spacecraft and its successor, GAIA, launched from Kourou, French Guiana December 19th on a Soyuz Fregat rocket (see **Fig. 1**).

For many of us interested in extrasolar planets and stellar astronomy, the European Space Agency's GAIA observatory might have slipped in under the horizon. Despite the name that suggests terrestrial application, GAIA is a successor to Hipparcos' astrometric mission of the 1990s. The objective of GAIA's space telescope is to catalog about one billion astronomical objects over a period of five years. In contrast, we have the Hipparcos 130,000 star precision catalog. What's more, GAIA is designed for much greater angular position accuracy. GAIA stands (or stood) for Global Astrometric Interferometer for Astrophysics, but the

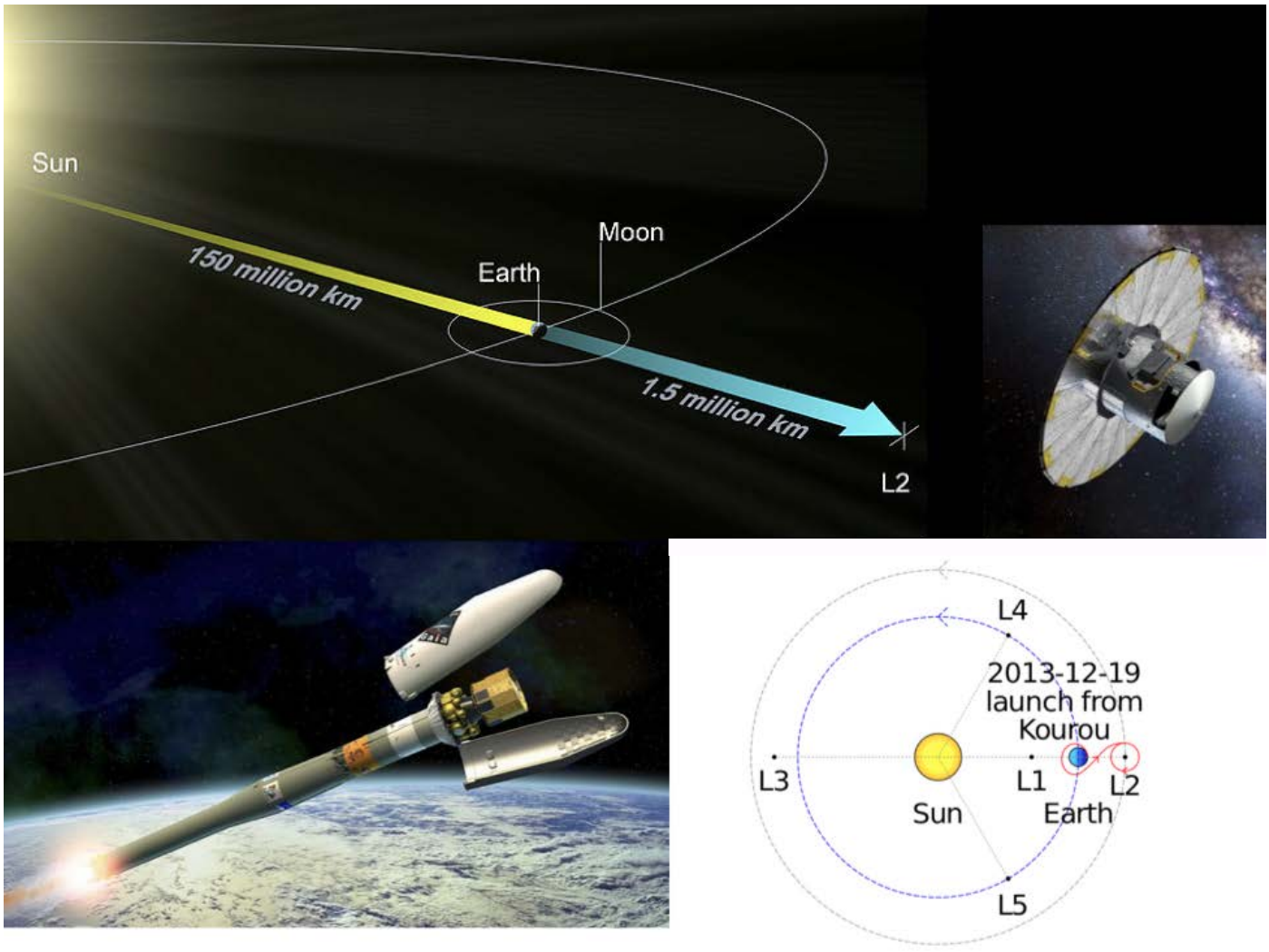


Figure 1. GAIA Mission Deployment to Sun-Earth L2 Lagrangian Point Station. Image credits: top left: ESA. top right: Cmglee. Bottom left: ESA blog entry. Bottom right: Euopean Space Agency (ESA).

interferometer has been replaced! The scientific payload aboard GAIA (**Figures 2 & 3**) is comprised of three other instruments:

1. blue and red band photometer (BP/RP),
2. astrometry instrument (ASTRO) to determine star positions, and
3. radial velocity spectrometer (RVS).

Precise angular measures and distances to the stars not only provide a 3-dimensional map of this quadrant of the galaxy, it but they unlock the nature of the stars as well, even stars and features beyond the range of parallax, since far beacon star luminosities are based on calibrations of similar local stars. With this instrument combination housed under one roof and sharing one optical system, data provided about the nature of stars observed will all have a shared provenance. In combination, these devices will provide measures of stellar luminosity (L), effective surface temperature (T_{*S}), surface gravity (g_{*S}) surface radius (R_{*S}), and surface elemental or chemical composition for luminous objects down to 20th magnitude and over a bandwidth somewhat wider than visual (1000 to 400 nanometers), from near ultraviolet to the near infrared. To denote stellar values we use the subscript *S.

$$L\left(R_{*S},T_{*S}\right)=4\pi\sigma R_{*S}^{2}T_{*S}^{4} \qquad \text{(1) Units of Solar Luminosity } L_{0}$$

$$g_{*S}\left(R_{*S},M_{*S}\right)=G\,M_{*S}/R_{*S}^{2} \qquad \text{(2) A ameans to derive stellar surface radius } R_{*S} \text{ from stellar mass}$$

$$T_{*S}\lambda_{*S}=K \qquad \text{(3) A means to evaluate temperature from BP / RP } \lambda_{*S}$$

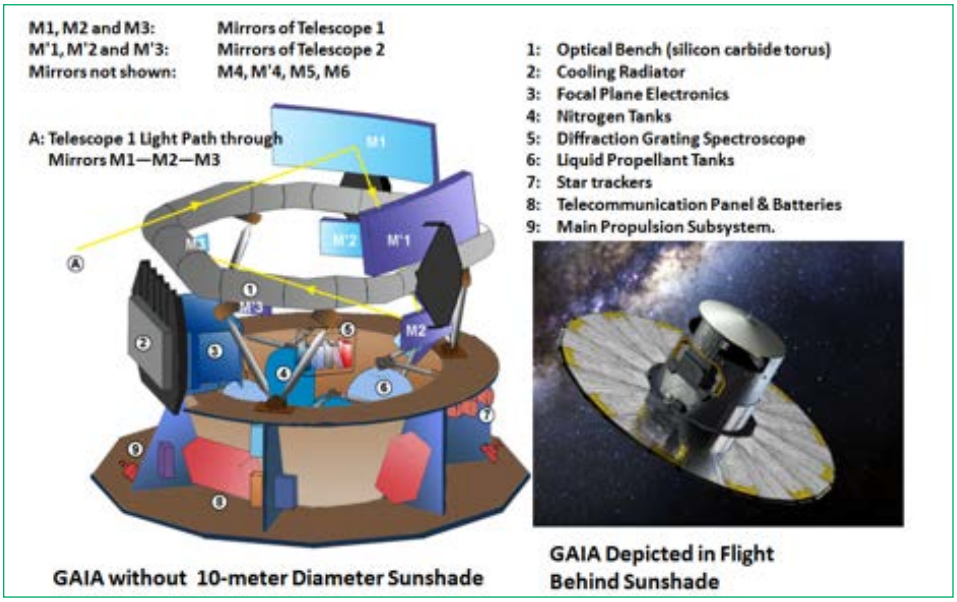


Figure 2. GAIA instrumentation layout. Image credits: Left: Pline. Right: European Space Agency (ESA).

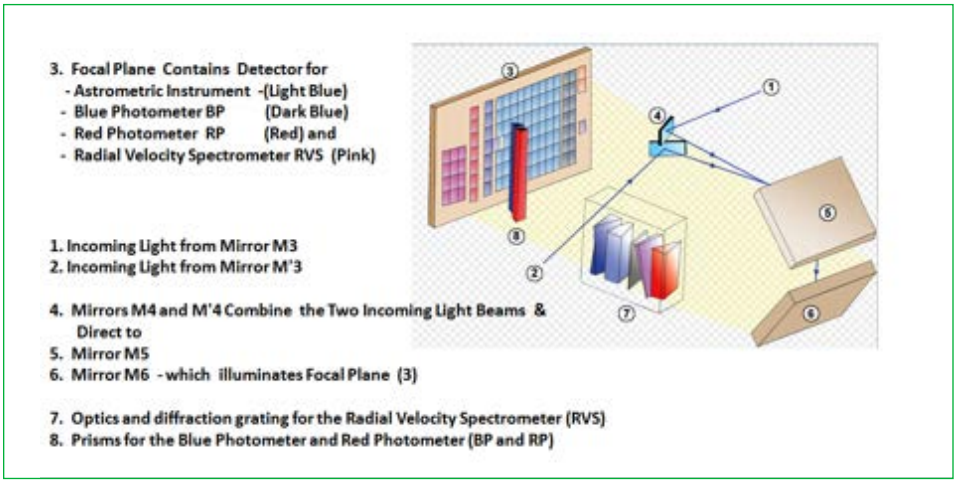


Figure 3. Following GAIA optics to its three principal instruments. Image credit: Pline.

In an earlier Horizons article (January / February 2012, "Planet Kepler 22b, An Historic Discovery"), we described blackbody radiation curves and their peak temperatures. The Wien approximation (equation 3) showed an inverse relation between effective surface temperature and wavelength. If, for example, the GAIA photometer identifies a peak radiation flux at a characteristic wavelength in the bandwidth given above, T_{*S} can be estimated or inferred.

Brightness registered at Earth by an instrument is not exactly luminosity. We do not necessarily know how far away an object is, nor do we necessarily know its surface temperature or surface radius. If we know distance and infer temperature from a surface radius off by a factor of 2, surface temperature is off by a factor of 0.707 or $(1/2)^{0.5}$. Similarly, doubling the temperature reduces radius to ¼. The surface gravity and peak flux measurements reduce uncertainties of these estimates.

A "5" increase in magnitude M_I represents a luminosity decrease by a 1/100th and radiation falls off with distance according to an inverse square relationship. Stars have an apparent magnitude as seen in the sky and an "absolute" magnitude calibrated with their luminosity as seen from a distance of 10 parsecs. The conversion between luminosity and distance requires us to provide two more simplified equations to explain GAIA's operations.

$m_I - M_I = 5\log(d/10) = -5\log(\theta) - 5$ (4) d, distance in parsecs; θ, angle in arc seconds

$\log(L_{*S}/L_0) = -0.4(M_I - M_{I0})$ (5) Solar magnitude in this system is about 4.75.

This gives us a system of equations to describe stars and derive other properties which correspond to the GAIA instrumentation, with equations 4 and 5 connecting to ASTRO. How far away are these radiation sources?

New Capabilities for Parallax Measurements

Key to breaking down all this information is GAIA's remarkable astrometric angular resolution to about 20 microarcseconds. (An arcsecond is 1/3600th degree.) No mean feat two decades ago, Hipparcos had achieved 2-milliarcsecond accuracies, which considerably corrected our vision of nearby galactic objects. This helped settle controversies about distances to stars and star clusters where the uncertainties were often a factor of two. The expected 100-fold increase in accuracy with GAIA should improve estimates to even more distant objects in space.

But once again, how far? Imagine if Earth were observed from deeper space at its orbital radius separation of 1 astronomical unit (AU) from the Sun, 150 million kilometers from the Sun, and imagine Earth's separation was 1 arcsecond or 1/3600th of a degree. Then the baseline of observation is 206,264 times farther away, where 206,264 AUs is found from (180/π) x 3600 AUs (which is the definition of 1 parsec, or 3.2593 light years). At 500 times as far out (500 parsecs), 1 AU would be in the noise level for Hipparcos, but distinguishable by GAIA with 99 units of measure above that. GAIA would encounter the same or similar noise level measurement problems at a distance of about 50,000 parsecs! Consequently we would not expect placement measurements to 1 AU resolution from 50,000 parsecs, but distant features will be more accurately placed than before. We can expect knowledge to within 1 AU resolution in regions 5,000 or 10,000 parsecs away. In all, something like a billion nearby stars in this segment of the galaxy are targeted.

Another way to look at things: If a star as massive as the Sun had an invisible partner 1 AU away and it was 1/1000th as massive (e.g., like Jupiter), in about a year the Sun (the primary star) would move in a circular path with a radius of 1/1000th of an AU. At 50 parsecs distance, GAIA should be able to track the primary star's projected path on the celestial sphere with a diameter of 20x higher than its noise level.

The ancient magnitude system of astronomy is descending in nature. Every 5 magnitudes represent a reduction in stellar luminosity (L) by a factor of 1/100. If Jupiter, 5.2 AUs from the Sun, is observed from Earth at 0 magnitude from 5 AUs away, then how far away would it be before its luminosity is reduced to 20th magnitude or 100 millionths of its presumed value? The answer is 10,000 times as far away as our assumed distance of 5 AUs. That is 50,000 AUs away, about a quarter of a parsec, or a sixth of the distance to the nearest star. Yet, as shown above, astrometry will allow detection of Jupiter like planets thousands of times further away! Despite being only a 2,029-kilogram spacecraft with dual telescopes of about 1 meter apertures, GAIA is a remarkably effective package for planet finding.

The most distant and luminous objects are quasars, quasi stellar radio sources. Shifts in the positions of stars (observed from Earth or Earth orbit) near the ecliptic plane at half year intervals can be attributed to either their distance from Earth, the fact that they moved, or both. GAIA's RVS instrument will make relevant measurements. Successive observations will be required to determine which bodies are in motion about centers of binary system barycenters or possess large proper motions with respect to Earth and the Sun. Quasars, however, because of their distance from observers, will not move at all.

Astrometry Catching Up with Doppler and Transit Methods

Extrasolar planet astrometry has had a long, difficult and tedious history. A several-decade 20th century program with growing evidence of several planets orbiting about the nearby red dwarf Barnard's Star eventually conceded failure due to a bias which crept into observations and calculations after an instrument maintenance overhaul. By the time this was widely acknowledged, pioneers (e.g., Mayor in Switzerland, Marcy and Butler in the US) in radial velocity or Doppler searches for extrasolar planets were beginning to get positive results from ground-based observatories.

William Borucki's advocacy of searches for transits of planets across stellar disks helped launch the Kepler Observatory. It detected extrasolar planets at an even greater rate than ground-based Doppler studies, but the program faces curtailment or modification due to the loss of reaction wheel controllers. Large ground sites and proposed space observatories have picked up some of the slack.

With similar large, new resources, some astrometric detections have already been made, but they are difficult to verify due to the slow rates of motion and small differences in angular position. By one estimate, based on the volumes of space, the population of stars, and Kepler-derived statistics, GAIA could detect as many as 50,000 planets. GAIA is unlikely to detect the light reflected by extrasolar planets. Planets are dim, with a magnitude of about 20. But by detecting their primary star's reactive motions, instruments such as the James Webb Space Telescope, with larger telescope apertures and more infrared sensitivity, will have precise instructions on where to look for extrasolar planets, thanks to GAIA.

Perryman's Handbook, after providing an introductory survey of pertinent astronomy and taxonomy, begins describing methods of exoplanet detection in chapters 2-7. Radial velocity or Doppler measurements (chapter 2) and transit methods (chapter 6) obtain detailed, lengthy accounts of 51 and 43 pages, respectively, but astrometry (chapter 3) requires only 10 pages. However, this chapter ends with a section

devoted to astrometric measurements from space in which the GAIA program is described. "Extrapolating from the statistical properties of the known exoplanet sample, GAIA should discover several thousand giant planets with semi-major axes [from 3 or 4 AU out to 200 parsecs] and will characterize hundreds of [multiple-planet] systems…" A number of other programs in addition to GAIA are described, including some even higher-accuracy US proposals (e.g., NASA's Planet Finder, Space Interferometry Mission), but Perryman concludes that "Space astrometry does not appear as a high priority in the 2010 US Decadal Survey Report." Four years into the decade, we see no evidence this evaluation has changed.

The information about nearly invisible planets that GAIA might provide begs the question, "Just how much more can other space telescopes see beyond stellar brightness magnitude 20?" Surprisingly, descriptions of the latest telescopes speak of magnitudes sparingly. From my old astronomy textbook (**ref. 3**), published before the creation of the Hubble Space Telescope (HST), before widespread use of cryo-cooled instruments, before the existence of charge-coupled devices (CCDs), and before the creation of data reduction systems widely used today, the faintest solar system satellites (listed in appendices) were magnitudes 19 and 20, evidently the limits of ground based observatories at the time. Since HST launch, numerous satellites of Pluto have been discovered, the most recent (2012) and faintest a magnitude 27 moon named Styx. If an object is moved ten times as far away as its initial distance, its brightness is reduced to one hundredth of its previous value, or about 5 magnitudes. Taking our above example of Jupiter, it would be perceived as a magnitude 25 star from 2.5 parsecs or a magnitude 30 star from 25 parsecs, perhaps within the reach of the James Webb Space Telescope (JWST) – or within the reach of HST, using procedures with several days of viewing, similar to the manner in which HST ultra deep fields were obtained.

Space observatories, of course, have light gathering advantages over ground observatories. They are unaffected by the rotation of the earth or the background brightness or turbulence of the atmosphere. They can leave wide aperture arrays fixed on regions of space for more than 24 hours. As a result, from the HST's fixed gaze on apparently empty regions of the celestial sphere have emerged images of galaxies billions of light years away (**Fig. 4**). But whatever the visual magnitude of these individual galaxies might be, imaging planets near stars presents separate problems. Glare from the light of the primary star often blocks out the faint reflected light of planetary targets. If Earth were to be observed from deep space, this would have to be accounted for as well as the presence of so-called zodiacal dust.

