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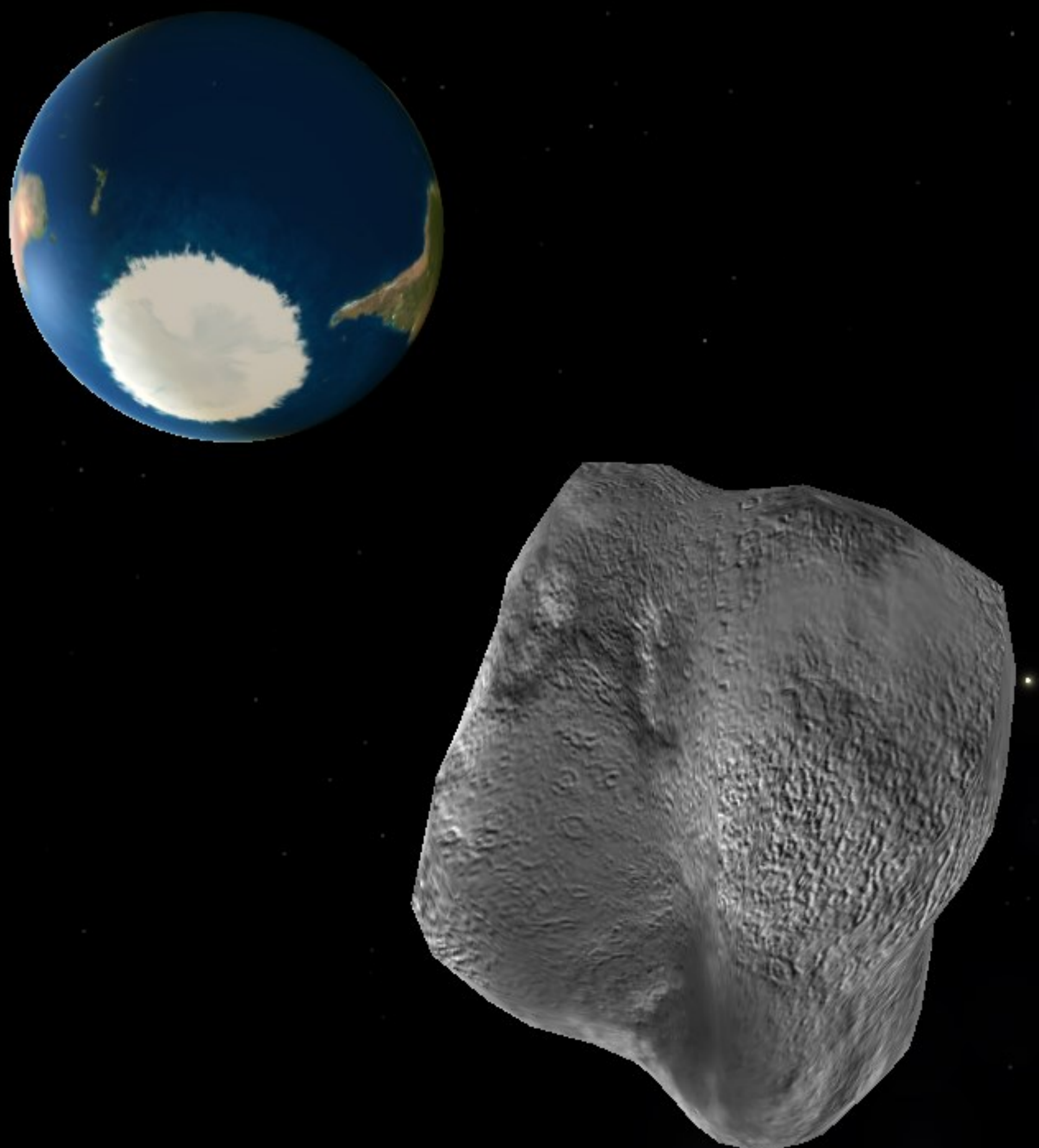
Potentially Hazardous Object (PHO) 2013 TV_{135}

Daniel R. Adamo, Astrodynamics Consultant



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Cover: This view of a cloudless Earth at 06:01 UT on 26 August 2032 is from an altitude of 70,300 km. In the foreground is a hypothetical asteroid 400 m across on a trajectory which will graze Earth's atmosphere at an altitude of 42 km in just under two hours (see the Leading Graze trajectory in Figure 3 of the story starting on page 5). This asteroid is in an orbit about the Sun very similar to that of small body 2013 TV_{135}, but implausibly behind current best estimates of 2013 TV_{135}'s position nearly 19 years from now. Image credit: Daniel R. Adamo & Celestia. This page: the 1889 van Gogh painting The Starry Night.

The International Space Station—15 Years in Orbit

Chair's Corner

Michael Frostad, Chair

The International Space Station (ISS), a hub for current human exploration science, has just celebrated its 15th anniversary. For any child born after November 2000, they have never known a time in which there have been no humans in space! This is truly an amazing feat of humanity and it is due to the dedication and work of those here on the ground that makes it happen. It is the coordinated efforts of those on the ground and those in space that insure the ISS is continually supplied, continues to function, and continues to explore.

This year alone the ISS has been visited by six resupply vehicles, with one more targeted for late December. In addition, there have been four Expeditions launched to the ISS, each with three crew members trained for years to maintain the space station, perform the science experiments on orbit, and to do direct educational outreach from the orbiting platform. By the end of this year the ISS will have been visited by 10 spacecraft from Russia, Japan, Europe, and the United States.

But what of the science being performed on the ISS? In the field of physics, earlier this year the Alpha Magnetic Spectrometer (AMS) made headlines. It was announced that over two years AMS had counted billions of particles, both electrons and positrons. Upon analysis of the data, it was shown that the data backs the idea of positrons coming from the destruction of dark matter, but it does not conclusively rule out other explanations (yet). Data collection by the AMS continues. The more we know of how the universe works, the more we can explore it, harness it, and ensure humanity's future.

On the human physiology side, research continues on muscle and bone mass of astronauts and cosmonauts, but an increasing amount of attention is being given to eyesight. It has been shown that about 60% of astronauts have had varying levels of vision impairment due to extra pressure on the eyes from fluid redistribution in the body in microgravity. (Astronaut vision returned to normal upon returning to Earth.) Continuing to monitor the eyes of the ISS crew, in addition to other organs and bodily functions, will build the data sets necessary to develop effective countermeasures. If we are to do long duration microgravity spaceflight, understanding these effects will be of paramount concern. This will be a major part of the upcoming year-long stay of astronaut Scott Kelly and Cosmonaut Mikhail Kornienko in 2015. This data cannot currently be obtained anywhere else. The ISS is an essential component for addressing these issues and thus the future of human spaceflight.

From the science mentioned above, the ISS can be seen to perform an essential role for the future of human spaceflight. The science being performed on the ISS is building up our knowledge of the human body and helping us to build a clearer understanding of the universe and our place in it. The more we understand our place in this universe and how we ourselves react to its many environments the better we will be prepared for the future. This research, in addition to other ISS research projects not mentioned here, is not just for human spaceflight, but for the future of humanity.

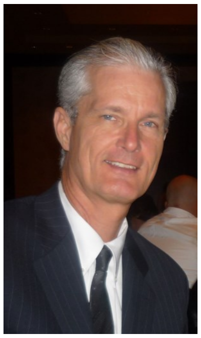
So as we take a moment to celebrate 15 years of the ISS in orbit, let us also say to all those who have worked on the ISS and those that continue to do so, "Congratulations on 15 years of successful operation, thank you for your hard work, and we look forward to the next discovery!"

Image credit: NASA. Image source: www.enjoyspace.com, the website of la Cité de l'Espace.

From the Editor

Asteroid Trackers, Mars Rovers, and Moonwalkers

Douglas Yazell, Editor



Our cover story by Dan Adamo ("asteroid tracker") is a great start for this issue. We now return to our bimonthly schedule after delays since April of this year. This issue will be online and publicized by December 10, 2013, completing our work on three issues in three months. Our next issue will be online by February 28, 2014.

Dr. Larry Friesen and Dr. Dorothy Oehler volunteered excellent articles for this issue, just in time after our busy few months. In fact, Oehler's article ("about a Mars rover") is adapted from her cover story for the Planetary Report, the magazine of the Planetary Society. Friesen's article (about the Golden Spike Company, including "their future Moonwalkers") is adapted from his article for the Moon Miner's Manifesto.

Ryan Miller joined our Horizons team, as noted on the masthead on page 2. When he was living in Philadelphia, he was editor for that Section's newsletter.

Our masthead now shows that Wes Kelly joined our Horizons team as a regular contributor, after writing occasional Horizons cover stories and feature articles. For this first installment of his proposed column, we used his comments from some recent email notes among his friends. He also suggested that we start a Horizons LinkedIn professional group or discussion group, so that is now working. Please join us there often with your comments.

Dr. James Everett of the Johnson Space Center Astronomical Society (JSCAS) continues allowing us to reprint his series of articles about building an astronomy chair. Dr. Stanley G. Love allowed James Everett and me to create an article about Love's November 2013 presentation at the monthly JSCAS meeting. Love described his 2012-2013 Antarctic search for meteorites.

Back in 2004 or 2005 Jon Berndt started his tenure as Horizons Editor. He used Microsoft Publisher to create the format will still use today. He taught me to use that software in a single long training session of one or two hours in late 2007. I was acting Editor for three issues in 2008. I started my tenure as Horizons Editor on April 11, 2011.

This format for Horizons is excellent, but no format should remain the same for so long. If all goes well, I will learn to use Adobe InDesign for Horizons starting with our next issue. That is the industry standard. It allows more variety in output formats. I first heard about it when the American Astronautical Society (AAS) started using it for their excellent magazine, Space Times.

Now that we are returning to our bimonthly schedule, a quarterly schedule is not tempting, but a monthly schedule is tempting. Maybe the best idea is to produce an occasional special issue, such as our Section's 50th anniversary issue.

A reprint of the entire 1952-1954 Collier's series, about 89 pages (Man Will Conquer Space Soon!) is one project on our minds, but Scott Lowther might create that. Scott is a Horizons columnist (Aerospace Projects Review, APR Corner) and a Horizons Collier's team member.

Another idea for a special issue is climate change, a subject of interest for NASA and AIAA. President Obama is also addressing this subject.

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Submissions deadline:
February 7, 2014, for the January / February 2014 issue (online by February 28, 2013).

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Above: The Boeing Way alligator in the Bay Area Blvd ditch in November of 2013. The ditch contains fish, bullfrogs (at least one) and turtles, and it attracts birds such as Kingfishers (at least one) and egrets. In the picture, the alligator is enjoying the sunlight and going fishing at the same time. Image credit: Douglas Yazell.

Potentially Hazardous Object (PHO) 2013 TV$_{135}$

Cover Story

DANIEL R. ADAMO, ASTRODYNAMICS CONSULTANT

1. Introduction

On 8 October 2013, near-Earth object (NEO) 2013 TV$_{135}$ was discovered at the Crimean Astrophysical Observatory in Ukraine[1]. Heliocentric motion of 2013 TV$_{135}$ from August 2013 through nearly one orbit period to May 2017 is plotted in Figure 1[2]. Note how this NEO was closest to Earth in mid-September, weeks before its discovery. Because closest approach was inside Earth's orbit, however, observing 2013 TV$_{135}$ was difficult at that time. From 1 September until 10 October 2013, 2013 TV$_{135}$ was less than 100° from the Sun in Earth's sky, but minimum solar elongation was an observable 77.3° on 18 September.

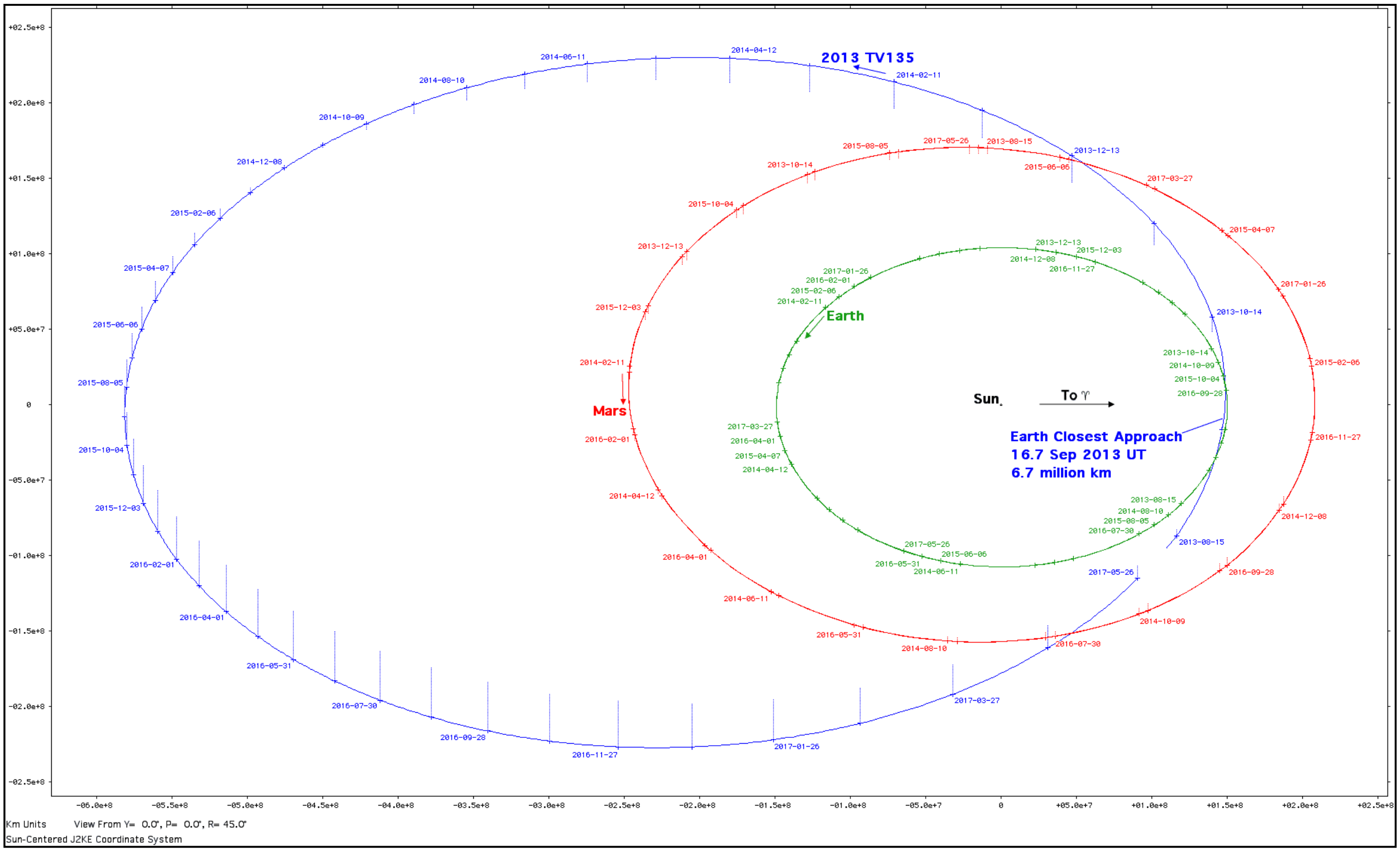

Figure 1. Motion of the Earth (green), Mars (red), and NEO 2013 TV$_{135}$ (blue) is plotted relative to the Sun from August 2013 until May 2017. This heliocentric motion is viewed from a perspective 45° above Earth's orbit plane, the ecliptic. Time ticks (" + " markers) are at 30-day intervals and are labeled with the corresponding date in YYYY-MM-DD format at 60-day intervals. Dotted lines emanating from time ticks are projections onto the ecliptic plane. From these projections, note how the 2013 TV$_{135}$ orbit's ascending node on the ecliptic closely coincides with crossing Earth's orbit inbound toward perihelion.

By the time 2013 TV$_{135}$ was discovered, its Earth distance had increased to over 17 million km. To be observable from such a distance requires a NEO be relatively large, even if its reflectivity is high. Current best estimates place 2013 TV$_{135}$'s diameter at about 400 m based on its absolute magnitude H = +19.4. When a NEO is brighter than (numerically less than) H = +22.0 and its minimum orbit intersection distance with Earth's orbit (MOID) is less than 7.5 million km, it is classified as a potentially hazardous object (PHO). With a MOID of 1.8 million km, 2013 TV$_{135}$ became one of the 1435 PHOs known on 23 October 2013[3].

Before November 2013, very little of 2013 TV$_{135}$'s orbit had been observed. Future position predictions rapidly grow

(Continued on page 6)

[1] Reference the NASA/JPL NEO Program Office's article on 2013 TV$_{135}$ and its Earth collision prospects at http://neo.jpl.nasa.gov/news/news180.html dated 17 October 2013.

[2] Unless noted otherwise, all 2013 TV$_{135}$-related data presented in this article are obtained from JPL's *Horizons* ephemeris computation service. *Horizons* may be accessed at http://ssd.jpl.nasa.gov/?horizons.

[3] Reference http://neo.jpl.nasa.gov/neo/groups.html for PHO criteria (synonymous with "PHA" on this web page) and a current tally of known PHOs.

(Continued from page 5)

in uncertainty when only minimal observations are available. Twenty years in the future, this PHO could plausibly occupy half of its orbit along an arc known as the line of variations (LOV)[4]. On 26 August 2032, Earth is very close to the ascending node where 2013 TV_{135}'s orbit crosses the ecliptic plane from below to above in Figure 1. Positions near the ascending node undergoing Earth collision are among the LOV points 2013 TV_{135} could occupy at that time.

As additional 2013 TV_{135} observations were obtained, its LOV on 26 August 2032 contracted. At first, this caused the probability of Earth collision P_C to increase because LOV points that do *not* collide were excluded. But eventually the tiny subset of LOV points that *do* collide with Earth was also excluded, and P_C in 2032 rapidly fell to infinitesimal levels.

Figure 2 chronicles variations in 26 August 2032 P_C during October/November 2013 as additional 2013 TV_{135} observations were accumulated. The Sentry processor computes each P_C in the Figure 2 plot. Sentry is run by JPL for NASA's NEO Program Office and is among the best sources of data on possible Earth collisions by known small bodies throughout the solar system[5]. Each Figure 2 P_C data marker is accompanied by an annotation of the form "n Obs, $\pm x$ σ", where n is the number of 2013 TV_{135} observations used by Sentry to compute the associated P_C and $\pm x$ is the LOV coordinate at which Sentry finds Earth collisions. Assuming probability density along the LOV is Gaussian, $\pm x$ values are expressed in standard deviations σ from the nominal or "best-fit" position. A sign convention is applied to x such that a positive value signifies "in the direction of 2013 TV_{135} heliocentric motion".

Sentry searches for collision cases along the LOV out to ±5 σ from nominal. Ultimately, no Earth collisions by 2013 TV_{135} were found within this LOV interval after Sentry processing on 7 November 2013, and 2013 TV_{135} was therefore removed from the Sentry Risk Table the following day[6]. Figure 2's rightmost data point reflects the last Sentry processing detecting Earth collisions within the ±5 σ LOV in-

(Continued on page 7)

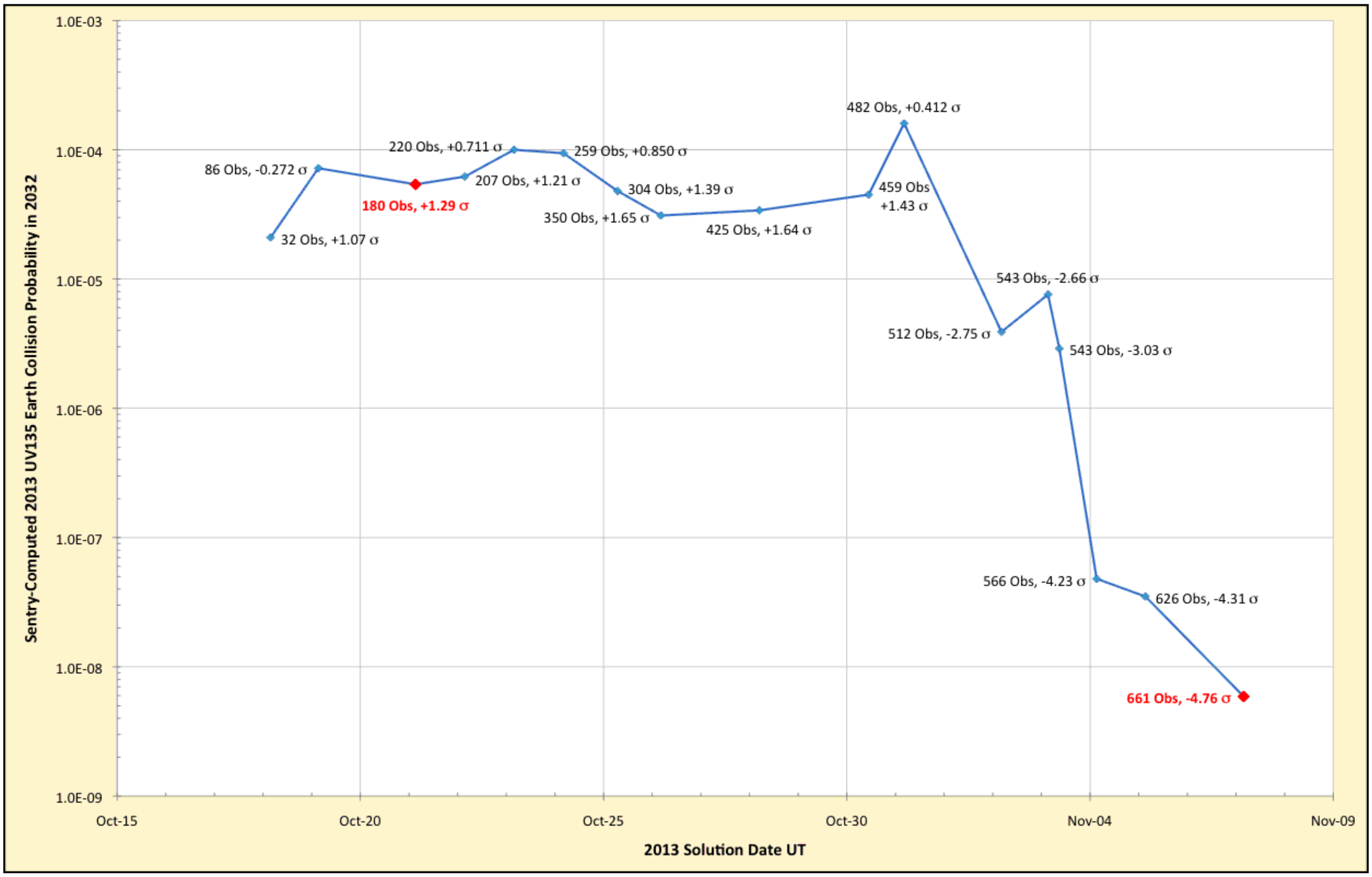

Figure 2. Sentry-computed P_C of 2013 TV_{135} collision with Earth on 26 August 2032 is plotted as a function of Universal Time (UT) corresponding to when the associated 2013 TV_{135} orbit determination is dated in JPL's *Horizons* ephemeris computation service. Data marker annotations are explained in the foregoing narrative text. The two red data markers correspond to orbit determination and Sentry processing further analyzed in Sections 2.1 and 2.2.

[4] At a given instant, the LOV is a one-dimensional subset of all possible positions. The LOV is restricted to lie on the nominal "best guess" orbit, but other plausible locations lie adjacent to it.

[5] Sentry analysis is described at http://neo.jpl.nasa.gov/risk/doc/sentry.html.

[6] Sentry Risk Table removals are chronicled at http://neo.jpl.nasa.gov/risk/removed.html.

(Continued from page 6)

terval.

The remainder of this article develops geometric/statistic data and visualizations of how the 2013 TV_{135} LOV can collide with Earth on 26 August 2032 assuming knowledge of this PHO's orbit on 21 October and 7 November 2013. Orbit determination and Sentry processing supporting this analysis correspond to the two **red** data markers in Figure 2.

2. Liminal Earth-Mapped Uncertainty Region (LEMUR) Analysis

Both Sentry and similar Monte Carlo analyses randomly sample the LOV for potential Earth collision cases. The LEMUR analysis described here uses the JPL *Horizons* ephemeris computation service to systematically sample the LOV for collision cases previously identified by Sentry. These cases are coasted forward in time by *Horizons* as user-specified small bodies (USSBs) to a terminal epoch several hours before collision. A USSB coast is subject to the same JPL solar system standard dynamical modeling used by Sentry.

Geocentric position and velocity at the USSB terminal epoch are then coasted to Earth impact at a height of +42 km with the WeavEncke predictor[7] modeling accelerations from Earth, Sun, and Moon gravity. The +42 km impact height is reckoned with respect to a *Horizons* spherical Earth radius of 6378.136 km and is consistent with the 6420 km marginal or grazing impact distance given in Sentry's "Impact Table Legend"[8]. Final conditions from each WeavEncke coast provide geodetic impact data for visualization purposes.

The following two subsections document LEMUR analysis results from *Horizons* and Sentry data available on two dates 17.0 days apart. These two data sets correspond to **red** data markers in Figure 2.

