

# Astronomy & Physics Weekly News

Dept. of Applied Physics & Astronomy - University of Sharjah

Compiled by **Dr. Ilias Fernini**



## Top News

**Researchers posit way to locally circumvent Second Law of Thermodynamics**

**Mars Reconnaissance Orbiter views Schiaparelli landing site**

**Scientists create most efficient quantum cascade laser ever**

**Quantum computers: 10-fold boost in stability achieved**

**Astronomers explore mysteries of star formation with uniquely sensitive camera**

**Either stars are strange, or there are 234 aliens trying to contact us**

**Scientists gain insight on mechanism of unconventional superconductivity**

**Scientists manipulate surfaces to make them invisible**

**MAVEN mission observes ups and downs of water escape from Mars**

**The universe is expanding at an accelerating rate—or is it?**

**Going Out in a Blaze of Glory: Cassini's Grand Finale**

**Mars: graveyard of broken dreams and landers**

### SCASS ACTIVITIES:

**Open House**

**SCASS Observatory**

**Friday - Oct. 28, 2016**

**18:00 - 20:00**

**This Week's Sky at a Glance,**

**Oct. 22 - 28**

**15 Days of Darkness in November.**

**It's Another Stupid Hoax.**



## Researchers posit way to locally circumvent Second Law of Thermodynamics



Argonne scientists Ivan Sadovskyy (left) and Valerii Vinokur published a paper showing a mathematical construction to a possible local violation of the Second Law of the Thermodynamics. One implication for the research could be a way to one day remotely power a device -- that is, the energy expended to light the lamp could take place anywhere. Credit: Mark Lopez/ Argonne National Laboratory

For more than a century and a half of physics, the Second Law of Thermodynamics, which states that entropy always increases, has been as close to inviolable as any law we know. In this universe, chaos reigns supreme.

But researchers with the U.S. Department of Energy's (DOE's) Argonne National Laboratory announced recently that they may have discovered a little loophole in this famous maxim.

Their research, published in Scientific Reports, lays out a possible avenue to a situation where the Second Law is violated on the microscopic level.

The Second Law is underpinned by what is called the H-theorem, which says that if you open a door between two rooms, one hot and one cold, they will eventually settle into lukewarm equilibrium; the hot room will never end up hotter.

But even in the twentieth century, as our knowledge of quantum mechanics advanced, we didn't fully understand the fundamental physical origins of the H-theorem.

Recent advancements in a field called quantum information theory offered a mathematical construction in which entropy increases.

"What we did was formulate how these beautiful abstract mathematical theories could be connected to our crude reality," said Valerii Vinokur, an Argonne Distinguished Fellow and corresponding author on the study. The scientists took quantum information theory, which is based on abstract mathematical systems, and applied it to condensed matter physics, a well-explored field with [...Read More...](#)

## Mars Reconnaissance Orbiter views Schiaparelli landing site



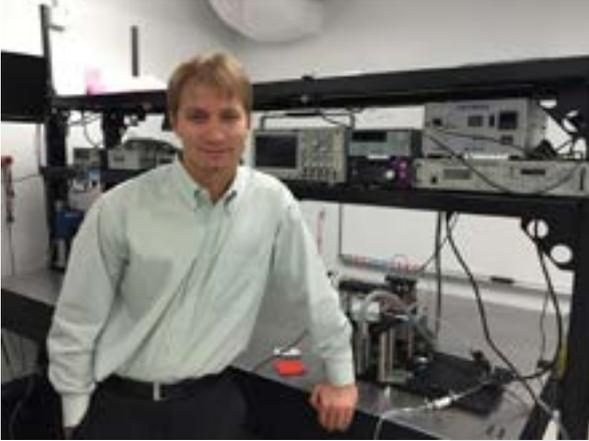
The landing site of the Schiaparelli module within the predicted landing ellipse in a mosaic of images from the Context Camera (CTX) on NASA's Mars Reconnaissance Orbiter and the Thermal Emission Imaging System (THEMIS) on NASA's 2001 Mars Odyssey orbiter. Below the main image are a pair of before-and-after images, taken by the CTX camera on 29 May 2016 (left) and 20 October 2016 (right), respectively. The 20 October image shows two new features appearing following the arrival of the Schiaparelli test lander module on the martian surface on 19 October. One of the features is bright and can be associated with the 12-m diameter parachute used in the second stage of Schiaparelli's descent, after the initial heat shield entry. The parachute and the associated back shield were released from Schiaparelli prior to the final phase, during which its nine thrusters should have slowed it to a standstill just above the surface. The other new feature is a fuzzy dark patch roughly 15 x 40 metres in size and about 1 km north of the parachute. This is interpreted as arising from the impact of the Schiaparelli module itself following a much longer free fall than planned, after the thrusters were switched off prematurely. The landing ellipse is 100 km x 15 km, and is centred on 2 degrees south in latitude and 353 degrees east longitude, in the Meridiani Planum region of Mars, close to the planet's equator. The image measures about 100 km; north is up. The dark spot on the image, associated with the Schiaparelli module, is located approximately 5.4 km west of the centre of the landing ellipse. Credit: Main image: NASA/JPL-Caltech/MSSS, Arizona State University; inserts: NASA/JPL-Caltech/MSSS

