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Randomness leads to structure!

RESEARCHERS trying to herd tiny particles into useful ordered formations have found an unlikely ally: entropy, a tendency generally described as "disorder."

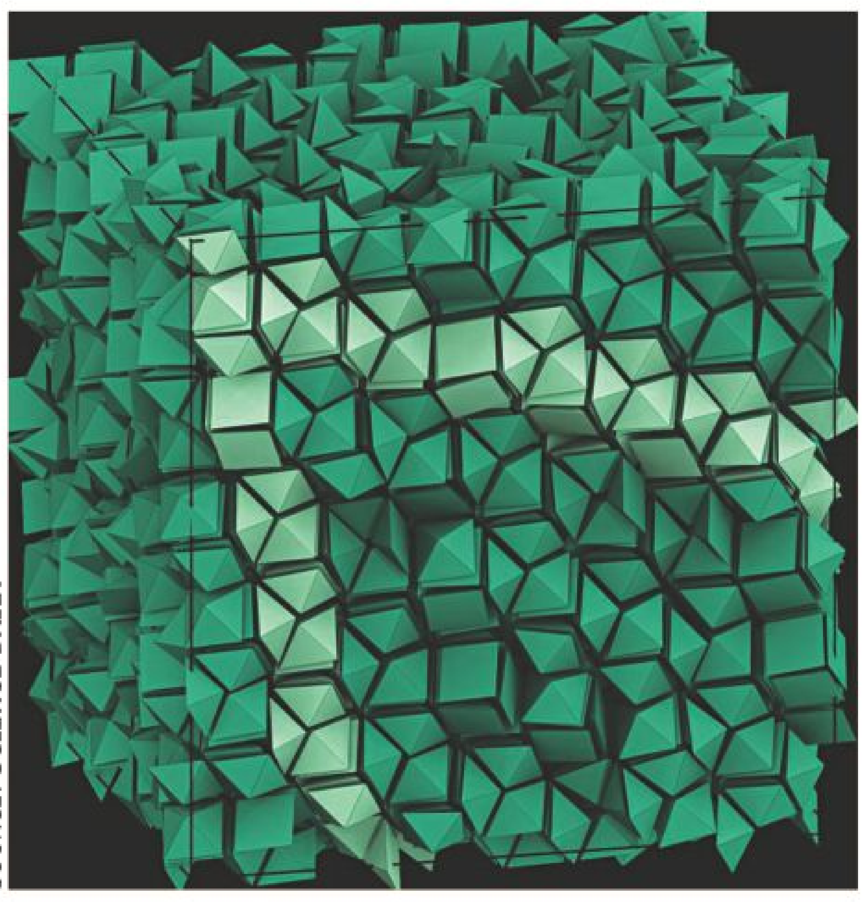
Computer simulations by University of Michigan scientists and engineers show that the property can nudge particles to form organized structures. By analyzing the shapes of the particles beforehand, they can even predict what kinds of structures will form. The findings, published in this week's edition of Science, help lay the ground rules for making designer materials with wild capabilities such as shape-shifting skins to camouflage a vehicle or optimize its aerodynamics.

Physicist and chemical engineering professor Sharon Glotzer proposes that such materials could be designed by working backward from the desired properties to generate a blueprint. That design can then be realized with nanoparticles -- particles a thousand times smaller than the width of a human hair that can combine in ways that would be impossible through ordinary chemistry alone.

One of the major challenges is persuading the nanoparticles to create the intended structures, but recent studies by Glotzer's group and others showed that some simple particle shapes do so spontaneously as the particles are crowded together. The team wondered if other particle shapes could do the same.

"We studied 145 different shapes, and that gave us more data than anyone has ever had on these types of potential crystal-formers," Glotzer said. "With so much information, we could begin to see just how many structures are possible from particle shape alone, and look for trends."

Using computer code written by chemical engineering research investigator Michael Engel, applied physics graduate student Pablo Damasceno ran thousands of virtual experiments, exploring how each shape behaved under different levels of crowding. The program could handle any polyhedral shape, such as dice with any number of sides.


SOURCE: SCIENCE DAILY

Shapes can arrange themselves into crystal structures through entropy alone, new research from the University of Michigan shows.

Left to their own devices, drifting particles find the arrangements with the highest entropy. That arrangement matches the idea that entropy is a disorder if the particles have enough space: they disperse, pointed in random directions. But crowded tightly, the particles began forming crystal structures like atoms do -- even though they couldn't make bonds. These ordered crystals had to be the high-entropy arrangements, too.

