Space News Update  
— August 2, 2016 —

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1. NASA’s Solar Probe Plus Mission Moves One Step Closer to Launch

Engineers at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, prepare the developing Solar Probe Plus spacecraft for thermal vacuum tests that simulate conditions in space. Today the spacecraft includes the primary structure and its propulsion system; still to be installed over the next several months are critical systems such as power, communications and thermal protection, as well as science instruments. Credits: NASA/JHUAPL

NASA’s Solar Probe Plus – the first mission that will fly into sun's upper atmosphere and “touch” the sun – has passed a design review, an important milestone leading to its anticipated summer 2018 launch. The successful review means the mission may now transition from formulation and design to final assembly and implementation. The spacecraft, as it appears in the image, currently includes the primary structure and propulsion system. Over the next phase of the mission, engineers at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland – which manages the mission and is building the spacecraft – will finish assembly and install the rest of the spacecraft systems and science instruments.

Solar Probe Plus is slated to launch during a 20-day window that opens July 31, 2018. The spacecraft will collect data on the mechanisms that heat the corona and accelerate the solar wind, a constant flow of charged particles from the sun. These are two processes with fundamental roles in the complex interconnected system linking the sun and near-Earth space – a system that can drive changes in our space weather and impact our satellites. Solar Probe Plus is part of NASA’s Living With a Star program, an initiative focused on aspects of the sun-Earth system that directly affect human lives and society. The program is managed by NASA’s Goddard Spaceflight Center in Greenbelt, Maryland.

Source: NASA

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2. Mars 2020 Rover Construction Moves Ahead

*The Mars 2020 rover reaches a third milestone on the path to the launch pad.*

Things are getting real now. Last week, NASA announced that it will proceed with the final design and construction of the Mars 2020 rover. The announcement comes after intensive engineering and design studies that evaluated proposals for instrument packages.

Set to launch in the summer of 2020, the as-yet unnamed Mars 2020 rover will arrive at the Red Planet for its very own “seven minutes of terror” by February 2021. And it has now reached the third of four Key Decision Points on the long road to the launch pad. Phase A was the concept and requirements definition and Phase B was preliminary design and technology development. Now NASA has approved entry to Phase C, the final design and fabrication of the actual rover. (The final Phase D will include assembly, integration, and testing leading up to launch.)


**Mars 2020 Instruments**

We're also now getting a good look at just what instrument packages will make the cut.
Unlike Curiosity, Mars 2020 will explicitly look for signs of life, past and present. The primary goal of the mission is motivated by exploring regions where life could have existed. To this end, the Mars 2020 rover will carry a suite of instruments from institutions in the U.S., France, Spain, and Norway. This vehicle weighs in at about 1,050 kilograms, the heaviest payload fielded on any planetary surface yet. (It beats Curiosity by 150 kg).

Like Curiosity, the Mars 2020 rover is equipped with a powerful laser and drill, complete with replacement bits. This isn't your parent's Mars rover, however.

**Here's a rundown of what's onboard Mars 2020:**

- **PIXL**: The Planetary Instrument for X-ray Lithochemistry: This X-ray fluorescence spectrometer will enable high resolution analysis of soil samples. The Mars 2020 mission will also package and cache the soil samples it collects for a later potential sample return mission.

- **RIMFAX**: The Radar Imager for Mars' subsurFACe eXperiment generates powerful ground-penetrating radar that will probe below the rover to a depth of several dozen meters.

- **MEDA**: The Mars Environmental Dynamic Analyzer, this instrument package will provide extensive meteorological measurements, including wind direction, speed, temperature, pressure, humidity, and dust particle shape and size during dust storms.

- **MOXIE**: The Mars Oxygen ISRU Experiment (yes, an acronym containing acronyms!) will test the ability for future astronauts to "live off the land," producing oxygen from carbon dioxide drawn from the tenuous Martian atmosphere.

- **SHERLOC**: The Scanning for Habitable Environments with Raman and Luminescence for Organics and Chemicals. This is the potential "life-finder," which will utilize fine scale UV-imaging in the search for organic compounds.

- **SuperCam**: This instrument will image and analyze the chemical composition of the surrounding terrain, as well as detect the presence of organic compounds in rocks and regolith from a distance.

A new and improved stereoscopic imaging system known as Mastcam-Z will also scan the terrain around the rover in high-definition detail. Though previous rovers weren't meant to scan the skies, they've proven to be serendipitous Martian astronomers as well, nabbing images of the fleeting Martian moons.