2.1 LEMUR Analysis With 2013 TV_{135} Orbit Determination JPL#7

The LEMUR analysis documented here for 2013 TV_{135} uses *Horizons* data in Table 1 to define the nominal orbit along which the LOV will be sampled. Seven Table 1 parameters appearing in **bold** are used to create USSB orbits in *Horizons* sampling the 2013 TV_{135} LOV. These parameters are defined in Table 2.

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Table 1. This 2013 TV_{135} orbit determination was generated circa 21.1 October 2013 UT and incorporates 180 observations spanning 12 days, as noted in its second line of data. The solution is tagged "JPL#7" in the second-to-last line of data. Parameters in bold are defined in Table 2.

```
*******************************************************************************
JPL/HORIZONS          (2013 TV135)       2013-Oct-21 07:50:50
Rec #:752349 (+COV) Soln.date: 2013-Oct-21_03:15:08   # obs: 180 (12 days)

FK5/J2000.0 helio. ecliptic osc. elements (au, days, deg., period=Julian yrs):

 EPOCH= 2456584.5 ! 2013-Oct-19.00 (CT)             Residual RMS= .34054
 EC= .5933521715952487      QR= .9954267524114992    TP= 2456555.7240458783
 OM= 333.4318585954334      W= 23.70784723315245     IN= 6.766820228742517
 A= 2.447884097442456       MA= 7.405383086758426    ADIST= 3.900341442473412
 PER= 3.82996               N= .257346215            ANGMOM= .021664166
 DAN= 1.02773               DDN= 3.47271             L= 356.9926052
 B= 2.7154528               MOID= .0118506           TP= 2013-Sep-20.2240458783

Asteroid physical parameters (km, seconds, rotational period in hours):
 GM= n.a.                   RAD= n.a.                ROTPER= n.a.
 H= 19.418                  G= .150                  B-V= n.a.
                            ALBEDO= n.a.             STYP= n.a.

ASTEROID comments:
1: soln ref.= JPL#7, PHA OCC=7
2: source=ORB
*******************************************************************************
```

[7] Reference Adamo, D. R., "A Precision Orbit Predictor Optimized for Complex Trajectory Operations," *Astrodynamics 2003, Advances in the Astronautical Sciences*, Vol. 116, Univelt, San Diego, CA, 2003, pp. 2567–2586.

[8] This legend is displayed with PHO-specific Sentry data. To access the legend, display the Sentry Risk Table at http://neo.jpl.nasa.gov/risk/ and click any link in the Object Designation column.

Table 2. Definitions are provided for Table 1 parameters appearing in bold. This dataset is used to create USSB orbits in *Horizons* sampling the 2013 TV$_{135}$ LOV.

Parameter	Definition
EPOCH	Coordinate Time (CT)[9] expressed as a Julian date at which all other Table 2 parametric values are applicable
EC	Eccentricity
QR	Perihelion distance in astronomical units (AU)
TP	CT of perihelion passage expressed as a Julian date
OM	Ecliptic longitude of the ascending node on the ecliptic in degrees
W	Argument of the perihelion in degrees
IN	Ecliptic inclination in degrees

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Excepting EPOCH (a specified parameter), *Horizons* provides ±1 σ variance data for all Table 2 statistically estimated parameters associated with the latest orbit solution. In principle, the entire 2013 TV$_{135}$ uncertainty region can be sampled by introducing deviations from nominal values in Table 1 that are plausible with respect to their variances. Assuming no significant perturbations, such as would be incurred from a close planetary encounter, effects of these deviations over time fall into three classes. Deviations in EC or QR produce secular effects because either change implicitly alters nominal orbit period and can significantly depart from nominal position given sufficient coast time from EPOCH. In contrast, a TP deviation introduces a bias from nominal position along the LOV at EPOCH, and this bias does not grow significantly with time from EPOCH. Finally, deviations in OM, W, and IN produce bounded periodic departures from nominal position as a function of time from EPOCH.

Because the USSB coast time from EPOCH to Earth collision spans multiple 2013 TV$_{135}$ orbits, EC is selected for LOV sampling in this LEMUR analysis. Sentry analysis utilizing Table 1's JPL#7 orbit determination finds Earth collision cases at +1.28653 σ from nominal position along the LOV. The ±1 σ variance in EC from *Horizons* for JPL#7 is ±0.001070098. Thus, a good starting guess at an LOV sample colliding with Earth would be a USSB having Table 1 values with an EC deviation to 0.5933521715952487 - 1.28653 * 0.001070098 = 0.591975459[10]. Table 3 provides results from sampling the JPL#7 LOV with EC deviations.

In Table 3's LOV sampling, the Sentry-based guess for an EC deviation leading to Earth collision has a σ value of -1.28653, only 0.6% from that of the nearest grazing case found by LEMUR analysis. Table 3 data also lead to a reasonable estimate of P_C using Excel's standard normal cumulative distribution function NORMSDIST. Assuming Gaussian probability density along the LOV, P_C = |NORMSDIST(-1.27876) - NORMSDIST (-1.27846)| = 5.28e-5 = 1-in-18,900. The P_C computed by Sentry from JPL#7 data is 5.4e-5 or 1-in-18,000, 2% greater than the LEMUR estimate. In Figure 3, Table 3's two grazing cases are plotted relative to Earth. The leading graze impacts at 07:57 CT and the trailing graze at 08:34 CT. Sentry's predicted impact is at 08:24 CT.

Table 3. Earth miss distances from EC deviations sampling the 2013 TV$_{135}$ JPL#7 orbit determination's LOV are listed in order of increasing EC. The EC interval giving rise to all possible Earth impacts from this LEMUR analysis lies between the marginal leading and trailing graze cases. Values in the σ column are EC deviations from the nominal Table 1 value normalized to the *Horizons* variance of ±0.001070098.

EC	σ	Earth Miss (km)	Remark
0.5919754590	-1.28653	679,354	Sentry-based guess
0.5919837773	-1.27876	6421	Leading graze
0.5919840948	-1.27846	6421	Trailing graze
0.5933521716	0	105,271,694	Nominal

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9 A uniform time scale void of leap seconds, CT is used as the fundamental ephemeris argument by *Horizons*. To a precision of ±0.002 s, CT is related to international atomic time (TAI) by CT = TAI + 32.184 s.

10 The sampled EC value for Earth collision is less than the nominal EC value because of Sentry's sign convention for displacement along the LOV with respect to nominal position. Recall positive Sentry LOV displacement signifies "displace from nominal in the direction of heliocentric motion". To impart such a displacement requires a shorter orbit period than nominal. If QR (the only other Table 2 parameter capable of affecting orbit period) is held at its nominal value, EC must be decreased to shorten orbit period.

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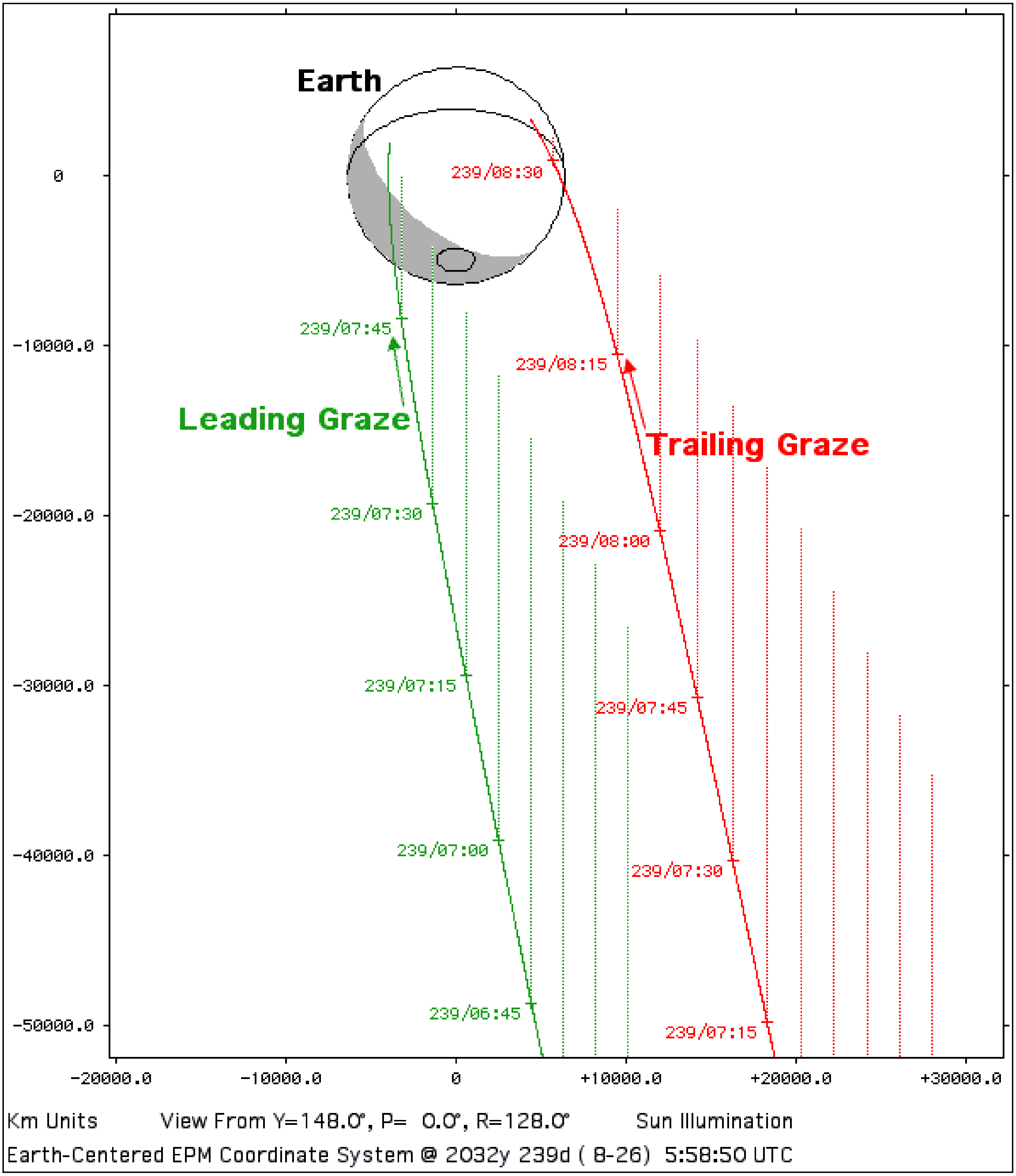

Figure 3. Grazing impact trajectories are plotted relative to Earth and delimit the minute 2013 TV$_{135}$ LOV segment containing all possible collision cases from this LEMUR analysis of JPL#7 orbit determination data. Time ticks are at 15-min intervals and are annotated with 26 August 2032 UT in DOY/hh:mm format. Dotted lines are projections onto Earth's equatorial plane. Earth is annotated with its equator and the parallel at 80° S latitude. The shaded area is Earth's nightside.

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2.2 LEMUR Analysis With 2013 TV_{135} Orbit Determination JPL#31

The LEMUR analysis documented here for 2013 TV_{135} uses *Horizons* data in Table 4 to define the nominal orbit along which the LOV will be sampled. Seven Table 1 parameters appearing in **bold** are used to create USSB orbits in *Horizons* sampling the 2013 TV_{135} LOV. These parameters are defined in Table 2.

Table 4. This 2013 TV_{135} orbit determination was generated circa 7.2 November 2013 UT and incorporates 661 observations spanning 26 days, as noted in its second line of data. The solution is tagged "JPL#31" in the second-to-last line of data. Parameters in bold are defined in Table 2.

```
*******************************************************************************
JPL/HORIZONS          (2013 TV135)       2013-Nov-07 07:39:13
Rec #:750134 (+COV) Soln.date: 2013-Nov-07_03:46:00   # obs: 661 (26 days)

FK5/J2000.0 helio. ecliptic osc. elements (au, days, deg., period=Julian yrs):

 EPOCH= 2456592.5 ! 2013-Oct-27.00 (CT)          Residual RMS= .19007
 EC= .5908580294949625   QR= .9954524306344258    TP= 2456555.7325275815
 OM= 333.460546709033    W= 23.68872923572981     IN= 6.746628135329265
 A= 2.433024481467049    MA= 9.548785351056903    ADIST= 3.870596532299673
 PER= 3.79514            N= .259707411            ANGMOM= .021647483
 DAN= 1.02761            DDN= 3.45071             L= 357.0031418
 B= 2.7053226            MOID= .0117562           TP= 2013-Sep-20.2325275815

Asteroid physical parameters (km, seconds, rotational period in hours):
 GM= n.a.                RAD= n.a.                ROTPER= n.a.
 H= 19.4                 G= .150                  B-V= n.a.
                         ALBEDO= n.a.             STYP= n.a.

ASTEROID comments:
1: soln ref.= JPL#31,    PHA OCC=6
2: source=ORB
*******************************************************************************
```

Because the USSB coast time from EPOCH to Earth collision spans multiple 2013 TV_{135} orbits, EC is selected for LOV sampling in this LEMUR analysis as explained in Section 2.1. Sentry analysis utilizing Table 4's JPL#31 orbit determination finds Earth collision cases at -4.75804 σ from nominal position along the LOV. The ±1 σ variance in EC from *Horizons* for JPL#31 is ±0.000230863. Thus, a good starting guess at an LOV sample colliding with Earth would be a USSB having Table 1 values with an EC deviation to 0.5908580294949625 + 4.75804 * 0.000230863 = 0.591956484[11]. Table 5 provides results from sampling the JPL#31 LOV with EC

(Continued on page 11)

Table 5. Earth miss distances from EC deviations sampling the 2013 TV_{135} JPL#31 orbit determination's LOV are listed in order of increasing EC. The EC interval giving rise to all possible Earth impacts from this LEMUR analysis lies between the marginal leading and trailing graze cases. Values in the σ column are EC deviations from the nominal Table 4 value normalized to the *Horizons* variance of ±0.000230863.

EC	σ	Earth Miss (km)	Remark
0.5908580295	0	88,647,714	Nominal
0.5919525516	+4.74100	6420	Leading graze
0.5919527361	+4.74180	6421	Trailing graze
0.5919564840	+4.75804	330,086	Sentry-based guess

[11] The sampled EC value for Earth collision is greater than the nominal EC value because of Sentry's sign convention for displacement along the LOV with respect to nominal position. Negative Sentry LOV displacement signifies "displace from nominal in the direction opposite heliocentric motion". To impart such a displacement requires a longer orbit period than nominal. If QR (the only other Table 4 parameter capable of affecting orbit period) is held at its nominal value, EC must be increased to lengthen orbit period.

(Continued from page 10)

deviations.

In Table 5's LOV sampling, the Sentry-based guess for an EC deviation leading to Earth collision has a σ value of +4.75804, only 0.3% from that of the nearest grazing case found by LEMUR analysis. Table 5 data also lead to a reasonable estimate of P_C. Assuming Gaussian probability density along the LOV, P_C = |NORMSDIST(+4.74100) - NORMSDIST(+4.74180)| = 4.19e-9 = 1-in-239 million. The P_C computed by Sentry from JPL#31 data is 5.9e-9 or 1-in-170 million, 41% greater than the LEMUR estimate. In Figure 4, Table 5's two grazing cases are plotted relative to Earth. The leading graze impacts at 08:44

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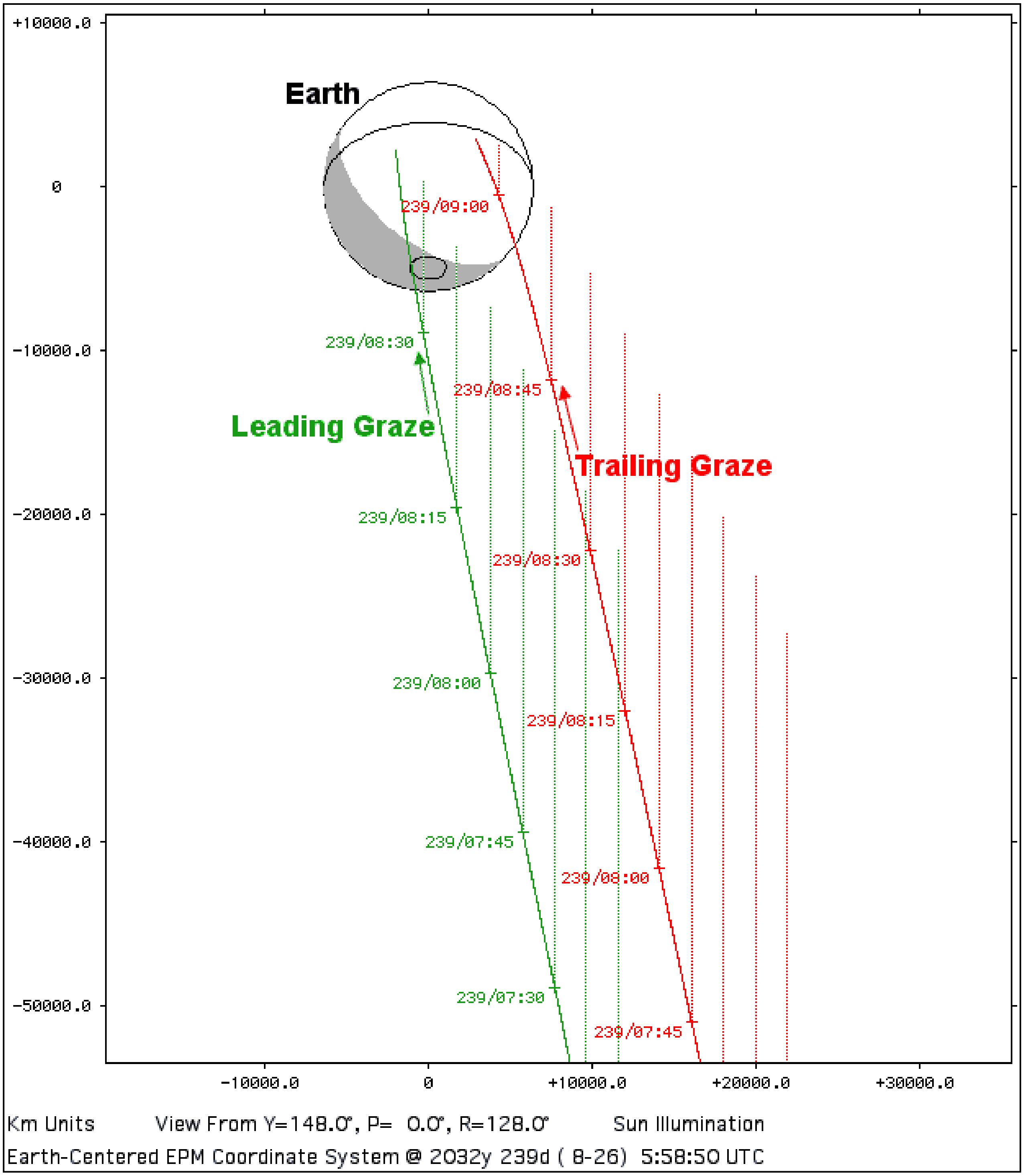

Figure 4. Grazing impact trajectories are plotted relative to Earth and delimit the minute 2013 TV_{135} LOV segment containing all possible collision cases from this LEMUR analysis of JPL#31 orbit determination data. Time ticks are at 15-min intervals and are annotated with 26 August 2032 UT in DOY/hh:mm format. Dotted lines are projections onto Earth's equatorial plane. Earth is annotated with its equator and the parallel at 80° S latitude. The shaded area is Earth's nightside.

(Continued from page 11)

CT and the trailing graze at 09:05 CT. Sentry's predicted impact is at 08:38 CT.

3. LEMUR Loci For JPL#7 And JPL#31

The EC interval between grazing cases in Tables 3 and 5 can be divided into small increments to produce LEMUR loci for 2013 TV_{135} orbit determinations JPL#7 and JPL#31, respectively. Through this pedigree, each LEMUR locus consists of all possible Earth impact points associated with a specific orbit determination's LOV.

Figure 5 co-plots LEMUR loci for JPL#7 and JPL#31 onto a segment of Earth's surface. These loci differ primarily from two effects. First, as is evident from comparing Figures 3 and 4, the 2013 TV_{135} LOV has shifted in inertial space as observations were accumulated and edited during the 17 days between the two orbit determinations. Whereas the JPL#7 locus can impact with a geocentric inertial flight path angle γ as steep as -46.8°, JPL#31 locus impacts can only be as steep as γ = -25.0°[12]. Second, the center of curvature associated with the JPL#7 locus is geographically east of that associated with the JPL#31 locus due to Earth rotation. Impacts in the JPL#7 LEMUR locus occur from 46 minutes earlier (at leading graze)

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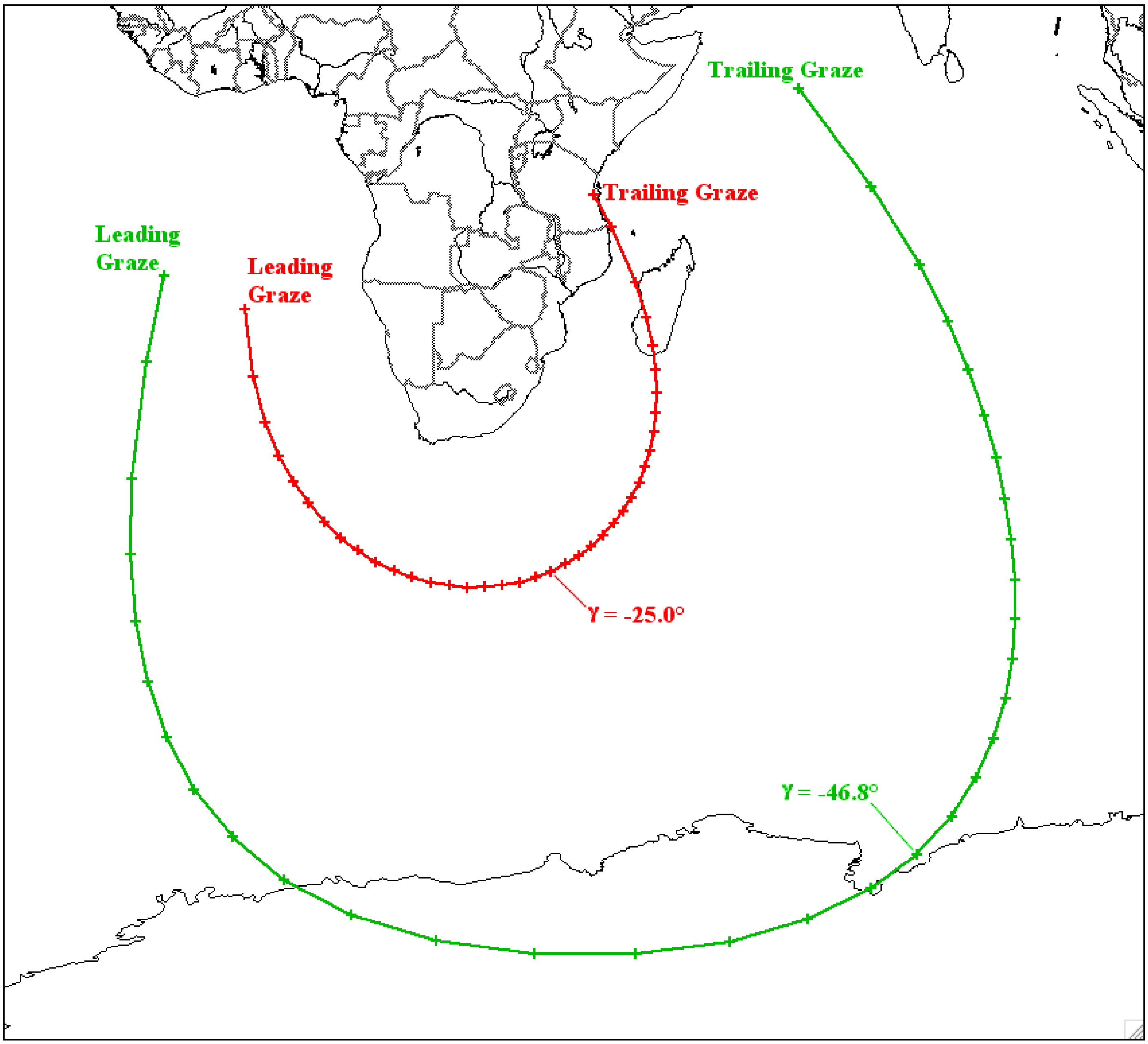

Figure 5. Two LEMUR loci of all possible Earth collisions for 2013 TV_{135} on 26 August 2032 are plotted based on JPL#7 orbit determination data (green) and JPL#31 orbit determination data (red). These LEMUR loci correspond to red data markers in Figure 2. As indicated by steepest γ values annotated on each locus, the JPL#31 LOV more nearly misses Earth than does the JPL#7 LOV.

[12] Marginal grazing cases impact at $\gamma = 0$.

(Continued from page 12)

to 31 minutes earlier (at trailing graze) with respect to the JPL#31 LEMUR locus.