Glotzer explains that this isn't really disorder creating order -- entropy needs its image updated. Instead, she describes it as a measure of possibilities. If you could turn off gravity and empty a bag full of dice into a jar, the floating dice would point every which way. However, if you keep adding dice, eventually space becomes so limited that the dice have more options to align face-to-face. The same thing happens to the nanoparticles, which are so small that they feel entropy's influence more strongly than gravity's.

"It's all about options. In this case, ordered arrangements produce the most possibilities, the most options. It's counterintuitive, to be sure," Glotzer said.

The simulation results showed that nearly 70 percent of the shapes tested produced crystal-like structures under entropy alone. But the shocker was how complicated some of these structures were, with up to 52 particles involved in the pattern that repeated throughout the crystal.

"That's an extraordinarily complex crystal structure even for atoms to form, let alone particles that can't chemically bond," Glotzer said.

The particle shapes produced three crystal types: regular crystals like salt, liquid crystals as found in some flat-screen TVs and plastic crystals in which particles can spin in place. By analyzing the shape of the particle and how groups of them behave before they crystallize, Damasceno said that it is possible to predict which type of crystal the particles would make.

"The geometry of the particles themselves holds the secret for their assembly behavior," he said.

Why the other 30 percent never formed crystal structures, remaining as disordered glasses, is a mystery.

"These may still want to form crystals but got stuck. What's neat is that for any particle that gets stuck, we had other, awfully similar shapes forming crystals," Glotzer said.

In addition to finding out more about how to coax nanoparticles into structures, her team will also try to discover why some shapes resist order.

This research was supported by the U.S. departments of Defense and Energy, the Deutsche Forschungsgemeinschaft and the National Science Foundation. The paper is titled "Predictive Self-Assembly of Polyhedra into Complex Structures."

LEADING LIGHTS

Hess's Law


Henri Hess

HENRI Hess, who formulated Hess's Law, is known to be the early exponent of the principle of thermochemistry. His most renowned paper, outlining his law on thermochemistry, was published in 1840. His principle was a progenitor for the first law of thermodynamics. It states that in a series of chemical reactions, the total energy gained or lost depends only on the initial and final states, regardless of the number or path of the steps. This is also known as the law of constant heat summation.

Hess's further discoveries include the discovery that sugar when oxidised yields saccharic acid. The mineral Ag2Te is named Hessite in his honor. Hess wrote the chemistry textbook that was the standard Russian chemistry text for several decades.

Russian Chemist and Doctor, Germain Henri Hess, was born in Geneva, Switzerland on August 7, 1802. His father, who was an artist, moved the family to Russia searching for employment in 1805.

In 1830, Hess moved to St. Petersburg, took part in a geological expedition to the Urals. There, he set up a medical practice in Irkutsk where he remained for two years. Later, he became a professor of Chemistry at the St. Petersburg Technological Institute, doing research and remaining there for the rest of his life.

Hess was forced to retire due to failing health in 1848. He died in St. Petersburg on November 30, 1850.

Sources: Wikipedia.org, and deadscientistoftheweek.blogspot.com

LEAP

Air-charged battery


SOURCE: ABC NEWS

A chemical reaction that allows the battery to be recharged.

UK researchers have made a key step in development of a lithium-air battery, a device that promises three to five times as much energy per unit mass as the existing lithium-ion.

Once built, such a battery could allow you to fly cross-country flights with a functioning laptop, or talk for a week without charging your mobile phone or even a take a 800-kilometre journey in an electric car.

The experiment by Professor Peter G Bruce at the University of St. Andrew's in Scotland, and colleagues was published today in online journal Science Express. It describes a chemical reaction that allows the battery to be recharged without degradation of the battery's electrode.

"We have demonstrated that sustainable cycling is possible," says Bruce. "That is the real step here. We haven't solved all the practical problems and it's not a solution, but it does demonstrate this critical reaction can be sustained and cycled."

Scientists are pushing to develop a lithium air battery because they use air as the cathode and lithium metal as the anode. Oxygen is both cheap and light. It doesn't require the battery to be built with heavy casing to contain the electrodes.

In existing batteries, lithium ions move from the cathode to the anode through an electrolyte, or a chemical solution. When you use the battery, the process is reversed and the flow of ions produce an electric current.

In a lithium-air battery, oxygen enters the cathode and combines with lithium ions to produce lithium peroxide, which accumulates as the battery is discharged.

