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SCIENCE & LIFE

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Cheap fuel from liquid biomass

A team of University of Massachusetts Amherst chemical engineers have developed a way to produce high-volume chemical feedstocks including benzene, toluene, xylenes and olefins from pyrolytic bio-oils, the cheapest liquid fuels available today derived from biomass. The new process could reduce or eliminate industry's reliance on fossil fuels to make industrial chemicals worth an estimated $400 billion annually.

INSTEAD of buying petroleum by the barrel, chemical manufacturers will now be able to use relatively cheaper, widely available pyrolysis oils made from waste wood, agricultural waste and non-food energy crops to produce the same high-value materials for making everything from solvents and detergents to plastics and fibers.

As principal investigator George Huber, associate professor of chemical engineering at UMass Amherst, explains, "Thanks to this breakthrough, we can meet the need to make commodity chemical feedstocks entirely through processing pyrolysis oils. We are making the same molecules from biomass that are currently being produced from petroleum, with no infrastructure changes required."

He adds, "We think this technology will provide a big boost to the economy because pyrolysis oils are commercially available now. The major difference between our approach and the current method is the feedstock; our process uses a renewable feedstock, that is, plant biomass. Rather than purchasing petroleum to make these chemicals, we use pyrolysis oils made from non-food agricultural crops and woody biomass grown domestically. This will also provide United States farmers and landowners a large additional revenue stream."

In the past, these compounds were made in a low-yield process, the chemical engineer adds. "But here we show how to achieve three times higher yields of chemicals from pyrolysis oil than ever achieved before. We've essentially provided a roadmap for converting low-value pyrolysis oils into products with a higher value than transportation fuels."

In the paper, he and doctoral students Tushar Vispute, Aimaro Sanno and Huiyan Zhang show how to make olefins such as ethylene and propylene, the building blocks of many plastics and resins, plus aromatics such as benzene, toluene and xylenes found in dyes, plastics and polyurethane, from biomass-based pyrolysis oils. They use a two-step, integrated catalytic approach starting with a "tunable," variable-reaction hydrogenation stage followed by a second, zeolite catalytic step. The zeolite catalyst has the proper pore structure and active sites to convert biomass-based molecules into aromatic hydrocarbons and olefins.

Huber, Vispute and colleagues discuss how to choose among three options including low- and high-temperature hydrogenation steps as well as the zeolite conversion for optimal results. Their findings indicate that "the olefin-to-aromatic ratio and the types of olefins and aromatics produced can be adjusted according to market demand." That is, using the new techniques, chemical producers can manage the carbon content from biomass they need, as well as hydrogen amounts. Huber and colleagues provide economic calculations for determining the optimal mix of hydrogen and pyrolytic oils, depending on market prices, to yield the highest-grade product at the lowest cost.

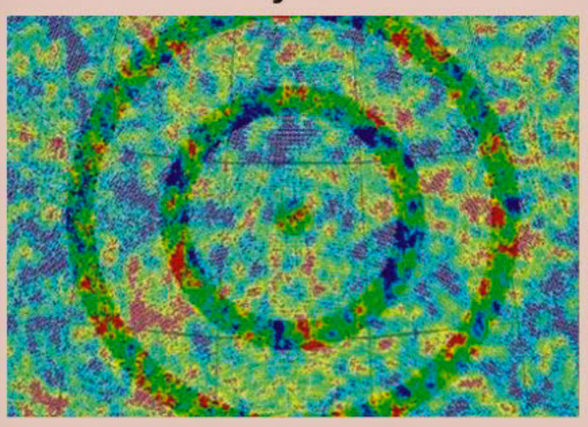
A pilot plant on the UMass Amherst campus is now producing these chemicals on a liter-quantity scale using this new method. The technology has been licensed to Anellotech Corp., co-founded by Huber and David Sudolsky of New York City. Anellotech is also developing UMass Amherst technology invented by the Huber research team to convert solid biomass directly into chemicals. Thus, pyrolysis oil represents a second renewable feedstock for Anellotech.

Sudolsky, Anellotech's CEO, says, "There are several companies developing technology to produce pyrolysis oil from biomass. The problem has been that pyrolysis oils must be upgraded to be useable. But with the new UMass Amherst process, Anellotech can now convert these pyrolysis oils into valuable chemicals at higher efficiency and with very attractive economics. This is very exciting."

Source: Science Daily

REINCARNATION

Cosmos had cycles of rebirth?



Dark circles indicate regions in space where the cosmic microwave background has temperature variations that are lower than average

MOST cosmologists trace the birth of the universe to the Big Bang 13.7 billion years ago. But a new analysis of the relic radiation generated by that explosive event suggests the universe got its start eons earlier and has cycled through myriad episodes of birth and death, with the Big Bang merely the most recent in a series of starting guns.