The LOV shift between JPL#7 and JPL#31 is confirmed by the Sentry parameter *d*. Measured in Earth radii and tabulated as “Distance” in 2013 TV$_{135}$-specific Sentry Earth impact tables, *d* is the 26 August 2032 LOV's minimum geocentric distance. Figure 6 chronicles variations in 26 August 2032 *d* during October/ November 2013 as additional 2013 TV$_{135}$ observations were accumulated. **Red** data markers in Figure 6 correspond to the two LEMUR loci plotted in Figure 5 and indi-

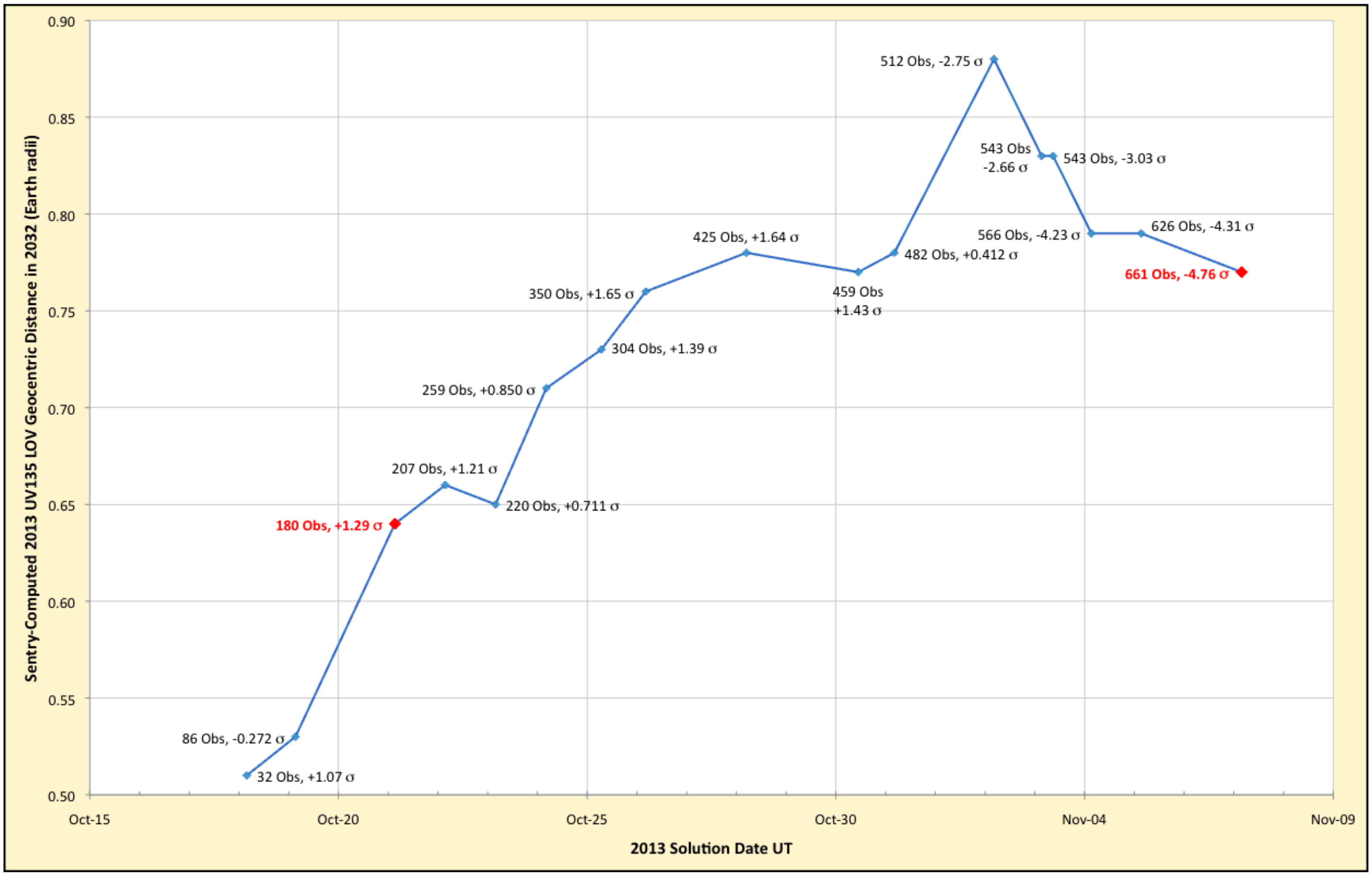

Figure 6. Sentry-computed minimum geocentric distance of 2013 TV$_{135}$'s LOV on 26 August 2032 is plotted as a function of UT corresponding to when the associated 2013 TV$_{135}$ orbit determination is dated in JPL's *Horizons* ephemeris computation service. Data marker annotations are explained prior to Figure 2. The two red data markers correspond to LEMUR loci plotted in Figure 5.

4. Conclusions

In the weeks following PHO 2013 TV$_{135}$ discovery, predicted position uncertainty could not exclude a remote possibility of Earth collision on 26 August 2032. When enough observations of 2013 TV$_{135}$ were accumulated over a sufficiently extended heliocentric arc, however, probability of this collision decreased by more than four orders of magnitude in a week (see Figure 2). Consequently, the 2032 collision between 2013 TV$_{135}$ and Earth is no longer considered a credible event. It is studied here purely for academic purposes.

Systematic LEMUR analysis of the 2032 collision has been documented and shown to agree with NASA's automated Sentry software results. Although Sentry output is publicly accessible, geometric insights from LEMUR analysis are not generally available as of this writing. Chief among these insights is a LEMUR locus of possible impact points associated with a specific 2013 TV$_{135}$ orbit determination. A LEMUR locus contains all Earth collision points along the orbit determination's LOV with critical Earth grazing cases at the locus termini.

A byproduct from LEMUR analysis is a P_C estimate within the same order of magnitude as Sentry's value. Both LEMUR estimates documented in this article are smaller than the corresponding Sentry values. Sentry computations for 2013 TV$_{135}$ Earth collisions include an estimate of uncertainty region semi-width about the near-Earth LOV. If Sentry P_C values reflect collision cases from a full 3-dimensional uncertainty region, that could explain why the 1-dimensional LEMUR analysis, restricted to collision cases on the LOV, produces smaller P_C estimates.

As 2013 TV$_{135}$ observations accumulated, the LOV (as defined to lie within a fixed maximum deviation from nominal) came to subtend progressively smaller heliocen-

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tric arcs on 26 August 2032. Accumulating observations also caused the 26 August 2032 LOV to shift in inertial space on a scale comparable to Earth's radius (see Figure 6). The shrinking LOV ultimately caused 2013 TV_{135}'s probability of Earth collision on 26 August 2032 to assume infinitesimal values. A similar P_C falloff could also have been triggered by a LOV shift completely off the Earth, but this had not happened before Sentry collisions within ±5 σ of nominal along the LOV were no longer detectable after 7 November 2013.

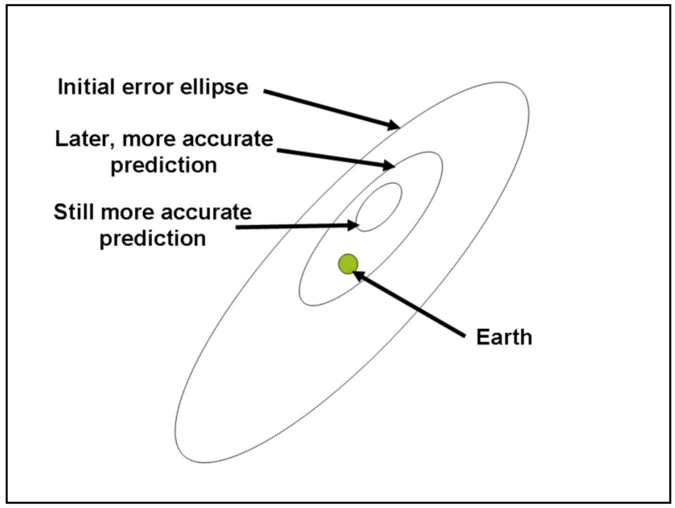
There appears to be no P_C threshold below which a LEMUR locus cannot be determined, provided the associated LOV intersects Earth. Furthermore, the notion of fixed LEMUR loci from one orbit determination to the next must be qualified. Such invariance should only be expected for mature observation datasets extending over most of a small body's heliocentric orbit or more. In the weeks following 2013 TV_{135}'s discovery, slowly converging orbit determinations led to LOV shifts on 26 August 2032 and corresponding LEMUR locus variations extending over substantial portions of the Earth hemisphere centered about southern Africa (see Figure 5).

[End]

[Our cover story by Daniel R. Adamo ends at the top of this page, so we add a few related notes here.]

November 19, 2013

After the February 2013 Earth-asteroid impact in Chelyabinsk, Russia, did scientists review old government surveillance films (nuclear weapons treaty verification) to look for undocumented Earth-asteroid impacts? More than 1,000 people were injured in Chelyabinsk. After that video review, are odds of such Earth-asteroid impacts now once every decade instead of once every century? Once twenty years? Once every thirty years? Public Broadcasting Service (PBS) television and PBS journalist Miles O'Brien reported about those revised odds of Earth-asteroid impact in the PBS Newshour episode of November 7, 2013. A transcript of that television news segment is available on that PBS website. The related PBS video segment is also available for viewing on that website.



Above: This image shows why asteroid impact probability goes up, then down. Image source: Wikipedia (public domain). Image credit: Lou Scheffer.

Above: Image source: Wikipedia. Image credit: NASA (2001). A collision between a comet and the Earth.

Comments on an Aviation Week Cover Story: Son of Blackbird

WES KELLY, TRITON SYSTEMS LLC

This U.S. Air Force SR-71 Blackbird configuration guide (available via this link from an Aviation Week magazine article's website) is the most specific description I have ever seen of the reconfiguration of the SR-71 Blackbird engines as a function of Mach. I remember some earlier online discussions about the ramjet nature of the engines, searching for the vents that are briefly mentioned in cross sectional illustrations - and then turning away perplexed. But here's a series of illustrations indicating four or five channel controls reconfigured as a function of Mach.

Curiously, this Aviation Week magazine cover article (Son of Blackbird, the SR-72, a Lockheed Martin concept) of November 1, 2013, says that the flight crews had to perform these functions manually. I can believe that would be the case on the Lockheed A-11 (discussed in this Wikipedia A-12 article), circa 1964, but decades of flight control technology have been provided since then. For example space shuttle ascent re-entry flight controls are largely driven by air speed or Mach. What would have been the implementation problem?

There is some overall information about thrust and scramjet flight control (SFC) for the engines, but putting together specific thermodynamic engine cycle charts would be challenging from the data provided. Still, it gives one inspiration to "build your own engine," ideas that do not necessarily address the needs of the Mach 6 vehicle.

It would appear that by some unspecified development, a turbojet was coaxed to behave productively up to the Mach 4 region. I suspect that high temperature alloys had something to do with this development. Usually they are applied to get higher and higher pressure (and temperature) ratios in subsonic cruise turbines. No doubt they have something to offer for high speed flight as well.

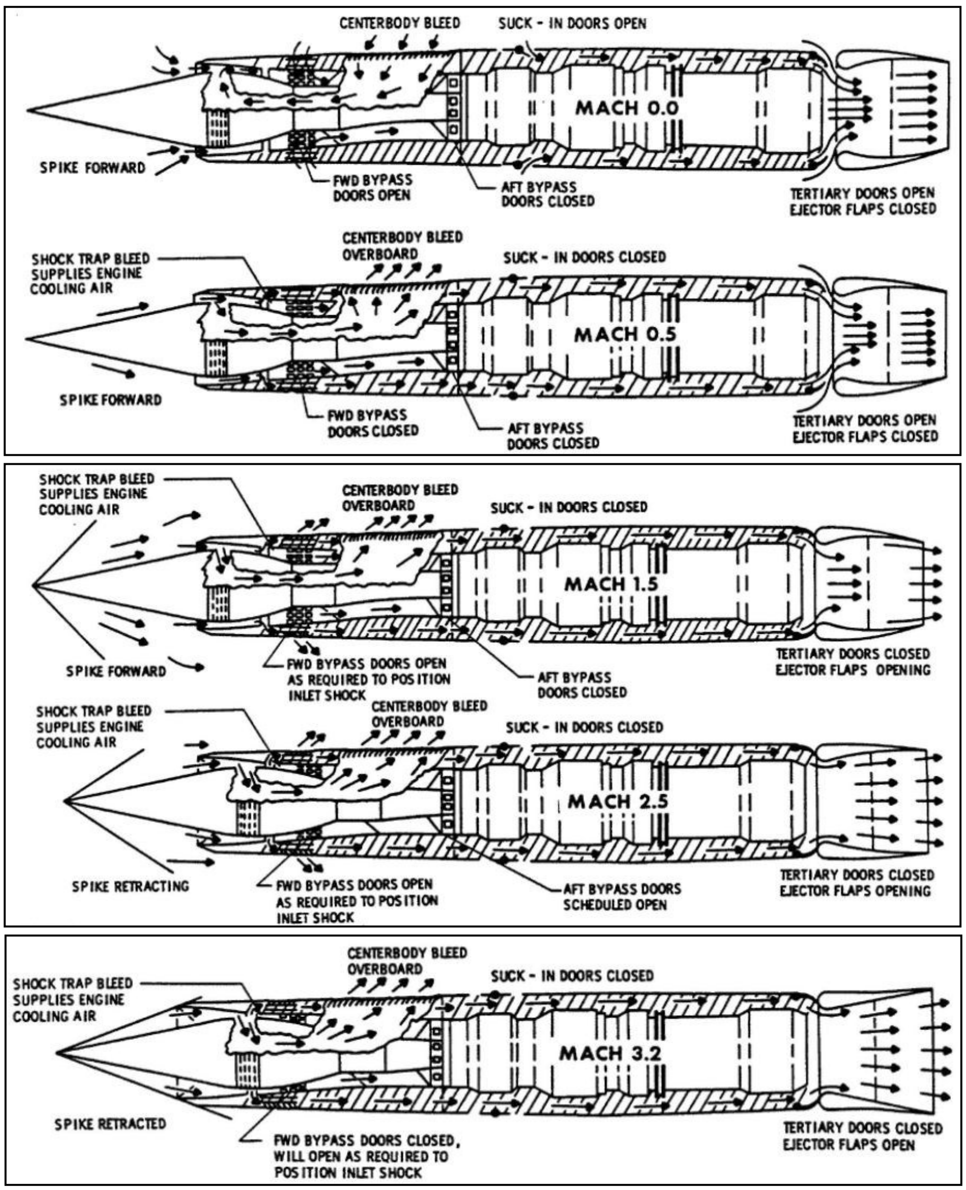
Now if this SR-72 vehicle is to cruise at Mach 6, what altitude would that be and what sort of leading edge temperature would we expect? The SR-71 was associated with over 300 degrees F (or ~850 R) on leading edges. I can't recall the Concorde figure for half the speed. But if all else remains the same, say 60,000 feet for altitude, with doubled speed, the heat load rises cubically (x 8) and the temperature rises by the power of 1.5 or the square root of 8?

I'd say that would be hot and the SR-72 bird would probably cruise higher.

The curious thing about this story is that a proposal presentation is given about as much or more weight as anomalous observations (vapor trails and seismic readings of Aurora, etc.). Both these observations are about as substantive as a Cheshire Cat, but for differing and self-evident reasons. Though I do remember a number of stories in Aviation Week magazine about combined or multi-cycle engines like this over the years.

Maybe a new engine would not use traditional kerosene derivatives. JP-8 is used for conventional high performance aircraft. Other possibilities are methane, propane or hydrogen. These would be very good for performance objectives, but not very good for operations. How many airfields would have readily available fuel?

So what are the other guys [Lockheed Martin's competitors] planning to do?



Above: SR-71 Blackbird diagrams as a function of Mach. Image credit: U.S. Air Force. Image source: Aviation Week magazine cover story of November 1, 2013.

The Enigmatic Giant Polygons of Mars Are They Clues to Past Oceans?

DR. DOROTHY Z. OEHLER

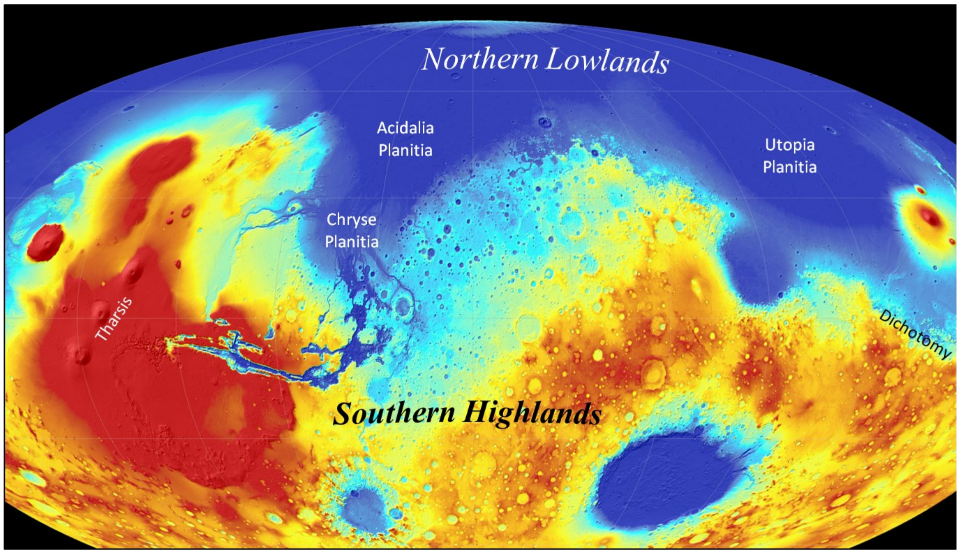


Figure 1. This map, created from elevation data returned by the Mars Orbiter Laser Altimeter (MOLA) on NASA's Mars Global Surveyor, shows the dichotomy between Mars' northern lowlands (where most of its potential ancient ocean would have been) and its southern highlands. Blue denotes low elevations and red depicts high. Acidalia and Utopia Planitiae have extensive giant polygon development. Image credit: Oehler/ NASA/USGS.

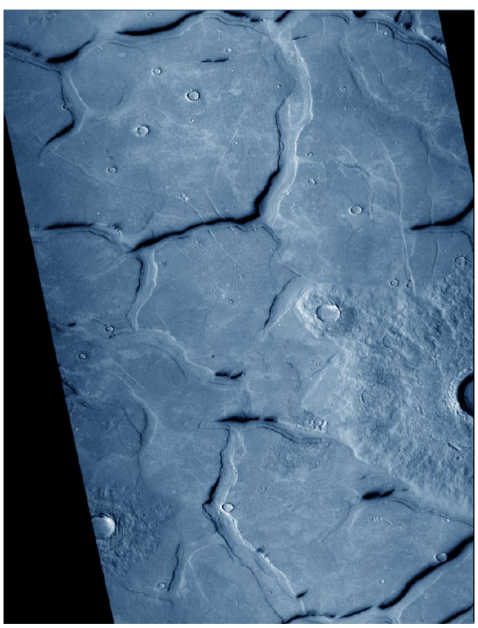


Figure 2. Giant polygons in southern Utopia Planitia. Although some scientists believe these polygons could be evidence of an ancient ocean, their exact origin remains a mystery. This image, from the context (CTX) camera on NASA's Mars Reconnaissance Orbiter, spans 29 kilometers. Image #: P17_007713_2172. Image credit: NASA/ASU.

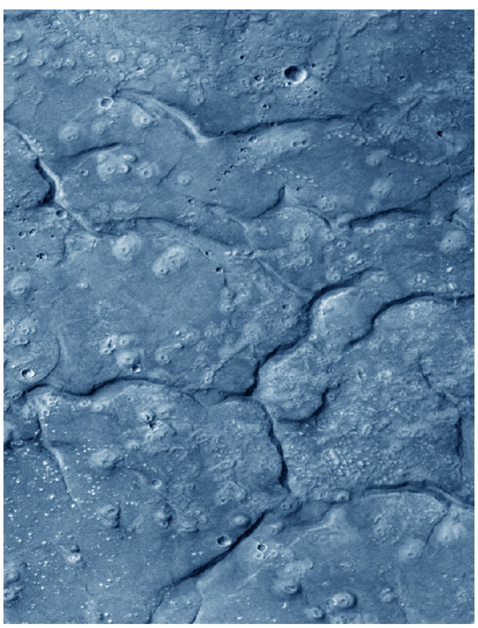


Figure 3. Giant polygons in part of southern Acidalia Planitia. These are dotted with bright mounds. This image, from the context (CTX) camera on NASA's Mars Reconnaissance Orbiter, spans about 11 kilometers. Image # B18_016644_2188. Image credit: NASA/ASU.

Early telescopes told us first of Mars' characteristic red color, then its canals. Flash forward hundreds of years, and various Martian orbiters, as well as the twin rovers *Spirit* and *Opportunity* and the more recent *Curiosity* rover have revealed details of the Red Planet's surface, offering clues to the possibility of water and habitable settings for potential past life. What new facts and further mysteries will Mars give up? Perhaps they lie in its giant polygons.

MARTIAN GIANT POLYGONS AND A NEW ANALOG

Giant polygons have been recognized on the Martian surface since the 1970s from images taken by the *Mariner 9* and *Viking* orbiters. These features occur almost exclusively in the northern lowlands and are particularly abundant in Acidalia and Utopia Planitiae (Figures 1-3).

The giant polygons are kilometer-scale in size; most examples are 2 to 20 kilometers across (Figures 2-3). Their outlines are defined by troughs and their shapes can be rectangles, hexagons, or morphologies with curved boundaries. It is the large size of these polygons that distinguishes them from the variety of smaller-scale polygons on Mars, which are typically less than 250 meters across.

Similarly, on Earth, most polygonal terrains involve features that are only a few hundred meters across. Because of this, few terrestrial analogs (such as desiccation or ice-wedge polygons) have seemed a good fit for the giant polygons on Mars.

Without a good analog, the origin and significance of the giant polygons on Mars are still a mystery. There have been suggestions that their origins involve tectonism associated with uplift due to unloading of water or ice, compaction of fluid-rich sediments over irregular terrain, or convection of water through permafrost followed by desiccation, compaction, or thermal contraction.

However, recent research has offered a new possibility of their origin – one that involves compaction of rapidly deposited,

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fine-grained sediments in subaqueous settings. This idea is based on results of three-dimensional (3–D) seismic data acquired by the petroleum industry as part of their exploration in offshore basins. These 3–D datasets allow creation of detailed plan-view maps of the shallow subsurface, and it is these maps that have revealed numerous examples of kilometer-scale polygons in the uppermost kilometer of subsea basins (compare Figures 4-5). Until recently, these large-scale polygonal features were completely unknown, but there are now more than 50 examples of marine basins that have terrestrial giant polygons.

TERRESTRIAL GIANT POLYGONS

The subsea polygons range from about 0.5 to 4 kilometers across and are bounded by faults (Figure 4). They occur from the sediment surface to depths of about 700 meters. They can have basin-wide extent (some occur over areas larger than a million square kilometers), and many are associated with fluid expulsion features such as mud volcanoes or depressions on the sea floor called pockmarks, which result from subaqueous gas release.

Common to all the basins with these features is an accumulation of rapidly deposited, fine-grained sediments in a subaqueous depocenter (a depocenter is typically the point of deepest and thickest deposits in a sedimentary basin). Of particular note, all the basins that have the large-scale polygons are located in settings that lack strong horizontal stresses. These settings are called passive margins. Many relatively wide continental shelves are passive margins and are sites of accumulation of thick sections of sedimentary rock. Various mechanisms have been put forth for the formation of terrestrial giant polygons, but at a minimum, we know that they involve three-dimensional contraction and dewatering due to sediment loading.

The sequence of events thought to lead to formation of these large-scale features is as follows: During initial stages of burial, sediment porosity and permeability decrease due to initial compaction. Polygonal faulting begins as linear furrows that develop near the sediment-water interface, apparently in response to mono-directional volume contraction. With burial of about 21 meters, sediment contraction becomes radial, and a hexagonal pattern of furrows develops. With greater burial, sediment strength due to compaction increases to the point where it is sufficient for the formation and maintenance of faults, and the polygonal furrows develop into polygonal faults. With burial beyond 300 meters, polygonal faulting becomes more closely spaced, and large polygons are divided into smaller, second-order polygons. This process continues until about 700 meters of burial, where compaction by sediment shrinkage is completed, and the fault frequency has reached its maximum.

Figure 4. Map view from 3-D seismic data, illustrating large-scale polygons in strata below the ocean, offshore Norway. This image spans 6 kilometers. Image credit: Stuevold et al., 2003, in Geol. Soc. London Sp. Publ. 216, 263-281. Image reprinted by permission of the Geological Society.

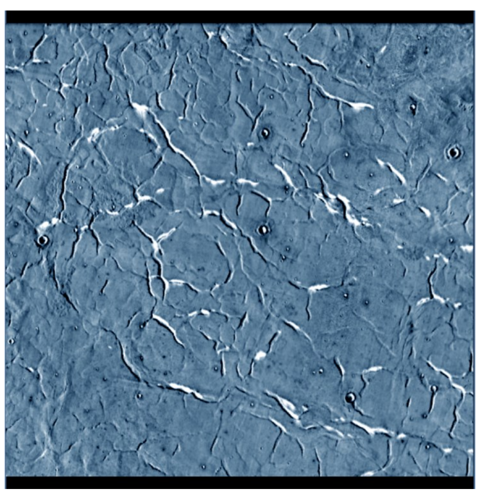

Figure 5. These giant polygons in southern Utopia are between 4 and 20 kilometers across. This view is a mosaic of daytime infrared images captured by the Thermal Emission Imaging System (THEMIS) on NASA's Mars Odyssey orbiter. Image credit: NASA/ASU/USGS.