NASA's Mars Reconnaissance Orbiter has identified new markings on the surface of the Red Planet that are believed to be related to ESA's ExoMars Schiaparelli entry, descent and landing technology demonstrator module.

Schiaparelli entered the martian atmosphere at 14:42 GMT on 19 October for its 6-minute descent to the surface, but contact was lost shortly before expected touchdown. Data recorded by its mothership, the Trace Gas Orbiter, are currently being analysed to understand what happened during the descent sequence.

In the meantime, the low-resolution CTX camera on-board the Mars Reconnaissance Orbiter (MRO) took pictures of the expected touchdown site in Meridiani Planum on 20 October as part of a planned imaging campaign. The image released today has a resolution of 6 metres per pixel and shows two new features on the surface when compared to an image from the same camera taken [...Read More...](#)

## Scientists create most efficient quantum cascade laser ever



Assistant Professor Arkadiy Lyakh of UCF's NanoScience Technology Center has developed the most efficient Quantum Cascade Laser ever. Credit: University of Central Florida

A team of UCF researchers has produced the most efficient quantum cascade laser ever designed - and done it in a way that makes the lasers easier to manufacture.

Quantum cascade lasers, or QCLs, are tiny - smaller than a grain of rice - but they pack a punch. Compared to traditional lasers, QCLs offer higher power output and can be tuned to a wide range of infrared wavelengths. They can also be used at room temperature without the need for bulky cooling systems.

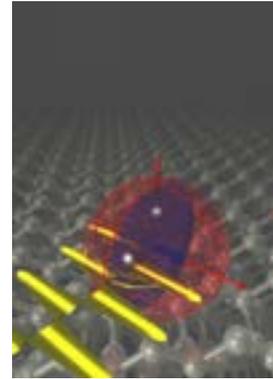
But because they're difficult and costly to produce, QCLs aren't used much outside the Department of Defense. A University of Central Florida team led by Assistant Professor Arkadiy Lyakh has developed a simpler process for creating such lasers, with comparable performance and better efficiency. The results were published recently in the scientific journal *Applied Physics Letters*.

"The previous record was achieved using a design that's a little exotic, that's somewhat difficult to reproduce in real life," Lyakh said. "We improved on that record, but what's really important is that we did it in such a way that it's easier to transition this technology to production. From a practical standpoint, it's an important result."

That could lead to greater usage in spectroscopy, such as using the infrared lasers as remote sensors to detect gases and toxins in the atmosphere. Lyakh, who has joint appointments with UCF's NanoScience Technology Center and the College of Optics and Photonics, envisions portable health devices. For instance, a small QCL-embedded device could be plugged into a smartphone and used to diagnose health problems by simply analyzing one's exhaled breath.