That startling notion, proposed by theoretical physicist Roger Penrose of the University of Oxford in England and Vahe Gurzadyan of the Yerevan Physics Institute and Yerevan State University in Armenia, goes against the standard theory of cosmology known as inflation.

The researchers base their findings on circular patterns they discovered in the cosmic microwave background, the ubiquitous microwave glow left over from the Big Bang. The circular features indicate that the cosmos itself circles through epochs of endings and beginnings, Penrose and Gurzadyan assert. The researchers describe their controversial findings in an article posted at arXiv.org on November 17.

The circular features are regions where tiny temperature variations in the otherwise uniform microwave background are smaller than average. Those features, Penrose said, cannot be explained by the highly successful inflation theory, which posits that the infant cosmos underwent an enormous growth spurt, ballooning from something on the scale of an atom to the size of a grapefruit during the universe's first tiny fraction of a second. Inflation would erase such patterns.

"The existence of large-scale coherent features in the microwave background of this form would appear to contradict the inflationary model and would be a very distinctive signature of Penrose's model" of a cyclic universe, comments cosmologist David Spergel of Princeton University. But, he adds, "The paper does not provide enough detail about the analysis to assess the reality of these circles."

Source: Science News

UNDER THE SAND

Egypt's lost great lake

A huge lake once waxed and waned deep in the sandy heart of the Egyptian Sahara, geologists have found.

Radar images taken from the space shuttle confirm that a lake broader than Lake Erie once sprawled a few hundred kilometers west of the Nile, researchers report in the December issue of Geology. Since the lake first appeared around 250,000 years ago, it would have ballooned and shrunk until finally petering out around 80,000 years ago.

Knowing where and when such oases existed could help archaeologists understand the environment Homo sapiens traveled while migrating out of Africa for the first time, says team leader Ted Maxwell, a geologist at the Smithsonian National Air and Space Museum in Washington, D.C. Modern humans arose in Africa about 200,000 years ago.

"You realize that hey, this place was full of really large lakes when people were wandering into the rest of the world," he says.

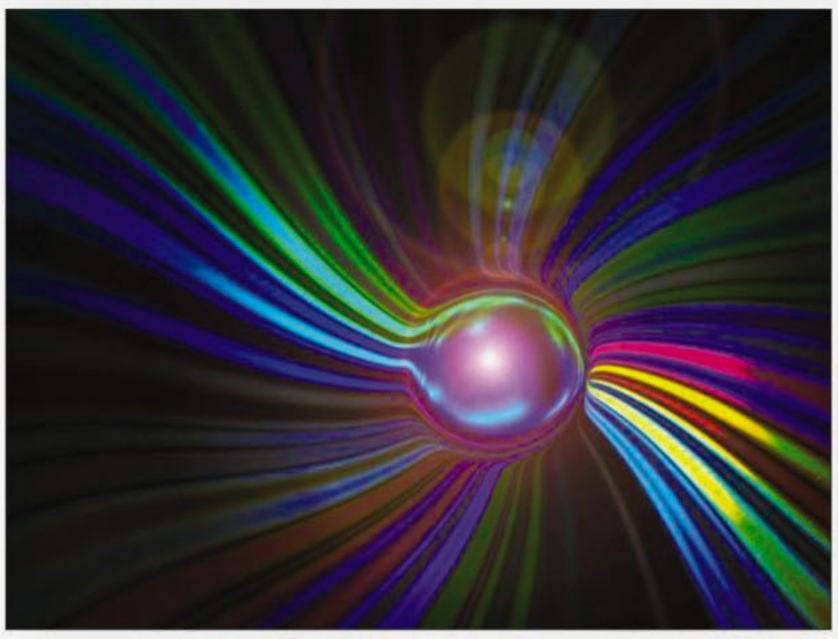
Since then, desert winds have eroded and sands have buried much of the region's landscape, says Maxine Kleindienst, an anthropologist at the University of Toronto. But during next summer's field season, she and her colleagues will be checking for ancient shorelines at the elevations suggested in the new paper.

Source: Science News

Sand-covered Tushka region of Egypt was once home to a lake as big as one of the Great Lakes, scientists say

CHILLED PHOTONS

Scientists create new kind of light



An illustration of a "super-photon" created when physicists turned photons of light into a state of matter called a Bose-Einstein condensate.

PHYSICISTS have created a new kind of light by chilling photons into a blob state.

Just like solids, liquids and gases, this recently discovered condition represents a state of matter. Called a Bose-Einstein condensate, it was created in 1995 with super-cold atoms of a gas, but scientists had thought it could not be done with photons, which are basic units of light. However, physicists Jan Klärs, Julian Schmitt, Frank Vewinger and Martin Weitz of the University of Bonn in Germany reported accomplishing it. They have dubbed the new particles "super photons."