For now, we now have only a limited number of visual images of extrasolar planets. Among the most notable examples are an image obtained by HST of a planet orbiting the star Fomalhaut (**Fig. 5**) and an image obtained by the ground-based Keck Observatory of three planets orbiting star HR8799 (related data in **Table 3**). These stars are both hotter, brighter and much younger than our Sun, with much evidence of circumstellar accretion disks (consisting of dust, rocks, and gas). Models of these planets suggest temperatures much higher than the 150° K or so characteristic of our own solar system neighbor Jupiter. If, as reported, one of these had a temperature of 1500° K or ten times higher, it would 10,000 times intrinsically more luminous than Jupiter.

It should be no surprise that some of the brightest stars in the sky are some of the nearest. And among the nearest 25, several of the most Sun-like stars exceed in brightness the lower visual magnitude limit imposed on the GAIA survey mission: Alpha Centauri A (.01), Alpha Cen. B (1.4), Sirius (-1.4), Epsilon Eridani (3.7), Procyon (.34), Tau Ceti (3.5) and 61 Cygni A (5.1), but not 61 Cygni B (6.02). We hope that some exceptions to these restrictions can be made in a survey of a billion stellar objects.

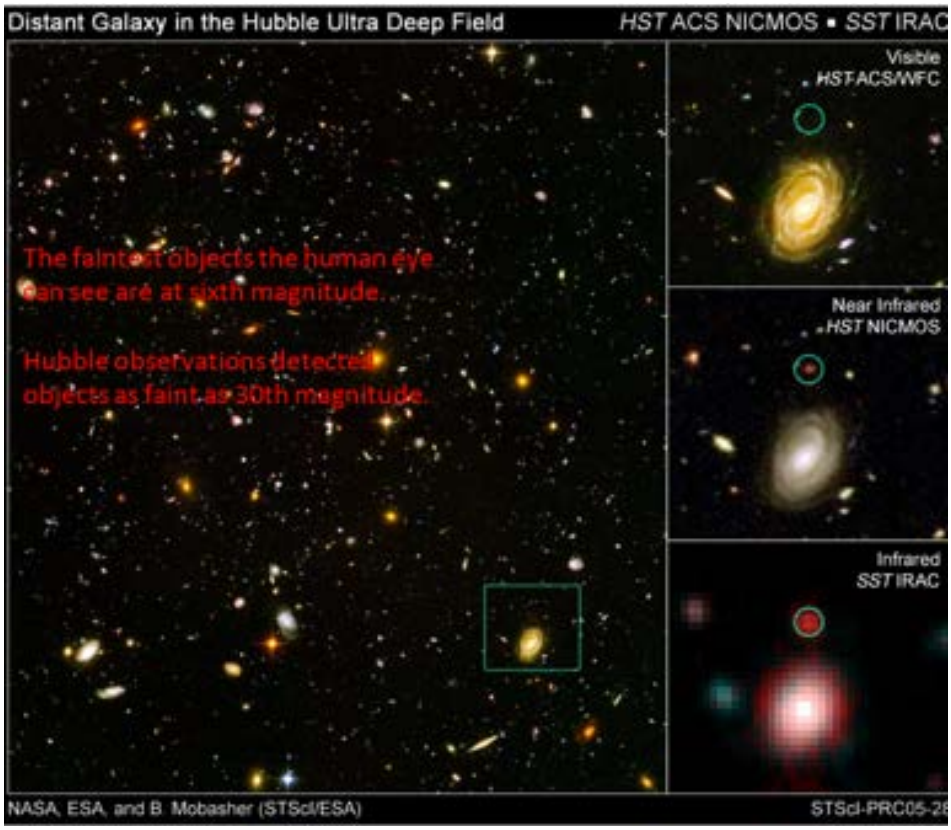


Figure 4. Hubble Space Telescope ultra deep space view – limits of current visual acquisition.

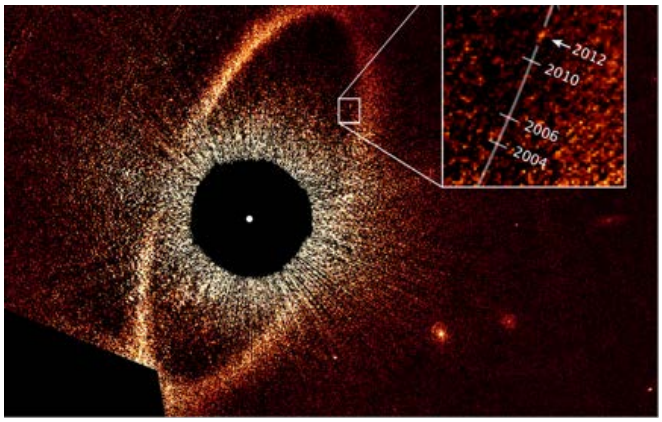


Figure 5. Fomalhaut System viewed with coronograph to reveal planet in circum-stellar ring. Image credit: NASA and the European Space Agency (ESA).

On January 23, 2014, it was announced that another European Space Agency (ESA) observatory, the Herschel infrared space telescope, had detected water vapor emissions from the asteroid Ceres during the course of observations in December 2012. Ceres is the largest body in the asteroid belt and the next objective of NASA's Dawn solar electric spacecraft. Much study in recent years has been devoted to determining whether main belt asteroids have water. This work is done by modeling their geochemistry and scanning their reflectance spectra.

Dawn's stop at Vesta, the second largest asteroid, was a disappointment in this search for water, but the detection at Ceres was not completely unanticipated. Back in the early 1960s, John Campbell, editor of Analog (science fact and science fiction) used to write about such a potential water bounty. Evidence for and against water on asteroids has been repeatedly weighed at the Lunar and Planetary Science Conference, which, since the Apollo landings, meets every March in the Houston vicinity.

A few days after the discovery of water on Ceres, we learned that the Rosetta spacecraft had re-awakened for its near approach to comet 67P/Churyumov-Gerasimenko. Searching for background on these events, we note this description in the Wikipedia: "Herschel was the fourth cornerstone mission in the ESA science program, along with Rosetta, Planck, and GAIA."

Table 1 ESA Spacecraft Observatories Hipparcos and GAIA Compared

Feature	Hipparcos	GAIA
Launch Date	8 August 1989	19 December 2013
Launch Site	Kourou, French Guiana	Kourou
Launch Vehicle	Ariane 4 (V33)	Soyuz ST-B Fregat
Spacecraft Mass	1140 kg (2,513 lb)	2029 kg (4,470 lb)
Mission Duration	3.5 Years to March '93	5 years anticipated
Type of Orbit	Geostationary Transfer	Lissajous about Earth-Sun L2
	(hp x ha = 507 x 35,888 km)	180 day
	Apogee Kick Motor Failure	90,000 x 340,000 km
Focal Length	1.4 meters	
Diameter	29 cm	
Instrumentation	Astrometer	ASTRO Astronmetric instrument
	Photometer	BP/RP Blue & Red Band Photometer
		RVS Radial Velocity Spectrometer
High Precision Catalog Data		
Number of Stars	118,200	1billion (projected)
Angular Resolution	.002 arc second	.00002 arc second (See Table-2)
Magnitude Limits	11	5.7 to 20

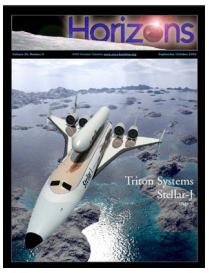
Table 2 GAIA Detailed Measurement Capabilities and Objectives

Magnitude MI	Resolution Limits micro-arcseconds
5.7	n/a
10	7
15	20
20	200
Distance Accuracies	
Number	Error / Distance Parsecs
20 million	1%
200 million	10% / 10,000
Measure Orbits, Masses and Inclinations of ~1000 extra solar planets	

Table 3 Extra Solar Planets Detected Via Direct Imaging

Object	Distance (parsecs)	Planet Mass Mass (Jupiters)	Angular Separation (milliarcsecs)	Orbit Radius (AUs)	Year of Discovery
Fomalhaut b	8	3	15	119	2008
HR8799b	39	7	1.7	68	2008
c		10	1.0	38	
d		10	0.6	24	

Right: Wes Kelly, Triton Systems LLC, is the author of the *Horizons September 2005* cover story *Triton Systems Stellar-J.*



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Kelly's Corner

History as Science: Megatons to Megawatts

Wes Kelly, Triton Systems LLC

"It is the design of this, and of the two succeeding chapters, to describe the prosperous condition of their empire; and afterwards, from the death of Marcus Antoninus, ***to deduce the most important circumstances of its decline and fall; a revolution which will ever be remembered, and is still felt by the nations of the Earth***." Edward Gibbon, *Decline and Fall of the Roman Empire*, Introduction, Chapter 1, (1776).

"***To understand the laws of this continuous movement is the aim of history. But to arrive at these laws, resulting from the sum of all those human wills***, man's mind postulates arbitrary and disconnected units." L. N. Tolstoy, *War and Peace,* Book 9, Chapter 1, Paragraph 6 (1868-73).

"***Only by taking infinitesimally small units for observation (the differential of history, that is, the individual tendencies of men) and attaining to the art of integrating them*** (that is, finding the sum of these infinitesimals) can we hope to arrive at the laws of history." L.N. Tolstoy, *War and Peace*, Book 11, Chapter 1, Paragraph 10.

"***For the past two decades, 10% of all the electricity consumed in the United States has come from Russian nuclear warheads***." National Public Radio (NPR) news article, 11 December 2013 (**reference 1**).

Introductory Kinetic Theory

For the last twenty years, ten percent of electricity for the USA was obtained from re-use of Russian nuclear warheads! *Megatons to Megawatts*: this 2013 NPR news article leads me to reflect on science and the history of nations and empires as a survivor of the 1947-1991 Cold War.

In my junior year of high school, on a day when our history teacher called in sick, Mr. Brett, our physics teacher, was our substitute teacher. To commence class, he picked up the text and inquired, "History. Is it a science? Joe? Rich?" Since Mr. Brett was the track coach and they were members of the school team, they hesitantly answered, "Yes," and were glad they guessed the correct answer. I still think about Mr. Brett's question.

Nuclear arms once trained on two countries were disassembled and reduced to a tenth of their former sizes, providing monetary and electrical benefits to their two respective societies. That is an amazing example of that familiar biblical phrase, turning "swords into plowshares."

In that high school era noted above, *Outline of History*, by science fiction writer H. G. Wells, was a staple of book clubs and living room bookshelves. The1918 introduction promised to explain why Japanese warships were now steaming about the Mediterranean Sea. I read the book twice, and I recall not finding any such explanation, but it provided more coverage of East Asian history than other popular texts. Wells also provided plenty of opinions about other historical people. But was this science?

The Molecular Model: Pressure, Temperature and Internal Energy

Isaac Asimov, another science fiction writer, drew from two books mentioned above for his famous *Foundation* series: Edward Gibbon's *The Decline and Fall of the Roman Empire* and Lev Tolstoy's *War and Peace*. Asimov's tales of the decline of a future galactic empire presented an inspiring history within history, and then a history projected beyond, stringing along readers and publishers. It also revered a far future

Above: Dramatis Personae: (L to R from top) Edward Gibbon, Ludwig Boltzmann, H.G. Wells, Leo Tolstoy, Napoleon Bonaparte and Isaac Asimov. Image credits: Sir Joshua Reynolds (flipped image), public domain, public domain, public domain, public domain, public domain (1965, taken by Phillip Leonian).

social science. In these tales by Asimov, scientist Hari Seldon and his Foundation's *psychohistory* predict the fate of the Milky Way's population of a quadrillion (10 raised to the power of 16, or ten million billion) or more, much like Ludwig Boltzmann deriving thermodynamics from statistical mechanics of atoms. The Asimov stories foresee a 30,000-year period of upheaval and prey to barbarians resembling the predicament in Gibbon's chronicle, but on a grander scale of space and time – unless there's intervention. Distinct from Gibbon's post mortem, Seldon's verdict was prior. Gibbon's and Asimov's narratives consume nearly equal numbers of pages and readers are left with similar forebodings about their own future when they put the volumes down.

Asimov's *psychohistory* was a background black box device unlike Gibbon's lengthy analyses of Roman and Byzantine situations. Gibbon surveys history, intermittently amid threading together, in 72 chapters, accounts of numerous ancient historians: Dion Cassius, Herodian, Tacitus, Eusebius, Ammianus, … the list goes on! For this, Asimov's Hari Seldon probably owes Gibbon a database debt. Gibbon's observations exist with their own 18th-century biases; yet, Gibbon is compelling. Sections in chapter 31 surveying social strata on the eve of Rome's sack by Alaric and the Visigoths could be mistaken as contemporary criticism.

Is history a science? There are no equations in the work by Gibbons.

Equations of State for a Perfect Gas

Yet when it comes to classical authors struggling with the meaning of history, Tolstoy's reflections in *War and Peace* come more readily to mind. It the quote above, it is amusing for our aerospace community to note that Tolstoy talks about elementary calculus as a model for the laws of history. Tolstoy's *War and Peace* deals with the Corsican corporal, Napoleon. For Asimov's *Foundation*, the Mule is a person throwing a monkey wrench into the galactic empire. For me, Tolstoy's Napoleon is the model for Asimov's Mule. Of course, an Austrian lance corporal named Adolf Hitler might have been the model for Asimov's mule, since what came to be called the *Foundation* series was first published in science fiction magazines of the 1940s.

In the Christmas season during which I write this article, *War and Peace,* as book or film, seems like an adjunct to other seasonal traditions like Tchaikovsky's *Nutcracker* ballet or sleigh rides across snowy landscapes. From the very beginning you sense that the author is plagued by the question, "Where *did* this man, Napoleon, the Emperor of France, come from?" From decades back, amid my family gatherings and Tolstoy's war reporting spread over a thousand or more pages, I remember the narrator weighing whether individuals, emperors, *masses*, or something else shaped history. With this in mind, I looked online for Tolstoy's theory of history.

Inquiries pointed to several sections of the text: for example, in chapter 1, book 9, "Toward the end of the year 1811… What brought about this extraordinary event?" A host of historical reasons and incidents are offered - and then evidently dismissed, starting anew in book 11, chapter 1. Another point about *War and Peace* and *Decline and Fall*: paperback editions are severely abridged through deletions or brief summaries of many chapters. If you are suspicious or curious as I was about why, you might seek out online public domain full texts.

As noted in the December 11, 2013 NPR news article, the agreement, providing nuclear fuel from Soviet-era nuclear warheads for generation of electricity for the USA, wrapped up recently with a final delivery to a US facility. The plan, Megatons to Megawatts, began with initiatives in the 1990s. The US Department of Energy official Phillip Sewell inquired if the Russian government would sell raw material assets for 20,000 nuclear bombs, or 500 metric tons of weapon grade highly enriched uranium. This material was converted or mixed into a lower enrichment nuclear plant fuel comprising about 15,000 tons at about 5% enrichment based on an isotope

Below: The maximum territorial extent of countries in the world under Soviet influence, after the Cuban Revolution of 1959 and before the official Sino-Soviet split of 1961 The maximum territorial extent of countries in the world under Soviet influence, after the Cuban Revolution of 1959 and before the official Sino-Soviet split of 1961. Image credit: MaGioZal.

fraction [$U^{235}/(U^{238}+U^{235})$]. The original material was exported over a period of 20 years for a total price of $17 billion. The Russian nuclear industry had nearly one million unpaid workers and its facilities lacked much needed security and repair.

The Megatons to Megawatts program was initiated in 1993, but the concept can be traced [Wikipedia] at least as far back as a 1991 New York Times editorial written by Thomas Neff. Sadly, Megatons to Megawatts ended in December of 2013, and both Russia and the USA are still creating new strategic weapons. For example, later that same month, Russia launched the *Aleksandr Nevsky* [Wikipedia], a new ballistic missile submarine. But Professor Matthew Bunn of Harvard's Kennedy School of Government emphasized the good news as part of that NPR report. (His research interests include nuclear theft and terrorism, nuclear proliferation and nuclear control measures.) *"Still Bunn says this deal will go down in history as one of the greatest diplomatic achievements ever. 'I mean, think about it – 20,000 bombs worth of nuclear material, destroyed forever,' he says. '[Bombs that] will never threaten anybody ever again.'"*

Collision Rate and Mean Free Path

We tend to be ignorant about the size and the dangerous potential of that old nuclear arsenal. As someone who for a short time got involved in the war games that constituted "strategy," and as someone who, during military service, was tied up in the vigilance this situation demanded, I find our ignorance regrettable.

There are a number of post-Soviet Union agreements about to expire. Access to Soviet-developed rocket engines is one of them (RD-180s), but more significantly, the disposal of nuclear fuel in this manner is another.

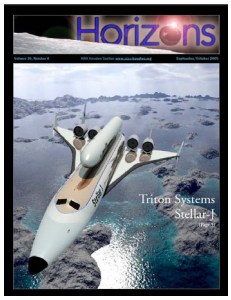
This is the biggest example of beating swords into plowshares in history: 20,000 bombs, each one at least as big as those dropped on Nagasaki and Hiroshima! A generation of us almost grew to expect gloomy futures as presented in Neville Shute's *On the Beach* or Pat Frank's *Alas Babylon*. Thankfully, things are not that bad.

Whether future domestic nuclear fuel supplies will be adequate or economical is open to debate. We learn now that the USA is the world's leading producer of oil and natural gas (NG), and NG is very competitive with nuclear power domestically. This NG news stems from discoveries of shale oil such as the Bakken formation in North Dakota and the new technologies of hydraulic fracturing (fracking) and horizontal drilling.

Gibbon gave little account to technologies. Futurists and science fiction authors write technologies into projected history. But as to the science of history and its mechanics, when studying the kinetic theory of gases in my Aerospace 501 course in college (section titles in this article are some of the Aerospace 501 textbook section titles, see **Ref. 3**.), our instructor remarked that in statistical mechanics there was a remote probability, far from the norm, that all the molecules of air in the room could be stacked in a corner when he walked in the room. *Megatons to Megawatts* is an example of history far from the norm.

