INTERNATIONAL YEAR OF LIGHT 2015

100 Million Stars in the Andromeda galaxy.

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Department of Physics—United Arab Emirates University

Weekly news from around the world compiled by Dr. Ilias Fernini

Inside this issue:

Loophole in theory offers insight into the 'lithium problem'

There's not as much lithium in the universe as predicted, and scientists aren't sure why. According to the theory of big bang nucleosynthesis (BBN), isotopes of the three lightest elements—hydrogen, helium, and lithium—were created within the first 20 minutes after the big bang. The theory predicts with remarkable accuracy the observed amounts of hydrogen and helium, but its estimate for lithium is three times too high.

The problem has frustrated scientists working in cosmology, since almost any modification to the BBN theory that corrects the lithium abundance inadvertently throws off the hydrogen or helium abundances, or contradicts other constraints on the theory. The situation may be compared to trying to solve a Rubik's cube that has only one square of the wrong color.

Now in a new paper published in Physical Review Letters, physicists Vivian Poulin and Pasquale Dario Serpico at Université Savoie Mont Blanc, CNRS, in Annecy-le-Vieux, France, have suggested that the lithium problem may be connected to an overlooked loophole in another theory: that of electromagnetic cascades. ...***Read More***...

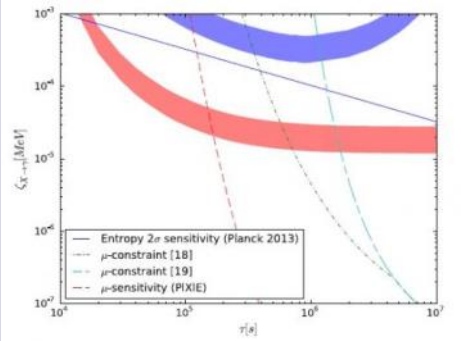


Figure showing constraints on the primordial lithium abundance. A loophole in the way that electromagnetic cascades are computed opens up the possibility of solutions to the lithium problem. Credit: Poulin and Serpico. ©2015

Dunkin' Donuts ditches titanium dioxide – but is it actually harmful?

In response to pressure from the advocacy group As You Sow, Dunkin' Brands has announced that it will be removing allegedly "nano" titanium dioxide from Dunkin' Donuts' powdered sugar donuts. As You Sow claims there are safety concerns around the use of the material, while Dunkin' Brands cites concerns over investor confidence. It's a move that further confirms the food sector's conservatism over adopting new technologies in the face of public uncertainty. But how justified is it based on what we know about the safety of nanoparticles?

Titanium dioxide (which isn't the same thing as the metal titanium) is an inert, insoluble material that's used as a whitener in everything from paper and paint to plastics. It's the active ingredient in many mineral-based sunscreens. And as a pigment, is also used to make food products look more appealing.

Part of the appeal to food producers is that titanium dioxide is a pretty dull chemical. It doesn't dissolve in water. It isn't particularly reactive. It isn't easily absorbed into the body from food. And it doesn't seem to cause adverse health problems. It just seems to do what manufacturers want it to do – make food look better. It's what makes the powdered sugar coating .***Read More***...

Sweet, sweet donuts. Credit: www.shutterstock.com

Nano-device used to create and control rogue optical waves

A tiny chip, developed by scientists at the University of St Andrews, could help aid understanding into how rare events such as rogue waves occur.

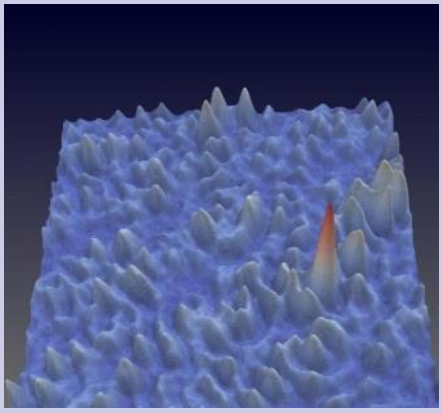
The nano-device, which has been used to create and control rogue optical waves, has potential applications for research in energy, advanced imaging and environmental safety.