Particles in a traditional Bose-Einstein condensate are cooled down close to absolute zero, until they glom onto each other and become indistinguishable, acting as one giant particle. Experts thought photons (packets of light) would be unable to achieve this state because it seemed impossible to cool light while concentrating it at the same time. Because photons are massless particles, they can simply be absorbed into their surroundings and disappear, which usually happens when they are cooled down.

The scientists needed to find a way to cool the photons without decreasing their numbers.

"Many scientists believed that it would not be possible, but I was pretty sure that it would work," Weitz told LiveScience.

To trap the photons, the researchers devised a container made of mirrors placed very, very close together about a millionth of a meter (1 micron) apart. Between the mirrors, the researchers placed dye molecules basically, little bits of color pigment. When the photons hit these molecules, they were absorbed and then re-emitted.

The mirrors trapped the photons by keeping them bouncing back and forth in a confined state. In the process, the light packets exchanged thermal energy every time they hit a dye molecule, and they eventually cooled down to about room temperature

While room temperature is nowhere near absolute zero, it was cold enough for photons to coalesce into a Bose-Einstein condensate.

"Whether a temperature is cold enough to start the condensation depends on the density of the particles," Klärs wrote in an e-mail. "Ultra-cold atomic gases are very dilute and they therefore have very low condensation temperatures. Our photon gas has a billion times higher density and we can achieve the condensation already at room temperature."

The researchers detail their findings in the Nov. 25 issue of the journal Nature.

Physicist James Anglin of Germany's Technical University Kaiserslautern, who was not involved in the project, called the experiment "a landmark achievement" in an accompanying essay in the same issue of Nature.

In effect, getting the photons to condense into this state caused them to behave more like regular matter particles. It also showcased the ability of photons, and indeed all particles, to behave as both a point-like particle and a wave one of the most perplexing revelations of modern quantum physics.

Source: Strange News

GET THEM SOME SLEEP

Delinquency linked to sleep-debt!

ALTHOUGH a handful of past studies have suggested such a link could exist, little detailed information exists. The new analysis found that more serious forms of delinquency appear to become more common in relation to the severity of youngsters' sleep deficit.

The study re-examined 15-year-old data from the National Longitudinal Study of Adolescent Health, a federally funded project that surveyed adolescent health in the United States in relation to a variety of risky behaviors.

The survey sample used for the study on sleep and delinquency encompassed 14,382 high school studentshalf male, half female, 63.5 percent white.

Students who slept seven or fewer hours nightly reported "significantly more property delinquency," such as vandalism or theft, than students who slept the recommended eight to 10 hours, the authors of the new study reported. The findings appear in the Oct. 10 issue of the Journal of Youth and Adolescence.

Those who slept five or fewer hours per night, meanwhile, "reported significantly more violent delinquency," wrote the researchers, Samantha Clinkinbeard and colleagues at the University of Nebraska at Omaha.

"Lack of sleep has been linked to a wide range of negative developmental outcomes," but "largely overlooked among researchers interested in adolescent delinquency," the group wrote.

Although the study couldn't demonstrate that insufficient snoozing caused delinquency rather than, for example, the other way around, "the findings suggest that sleep is an important, and overlooked, dimension of delinquent behavior," the researchers wrote. They argued that this aspect deserves further investigation.

The study didn't determine whether insomnia, home environment or other factors caused the sleep shortage possibly linked to delinquency. But a smaller study, published in last December's issue of the Journal of Genetic Psychology, found that "possible insomnia" predicted smoking, delinquency and drinking-and-driving among high schoolers.

"Sleep and other relevant health behaviors [should] be considered in the context of more comprehensive approaches to delinquency prevention and intervention," Clinkinbeard and colleagues wrote.

Source: World Science

Juvenile delinquency among high school students may be partly linked to lack of sleep, researchers have found based on a new study

KALEIDOSCOPE

Liquid crystal

A dazzling array of unusual patterns can be found in a thin, liquid crystalline film seen through a polarizing microscope. A crystalline substance is marked by an orderly arrangement of molecules overall, but distortions can arise from point to point, resulting in the striking visual forms such as those seen here. In the liquid crystal shown above, called a nematic fluid, there are rod-like, elongated molecules that are free to move around, but tend to be parallel to each other. Their average orientation, however, changes from place to place in the film, which is only a thousandth of a millimeter thick.

Source: World Science

DID YOU KNOW?

What makes egg shell strong?

Have you ever wondered why hens don't break their eggs when they sit on them? The secret lies in the shape of the egg. An egg is a great example of nature's excellent skills in packing. If you squeeze the ends of an egg between the palms of your hands, it won't break. However, if you squeeze it in the middle, it pops and creates a terrible mess.

If you have seen the way eggs are sold in the market, you would have noticed that they are kept with their ends pointing up and are never left lying horizontally. Hens, too, incubate their eggs the same way, with the narrower end pointing upwards.