Human decency can make a difference in human events. So let's be thankful for Thomas Neff, Philippe Sewell, and like-minded people of the past, present and future. We will long remember the surprising good news (1993-2013) of *Megatons to Megawatts*. ■

Right: From A Transparent Success: Megatons to Megawatts Program. Image credit: Lawrence Livermore National Laboratory.



Left: Wes Kelly, Triton Systems LLC, is the author of the *Horizons September 2005* cover story *Triton Systems Stellar-J*.

Under the U.S.–Russian Highly Enriched Uranium Purchase Agreement, Russia processes highly enriched uranium (HEU) from dismantled Russian nuclear weapons at four sites: Mayak Production Association, Siberian Chemical Enterprises, Electrochemical Plant, and Ural Electrochemical Integrated Enterprise. HEU is processed into low-enriched uranium (LEU) for peaceful use in the U.S.

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1. *Megatons To Megawatts: Russian Warheads Fuel U.S. Power Plants*, Geoff Brumfiel, National Public Radio, December 11, 2013. http://www.npr.org/2013/12/11/250007526/megatons-to-megawatts-russian-warheads-fuel-u-s-power-plants
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3. Vincenti, W., Kruger, C., *Introduction to Physical Gas Dynamics*, John Wiley & Sons, New York, 1965.

LINKS

Edward Gibbon's *Decline and Fall of the Roman Empire*:
http://oll.libertyfund.org/?option=com_staticxt&staticfile=show.php%3Ftitle=1365&chapter=50981&layout=html&Itemid=27
Leo Tolstoy's *War and Peace:*
http://ebooks.adelaide.edu.au/t/tolstoy/leo/ English Translation on line text
http://www.youtube.com/watch?v=YPdhZe7UL_s Series of YouTube audio book readings in Russian
http://www.online-literature.com/tolstoy/war_and_peace/ Audio book readings in English
http://www.free-ebooks.net/ebook/War-and-Peace/pdf/view PDF English text
http://ilibrary.ru/text/11/p.1/index.html Russian text on line.

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 valu able 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!

Profiles in General and Experimental Aviation

(1) Lance Borden (Horizons *May 2011 issue*)
(2) Paul F. Dye (Horizons *July/August 2011 issue*)
More profiles will appear as soon as possible. Thanks to Richard Sessions (EAA Chapter 12) for suggesting this series.

Ideas for a meeting? Contact Richard at *rtsessions[at]earthlink.net.*
Another email contact: *eaachapt12[at]gmail.com.*
Experimental Aircraft Association (EAA) web site: *www.eaa.org*.
Chapter 12 web site: *www.eaa12.org*. Meeting dates are noted on their calendar.

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 Saturday:	Waco/Macgregor TX (KPWG), far east side of field, Chapter 59, pancake breakfast with all the goodies 8-10 AM, Dale Breedlove, jdbvmt[at]netscape.com
2nd Saturday:	Conroe TX Ch. 302 10 AM Lone Star Builder's Ctr Lone Star Exec.
2nd Saturday:	Lufkin TX, Fajita Fly-In (LFK)
2nd Saturday:	New Braunfels TX, pancake Fly-In
3rd Saturday:	Wings & Wheels, 1940 Air Terminal Museum, Hobby Airport, Houston TX, *www.1940airterminal.org*
3rd Saturday:	Jasper TX BBQ lunch, Fly-In (JAS)
3rd Saturday:	Tyler TX, breakfast fly-in, 8-11 AM, Pounds Field (TYR)
4th Saturday:	Denton TX, Tex-Mex Fly-In
4th Saturday:	Leesville LA, Lunch Fly-In (L39)
4th Saturday:	Shreveport LA, Lunch Fly-In (DTN)
Last Saturday:	Denton TX, Fly-In, 11AM-2 PM (KDTO)

Wings Over Houston 2013

Adapted from the Chapter 12 website, December 22, 2013: This year was one for the books, as far as chapter firsts, and the governments sequestration is to blame for our good news. We were invited to take part in the airshow both days for a General Aviation flight. Perhaps we did not do barrel rolls 50' above the runway, but I think we did prove that you don't have to be rich to fly. Here you can see our pilots at work.









The 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
www.1940airterminal.org

Welcome to the
1940 Air Terminal Museum!

The 1940 Air Terminal Museum is housed in the original art-deco Houston Municipal Airport building at present-day William P. Hobby Airport. The Museum showcases the rich heritage of civil aviation, including the airlines, general aviation and business aviation. Exhibits include Houston's fascinating aviation history.

Where Houston's
aviation history comes alive!

A visit to the Museum also affords a front row vantage point to Hobby Airport's diverse airport operations. Between airline traffic, business aviation and frequent fixed wing and rotary wing general aviation traffic, the Museum has an air show every day. The entire ground floor of the historic Terminal is occupied by the Museum. The restoration of the upper floors, including the observation decks and the tower cab, is pending. Our campus has expanded to include the recently restored 1928 Carter Field Airmail Hangar. *[This text is taken from the home page of the 1940 Air Terminal Museum's website.]*

Below: The Manhattan Dolls returned for a second show recently, recorded in the museum blog entry of August 31, 2013.

Above: The monthly Wings & Wheels event theme for October 2013 was the museum's second hosting of the Houston Airline Collectibles Show. One of two fly-in aircraft for the day was a Beechcraft Bonanza named Luv Bird. Image credits: The museum website.

Address to AIAA Houston Section about the late James C. McLane, Jr., Part 4 of 6

James C. McLane, Jr.
1923-2012

James C. McLane III, from the Presentation of June 13, 2013

I want to say a little about my dad's approach to life. He had a wide range of interests and when he became interested in something he could not be just casually involved. When he was just 14 years old without any technical guidance or help he built and flew one of the first gas powered model airplanes, first in South Carolina and later a second plane in Georgia. This was so remarkable that it was covered in the newspapers.

He liked aviation so much that he became a WW2 Fighter pilot. He was interested in music and in the early 1950's he built a tube type hi-fi stereo. Back then hi-fi was so new you couldn't buy the equipment, you had to make it! He even made the record turntable. When I was a kid my dad didn't drive to work in an ordinary car, he had an unreliable little MG convertible that previously had been a race car. He liked photography so he outfitted a complete color darkroom inside his house. In the 1970's, way before the advent of the IBM PC, he owned a Kapro personal computer with a little 6-inch screen. With his own hands he constructed additions to two houses. He was fanatical about family history and made special trips to acquire genealogical information.

My father grew up in the South during the great depression. One of his grandfathers was a sheriff and for a while my dad lived in the city jail in Abbeville, South Carolina, a creepy place that featured a tall windowless room where they conducted hangings.

His father was born in 1900 and had an eighth grade education (typical for the time), but his mother attended college and could even read and write Latin. His father was a superintendent for highway construction companies. In the early 1930's the family lived in Chile in South America, where his father built the first asphalt road in that country. My dad grew up in a family environment that emphasized hard work and supported personal initiative.

Above: James C. McLane, Jr. is two years old in Daytona Beach, Florida in his mother's arms. That is a 1925 photograph wtih his mother Martha L. McLane. Five photographs show James and his sister Alice on the ship to Chile. The date on the newspaper clipping is February 17, 1938.

3AF MP

Collages by Jean-Pierre Condat

Philippe Mairet, 3AF MP, and Douglas Yazell, Horizons Editor

Born in 1957 in Toulouse, France, *autodidact* Jean-Pierre Condat has been a painter and collagist since 1981. Since 2000, he publishes postcards from his own works distributed at the *Museum of Air and Space* at le Bourget (Paris Airport). At our request, Mr. Condat sent us a few of his collage images for this article. His *website* is Collages of the South, better translated as Collages from the South of France. This website address is

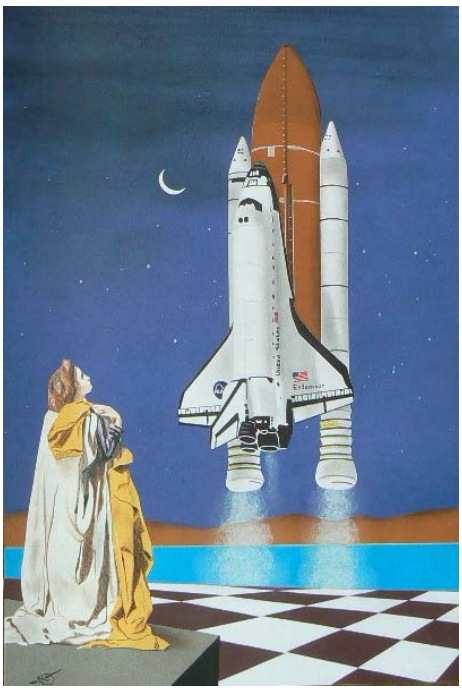
http://www.descollagesdusud.fr/

AIAA Houston Section and l'Association Aéronautique et Astronautique de France, Midi-Pyrénées Chapter (*3AF MP)* have been sister sections since 2007, as *noted* on a later page.

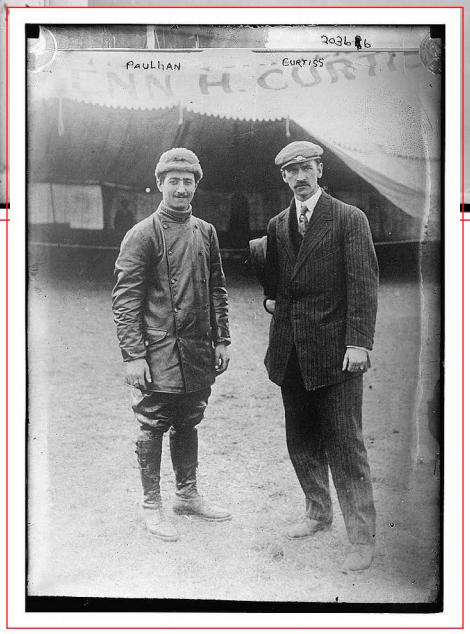
Mr. Condat's space shuttle image appears in a collage inspired by a Salvador Dali painting. This collage is from a July 2011 exhibition in which Mr. Condat blended aviation and space images with works of art by artists including Dali , Matisse , Warhol, Hopper, Delacroix , Millet , Magritte, Lichtenstein , De La Tour, Michelangelo, Adami, Vettriano, and Hokusai.

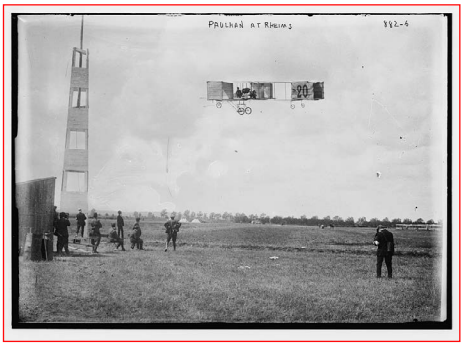
Since Mr. Condat lives and works in *Toulouse*, France, the largest city in the territory covered by 3AF MP, it is not surprising to find that his website contains sample images with themes of Toulouse and aviation. Among his Beginnings of Aviation images is a collage featuring aviation pioneer *Louis Paulhan* of France. As noted on page 16 of the Horizons issue of March 2010 (*First Flight in Texas*) and starting on page 12 of the Horizons issue of November 2009 (*The First Aviators in Texas and Houston*), Louis Paulhan, as the feature attraction of a 1910 airshow, became the first person to fly an airplane in Texas.

We send our thanks again to Mr. Condat for the use of these five collage images!



Mr. Condat's collage featuring Louis Paulhan celebrates Paulhan's winning the first *Daily Mail Aviation Prize* for the 1910 flight from London to Manchester. This reminder about Paulhan and his Texas connections led us to the Library of Congress website where several Paulhan public domain images are available from the George Grantham Bain *collection*.





Optimization Physics-Inspired Optimization Methods

Dr. Patrick E. Rodi

Solution optimization has been performed using classical methods, such as Calculus of Variations, for years. Such approaches have produced some powerful and well known solutions such as the Hohmann transfer orbit to minimize the delta-velocity required to change orbits and Sears-Haack shaping for low transonic wave drag in linear flow theory. In more recent times numerical optimization has produced significant advances in subjects such as aircraft/spacecraft trajectory design, and air vehicle shaping.

Over the past few years there has been an explosion of new numerical optimization techniques inspired by behaviors found in nature. Often these methods are based on very simple rule sets, that produce surprisingly effective optimization strategies. Consequently, these physics-based methods are both interesting in their operation, and powerful in their capabilities. This article will briefly review a number of the more interesting physics-based methods that have been recently developed.

Genetic Algorithms

One of the earliest nature-inspired optimization methods was the Genetic Algorithm (GA). The GA is a numerical method that finds a near optimal solution by mimicking the evolutionary concepts of "natural selection" by Charles Darwin. A given problem solution is characterized by a series of chromosomes and is compared against rival solutions within a solution population. The best performing solutions from this population are permitted to survive to the next generation, and to breed and yield offspring that are also compared. A near optimal solution is quickly reached by application of the "survival of the fittest" filter over a number of generations. Hence the method's name Genetic Algorithms.

Experience has shown that the GA method is very adaptable and can quickly find a near optimal solution. Guaranteeing the finding The Optimum for a given problem is not possible. However, for most problems a near optimal solution is sufficient. The GA method can incorporate a broad range of constraints and cost functions. GAs can be employed both strategically and tactically (e.g. in real-time) and have proven to be far more flexible than many other optimization approaches. Each solution is evaluated via a cost function, which can include a wide variety of factors. Additionally, the cost function can be a composite of a number of parameters that all need to be optimized together. Problem constraints can be included by not permitting certain chromosomes from existing in the population or by imposing a severe penalty in the cost function formulation for undesirable characteristics. Additionally, GAs can produce the "best possible" solution for over-constrained problems. Many other methods would fail to provide an answer to such impossible problems. As an example, the physical configuration of the X-band antenna geometry on NASA's ST-5 spacecraft has been optimized using the Genetic Algorithm. See Figure 1. This shape was found to produce the best radiation pattern, within the design constraints for this application.

Figure 1. The GA Optimized X-Band Antenna for the NASA ST-5 Spacecraft. (Photo Credit: NASA.)

The GA method has been successfully applied over a wide range of problems *including*:

- Automated design of financial trading systems
- Code-breaking, using the GA to search large solution spaces of ciphers for the one correct decryption.
- Computer architecture and distributed computer network topologies
- Evolvable hardware (e.g. electronic circuit design and structural design)
- File allocation for a distributed system.
- Plant floor layout
- Timetabling problems, both strategic (defining schedules) and tactical (real-time dispatching)
- Vehicle routing problems such as the NP-hard *Traveling Salesman Problem*, where NP means *Non-deterministic Polynomial-time hard*.

Unfortunately, the GA method is relatively slow to optimize. This is primarily due to having a superior solution's characteristics influence only its own off-spring, and not the entire population at once. Consequently, such favorable characteristics may require many generations to become widely incorporated across the population enabling further improvements to be made.

Intelligent Water Droplet

The Intelligent Water Droplet (IWD) algorithm is a population based optimization algorithm inspired by natural rivers and exploit the "path finding" strategies of flowing water. In nature a river often finds advantageous paths among lots of possible paths in its ways from the source (e.g. a spring) to the destination (e.g. a larger river, lake or ocean). These optimal or near optimal paths are a result of actions and reactions occurring between water droplets and between the water droplets with the local soil conditions. In the IWD algorithm, several water droplets cooperate to change their environment in such a way that the optimal path is revealed as the one

with the lowest soil along its path (i.e. link) between the source and the destination. The solutions are thus incrementally constructed by the IWD algorithm. In the original IWD algorithm the water drops are created with two main properties: 1) velocity, and 2) soil. The velocity describes the IWD's motion, while the soil is a term that resists motion. Both of these properties may change during a given droplet's lifetime. The IWD begins from a source to reach some destination with an initial velocity and zero soil. During its trip, an IWD travels through the environment from which it removes some soil and may increase speed. This soil is removed from the path joining the two locations, called a link. The IWD moves in discrete steps. From its current location to its next location, its velocity is increased by the amount that is non-linearly proportional to the inverse of the soil between the two locations and the amount of soil added to the IWD is non-linearly proportional to the inverse of the time needed for the IWD to pass from its current location to the next location. Therefore, a path having less soil (i.e. less resistance to motion) permits the IWD to move faster, than a path having more soil (i.e. more resistance to motion), and the time interval to traverse that path is less. Thus, the time taken is proportional to the velocity of the IWD and inversely proportional to the distance between the two locations. An IWD prefers the paths having low soil content than the paths having high soil content. The IWD rule set contains:

1. Initialization of static parameters
2. Initialization of dynamic parameters
3. Spread the IWDs randomly on the nodes of the graph
4. Update the visited node list of each IWD
5. Repeat Steps a to d for those IWDs with partial solutions
   a. For the IWD residing in node i, choose the next node j, which does not violate any constraints of the problem and is not in the visited node list of the IWD
   b. For each IWD moving from node i to node j, update its velocity
   c. Compute the soil
   d. Update the soil
6. Find the iteration-best solution from all the solutions found by the IWDs
7. Update the soils on the paths that form the current iteration best solution
8. Update the total best solution by the current iteration - best solution
9. Increment the iteration number
10. Stop with the total best solution

As with the GA method, the IWD is relatively slow to optimize and can miss extrema. While droplets do cooperate by reinforcement of a favorable path, such interactions are local and do not generate a global change in behavior.

Ant Colony Optimization

The natural behavior inspiration for the Ant Colony Optimization (ACO) is the behavior of a colony of ants. When beginning to search for food, forager ants randomly explore the area surrounding their nest. Once as an ant finds a food source, it evaluates the quantity and the quality of the food and carries some of it back to the nest. During the return trip, the ant deposits a chemical pheromone trail on the ground to mark the path to the food source. The quantity of pheromone deposited, which may depend on the quantity and quality of the food, will direct subsequent ants to the newly discovered food source. The pheromone attracts ants and therefore ants will tend to follow trails that have higher pheromone concentrations. As more ants follow the same path, more pheromones are released, thereby increasing the appeal of that particular path. The ACO rule set contains:

1. Set initial parameters and reset the pheromone trails
2. Construct ants solutions
3. Apply local search
4. Update pheromones
5. Compare against termination criteria

The ACO behavior is illustrated in Figure 2 for the Traveling Salesman Problem. In the first image, from left-to-right, a series of 13 locations are defined that are to be visited once while minimizing the distance traveled. In the second image a number of alternative paths are evaluated by numerous ants. By the third image preferred routes are beginning to emerge. In the last image, the optimized path has emerged.