In a study published today (Monday 9 March 2015), researchers looked at those rare moments in which large amounts of energy, normally in a 'quiet' state, build up spontaneously to create phenomena on a potentially disastrous scale.

In a new, innovative piece of research, a team of scientists from Saudi Arabia, the Netherlands and UK, set out to understand the dynamics of such destructive events by controlling their formation in photonic crystal-based optical chips.

The team began the research by developing new theoretical ideas to explain the formation of rare energetic natural events such as rogue waves, large surface waves that develop out of the blue in deep water and represent a potential risk for vessels and open-ocean oil platforms. Specifically the researchers linked the probability of these events with the rate at which energy is lost in a chaotic sea.

Professor Fratalocchi of the King Abdullah University of Science and Technology, who led the study, said, "We wanted to demonstrate that small perturbations of a chaotic ...*Read More*...



Researchers manipulate gold-coated nanoparticles with lasers

Tiny glass nanospheres coated on one side with a very fine gold film: LMU scientists have shown that particles modified in this way can be moved about with high precision using laser beams, creating an optically controlled micro-elevator.

hey owe their name to the two-faced Roman god Janus. Symbol of the turning year, Janus looks back and looks forward at the same time, just like so-called Janus particles, which display two different faces to the world. A research team led by the LMU physicists Professor Jochen Feldmann and Dr. Alexander Urban, both affiliated with the Nanosystems Initiative Munich (NIM) Cluster of Excellence, has now synthesized a class of Janus particles which, thanks to the distinct properties of their two hemispheres, can be manipulated with unprecedented precision with laser beams.

If a laser beam is focused by the lens of a microscope, it can be used as an optical tweezers to trap a nanoparticle at the focal point of the beam. The effect makes use of the forces exerted by the scattering of the light waves that impinge on the particle. "The ability not just to trap particles, but also to control their displacement by means of laser light would be extremely useful for a wide range of applications, such as the analysis of liquid samples with the aid of microfluidics chips," says Urban. But up to now, optical tweezers for this purpose was hampered by the fact that the position and direction of displacement of particles could not be controlled with sufficient precision."...*Read More*...

Credit: NIM

Fractal patterns may uncover new line of attack on cancer

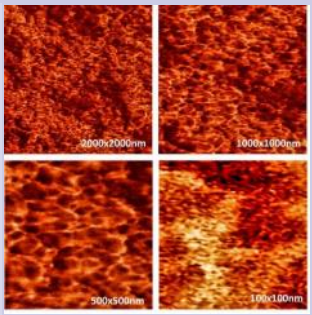
Studying the intricate fractal patterns on the surface of cells could give researchers a new insight into the physical nature of cancer, and provide new ways of preventing the disease from developing.

This is according to scientists in the US who have, for the first time, shown how physical fractal patterns emerge on the surface of human cancer cells at a specific point of progression towards cancer.

Publishing their results today, 11 March, in the Institute of Physics and Germany Physical Society's New Journal of Physics, they found that the distinctive repeating fractal patterns develop at the precise point in which precancerous cells transform into cancer cells, and that fractal patterns are not present either before or after this point.

The researchers hope the new findings can inspire biologists to search for specific "weak" points in the pathways that lead to the alteration of precancerous cells at this specific moment. By targeting these weak points, the researchers believe they could influence the process and thus prevent cancer from developing. Lead author of the study Professor Igor Sokolov said: "Despite many decades of fighting cancer, the war is far from being victorious. A sharp increase in the complexity and variability of genetic signatures has slowed the advancement based on finding specific cancer genes in patients.

"Thus, more than ever, there is a need for new conceptual paradigms about the nature of cancer, and what we have found adds ...*Read More*...



This image shows the appearance of fractal patterns on the surface of cancer cells. Credit: Credit: M. Dokukin and I. Sokolov

Detection of gamma rays from a newly discovered dwarf galaxy may point to dark matter

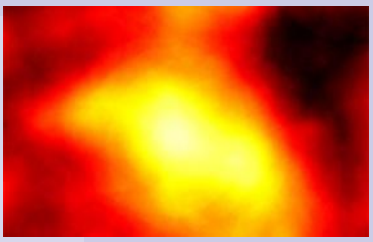
A newly discovered dwarf galaxy orbiting our own Milky Way has offered up a surprise — it appears to be radiating gamma rays, according to an analysis by physicists at Carnegie Mellon, Brown, and Cambridge universities. The exact source of this high-energy light is uncertain at this point, but it just might be a signal of dark matter lurking at the galaxy's center.