"But for a handheld device, it has to be as efficient as possible so it doesn't drain your battery and it won't generate a lot of heat," Lyakh said. [...Read More...](#)

## Quantum computers: 10-fold boost in stability achieved



Artist's impression of a single-atom electron spin, hosted in a silicon crystal and dressed by an oscillating electromagnetic field. Credit: Arne Laucht/UNSW

Australian engineers have created a new quantum bit which remains in a stable superposition for 10 times longer than previously achieved, dramatically expanding the time during which calculations could be performed in a future silicon quantum computer.

The new quantum bit, made up of the spin of a single atom in silicon and merged with an electromagnetic field - known as 'dressed qubit' - retains quantum information for much longer than an 'undressed' atom, opening up new avenues to build and operate the superpowerful quantum computers of the future.

The result by a team at Australia's University of New South Wales (UNSW), appears today in the online version of the international journal, *Nature Nanotechnology*.

"We have created a new quantum bit where the spin of a single electron is merged together with a strong electromagnetic field," said Arne Laucht, a Research Fellow at the School of Electrical Engineering & Telecommunications at UNSW, and lead author of the paper. "This quantum bit is more versatile and more long-lived than the electron alone, and will allow us to build more reliable quantum computers."

Building a quantum computer has been called the 'space race of the 21st century' - a difficult and ambitious challenge with the potential to deliver revolutionary tools for tackling otherwise impossible calculations, such as the design of complex drugs and advanced materials, or the rapid search of massive, unsorted databases.

Its speed and power lie in the fact that quantum systems can host multiple 'superpositions' of different initial states, which in a computer are treated as inputs which, in turn, all get processed at the same time.

"The greatest hurdle in using quantum objects for computing is to preserve their delicate superpositions long enough to allow us to perform useful [...Read More...](#)

## Astronomers explore mysteries of star formation with uniquely sensitive camera



Credit: Arizona State University

How do stars form deep inside clouds of molecular gas? What's the history of star formation throughout cosmic time? When did the first stars form? And how did they produce the materials necessary for life on Earth?

A group of astronomers at Arizona State University is seeking answers to such questions as part of an international experiment that has been awarded more than \$6 million in funding from the National Science Foundation to help build a uniquely sensitive camera, called ToI TEC, to probe these mysteries.

"Half the light from stars in the universe is absorbed by clouds of interstellar dust and then re-radiated at long wavelengths invisible to the human eye," said Philip Maukopf, of Arizona State University's School of Earth and Space Exploration (SESE). "Astronomical observations at these wavelengths can let us see into the cores of stellar nurseries where new stars are forming."

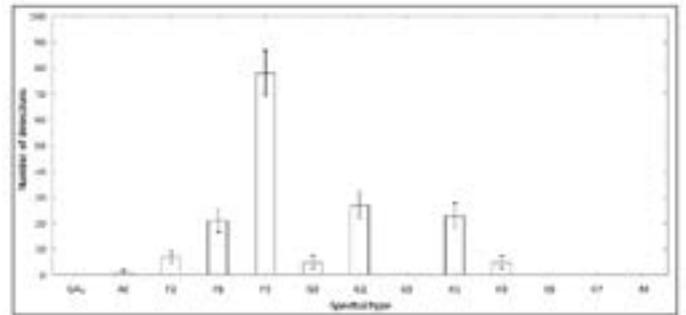
Maukopf, a professor in SESE, is the leader of the ASU team that will design and construct the optics for the new camera. The team will also develop the electronics for producing images from the instrument's superconducting detectors.

### Big eye

The new camera will be attached to a giant telescope in Mexico. On top of the 15,000-foot Sierra Negra in the state of Puebla sits the Large Millimeter Telescope (pictured above), with a 50-meter (164-foot) diameter main mirror. It is the largest telescope in the world designed to operate at a wavelength of 1 millimeter, ideal for making detailed study of the dusty universe. The construction of this telescope, with contributions from the University of Massachusetts, has been the biggest scientific project in the history of Mexico.

Over the next three years, an international consortium, led by UMass, will build the golf-cart-size ToI TEC cryogenic camera for the Large Millimeter Telescope. It will survey the universe, imaging radiation from [...Read More...](#)

## Either stars are strange, or there are 234 aliens trying to contact us



A portion of the 234 stars that are sources of the pulsed ETI-like signal. Note that all the stars are in the narrow spectral range F2 to K1, very similar to our own sun. Credit: Ermanno F. Borra and Eric Trottier This graph shows the number of detected signals by Spectral Type of star. Credit: Ermanno F. Borra and Eric Trottier

We all want there to be aliens. Green ones, pink ones, brown ones, Greys. Or maybe Vulcans, Klingons, even a being of pure energy. Any type will do.