COMPARISON OF MARTIAN AND TERRESTRIAL GIANT POLYGONS

The similarities between the Martian giant polygons and those in terrestrial offshore basins are intriguing. The kilometer-scale size of each stands out from other potential types of polygonal landforms. While the terrestrial offshore polygons appear to have a smaller size range (0.5 to 4 kilometers) compared to the size of most of the Martian examples (2 to 20 kilometers), this discrepancy may be only apparent. Some of the newer image data from the Context (CTX) and High Resolution Imaging Science Experiment (HiRISE) cameras on NASA's *Mars Reconnaissance Orbiter* (with resolutions of 6 meters/pixel and 25 centimeters/pixel, respectively) show that many of the Martian giant polygons are actually composed of smaller, second-order polygons that are approximately 2.5 to 5 kilometers across. Other HiRISE images show subtle polygons, about 1 kilometer across, which were never observed in the older datasets. In addition, the sizes of terrestrial polygons scale with burial depth and grain size, such that larger features occur in areas with least burial and/or smallest grain size. These are the Earth analogs that may be most comparable to the Martian giant polygons.

Importantly, the geologic contexts of terrestrial and Martian giant polygons are similar. The Earth features form in passive margins. On Mars, the general lack of plate tectonics would have resulted in many basinal settings similar to passive margins in that they also would lack strong horizontal stresses. This is the type

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of tectonic setting that allows formation of the giant polygons on Earth.

In addition, both the Earth and Martian giant polygons appear to involve settings where fine-grained sediment accumulated rapidly. The terrestrial features occur exclusively in fine-grained sediments, and rapid deposition has been implicated in several occurrences. On Mars, it is generally thought that catastrophic outflow floods would have resulted in massive amounts of rapidly deposited sediment in northern Chryse and southern Acidalia, and recent research has suggested that the most distal and therefore, the most fine-grained sediments deposited by those floods would accumulate in southern Acidalia Planitia—a region coincident with the giant polygons.

Finally, there is the common association of the terrestrial giant polygons with features associated with fluid expulsion, such as mud volcanoes (Figure 6) and pockmarks. On Mars, there may be features analogous to mud volcanoes in some of the areas of giant polygons, as masses of bright, circular mounds in southern Acidalia (Figure 3) have most recently been compared to mud volcanoes. Mud volcanoes are sedimentary diapirs that rise through the subsurface in a slurry of fluid and fine-grained sediment, as a result of overpressure in rapidly compacting basins. In Acidalia, approximately 40,000 of these mud volcano-like mounds have been estimated to occur and their distribution overlaps that of the giant polygons (Figure 7). While the distribution of the mounds is broader than that mapped for the giant polygons (from older *Viking* data), both sets of features are centered in southern Acidalia, and both are restricted to areas predicted to have accumulations of fine-grained sediment.

Utopia is different in that many fewer mounds have been noted there, and some of them may be pingos (diapiric mounds of ice). Nevertheless, while both mud volcanoes and large-scale polygons on Earth require fine-grained sediments and compaction of thick accumulations of sediments, the formation requirements for the giant polygons and mud volcanoes can be distinct in detail. Accordingly, the two sets of features are not necessarily coincident. They may overlap in some areas, but in others they can be adjacent to one another or each may occur in isolation. This may explain the differences between the features of Acidalia and Utopia.

IMPLICATIONS FOR AN OCEAN

The fundamental question of whether an ocean ever existed on Mars remains controversial. Many researchers have proposed that major bodies of water once existed on Mars in the northern plains. This interpretation has been drawn from landforms suggestive of ancient shorelines, and the distribution of valley networks (presumed to be ancient rivers) in the highlands that are consistent with, and may even require, a major source of water in the northern lowlands. More recently, a network of channels just north of the dichotomy that separates the northern and southern plains has been re-interpreted as a delta that flowed into standing water. In addition, data obtained with the radar

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Figure 6. Mud volcanoes - commonly associated with fluid expulsion - often appear with terrestrial polygons. These cold "mud pots" were photographed in northern California. The one at the right is about 10 centimeters high and 18 centimeters wide. Similar features, such as the bright mounds in Figure 3, occur with some of the giant polygons on Mars. Image credit: Wikipedia/Creative Commons.

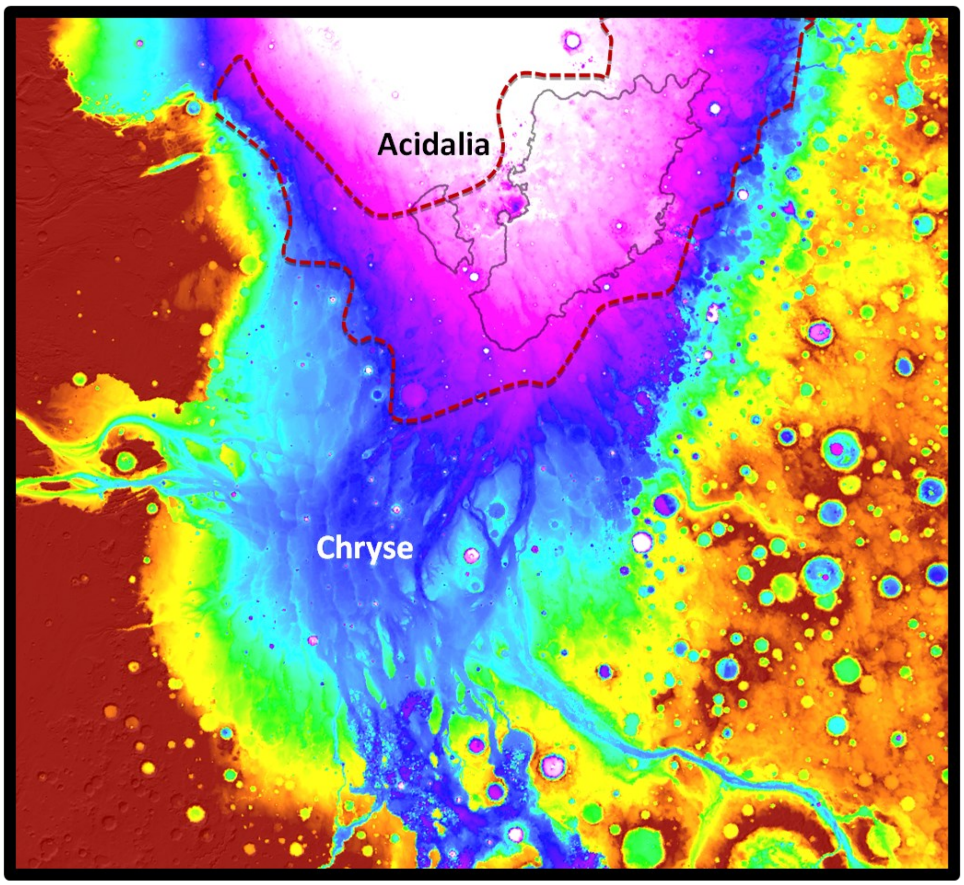

Figure 7. Based on MOLA data, this map of Mars' Chryse and Acidalia regions indicates elevations above–1,600 meters in red-browns and elevations below -4900 meters in and pinkish purples. The red dashed line shows the extent of recently mapped mud volcano-like mounds. The thin black line in Acidalia shows the area where giant polygons were mapped by other authors previously using older Viking data. Newer CTX and HiRISE data reveal giant polygons beyond the originally mapped area. Image credit: Oehler/NASA/USGS.

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sounder (MARSIS) on the European Space Agency's Mars Express have been interpreted to suggest that massive, subsurface ground ice "interior to previously proposed shorelines" may be the remnant of an ancient northern ocean. The comparison of Martian giant polygons to subsea features on Earth is supportive of these ideas.

CONTINUING CONTROVERSY

But more work needs to be done. Some question the interpretation of landforms as shorelines and others who have modeled Mars' ancient climate wonder if the planet was ever warm enough to support a major body of liquid water for any length of time. Work continues on climate models, and research scientists who have studied potential shorelines are refining their work with the higher resolution orbital image data that are now available. Maps are being constructed to look for evidence of equipotential surfaces (potential indicators of ancient sea levels) in the possible shoreline features. In addition, crustal deformations due to sediment accumulation or the weight of volcanics introduced in the Tharsis region (southwest of Chryse Planitia) are being considered to assess deviations from horizontality in potential shoreline features. The newer, higher resolution data are also being used to fine-tune our understanding of the spatial occurrences of the giant polygons and mounds. Initial results suggest that densely occurring mounds and giant polygons in Acidalia as well as the giant polygons in Utopia all occur below elevations of -4000 to -4100 meters. This range is close to previously proposed levels suggested to be ancient shorelines and possible equipotential surfaces and, accordingly, work is continuing to determine whether the distributions of giant polygons and mounds may reflect past water levels.

WHAT IF …

The possibility that Mars once hosted a major ocean is of great importance, not only to understanding the climate history of the Red Planet, but also to our evaluation of habitable regions on Mars. If the northern plains were the site of a major body of water, then habitats there may have supported life for relatively long periods. And when conditions deteriorated as the climate became colder and drier and the atmosphere thinned (allowing more destructive radiation to reach the planet), potential life that had thrived on the surface could have moved into the protection of the subsurface. There, life may have been able to persist within sediment pores, as occurs in the vast communities of endolithic organisms known to inhabit spaces with rocks of the Earth's subsurface. These would be the areas marked by the giant polygons.

Moreover, if the analogy to the subsea polygons on Earth is correct, then the giant polygons on Mars not only would represent sites of long-lasting liquid water, but they also would imply locales of fine-grained sediment accumulation and burial – both of which would enhance preservation of potential geochemical fossils. Thus, in the search for possible evidence of past life on the Mars, the giant polygons in the northern plains may point the way to prime areas for future exploration.

For more detail and references about these polygons, their interpretations, and ideas about an ocean on Mars, see the following:

Oehler, D. Z., Allen, C. C. (2012). Giant Polygons and Mounds in the Lowlands of Mars: Signatures of an Ancient Ocean? Astrobiology 12 (6), 601-615.

This Horizons article is adapted from an article which first appeared as the cover story *Polygons on Mars* for the 2013 Volume 33 Number 3 issue of the Planetary Report, the magazine of the Planetary Society.

Dr. Oehler works as a geologist in the Astromaterials Research and Exploration Science Directorate (ARES) at Johnson Space Center where she is concentrating on assessing potentially habitable regions on Mars. She was recently awarded the 2012 Distinguished Alumni Award from the University of California at Los Angeles (UCLA), and she is currently a member of the Mars Science Laboratory Mission (MSL Curiosity Rover) Science Team. She lives in Houston with her husband, John Oehler, who has just published his second novel, *Papyrus: A Thriller* (available via Amazon), an award-winning book about a secret message discovered on an ancient papyrus. *Papyrus* has garnered excellent reviews and has been likened by Kirkus Reviews to *The Da Vinci Code.*

Short Report from the Golden Spike Workshop

Larry Jay Friesen

GOLDEN SPIKE
Human Lunar Expeditions for Nations, Corporations, and Individuals

The Golden Spike Company held a 2-day workshop October 3 and 4 of this year (2013). The workshop was hosted by the Lunar and Planetary Institute (LPI) at their facility in Houston, Texas.

The Golden Spike Company was founded by planetary scientist Dr. Alan Stern. Alan Stern was at one time head of NASA's Science Mission Directorate, and is presently Principal Investigator for the New Horizons mission, on its way out to investigate Pluto and the Kuiper Belt. Dr. Stern is President and CEO of Golden Spike. Chairman of the Board for the company is Gerry Griffin, known to many in the Houston community for his distinguished career at Johnson Space Center, including a period when he was Director of JSC.

The Golden Spike Company's objective is to get humans back to the Moon using private funding. I have previously reported on Golden Spike's plans, and how they expect to make money at it, based on a presentation Alan Stern made about Golden Spike at the 2013 Lunar and Planetary Science Conference in March.

Golden Spike's purpose for the October 3-4 workshop was to seek input from the lunar and planetary science community. Golden Spike's business plan is to develop a low cost transportation system capable of taking human crews to the lunar surface and returning them to Earth. They would then sell rides to nations or companies who want a mission to the Moon. The crews of these missions would, among other activities, collect lunar samples and deploy experiment packages. Golden Spike wanted to learn from the planetary scientists attending what sort of planning, training, and so forth they would recommend to Golden Spike's customers, to maximize the scientific return for those customers who intend to do science.

Dr. Steven Mackwell, Director of LPI, opened the workshop by welcoming those attending and discussing the context for the meeting.

Gerry Griffin gave the second presentation Thursday morning, October 3. He described how the Golden Spike concept and company got started in 2010. The Obama Administration had looked at the Augustine Report and its conclusion that the Constellation program for putting humans on the Moon could not be done with the resources it had been given. Their decision was to change the direction for the US human spaceflight program and put an end to the Constellation program. Alan Stern looked at the situation and asked himself, "Now what?" He came up with the beginning of the Golden Spike concept.

In August of 2010, a small meeting was held in Telluride, Colorado, to sound out the idea, and judge if it had enough merit to pursue. This was followed by a 10-week study in August through October of 2010. The Golden Spike Company was then formed. Mr. Griffin offered the news note that Jim Lovell has recently joined. This is newsworthy because Mr. Lovell, like some other Apollo astronauts, was initially opposed to the idea.

So, what has been happening for the last three years? The people in the company have been doing their homework. They have been refining architectures and doing studies of systems requirements and modes of development. They have also briefed various people. They have deliberately stayed under the radar. Not secret, just quiet. Some people in the company had observed previous space ventures make bold public announcements too soon, then falter. They wished to avoid that fate.

Today, they have -

- Completed a business plan.
- Successfully identified more funding sources, investors, and customers.
- Published an architecture description.

Griffin closed by noting that a new domain, commercial human space travel, has opened.

Dr. Clive Neal of Notre Dame addressed the question of why we need to go to the Moon with humans. One reason is for science. This includes sample return, deploying experiments, making observations, geologic field mapping, and serendipitous science. Could not this be done with unmanned probes? He mentioned that Steve Squyres, who has managed the Mars Exploration Rovers, has stated that a trained human field geologist could do in hours or days what took the MERs months. And one thing no robot can do is the serendipitous science: responding to the truly unexpected. Humans could also deploy in situ resource utilization (ISRU) experiments.

Dr. Neal said that we need to re-learn how to take humans to the Moon and back, and start taking small steps in learning how to live on the Moon. He offered what he called the "three E's" as advantages humans can provide, and as things that need to be taken into account when planning for human missions: Efficiency, Exploration, and Economics.

William McKinnon spoke on "Remarkable Recent Discoveries in Lunar Science, and the Scientific Rationale for New Human Expeditions." Dr. McKinnon is a scientific advisor to Golden Spike. He was chosen in part because, as he described it, although he is in the planetary science field, he is not directly involved in lunar studies, and thus is viewed by the company as more objective. He reminded us that the Moon is key to understanding the solar system, as well as understanding the Moon itself. One new discovery is that there is a lot more mercury in lunar polar volatiles than was expected prior to the Lunar Reconnaissance Orbiter (LRO) mission. He also reported that the age for the Imbrium basin impact is now estimated to be 3.91 billion years.

Alan Stern was the final speaker Thursday morning. He began by making comparisons between Golden Spike and the New Horizons mission, another enterprise which he helped start. He then said that the company has so far identified three potential markets: nations (they have identified twenty to thirty nations that have the means and might potentially be interested), corporations, and wealthy tourists.

Dr. Stern described Golden Spike's mission plan. They intend to use: (1) existing expendable launch vehicles (ELV's), modified as needed; (2) an Earth orbital capsule modified and adapted for a lunar mission; and (3) a new lander and

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new EVA suits. The current plan is to use four launches in salvos of two. Each salvo will be of one Atlas and one Falcon 9. Their plan has been published in AIAA's *Journal of Spacecraft and Rockets*. If the Falcon Heavy becomes available, Golden Spike can change the scenario to do everything with two launches. Another architecture would involve two uprated versions of the Atlas.

Northrop Grumman has devised a lightweight lunar lander concept. United Launch Alliance (ULA) has developed a competing version. Northrop calls theirs the "Pumpkin."

Dr. Stern mentioned some of the flight systems milestones that lie ahead for Golden Spike. He also discussed some future capabilities Golden Spike might develop if it is successful in its initial missions. Those future capabilities include longer stay times, far side exploration (current plans are for missions to the near side of the Moon only), and a rover for the crew.

Dr. Stern's talk was followed by a discussion period and then a lunch break.

On Thursday afternoon, Dr. David Kring of NASA Johnson Space Center spoke on "Landing Site Options for Short-Duration EVA Human Exploration and Sample Return Opportunities." Dr. Kring suggested that for short-duration missions,

as Golden Spike's proposed flights would be, geologically simple sites might be preferable. Limitations on duration and number (probably two) of EVA's would likely limit how many parts of a more complex site astronauts could explore. He pointed out that the missions Golden Spike is proposing would be very similar to Apollo H class missions. Apollo 12 and 14 are examples of these.

C. K Shearer spoke on "Human Sample Return on the Moon: A Science, Exploration, and Technology View from the Apollo Program to the Future." He listed some topics that can be addressed by sample return. These include: (a) planetary differentiation, both timing and causes; (b) the origin and distribution of volatile sources; (c) the bombardment history of the Moon and inner solar system. All of these require global sampling of the Moon. He raised the question: what instruments might be useful for "high grading" samples?

Dr. Pat McGovern *et al.* spoke on "Lunar Nearside Olivine Exposures as Targets for Human Exploration."

Lawrence, Robinson, and Joliffe made a presentation remotely, by telecon, due to travel restrictions caused by the government shutdown. Their presentation was on "High Priority Locations for Nearside Lunar Sortie Missions." They used data from the LRO extended mission to aid identification of sites of interest. Their candidates include Mons Hansteen, Gruithuison Domes, Lassell Massif, Mairan T, Marius Hills, Mare Ruemker, Hortensius, the cones Isis and Osiris, young basalts directly south of Aristarchus, Lichtenberg, Copernicus, Aristarchus (the crater and some pyroclastic deposits near it are treated as separate targets), and Sulpicius Gallus.

Gruener and Lawrence spoke on "A Nearside Lunar Geophysical Network with Benefits." They are trying to identify lunar surface locations which, in combination, would give good coverage for a seismic network.

Stininger *et al.* presented a method for getting precision landing on the Moon using lidar hazard avoidance and terrain relative navigation (TRN). Their system starts from a parking orbit around the Moon using a global map for navigation. It has a crater identification algorithm and a crater avoidance algorithm. It is designed to detect and avoid discontinuities, craters, rocks, and excessive slopes.

Thursday afternoon finished with a panel discussion. Panel members included Gary Lofgren of NASA-JSC, Clive Neal of Notre Dame, and Samuel Lawrence of Arizona State University. Much of the discussion centered on the need for two things, training for the people who go and curation. A point was made that curation really starts with mission planning and equipment selection. Someone on the panel raised the question: are all seismic instruments alike? If we wish to set up a seismic network for the Moon, it would help a great deal in data interpretation, if all the seismic instruments respond in the same way to the same inputs. Everyone was reminded that the scientific community cannot impose conditions upon Golden Spike's paying customers. However, scientists can say that if the customers genuinely wish to contribute to the scientific understanding of the Moon, here are some things they need to consider.

Thursday also included a poster session. I regret I did not take notes on all the posters, but here are a few examples whose topics I found interesting:

H. Fink showed examples of raised relief maps of the Moon.

D. M. Hooper *et al.* presented a poster on "Lunar Reconnaissance and Site Characteristics of the Marius Hills Skylight."

R. R. Chau and A. A. Mardon had a poster on "Lunar Caving and Lava Tubes."

P. J. Stooke had a poster titled "Ina-Like Young Volcanic Structures as Golden Spike Sites."

On Thursday evening, Alan Stern and Gerry Griffin made a public presentation about Golden Spike at LPI.

On Friday morning, October 4, Dr. Steven Mackwell began by summarizing thoughts from day 1. He observed that there had been a lot of focus on sample collection and network deployment.

R. Jaumann then spoke on *A Dedicated Small Exploration Orbiter (S-LEO) and Mobile Payload Element*. The orbiter would carry scientific instruments and also act as a far side communication relay. The goal would be to map resources. Jaumann suggested that volatiles may be the most important resource. He listed the instruments and what they measure, but stated that the payload is not finalized. He also discussed orbits around the Moon

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being considered. The mobile payload element would be a lander with a small rover to sample volatiles outside the contamination zone of the lander's rocket plume.

De Rosa *et al.* presented their paper via telecon. They discussed landing precision requirements and goals. A spacecraft needs hazard detection and avoidance in real time. Technologies related to this are under development in Europe. Their plan is to use optical relative and absolute navigation. Their relative navigation system has been field tested; their absolute navigation system has been lab tested.

Abercromby *et al.* presented a paper on Multi-Mission Space Exploration Vehicle (MMSEV). This is intended to be an EVA and robotics work system for multiple destinations. It is a standard cabin that can be kitted with various front ends and back ends for various applications and destinations; for example, as a rover for the lunar surface. They propose a mission mode that would use two rovers, with two crew members each. However, if one rover breaks down, all four crew members can get home in the other. Their design has great windows, to enable good observation from inside. This would minimize the occasions when crew would need to go EVA. Their rovers can dock to each other, and each has four suit ports. They also have external manipulator attachments.

In a talk added to the schedule, Georgiana Kramer discussed lunar swirls, and why they are an important landing target.

Clive Neal made a presentation on behalf of Dean Eppler, a NASA employee who was unable to be present. Eppler's paper discussed science operations on the lunar surface. Eppler considered both the experience of the Apollo astronauts and the annual NASA-JSC "Desert Rats" operations where people field test equipment and operational methods proposed for lunar or Mars surface operations, in which he is a regular participant. He concluded that to conduct effective science operations on the Moon, crew members need training in both geology and field communications. He noted that it took a minimum of two years for each Apollo group to work as a team. "Apollo group" did not just mean the flight crew; it included the support team on Earth. Eppler does not think the training of flight and ground crews has to take that long, since both astronauts and ground crew members had many other duties besides training during Apollo, but a significant investment in training time will be needed.

From his Desert Rats experience, Eppler sees safety as the biggest operational issue. Voice recognition does not work well; the field environment is very noisy, especially when wearing pressure suits. The Apollo 14 cart turned out to be more a liability than a help, and wheels were the main problem. To provide an effective cart for future Moon walkers, it would be necessary to redesign the wheels for difficult terrain; for example, soft terrain around a crater.

Nagihara *et al.* discussed heat flow probes for human lunar missions. They have a compact, modular design in mind. They propose that drilling a hole for a heat flow probe needs to be done robotically, based on Jack Schmitt's experience on the lunar surface, and his comments. They've developed a pneumatically based system to do this task. They discussed what they see as their system's advantages.

Zacny *et al.* presented on "Past, Present, and Future Drilling Technologies Enabling Lunar Exploration." This was a more general look at drilling than Nagihara *et al.*'s paper. They reminded us that drill extraction was a problem on Apollo 15. If we wish to extract water at the lunar poles, it will likely be in the form of ice or icy soil. They explained that drilling into icy soil on Earth is like drilling into concrete. You need to use a rotary or percussion drill. They have performed some experiments to try to learn if it is feasible to extract water from icy soil at the drill site, rather than transporting extracted material to a central location. Manipulating a drill core after getting one can be a problem.

Lucey *et al.* spoke of achieving ten meter resolution of thermal infrared spectroscopy and thermophysical properties from lunar orbit. The Moon Mineralogy Mapper (M-cubed or M^3) aboard the Chandrayan-1 spacecraft gave 140 meter resolution. They think that instruments comparable to some now aboard spacecraft in Mars orbit could achieve the resolution they seek.

Dr. T. S. Lee of Korea spoke about an International Space Exploration Research Institute (ISERI). His group has an objective of making a landing pad for a spaceport on the Moon. He discussed their approach to doing so. It will be important to store water, especially if people manage to produce any on the Moon. He thinks this could be done with concrete under the surface. His group has made prototypes of lunar concrete with no sand and no water. They use volcanic ash, with enzymes or polymer as binders. Korea has plans to send a lunar orbiter and a lunar lander by 2020. Dr. Lee's group has also made a habitat for four from soil, using a 3D printer.

William McKinnon and Steven Mackwell presented a summary and findings from the workshop.

Alan Stern was the final speaker of the workshop. He noted that he had not seen any "giggle factor" among the scientists attending the workshop, and not at other occasions where he has discussed the Golden Spike project. People are taking it seriously. Dr. Stern intents to assimilate what he has learned from the workshop, and use that information to help build enthusiasm. He will also continue to solicit inputs from those interested in the project.