The sky crane Entry Descent and Landing (EDL) phase for Mars 2020 also borrows from Curiosity's historic landing procedure. An onboard range trigger will allow for a parachute from the rover to open on command after terrain analysis. Curiosity opened its chute only when it hit a certain descent speed. Mars 2020 will do the same, but it will have an estimated 50% smaller landing ellipse. It'll also have the option of diverting its landing site if it spots hazards. We should see some amazing video shot not only from the sky crane as the rover descends, but from the rover looking back up at the chutes as they deploy.

Mars 2020 will, like Curiosity, sport a plutonium-238 powered Multi-Mission Radioisotope Thermoelectric Generator. This will give it an estimated 10-year operational life span (Pu-238 has a 87.7 year half-life). NASA is experiencing a plutonium shortfall, and the Department of Energy only in 2013 announced that it would restart the plutonium production pipeline for U.S. space exploration. Curiosity actually used plutonium purchased and re-purposed from the Russians. (Note: the Pu-239 isotope is the fissile weaponized version and, unfortunately, can't be reused in RTGs).
NASA has yet to announce a formal name for the Mars 2020 rover, but a naming campaign similar to the one that christened Curiosity will get underway later this year. Landing site selection is also currently in progress, with sites narrowed down to eight regions. A final decision should be announced in July 2019. There's always a bit of tension in this process, as engineers prefer to land in safe areas, while scientists would love to go explore interesting (and more rugged) terrain.

**Mars Microphones & Helicopter Drones**

A set of microphones will also fly to Mars in 2020. What does a Martian dust storm sound like? What noises does a rover make, as it creaks along? The Mars 2020 mission will let us hear for the very first time the sounds that accompany the sights from the surface of a brave new alien planet.

The road to put a microphone on another world has been a long one. The Mars Polar Lander featured a microphone, but the rover crashed on descent on December 3, 1999. Its predecessor, the Phoenix Lander, delivered a microphone intact to the Martian surface, installed on the MARDI descent imager package, but engineers switched it off due to concerns that MARDI would interfere with other crucial electrical systems. The acoustic sensor aboard ESA's Cassini-Huygens mission did return some very brief audio during its descent through the atmosphere of Saturn's large moon, Titan. The addition of microphones to Mars 2020 rover gives us a new chance at hearing an alien world.

Meanwhile, though NASA has been funding the development of helicopter drones, there's no official word yet if one would head to Mars in 2020. Such a drone would make short scouting flights, using the 2020 rover as a base for operations.

**The Next Mars Orbiter**

Another key announcement came out this week, as NASA selected five U.S. aerospace companies to compete in a four-month concept study to develop the next-gen Mars orbiter.

“"We're excited to continue planning for the next decade of Mars exploration," said Yoder in a press release.

NASA has a fleet of aging orbiters circling the Red Planet, including MAVEN, the Mars Reconnaissance Orbiter, and Mars Odyssey, which has been orbiting Mars for an amazing 14 plus years. Newer missions include the European Space Agency's ExoMars Trace Gas Orbiter, due to arrive in September, and India's Mars Orbiter Mission. In addition to research, a future NASA orbiter would provide essential communications relays with the surface.

Source: Sky and Telescope

*An artist's concept of the Mars 2020 rover in action. Credit: NASA*
3. How Comets Are Born

Detailed analysis of data collected by Rosetta show that comets are the ancient leftovers of early Solar System formation, and not younger fragments resulting from subsequent collisions between other, larger bodies.

Understanding how and when objects like Comet 67P/Churyumov–Gerasimenko took shape is of utmost importance in determining how exactly they can be used to interpret the formation and early evolution of our Solar System.

A new study addressing this question led by Björn Davidsson of the Jet Propulsion Laboratory, California Institute of Technology in Pasadena (USA), has been published in Astronomy & Astrophysics.

If comets are primordial, then they could help reveal the properties of the solar nebula from which the Sun, planets and small bodies condensed 4.6 billion years ago, and the processes that transformed our planetary system into the architecture we see today.

The alternative hypothesis is that they are younger fragments resulting from collisions between older ‘parent’ bodies such as icy trans-Neptunian objects (TNOs). They would then provide insight into the interior of such larger bodies, the collisions that disrupted them, and the process of building new bodies from the remains of older ones.

"Either way, comets have been witness to important Solar System evolution events, and this is why we have made these detailed measurements with Rosetta – along with observations of other comets – to find out which scenario is more likely," says Matt Taylor, ESA’s Rosetta project scientist.