That's why whenever a mysterious signal or energetic fluctuation arrives from somewhere in the cosmos and hits one of our many telescopes, headlines erupt across the media: "Have We Finally Detected An Alien Signal?" or "Have Astronomers Discovered An Alien Megastructure?" But science-minded people know that we're probably getting ahead of ourselves.

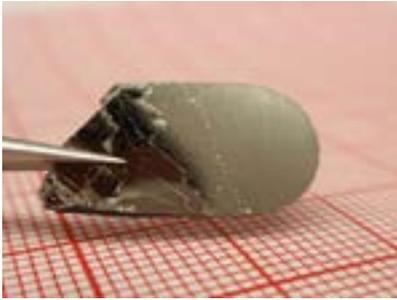
Skepticism still rules the day when it comes to these headlines, and the events that spawn them. That's the way it should be, because we've always found a more prosaic reason for whatever signal from space we're talking about. But, being skeptical is a balancing act; it doesn't mean being dismissive.

What we're talking about here is a new study from E.F. Borra and E. Trottier, two astronomers at Laval University in Canada. Their study, titled "Discovery of peculiar periodic spectral modulations in a small fraction of solar type stars" was just published at arXiv.org. ArXiv.org is a pre-print website, so the paper itself hasn't been peer reviewed yet. But it is generating interest.

The two astronomers used data from the Sloan Digital Sky Survey, and analyzed the spectra of 2.5 million stars. Of all those stars, they found 234 stars that are producing a puzzling signal. That's only a tiny percentage. And, they say, these signals "have exactly the shape of an ETI signal" that was predicted in a previous study by Borra.

Prediction is a key part of the scientific method. If you develop a theory, your theory looks better and better the more you can use it to correctly predict some future events based on it. Look how many times [...Read More...](#)

## Scientists gain insight on mechanism of unconventional superconductivity



A crystal sample of one of the iron-based unconventional superconductors studied by Ames Laboratory scientists. Their systematic investigation of this class of superconductors may lead to the creation of new materials with unique superconducting properties. Credit: U.S. Department of Energy, Ames Laboratory

Researchers at the U.S. Department of Energy's Ames Laboratory and partner institutions conducted a systematic investigation into the properties of the newest family of unconventional superconducting materials, iron-based compounds. The study may help the scientific community discover new superconducting materials with unique properties.

Researchers combined innovative crystal growth, highly sensitive magnetic measurements, and the controlled introduction of disorder through electron bombardment to create and study an entire range of compositions within a class of iron-based superconductors. They found that the key fundamental properties—transition temperature and magnetic field penetration depth—of these complex superconductors were dependent on composition and the degree of disorder in the material structure.

"This was a systematic approach to more fully understand the behavior of unconventional superconductors," said Ruslan Prozorov, Ames Laboratory faculty scientist and professor in the Department of Physics and Astronomy at Iowa State University. "We found that some proposed models of unconventional superconductivity in these iron-based compounds were compatible with our results, and this study further limited the possible theoretical mechanisms of superconductivity." Researchers combined innovative crystal growth, highly sensitive magnetic measurements, and the controlled introduction of disorder through electron bombardment to create and study an entire range of compositions within a class of iron-based superconductors. They found that the key fundamental properties—transition temperature and magnetic field penetration depth—of these complex superconductors were dependent on composition and the degree of disorder in the material structure.