The Scottish team was able to produce this chemical reaction over and over again without decomposition, says Bruce, using a thin film of porous gold as an electrode.

That may be the battery's Achilles heel, says Steve Visco, president and CEO of Polyplus, a California-based firm that is building advanced lithium-sulfur, lithium-seawater and lithium-air batteries.

HOLEIN SKY

Climate change linked to ozone loss?

By Devin Powell

CLIMATE change may spur the destruction of ozone in unexpected parts of the globe.

In a warming world, many scientists believe, severe weather will become more common. That could be a problem in part because powerful rainstorms have the potential to erode ozone above the United States, researchers report online July 27 in Science.

"For 30 years, we've studied the problems of ozone loss and climate change separately," says team leader James Anderson, a Harvard atmospheric scientist. "Now it's pretty clear that climate change appears to be linked directly to the loss of ozone." High-altitude ozone acts as a protective shield, blocking ultraviolet rays that can cause skin cancer.


SOURCE: SCIENCE NEWS

NASA aircraft studying convective storms over the United States have found evidence to suggest that global warming may increase the lofting of water vapor into the stratosphere, which could in turn spur ozone destruction. Carla Thomas/NASA

Anderson and his colleagues stumbled on the unexpected connection while studying strong summer storms fuelled by rising heat. During missions from 2001 to 2007, NASA planes flying close to the edge of space spotted water spewed high into the sky by convective storms over the U.S. The goal was to gather useful measurements for figuring out how high-altitude clouds form and trap heat.

But the data also revealed a possible threat to ozone molecules floating 15 to 20 kilometres up. Large storms often left behind extra water vapour in this part of the stratosphere, the remnants of melted ice crystals propelled upward.

That vapour could set the stage for a chemical chain reaction, Anderson says. Aerosol particles swollen with water can dissolve airborne hydrochloric acid. The acid can then react and form other chlorine compounds, including pairs of chlorine atoms. Sunlight cleaves those molecules, spitting out unstable chlorine atoms that break down ozone.

"It's the same chemistry as that going on above the Arctic and the Antarctic," says Anderson. Chlorine from human-made chemicals has chewed seasonal holes in ozone above Antarctica and caused thinning above the Arctic. These ozone-destroying chemicals are being phased out under the 1987 Montreal Protocol.

The team's calculations suggest that the havoc wreaked by water vapour could continue for days after a storm, as humidity levels slowly fall. As much as 25 to 35 percent of ozone, over a horizontal distance of 100 kilometres, could be annihilated in a week.

"I was surprised that so much ozone could be removed in such a short time," says Dale Hurst, an atmospheric chemist at the University of Colorado Boulder's Cooperative Institute for Research in Environmental Sciences.

For now, the danger exists only on paper. Actual measurements tracking chlorine compounds in the stratosphere would help to confirm whether the damage is taking place and, if so, how widespread the problem may be. And while many climate simulations do call for more strong storms as temperatures continue to rise, the future is still somewhat fuzzy. A warmer atmosphere would hold more moisture but would also weaken the wind shear that whips up extreme weather.

"It's a bold idea that raises more questions than it answers," says Andrew Dessler, a climate scientist at Texas A&M University in College Station. "But this is what great scientists do; they come with ideas that spur people to start working on new things."

IT ISN'T DUMB

Not just parroting


SOURCE: WORLD SCIENCE

An African Grey parrot.

FAR from just mindlessly repeating sounds they hear, pet parrots may have a purpose for their vocal expressions, including trying to try to track their owners' location, a study has found.

While many owners will attest that pet parrots have a purpose in their talking, the subject was little studied before recently. Certainly parrots have shown feats of intelligenceone reportedly formed a concept of the number zerobut most research on captive parrots has focused on lab-reared birds' responses in question-and-answer tasks, scientists say.

The new study instead analyzed the types of sounds a parrot decides to make spontaneous, and how these might vary depending on social context.

Researchers at the University of Georgia studied hours of videotape of a home-raised, talking African Grey parrot named Cosmo. They noted what they called significant differences in her talking habits, and themes addressed, depending on which people were around her, what they were doing and how far away they were.