During its two-year sojourn at Comet 67P/Churyumov–Gerasimenko, Rosetta has revealed a picture of the comet as a low-density, high-porosity, double-lobed body with extensive layering, suggesting that the lobes accumulated material over time before they merged.

The unusually high porosity of the interior of the nucleus provides the first indication that this growth cannot have been via violent collisions, as these would have compacted the fragile material. Structures and features
on different size scales observed by Rosetta’s cameras provide further information on how this growth may have taken place.

Earlier work showed that the head and body were originally separate objects, but the collision that merged them must have been at low speed in order not to destroy both of them. The fact that both parts have similar layering also tells us that they must have undergone similar evolutionary histories and that survival rates against catastrophic collision must have been high for a significant period of time.

Merging events may also have happened on smaller scales. For example, three spherical ‘caps’ have been identified in the Bastet region on the small comet lobe, and suggestions are that they are remnants of smaller cometesimals that are still partially preserved today.

At even smaller scales of just a few metres across, there are the so-called ‘goosebumps’ and ‘clod’ features, rough textures observed in numerous pits and exposed cliff walls in various locations on the comet.

While it is possible that this morphology might arise from fracturing alone, it is actually thought to represent an intrinsic ‘lumpiness’ of the comet’s constituents. That is, these ‘goosebumps’ could be showing the typical size of the smallest cometesimals that accumulated and merged to build up the comet, made visible again today through erosion due to sunlight.

According to theory, the speeds at which cometesimals collide and merge change during the growth process, with a peak when the lumps have sizes of a few metres. For this reason, metre-sized structures are expected to be the most compact and resilient, and it is particularly interesting that the comet material appears lumpy on that particular size scale.

Further lines of evidence include spectral analysis of the comet’s composition showing that the surface has experienced little or no in situ alteration by liquid water, and analysis of the gases ejected from sublimating ices buried deeper within the surface, which finds the comet to be rich in supervolatiles such as carbon monoxide, oxygen, nitrogen and argon.

These observations imply that comets formed in extremely cold conditions and did not experience significant thermal processing during most of their lifetimes. Instead, to explain the low temperatures, survival of certain ices and retention of supervolatiles, they must have accumulated slowly over a significant time period.

“While larger TNOs in the outer reaches of the Solar System appear to have been heated by short-lived radioactive substances, comets don’t seem to show similar signs of thermal processing. We had to resolve this paradox by taking a detailed look at the time line of our current Solar System models, and consider new ideas,” says Björn.

Björn and colleagues propose that the larger members of the TNO population formed rapidly within the first one million years of the solar nebula, aided by turbulent gas streams that rapidly accelerated their growth to sizes of up to 400 km.

Around three million years into the Solar System’s history, gas had disappeared from the solar nebula, only leaving solid material behind. Then, over a much longer period of around 400 million years, the already massive TNOs slowly accreted further material and underwent compaction into layers, their ices melting and refreezing, for example. Some TNOs even grew into Pluto or Triton-sized objects.

Comets took a different path. After the rapid initial growth phase of the TNOs, leftover grains and ‘pebbles’ of icy material in the cold, outer parts of the solar nebula started to come together at low velocity, yielding comets roughly 5 km in size by the time gas has disappeared from the solar nebula. The low speeds at which the material accumulated led to objects with fragile nuclei with high porosity and low density.
This slow growth also allowed comets to preserve some of the oldest, volatile-rich material from the solar nebula, since they were able to release the energy generated by radioactive decay inside them without heating up too much.

The larger TNOs played a further role in the evolution of comets. By ‘stirring’ the cometary orbits, additional material was accreted at somewhat higher speed over the next 25 million years, forming the outer layers of comets. The stirring also made it possible for the few kilometre-sized objects in size to bump gently into each other, leading to the bi-lobed nature of some observed comets.

“Comets do not appear to display the characteristics expected for collisional rubble piles, which result from the smash-up of large objects like TNOs. Rather, we think they grew gently in the shadow of the TNOs, surviving essentially undamaged for 4.6 billion years,” concludes Björn.

“Our new model explains what we see in Rosetta’s detailed observations of its comet, and what had been hinted at by previous comet flyby missions.”

“Comets really are the treasure-troves of the Solar System,” adds Matt.

“They give us unparalleled insight into the processes that were important in the planetary construction yard at these early times and how they relate to the Solar System architecture that we see today.”
The Night Sky

Tuesday, August 2

- Explore faint little Lacerta, the Lizard tucked between Cygnus and Andromeda, using binoculars and Mathew Wedel’s Binocular Highlights column and map in the August Sky & Telescope, page 43. Can you make out the little arrowhead of NGC 7243?
- New Moon (exact at 4:45 p.m. Eastern Daylight Time).