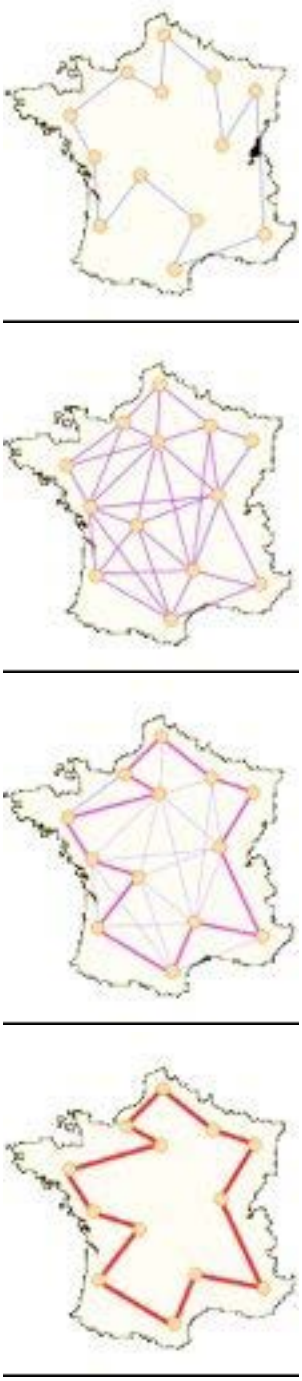


Figure 2. Using Ant Colony Optimization for the Traveling Salesman Problem. Photo *Credit*: Wikipedia.)

The ACO method employs a limited form of swarm intelligence, wherein a superior solution immediately has an impact on all of the other candidate solutions within the solution population. Such communication across a solution

population has been found to be very advantageous in optimization.

Gravity Search Algorithm

The Gravity Search Algorithm (GSA) is one physics-based method that employs a global form of swarm intelligence. The GSA is based on the Newtonian laws of gravity and of motion. In the GSA method there exist a finite number of mass-containing objects contained within the solution space. Each object represents one unique solution to the problem. According to the Newton's law of gravitation, each object attracts every other object with an attractive force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The mass assigned to a given object (i.e. solution) is a measure of the cost function to be optimized. Objects having higher masses are deemed to be superior to those with lower masses. All the objects attract one another via Newton's gravitational force model. Swam intelligence is obtained as a superior solution has an immediate impact on all of the other solutions within the population by its higher gravitational force. As a result the heavier object(s) influence the movement of all the objects; generally migrating towards the superior solutions. In GSA, each object has four characteristics: 1) position, 2) inertial mass, 3) active gravitational mass, and 4) passive gravitational mass. The GSA rule set contains:

1. Randomly generate an initial population of solutions
2. Evaluate fitness of each solution
3. Update gravitational constant and objects having best and worst fitness
4. Calculate mass and acceleration for each agent
5. Update velocity and position of each agent
6. Compare the best solution to the termination criterion

The position of a given mass corresponds to a solution of the problem, and its gravitational and inertial masses are determined using a cost function. As the process is advanced in time the objects move around the solution space. Over time, the masses be attracted by the heaviest mass(-es). The identity of the heaviest mass can change from one individual to another, as a new "most superior solution" is discovered. At any point during the process, the heaviest mass presents optimum solution to the problem up to that point. Subsequent time increments (generally) improve the optimum solution.

An example of the GSA method in practice is shown in Figure 3. In this figure the algorithm is attempting to maximize a function. The function's maximum occurs at (0, 0). A series of images shows the progress of the solution population from randomly assigned initial conditions to convergence. The GSA's best solution is identified by the red plus symbol in the image.

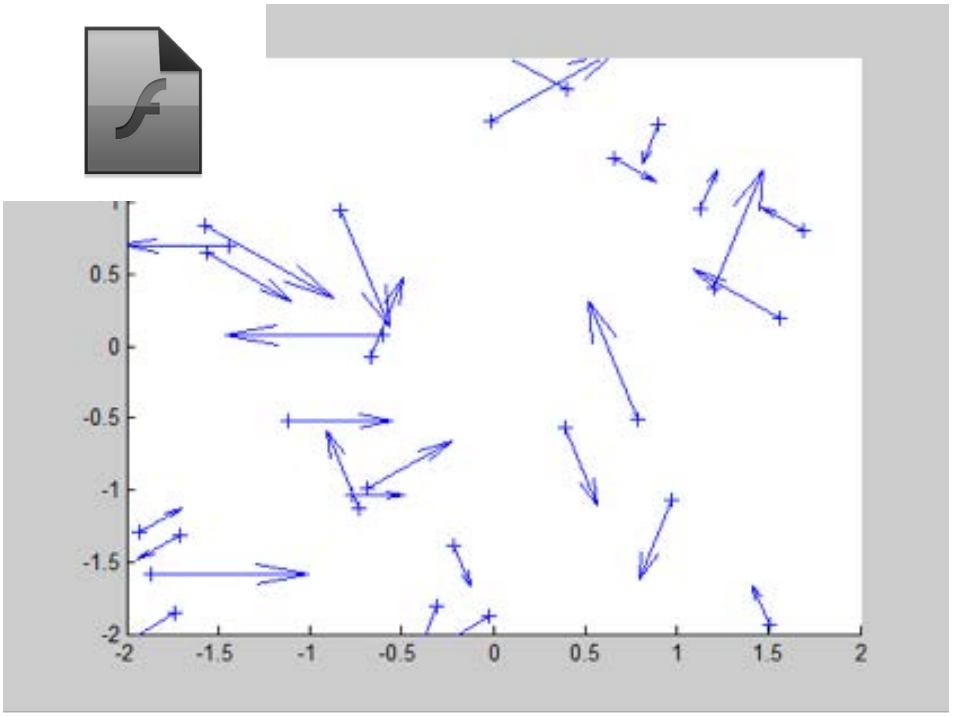


Figure 3. Gravity Search Algorithm Used to Maximize a Function. Click above to activate the Adobe Flash animation in this Horizons Flash file (a .swf file) or in this Horizons interactive PDF file (a .pdf file). That animation is visible on some devices and not others. For example, it is visible using Mac OS Mavericks and Safari or Adobe Acobat Reader to read the PDF file. It is also visible using Mac OS Mavericks and the Google Chrome browser to read the SWF file. (Photo Credit: the author.)

Particle Swarm Optimization

Often flocks of birds and schools of fish move in coordinated motions displaying strong synchronization in initiation of movement, initial direction, turning, and stopping without any member apparently functioning as the group's leader. Yet, such behavior is successful in finding foot and for defense against predators. To generate this swarm intelligence, they follow certain rules for their movement. The simulation of a bird swarm was identified as an optimization process sweeping through a solution space and led to the development of Particle Swarm Optimization (PSO). Searching procedures for PSO can be described as follows:

1) Each group member represents a solution of the problem and is randomly assigned an initial location and velocity vector within the solution space
2) Each member remembers the best value it has found so far (*Pbest*) and that solution's location
3) Each member also knows the best solution and location that any member of the flock has found (*Gbest*)
4) Using the locations of the *Pbest* and *Gbest* solutions each particle creates a new velocity by adapting its current velocity and then moving to a new position in the solution space

The forth step can best be easily visualized

with an illustration. Figure 4 shows the current location for the ith member at time step k as X_i^k. The current velocity is shown by the vector V_i^k.

A new vector is formed between the current location and the *Pbest* location for this ith member, V_i^{Pbest}. A second new vector is formed between the current ith location and the *Gbest* location, V_i^{Gbest}. The new velocity, V_i^{k+1}, is the vector sum of the three vectors. The new velocity is used to advance the ith member to the its location for the k+1 time step, X_i^{k+1}. Coefficients are usually employed to weight each of these three vectors by differing amounts. This can influence the resulting particle movements among: inertia-dominated, global search-dominated, and local exploitive-dominated behaviors. By adding a limited amount of randomness to the coefficients, convergence performance has been improved for many problems.

From these simple rules an interesting and powerful optimization scheme is produced. An example of the Particle Swarm Optimization method in use is shown in Figure 5. A group of seven members (shown by the red dots) form a flock and are swarming to find the minimum value of this function. Even with this small group size, the global minimization is quickly found.

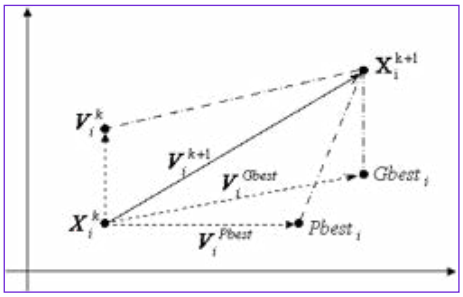


Figure 4. Vectors Used to Create a New Velocity Vector in Particle Swarm Optimization. (Photo Credit: the author.)

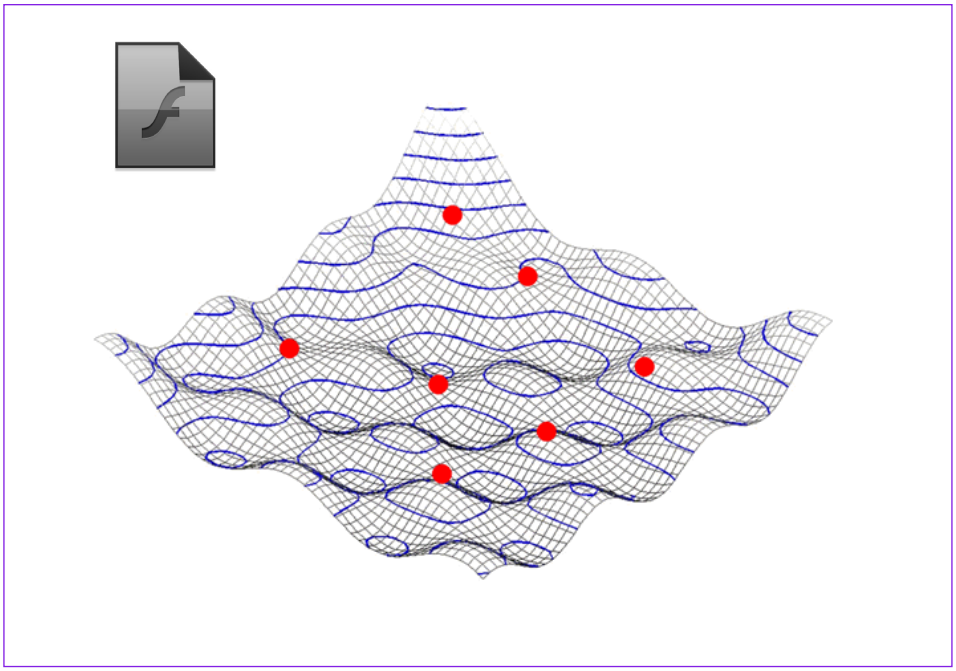
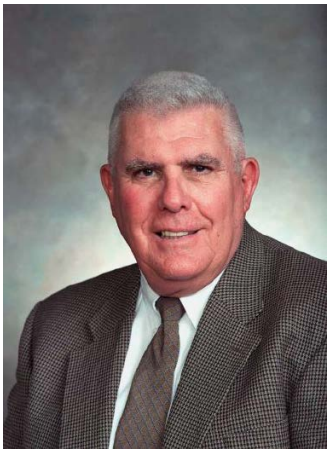


Figure 5. Particle Swam Optimization Used to Minimize a Function. Click above to activate the Adobe Flash animation in this Horizons Flash file (a .swf file) or in this Horizons interactive PDF file (a .pdf file). That animation is visible on some devices and not others. For example, it is visible using Mac OS Mavericks and Safari or Adobe Acobat Reader to read the PDF file. It is also visible using Mac OS Mavericks and the Google Chrome browser to read the SWF file. (Photo Credit: University of Stuttgart.)

There are many other examples of physics-based optimization methods in the literature. Other methods include: Artificial Bee Colony, Bacterial Foraging Optimization, Hysteretic Optimization, Spiral Galaxy-Based Search Algorithm, Big Bang-Big Crunch, etc. Each method has advantages and disadvantages. Additionally, hybrid schemes have been created to attempt to blend the best features from multiple methods. In general, all of these methods use simple rules to produce complex behaviors that result in powerful optimization tools. It is just fortuitous that the human eye can appreciate the esoteric beauty of the solution patterns during optimization. ■

In Memoriam Robert L. Sackheim (1937-2013)

Edited by Douglas Yazell, Horizons Editor



Robert Sackheim
May 16, 1937 - December 22, 2013

Robert (Bob) L. Sackheim, Assistant Director and Chief Engineer for Space Propulsion (retired) at NASA's Marshall Space Flight Center in Huntsville, Ala., served on the Marshall Center Director's Executive Staff and provided technical review in the area of space propulsion and space transportation. Mr. Sackheim was a chief advisor for the Marshall Center for propulsion activities, including advanced technologies and space transportation for Exploration activities He held that position from 1999 until his retirement in 2006. At the time of his passing, he was a consultant to several aerospace contractor and government organizations.

Prior to joining NASA in 1999, Mr. Sackheim spent 35 years in various technical management positions at TRW Space and Electronics Group, then an operating unit of Cleveland, Ohio-based TRW Inc. From 1990 to 1999, he managed the TRW Propulsion and Combustion Center in Redondo Beach, Calif., and was responsible for the design, development and testing of all new propulsion, combustion and fluid systems products. From 1996 to 1999, Mr. Sackheim led the TRW team responsible for design, development and flight qualification of the Chandra Integral Propulsion System, which successfully placed NASA's Chandra X-ray Observatory – the world's most powerful X- ray telescope – into its final operational orbit in 1999.

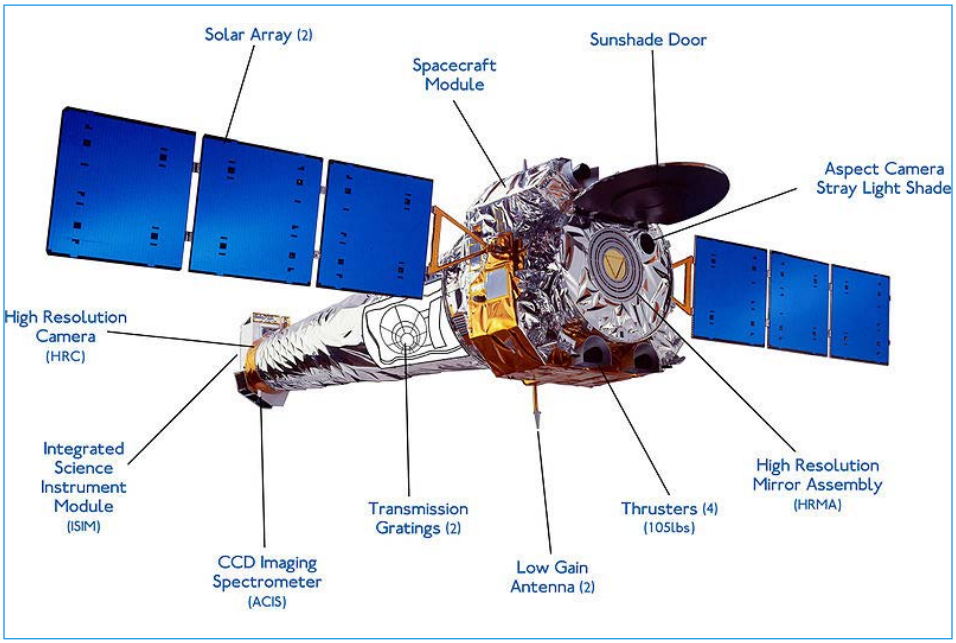
Mr. Sackheim was deputy director of the Propulsion and Fluid Mechanics Center at TRW in Redondo Beach from 1988 to 1990, responsible for new propulsion, energy, high-energy laser and fluid systems for space and defense applications. He served from 1986 to 1988 as TRW's project manager for the Orbital Maneuvering Vehicle Propulsion Modules Project in Redondo Beach, where he oversaw its design, development and operations planning.

Mr. Sackheim served in various engineering management roles at TRW Inc. from 1972 to 1986, including section head of spacecraft propulsion, assistant manager of the Hardware Engineering Department and deputy manager of the Fluid and Combustion Systems Laboratory. In 1983, he was recognized for leading the propulsion team responsible for enabling the rescue of NASA's Tracking and Data Relay Satellite (TDRS), Flight No. 1, a communication signal relay system that transmits to and receives data from spacecraft in low Earth orbit, including the Space Shuttle. TDRS was nearly lost in space in 1983 when its upper stage failed.

Mr. Sackheim's first TRW job, from 1964 to 1969, was as project manager for the Mariner Mars Propulsion Subsystem, a technology used for midcourse correction, trajectory control and maneuvering on NASA's Mariner 6 and 7 spacecrafts. From 1969 to 1972, he served as project manager for the Intelsat IV Propulsion Positioning and Orientation System with COMSAT Corporation in Los Angeles.

From 1960 to 1964, Mr. Sackheim served in the U.S. Air Force, achieving the rank of Captain. He served as propulsion chief for the Titan II Development Launch Crew, responsible for development, testing and launch of the Titan II missile system.

Mr. Sackheim held a bachelor's degree in chemical engineering from the University of Virginia in Charlottesville, and a master's degree in chemical engineering from Columbia University in New York. He had completed all doctoral coursework



Above: The Chandra X-ray Observatory, previously known as the Advanced X-ray Astrophysics Facility (AXAF), is a space telescope launched on STS-93 by NASA on July 23, 1999. Chandra is sensitive to X-ray sources 100 times fainter than any previous X-ray telescope, enabled by the high angular resolution of its mirrors. Since the Earth's atmosphere absorbs the vast majority of X-rays, they are not detectable from Earth-based telescopes; therefore space-based telescopes are required to make these observations. Chandra is an Earth satellite in a 64-hour orbit, and its mission is ongoing as of 2014. Chandra is one of the Great Observatories, along with the Hubble Space Telescope, Compton Gamma Ray Observatory (1991–2000), and the Spitzer Space Telescope. Chandra has been described as being as revolutionary to astronomy as Galileo's first telescope. Caption text credit: Wikipedia. Image credit: NASA.

in chemical engineering at the University of California in Los Angeles (UCLA).