Dr. Stern also mentioned future aspirations. Golden Spike intends to use the income stream from their missions to fund development of next-generation spacecraft, landers, equipment, etc., to enable longer stay times on the Moon, and perhaps a greater breadth of lunar surface activities. In other words, if Golden Spike is successful, their initial mission scenario will only be the first step for future human activities on the Moon.

GOLDEN SPIKE

[Image credits for this article: the Golden Spike Company media downloads, where the Moon walker on the preceding page is labeled a Spikonaut.]

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

Mission

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

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

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

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

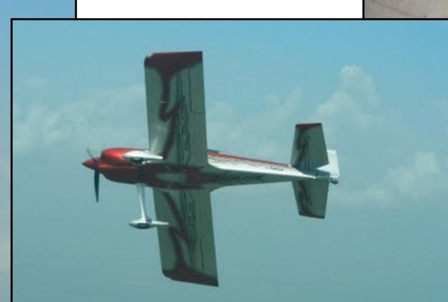
Ideas for a meeting? Contact Richard at rtsessions[at]earthlink.net, Chapter 12 web site: www.eaa12.org. Another email contact: eaachapt12[at]gmail.com. As of April 13, 2012, EAA Chapter 12 is meeting on the first Tuesday of month, based on the calendar on the web site. Experimental Aircraft Association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

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

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

Above and below: From Dave and Avril Forster's website, their F1 Rocket Kit Plane. Source: projects web page on the EAA Chapter 12 website.

[Two issues ago we featured Dave and Avril Forster's SeaRey on page 15. That link leads to a low resolution Horizons PDF file, 8 MB, 62 pages.]



The Fifteenth Anniversary of the International Space Station

OLIVIER SANGUY, WWW.ENJOYSPACE.COM (LA CITÉ DE L'ESPACE)

Adapted from the article in www.enjoyspace.com

The first International Space Station (ISS) element, the Russian module Zarya, was launched on November 20, 1998. The ISS now weighs 419 tons, is home to six astronauts, and involves the USA, Russia, Europe, Canada and Japan. It is the largest structure assembled in orbit.

Fifteen years ago on November 20, 1998, a Russian Proton rocket took off from the Baikonur cosmodrome in Kazakhstan. It successfully placed the Russian module Zarya into orbit, the first element of the future International Space Station (ISS), a program that involves the United States, Russia, Europe, Canada and Japan and their respective space agencies (NASA, Roscosmos, ESA, CSA and JAXA).

Today, the space station is the largest orbiting complex ever assembled, weighing in at 419 tons, and capable of permanently accommodating six astronauts and many scientific experiments that would be impossible to perform on Earth.

The ISS is primarily a scientific laboratory in orbit. The United States, Europe and Japan each have a laboratory module. (The largest one belongs to Japan.) As for Canada, it supplied the robotic arm Canadarm 2. Without this, ISS assembly would not have been possible. This robotic arm is also used to capture the cargo ships H-II Transfer Vehicle (HTV, from Japan), Dragon (from SpaceX), and Cygnus (from Orbital Sciences Corporation). Two other cargo spacecraft, Progress (from Russia) and the Automated Transfer Vehicle (ATV, from ESA), dock automatically. It should be noted that the Russian modules Zarya and Zvezda are "descendants" of the equivalent modules from the famous Mir space station. (A Mir technical replica can be visited at the Cité de l'Espace in Toulouse.)

In addition to its scientific aspect, the ISS is also an excellent example of successful international cooperation in space; complex modules and facilities manufactured in different countries work in orbit. This requires an unprecedented level of technical and industrial coordination. It is estimated that the ISS program provides work for 100,000 people on the ground! In this sense, the ISS paves the way for future crewed exploration projects with several countries working together. For example, current plans have NASA sending astronauts to an asteroid. NASA's human space program later targets Mars and other destinations such as the Moon, Lagrange points, and the Martian moons.

Above: The Zarya module in orbit in 1998, the first element of the ISS. Image credit: NASA.

Permanently inhabited by two or three people since October 30, 2000, the ISS moved to a crew of six on May 29, 2009. This was Expedition 20.

On November 15, 2013, we have now reached Expedition 38. Under current agreements, the ISS will remain operational until at least 2020.

(Continued on page 25)

Above: The International Space Station (ISS) today: the largest structure ever assembled in orbit. A genuine "school" for future manned exploration projects. Image credit: NASA

Above: Launch of the Russian Proton rocket that carried Zarya, the first module of the International Space Station on November 15, 1998. Image credit: NASA.

(Continued from page 24)

Since NASA's space shuttle program ended in 2011, the Russian three-seater Soyuz spacecraft is the only means of transport available to the astronauts.

However, the United States of America hopes to have a new crewed spacecraft from the private sector as early as 2017. NASA is now supporting private manufacturers so that they can develop crewed spacecraft to be used by NASA under a service provision agreement. This time the new spacecraft will not be used to transport freight, but astronauts! By privatizing the crew transportation service to the ISS, NASA hopes to save money while boosting a new business sector.

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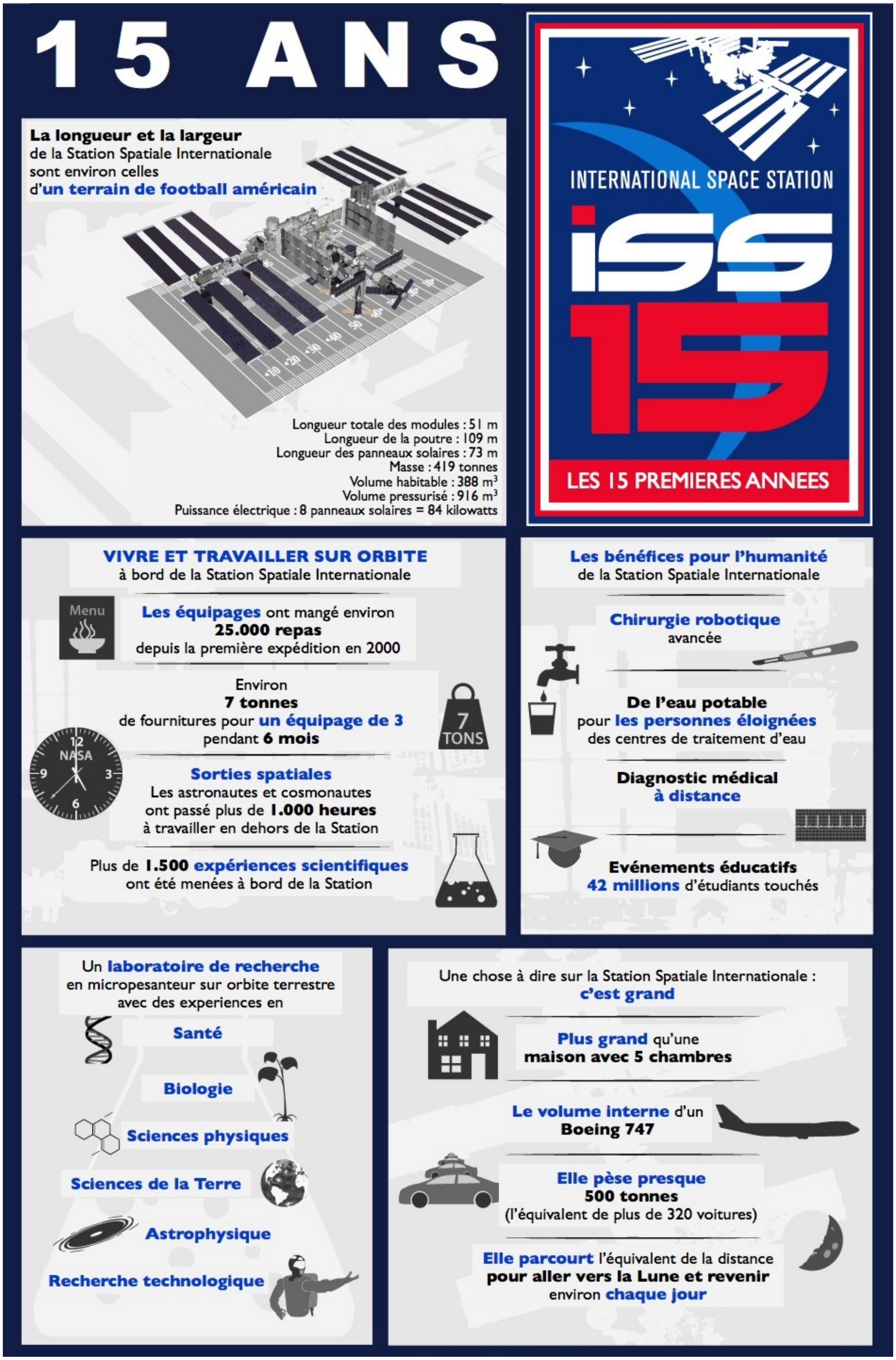


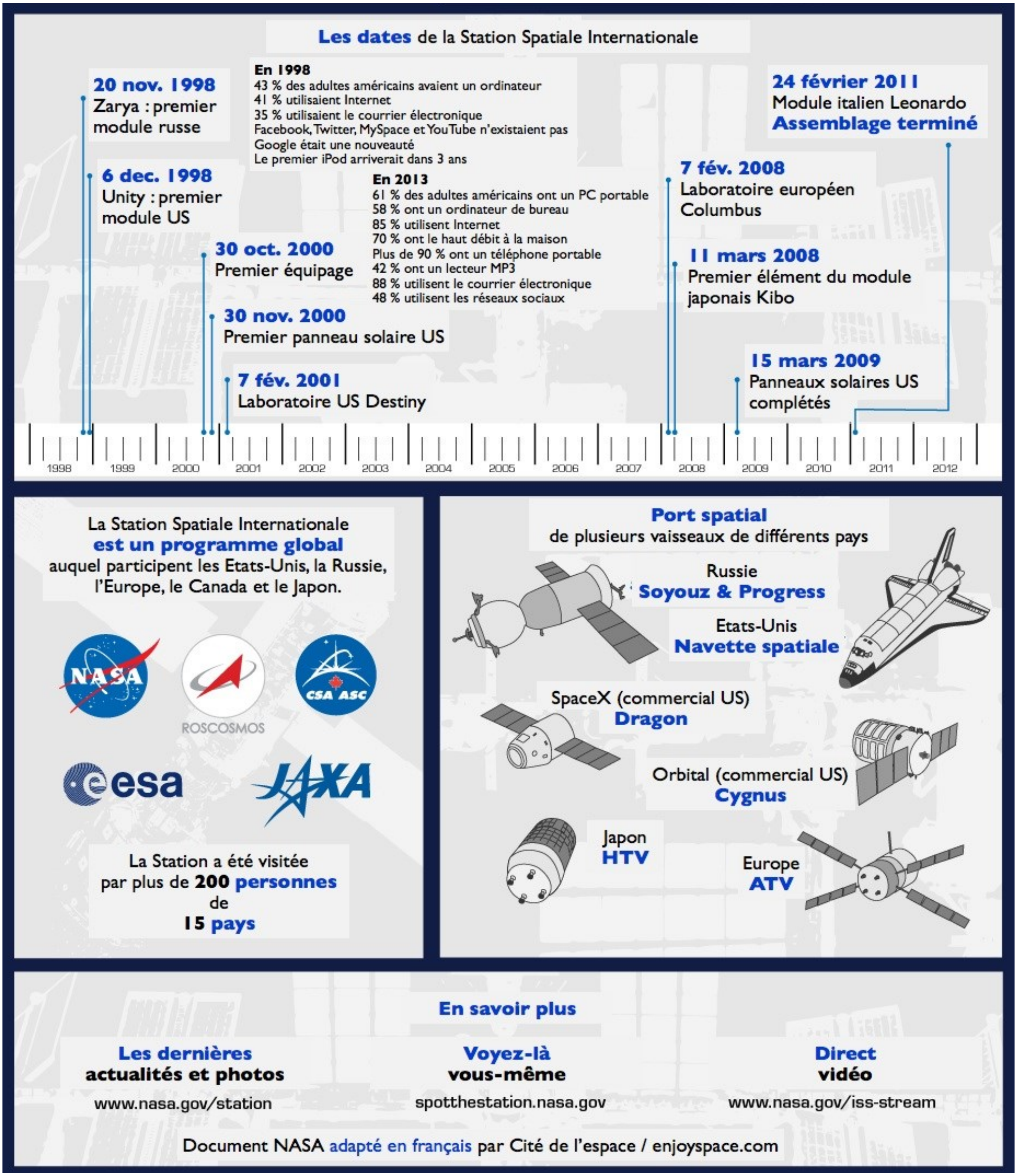
Left and on the next page: To celebrate fifteen years of the ISS, NASA produced a visual containing the most significant facts and figures. [The website www.enjoyspace.com translated this NASA document into French. Since AIAA Houston Section has a French sister section since 2007 (3AF MP), Horizons presents this figure using its French translation: something different for our American audience.]

(Continued from page 25)

The ISS is already a remarkable achievement as we celebrate its 15th anniversary.

The ISS is also a step into a bright future for the impulse of humanity to travel to the stars.

Additional contributors for this article: Philippe Mairet, 3AF MP and Douglas Yazell, Horizons Editor.



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

Douglas Yazell, Editor

These amazing pictures show the attraction of the exterior of this art deco building. The museum's air traffic control tower is no longer in use for now, but it is closer to the runways than the new tower. I was among the Wings & Wheels event visitors in the past when we walked outside on top of the first and second floors. That provided a great view of the runways. We also walked in the old control tower and around the outside of those windows. Those visits will take place again once the building restoration advances far enough.

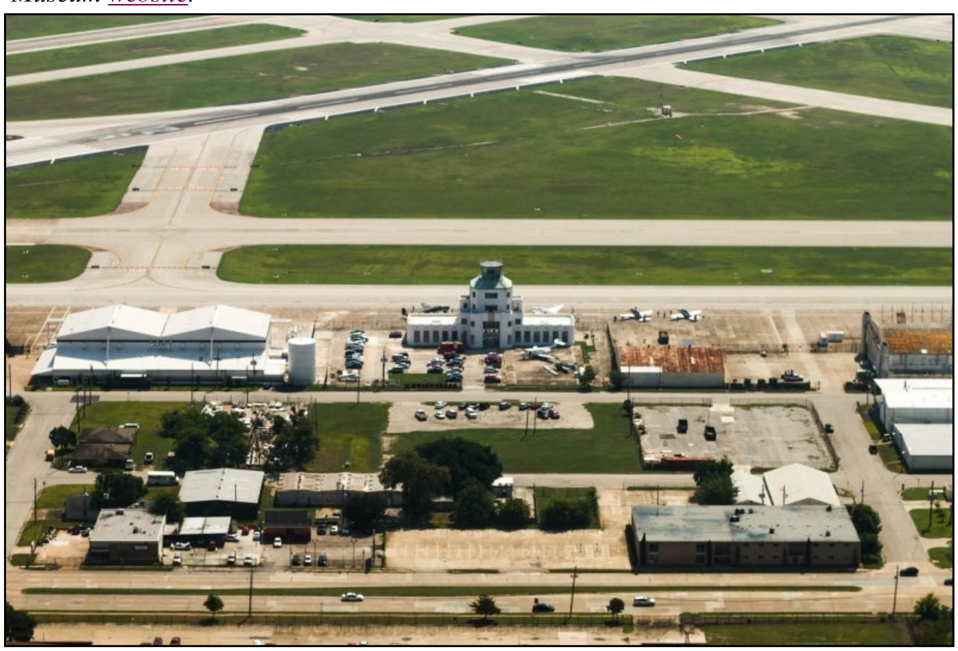
On the other side of the building from the runways is Travelair Street. Additional museum parking is available on the far side of that street. The next street parallel to Travelair Street is Telephone Road. Some museum plans show a grand museum entrance starting at Telephone Road. The plans include gardens and an airplane on a stick, a dramatic sight.

As the museum continues to raise money for building restoration, let us support them via occasional visits to their monthly Wings & Wheels events. It is always a fun visit, with lunch usually available for purchase from the gourmet truck Flaming Patties. Membership is very affordable, too. Souvenirs include attractive polo shirts of various solid colors with the museum logo on the left of the chest.

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

Above and below: August 2013 Wings & Wheels event pictures of the museum by museum volunteers Larry Orr (photographer) and Max Tribolet (pilot). Image credits: Museum website.



Astronaut Scott Carpenter, 1925-2013

Douglas Yazell, Editor

Scott Carpenter 1925-2013
Adapted from the Wikipedia article

Malcolm Scott Carpenter (May 1, 1925 – October 10, 2013) was an American test pilot, astronaut, and aquanaut. He was one of the original seven astronauts selected for NASA's Project Mercury in April 1959. Carpenter was the second American to orbit the Earth and the fourth American in space, following Alan Shepard, Gus Grissom, and John Glenn.

Early life

Born in Boulder, Colorado, Carpenter moved to New York City with his parents Marion Scott Carpenter and Florence [née Noxon] Carpenter for the first two years of his life. His father had been awarded a postdoctoral research post at Columbia University. In the summer of 1927, Scott returned to Boulder with his mother, then ill with tuberculosis. He was raised by his maternal grandparents in the family home at the corner of Aurora Avenue and Seventh Street, until his graduation from Boulder High School in 1943. (It was claimed that his reason for choosing the name "Aurora 7" for his spacecraft was for the fact that he was raised at this house on the corner of Aurora and Seventh, but Carpenter denied this.)

Naval aviator

Upon graduation, he was accepted into the V-12 Navy College Training Program as an aviation cadet (V-12a), where he trained until the end of World War II. The war ended before he was able to finish training and receive an overseas assignment, so the Navy released him from active duty. He returned to Boulder in November 1945 to study aeronautical engineering at the University of Colorado at Boulder. While at Colorado he joined Delta Tau Delta International Fraternity. At the end of his senior year, he missed the final examination in heat transfer, leaving him one requirement short of a degree. After his Mercury flight, the university granted him the degree on grounds that, "His subsequent training as an Astronaut has more than made up for the deficiency in the subject of heat transfer."

On the eve of the Korean War, Carpenter was recruited by the United States Navy's Direct Procurement Program (DPP), and reported to Naval Air Station Pensacola, Florida in the fall of 1949 for pre-flight and primary flight training. He earned his aviator wings on April 19, 1951, in Corpus Christi, Texas. During his first tour of duty, on his first deployment, Carpenter flew Lockheed P2V Neptunes for Patrol Squadron Six (VP-6) on reconnaissance and anti-submarine warfare (ASW) missions during the Korean War. Forward-based in Adak, Alaska, Carpenter then flew surveillance missions along the Soviet and Chinese coasts during his second deployment; designated as PPC (patrol plane commander) for his third deployment, LTJG Carpenter was based with his squadron in Guam.

Carpenter was then appointed to the United States Naval Test Pilot School, class 13, at NAS Patuxent River, Maryland in 1954. He continued at Patuxent until 1957, working as a test pilot in the Electronics Test Division; his next tour of duty was spent in Monterey, California, at the Navy Line School. In 1958, Carpenter was named Air Intelligence Officer for the USS Hornet.

NASA career

After being chosen for Project Mercury in

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Above: A pair of fighter planes show how aerospace technology has moved ahead. The F-22 Raptor is powered by engines that can steer the exhaust up or down to enhance maneuverability. It is technology NASA helped pioneer with the X-31 program. The P-51 Mustang, still in service when the Air Force was formed 60 years ago, was considered the premier fighter of the World War II era. Image credit: NASA/Chris Chamberland.

Above: While the jets rocketed overhead, former astronauts John Glenn, Scott Carpenter and Al Worden watched the demonstrations within miles of the launch pads where they began their historic flights into space and, in Worden's case, to the Moon. They also took part, along with other astronauts, in Expo events at the Kennedy Space Center Visitor Complex, which hosted the weekend celebration. Text credit: NASA, November 6, 2007, reporting on the airshow at Kennedy Space Center.

Scott Carpenter 1925-2013

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1959, Carpenter served as backup pilot for John Glenn, who flew the first U.S. orbital mission aboard Friendship 7 in February 1962. When Deke Slayton was withdrawn on medical grounds from Project Mercury's second manned orbital flight (to be titled Delta 7), Carpenter was assigned to replace him. He flew into space on May 24, 1962, atop the Mercury-Atlas 7 rocket for a three-orbit science mission that lasted nearly five hours. His Aurora 7 spacecraft attained a maximum altitude of 164 miles (264 km) and an orbital velocity of 17,532 miles per hour (28,215 km/h).

Working through five onboard experiments dictated by the flight plan, Carpenter helped, among other things, to identify the mysterious "fireflies" (which he renamed "frostflies," as they were in reality particles of frozen liquid around the craft), first observed by Glenn during MA-6. Carpenter was the first American astronaut to eat solid food in space.

Carpenter's performance in space was the subject of criticism and controversy. While one source has Christopher C. Kraft (Chris Kraft), directing the flight from Cape Canaveral, considering Carpenter's "mission the most successful to date; everything had gone perfectly except for some overexpenditure of fuel." The New York Times reported in its obituary for Carpenter that Kraft was angry because Carpenter was not paying attention to his instruments and ignoring instructions from Mission Control. Kraft opposed Carpenter's assignment to future space missions.

Unnoticed by ground control or pilot, however, this "overexpenditure of fuel" was caused by an intermittently malfunctioning pitch horizon scanner (PHS) that later malfunctioned at reentry. Still, NASA later reported that Carpenter had:

"exercised his manual controls with ease in a number of [required] spacecraft maneuvers and had made numerous and valuable observations in the interest of space science. ... By the time he drifted near Hawaii on the third pass, Carpenter had successfully maintained more than 40 percent of his fuel in both the automatic and the manual tanks. According to mission rules, this ought to be quite enough hydrogen peroxide, reckoned Kraft, to thrust the capsule into the retrofire attitude, hold it, and then to reenter the atmosphere using either the automatic or the manual control system."

At the retrofire event, the pitch horizon scanner malfunctioned once more, forcing Carpenter to manually control his reentry, which caused him to overshoot the planned splashdown point by 250 miles (400 km). ("The malfunction of the pitch horizon scanner circuit [a component of the automatic control system] dictated that the pilot manually control the spacecraft attitudes during this event.") The PHS malfunction jerked the spacecraft off in yaw by 25 degrees to the right, accounting for 170 miles (270 km) of the overshoot; the delay caused by the automatic sequencer required Carpenter to fire the retrorockets manually. This effort took two pushes of the override button and accounted for another 15 to 20 miles (30 km) of the overshoot. The loss of thrust in the ripple pattern of the retros added another 60 miles (100 km), producing a 250-mile (400 km) overshoot.

Above: Mercury astronaut Scott Carpenter, right and United States Postal Service Vice President of Finance Steve Masse unveil a pair of stamps to commemorate the 50th anniversary of Alan Shepard's launch into space aboard the Mercury spacecraft "Freedom 7." Image credit: NASA/Bill Ingalls.

During reentry, there was a great deal of concern over whether Carpenter had actually survived, since he splashed down 250 miles off course. Forty minutes after splashdown, Carpenter was located in his life raft, safe and in good health by Maj. Fred Brown under the command of the Puerto Rico Air National Guard, and recovered three hours later by the USS Intrepid.

Postflight analysis described the PHS malfunction as "mission critical" but noted that the pilot "adequately compensated" for "this anomaly ... in subsequent inflight procedures," confirming that backup systems—human pilots—could succeed when automatic systems fail.

Some memoirs have revived the simmering controversy over who or what, exactly, was to blame for the overshoot, suggesting, for example, that Carpenter was distracted by the science and engineering experiments dictated by the flight plan and by the well-reported fireflies phenomenon. Yet fuel consumption and other aspects of the vehicle operation were, during Project Mercury, as much, if not more, the responsibility of the ground controllers. Moreover, hardware malfunctions went unidentified, while organizational tensions between the astronaut of-

(Continued on page 30)

Scott Carpenter 1925-2013

(Continued from page 29)

fice and the flight controller office—tensions that NASA did not resolve until the later Gemini and Apollo programs—may account for much of the latter-day criticism of Carpenter's performance during his flight.

Carpenter never flew another mission in space. After taking a leave of absence from the astronaut corps in the fall of 1963 to train for and participate in the Navy's SEALAB program, Carpenter sustained a medically grounding injury to his left arm in a motorbike accident. After failing to regain mobility in his arm after two surgical interventions (in 1964 and 1967), Carpenter was ruled ineligible for spaceflight. He resigned from NASA in August 1967. He spent the last part of his NASA career developing underwater training to help astronauts with future spacewalks.

Ocean research

In July 1964 in Bermuda, Carpenter sustained a grounding injury from a motorbike accident while on leave from NASA to train for the Navy's SEALAB project. In 1965, for SEALAB II, he spent 28 days living on the ocean floor off the coast of California. During the SEALAB II mission, Carpenter's right index finger was wounded by the toxic spines of a scorpion fish. He returned to work at NASA as Executive Assistant to the Director of the Manned Spacecraft Center, then returned to the Navy's Deep Submergence Systems Project in 1967, based in Bethesda, Maryland, as a Director of Aquanaut Operations for SEALAB III. In the aftermath of aquanaut Berry L. Cannon's death while attempting to repair a leak in SEALAB III, Carpenter volunteered to dive down to SEALAB and help return it to the surface, although SEALAB was ultimately salvaged in a less hazardous way. Carpenter retired from the Navy in 1969, after which he founded Sea Sciences, Inc., a corporation for developing programs for utilizing ocean resources and improving environmental health.

