Best of Last Year: The top Phys.org articles of 2020

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Credit: Pixabay/CC0 Public Domain

It was a good year for research of all kinds as a team of geophysicists at the University of Maryland detected unexpected widespread structures

near Earth's core. The structures were revealed as the researchers analyzed thousands of recordings of seismic waves traveling through the Earth—they turned out to be areas of unusually dense, hot rock.

Also, a team of planetary scientists at Stanford University discovered that a regime shift is happening in the Arctic Ocean. They discovered that exploding blooms of phytoplankton have dramatically altered the Arctic's ability to transform atmospheric carbon into living matter—an indication that the region is warming faster than anywhere else on Earth.

And a team working at the University of Glasgow's School of Physics and Astronomy conducted an experiment that confirmed a 50-year-old theory that described how an alien civilization could exploit a black hole. The theory described how energy could be generated by dropping an object into a black hole's ergosphere. The work, by a team in Scotland, involved building a system that used small rings of speakers to create a twist in the sound waves that were analogous to the twists in the light waves proposed by the theory.

A team of physicists at the University of Arkansas developed a circuit that was capable of capturing graphene's thermal motion and converting it into an electrical current. The design was based on research conducted at the university three years ago that suggested the ripples and buckles in graphene sheets hold promise for energy harvesting—this contradicted work by Richard Feynman that had shown Brownian motion cannot do work.

A team of researchers at NASA announced that the quantum "fifth state of matter" had been observed in space for the first time—an observation that could help solve some of the quantum universe's most intractable conundrums. The observations came from Bose-Einstein condensate instruments conducting experiments aboard the International Space Station.

A team led by Ph.D. student Laura van Holstein at St John's College, University of Cambridge proved one of Charles Darwin's theories of evolution for the first time—nearly 140 years after his death. The theory suggested that mammal subspecies play a more important role in evolution than had been previously thought and its proof could play an important role in helping to protect endangered species.

And a team of researchers at the University of Arizona found a way to determine how cold the Ice Age was. They discovered that for every doubling of atmospheric carbon, global temperature should increase by 3.4 degrees Celsius, which is in the middle of the range predicted by the latest generation of climate models (1.8 to 5.6 degrees Celsius). They then noted that atmospheric carbon dioxide levels during the ice age were about 180 parts per million—that allowed them to calculate temperatures during that period.

Also, a team at the University of Minnesota found a way to make "fool's gold" valuable after all—they electrically transformed samples of the normally non-magnetic material made of iron sulfide into a magnetic material. The researchers noted that it was the first time an entirely non-magnetic material was transformed into one that was magnetic and suggested their technique could lead to the creation of new magnetic materials.

And a team working at the European Southern Observatory's Very Large Telescope, captured the first ever image of a young, sun-like star accompanied by two giant exoplanets—an observation that could help astronomers better understand how the planets in our solar system formed. The new system was located approximately 300 light-years away and has been named TYC 8998-760-1.

A team led by researchers at the University of California, Riverside identified the ancestor of all animals alive today. The 555-million-year-

old fossilized burrows of a tiny, wormlike creature called Ikaria wariootia were found 15 years ago in Nilpena, South Australia. The researchers with this new effort used 3-D laser scanners to reveal the fossilized remains of the creatures that made them.

And a team at Michigan State University found that the innermost parts of supernovae can forge carbon atoms over 10 times faster than previously thought. Such reactions, known as triple-alpha processes, challenge theories that explain why Earth has unusually high amounts of some of its heaviest elements such as isotopes of molybdenum and ruthenium.

Also, a combined team from Texas A&M, the University of Houston and Baylor University found that sediment samples taken from a Texas cave could upend the meteorite explanation for ancient global cooling. The geochemical makeup of the sediment suggested that the Younger Dryas was set off by a series of volcanic eruptions and an already cooling planet, not an asteroid strike, as earlier evidence had suggested.

And a new Chinese manned submersible reached the Earth's deepest ocean trench. The underwater vehicle, named the "Fendouzhe," descended more than 10,000 meters into the Mariana Trench in a western part of the Pacific Ocean. It carried three researchers. The dive marked the first live video feed from the bottom of the famous trench. The vehicle was also equipped with robotic arms that allowed the team to collect biological samples.