Mr. Sackheim received numerous awards and honors. In 2003, he received the Marshall Center Director's Commendation for outstanding service; the Presidential Rank Award for Meritorious Executive Service, presented to government's top executives for their contributions in leading vital federal programs; and the American Institute of Aeronautics and Astronautics (AIAA) Holger Toftoy Award for outstanding technical leadership in space systems.

In 2002, AIAA Alabama/Mississippi Section presented Mr. Sackheim the Hermann Oberth Award, the Section's most prestigious honor, for his outstanding scientific achievement in the fields of astronautics and space sciences. He also was recognized by the l'Association Aéronautique et Astronautique de France (3AF) for "high quality contributions to the propulsion field." In 2001, he received the NASA Medal for Outstanding Technical Leadership in space propulsion.

In 2000, Mr. Sackheim was presented the Martin Schilling Award for outstanding service to AIAA Alabama/Mississippi Section, and he received the AIAA Sustained Service Award for outstanding contributions to the Institute. In addition, he was elected to membership in the National Academy of Engineering, a private, non-profit institution that serves as advisor to the federal government on important topics in engineering and technology. Mr. Sackheim's awards and honors also include the 1992 AIAA James Wyld Award for outstanding technical contributions to the field of rocket propulsion, as well as 12 NASA Group Achievement Awards. He was also a member of Sigma Xi.

At TRW, Mr. Sackheim received three annual Chairman's Awards for outstanding technical contributions to the corporation, and a TRW Patent of the Year Award in 1992.

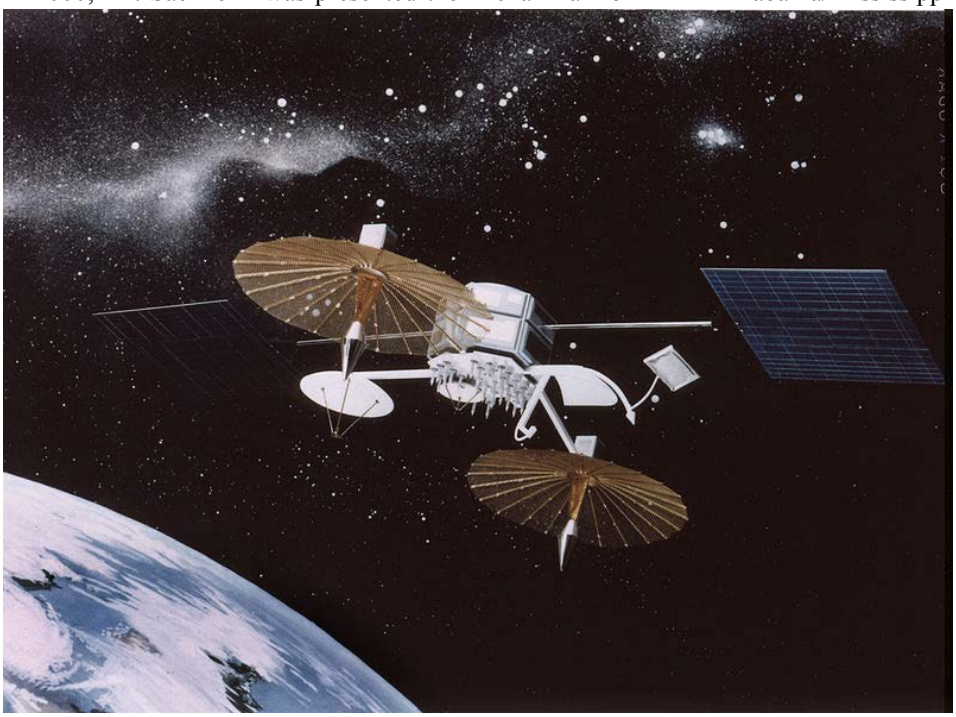
Mr. Sackheim served on numerous boards and councils. He served as chairman of the AIAA Liquid Propulsion Technical Committee in 2003 and was appointed to the AIAA Journal of Propulsion and Power Editorial Advisory Board in 2001. He was chairman of AIAA Alabama/Mississippi Section from 2000 to 2001. In 1997, he was elected to the International Academy of Astronautics, which brings together astronautics experts from around the world to recognize accomplishments and to discuss space research and technology.

Mr. Sackheim also served on numerous National Research Council committees, which provide science and technology policy advice to the federal government under a congressional charter. He was elected in 1996 as a Fellow of the AIAA. He was chairman of AIAA Los Angeles Section from 1996 to 1998.

At NASA, Mr. Sackheim served on the Shuttle Independent Assessment Team, commissioned to review Space Shuttle systems and maintenance practices, and on the Mars Climate Orbiter Mishap Investigation Board, established in 1999 to determine the cause or contributing factors resulting in the loss of the orbiter, launched in 1998 to serve as a weather satellite and to provide a communications relay for the Mars Polar Lander. Mr. Sackheim also served on the Mars Polar Lander Mishap Board, which investigated the loss of the spacecraft during its attempted landing on the Red Planet in 1999. He also served on the Post-Columbia Accident Chief Engineer's team in 2002 and on the Agency-wide Exploration Core/Blue/Red Architecture process teams.

From 1988 to 1999, Mr. Sackheim taught in the Engineering Extension School at the University of UCLA. In 2003, he became an instructor of short courses at the University of Alabama in Huntsville and subsequently became an Adjunct Professor of Mechanical Engineering there. He authored more than 250 technical papers and authored or co-authored chapters on rocket propulsion for four books on space propulsion, launch vehicles and missiles. He held eight patents in spacecraft, launch vehicle propulsion and control systems technology, including one NASA patent.

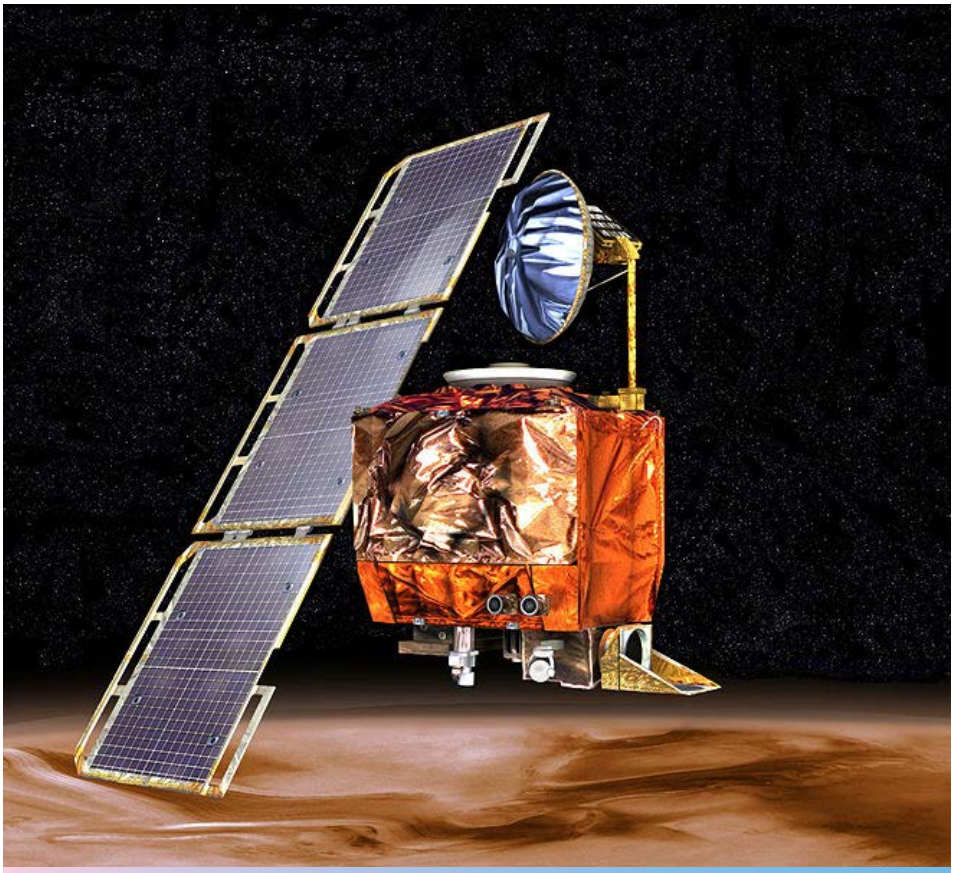
Robert Sackheim is survived by his wife, the former Babette Freund of New York City, New York, now living in Madison, Alabama, their two children, Karen and Andrew, and three grandchildren.



Above: This artist's concept drawing depicts the Tracking and Data Relay Satellite-C (TDRS-C), which was the primary payload of the Space Shuttle Discovery on the STS-26 mission, launched on September 29, 1988. The TDRS system provides almost uninterrupted communications with Earth-orbiting Shuttles and satellites, and had replaced the intermittent coverage provided by globe-encircling ground tracking stations used during the early space program. The TDRS can transmit and receive data, and track a user spacecraft in a low Earth orbit. The deployment of TDRS-G on the STS-70 mission being the latest in the series, NASA has successfully launched six TDRSs. TDRS satellite of the first generation. Image and caption credit: NASA via Wikipedia.

Bob leaves behind a generation of aerospace engineers who have benefitted from his mentorship as a university professor, a prolific author, and a frequent lecturer. He will be remembered as a person eager to pass along his knowledge, expertise and experience. ■

Left: Robert Sackheim was a modern Renaissance man being a spacecraft propulsion guru, inspiring teacher and Civil War artifacts collector. He spent the last part of his space engineering career at Huntsville's Marshall Space Flight Center. He is seen here among the artifacts he donated to start the Blue and Gray Museum of North Alabama in Decatur. (Contributed by Blue and Gray Museum of North Alabama.) Image credit: AL.com and Paul Huggins, phuggins@al.com.



Above: NASA's Mars Climate Orbiter. Image credit (via Wikipedia): NASA/JPL/Corby Waste. The Mars Climate Orbiter (formerly the Mars Surveyor '98 Orbiter) was a 338 kilogram (750 lb) robotic space probe launched by NASA on December 11, 1998 to study the Martian climate, atmosphere, surface changes and to act as the communications relay in the Mars Surveyor '98 program, for Mars Polar Lander. However, on September 23, 1999, communication with the spacecraft was lost as the spacecraft went into orbital insertion, due to ground-based computer software which produced output in non-SI units of pound-seconds (lbf×s) instead of the metric units of newton-seconds (N×s) specified in the contract between NASA and Lockheed. The spacecraft encountered Mars on a trajectory that brought it too close to the planet, causing it to pass through the upper atmosphere and disintegrate. Caption credit: Wikipedia Mars Climate Orbiter article.

The SpaceRef website presents a 2003 NASA Marshall Space Flight Center profile of Mr. Sackheim. The Blue & Gray Museum of North Alabama in the city of Decatur displays an amazing number of collectible items from the American Civil War of 1861 - 1865. The museum started with the collection of one man, Robert L. Sackheim. These items are rare Civil War relics. This is the largest privately owned Civil War collection in the United States of America. The museum's website is

www.alabamacivilwarmuseum.com.

Paul Huggins profiled the late Mr. Sackheim on January 26, 2014, in the Alabama website AL.com.

Above: Mr. Sackheim's Herman Oberth Award from AIAA Alabama/Mississippi Section. Image credit: AIAA.

Two New Science Books from the Science Deck of the Virginia Edition

Douglas Yazell, Editor

Rather than write two book reviews, we present the advertising copy from the publisher, the Virginia Edition. These two books appear to be their first science books, offered by the *Science Deck* of their website.

Space Elevators: An Assessment of the Technological Feasibility and the Way Forward

This book addresses the simple and complex issues that have been identified through the development of space elevator concepts over the last decade. The report begins with a summary of those ideas in Edwards' and Westling's book The Space Elevator (2003). Out of these beginnings has risen a worldwide cadre focused upon their areas of expertise as applied to space elevator development and operational infrastructure. The report answers some basic questions about the feasibility of a space elevator infrastructure. A preview of the main questions and answers shows the depth and breadth of this Cosmic Study.

- Why a space elevator?
- Can it be done?
- How would all the elements fit together to create a system of systems?
- What are the technical feasibility of each major space elevator element?

This study was conducted under the auspices of the International Academy of Astronautics (IAA) and benefited from review and comments by numerous members of the Academy, as well as the International Space Elevator Consortium. The study could not have been completed to this level of detail without the timely and invaluable efforts of a diverse collection of experts from around the world who contributed not only their time and knowledge, but also provided material as well as their technical expertise for the study. There were 41 authors and 5 editors.

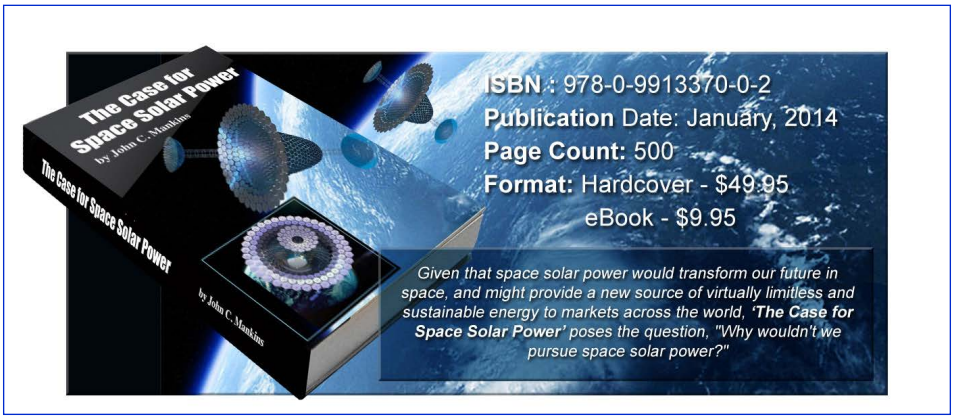
The Case For Space Solar Power

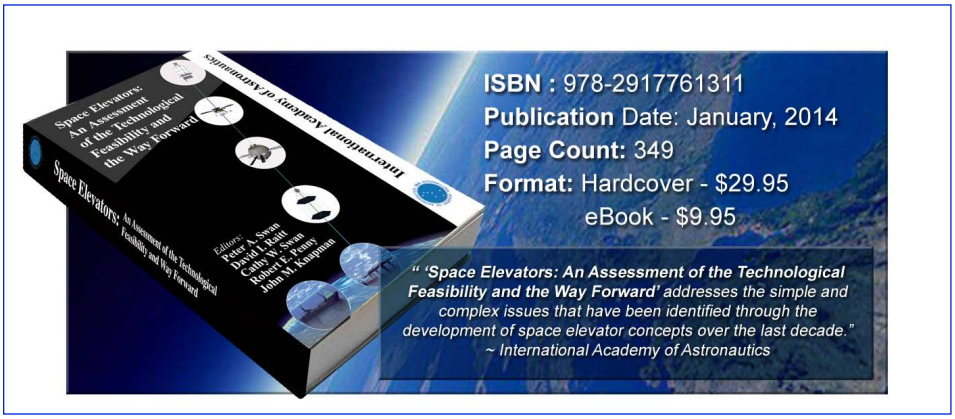
This book makes the case for Space Solar Power; recounting the history of this fascinating concept and summarizing the many different ways in which it might be accomplished.

The book describes in detail a highly promising concept - SPS-ALPHA (Solar Power Satellite by means of Arbitrarily Large Phased Array) - and presents a business case comprising applications in space and markets on Earth. The book explains how it is possible to begin now with technologies that are already at hand, while developing the more advanced technologies that will be needed to deliver power economically to markets on Earth.

The Case for Space Solar Power concludes by laying out a path forward that is both achievable and affordable: within a dozen years or less, the first multi-megawatt pilot plant could be in operation. Getting started could cost less than $10 million over the first 2 years, less than $100 million over the next half dozen years.

Given that space solar power would transform our future in space, and might provide a new source of virtually limitless and sustainable energy to markets across the world, the book poses the question, "Why wouldn't we pursue space solar power?" ■





Science & Public Policy

Climate Change and Local Responses

Douglas Yazell, February 24, 2014 (Article #7 in this Bimonthly Series)

Institutionalizing Delay

An new research paper was released by Robert J. Brulle, PhD, of Drexel University recently, *Institutionalizing delay: foundation funding and the creation of the U.S. climate change counter-movement (CCCM) organizations*. The Drexel Now *press release* appeared on December 20, 2013, *Not just the Koch Brothers: New Drexel Study Reveals Funders Behind the Climate Change Denial Effort*.

Climate denial organizations listed as receiving money include Heartland Institute, American Enterprise Institute for Public Policy Research, Landmark Legal Foundation, Heritage Foundation, Cato Institute, Americans for Prosperity Foundation, and Competitve Enterprise Institute. The biggest sources of the funding sources are now anonymous, but funding sources include Koch Affiliated Foundations, Scaife Affiliated Foundations, Annenberg Foundation, Lily Endowment Inc., ExxonMobil Foundation, and Coors Affiliated Foundations. The sociogram in the paper is a figure resembling a spiderweb connecting funding sources to recipients. It includes American Petroleum Institute among the sources and Texas Public Policy Foundation among the recipients.

The final sentence of the paper mentions anthropogenic climate change, controversy, and scientific fact. The paper mentions, "... an active campaign to manipulate and mislead the public over the nature of climate science and the threat posed by climate change." The paper also states, "With delay and obfuscation as their goals, the U.S. CCCM has been quite successful in recent decades."

From the press release, "This study is part one of a three-part project by Brulle to examine the climate movement in the U.S. at the national level. The next step in the project is to examine the environmental movement or the climate change movement. Brulle will then compare the whole funding flow to the entire range of organizations on both sides of the debate. See more at: this *link*."

I no longer participate as a member in the climate group mentioned in my first column on page 28 of our January / February 2013 *issue*. I ended that participation on November 1, 2013. In that first column I mentioned the October 23, 2012 episode of Frontline, *Climate of Doubt*. That episode's *website* includes a Septbember 30, 2012 *interview* with Brull, *Robert Brull: Inside the Climate Change Countermovement*.

Elsewhere in this issue

RapidScat is mentioned on a later *page* in this issue, since the NASA climate news *article* explains that this instrument will be attached to the International Space Station. A Texas A&M University press release lists climate change experts at that institution where they stand by to help journalists. That list is presented on a later *page* in this issue.