"This was a systematic approach to more fully understand the behavior of unconventional [...Read More...](#)

## Scientists manipulate surfaces to make them invisible

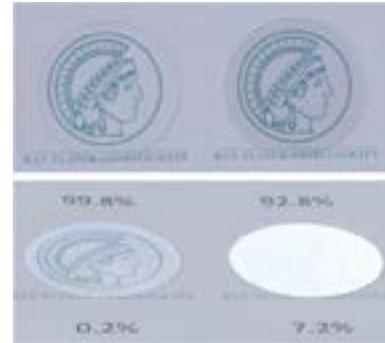


Image of the Greek goddess Minerva as seen under a fused silica substrate with 450 nm nanopillars on both sides (left) compared to an unstructured reference (right). Each substrate has a diameter of 25 mm, matching the size of the drawing. The top set of images were taken at an observation angle of 0°, the bottom set of images at an observation angle of 30°. Credit: Zhaolu Diao

Most lenses, objectives, eyeglass lenses, and lasers come with an anti-reflective coating. Unfortunately, this coating works optimally only within a narrow wavelength range. Scientists at the Max Planck Institute for Intelligent Systems in Stuttgart have now introduced an alternative technology. Instead of coating a surface, they manipulate the surface itself. By comparison with conventional procedures, this provides the desired anti-reflective effect across a wider wavelength range. But more than this, it largely increases the light transmittance through surfaces. In the future, the nanostructured surfaces may improve high-energy lasers as well as touchscreens and the output of solar modules.

Researchers at the Max Planck Institute for Intelligent Systems took a page out of the design book for moth cornea. The corneas of these mostly nocturnal insects reflect almost no incoming light. There is no glow of light bouncing off the moth's eyes to betray their presence to potential predators. Less reflected light also means that moths are able to use practically all the scarce night-time light to see. This magic from the world of insects inspired scientists to try the same tactics for the design of optical components. Like the corneas of moths, the components must allow light to pass through while light reflection is of little use. So far, component designers apply anti-reflective coating to lenses, display screens, monitors and laser components. However, these coatings have disadvantages. Most of them work only in a narrow wavelength range, and they produce lens errors dependent on the angle of light incidence.

Applying the moth cornea principle will put an end to these problems. Scientists at the Max Planck Institute for Intelligent Systems, Department for New Materials and Biosystems, under the guidance of Director Joachim Spatz had a good look at their natural model. Physicist Zhaolu Diao explains nature's design: "The eye [...Read More...](#)

# MAVEN mission observes ups and downs of water escape from Mars

## The universe is expanding at an accelerating rate—or is it?



This image shows atomic hydrogen scattering sunlight in the upper atmosphere of Mars, as seen by the Imaging Ultraviolet Spectrograph on NASA's Mars Atmosphere and Volatile Evolution mission. About 400,000 observations, taken over the course of four days shortly after the spacecraft entered orbit around Mars, were used to create the image. Hydrogen is produced by the breakdown of water, which was once abundant on Mars' surface. Because hydrogen has low atomic mass and is weakly bound by gravity, it extends far from the planet (the darkened circle) and can readily escape. Credit: NASA/University of Colorado

After investigating the upper atmosphere of the Red Planet for a full Martian year, NASA's MAVEN mission has determined that the escaping water does not always go gently into space. Sophisticated measurements made by a suite of instruments on the Mars Atmosphere and Volatile Evolution, or MAVEN, spacecraft revealed the ups and downs of hydrogen escape - and therefore water loss.

The escape rate peaked when Mars was at its closest point to the sun and dropped off when the planet was farthest from the sun. The rate of loss varied dramatically overall, with 10 times more hydrogen escaping at the maximum.

"MAVEN is giving us unprecedented detail about hydrogen escape from the upper atmosphere of Mars, and this is crucial for helping us figure out the total amount of water lost over billions of years," said Ali Rahmati, a MAVEN team member at the University of California at Berkeley who analyzed data from two of the spacecraft's instruments.

Hydrogen in Mars' upper atmosphere comes from water vapor in the lower atmosphere. An atmospheric water molecule can be broken apart by sunlight, releasing the two hydrogen atoms from the oxygen atom that they had been bound to. Several processes at work in Mars' upper atmosphere may then act on the hydrogen, leading to its escape.