"Something in the direction of this dwarf galaxy is emitting gamma rays," said Alex Geringer-Sameth, a postdoctoral research associate in CMU's Department of Physics and the paper's lead author. "There's no conventional reason this galaxy should be giving off gamma rays, so it's potentially a signal for dark matter."

The galaxy, named Reticulum 2, was discovered within the last few weeks in the data of the Dark Energy Survey, an experiment that maps the southern sky to understand the accelerated expansion of the universe. At approximately 98,000 light-years from Earth, Reticulum 2 is one of the nearest dwarf galaxies yet detected. Using publicly available data from NASA's Fermi Gamma-ray Space Telescope, CMU's Geringer-Sameth and Matthew Walker and Brown's Savvas Koushiappas have shown gamma rays coming from the direction of the galaxy in excess of what would be expected from normal background.

"In the search for dark matter, gamma rays from a dwarf galaxy have long been considered a very strong signature," said Koushiappas, assistant professor of physics at Brown. "It seems like we may now be detecting such a thing for the first time."

The researchers have submitted their analysis to the journal Physical Review Letters and posted it on ...***Read More***….

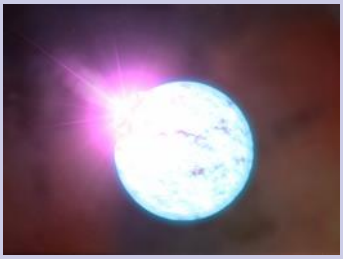


Scientists at Brown, Carnegie Mellon, and Cambridge universities have detected gamma ray emissions from the direction of the galaxy Reticulum 2. Bright areas indicate a strong gamma ray signal coming from the direction of the galaxy, according to the researchers' search algorithm. Image: NASA/DOE/Fermi-LAT Collaboration/Geringer-Sameth & Walker/Carnegie Mellon University/Koushiappas/Brown University

Solving the riddle of neutron stars

It has not yet been possible to measure the gravitational waves predicted by Einstein's theory of general relativity. They are so weak that they get lost in the noise of the measurements. But thanks to the latest simulations of the merging of binary neutron star systems, the structure of the sought-after signals is now known. As a team of German and Japanese theoretical astrophysicists reports in the Editor's choice of the current edition of the scientific journal Physical Review D, gravitational waves have a characteristic spectrum that is similar to the spectral lines of atoms.

Gravitational waves are generated when masses accelerate. The first indirect evidence for their existence was detected in 1974 when the binary pulsar PSR B1913+16 was discovered in the constellation Aquila. The two rapidly rotating neutron stars are drifting towards each other in a spiral shape, which is why, the astrophysicists explain, they are losing energy and emitting gravitational waves. Russell A. Hulse and Joseph H. Taylor received the 1993 Nobel Prize in Physics for this discovery. In the meantime, there are now several large-scale experiments for detecting gravitational waves: the American LIGO experiment, the European Virgo experiment, and the Japanese KAGRA detector. Experts estimate that signals of gravitational ...***Read More***...



Neutron star. Credit: NASA

Exploring the Depths of Titan's Seas

In our solar system, there are only two planetary bodies with liquid lakes and seas-Earth and Titan, a moon of Saturn. But instead of water, Titan lakes are made of liquid methane with temperatures registering at almost -300 F.

So how would NASA study this interesting place? Steve Oleson of NASA Glenn's COMPASS Lab (Collaborative Modeling for Parametric Assessment of Space Systems) believes the team, along with partners from the Johns Hopkins Applied Physics Lab and the Penn State University Applied Research Lab have come up with an innovative answer.

"We have developed a concept to send a submarine to Titan's largest northern sea," says Oleson. "This craft would be loaded with scientific instruments that could carry out detailed investigations under the surface providing unprecedented knowledge of an extraterrestrial sea."