Global Warming
Since 1997 Underestimated by Half

This headline about underestimating global warming comes from a Real Climate blog *post* dated November 13, 2013. That blog can be found by starting at *http://climate.nasa.gov* and clicking on My Big Fat Planet, a blog by Dr. Amber Jenkins. Her blogroll includes Real Climate. A 2012 *discussion* of this subject, *About the Lack of Warming*, is available via the Houston Chronicle from the Climate Abyss blog by Dr. John Nielsen-Gammon.

C40 Cities
Climate Leadership Group

The website *www.c40.org* presents the list of cities in this climate leadership group, including Houston, Austin, New Orleans, Paris, France, and in China, Shanghai and Beijing. C40 started in 2005 led by London Mayor Ken Livingstone. In 2006, C40 invited the Clinton Climate Initiative (CCI) to be its delivery partner. Johannesburg, South Africa hosted the fifth biennial C40 mayors summit February 4-6, 2014. Houston Mayor Annise Parker participates in Plenary Session 1. Mayor Parker is *featured* in a six-minute video at the C40 YouTube *channel*, too.

Aerospace America
Climate Change Cover Story

AIAA members can enjoy the article by logging into the website at www.aiaa.org, clicking on My AIAA, then scrolling down for the link to the magazine (the February 2014 issue).

Tara Expeditions

Tara Expeditions is the organizer of voyages to study and understand the impact of climate change and the ecological crisis facing the world's oceans.

Tara Expeditions is a French non-profit organization active since 2003 in favor of the environment. A legendary boat built for extreme conditions, Tara is the platform for high-level scientific research missions. Initiated by Agnes B. and *Etienne Bourgois*,

HOME

The 90-minute 2009 *video* (YouTube).

In Closing

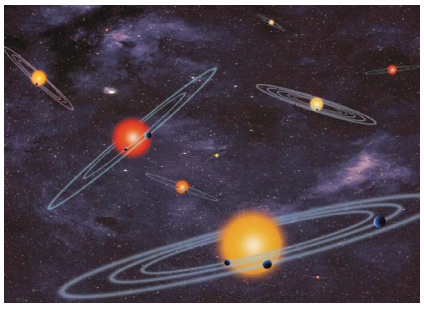
Andrew Revkin's Dot Earth *blog* in the New York Times is always good reading. It often discusses climate change. Mathematician John Baez is mentioned in this issue's Cranium Cruncher *page*. He attended the October 25-26, 2013 climate change conference *(Workshop: What is Climate Change?)* in Canada at the Balsillie School of International Affairs. The Baez web *page* about this conference includes a 9-page Baez *presentation*, *What is Climate Change?*, and a 10-page Baez *presentation*, *What To Do About Climate Change?*

Water Vapor Discovered In Exoplanet's Atmosphere

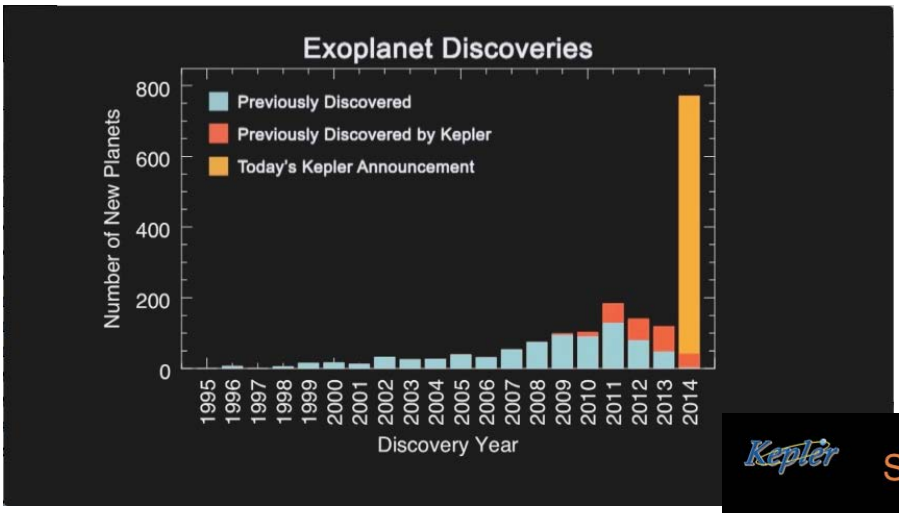
[AIAA Daily Launch] SPACE (2/26, Gannon) reports that a team led by Alexandra Lockwood of Caltech has used the Near Infrared Echelle Spectrograph (NIRSPEC) at the Keck Observatory to discover water vapor in the atmosphere of the exoplanet Tau Boötis b, a "hot Jupiter" first discovered back in 1996. In a statement, Caltech's Geoffrey Blake said the Keck telescope also should be able to determine if a "super-Earth" has water vapor under the right conditions, while the James Webb Space Telescope and the Thirty Meter Telescope will be able to see the vapor on "much cooler planets that are more distant from their host stars."

Kepler Finds And Confirms Over 700 New Exoplanets

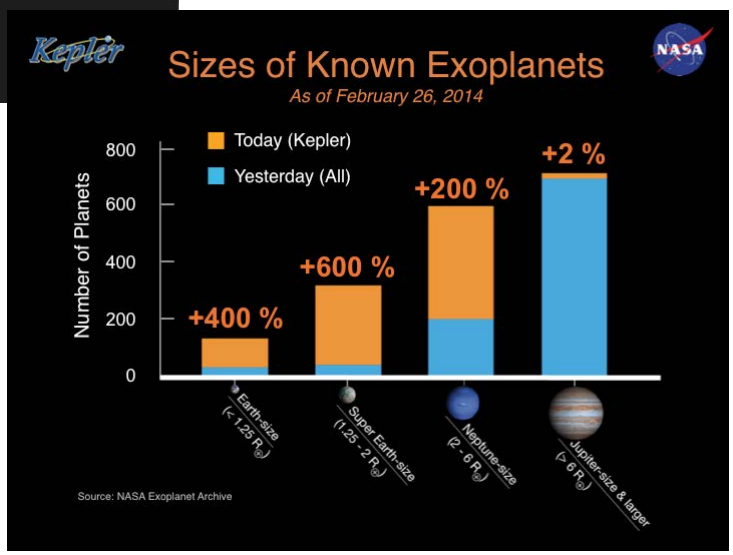
[AIAA Daily Launch] The AP (2/27, Borenstein) reports that using the Kepler telescope and a new technique, researchers have confirmed the existence of 715 new exoplanets. During a briefing, NASA planetary scientist Jack Lissauer said, "We almost doubled just today the number of planets known to humanity" with "the big mother lode" of planets. All of these new finds were in systems with multiple planets, with four in a star's habitable zone, although all were at least twice the size of Earth. Douglas Hudgins, NASA's exoplanet exploration program scientist, said this announcement brings the world closer to "finding Earth 2.0." MIT's Sara Seagar, who did not take part in the research, also noted the data showed that small planets were common. This, according to Lisa Kaltenegger, a Harvard and Max Planck Institute astronomer, increases the chances for life.



Above: The artist concept depicts multiple-transiting planet systems, which are stars with more than one planet. The planets eclipse or transit their host star from the vantage point of the observer. This angle is called edge-on. Image credit: NASA.



Above: The histogram shows the number of planet discoveries by year for roughly the past two decades of the exoplanet search. The blue bar shows previous planet discoveries, the red bar shows previous Kepler planet discoveries, the gold bar displays the 715 new planets verified by multiplicity. Image credit: NASA Ames/SETI/J Rowe.



Above: The histogram shows the number of planets by size for all known exoplanets. The blue bars on the histogram represents all the exoplanets known, by size, before the Kepler Planet Bonanza announcement on Feb. 26, 2014. The gold bars on the histogram represent Kepler's newly-verified planets. Image credit: NASA Ames/W Stenzel.

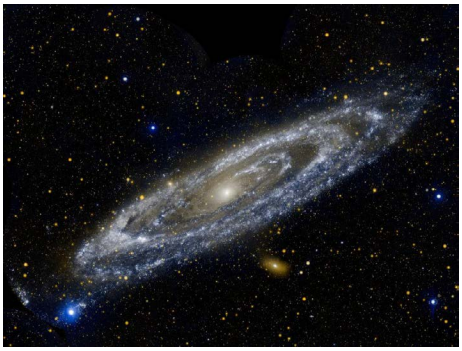
The JSC Astronomical Society

Building an Astronomer's Chair Complete with Sketch Desk and Red Lighting (Part 5 of 7)

Jim Wessel, JSCAS Educational Outreach Chairman

The JSC Astronomical Society (JSCAS)
www.jscas.net

This article is adapted from its first appearance in the December 2010 issue of Starscan, the JSCAS newsletter.



Above: GALEX: The Andromeda Galaxy. Image source: the Astronomy Picture of the Day (APOD), May 18, 2012. Image credit: GALEX, JPL-Caltech, NASA.

This Issue: Building a sketch desk and the decision of paint.

Even Rembrandt needed an easel…

I really enjoy drawing what I see through the eyepiece. In my pursuit of this facet of my hobby, I have learned that using a clipboard isn't ideal for recording my observations, and a little more room to spread out will help me a lot. The idea of a sketch desk was not something I originally set out to make, and it sort of naturally fell into place as a logical extension of the armrests. One afternoon, I was sitting in the built out chair, remarking to John that it 'just felt right', and that the only thing I was missing was a way to make my drawing effort easier. I reached out, grabbed a reasonable piece of plywood, held it at an angle that seemed comfortable to rest my forearms against, and poof, the initial concept of the sketch desk was born. Please be aware that I can't provide accurate measurements of any of the wood parts of the sketch desk as a definitive plan for interested do-it-yourselfers, as it is completely contingent on your particular chair and its respective armrests. The following description should be taken as a representative method for building your own desk and any measurement I may give is unique to my own situation.

That original piece of scrap plywood actually turned out to be the large flat surface of the desk, with a few minor modifications, of course. As it has occurred time and time again through this project, John just happened to have some Plexiglas lying around that would work just fine as a hard smooth writing surface. A very meager amount of scrap 1" x 6" and 2" x 4" provided the basis for the side supports and the underside structurally bracing ribs. John also had the needed wood screws in his workshop, so the only thing I was out of pocket on was the small screws needed to secure the Plexiglas to the plywood and the final overcoat of paint. If you decide to build your own version of a desk, I included a reasonable approximation of the costs in the parts breakdown earlier in this description.

The first thing necessary is that the piece of plywood be wider than the width of the armrests so that it can span the gap between them. The armrests on my chair are 21.5" apart to the external edges (18.5" to internal edges), and the top of the desk is just under 24" wide (and about 15"deep), so this detail is covered. Here in southeastern Texas, with our nearly perpetually cloudy summertime skies, most of my observing is in the somewhat cooler months. Any seasoned observer will remark that if you are cold, you are going to be uncomfortable, and likely shorten your observing. To prevent this, you wear layers of clothing or a heavy coat, and those items have a volume associated with them, which in turn, makes your circumference larger. If you are larger around, you have to extend your arms further to reach. To help counter this problem, John and I elected to cut a notch out of the edge of the sketch deck (and the corresponding Plexiglas edge) that would normally rest against my abdomen. The picture below shows the top of the desk with the screws securing the Plexiglas, and the notch removed.

The final, comfortable angle for the total sketch desk assembly was conceptualized in much the same manner as was previous-

Continued on page 28

Continued from page 28

ly described in the section for determining the armrests' height. After that angle was decided upon, what would become the two pairs of side pieces of wood were cut at the desired angle and heavily sanded. It's important to do a good job of sanding here, because doing so will reduce the chance of marring the surfaces of the armrests. In fact, I have taken this one step further, and put the soft part of some Velcro stripping (with adhesive on the other side) on this wood to protect the armrests even more (the picture of Velcro placement is not shown). The following close-up picture shows the side design better than I can explain in words.

The next image shows the total underside of the desk with the side supports and the cross braces. All of this wood was connected together with finishing nails and wood glued to the underside of the plywood that forms the desktop. The distal pieces of wood are the aforementioned 1 x 6s. Taken together, they form the side edges of a shell that fits over and to the outside of the armrests, and ultimately prevents the desk from moving side to side. The two interior pieces of wood, just proximal to the larger outside 1 x 6s, are the pieces of wood that actually rest directly onto the upper surface of the armrests. Care was taken so that the position of the cross brace was placed so that it's closest edge did not break the plane of the two pieces of wood that rest on the armrests, otherwise over time you would end up scalloping the inside edge of your armrests. A second cross bracing piece forms the front edge of the sketch desk.

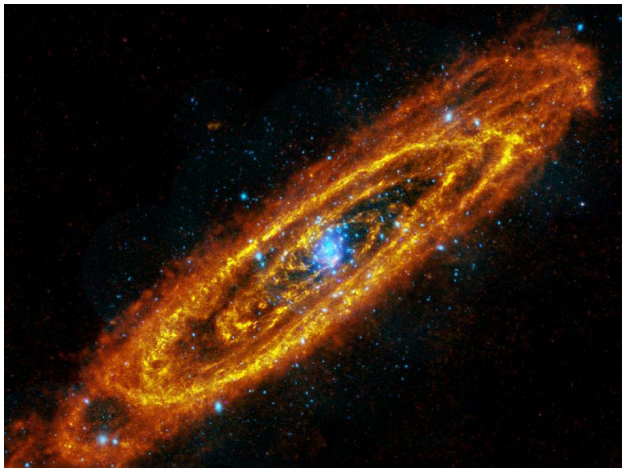
The sketch desk is rigid, light (about 5 lbs), fits my chair perfectly, and is totally functional for my needs as a beginning astronomical sketcher. A three quarters view of the completed sketch desk, in its typical position on the armrests is seen in the image below. The careful observer will notice the reflectivity of the Plexiglas writing surface. What is not shown in the picture are the later additions of an screw eye and rope to the side of the desk (used to retain the desk while entering or exiting the chair), a modified clipboard holder to keep my log sheets held in place, and my post-construction lighting system for the illuminating the writing surface.

To paint, or not to paint?
That is the question.

My original intent was to give the wood a nice rich stain to accentuate the inherent grain. After seeking a few external opinions, I was convinced that paint was a better choice. I settled on a high quality exterior latex, and actually carried the boat seat into the paint store to get the best match possible. Two thick coats later, and all the wood surfaces almost identically match the lighter grey color of the seat. John had on hand a can of rust inhibiting metal paint to be used as a primer, and I purchased a black satin rust inhibiting paint to act as a sealant. This was used almost exclusively for the metal that formed the supports for the armrests. I decided that I would go ahead and paint over the pipe floor fittings, and the protective metal channel and 90° angles, knowing that it would have to be periodically touched up due to abrasion between the hanging footrest and the edges of the plywood legs. The sketch desk was painted as well. Since the lighting system was constructed after the painting was completed, I had a series of minor touch-ups to the painting afterwards.

Next Issue:
A Red LED lighting system.

JSCAS articles continue on the next page



Above: Andromeda's Once and Future Stars (Christmas 2010)

Two European Space Agency observatories combined forces to show the Andromeda Galaxy in a new light. Herschel sees rings of star formation in this, the most detailed image of the Andromeda Galaxy ever taken at infrared wavelengths, and XMM-Newton shows dying stars shining X-rays into space.

ESA's Herschel and XMM-Newton space observatories targeted the Andromeda Galaxy, the nearest large spiral galaxy, which like our own Milky Way contains several hundred billion stars. This is the most detailed far-infrared image of the Andromeda Galaxy ever taken and clearly shows that more stars are on their way.

In this image, Herschel's infrared image of the Andromeda Galaxy shows rings of dust that trace gaseous reservoirs where new stars are forming and XMM-Newton's X-ray image shows stars approaching the ends of their lives. Both infrared and X-ray images convey information impossible to collect from the ground because these wavelengths are absorbed by Earth's atmosphere.

For more information and images, visit the ESA site.

Image credit: ESA/Herschel/PACS/SPIRE/J.Fritz, U.Gent/XMM-Newton/EPIC/W. Pietsch, MPE

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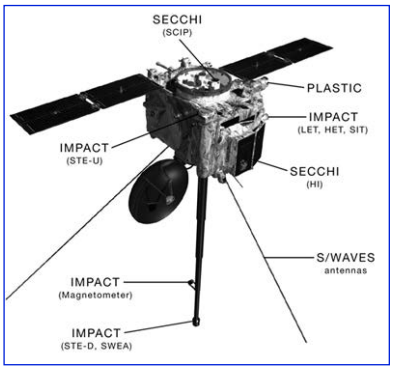


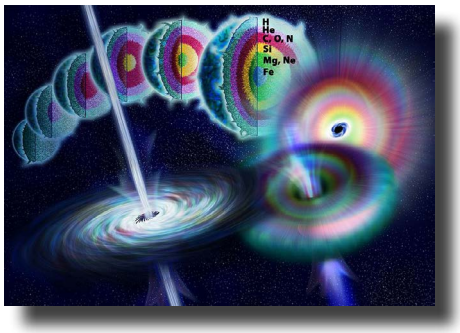
Right: STEREO (Solar TErrestrial RElations Observatory), a solar observation mission. Two nearly identical spacecraft were launched in 2006 into orbits around the Sun that cause them to respectively pull farther ahead of and fall gradually behind the Earth. This enables stereoscopic imaging of the Sun and solar phenomena, such as coronal mass ejections. ***Mission Profile****: The 2 spacecraft launched on Oct. 26, 2006 from Cape Canaveral Air Force Station on a Delta II 7925-10L launcher into highly elliptical geocentric orbits. The apogee reached the Moon's orbit. On Dec. 15, 2006, on the 5th orbit, the pair swung by the Moon for a gravitational slingshot. Because the 2 spacecraft were in slightly different orbits, the "ahead" (A) spacecraft was ejected to a heliocentric orbit inside Earth's orbit while the "behind" (B) spacecraft remained temporarily in a high Earth orbit. The B spacecraft encountered the Moon again on the same orbital revolution on Jan. 21, 2007, ejecting itself from Earth orbit in the opposite direction from spacecraft A. Spacecraft B entered a heliocentric orbit outside the Earth's orbit. Spacecraft A will take 347 days to complete 1 revolution of the sun and Spacecraft B will take 387 days. The A spacecraft/sun/earth angle will increase at 21.650 degree/year. The B spacecraft/sun/earth angle will change −21.999 degrees per year. Image credit: NASA via Wikipedia. Caption credit: Wikipedia.*

JSC Astronomical Society (JSCAS) Calendar
Upcoming Items from the JSCAS Calendar (Copied on February 25, 2014)

JSCAS meetings are held on the second Friday of every month at 7:30 PM in the auditorium of the USRA building (almost always at this location): 3600 Bay Area Blvd, at the SW corner of the intersection with Middlebrook Drive.