This loss had long been assumed to be more-or-less constant, like a slow leak in a tire. But previous observations made using NASA's Hubble Space Telescope and ESA's Mars Express orbiter found unexpected fluctuations. Only a handful of these measurements have been made so far, and most were essentially snapshots [...Read More...](#)



This is the "South Pillar" region of the star-forming region called the Carina Nebula. Like cracking open a watermelon and finding its seeds, the infrared telescope "busted open" this murky cloud to reveal star embryos tucked inside finger-like pillars of thick dust. Credit: NASA

Five years ago, the Nobel Prize in Physics was awarded to three astronomers for their discovery, in the late 1990s, that the universe is expanding at an accelerating pace.

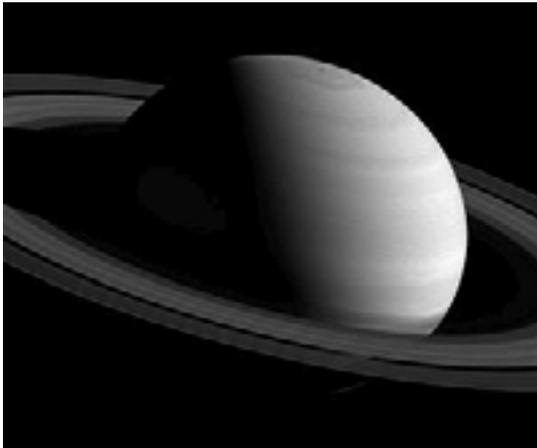
Their conclusions were based on analysis of Type Ia supernovae - the spectacular thermonuclear explosion of dying stars - picked up by the Hubble space telescope and large ground-based telescopes. It led to the widespread acceptance of the idea that the universe is dominated by a mysterious substance named 'dark energy' that drives this accelerating expansion.

Now, a team of scientists led by Professor Subir Sarkar of Oxford University's Department of Physics has cast doubt on this standard cosmological concept. Making use of a vastly increased data set - a catalogue of 740 Type Ia supernovae, more than ten times the original sample size - the researchers have found that the evidence for acceleration may be flimsier than previously thought, with the data being consistent with a constant rate of expansion. The study is published in the Nature journal Scientific Reports.

Professor Sarkar, who also holds a position at the Niels Bohr Institute in Copenhagen, said: 'The discovery of the accelerating expansion of the universe won the Nobel Prize, the Gruber Cosmology Prize, and the Breakthrough Prize in Fundamental Physics. It led to the widespread acceptance of the idea that the universe is dominated by "dark energy" that behaves like a cosmological constant - this is now the "standard model" of cosmology.

'However, there now exists a much bigger database of supernovae on which to perform rigorous and detailed statistical analyses. We analysed the latest catalogue of 740 Type Ia supernovae - over ten times bigger than the original samples on which the discovery claim was based - and found that the evidence for accelerated expansion is, at most, what physicists call "3 sigma". This is far short of the "5 sigma" standard required to claim a discovery of fundamental significance. [...Read More...](#)

## Going Out in a Blaze of Glory: Mars: graveyard of broken Cassini's Grand Finale dreams and landers



During the Grand Finale, Cassini will make the closest-ever observations of Saturn, mapping the planet's magnetic and gravity fields with exquisite precision and returning ultra-close views of the atmosphere. Scientists also hope to gain new insights into Saturn's interior structure, the precise length of a Saturn day, and the total mass of the rings - which may finally help settle the question of their age.

With the conclusion of the international Cassini mission set for September 15, 2017, the spacecraft is poised to soon begin a thrilling two-part endgame. Cassini will enter the first part of this denouement on November 30, 2016, when the spacecraft begins a series of 20 passes just beyond the outer edge of the main rings. These weekly loops around Saturn are called the F ring orbits, and they send the spacecraft high above and below the planet's poles.

During these orbits, Cassini will approach to within 4,850 miles (7,800 kilometers) of the center of the narrow F ring, with its wispy and ever-changing structure. "During the F ring orbits we expect incredible views of the rings, along with the small moons and other structures embedded in them, as we've never seen them before," said Linda Spilker, Cassini project scientist at NASA's Jet Propulsion Laboratory, Pasadena, California.

"The last time we got this close to the rings was during arrival at Saturn in 2004, and we saw only their backlit side. Now we have dozens of opportunities to examine their structure at extremely high resolution on both sides."