Personal life

Carpenter was married four times and divorced three. He married Rene Louise Price in 1948. In 1972, he married Maria Roach, daughter of film producer Hal Roach. He married Barbara Curtin in 1988 and divorced several years later. He married Patty Barrett in 1999. He had four children from his first marriage: Marc Scott, Kristen Elaine, Candace Noxon, and Robyn Jay. He also had two children from his second marriage: Matthew Scott and filmmaker Nicholas Andre, and one child from his third marriage, Zachary Scott. Carpenter had a stroke and entered The Denver Hospice Inpatient Care Center at Lowry where he died on October 10, 2013. He was 88 and was survived by his wife, Patty; four sons, Jay, Matthew, Nicholas, and Zachary; two daughters, Kristen Stoever and Candace Carpenter; a granddaughter; and five step-grandchildren. One son, Marc, predeceased him.

When Carpenter died, John Glenn became the last living member of the Mercury Seven.

Honors and awards

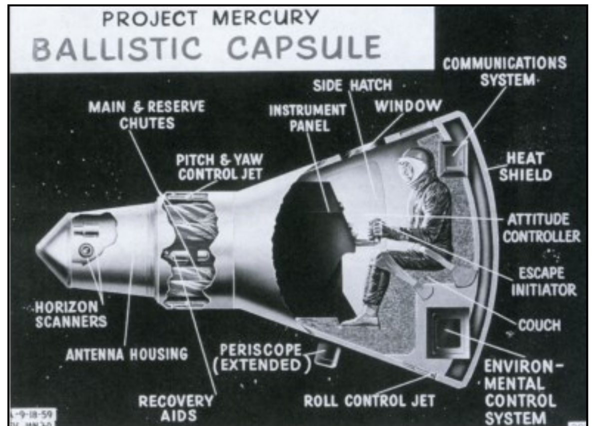
Carpenter received:

- Navy Astronaut Wings
- Navy's Legion of Merit
- Distinguished Flying Cross
- NASA Distinguished Service Medal
- University of Colorado Recognition Medal
- Collier Trophy
- New York City Gold Medal of Honor
- Elisha Kent Kane Medal
- Ustica Gold Trident
- Boy Scouts of America Silver Buffalo Award.
- Academy of Underwater Arts & Sciences 1995 NOGI Award for Distinguished Service

In 1962, Boulder community leaders dedicated Scott Carpenter Park and Pool in honor of native son turned Mercury astronaut. The Aurora 7 Elementary School, also in Boulder, was named for Carpenter's spacecraft.

Scott Carpenter Middle School in Westminster, Colorado, was named in his honor, as was M. Scott Carpenter Elementary School in Old Bridge, New Jersey.

The Scott Carpenter Space Analog Station was placed on the ocean floor in 1997 and 1998. It was named in honor of Carpenter's SEALAB work in the 1960s.



Above: The Mercury Capsule, America's first true spacecraft, shown in a cutaway drawing made in January 1960. (NASA photo no. M-278, ASTRO 17).

In popular culture

Speaking from the blockhouse at the launch of Friendship 7, Carpenter, John Glenn's backup pilot, said "Godspeed, John Glenn," as Glenn rose off the launch pad to begin his first U.S. orbital mission on February 20, 1962.

This quote was included in the voiceovers of the teaser trailer for the 2009 Star Trek film. The audio phrase is used in Kenny G's "Auld Lang Syne" (The Millennium Mix). It is also used as a part of an audio introduction for the Ian Brown song "My Star."

Less officially, Carpenter has been reported to add, sarcastically, "Remember, John, this was built by the low bidder." This quote is sometimes improperly attributed to John Glenn.

In the 1983 film, The Right Stuff, Carpenter was played by Charles Frank. Although his appearance was relatively minor, the film played up Carpenter's friendship with John Glenn, as played by Ed Harris. This film is based on the book of the same name by Tom Wolfe.

(Continued on page 31)

Scott Carpenter 1925-2013

Links

http://www.jsc.nasa.gov/Bios/htmlbios/carpenter-ms.html
http://www.nasa.gov/content/carpenter-pioneered-exploration-in-space-and-the-oceans/
http://www.nasa.gov/astronautprofiles/carpenter/
http://history.nasa.gov/40thmerc7/timeline.htm
http://www.nasa.gov/press/2013/october/nasa-administrator-remembers-mercury-astronaut-scott-carpenter/

(Continued from page 30)

The character of Scott Tracy in the Thunderbirds television series was named after him.

His recovery is referred to in the Peanuts comic strip of June 28, 1962, after Linus' security blanket is rescued under similar circumstances.

Books

- *We Seven: By the Astronauts Themselves*, ISBN 978-1439181034, by M. Scott Carpenter (Author), Gordon L. Cooper (Author), John H. Glenn (Author), Virgil I. Grissom (Author), Walter M. Schirra (Author), Alan B. Shepard (Author), Donald K. Slayton (Author),
- *For Spacious Skies: The Uncommon Journey of a Mercury Astronaut*, ISBN 0-15-100467-6 or the revised paperback edition ISBN 0-451-21105-7, Carpenter's biography, co-written with his daughter Kris Stoever; describes his childhood, his experiences as a naval aviator, a Mercury astronaut, including an account of what went wrong, and right, on the flight of *Aurora 7.*
- *Into That Silent Sea: Trailblazers of the Space Era, 1961–1965*, by Francis French and Colin Burgess, 2007. A Carpenter-approved account of his life and space flight.
- *The Steel Albatross*, ISBN 978-0831776084. Science Fiction. A "technothriller" set around the life of a fighter pilot in the US Navy's Top Gun school.
- *Deep Flight*, ISBN 978-0671759032. Science Fiction. This follow-on to The Steel Albatross is an underwater outburst of war and action.

(Continued on page 32)

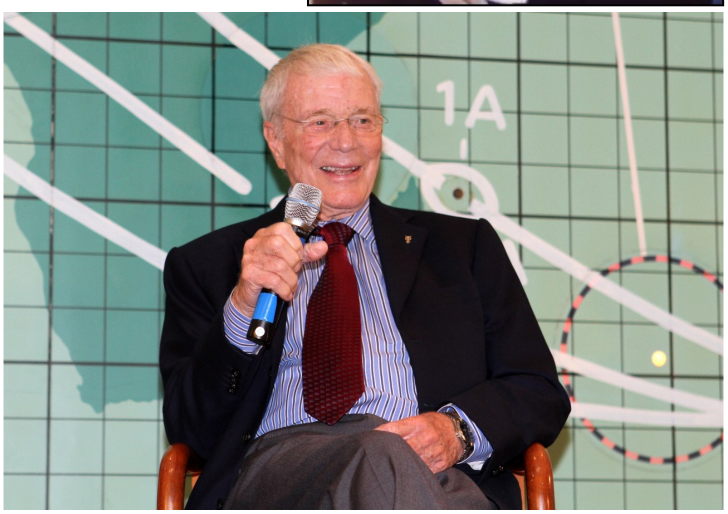
Above: Scott Carpenter at the Mercury Control Center in Florida. Image credit: NASA.

Scott Carpenter 1925-2013

(Continued from page 31)

Left and below: Image credits: Screen capture images from the NASA video.

Above and right: NASA Administrator James Webb honoring Scott Carpenter at the NASA Manned Spacecraft Center in Houston, Texas, now Johnson Space Center.



Above: Scott Carpenter in February of 2012. Image credit: NASA/Kim Shiflett.

Above: Scott Carpenter in May of 2011. Image credit: NASA/Kim Shiflett.

Timeline

October 1, 1958	National Aeronautics and Space Administration (NASA) created
October 7, 1958	NASA formally organized its first "man-in-space program"
November 26, 1958	"Man-in-space program" dubbed "Project Mercury"
December 1958	NASA's selection committee decides the candidate pool for astronaut selection will be from military test pilots
December 4, 1959	Launch of Sam (a monkey) on Little Joe 2
January 1959	Service records screened of 508 candidates
February 1959	Candidates pared to 110 men
March 1959	More testing of candidates, pool winnowed to 32 men.
Late March 1959	Eighteen men recommended without medical reservation
January 31, 1961	Launch of Ham (a chimpanzee) on Mercury Redstone 2
April 1, 1959	Selection committee decides on Mercury Seven
April 9, 1959	NASA introduces Carpenter, Cooper, Glenn, Grissom, Schirra, Shepard, and Slayton to the world at press conference
January 21, 1960	Launch of Miss Sam (a monkey) on Little Joe IB
May 5, 1961	Launch of Alan Shepard in *Freedom 7*, first American human suborbital flight
July 21, 1961	Launch of Gus Grissom in *Liberty 7*, second American human suborbital flight
November 29, 1961	Launch of Enos (a chimpanzee) on Mercury Atlas 5, an orbital flight
January 3, 1962	Project Gemini formally conceived
February 20, 1962	Launch of John Glenn in *Friendship 7*, first American human orbital flight
May 24, 1962	Launch of Scott Carpenter in *Aurora 7*
October 3, 1962	Launch of Walter Schirra in *Sigma 7*
May 15, 1963	Launch of Gordon Cooper in *Faith 7*, the final mission of Project Mercury

Above: Mercury 7 timeline. Image credit: NASA.

[Thanks to our French sister section 3AF MP for suggesting the creation of this article for Horizons.]

Address to AIAA Houston Section about the late James C. McLane, Jr., Part 3 of 6

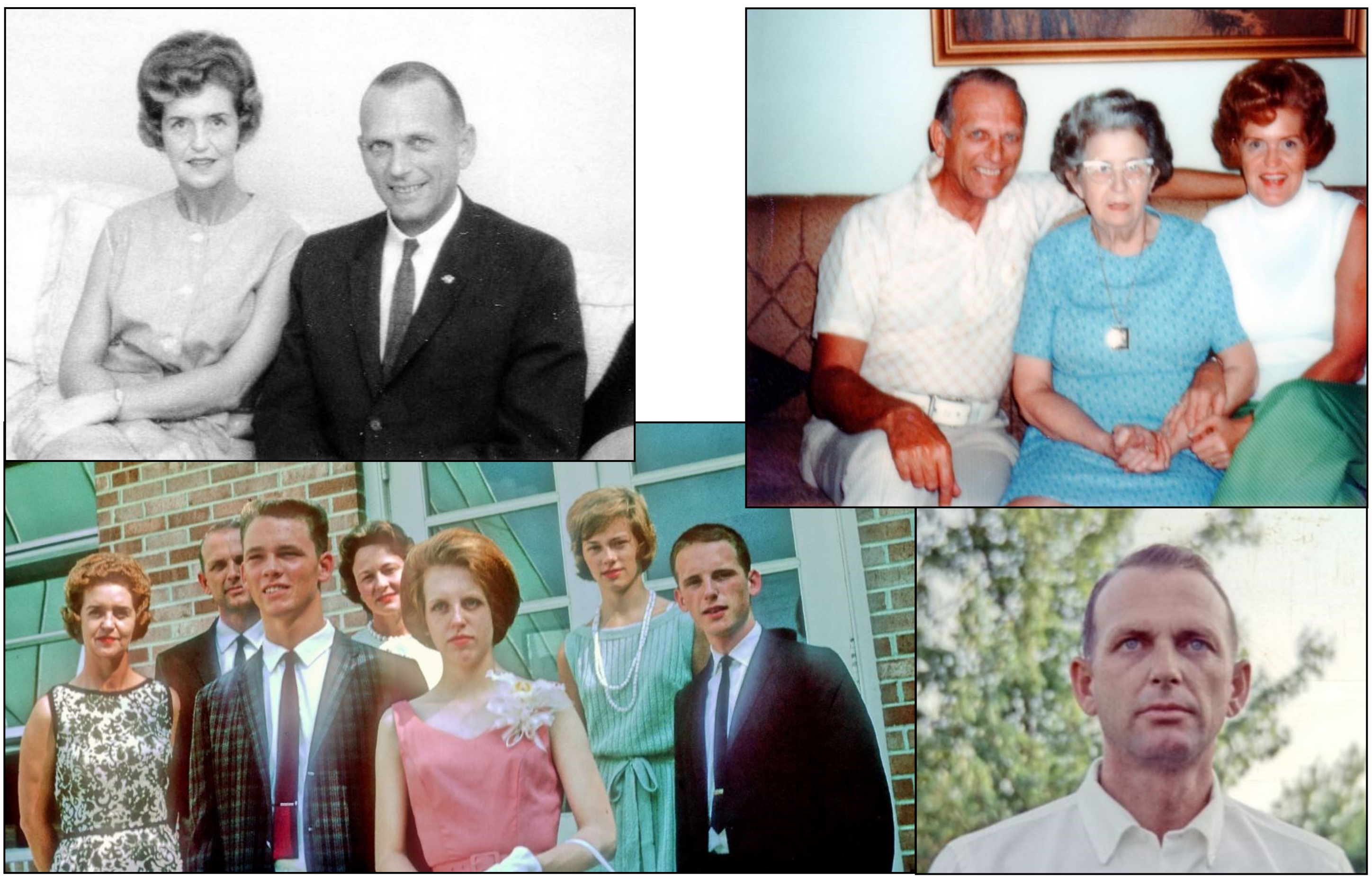
James C. McLane, Jr.
1923 - 2012

JAMES C. MCLANE III

NASA's Relationship with Russia is an Exception

As far back as the early 1970s the Apollo-Soyuz Test Project (ASTP) had required the exchange of technical experts and information between two countries who were serious enemies. Perhaps 100 Russians were stationed in Houston for several months. My father was involved, since he was the Chief of the Space Environment Test Division. The ASTP docking adapter was tested in his NASA/JSC Building 32 space chambers. At the time I was living with my parents and working downtown for Brown and Root, the world's largest engineering and construction firm. My group was competing to win a contract with the Soviet Union to build a pipeline in Siberia to deliver natural gas to Europe. No western firm was doing business with the Soviets, so this would be a pioneering job. We had hired an elegant young Texas lady with a Master's degree in Russian language to handle translation.

The ASTP was nearing an end so my father invited the head Russian representative, Air Force General Kolodkov, to come to our house for a backyard barbeque cookout. I brought Brown and Root's Russian-speaking secretary. The General showed up with a man he identified as an engineer, but the man did not seem to know anything technical. I believe he was a KGB secret agent who kept an eye on the Russians assigned to Houston. The General spoke excellent English because during WW2 he was stationed on Long Island in the state of New York working with Bell Aircraft to ship P-39 fighter airplanes to Russia. At the cookout, the General and the KGB man often said that it was not possible that the lady was really a secretary. I think they suspected she was some sort of intelligence agent. Many years later I did some research and found that the General eventually served as head of all Soviet ICBM forces. I'm glad we gave him a good impression of the USA.



Above: Family snapshots provided by James C. McLane III. Moving clockwise from the top left, we recognize Mr. and Mrs. James C. McLane, Jr., Dorothy and James McLane. These images might fit well with this article and its description of a McLane backyard barbecue during the era of the 1975 Apollo-Soyuz Test Program (ASTP). McLane's WW2 fighter airplane was named Dainty Dotty in honor of his wife Mrs. Dorothy McLane.

Automated Transfer Vehicle Disintegrates, as Expected, Below the Eyes of the Astronauts

ADAPTED FROM THE WEBSITE OF THE FRENCH NATIONAL CENTER FOR SPACE STUDIES (CNES)

November 2, 2013

The fourth Automated Transfer Vehicle (ATV-4) Albert Einstein disintegrated this afternoon, 12:00 to 1:04 P.M. (Paris time) during its reentry.

The ATV-4 burned with 1300 kg of waste onboard from the International Space Station (ISS). The cargo ship remained in orbit five days after its separation from the ISS Monday, October 28, 2013. During this trip, the control center ATV- CC at the National Center for Space Studies (CNES) in Toulouse, gradually lowered the altitude of the cargo spacecraft from 400 to 300 kilometers, using the ATV engines.

Above: ATV-4 disintegration was recorded by the crew from the ISS cupola. Image credit: NASA.

More calculations

The goal was to position the ATV reentry exactly below the ISS. In this manner, CNES responded effectively to the requests of the ISS partner nations. (This below-the-ISS reentry is an activity that was not originally planned for ATV-4.) “All of our software has been modified to make this deorbit. We caused the ATV to believe it was joining another space station,” explained Patrice Benarroche, the CNES operations chief.

Tense moments when docking on June 15. Image credit: CNES/Sébastien Girard, 2013.

The CNES engineers positioned ATV-4 exactly below the station so that astronauts could take photographs of the ATV disintegration from the famous ISS cupola. This was a request from NASA and ROSCOSMOS (the Russian Space Agency), as the two major ISS partners want to study the ISS reentry, which could take place in 2020.

The breakup occurred in a safe zone above the South Pacific, the area farthest from all human concentration.

Emotion

A certain sensation of sadness invaded the teams upon the disappearance of a vehicle they accompanied for more than a

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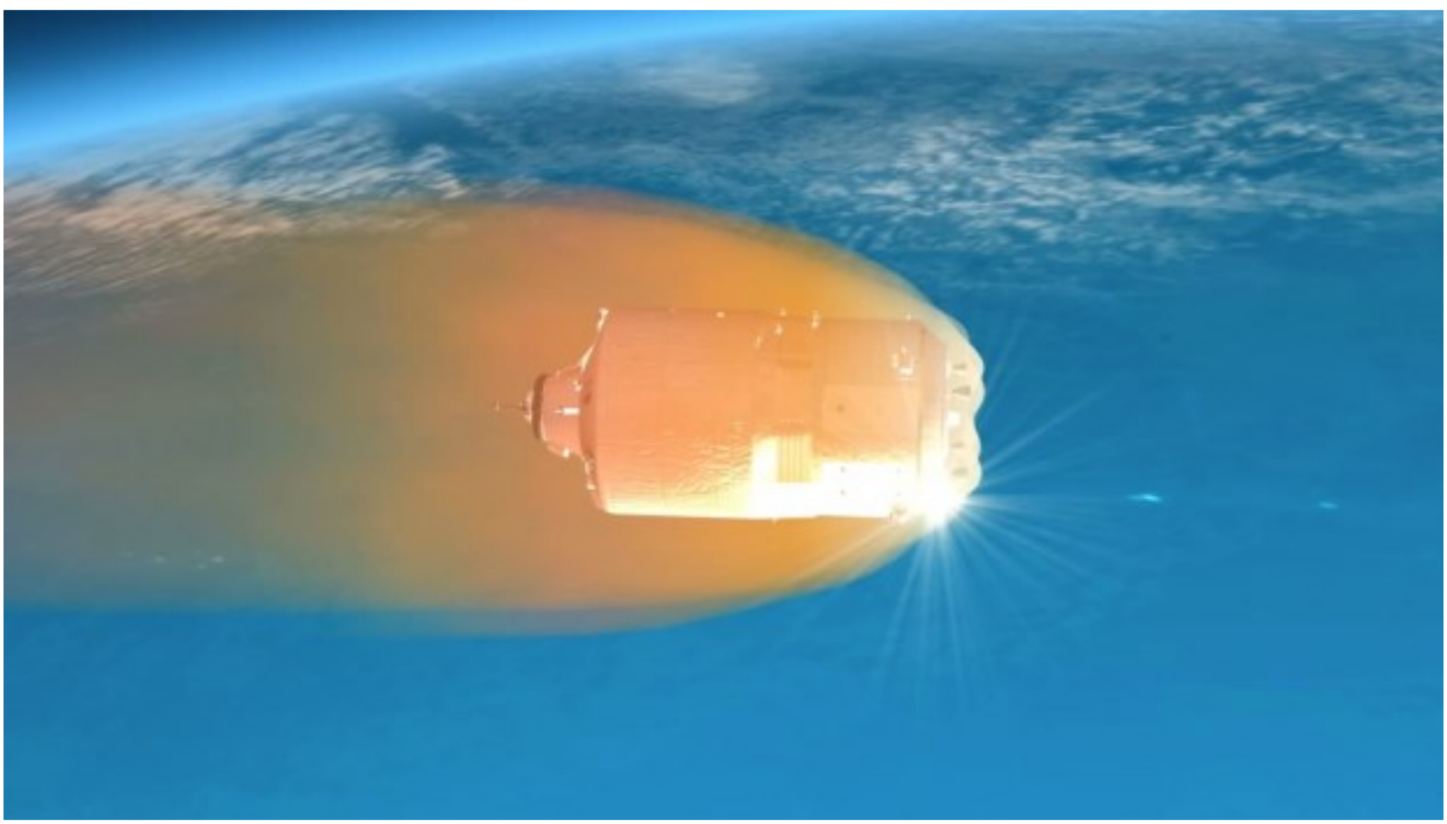


Above: The disintegration of the ATV (artist’s impression). Credits: CNES, October 2013 - David Ducros.

(Continued from page 34)

year from its assembly until Saturday, November 2, 2013 at 1304 hours (Paris time). But the ATV-5 mission is already in progress ... Goodbye, Albert Einstein, hello, Georges Lemaitre!

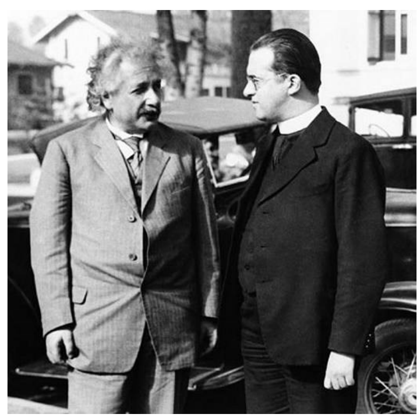
ATV-4: a Campaign in Pictures

Above: Chris Cassidy, Karen L. Nyberg and Luca Parmitano unpack the ATV-4 cargo. Image credit: NASA.

Above: A nod to Albert Einstein in the halls of the ATV control center in Toulouse, France. Image credit: CNES 2013. "Theory is when we know everything and nothing works. Practice is when everything works and no one knows why. Here, we united theory and practice: nothing works, and no one knows why!" Albert Einstein. [Now I am worried!]

Above: A tribute from the ISS crew to Albert Einstein and to the ATV bearing his name. Image credit: NASA.

Above: A view of ATV- 4 during its separation from the Russian ISS module, Monday, October 28, 2013. On the docking ring, you can see an electrical connector, a connector used for refueling the ISS, some hooks and a pushbutton that gives to the ATV the first impulse to move away from the Russian service module. Image credit: NASA.



Above: An image for collectors! Albert Einstein and Georges Lemaitre at a meeting in Pasadena, California, in 1932. Logo ATV-4 & 5. Image credit: ESA.

Opinion

Climate Change and Local Responses

DOUGLAS YAZELL, EDITOR (ARTICLE #6 IN THIS BIMONTHLY SERIES)

A great friend mentioned a May 17, 2013 climate change episode of This American Life on National Public Radio (NPR). Is the conversation stuck? With host Ira Glass, they tried to assemble an hour of stuff that has not been heard before.

NPR's Houston Matters demonstrated in their broadcast of November 25, 2013 that the conversation has changed. Guest Alex Chadwick presented an NPR special presentation the night before called Rising Seas, part of a new series about energy and the environment called Burn. (Rising Seas was to be repeated November 27 at noon in Houston in place of Houston Matters.)

Have we reached a threshold in this national conversation? Alex Chadwick replies in part, "… I am not talking to people who don't believe in science." He also says, "There are going to be climate refugees."

The next segment of this episode of Houston Matters featured two guests, Dr. Jim Lester of the Houston Advanced Research Center (HARC) and Dr. John Anderson of Rice University. The subject was rising sea levels and their impacts on the Gulf region.

The October 29, 2013 episode of *Democracy Now* featured the former president of Ireland, Mary Robinson. She created the Mary Robinson Foundation—Climate Justice. Interviewed in that episode, Robinson says, "The prediction is we may have up to 200 million climate-displaced people by 2050. … We can't call them climate refugees like we have other refugees because there is no convention."

TED talks are a popular series of presentations at www.ted.com, where TED stands for Technology, Entertainment and Design. Searching for climate change there quickly leads to quite a few climate change presentations. Talks are limited to at most 18 minutes. Rachel Pike presents a talk that is very memorable, *The Science Behind a Climate Headline*. The details are numerous, but her presentation lasts only about four minutes. In fact, that web page says, "talks in less than six minutes."

President Obama helped to change the conversation in his major speech of June 25, 2013. "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. We don't have time for a meeting of the Flat Earth Society." He went on to say, "Understand that this is not just a job for politicians. So I'm going to need all of you to educate your classmates, your colleagues, your parents, your friends. Tell them what's at stake. Speak up at town halls, church groups, PTA meetings. Push back on misinformation. Speak up for the facts. Broaden the circle of those who are willing to stand up for our future."

Andrew Revkin writes the Dot Earth opinion blog for the New York Times. This blog is a good summary of the science and public policy of climate change.

The United Nations Intergovernmental Panel on Climate Change (IPCC) has been summarizing these science results and preparing a Summary for Policymakers. Their first report was issued in 1990. The release of their fifth report started on September 27, 2013. Revkin's blog entry of that date summarizes that report.

