Best of Last Year: The top Phys.org articles of 2019

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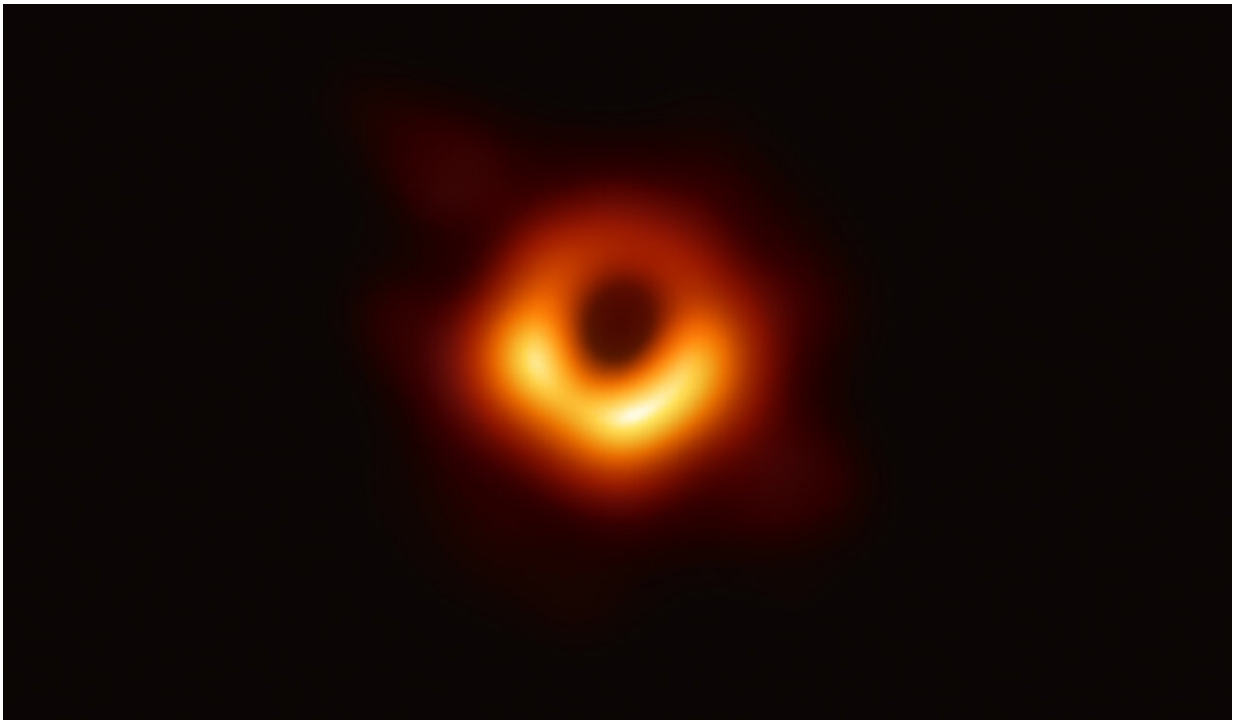

Credit: NSF

It was a great year for research of all kinds as a team of astronomers from around the globe delivered the first photo of a black hole. Over several days in April 2017, eight radio telescopes in Hawaii, Arizona, Spain, Mexico, Chile, and the South Pole focused on the black hole at the center of galaxy M87. They then stitched the data together to form a

virtual observatory approximately 12,000 kilometers across—roughly the diameter of Earth.

A team of researchers affiliated with institutions in Austria, the U.S. and Switzerland found evidence of negative emotional contagion in lab ravens. In experiments with the birds, the group found that when one in a group observed another behaving badly, it pushed them to behave badly, as well—and that behavior gave rise to a chain reaction, making the whole group grumpy.

Also, a team from the Moscow Institute of Physics and Technology teamed up with colleagues from the U.S. and Switzerland and reported that they had reversed time using a quantum computer. In their four-stage experiment, they set up a highly ordered ground state, allowed it to degrade, then used a special program to evolve backward from chaos to order and then regenerated the qubits back to their original state.

Also, a team at Columbia University found that bone, not adrenaline, drives the fight-or-flight response. They found that upon encountering a threat, the brains of both mice and humans instruct the skeleton to flood the bloodstream with the bone-derived hormone osteocalcin, which is activates the fight-or-flight response.

And a team with members from Austria and China announced that they had achieved complex quantum teleportation for the first time. In their work, they came up with a way to teleport a three-level, quantum state (qutrit) of one photon to another distant one. Their work showed that it was possible to teleport a third state to represent the in-between possibilities inherent in quantum systems.

Also, a group of German entomology enthusiasts sounded the alarm over an insect apocalypse. Members of the Amateur Entomology Society of Krefeld documented the rapid decline of flying insects in the Rhine

countryside, and in so doing, found evidence of what has been described as one of Earth's worst extinction phases since the dinosaurs vanished.

And a team at the University of Iowa made worldwide headlines when they announced that Voyager 2 had reached interstellar space. It became just the second human-made object to do so—after Voyager 1 in 2012. They noted that they were able to determine that the craft had made the crossover by readings that showed a jump in plasma.

The past year was also a good one for Canadian-American cosmologist James Peebles and Swiss astronomers Michel Mayor and Didier Queloz—they won the Nobel Physics Prize for research that increased the understanding of our place in the universe. Their work with dark matter and exoplanet discoveries has illuminated what happened after the Big Bang.

