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Department of Physics—United Arab Emirates University

Inside this issue:

NASA's New Horizons Zooms By Pluto, Solar Systems Last Planet – King of The Kuiper Belt

Pluto nearly fills the frame in this image from the Long Range Reconnaissance Imager (LORRI) aboard NASA's New Horizons spacecraft, taken on July 13, 2015 when the spacecraft was 476,000 miles (768,000 kilometers) from the surface. This is the last and most detailed image sent to Earth before the spacecraft's closest approach to Pluto on July 14. The color image has been combined with lower-resolution color information from the Ralph instrument that was acquired earlier on July 13. This view is dominated by the large, bright feature informally named the "heart," which measures approximately 1,000 miles (1,600 kilometers) across. The heart borders darker equatorial terrains, and the mottled terrain to its east (right) are complex. However, even at this resolution, much of the heart's interior appears remarkably featureless—possibly a sign of ongoing geologic processes. Credits: NASA/APL/SwRI

With this morning's (July 14) do or die flyby of Pluto by NASA's New Horizons spacecraft at 7:49 a.m. EDT while traveling over 3 billion miles away, America completed the initial up close reconnaissance of the last explored planet of our solar system at its frigid, far flung reaches and revealed a remarkably differentiated world dazzling us with alien terrain far beyond anyone's expectation.

New Horizons barreled past Pluto for a history making first ever flyby at over 31,000 mph (49,600 kph) and passed only 7,750 miles (12,500 kilometers) above the planet's amazingly diverse surface.

To mark the occasion, NASA released the highest resolution image ever taken of Pluto as the probe swooped past its prey this morning, centered on the two lobed, differentiated 'heart'.

But because the one ton piano shaped spacecraft has been out of touch with Mission Control for the past day as planned and busily gathering hordes of priceless data, confirmation of a successful flyby didn't reach Mission Control on Earth until half a day later when New Horizons 'phoned home' with critical engineering data confirmed the health of the probe at 8:53 p.m. EDT this evening- basically saying "I'm Alive".

"With this mission we have we have visited every planet in our solar system," proclaimed NASA Administrator Charles Bolden this evening, July 14, to a packed house of cheering team members, invited guests and media including Universe Today at the Johns Hopkins University Applied Physics Laboratory (APL) in Laurel, Maryland, during a live NASA TV media briefing shortly after accomplishing the historic feat after the nine year interplanetary voyage.

"No other nation has that capability. It's a historic day for exploration."...Read More...

New methodology to study nanoparticle structures

Nanoscience is the study of materials that measure at the scale of one-billionth of a metre in length. While "tiny" is the very nature of this scientific field, nanoscience is a huge force behind modern day technology and communication, with promise in many more fields. Anyone who uses a cell phone or laptop has seen the outcome of materials scientists studying the mysterious chemical behaviours at the nano-scale.

Peng Zhang, a professor with Dalhousie's Department of Chemistry, leads a nanoscience research team of undergraduate and graduate students. Published this week in the prestigious scientific journal Nature Communications, Zhang's team's discovery on new methodology to study nanoparticle structures will make the materials science and biomedical communities buzz with excitement.

Dr. Zhang and his PhD student Daniel Padmos examined gold and silver nanoparticles—two very important materials, particularly in the future of biomedicine. At this size, gold and silver look and behave much differently than they do when they're used to make rings and necklaces.

"Only when they're very small do they begin to show new properties, and these properties can be used in many different biomedical applications," explains Dr. Zhang, lead author of the study.

Nanogold, for example, has incredible optical properties that allow it to absorb light energy very well. Currently only tested in mice, biomedical scientists have developed drugs with nanogold to target malignant tumours. ...*Read More*...