Cassini's final phase - called the Grand Finale - begins in earnest in April 2017. A close flyby of Saturn's giant moon Titan will reshape the spacecraft's orbit so that, instead of passing outside the rings, it passes through the gap between the rings and the planet. The spacecraft is expected to make 22 plunges through this gap - an unexplored space only about 1,500 miles (2,400 kilometers) wide - beginning with its first dive on April 27.

During the Grand Finale, Cassini will make the closest-ever observations of Saturn, mapping the planet's magnetic and gravity fields with exquisite precision and returning ultra-close views of the atmosphere. [...Read More...](#)



Mars Marathon Valley - NASA

Mars, the fourth planet from the Sun, has become a veritable graveyard for landers and rovers despatched to its surface from neighbouring Earth.

Only the United States has successfully operated rovers on the Red Planet, four in all, and has lost only one stationary lander.

The former Soviet Union had chalked up repeated failures, while Russia's first attempt at a rover will be a joint mission along with Europe dubbed ExoMars.

If data shows that Europe's Schiaparelli lander crashed into the Red Planet on Wednesday, it will be the second failed attempt for Europe in 13 years.

Overall, almost half of all attempts to land on Mars since the 1960s have ended in disappointment.

A recap of surface-bound missions that missed the mark.

- USSR - Russia -

The Soviet Union (USSR) was the first to attempt to place a craft on Mars.

A launch failure spoiled its first bid in 1962, followed in 1971 with its Mars 2 lander becoming the first pile of man-made debris on the Red Planet.

Less than a week later, Mars 3 became the first craft to make a soft Mars landing, though contact was lost after mere seconds and the mission was chalked up as a partial failure. A small "walking" rover on board Mars 3 did not deploy.

Moscow tried again in 1973 with its Mars 6 and Mars 7 landers, but contact with the first was lost as it reached the surface, and the second never penetrated the Martian atmosphere.

Pre-touchdown communications were lost with two further would-be landers, Fobos 1 and Fobos 2, both launched in 1988. [...Read More...](#)

## This Week's Sky at a Glance Oct. 22 - 28

- Oct 22** Meteor shower Orionids - Parent body: Halley's comet - Active dates: 16-27 Oct  
**Oct 22** Last Quarter (23:13) - Meridian passage (05:41) - Altitude: 83°  
**Oct 26** Moon at ascending node (Local Time: 05:44)  
**Oct 27** Mercury at superior conjunction (20:16)

## Open House - SCASS Observatory Friday - Oct. 28, 2016 18:00 - 20:00

### No, There Won't Be 15 Days of Darkness in November. It's Another Stupid Hoax.

The internet is great, isn't it?

You can post anything you want on the internet, and if people like the sound of it, they spread it. It doesn't make any difference if it's true or not. We're not born fact checkers and skeptics, are we?

Pretty soon, before you know it, it's gone viral. Then it becomes its own sensation, and people who don't even believe it start reporting it. Never is this more true than with hoaxes.

The latest hoax is the "15 Days of Darkness in November" thing that's going around. Everyone's on the bandwagon.

The 15 days hoax is not new. It made an appearance last year, and was thoroughly debunked. And of course, there wasn't 15 day of darkness last year, was there? (Unless NASA covered it up!)

It's here again this year, and will be debunked again, and will probably be here next year, too.

The whole thing started at a site that will remain linkless, and caught on from there. This is what the site reported:

"NASA has confirmed that the Earth will experience 15 days of total darkness between November 15 and November 29, 2015. The event, according to NASA, hasn't occurred in over 1 Million years."

Of course, NASA never said any such thing. [...Read More...](#)



Sharjah Center for Astronomy and Space Sciences  
Sharjah - United Arab Emirates  
Phone: 00-971-6-5166000  
Website: [www.scass.ae](http://www.scass.ae)  
Email: [scass@scass.ae](mailto:scass@scass.ae)



College of Sciences - University of Sharjah  
POB 27272 - Sharjah - United Arab Emirates  
Phone: 00-971-6-5050351  
Website: [www.sharjah.ac.ae](http://www.sharjah.ac.ae)  
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