2014

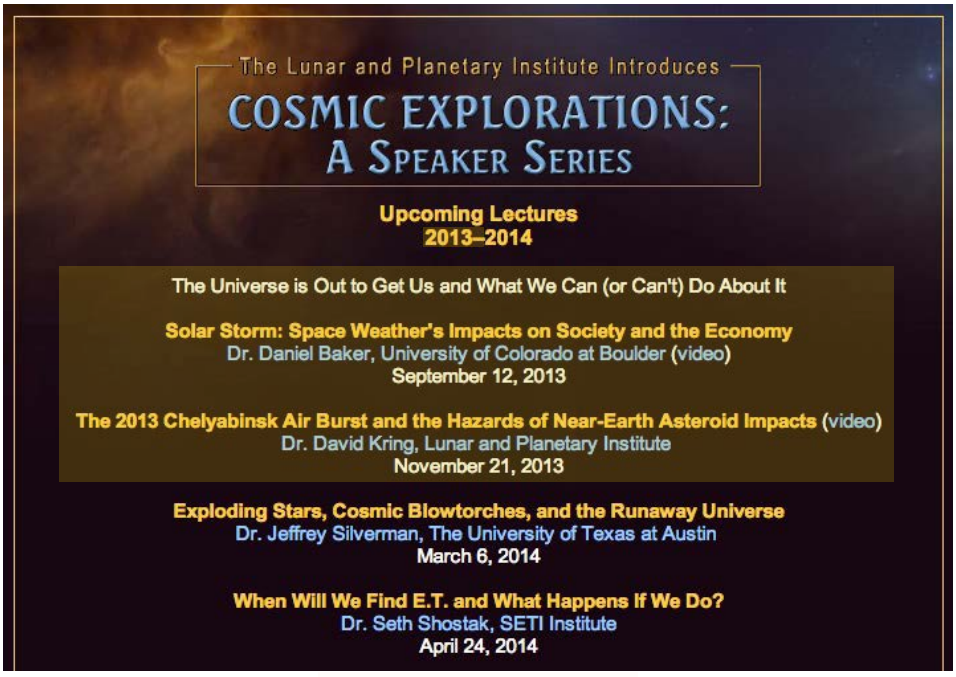
March 14:	Annie Wargetz. Subject: Solar TErrestrial RElations Observatory (STEREO), a NASA solar observation mission
March 27 - 30:	JSCAS trip to Fort McKavett
April 11, 2014:	Paul Maley. Subject: to be announced
May 9:	Dr. Stanley Love. Subject: to be announced
May 25 - June 1:	Texas Star Party
June 13:	Dr. David Talent. Subject: to be announced



Above: Drawing of a massive star collapsing to form a black hole. Energy released as jets along the axis of rotation forms a gamma ray burst that lasts from a few milliseconds to minutes. Such an event within several thousand light years of Earth could disrupt the biosphere by wiping out half of the ozone layer, creating nitrogen dioxide and potentially cause a mass extinction. 12 September 2005. See the 2005 National Science Foundation Press Release 05-156: Gamma-Ray Burst Smashes a Record. Image source: Wikipedia. Image credit: Nicolle Rager Fuller of the NSF.

Below: Education and public outreach from the Lunar and Planetary Institute includes "Cosmic Explorations: A Speaker Series."

http://www.lpi.usra.edu/education/lectures



Speaker Series Archive


esa
rosetta
→ RENDEZVOUS
WITH A COMET
www.esa.int
European Space Agency

France Celebrates Naming of its First International Dark Sky Reserve

Philippe Mairet, 3AF MP and Douglas Yazell, Editor

TUCSON, AZ, AND
TOULOUSE, FRANCE,
19 December 2013: *www.darksky.org*

The International Dark-Sky Association (IDA) announced today the designation of the first International Dark Sky Place in France. In naming the Pic du Midi International Dark Sky Reserve (IDSR), IDA is pleased to recognize the immense local efforts to preserve and protect the exceptionally dark night skies over the Pyrénées Mountains.

"In creating the Reserve, the Pic du Midi team has not only protected a vanishing resource, they have made it better than it was," said IDA Executive Director Bob Parks. "We commend and celebrate their exceptional efforts."

The new Dark Sky Reserve will be known in France as Réserve Internationale de Ciel Étoilé du Pic du Midi. It is located in a region that currently draws 1.5 million visitors per year. Consisting of 1,202 square miles (3,112 km2) of public and private lands, it encompasses a UNESCO World Heritage Site (Pyrénées-Mont Perdu) and a French national park (Pyrénées National Park). It is the second-largest International Dark Sky Reserve in the world after Aoraki Mackenzie International Dark Sky Reserve in New Zealand.

Pic du Midi Observatory

The efforts leading to today's designation began in the 1990s when Europe nearly lost one its premiere astronomical research facilities, the Pic du Midi Observatory. As government budget cuts threatened permanent closure, Observatory supporters secured its renaissance through a "beautiful alliance between science and tourism," according to Daniel Soucaze des Soucaze, Ex- ecutive Director of Pic du Midi. He said the International Dark Sky Reserve designation repre- sents an "important milestone" in the history of the Observatory, and believes IDA's recognition coupled with the dedicated support of local communities greatly enhances the Observatory's long-term prospects.

Achieving this designation "is of utmost importance for the future of astronomy, both profes- sional and amateur," said Hubert Reeves, Québécois astrophysicist and Director of Research at the French National Centre for Scientific Research.

Energy Savings, Tourism, and Research

The motivations driving the four-year effort culminating in today's announcement expanded well beyond aesthetic and scientific considerations. According to French Senator François Fortassin, the "first aim" of the project was to minimize light pollution around Pic du Midi Observatory, but it soon became apparent there was much more to be gained.

As part of the efforts to achieve IDA recognition, a total of 251 communities adopted a compre- hensive outdoor lighting management plan (LMP) that included retrofits and replacements of ex- isting lighting fixtures, and the use of new lighting technologies. By 2013, early results showed the LMP could effectively reduce light pollution in the region by 85 percent and energy usage by 38 percent, all while maintaining safe lighting levels for residents and visitors.

The new lighting plan continues to provide "significant energy savings and offer economic de- velopment opportunities in the Hautes-Pyrénées area," said Christian Poncet, Regional Repre- sentative of the French power company Électricité de France.

The region is capitalizing on the IDA designation as a means of furthering re-

Continued on next page

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search into land use policy and practices, tourism business models, and resources sustainability at the nearby Univer- sity of Pau and Pays de l'Adour. A team has been designated by the University to manage the Pic du Midi IDSR project and to install and maintain scientific instruments in the Pic du Midi region to monitor the quality of the night sky in the future.

Officials at Pic du Midi have even grander aspirations for preserving dark skies in the Pyrénées. In coming years, they plan to work with their Spanish counterparts to expand the protected territory into Spain, making for the first IDA Dark Sky Reserve spanning two nations.

Images

Pic du Midi RICE Logo (French):
http://bit.ly/1keC0TS

Photographing the Milky Way near the village of Aulon, France (Credit: Nicolas Bourgeois / Pic du Midi):
http://bit.ly/1keBu8k

Star trails over Pic du Midi Observatory (Credit: Paul Compère / Pic du Midi):
http://bit.ly/1keApxq

Video: "Timelapse at the Pic du Midi Observatory" (credit: Romain Montaigut, romain- montaigut.fr):
http://vimeo.com/76724488

About the
IDA Dark Sky Places Program

IDA established the International Dark Sky Places conservation program in 2001 to recognize excellent stewardship of the night sky. Designations are based on stringent outdoor lighting standards and innovative community outreach. Since the program began, five communities, thir- teen parks and five reserves have received International Dark Sky designations. For more infor- mation about the International Dark Sky Places Program, visit http://darksky.org/night-sky- conservation/34-ida/about-ida/142-idsplaces.

About IDA

The International Dark Sky Association, a 501(c)(3) non-profit organization based in Tucson, Arizona, advocates for the protection of the nighttime environment and dark night skies by edu- cating the policymakers and the public on the subject of night sky conservation and promoting environmentally responsible outdoor lighting. More information about IDA and its mission may be found at http://www.darksky.org

END

Horizons

A related article about light pollution and the Pic du Midi starts on page 27 of our April 2008 *issue* of Horizons and is continued starting on page 40 of our June 2008 *issue*. That article is titled *Constellation Earth*, and its author is Michel Bonavitacola of *3AF MP*, our French sister section. The 3AF MP organization chart is presented on a later *page* in this issue of Horizons.

More IDA News

NEW MEXICAN SKIES
PROTECTED WITH
DARK SKY PARK DESIGNATION

28 August 2013. TUCSON, AZ – The 34,000-acre Chaco Culture National Historical Park is home to many ancient wonders including the remains of a civilization that thrived over 1,000 years ago. The park, which has been protecting its archaeological riches since it was established in 1907, is now protecting its views of the starry skies too. It has just been named as the International Dark-Sky Association's newest Dark Sky Park.

Lunch-and-Learn

Global Warming Effects on Human Infrastructure, by John M. DiIorio

BeBe Kelly-Serrato, Chair, AIAA Houston Section Space Operations technical committee

On November 13, 2013, our technical committee hosted a lunch-and-learn presentation on Global Warming Effects (GWE) by Quality Engineering (QE) consultant John M. DiIorio.

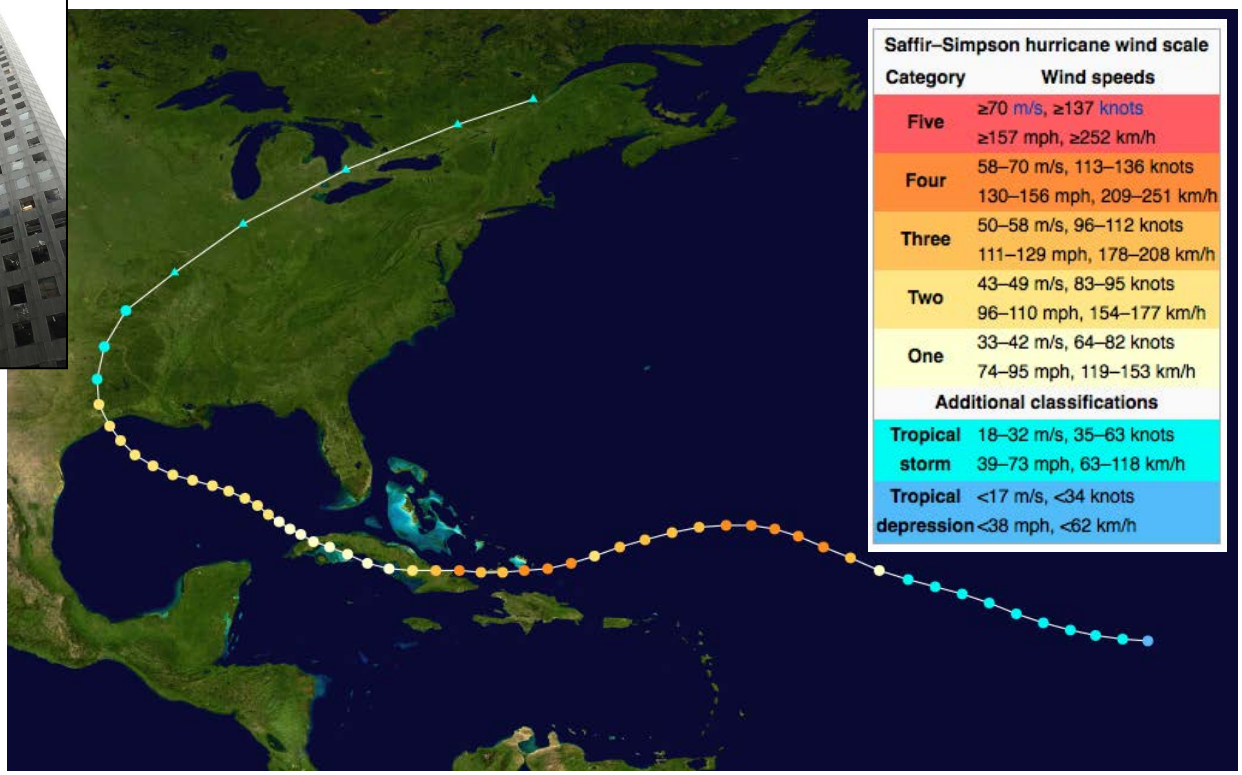
Mr. DiIorio opened his presentation with bridge structures. Examples included the Tacoma Narrows Bridge, I-280 suspension bridge, and the I-35 bridge.

The next part of the presentation focused on "Windows (Hurricane Ike, High-rises, and Skyscrapers)." Videos highlighted Hurricane Ike damage. The videos demonstrated that quite a lot of glass in downtown Houston shattered or blew out due to wind pressure, more glass than anyone anticipated, because the building-wind interaction created a vortex, allowing the glass breakage to occur due to wind tunnel effects [with tall buildings serving as the walls of a giant wind tunnel]. It is ironic and unfortunate that these buildings were hurricane Category 2-certified, but the damaging effects of Ike (a Category 2 hurricane) were those of a Category 4 storm. [The Saffir-Simpson hurricane wind scale is *described* in a Wikipedia article.]

The final segment of Mr. DiIorio's presentation provided measurements for CO2, methane, and magma, all of which impact GWE and, more generally, climate change effects. Mr. DiIorio explained that GWE result in a compelling threat for sea life, agriculture, plants, and animals (including domestic animals, birds, and fresh water fish). With this in mind, it was noted that 20% to 40% of our food sources come from these groups.

Mr. DiIorio encourages us to understand that GWE are problems with solutions, and humankind is responsible for the care of our life zone.

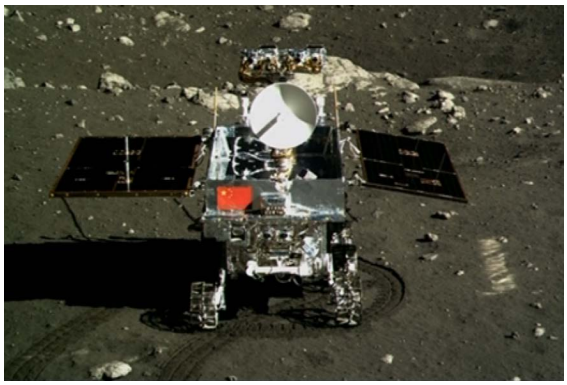
Above: Damage to the JP Morgan Chase Tower after Hurricane Ike, Houston, Texas. September 13, 2008. Image credit: Adam Baker.



Above: Hurricane Ike (2008) track using the Saffir-Simpson Hurricane Scale. Image credit: Potapych. Scale insert: Image credit: Wikipedia.

Chang'e 3

[Wikipedia] Chang'e 3 is a lunar exploration mission operated by the China National Space Administration (CNSA), incorporating a robotic lander and China's first lunar rover. It was launched in December 2013 as part of the second phase of the Chinese Lunar Exploration Program.
The spacecraft was named after Chang'e, the goddess of the Moon in Chinese mythology, and is a follow-up to the Chang'e 1 and Chang'e 2 lunar orbiters. The rover was named Yutu (literally "Jade Rabbit") following an online poll, after the mythological rabbit that lives on the Moon as a pet of the Moon goddess.
Chang'e 3 achieved lunar orbit on 6 December 2013 and landed on 14 December 2013, becoming the first probe to soft-land on the Moon since Luna 24 in 1976.
Image credit: CNSA and CCTV via NASA.



Marlo Graves (in Houston) is the contact person for the Chinese sister section of AIAA Houston Section, in Shanghai since 1987. Marlo later added Beijing to our sister section activity.

ESA Promises Orion Launch Date Will Not Slip Due To Its Work

[AIAA Daily Launch] Space News (1/18, de Selding, Subscription Publication) reported that the ESA has "promised" NASA that issues with its contribution to the Orion capsule will not cause the vehicle's 2017 unmanned launch to slip, even though the preliminary design review for the work is almost a year behind schedule. ESA Director-General Jean-Jacques Dordain, who made the statement, also "insisted" that the decision to team with Sierra Nevada on the Dream Chaser spacecraft was initiated by Sierra Nevada and will not be used to "tip the scales" of the Commercial Crew Program.

[Wikipedia] The Shanghai Tower is a supertall skyscraper under construction in Lujiazui, Pudong, Shanghai. Designed by Gensler, it is the tallest of a group of three adjacent supertall buildings in Pudong, the other two being the Jin Mao Tower and the Shanghai World Financial Center. Construction work on the tower began in November 2008. Upon its completion in 2014, the building will stand approximately 632 metres (2,073 ft) high and will have 121 stories, with a total floor area of 380,000 m2 (4,090,000 sq ft). It is expected to open to the public in 2015.

Following its topping out on 3 August 2013, the Shanghai Tower is currently the tallest building in China and the second-tallest in the world, surpassed by the Burj Khalifa in Dubai. It is also China's tallest structure of any kind, surpassing the 600-metre (2,000 ft) Canton Tower in Guangzhou. However, if Changsha's planned Sky City, which is planned to reach a height of 838 m (2,749 ft), is completed to plan and on schedule, it will overtake both the Shanghai Tower and the Burj Khalifa in height.

Above: The Shanghai Tower in May (left) and August 2013. Image credits: Wikipedia, TheDarkCurrent (left) and Yhz1221. This was the subject of a recent PBS television show, Super Skyscrapers.

Calendar

All calendar items are subject to change without notice.

Section council meetings (email secretary2013[at]aiaahouston.org)

Time: 5:30 - 6:30 PM usually

Day: First Tuesday of most months except for holidays.

Location: NASA/JSC Gilruth Center is often used. The room varies.