Revkin begins that blog entry with this quote from the new IPCC report:

By the mid-21st century the magnitudes of the projected changes are substantially affected by the choice of emissions scenario.

Revkin continues by quoting from the IPCC Headline Statements from the Summary for Policymakers. A few of those are presented here:

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

Human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system.

It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century.

Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

Cumulative emissions of CO2 largely determine global mean surface warming by the late 21st century and beyond. Most aspects of climate change will persist for many centuries even if emissions of CO2 are stopped. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO2.

In this Summary for Policymakers, the following summary terms are used to describe the available evidence: limited, medium, or robust; and for the degree of agreement: low, medium, or high. A level of confidence is expressed using five qualifiers: very low, low, medium, high, and very high, and typeset in italics, e.g., *medium confidence*. For a given evidence and agreement statement, different confidence levels can be assigned, but increasing levels of evidence and degrees of agreement are correlated with increasing confidence (see Chapter 1 and Box TS.1 for more details).

In this Summary for Policymakers, the following terms have been used to indicate the assessed likelihood of an outcome or a result: virtually certain 99–100% probability, very likely 90–100%, likely 66–100%, about as likely as not 33–66%, unlikely 0–33%, very unlikely 0–10%, exceptionally unlikely 0–1%. Additional terms (extremely likely: 95–100%, more likely than not >50–100%, and extremely unlikely 0–5%) may also be used when appropriate. Assessed likelihood is typeset in italics, e.g., *very likely* (see Chapter 1 and Box TS.1 for more details).

Above: Two footnotes from page 2 (page 8 of 33 pages in the PDF file) of the IPCC Summary for Policymakers.

The JSC Astronomical Society
Building an Astronomer's Chair Complete with Sketch Desk and Red Lighting (Part 4 of 7)

JIM WESSEL, JSCAS EDUCATIONAL OUTREACH CHAIRMAN

This Issue:
Construction of the Astronomer's Stool Support

A Good Leg (or Four) to Stand On

Earlier, I outlined the construction of the pedestal that forms the adjustable support for the seat, but that structure alone is insufficient to prevent the stool from falling over. In Rod Nabholz's original design, he used four 14-inch 2x4s attached on each of the bottom sides of the pedestal to increase the size of the footprint and add to the overall stability. John and I scaled up the legs for my considerably larger stool to 18 inches apiece and rounded the upper outside corner of the legs. One thing that I have noticed and utilized post hence is that the top surface of the legs are a ready and available built-in mini step stool, even for someone of my height, when the chair is nearing maximum extension. Here's a picture of the four legs:

We felt that my weight at the top of the stool against the limited surface area of the connection point between the four legs and the pedestal (and the limited screws) was just setting the scene for a leg to either start loosening causing the whole stool to become unlevel or the leg breaking off entirely. Both from a safety standpoint and from a stability issue, we wanted a bit more security in our design. So we made four plywood buttresses that were equal in height to the central pedestal and went roughly two thirds of the way out to the distal tip of the legs. The picture below gives an idea of their shape.

The next step was to attach the buttresses to the legs. We used glue and eight 1.5-inch woodscrews, and regularly spaced them out along the length of the leg. Two of these leg and buttress combinations were permanently attached to the central pedestal through the use of glue and 3-inch wood screws. The picture below shows a single leg and buttress unit attached to the pedestal.

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

This article first appeared in the December 2010 issue of *Starscan*, the JSCAS newsletter.

For the purpose of clarity let's call these permanently attached legs the Lateral Legs (primarily because they lay down in a side-to-side position in my car's trunk). I'll cover the Vertical Legs in a bit more detail later. This entire unit (the two permanent [lateral] legs and the central pedestal) plays an important role. This solidly constructed backbone is the strongest part of the entire stool assembly, and is the logical place for drilling the height adjustment holes, as the heavy hex bolt passes through four pieces of wood. The layers of wood are reinforcements for each other, and they along with the pin support the weight of chair and my 230 pounds. I am confident in our robust construction effort, and the fear of a catastrophic failure is absent in the resultant product. The image below shows the entire permanently assembled unit - complete with the pin placement holes, and the pin itself in the middle height position. Not shown are a pair of handles (for ease of carrying) that were later attached near the top after the picture was taken.

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A following picture shows the opposite side where the height adjustment pin protrudes. You can see the pin itself has been drilled to accept a retaining pin, which locks into place preventing the bolt from being able to be removed easily, and a large flat washer that protects the surface of the wood.

Now I return to the Vertical Legs. They were cleverly designed to be entirely removable (so that my trunk lid can close) for transport to distant dark sites. The Vertical Legs are the same exact construction as the Lateral Legs – nothing is changed there, but they have been drilled through the legs' 2x4s (and the center pedestal too,) to accept four threaded rods (1/4-20 x 8.5 inches). These threaded rods are below the lowest possible setting of the height adjustment pin, so there is no chance of conflict. Both ends of the rods have appropriately sized flat washers and wingnuts which are only finger tightened for final setup prior to observing. The plywood buttress portion of the legs is considerably thinner, and for attachment here we used four 1/4-20 x 5.5-inch bolts which were drilled into positions so that they would not impede the placement of the height adjustment pin which is perpendicular to the axis of the bolts. Shown below is a view providing the best angle for emphasizing the removable legs and their hardware.

Next Issue:
Making a Sketch Desk
and Painting the Assembly

The Antarctic Search for Meteorites: Exploring an Ice Planet by Dr. Stanley G. Love, NASA/JSC

James Wessel, JSCAS Educational Outreach Chairman and Douglas Yazell, Horizons Editor

The featured presentation was excellent at the November 8, 2013 Johnson Space Center Astronomical Society's (JSCAS) monthly meeting. Dr. Stanley Love is a graduate of Harvey Mudd College in Claremont, California and the University of Washington. His three degrees were physics and two in astronomy, respectively. His NASA experience is diverse and ongoing. He was a mission specialist astronaut on the space shuttle STS-122 mission aboard Atlantis in 2008. He later participated in NEEMO missions 15 and 16 in the Florida Keys.

As usual, the JSCAS meeting took place on the second Friday of the month in the auditorium of the Lunar and Planetary Institute at 3600 Bay Area Blvd, in the Clear Lake area of Houston.

To start his talk, Dr. Love related several details about Antarctic meteorites. After collection at the bottom of the world, they are taken back to laboratories to determine their age. The average Earth residence time of an Antarctic meteorite is about 200,000 years and is calculated by radioactive decay. As an explanation, Dr. Love offered that while the rocks were still in space, cosmic rays continually bombard asteroids causing a buildup of radioactivity. Once on Earth, the meteorites are shielded from those same rays and the residual radioactivity starts to decay, allowing determination of the ages of the meteorites. Interestingly, some meteorites do not like water. Water dissolves stony meteorites quickly on a geological time scale. For example, when a stony meteorite falls here in Texas, it turns to mush in a few thousand years. In comparison, in Antarctica they are pretty well preserved by the cold temperatures and the lack of liquid water.

A second major point of his presentation was a description of the Antarctic environment. Dr. Love illustrated the slow progression of entire Antarctic ice cap which tends to slide off of the continent at the edges into the Southern Sea. The flow of ice is interrupted in places by things such as mountain ranges, so there is some irregularity in ice travel speeds from place to place. Amazingly, the ice is two miles high. The surface of the ice is continually ablated by the fierce wind that can blow as fast as 300 km/hour. The ablated ice has the air bubbles squeezed out of it, and looks like a backyard swimming pool that is flat and frozen with little ripples in it. The intensely blue color of the ablated ice was a sight to behold, and is primary location where the meteorites were found. The Japanese were first to explore Antarctica to conduct searches for meteorites. Dr. Love related that the United States has been sending a team down there every year since 1976. The European Space Agency (ESA) and the Chinese also conduct meteorite searches.

Dr. Love had a unique perspective of comparing Antarctic field studies to work on the International Space station. Both feature months-long missions with a lethal outside environment. Both have international teams that endure isolation to some extent during operations. Workdays are long. Contact with friends and family is limited. Both share the difficulty of using the bathroom. His joint ISS and Antarctic experience is well suited for consultation for the future design of any manned space expedition.

With some background established, Dr.

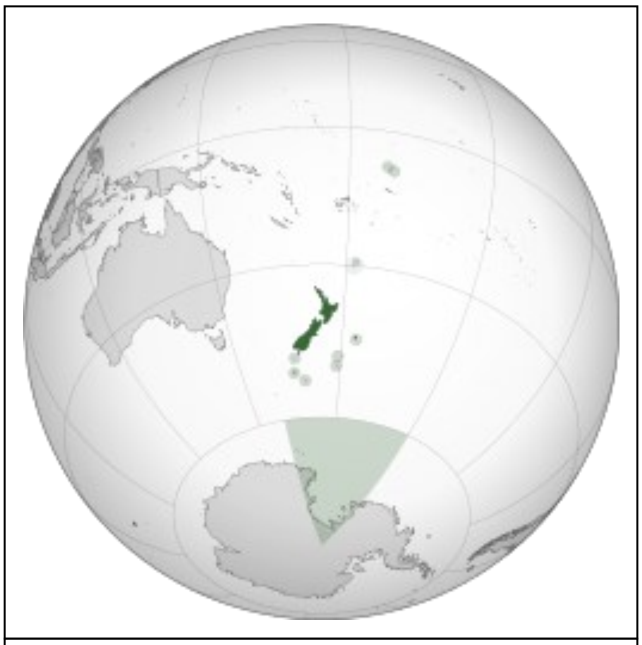
(Continued on page 39)

Above: McMurdo Station from Observation Hill. Image credit: Gaelen Marsden (Wikipedia).

(Continued from page 38)

Love provided a detailed travelogue with excellent accompanying photography that only a first-hand account can properly relate. Remember that the seasons are flipped for the southern hemisphere, so expeditions set out in our fall, just after Thanksgiving. Most of the true field time is in December and January during the height of summer. Fortunately, the Sun is up 24 hrs a day in summertime and the temperature relatively balmy, not minus 100°F like it is in the winter down there. The Sun moves around the horizon, never setting.

Love flew commercial from Dallas to Los Angeles, then to Sydney, Australia and on to Christchurch, New Zealand, which is the jumping off point for these expeditions since the days of Captain Scott, the famous English adventurer who died on the way back from the South Pole. The U.S. has a big supply depot in Christchurch. Visiting scientists start with the clothing distribution center. Everyone is given two big orange bags full of clothes. Each person tries them on to ensure they fit well, since those are worn during the entire field trip. All are given only two pairs of socks and one set of underwear! Those who ask are given another two pairs of socks, but no extra sets of underwear. A bit of humor is that experienced explorers wait until the trip is at the halfway point, then they turn the underwear inside out. After obtaining 35 pounds of heavy clothes and spending one day in Christchurch, the next flight is to McMurdo Station, the main U.S. base in Antarctica. It is on Ross Island, which is the farthest south a ship can go where the destination is dry land when the sea ice is at its minimum extent. Some unlucky scientists fly on a C-130 airplane, but the larger C-17 cargo airplane is much more pleasant for the passengers. They have room to stretch out their legs, and the noise level is reduced. The five-hour flight in the C-17 (eight hours in the C-130) from Christchurch to Antarctica is a straight line over the ocean. After about four hours the view out the window is less boring as the coast and Victoria Land comes into view. White, blue and black are the only colors in Antarctica.



Above: New Zealand and the Ross Dependency, the latter defined by longitude and latitude. Image credit: Gringer (Wikipedia).

Landing at McMurdo Station takes place on a 100-foot thick permanent ice shelf. They herd everyone onto Ivan the Terra Bus. This former Canadian tourist bus has big (blue) tires about six feet in diameter, so that it does not chew up snow roads in the summer when the weather is close to freezing. At the landing strip, off in the distance, Mount Erebus is visible as a dramatic sight complete with smoke plume. It is the most active volcano in the world and about 13,500 feet high. The drive to McMurdo is about 16 miles long. It looks much like a mining town, and is not very attractive. Observation Hill is a little volcanic peak near the town, a walk of about half of a mile. It is so named because every day the men who were left behind at the base by Scott would climb up there to look for the Scott party, since nothing impedes the view to the south. Alas, Scott never returned. As a result, a cross was erected there in memory of the Scott party. Like all objects left in Antarc-

(Continued on page 40)

(Continued from page 39)

tica before about 1950, the cross is protected by international treaty. Looking at a view of the town from high and far away, only a few buildings have something to directly do with people. Everything else is logistics. Fuel, vehicles, boxes of things getting ready to go out as garbage, things delivered but yet to be processed. Only a small percentage of that is staged to *go to Pole* or staged to *come back from Pole*. Logistics is about three quarters of McMurdo base. Support to science personnel ratio is 5 to 1. Support people drive trucks, cook food, sling cargo around, fly airplanes, manage air traffic control, talk to teams on the radio, and so on. Similarly, in his thoughts for a future permanent lunar base, Dr. Love strongly implied that there would be far greater need for logistics personnel than scientists.

Additional observations about McMurdo base revealed lots of information. The male to female ratio is about 3 to 1. The main building at the base contains the cafeteria, so it is everyone's favorite building. But, Love's favorite building was the coffee shop. Coffee and cocoa was free both in the dining hall and in the coffee shop. Recreation primarily occurred in a Quonset hut that contains old couches and a big screen television. They show movies and enjoy open microphone nights. The U.S. Navy founded McMurdo base, and there is a strong nautical presence. There is an interfaith chapel with old Navy anchors on display in front. The dining hall is called the Galley. The gift shop is the Ship's Store, although it rests firmly on land. Seabees mementos are all over town, with salutes to the Navy "Corp of Engineers," the U.S. Navy Construction Battalion (initials "CB"). All the buildings have an air gap under the structure. Otherwise the snow piles up around it and the building does not last long. Thanks to the air gap, the snow blows under the building. Without an air gap, the building is buried. He then described the living quarters, and stated the difficulties of sharing a room with sleep shifting roommates. The accommodations are not luxurious.

Throwing something in the garbage at McMurdo is serious business. Everything comes in or out in a ship or an aircraft. They are extremely serious about recycling. They recycle about 65% of their solid waste. That is about twice the percentage of even the greenest cities. There are about 14 categories for recycling. It all goes back to the United States in Oxnard, California, where it is recycled. Hot water is also conserved. "Use hot water sparingly" is posted on signs all over the base. Water comes from desalinated seawater. The desalinization process requires large amounts of energy. Diesel is shipped in great quantities at high cost. The situation is even worse at the South Pole where it costs roughly $20 to flush the toilet and $50 to take a shower. Conservation is reinforced at least six times a day when everyone walks by signs near the dining hall explaining the cost of electricity and how much electricity is used every day.

Dr. Love reported spending about ten days in McMurdo, processing about 50,000 pounds of gear. The gear was weighed, measured, and stored on pallets to be loaded on the C-130 aircraft. The plane was equipped with skis, which allows it to land anywhere, and provided transportation to the field site. Part of the equipment was secured on Nansen sleds. A Nansen sled, created by Norwegian polar explorer Fridtjof Nansen, is about eleven feet long and carries about half of a ton of equipment. It flexes so that it does not break while traversing rough icy terrain. These sleds are still in use in Antarctica today, albeit towed by snowmobiles instead of dogs. After the equipment and personnel are deployed, the plane leaves, and the landing area becomes the first exploration base.

While in the severe environment of the field, the housing is a Scott tent, named after Captain Scott. There are two people in each tent. With the stove running, it is near freezing at the bottom of the tent. Inside the top of the pyramid-shaped tent, it is warmer. Hanging there in the relative warmth, were boots, gloves, and hats, so that perspiration and water could be evaporated. That makes an ugly chandelier for every tent. The Scott tent weighs 90 pounds. The water supply for the expedition was ever present ice. It was chopped it up and put it on the stove. That is 200,000-year-old distilled water. For flavoring, crew added Tang or Scotch. Alcohol is allowed in surprising quantities. Each couple of tents tent has a shared toilet (in another tent), which is a gray box with a Styrofoam seat. When a toilet is full, it is hammered shut and put outside. A resupply plane takes it away. Every occupied tent has two solar panels and a battery, which can run a laptop computer and charge an iPod. Iridium satellite

(Continued on page 41)

Above: Map of U.S. permanent stations in Antarctica. Image credit: United States Antarctic Program.

(Continued from page 40)

telephones were used to intermittently talk to friends and family back in the U.S.

Transportation was a standard snowmobile. Dr. Love was proud that his sported a big pair of fuzzy dice near the handlebars. The snowmobile is a meteorite hunter's most important tool except for his eyes. Walking is difficult because ice is slippery and clothes are bulky. Also, breathing is difficult because the altitude is 8,500 feet. The snowmobile's odometer logged over 400 miles for this expedition while hunting for meteorites. To conduct the hunt, linear sweeps were performed on the blue ablated ice, at 10 meter intervals between the snowmobiles, with the wind at their backs with their jacket hoods up. Frostbite results from side winds so they are avoided. The return trip is directly into the wind where the snowmobile's windshield takes the brunt of the cold. The hunt is stopped when something black is found by one of the team members. Then, the location was marked with flags and GPS. An ice auger was used to make a hole for the flag post, and a number is recorded on the flag. These flags are used in case GPS does not work. The GPS coordinates are taken in a notebook in case of computer failure, so the flags are a second backup. Search areas are never duplicated, even since 1976 when this work began.

Above: Stan with a big meteorite! Image credit: ANSMET 2012-2013 blog entry of December 20, 2012.

On this expedition, about 300 pounds of meteorites, including a few big ones, were collected for scientific inquiry. Most of the meteorites found are tiny. Tongs were used to pick up a meteorite and put it in a collection bag. No detailed geologic analysis is conducted in the field, as it is too uncomfortable. Science is done somewhere far away in a nice, warm laboratory. Initial observations include numbering the meteorite and looking at its crust. A preliminary guess is made at its type, whether ordinary chondrite or achondrite. One notable meteorite was a 20-pound piece of asteroid Vesta, the second biggest asteroid in the asteroid belt. The chemical composition of the meteorite exactly matches the spectral analysis of Vesta, and a recent NASA spacecraft called Dawn has provided additional confirmation. Even so, Martian meteorites are more valuable still. Back at camp, the meteorites put into insulated containers. Most still have bits of ice clinging to them. During transportation back to JSC here in the U.S. for analysis, the meteorites are shipped frozen, as the melting ice water would change the chemical composition. The Smithsonian Institution provides permanent curation for the meteorites Dr. Love's team collected.

Above: Katie (Dr. Katherine Joy of the University of Manchester) with a find! Image credit: ANSMET 2012-2013 blog entry posted December 16, 2012.

When the field season neared to a close, the C-130 returned, all the gear and collections were loaded, and a take-off was attempted over the course of eight miles. The snow was soft and the takeoff ultimately failed. The airplane turned around and came back eight miles to again face into the wind. On the second try, the Jet-Assisted TakeOff (JATO) bottles were fired. The C-130 carries eight of these solid rocket motors. They fire for about five seconds. They provide about five knots of extra airspeed. The nose gear came up as planned, but then the plane hit a bump and the nose gear came back down! The plane then taxied back to camp, and everything non-essential was thrown off the airplane. The team was seated all way back in the tail cone in order to put as much weight as possible into the back of the aircraft. Following a successful take-off, there was insufficient fuel to return to McMurdo, so the plane was rerouted to the South Pole station for refueling. Dr. Love related that the South Pole station is at the geographic South Pole, because the magnetic pole wanders around continually. Even so, the flag marking the true geographic pole is relocated yearly because the entire ice cap moves about 10 feet each year.

Dr. Love closed his talk with a recap of the layover time back at McMurdo base, where all the equipment is stored between seasons, the flight back to Christchurch and how amazing it was to see living greenery again, and his final flight back to the U.S. After the audience showed its appreciation, he took several questions on his experiences both in space and in Antarctica. JSCAS is grateful for this great presentation and looks forward to another entertaining talk next year by Dr. Love for his insights for future manned exploration of the Solar System.

(Continued on page 42)

Astronomy

(Continued from page 41)

JSC Astronomical Society (JSCAS) Calendar

Upcoming Items from the JSCAS Calendar (Copied on December 4, 2013)

JSCAS meetings are held on the second Friday of every month at 7:30 P.M. 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.

2013

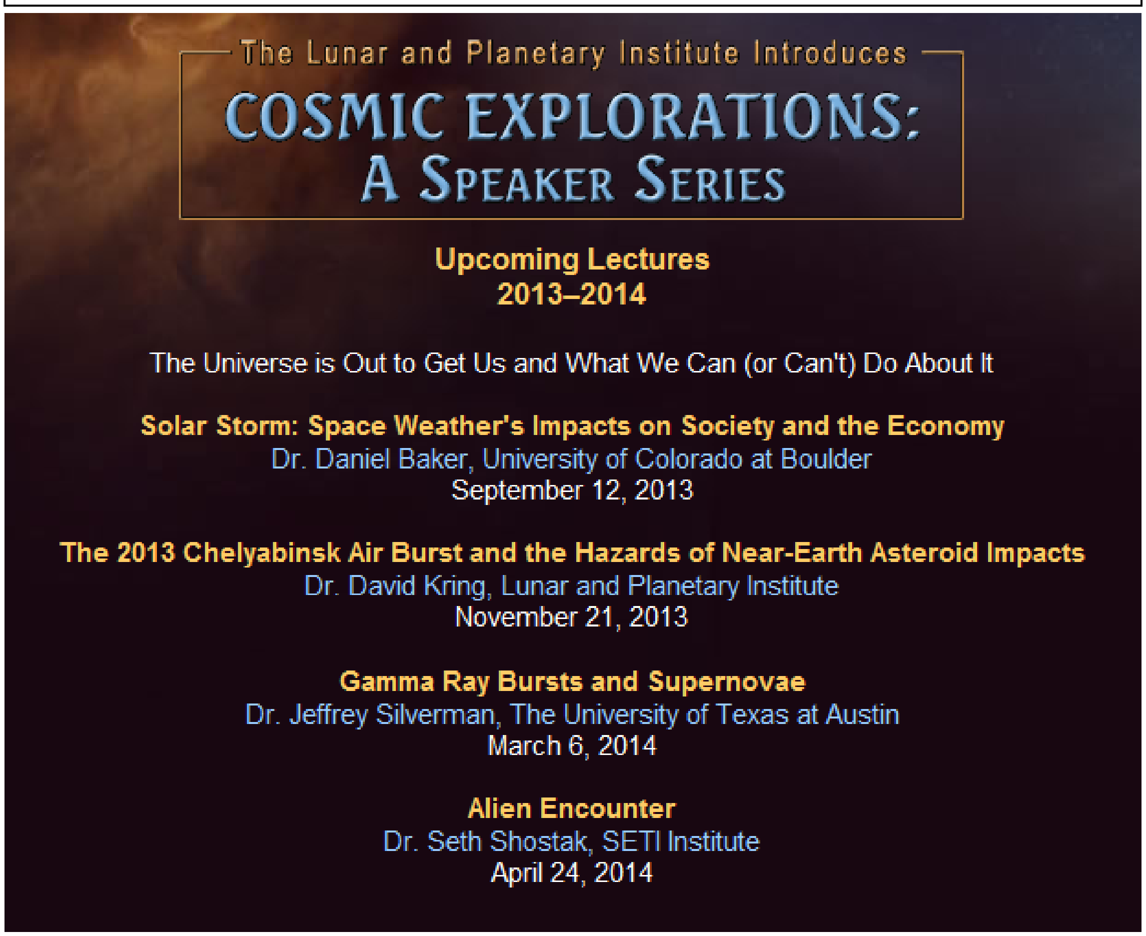
December 10, 2013:	Tuesday, Star Party, Hyde Elementary School, 3700 E. FM 518 (Deke Slayton Hwy), League City TX 77573, 5:30 PM - 7:30 PM
December 13, 2013:	Winter Solstice Party

2014

January 10, 2014:	Bob Taylor, *2013 Astronomy Year in Review*
January 30, 2014:	Thursday, 5:30 – 7:00 PM, Star Party, J.D. Parks Elementary School, 3302 San Augustine, Pasadena TX 77503
February 14, 2014:	Don Halter, subject TBA (To Be Announced)
March 14, 2014:	Annie Wargetz, subject TBA (To Be Announced)
March 27 - 30, 2014:	JSCAS trip to Fort McKavett
April 11, 2014:	Paul Maley, subject TBA (To Be Announced)
April 24 - 27, 2014:	Tentative, JSCAS trip to Fort McKavett
May 9, 2014:	Dr. Stanley Love, subject TBA (To Be Announced)
May 25-June 1, 2014:	Texas Star Party

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

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



Comet ISON: AWOL

Astronomy

DR. PATRICK E. RODI

Comet ISON (a.k.a C/2012 S1) was discovered in September 2012 by Russian astronomers Vitali Nevski and Artyom Novichonok using data from the International Scientific Optical Network (ISON). This sungrazing comet passed within 730,000 miles above the Sun's surface on Thanksgiving Day and experienced surface temperatures that were predicted to approach 5,000° F. What happened next is still open to debate, but the latest information is that the comet broke up during its close approach. What is left is a dust cloud with no discernable nucleus. A variety of spacecraft from the United States, and other countries, were observing the comet's close encounter with the Sun. Figure 1 shows a series of images obtained by NASA's Solar and Heliospheric Observatory (SOHO) spacecraft. (Time is increasing from left to right.)