An up-close look at nanogold, as seen in the lab of the Department of Physics and Atmospheric Science's Kevin Hewitt. Credit: Bruce Bottomley

Researchers build a transistor from a molecule and a few atoms

An international team of physicists has used a scanning tunneling microscope to create a minute transistor consisting of a single molecule and a small number of atoms. The observed transistor action is markedly different from the conventionally expected behavior and could be important for future device technologies as well as for fundamental studies of electron transport in molecular nanostructures. The physicists represent the Paul-Drude-Institut für Festkörperelektronik (PDI) and the Freie Universität Berlin (FUB), Germany, the NTT Basic Research Laboratories (NTT-BRL), Japan, and the U.S. Naval Research Laboratory (NRL). Their complete findings are published in the 13 July 2015 issue of the journal Nature Physics.

Transistors have a channel region between two external contacts and an electrical gate electrode to modulate the current flow through the channel. In atomic-scale transistors, this current is extremely sensitive to single electrons hopping via discrete energy levels. In earlier studies, researchers have examined single-electron transport in molecular transistors using top-down approaches, such as lithography and break junctions. But atomically precise control of the gate—which is crucial to transistor action at the smallest size scales—is not possible with these approaches.

The team used a highly stable scanning tunneling microscope (STM) to create a transistor consisting of a single organic molecule and positively charged metal atoms, positioning them with ...*Read More*...

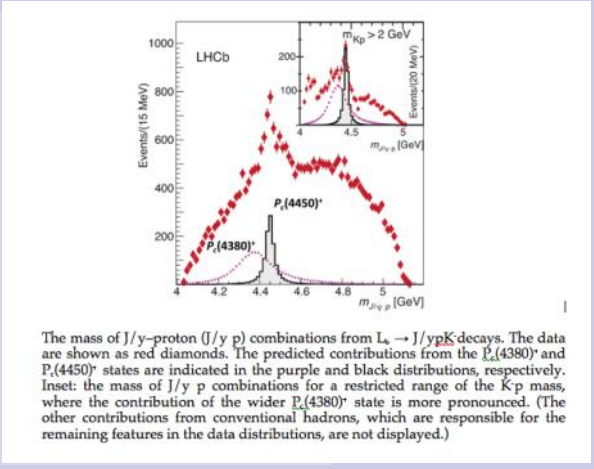
Scanning tunneling microscope image of a phthalocyanine molecule centered within a hexagon assembled from twelve indium atoms on an indium arsenide surface. The positively charged atoms provide the electrostatic gate …..

CERN's LHCb experiment reports observation of exotic pentaquark particles

The LHCb experiment at CERN's Large Hadron Collider has reported the discovery of a class of particles known as pentaquarks. The collaboration has submitted a paper reporting these findings to the journal Physical Review Letters.

"The pentaquark is not just any new particle," said LHCb spokesperson Guy Wilkinson. "It represents a way to aggregate quarks, namely the fundamental constituents of ordinary protons and neutrons, in a pattern that has never been observed before in over fifty years of experimental searches. Studying its properties may allow us to understand better how ordinary matter, the protons and neutrons from which we're all made, is constituted."

Our understanding of the structure of matter was revolutionized in 1964 when American physicist, Murray Gell-Mann, proposed that a category of particles known as baryons, which includes protons and neutrons, are comprised of three fractionally charged objects called quarks, and that another category, ...*Read More*..



The mass of J/ψ–proton (J/ψ p) combinations from $\Lambda_b \to J/\psi p K^-$ decays. The data are shown as red diamonds. The predicted contributions from the $P_c(4380)^+$ and $P_c(4450)^+$ states are indicated in the purple and black distributions, respectively. Inset: the mass of J/ψ p combinations for a restricted range of the K-p mass, where the contribution of the wider $P_c(4380)^+$ state is more pronounced. (The other contributions from conventional hadrons, which are responsible for the remaining features in the data distributions, are not displayed.)

What the Moon tells us about Earth

The surface of the Earth preserves little or no information about its distant past. Constant tectonic activity has recycled Earth's crust and shifted landmasses. Rainfall, wind, ice and snow have weathered away surface features over billions of years. Most of the craters formed by the impacts of asteroids and comets have been erased from the geologic record, with just over 100 known craters remaining on the continents.