Recent Section Events

25 October 2013, Workshop on Automation & Robotics (WAR), Dr. Zafar Taqvi

7 November 2013, Professional development event, 6:30—8:30 PM, Fuddruckers

13 November 2013, Lunch-and-learn, Global Warming Effects (GWE) on the Operations of Human Infrastructure, by John M. Dolorio, organized by BeBe Kelly-Serrato.

10 December 2013, Lunch-and-learn, Dr. Michael Lembeck, Space 3.0: How to be Successful without Drinking the Kool-Aid

25 January 2014, Annual Mars Rover Event from the University of Houston with Dr. Edgar Bering (not a Section event)

27 February 2014, Dinner meeting, NASA/JSC State of the Center, Deputy Director Kirk Shireman.

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. The author of this 1993 book is Henry C. Dethloff. See that web page for author information and a short bio.

2014 Conferences www.aiaa.org (Events link)

1 - 8 March 2014: Big Sky, Montana, 2014 IEEE Aerospace Conference

1 - 2 March 2014: Sacremento, CA, Region VI Student Paper Conference

12 March 2014: Washington, DC, Congressional Visits Day 2014

24 - 26 March 2014: Lille, France, 49th International Symposium of Applied Aerodynamics

2 - 4 April 2014: Minneapolis, MN, Region V Student Paper Conference

4 - 5 April 2014: Cleveland, OH, Region III Student Paper Confernece

7 - 8 April 2014: Memphis, TN, Region II Student Paper Confernece

15 - 16 April 2014: Arlington, Virginia, NASA MaterialsLAB Workshop

23 April - 25 March 2014: Prague, Region VII Student Paper Conference (Europe)

25 - 26 April 2014: Cornell, NY, Region I Student Paper Conference

25 - 26 April 2014: Albuquerque, NM, Region IV Student Paper Conference

30 April 2014: Washington, DC, 2014 Aerospace Spotlight Awards Gala

5 - 9 May 2014: Pasadena, California, SpaceOps 2014

26 - 29 May 2014: Istanbul, Turkey, 6th International Conference on Research in Air Transportation (ICRAT 2014)

26 - 28 May 2014: St. Petersburg, Russia, The 21st St. Petersburg International Conference on Integrated Navigation Systems

5 June 2014: Williamsburg, Virginia, 2014 Aerospace Today and Tomorrow

16 - 20 June 2014: Atlanta, Georgia, AIAA Aviation & Aeronautics Forum and Exposition (AVIATION 2014)

- 11th AIAA/ASME Joint Thermophysics and Heat Transfer Conference
- 14th AIAA Aviation Technology, Integration, and Operations Conference
- 15th AIAA/ISSMO Multidisciplinary Analysis and Optimization Conference
- 20th AIAA International Space Planes and Hypersonic Systems and Technologies Conference,
- 20th AIAA/CEAS Aeroacoustics Conference
- 21st AIAA Lighter-Than-Air Systems Technology Conference
- 30th AIAA Aerodynamic Measurement Technology and Ground Testing Conference
- 32nd AIAA Applied Aerodynamics Conference
- 44th AIAA Fluid Dynamics Conference
- 45th AIAA Plasmadynamics and Lasers Conference
- 6th AIAA Atmospheric and Space Environments Conference
- 7th AIAA Flow Control Conference
- 7th AIAA Theoretical Fluid Mechanics Conference
- AIAA Atmospheric Flight Mechanics Conference
- AIAA Balloon Systems Conference
- AIAA Flight Testing Conference
- AIAA Modeling and Simulation Technologies Conference
- AIAA/3AF Aircraft Noise and Emissions Reduction Symposium

22 - 27 June 2014: Honolulu, Hawaii, 12th International Probabilistic Safety Assessment and Management Conference

Cranium Crunchers

Dr. Steven E. Everett, Wes Kelly, Shen Ge, & Dr. Albert A. Jackson IV

Mathematics Video Attracts Almost 2 Million Views on YouTube in Less than 2 Months (1 + 2 + 3 + 4 + 5 + 6 + ... = -1/12)

February 20, 2014. *Numberphile* (videos by Brady Haran), supported by Mathematical Services Research Institute (MSRI), placed this *video* on YouTube on January 9, 2014. The speakers are Tony Padilla and Ed Copeland. "... what's even more bizarre, this result is used in many areas of physics!" says Copeland. These two speakers mention the Riemann zeta function. The related Wikipedia *article* mentions this result (-1/12) when analytic continuation is used to extend the domain of this zeta function to negative one. The Wikipedia *article* about this result (-1/12) provides an external link to more *comments* from Padilla and an external link to helpful *charts* from mathematician *John Baez*.

The *Casimir effect* uses the following *result* when this zeta function is *extended* to -3:

$$1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3 + \ldots = 1/120$$

Dr. Jackson mentions the 2003 *book* Prime Obsession by John Derbyshire.

Swept Under Fermat's Rug?

by Wes Kelly

It is noted that $3^2 + 4^2 = 5^2$, *or* $9 + 16 = 25$,
and that this equation describes a commonly used right triangle construction. When we examine this "anecdotal" case in more general terms, some branches of mathematical pursuit result. It can serve as a prelude to the more sweeping considerations of Fermat's Last theorem; that is, that for $a^n + b^n = c^n$ for integers, no positive integers *a, b,* and *c* can satisfy this relation for values of *n* greater than two. We also note that this series can be pursued in another sequential direction:

$3^3 + 4^3 + 5^3 = 6^3$, or $27 + 64 + 125 = 216$.

Sadly, we discover that this sequence does not continue indefinitely either, since

$3^4 + 4^4 + 5^4 + 6^4$ does not equal 7^4.

The general form of the equation above for right triangle construction is often called the law of cosines. It applies to any triangle lying in a plane (to any Euclidean space triangle):

$$a^2 + b^2 - 2\,a\,b\,\cos(C) = c^2,$$

where *a, b,* and *c* are lengths of sides, and *C* is the angle opposite side *c*. Perhaps there are *n*-dimensional analogs to this general form and the sequence above is simply not an orthogonal tesseract? Any takers? *[Please email comments to editor2013@aiaahouston.org.]* Sorry, answers will not be available on Phinney's page - yet. *[That page is a reference to Jack and Jill magazine. Wikipedia states this magazine was created in 1938 and is still in print today.]*

From Shen Ge in our last issue: One day while inspecting workers at the river unloading grain from a boat, a king decided to test his son's intelligence. He asked the boy to measure the weight of an elephant nearby. The only scale available was a small one for weighing sacks of grain. How can this be done?

Solution: The son first asked the workers to lead the elephant into the empty boat. He marked the water line. He then led the elephant out of the boat and loaded the boat with grain sacks until the boat sank to the level marked when the elephant was on board. He directed the workmen to weigh each grain sack he had put into the boat with the same scale. He then counted the total weight of all sacks of grain.

In the last issue, a starship captain was presented with the problem of escaping a faster enemy ship. The captain began with his ship at the center of a 1-light-year radius spherical anomaly, which slowed his speed to one quarter of the speed of an enemy ship waiting on the perimeter of this region.

Obviously making a dash to the edge opposite the enemy's initial position won't work. Assuming the captain's velocity is *v*, traveling over the radial distance of 1 light year, he traverses it in a time of *v*, which is greater than the time, $(\pi/4)/v$, the enemy would have taken to get there.

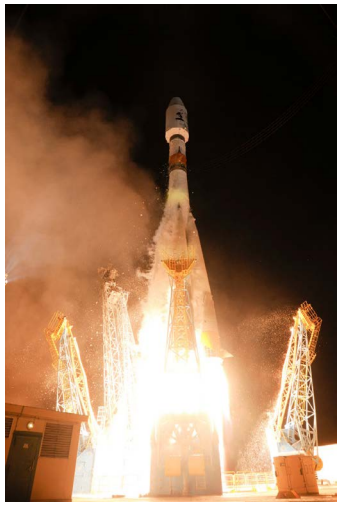
First, we need to calculate a position for which, by travelling radially, he would get to the perimeter quicker than the enemy can reach him. That distance *d* from the edge can be computed by equating the time it takes for his journey and that of the enemy, so that $(\pi/4)/v = d/v$, so *d* is $\pi/4$ light years, or 0.7854 light years. If he starts his journey to the edge of the region from a point any closer to the center, the enemy can arrive at the edge first.

The next task is figuring out how to get to that starting point. Since the captain starts out at the center of the region, as he moves outward, he can move in tight circles and travel circumferentially faster than the enemy can on the perimeter of the region. In fact, given that the enemy's speed is $(1/4)*v$, the captain can exceed the speed of the enemy in that direction until he is at a radius of (1/4) light year. Since that radius is at a distance of 0.75 light years from the edge, which is less than the distance 0.7854 light years needed to beat the enemy to the edge, the captain's strategy is to spiral out to at least the distance of 0.2146 light years from the center of the region, keeping the enemy on the opposite side, and then race to the edge, being sure of escape.

Congratulations to Stephen Schuyten, who suggested this same strategy on December 31, 2013! *[Steve Everett]*

Section News

Gaia is an unmanned space observatory of the European Space Agency (ESA) designed for astrometry. The mission aims to compile a 3D space catalogue of approximately 1 billion astronomical objects (approximately 1% of the Milky Way population) brighter than 20 G magnitudes, where G is the Gaia magnitude passband between about 400 and 1000 nanometers light wavelengths. Successor to the Hipparcos mission, it is part of ESA's Horizon 2000 Plus long-term scientific program. Gaia will monitor each of its target stars about 70 times over a period of five years. Image credits: NASA and ESA. Caption credit: Wikipedia.



Association Aéronautique et Astronautique de France (3AF)

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

3AF Association Aéronautique Astronautique de France

Midi-Pyrénées

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www.3af-mp.fr

Left: The International Space Station (ISS). Image credit: NASA, STS-132, December 22, 2008.

February 26, 2014:

Who is on the International Space Station now?

Expedition 38

November 2013 - March 2014

- Mikhail Tyurin
- Koichi Wakata
- Rick Mastracchio
- Sergey Ryazanskiy
- Oleg Kotov
- Mike Hopkins

The American Institute of Aeronautics and Astronautics (AIAA)

AIAA HOUSTON SECTION

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July 01, 2013 - June 30, 2014

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Downloaded December 22, 2013

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Updated August 14, 2013 , Executive Council Voting Members (20) are identified by:

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

Above: Image credit: Rice University

AIAA Region IV Student Paper Conference, April 24-26, 2014

Dr. Gary Turner, AIAA Houston Section College and Co-Op Chair (Event Venue: Albuquerque, New Mexico)

SAVE THE DATE!

The 2014 AIAA
Region IV Student Paper Conference

This event is gearing up. This year we will be in Albuquerque, NM on April 24-26, 2014. Details will be posted here as they become available.

The Student Paper Conference provides students from the region with an opportunity to present their research in a conference environment and to network with other students and professionals from around the region while competing for the coveted "Best Paper" awards.

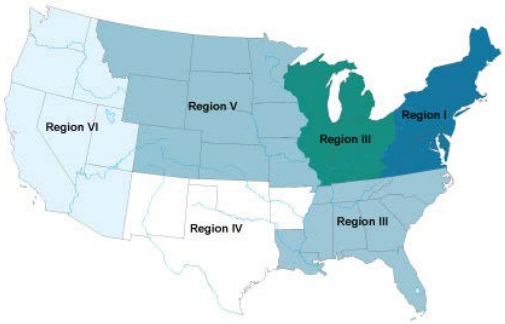
Registration is not yet open, but with the conference so far away this year, we are encouraging our student sections to plan ahead. Now is a good time for all students to be thinking about whether they would like to attend, what they would like to present, and how to go about getting research ready for presentation.

Traditionally in Region IV we provide a travel stipend to students attending the conference. The conference has usually been held somewhere in the Texas triangle, and travel distances have been relatively short for students in the Houston area. This year, with the additional travel distance, expenses are going to be much higher and we are going to look much harder for the financial support to cover travel. It would be useful in our search for sponsorship to have an early idea of how many students are planning to attend. If you know that you are likely to attend, please drop an email to *collegecoop2013@aiaahouston*.

Now is also a good time for students, particularly those veterans of previous conferences, to be thinking about what they want to get out of the conference. Any ideas at this point - what has worked or failed to work in the past, what has been missing in the past, any suggestions at all - will be forwarded to the planning committee as we try to make this the best possible experience for the region's students. Please, be creative, and send your ideas to *collegecoop2013@aiaahouston.org*.

Above: Albuquerque, New Mexico. Image source. Wikipedia. Credit: Daniel Schwen

Above: Image credits: Rice University in Houston.



Right: Albuquerque. Image credit: Wikipedia.

Student Section News
Please send inputs to Dr. Gary Turner, our College and Co-Op Chair: collegecoop2013[at]aiaahouston.org.

Student Section News

Faculty advisor: Professor John E. Hurtado
jehurtado[at]tamu.edu, 979-845-1659.
http://stuorg-sites.tamu.edu/~aiaa/

TEXAS A&M UNIVERSITY

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See the prior page for an announcement about the 2014 AIAA Region IV Student Paper Conference.

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Freshman Class Rep.	Farid Saemi	farid.saemi [at] gmail.com

Right: Rahul Venkatraman, Chair
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," from Dr. Kalpana Chawla, NASA Astronaut

TEXAS A&M UNIVERSITY CODEMAROON

Texas A&M University Climate Change Experts

Texas A&M University TAMU Times *article*, September 26, 2013, adapted here from the article

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[The AIAA student section is not associated with climate change studies, but climate change is a subject of interst for AIAA and NASA.]

Student Section News
Please send inputs to Dr. Gary Turner, our College and Co-Op Chair: collegecoop2013[at]aiaahouston.org.

AIAA Houston Section
P.O. Box 57524
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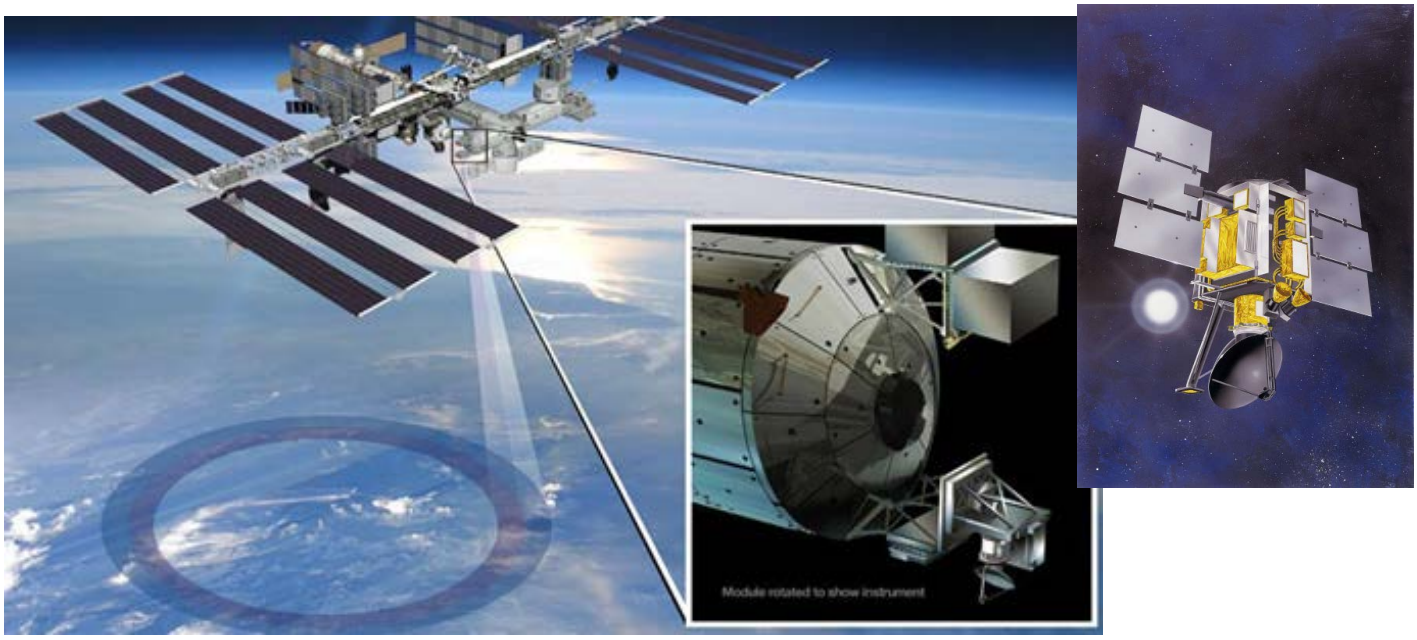
The American Institute of Aeronautics and Astronautics

The Back Cover Feature Article

Climate Change & NASA's QuikScat & RapidScat



Above: RapidScat is a spacecraft to be launched for NASA in 2014 by SpaceX. Four ISS resupply flights are planned by SpaceX for 2014. It will be attached to the International Space Station (ISS). We found this news as we looked at the NASA climate website, Global Climate Change: Vital Signs of the Planet. We noticed the Houston connection (ISS).

Above: Artist's rendering of NASA's ISS-RapidScat instrument (inset), which will launch to the International Space Station in 2014 to measure ocean surface wind speed and direction and help improve weather forecasts, including hurricane monitoring. It will be installed on the end of the station's Columbus laboratory. Credit: NASA/Jet Propulsion Laboratory/Johnson Space Center.

Above right: Quicksat mission summary: The Quick Scatterometer, or QuikScat, is an Earth satellite designed to provide valuable data on ocean winds that revolutionized environmental predictions and weather forecasting. Designed as a speedy replacement for the Japan Aerospace Exploration Agency's Advanced Earth Observing Satellite-1 and its NASA Scatterometer instrument, QuikScat was conceived, developed and launched in less than two years. The satellite is part of NASA's Earth Observing System monitoring global climate change and was designed as a two-year mission, but spent 10 years in operation until it stopped collecting wind data in 2009 due to an age-related failure of a mechanism that spins the scatterometer antenna. The data QuikScat collected has become such an intrinsic piece of weather predictions, including hurricane monitoring, that NASA has quickly begun preparations to launch a replacement instrument to the International Space Station in 2014. The new instrument, called ISS-RapidScat, was conceived with hardware originally built to test parts of QuikScat to allow the agency to cost-effectively and quickly put the replacement instrument in orbit.

AIAA Mission and Vision Statement

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