Wednesday, August 3

- As the stars come out, Vega shines near the zenith (if you’re in the mid-northern latitudes), and Arcturus shines in the west.
- A third of the way from Arcturus up to Vega, look for Corona Borealis, the Northern Crown, with its one modestly bright star: Alphecca or Gemma.
- Two thirds of the way to Vega is the dim Keystone of Hercules, with its 6th-magnitude globular cluster M13.

Thursday, August 4

- **Venus-Regulus conjunction.** Shortly after sunset this evening and tomorrow evening, Regulus is hardly more than 1° from much brighter Venus. About 15 or 20 minutes after your local sunset time, scan for Venus very low above the western horizon with binoculars or a wide-field telescope. Tonight Regulus is to Venus's lower left (for North America), as shown at right. On Friday it's below Venus.

Friday, August 5

- The crescent Moon poses with Jupiter low in the west in twilight, as shown here.
- The Big Dipper hangs diagonally in the northwest after dark. From its midpoint, look to the right to find Polaris (not very bright) glimmering due north as always.
- Polaris is the handle-end of the Little Dipper. The only other parts of the Little Dipper that are even modestly bright are the two stars forming the outer end of its bowl. On August evenings they're about a fist and a half (at arm's length) to Polaris's upper left.
- They're called the Guardians of the Pole, since they circle around Polaris throughout the night and throughout the year.

Source: Sky and Telescope

The lineup shifts as Regulus passes under Venus — while the waxing crescent Moon emerges in the evening twilight near Mercury and then Jupiter.
ISS Sighting Opportunities (from Denver)

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Sighting information for other cities can be found at [NASA’s Satellite Sighting Information](#).

**NASA-TV Highlights**  (all times Eastern Time Zone)

**Wednesday, August 3**
- 10 a.m. - ISS Expedition 48 In-Flight Interviews with KGO-TV, San Francisco and the History Channel with ISS Commander Jeff Williams and Flight Engineer Kate Rubins (starts at 10:20 a.m.) (NTV-1 (Public), NTV-3 (Media))

**Thursday, August 4**
- 10 a.m., - ISS Expedition 48 In-Flight Interviews with the Westwood One Radio Network and the San Diego Union Tribune with ISS Commander Jeff Williams and Flight Engineer Kate Rubins (starts at 10:05 a.m.) (NTV-1 (Public), NTV-3 (Media))

Watch NASA TV online by going to the [NASA website](#).
Space Calendar

- **Aug 02** - **Cassini**, Orbital Trim Maneuver #456 (OTM-456)
- Aug 02 - **Comet 9P/Tempe**l Perihelion (1.542 AU)
- Aug 02 - **Amor Asteroid 433 Eros Occults HIP 110426** (9.0 Magnitude Star)
- Aug 02 - **Amor Asteroid 2016 NX22** Near-Earth Flyby (0.033 AU)
- Aug 02 - **Apollo Asteroid 3103 Eger** Closest Approach To Earth (0.189 AU)
- Aug 02 - **Asteroid 4446 Carolyn** Closest Approach To Earth (1.867 AU)
- Aug 02 - **Asteroid 8623 Johnnygalecki** Closest Approach To Earth (2.314 AU)
- Aug 02 - 25th Anniversary (1991), **STS-43** Launch (Space Shuttle Atlantis, TDRS)
- Aug 02 - 45th Anniversary (1971), **Havero Meteорite** Fall (Hit Farm Building in Finland)
- Aug 03 - **Comet C/2016 K1 (LINEAR)** Closest Approach To Earth (1.511 AU)
- Aug 03 - **Comet 229P/Gibbs** At Opposition (2.092 AU)
- **Aug 03** - **Amor Asteroid 2005 OH3** Near-Earth Flyby (0.015 AU)
- Aug 03 - **Asteroid 8621 Jimparsons** Closest Approach To Earth (1.640 AU)
- Aug 03 - **Asteroid 20 Massalia** Closest Approach To Earth (1.689 AU)
- Aug 03 - **Asteroid 1288 Santa** Closest Approach To Earth (1.730 AU)
- Aug 03 - **Asteroid 3524 Schulz** Closest Approach To Earth (1.937 AU)
- Aug 03 - **Asteroid 8489 Boulder** Closest Approach To Earth (1.980 AU)
- Aug 03 - **Asteroid 3975 Verdi** Closest Approach To Earth (2.004 AU)
- Aug 03 - **Kuiper Belt Object 2008 OG19 At Opposition** (37.616 AU)
- Aug 03 - 420th Anniversary (1596), **David Fabricius'** Discovery of the First Perioidic Variable Star (**Mira**)
- **Aug 04** - **Moon Occults Mercury**
- Aug 04 - **Comet 40P/Vaisala At Opposition** (4.059 AU)
- Aug 04 - **Asteroid 207563 Toscan**a Closest Approach To Earth (1.722 AU)
- Aug 04 - **Asteroid 3154 Grant** Closest Approach To Earth (2.100 AU)
- Aug 05 - **Amor Asteroid 2016 NR55** Near-Earth Flyby (0.064 AU)
- Aug 05 - **Asteroid 15845 Bambi** Closest Approach To Earth (1.155 AU)
- Aug 05 - **Asteroid 32605 Lucy** Closest Approach To Earth (1.587 AU)
- Aug 05 - **Asteroid 18610 Arthurdent** Closest Approach To Earth (1.963 AU)
- Aug 05 - **Centaur Object 37117 Narcissus** At Opposition (5.228 AU)
- **Aug 05** - 5th Anniversary (2011), **Juno Atlas 5 Launch (Jupiter Orbiter)**
- Aug 06 - Southern Iota Aquarids Meteor Shower Peak
- **Aug 06** - **Moon Occults Jupiter**