But there is a place that we can go to learn more about the past of our own planet: the moon. In sharp contrast to Earth's surface, that of the moon is covered with thousands of craters of all sizes, many of them produced shortly after the moon was born. The moon doesn't have the winds, rivers or plate tectonics capable of erasing these marks of ancient impacts.

For that reason, the surface of the moon is like a window into the early history of our solar system. By studying the chemical composition of rocks and soil on our natural satellite, we could obtain a glimpse of the Earth's own geological infancy – including the emergence of life.

Way back when

The Earth formed 4.54 billion years ago, after ancient asteroids known as planetesimals piled up into a single, planet-sized body as they orbited the sun. Scientists think the moon formed roughly 70 million years later, when a planet about the size of Mars collided with the young Earth. With the aid of sophisticated computer models, experts have shown that this huge collision created a donut-shaped envelope of molten rock and hot gas around the Earth. By calculating how this scorching disk would lose its heat, they've deduced that the moon condensed from all this hot material in less than 100 years.

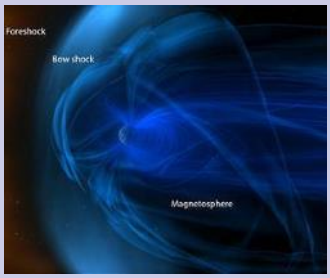
Fast forward some 500 million years. Around this time, the giant planets Jupiter, Saturn, Uranus...***Read More***….

What can what's on the moon tell us about our home planet? Image credit: NASA,

Discovery of zebra stripes in space resolves 50-year mystery

In the 1960s, NASA launched six satellites to study the Earth's atmosphere, magnetosphere and the space between Earth and the moon. Using observations from those satellites, Christopher Russell, a UCLA graduate student at the time, detected mysterious plasma waves in the Van Allen radiation belts, the donut-shaped rings surrounding the Earth that contain high-energy particles trapped by the planet's magnetic field.

Referred to as equatorial noise or "Russell noise," in tribute to Russell - who is now a professor of space physics and planetary science at UCLA - the waves are among the most frequently observed emissions in the near-Earth space. But until recently, scientists could not explain how these waves are excited. Now, after nearly a half century, the mystery has been solved - by a team co-led by another UCLA scientist. Yuri Shprits, a research geophysicist in the UCLA College, and his colleagues discovered the structure of these waves when they are very close to the equator. The scientists observed 13 equally spaced lines measured by two European Space Agency Cluster satellites, and found highly structured wave spectrograms that look like a zebra pedestrian crossing. "It's truly remarkable how nature managed to draw such clear, very narrow, and periodic lines in space," said Shprits ...***Read More***...



The Earth's magnetosphere is home to the plasma waves being studied by Yuri Shprits and colleagues. Image courtesy NASA.

Gaia satellite and amateur astronomers spot one in a billion star

An international team of researchers, with the assistance of amateur astronomers, have discovered a unique binary star system: the first known such system where one star completely eclipses the other. It is a type of two-star system known as a Cataclysmic Variable, where one super dense white dwarf star is stealing gas from its companion star, effectively 'cannibalising' it.

The system could also be an important laboratory for studying ultra-bright supernova explosions, which are a vital tool for measuring the expansion of the Universe. Details of the new research will be published in the journal Monthly Notices of the Royal Astronomical Society.

The system, named Gaia14aae, is located about 730 light years away in the Draco constellation. It was discovered by the European Space Agency's Gaia satellite in August 2014 when it suddenly became five times brighter over the course of a single day.

Astronomers led by the University of Cambridge analysed the information from Gaia and determined that the sudden outburst was due to the fact that the white dwarf - which is so dense that a teaspoonful of material from it would weigh as much as an elephant - is devouring its larger companion.

Additional observations of the system made by the Center for Backyard Astrophysics (CBA), a collaboration of amateur and professional astronomers, found that the system is a rare eclipsing binary, where one star passes directly in front of the other, completely blocking it out when viewed from Earth. The two stars are tightly orbiting each other, so a total eclipse occurs roughly every 50 minutes….***Read More***...