Also, a team from the University of Glasgow made a bit of history when they unveiled the first-ever image of quantum entanglement. They devised a system that fired a stream of entangled photons from a quantum source of light at "non-conventional objects." This was displayed on liquid-crystal materials that changed the phase of the photons as they passed through. And then took a picture of the results.

And a team affiliated with several institutions in Spain and the U.S. also made a bit of history when they announced that they had discovered a new property of light. Called self-torque, it arises when twisting light beams form a vortex. The group noted that not only was it a new form of light, it was of a kind that had never even been theorized.

Also, a team with members affiliated with several institutions in the U.S. announced that they had found evidence of a mass anomaly under the moon's largest crater. The team was not able to identify what the mass was, but suggested it was likely metal from the asteroid that had created

the moon's South Pole-Aitken basin, crater.

And a team with members from New York University, the University of Buffalo and Wayne State University made the news when they announced that they had discovered a new state of matter. While analyzing the transition of a quantum state from its conventional state to a new topological state—with a focus on Majorana particles—they discovered a state they called topological superconductivity. They believe it could be of use in quantum computers.

And just this month, a team at the University of Alberta found a dinosaur skull that could turn paleontology assumptions on their head—discovered four years ago, the new work found that the horned ancient skull of a Styracosaurus was not symmetrical, a finding that could have implications for assumptions made on a wide variety of fossils over the years.

Also, a team at the Flatiron Institute's Center for Computational Astrophysics in New York created the first AI universe sim that was so fast and accurate its creators didn't know how it worked. It marks the first time that astrophysicists have used artificial intelligence techniques to generate complex 3-D simulations of the universe—the system can run simulations in mere milliseconds as opposed to minutes, they found, and the results were more accurate than other fast simulators.

And a team at the University of Maryland's Center for Environmental Science carried out a study and used the results to build an interactive web global warming application. As part of their effort, they claimed that the climate of North American cities will shift hundreds of miles in one generation. The app demonstrates how the climate where residents live will change—with most areas mimicking current conditions as far as 500 miles south.

Also, researchers working on the XENON Collaboration announced that their dark matter detector had observed the rarest event ever recorded—the radioactive decay of xenon-124, which has a half-life of 1.8 X 10^{22} years. The researchers ran XENON1T, a 1,300-kilogram vat of super-pure liquid xenon shielded from cosmic rays in a cryostat submerged in water 1,500 meters beneath the Gran Sasso mountains of Italy to make their discovery.

And a team led by the Catholic University of America's Martin Cordiner reported that in studying data from Hubble they had found tiny 'electric soccer balls' in space that might help solve an interstellar mystery—by confirming the presence of electrically charged molecules in space shaped like soccer balls, the group might have found a way to better understand the content of the interstellar medium.

Also, a group of researchers from the Instituto de Astrofísica de Canarias solved the mystery of the galaxy with no dark matter. In studying the results of work conducted last year by another team that had found evidence of what appeared to be a galaxy with no dark matter, they found that there were distance anomalies that had thrown off calculations. They found that the galaxy was actually much closer than was thought.

And a combined team of MIT and NASA engineers demonstrated a new kind of airplane wing. The radically new wing design was assembled from hundreds of tiny identical pieces. The new way of putting together a wing allowed for changing the shape of the wing while the aircraft was flying. They suggested such a feature would provide a significant boost in aircraft production, flight and maintenance efficiency.

Also, an international team of researchers studying two fossilized skulls unearthed in the 1970s found evidence that they are actually the oldest remains outside of Africa and will reset the human migration clock. The

skulls found in a Greek cave were initially identified as Neanderthal, but the new work showed they were actually modern human—dating back 210,000 years, which pushes mankind's arrival in Europe back 150,000 years.

And astronomers Jakub Scholtz of Durham University and James Unwin of the University of Illinois at Chicago found evidence suggesting that Planet Nine could be a primordial black hole. They noted that the apparent mass of the theorized planet was more in line with that of a primordial black hole than a planet. Such black holes are thought to have emerged soon after the Big Bang.

Also, a team at the University of Luxembourg found a counterintuitive physics property to be widespread in living organisms. They discovered that negative resistance, which has been thought only to exist in man-made products, also exists naturally in biochemical systems that are in contact with multiple biochemical reservoirs. One example was substrate inhibition, a process used by enzymes to regulate their ability to catalyze chemical reactions.

And a team with members from Purdue University and the University of Rochester described research that they claim brings scientists one step closer to a fully functioning quantum computer. They demonstrated a method of relaying information by transferring the state of electrons. They cooled down a semiconductor chip to extremely low temperatures and then used quantum dots to trap four electrons in a row—they then moved the electrons so they came in contact, allowing their states to switch.

Also, NASA administrator Jim Bridenstine told the press that NASA will be heading back to the moon soon, this time to stay. In his announcement, he outlined the space agency's plans to send American astronauts back to the moon. In so doing, he revealed that the agency is

planning to speed up the process by using the work and skills of private companies. He suggested that the agency hopes to have humans back on the moon by 2028.

And finally, a trio of physicists from the National Autonomous University of Mexico and Tec de Monterrey announced that they had mathematically solved a 2,000-year-old optical problem—called the Wasserman-Wolf problem, it involves the fuzziness near the edges observed through optical equipment.

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