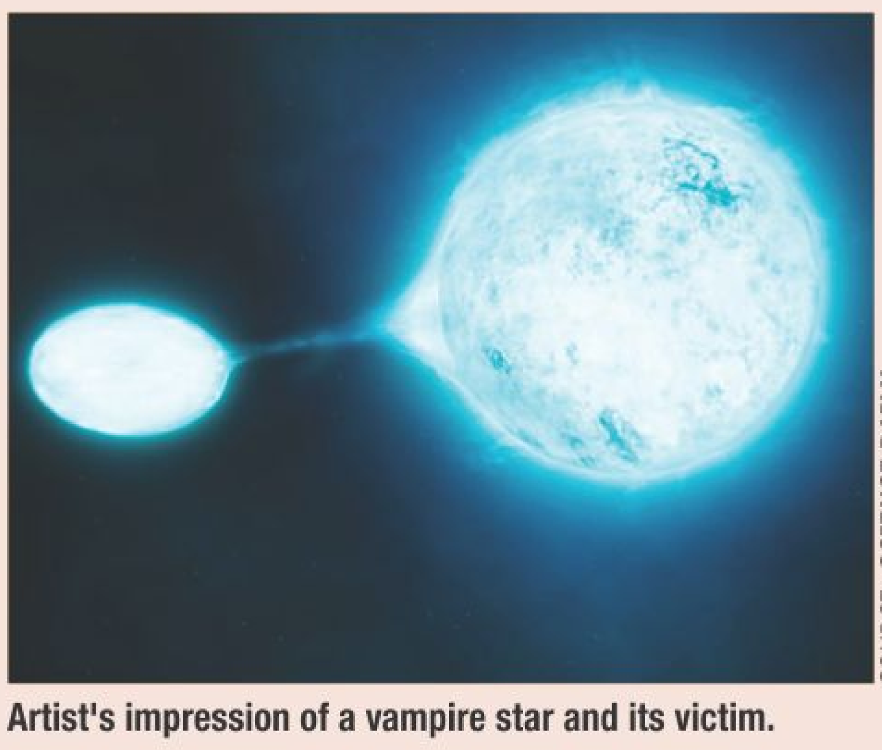
"Cosmo's vocal production is far from random and is strongly influenced by the context created by variations in her social partner's physical presence and willingness to reciprocate interaction," wrote the researchers, Erin N. Colbert-White and colleagues, in the May issue of the Journal of Comparative Psychology.

The bird vocalized almost twice much when the owner was in a neighboring room than when the owner was either out of the house or in the same room, they found.

"When she and her owner were in separate rooms," they wrote, Cosmo was "significantly more likely" to use utterances involving her spatial location or that of her owner, Colbert-White and colleagues wrote. These included "where are you" and "I'm here." Some of these sounds might thus be an "adaptation of the wild parrot contact call," they addeda type of call birds make when trying to determine the location of out-of-sight flock mates.

Moreover, "when her owner was in the room and willing to reciprocate communication, the parrot was more likely to use [sounds] that, in English, would be considered solicitations for vocal interaction (e.g., 'Cosmo wanna talk')," they wrote.

VAMPIRESTAR


Artist's impression of a vampire star and its victim.

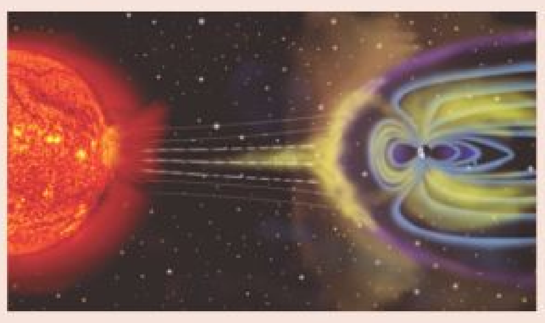
Brightest stars in pairs

SOURCE: SCIENCE DAILY

ScienceDaily (July 26, 2012) A new study using the European Southern Observatory's Very Large Telescope (VLT) has shown that most very bright high-mass stars, which drive the evolution of galaxies, do not live alone. Almost three quarters of these stars are found to have a close companion star, far more than previously thought. Surprisingly most of these pairs are also experiencing disruptive interactions, such as mass transfer from one star to the other, and about one third are even expected to ultimately merge to form a single star.

DID YOU KNOW?

What is magnetosphere?


Artistic rendition of a magnetosphere. Sizes are not to scale.

The magnetosphere refers to the region of magnetic influence of a celestial body. This varies depending on the size of the body and the magnetism it generates. Earth's magnetosphere is defined by the region in which the motions of charged particles are largely determined by earth's influence. This effect extends out to about 10 earth radii (63,731 km or 39,123 mi). Certain bodies known for their magnetism, such as magnetars, a form of pulsar, have magnetospheres that extend for millions of miles wide.

Not every astronomical object has a magnetosphere. All planets in the solar system do, except for the possible exception of Pluto.