Artist's impression of Gaia14aae. Credit: Marisa Grove/Institute of Astronomy

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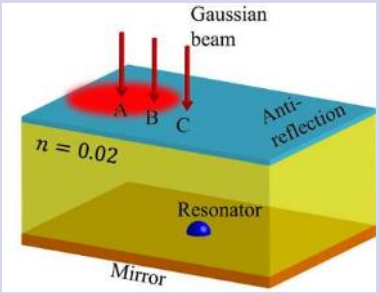
Nanoscale device that can emit light as powerfully as an object 10,000 times its size

University of Wisconsin-Madison engineers have created a nanoscale device that can emit light as powerfully as an object 10,000 times its size. It's an advance that could have huge implications for a variety of imaging and energy applications.

In a paper published July 10, 2015 in the journal Physical Review Letters, Zongfu Yu, an assistant professor of electrical and computer engineering at UW-Madison, and his collaborators describe nanoscale device that that drastically outpaces previous technology in its ability to scatter light. They showed how a single nanoresonator can manipulate light to cast a very large "reflection." The nanoresonator's capacity to absorb and emit light energy is such that it can make itself—and, in applications, other very small things—appear 10,000 times as large as its physical size.

"Making an object look much 10,000 times larger than its physical size has lots of implications in technologies related to light," Yu says. The researchers realized the advance through ...***Read More***....



A diagram shows an optical nanoresonator embedded within a slab of low-index material to test its performance.

More precise estimate of Avogadro's number to help redefine kilogram

An ongoing international effort to redefine the kilogram by 2018 has been helped by recent efforts from a team researchers from Italy, Japan and Germany to correlate two of the most precise measurements of Avogadro's number and obtain one averaged value that can be used for future calculations. Their results are published this week in the Journal of Physical and Chemical Reference Data.

Avogadro's number is approximately 6.022x10^23—an almost unfathomably large quantity, greater than the number of grains of sand on earth or even the number of stars in the universe. But the number, which represents the number of discrete particles like atoms or molecules in a "mole" of a substance, is a useful way to wrangle these tiny particles into more meaningful quantities. A mole of water molecules, for instance, is only a few teaspoons of liquid. Because Avogadro's number is linked to a number of other physical constants, its value can be used to express other units, such as the kilogram.

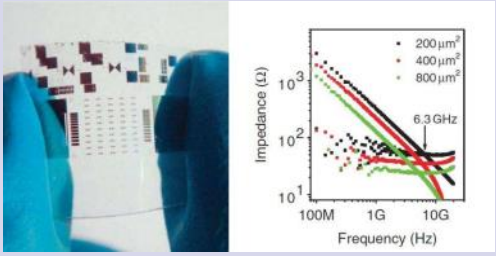
The team has calculated Avogadro's number several ...***Read More***...

The number of atoms in this silicon sphere is known given or taken 20 atoms each 10^9. The atom distance was measured by the X-ray interferometer on the left. Credit: Enrico Massa and Carlo Sasso

Fastest-ever flexible diode provides 'last missing piece' needed to realize bendable phones

While there are hints that Samsung and LG are developing flexible phones that can fold, roll up, and even be stretched into larger screens, there are still some obstacles to overcome before such bendable phones become a reality. Arguably the largest obstacle is the need for a high-speed flexible diode, which is what detects and modulates the cell phone's signal. The diode must operate at high speeds in order to match the transmission frequencies used by wireless cellular communication, Bluetooth, Wi-Fi, and GPS signals (which range from 935 MHz to 5 GHz).

In a new paper published in Nature Communications, a team of researchers led by Professor Aimin Song at the University of Manchester in the UK with collaborators at Shandong University in China have developed a flexible Schottky diode ...***Read More***...



(Left) Photograph of the flexible IGZO Schottky diodes. (Right) The highest frequency achieved by the flexible diodes is 6.3 GHz, which can accommodate all transmission frequencies of wireless communication. Credit: Zhang, et al. ©2015 Macmillan Publishers Limited