Source: [JPL Space Calendar](http://www.jpl.nasa.gov/missions/)
Food for Thought

Is Earthly Life Premature from a Cosmic Perspective?

The universe is 13.8 billion years old, while our planet formed just 4.5 billion years ago. Some scientists think this time gap means that life on other planets could be billions of years older than ours. However, new theoretical work suggests that present-day life is actually premature from a cosmic perspective.

"If you ask, 'When is life most likely to emerge?' you might naively say, 'Now,'" says lead author Avi Loeb of the Harvard-Smithsonian Center for Astrophysics. "But we find that the chance of life grows much higher in the distant future."

Life as we know it first became possible about 30 million years after the Big Bang, when the first stars seeded the cosmos with the necessary elements like carbon and oxygen. Life will end 10 trillion years from now when the last stars fade away and die. Loeb and his colleagues considered the relative likelihood of life between those two boundaries.

The dominant factor proved to be the lifetimes of stars. The higher a star's mass, the shorter its lifetime. Stars larger than about three times the sun's mass will expire before life has a chance to evolve.

Conversely, the smallest stars weigh less than 10 percent as much as the Sun. They will glow for 10 trillion years, giving life ample time to emerge on any planets they host. As a result, the probability of life grows over time. In fact, chances of life are 1000 times higher in the distant future than now.

"So then you may ask, why we aren't living in the future next to a low-mass star?" says Loeb.

"One possibility is we're premature. Another possibility is that the environment around a low-mass star is hazardous to life."

Although low-mass, red dwarf stars live for a long time, they also pose unique threats. In their youth they emit strong flares and ultraviolet radiation that could strip the atmosphere from any rocky world in the habitable zone.

To determine which possibility is correct -- our premature existence or the hazard of low-mass stars -- Loeb recommends studying nearby red dwarf stars and their planets for signs of habitability. Future space missions like the Transiting Exoplanet Survey Satellite and James Webb Space Telescope should help to answer these questions.

The paper describing this work has been accepted for publication in the Journal of Cosmology and Astroparticle Physics and is available online. Its co-authors are Avi Loeb (Harvard-Smithsonian Center for Astrophysics) and Rafael Batista and David Sloan (University of Oxford). Loeb simultaneously wrote an extended review on the habitability of the universe as a chapter for a forthcoming book.

Source: Harvard-Smithsonian Center for Astrophysics

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M13: A Great Globular Cluster of Stars
Image Credit & Copyright: Dean Fournier; Inset: ESA/Hubble & NASA

Explanation: M13 is one of the most prominent and best known globular clusters. Visible with binoculars in the constellation of Hercules, M13 is frequently one of the first objects found by curious sky gazers seeking celestials wonders beyond normal human vision. M13 is a colossal home to over 100,000 stars, spans over 150 light years across, lies over 20,000 light years distant, and is over 12 billion years old. At the 1974 dedication of Arecibo Observatory, a radio message about Earth was sent in the direction of M13. The featured image in HDR, taken through a small telescope, spans an angular size just larger than a full Moon, whereas the inset image, taken by Hubble Space Telescope, zooms in on the central 0.04 degrees.

Source: NASA APOD