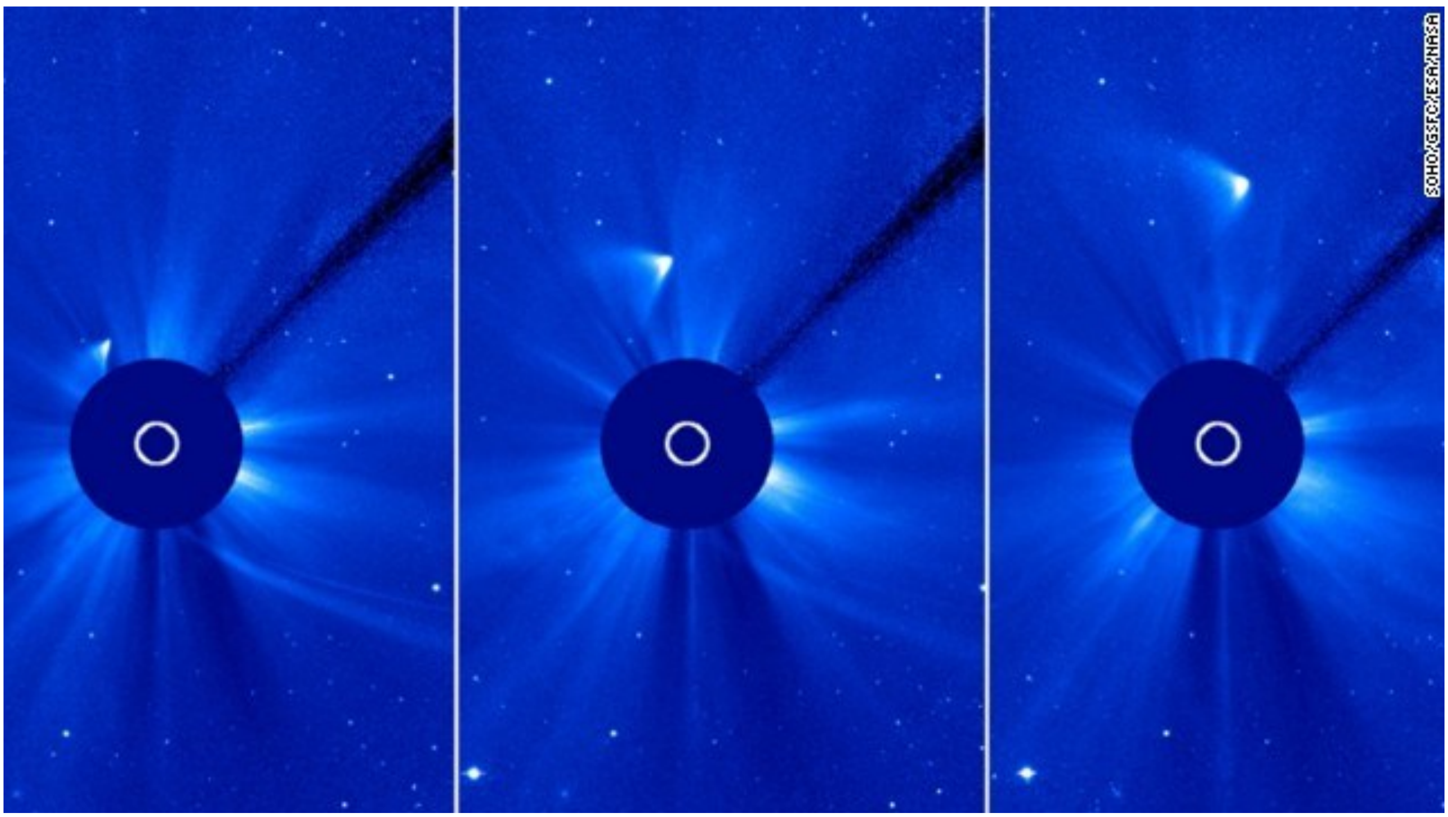


Figure 1. Comet ISON photographed after perihelion by SOHO. Image credit: NASA/Goddard Space Flight Center and the European Space Agency (ESA).

These images clearly show comet material moving away from the Sun. By mid-December, what is left of the comet is expected to have moved sufficiently far from the Sun to permit viewing by the Hubble Space Telescope. If any nucleus remains, it should be visible at that time. NASA has released a composite video (available for viewing on YouTube) showing the ISON passes from a number of different spacecraft.

If a nucleus or any other outgassing material remain, it may become visible as it moves away from the Sun. A figure in a Sky & Telescope (The Essential Guide to Astronomy) article shows the originally predicted location of the comet in early December. Scientists continue to examine the dust cloud to determine what materials comprised the comet.

Its original outbound trajectory will take it north on the celestial sphere, passing within two degrees of Polaris on 8 January, 2014. Earth will pass near the comet's path around January 14-15, 2014. Any remaining comet material could create a meteor shower.

Comet ISON is most definitely AWOL (Absent WithOut Leave), to the disappointment of many observers on Earth.

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. (December 10, 2013 meeting)
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

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

2014 Conferences www.aiaa.org (Events link)

13 - 17 January 2014, National Harbor, Maryland, 16th AIAA Non-Deterministic Approaches Conference
13 - 17 January 2014, National Harbor, Maryland, 22nd AIAA/ASME/AHS Adaptive Structures Conference
13 - 17 January 2014, National Harbor, Maryland, 32nd ASME Wind Energy Symposium
13 - 17 January 2014, National Harbor, Maryland, 52nd AIAA Aerospace Sciences Meeting
13 - 17 January 2014, National Harbor, Maryland, 55th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference
13 - 17 January 2014, National Harbor, Maryland, 7th Symposium on Space Resource Utilization
13 - 17 January 2014, National Harbor, Maryland, AIAA Atmospheric Flight Mechanics Conference
13 - 17 January 2014, National Harbor, Maryland, AIAA Guidance, Navigation, and Control Conference
13 - 17 January 2014, National Harbor, Maryland, AIAA Modeling and Simulation Technologies Conference
13 - 17 January 2014, National Harbor, Maryland, AIAA Science and Technology Forum and Exposition (SciTech2014)
13 - 17 January 2014, National Harbor, Maryland, AIAA Spacecraft Structures Conference (formerly the AIAA Gossamer Systems Forum)
26 - 30 January 2014, Santa Fe, New Mexico, 24th AAS/AIAA Space Flight Mechanics Meeting
27 - 30 January 2014, Colorado Springs, Colorado, Annual Reliability and Maintainability Symposium (RAMS) 2014
2 - 6 February 2014, Atlanta, Georgia, American Meteorological Society Annual Meeting
1 - 8 March 2014, Big Sky, Montana, 2014 IEEE Aerospace Conference
24 - 26 March 2014, Lille, France, 49th International Symposium of Applied Aerodynamics
30 April 2014, Washington, DC, 2014 Aerospace Spotlight Awards Gala
5 - 9 May 2014, Pasadena, California, SpaceOps 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, 11th AIAA/ASME Joint Thermophysics and Heat Transfer Conference

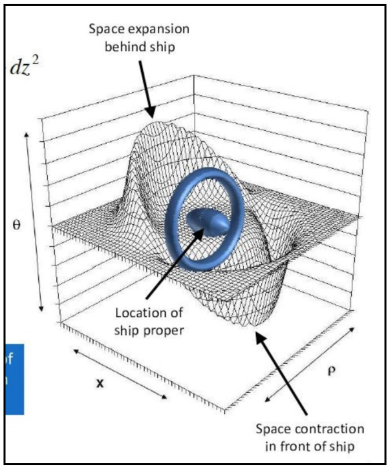
Cranium Crunchers

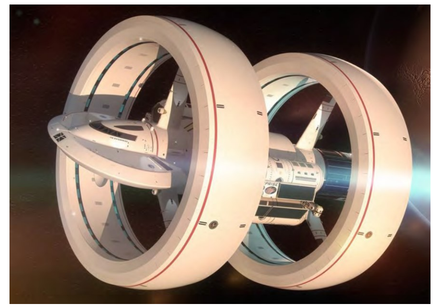
Dr. Steven E. Lee and Shen Ge

Section News

In this issue, a problem is posed in which you are a starship captain exploring deep space. While far from home, you enter an anomalous spherical region of space having a radius of one light year in which the speed you can attain with your warp drive engines as compared to that in normal space is reduced by a factor of eight. Unfortunately, while mired in the very center of this region, a ship from a warlike neighboring star system comes upon you. This enemy ship is out for your destruction but can move at only half the rate of your ship in normal space. Seeing that you are almost helpless but not wanting to become trapped as well, the enemy ship stations itself at the perimeter of the anomalous region. Obviously, if you head straight for any point on the surface of this sphere, the enemy ship, travelling at four times your present speed along the outside of the sphere, can catch you. Assuming that both you and the enemy ship can accelerate to your maximum speed instantaneously, can you devise a strategy whereby you can reach the edge of this space and then travel at your maximum speed in normal space to escape the enemy ship?

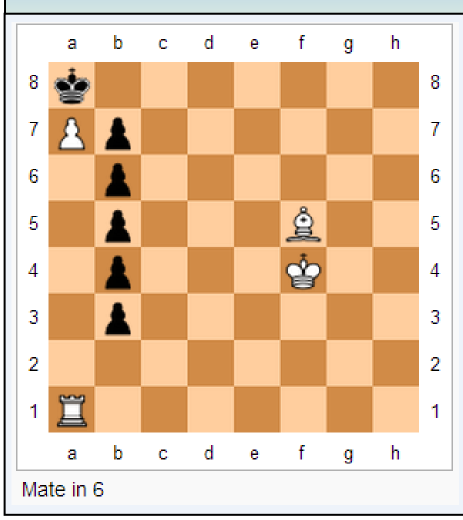
Email answers at steven-dot-e-dot-everett at boeing-dot-com.





Images: Warp drive? Above: Two images based on Dr. Harold "Sonny" White's theoretical findings. Images are rendered by Mark Rademaker with artwork and inputs from Mike Okuda. They are copied here from page 3 of the May / June 2013 issue of Horizons. Left: Image from Dr. White's article starting on page 26 of the January / February 2012 issue of Horizons. "Inflation: Alcubierre Metric. Warp Drive Metric. York Time. Shaping Function."

[Here is another Cranium Cruncher from Shen Ge. The solution will be presented here in our next 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?



Shen Ge found this chess puzzle for Horizons. It is proposed by Tim Krabbé, a former championship chess player and puzzle maker. White can checkmate black in six moves. What are the moves?

Shen Ge presents the solution to the chess puzzle on page 37 of our earlier issue of Horizons:

1. Bb1 b2
2. Ra2 b3
3. Ra3 b4
4. Ra4 b5
5. Ra5 b6
6. Be4 mate

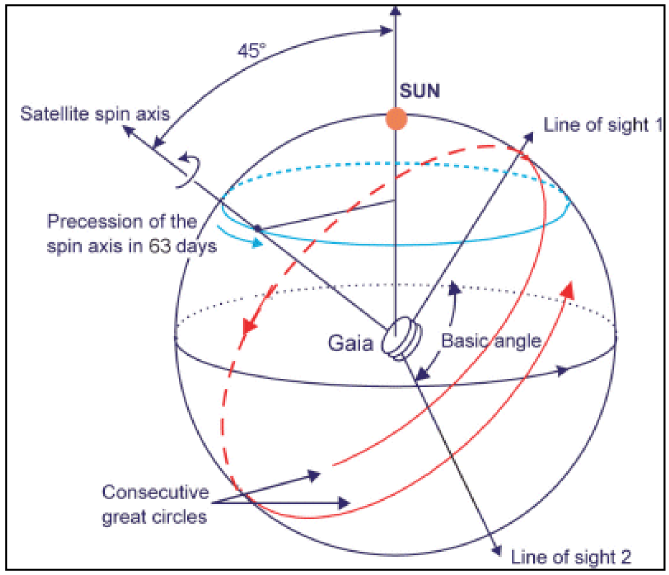
Notation: On each line, white moves first. An upper case letter is a piece (B for bishop and R for rook). A lower case letter followed by a number shows the destination. The upper case letter is omitted for pawns.

Above: Our first chess challenge was presented on page 37 of our July / August 2013 issue. The solution was presented on page 4 of our prior issue. They are presented here together.

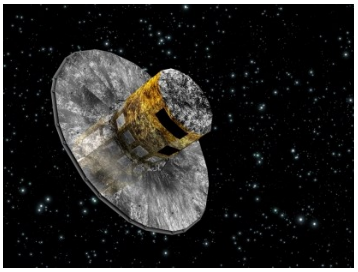
Above: The World Chess Championship 2013 was a match between reigning world champion Viswanathan Anand and challenger Magnus Carlsen, to determine the 2013 World Chess Champion. It was held from 9 to 22 November 2013 in Chennai, India, under the auspices of FIDE (the World Chess Federation). Carlsen won the match 6½–3½ after ten of the twelve scheduled games, becoming the new world chess champion. Text and image credit: Wikipedia.

Section News

Right: Gaia orbit, navigation, and observation principle. Image credit: European Space Agency (ESA).



Gaia is an ambitious mission to chart a three-dimensional map of our Galaxy, the Milky Way, in the process revealing the composition, formation and evolution of the Galaxy. Gaia will provide unprecedented positional and radial velocity measurements with the accuracies needed to produce a stereoscopic and kinematic census of about one billion stars in our Galaxy and throughout the Local Group. This amounts to about 1 per cent of the Galactic stellar population.



Left: Artist's impression of the Gaia spacecraft. Image credit: European Space Agency (ESA). Planned launch date: December 13, 2013.

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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- Critical Embedded Systems: G. Ladier

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- Light Aviation & Derived Machines: J.L. Chanel
- Environment : (D.Collin: TBC)
- Exploration and Observation of Space: M. Rieugnié

Section News

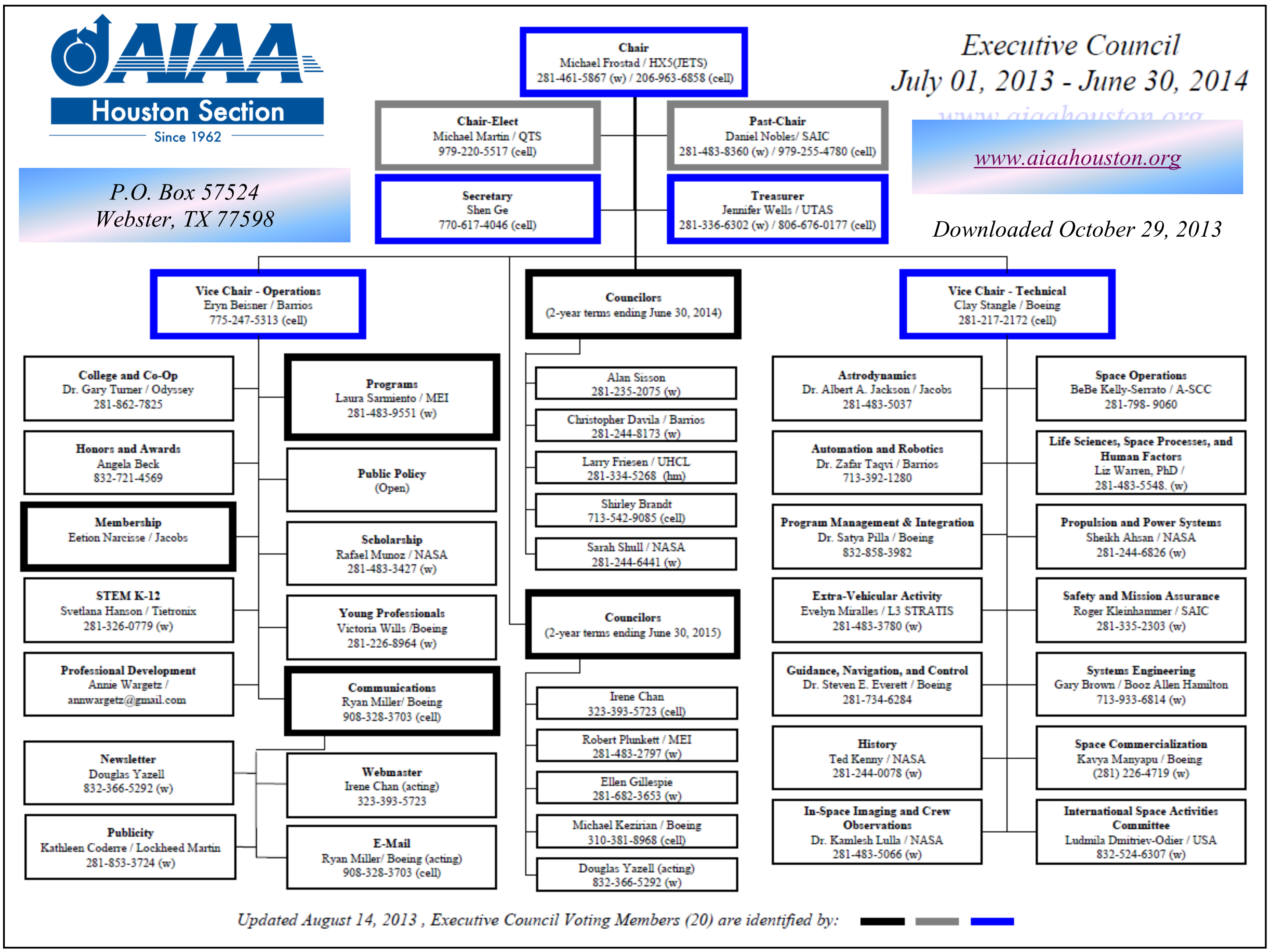
Above: The Great Lakes of the United States of America photographed by International Space Station (ISS) Expedition 31. Image credit: NASA.

From AIAA Daily Launch

New Time-Lapse Video Taken From The ISS Praised

Jason Major at Universe Today (12/4, Major) writes that David Peterson has assembled a time-lapse video of photos taken by ISS astronauts, "many of them by ***Don Pettit*** during Expedition 31," that is "well worth two minutes" of anyone's time to view. The video is titled "The World Outside My Window."

The American Institute of Aeronautics and Astronautics (AIAA)



Student Section News

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

[Below: This article is adapted from its publication on a Rice University website. The Houston Chronicle published an article describing the resolution of this issue. The article is dated December 21, 2011. The Houston Advanced Research Center (HARC) also published an article describing the resolution of this issue. The article is dated June 1, 2012.]

Rice Earth Science professor refuses publication of report with systematic deletions

Texas state environmental agency accused of censorship relating to climate change findings

Dr. John Anderson, Rice University's W. Maurice Ewing Professor of Oceanography, charges that The Texas Commission on Environmental Quality has systematically omitted all references to climate change and sea-level rise from an article he wrote about changes in Galveston Bay.

The deletions by the Texas agency are ideological and political, said Dr. Anderson. “I don't think there is any question but that their motive is to tone this thing down as it relates to global change,” Anderson said. “...It's not about the science. It's all politics.”

“Anderson said the TCEQ won't allow the article—written for a report by the TCEQ's Galveston Bay Estuary Program—to be published without the deletions. That, and Anderson's refusal to accept the changes, are holding up publication of The State of the Bay, a periodic report published by the program.”

The rest of the Houston Chronicle (October 10, 2011) article is here.

Additional media coverage on this issue:

UPI.com (October 14, 2011) - Scientists Revolt over Texas Censorship
The Guardian (UK), October 14, 2011 - Rick Perry officials spark revolt after doctoring environment report
New Scientist (October 17, 2011) - Texas officials censored climate change report

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

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 11-12. 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.

Above: Image credit: Rice University.

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.org with your name and university affiliation, and if available, a vague area of your research (e.g. life science, aeronautic structures, computer simulation, etc.). This does not commit you to anything. This just provides additional data for the organizing committee as they pursue funding.

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.

Student Section News: Please send inputs to Dr. Gary Turner, our College and Co-Op Chair. His e-mail address is: *collegecoop2013[at]aiaahouston.org.* His backup for this task is Editor Douglas Yazell: *editor2013[at]aiaahouston.org*. Our Section's web page lists the related websites. We publish most bimonthly issues of Horizons at www.aiaahouston.org by the last day of each even-numbered month, and the submissions deadline is three weeks earlier. The November / December issue is an exception. It is published by December 10, not December 31.

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

TEXAS A&M UNIVERSITY

Student Section News

Facebook American Institute of Aeronautics and Astronautics: Texas A&M Chapter
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LinkedIn AIAA - Texas A&M University Chapter

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

Chair	Rahul Venkatraman	acepilotrjv [at] tamu.edu
Vice Chair	Alejandro Azocar	alejandroazocar [at] tamu.edu
Treasurer	Steve Anderson	andeste [at] tamu.edu
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Activity Chair	Kristin Ehrhardt	kristin159 [at] tamu.edu
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SEC Representative	Nhan Phan	Trongnhanphan [at] tamu.edu
Webmaster	Nick Page	npage340 [at] tamu.edu
Graduate Class Rep.	Chris Greer	gree5362 [at] tamu.edu
Senior Class Rep.	Nicholas Ortiz	ibesmokin [at] tamu.edu
Freshman Class Rep.	Farid Saemi	farid.saemi [at] gmail.com

Student Section News

Please send inputs to Dr. Gary Turner, our College and Co-Op Chair. His e-mail address is: *collegecoop2013[at]aiaahouston.org.* His backup for this task is Editor Douglas Yazell: *editor2013[at]aiaahouston.org*. Our Section's web page lists the related websites. We publish most bimonthly issues of our Horizons newsletter at www.aiaahouston.org by the last day of each even-numbered month. The submissions deadline is three weeks earlier. The November / December issue is an exception. It is published by December 10, not December 31.

Experts on Climate Change

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

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

Gerald North
Global climate change and modeling, statistics, IPCC process
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Gunnar Schade
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Don Collins
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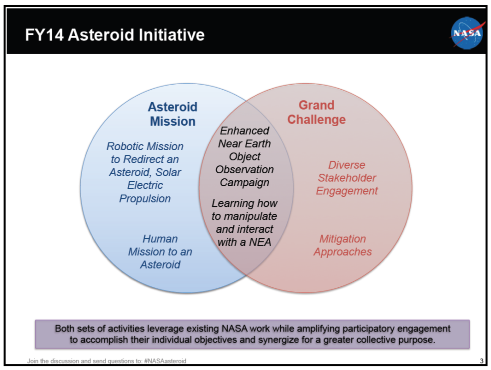
[See the NASA Asteroid Initiative Ideas Synthesis Workshop website for more information about the NASA Asteroid Redirect Mission (ARM). Charts: Robert Lightfoot/NASA.]

NASA's Asteroid Initiative

- **NASA is leveraging relevant portions of science, space technology, and human exploration capabilities toward a first-ever mission to capture and redirect a near Earth asteroid to earth-moon space, followed by a human exploration and sampling mission.**
- **The mission will demonstrate technologies for deep space exploration, advance efforts in planetary defense, and engage new industrial capabilities and partnerships. There are other benefits.**
- **NASA will also lead a broad effort to find all asteroid threats to human populations and know what to do about them: a "Grand Challenge"**
- **These two activities are mutually supporting, and both leverage on-going activities.**
- **This initiative includes a parallel, forward-looking mission development approach, partnership opportunities (nationally and internationally), open innovation, and participatory engagement.**



First Steps to Mars and Other Destinations

Sequence \ Mission	Current ISS Mission	Asteroid Redirect Mission	Long Stay In Deep Space	Humans to Mars Orbit	Humans to Surface, Short Stay	Humans to Surface, Long Stay
In Situ Resource Utilization & Surface Power						X
Surface Habitat						X
Entry Descent Landing, Human Lander					X	X
Aero-capture				X	X	X
Advanced Cryogenic Upper Stage				X	X	X
Solar Electric Propulsion for Cargo		X	X	X	X	X
Deep Space Guidance Navigation and Control		X	X	X	X	X
Crew Operations beyond LEO (Orion)		X	X	X	X	X
Crew Return from Beyond LEO – High Speed Entry (Orion)		X	X	X	X	X
Heavy Lift Beyond LEO (SLS)		X	X	X	X	X
Deep Space Habitat	X		X	X	X	X
High Reliability Life Support	X		X	X	X	X
Autonomous Assembly	X		X	X	X	X

Join the discussion and send questions to: #NASAasteroid 9

Leveraging Capabilities for an Asteroid Mission

- **NASA is aligning key ongoing activities in Science, Space Technology, and Human Exploration and Operations Mission Directorates**
  - Asteroid identification and characterization efforts for target selection
  - Solar electric propulsion for transport to and return of the target asteroid
  - Autonomous guidance and control for proximity operations and capture
  - Orion and Space Launch System (SLS) vehicles for asteroid rendezvous
  - Technologies for astronaut extra-vehicular activities
- **Each individual activity provides an important capability in its own right for human and robotic exploration**
- **We are working to utilize all of these activities to**
  - Identify and redirect a small asteroid to a stable orbit in the lunar vicinity;
  - Test human spaceflight systems and operations beyond LEO; and
  - Investigate and return samples with our astronauts using the Orion and SLS assets.
- **The FY14 budget supports continued advancement of the important individual elements and furthers the definition of the overall potential mission.**

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