Also, a pair of researchers in India, Padmanabha Prasanna Simha and Prasanna Simha Mohan Rao experimentally visualized the flow fields of coughs under common mouth-covering scenarios and found that the effectiveness of cloth masks used to prevent COVID-19 depended on the type of material involved and the way they were used to make the mask. They found that density and temperature were intricately related.

And Lucas Lombriser, a professor at the University of Geneva, suggested that the universe is not as homogeneous as once believed. He further suggested that if expansion were looked at from the perspective of the Earth existing in a kind of gigantic bubble—where the density of matter was significantly lower than the known density for the entire universe—the consequences could explain the differences that have been found in calculating the Hubble constant.

Also, a team of engineers at the University of New South Wales cracked a 58-year-old puzzle on the way to a quantum breakthrough. While conducting experiments involving nuclear magnetic resonance on a single atom of antimony, they found electric resonance instead of magnetic resonance, and in so doing, solved the mystery of how to control nuclear spin with an electric instead of a magnetic field.

And a team of researchers from the U.S., Germany and the U.K. studying data from the Hubble Telescope found evidence showing that Betelgeuse's mysterious dimming is due to a traumatic outburst. The unexpected diming of the famous star had some in the field believing that it was about to go supernova. Instead, the researchers found that the dimming was more likely due to the ejection and cooling of dense, hot gases, which suggested the star may be going through a dimming period a year earlier than normal.

Also, a team at the University of Massachusetts Amherst developed new green technology that generated electricity seemingly out of thin air. The device they created (which they called an "air-gen") used electrically conductive protein nanowires to create electricity from moisture in the air. They also pointed out that the device could run 24/7, was non-polluting, renewable and could be produced inexpensively.

And a team at the University of Chicago's Pritzker School of Molecular Engineering discovered a way to make quantum states last 10,000 times

longer—by tricking quantum systems into thinking they are not experiencing noise by adding an additional continuous alternating magnetic field. The change allowed the team to build a system capable of holding a quantum state for up to 22 milliseconds.

Also, a team of researchers affiliated with several institutions in the state of Washington found that so-called sushi parasites have increased 283-fold in the past 40 years. They sifted through thousands of papers looking at parasitic worms and found that they had increased dramatically in a large variety of fish over the past several decades, many of which are consumed as sushi. They recommend sushi eaters examine their meal before consumption.

And a team at the University of Copenhagen's Natural History Museum of Denmark discovered a bizarre new species of parasitic fungus on Twitter. One of the team members was scrolling through her Twitter feed when she came upon a photo of a North American millipede that had been shared by a U.S. colleague, Derek Hennen of Virginia Tech. She noticed a few tiny dots on the creature that resembled fungi. Further investigation showed the spots to be a previously unknown species of Laboulbeniales.

Also, a team at the Mount Desert Island Biological Laboratory, collaborating with a team from the Buck Institute for Research on Aging, identified synergistic cellular pathways that extended the lifespan of a nematode fivefold, which, the team notes, would translate to 400 or 500 years in humans. They suggested their findings could help explain how some people are able to live to a very old age without ever developing any age-related diseases.

And a team at Yonsei University working with collaborators at Lyon University and KASI found new evidence that showed that key assumptions made in the discovery of dark energy were in error. They

report that assumptions about the corrected luminosity of type Ia supernovae using empirical standardization would not evolve with redshift.

Also, a team at the University of California San Diego School of Medicine developed a formula that more accurately compares the ages of humans and dogs than the old "multiply by seven" rule of thumb. They found that since the two species do not age at the same rate, multiplying by a single factor did not reflect the aging process differences accurately.

And finally, a team at Washington University in St. Louis found that a meteorite chunk contained unexpected evidence of presolar grains. When the studied the chunk, they were surprised to find tiny bits of solid interstellar material that were formed before the sun was born—prior theory had suggested that such grains should not have been able to survive in such an environment.

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