A 90-day, 1,250-mile voyage exploring Kraken Mare, a sea comparable in size to the Great Lakes, is proposed.

"The mission concept will investigate a full spectrum of oceanographic phenomena: chemical composition of the liquid, surface and subsurface currents, mixing and layering in the "water" column, tides, wind and waves, bathymetry, and bottom features and composition," explains Oleson. "Measurements of all these aspects of Titan's hydrocarbon ocean environment can only be made through focused exploration with a well-instrumented craft."

Communicating with Earth would not be possible when the vehicle is submerged, so it would ...***Read More***...

A submarine concept that would explore the depths of Saturn's moon Titan. Image courtesy NASA. Watch an animation on the technology here.

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The Physics Department cordially invites you to the seminar:

Analyzer of Spectra for Age Determination (ASAD) – Algorithm and Applications

Dr. Randa S. Asa'd
American University of Sharjah

Abstract

Analyzer of Spectra for Age Determination (ASAD) is a new user-friendly package that can easily predict the age and reddening of stellar clusters from their observed optical integrated spectra by comparing them to synthesis model spectra. The ages obtained with ASAD are consistent with ages obtained from previous cluster age methods requiring a more rigorous and time-consuming analysis. This package not only provides fast results, but also allows the user to comprehend the accuracy of these results by providing surface plots and spectral plots for all combinations of observations and models. ASAD is available for download on the Web and can be immediately used on both Mac and Windows.

Wednesday, March 18th 2015 @ 2:00 PM, Room E1-2005

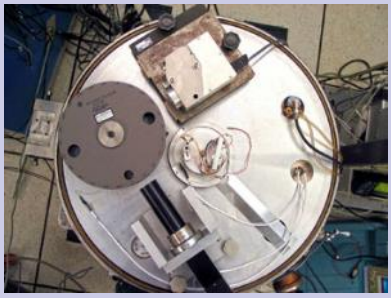
All are Welcome!

New angle on x-ray measurements

Criminal justice, cosmology and computer manufacturing may not look to have much in common, but these and many other disparate fields all depend on sensitive measurements of x-rays. Scientists at NIST have developed a new method to reduce uncertainty in x-ray wavelength measurement that could provide improvements awaited for decades.

Accurate measurement of x-ray wavelengths depends critically on the ability to measure angles very precisely and with very little margin for error. NIST's new approach is the first major advance since the 1970s in reducing certain sources of error common in x-ray angle measurement.

Many of us associate x-rays with a doctor's office, but the uses for these energetic beams go far beyond revealing our skeletons. The ability to sense x-rays at precise wavelengths allows law enforcement to detect and identify trace explosives, or astrophysicists to better understand cosmic phenomena. It all comes down to looking very closely at the x-ray spectrum and measuring the precise position of lines within it. Those lines represent specific wavelengths—which are associated with specific energies—of x-rays ...***Read More***….

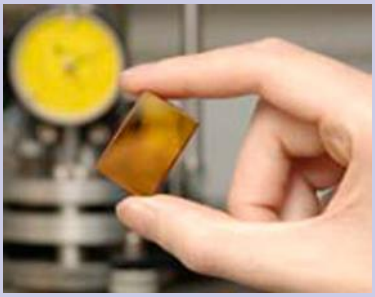


A laser from the NIST-designed autocollimator (square device at top) is beamed at the mirrored polygon in the gray circle at left, and its reflection allows the angle of the polygon's faces to be precisely determined while the polygon rotates. The black device at bottom takes measurements that minimizes the wobbling the polygon experiences while spinning. Image: Hudson/NIST

Optical fibers light the way for brain-like computing

Computers that function like the human brain could soon become a reality thanks to new research using optical fibers made of specialty glass. The research, published in Advanced Optical Materials, has the potential to allow faster and smarter optical computers capable of learning and evolving.

Researchers from the Optoelectronics Research Centre (ORC) at the Univ. of Southampton, U.K., and Centre for Disruptive Photonic Technologies (CDPT) at the Nanyang Technological Univ. (NTU), Singapore, have demonstrated how neural networks and synapses in the brain can be reproduced, with optical pulses ...***Read More***...



Chalcogenide glass sample