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By the students of New School Georgia

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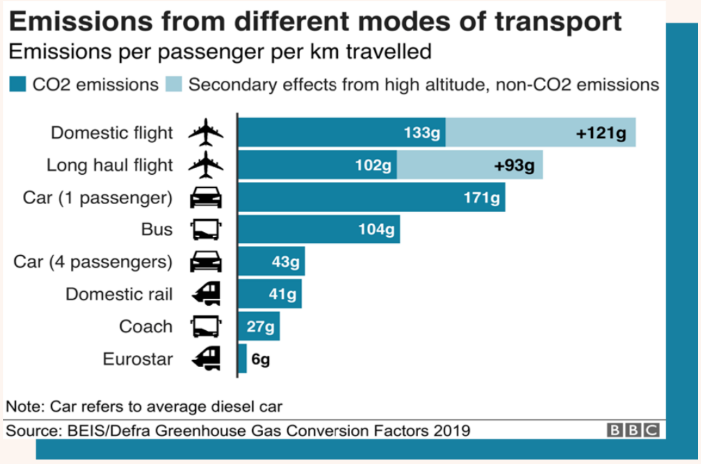
REVOLUTIONIZING AVIATION INDUSTRY WITH RESPECT TO CLIMATE CHANGE

BY CALIN-IULIAN LUNGU

In this article, the effect of the aviation industry on climate change and a new method of reducing these consequences will be addressed. This topic is of great concern for the entire society and therefore, also for me, as air travel is nowadays the most eco-unfriendly way of transportation, with a total of 254g of gas emissions per passenger per km compared to rail travel, with 41g of gas emissions per passenger per km.

With this as a starting point, researchers from ETH Zurich have implemented a pilot-project, with a mini-refinery built on the rooftop of the university campus, located in Zurich, Switzerland. Initially, water and carbon dioxide are extracted from air with the help of an amine-functionalized sorbent, and then are fed into one of the two solar redox reactors. With the sunlight directed by a parabolic dish and concentrator, this reactor reduces the redox material - cerium oxide CeO_2 thermally and emits oxygen O_2. The ceria, previously reduced, is going through a stage of reoxidation when carbon dioxide and water enter the chamber, and generates carbon monoxide and hydrogen.

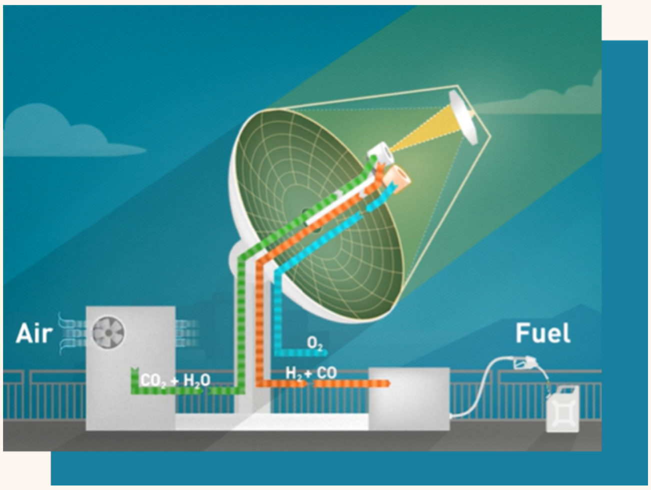


Meanwhile, the second reactor works in parallel as there is not a big need of solar radiation (just 1500 Celsius degrees and 10 mbar). The Swiss team leader, Aldo Steinfeld explains that while the first reactor uses the solar energy to reduce the reactants, the second one is oxidizing them.

Both temperature and pressure swings are applied to maximise the capacity of oxygen to exchange the cerium oxide, and therefore the capacity of fuel outcome per cycle.

As a perspective for the future, Aldo Steinfeld affirms that the costs for solar kerosene might become approximately equal to those of fossil kerosene just at the moment when solar jet fuels will constitute 10-15% of the whole fuel volume. Moreover, as the ETH Zurich Team understands that it will be hard to implement solar jet fuels at the beginning due to the high costs and unpredictability, they propose a quota system that would impose airlines and airports to buy renewable fuels, as a directive issued by relevant aviation authorities. Aldo Steinfeld notes that this would represent a really small proportion, such as 0,1%, which would have an insignificant impact on flying costs. But this quota would rise each year, stimulating investment." Their first goal remains to be the 10-15% stated above.

With planes consuming around 4 liters of kerosene every second, Swiss scientists predict a solar plant as big as 10 solar towers, to produce enough solar jet fuel - 95000 liters - for an Airbus A350 carrying in average 325 passengers from London to New York and back. Another calculation made by the team is the need for kerosene to be produced in order to cover the globally demanded quantity for it - around 414 billion liters per year. 45000 km² of solar plants would be needed to reach this aim, which represents roughly speaking 0,5% of the area of the Sahara Desert, where the climatic conditions are more optimal than those in Switzerland.



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RESEARCHERS BOOST HUMAN MENTAL FUNCTION WITH BRAIN STIMULATION

BY NURLANA ISMAYILZADA

Researchers from the University of Minnesota Medical School and Massachusetts General Hospital demonstrate it is possible to boost particular brain function associated with the strength of will and intellectual flexibility through merging synthetic intelligence with centered electric mind stimulation.

The Ph.D. of psychiatry and member of Medical Discovery Team, Alik Widge shared newly-conducted studies concerning biomedical engineering.

The studies include 12 patients going through brain surgery for epilepsy (process when small electrodes are attached to the brain to report the activity and discover the region of seizures), from which, Widge, Sydney Cash, and Darin Dougherty recognized a brain region - the Inner Capsule- that can enhance a person's intellectual features whilst stimulated. The Internal Capsule is liable for cognition while conduct can shift all of the time and cause mental illnesses.

Widge said that this method can detect the difficulty in a patient's mind and send electrical stimuli to overcome this difficulty. He gave an example of electrical-motorcycle to explain his statement: when a person has a hard time pedalling, the bike detects it and helps with an impulse to not make the biker stop.

The study showed that:

- Electrical stimulations will be useful in enhancing the human mental function connected to the mental illness
- A closed-loop controlling mechanism used was double more effective than random time stimulation
- Some elements of the inner capsule of the brain are more helpful for cognitive functions

Some of the patients had remarkable tension, similar to epilepsy. When given the cognitive-improving stimulation, they said that they overcame their anxieties easier as they could distract themselves effortlessly. Widge stated that this approach will be successful for patients with medication-resistant anxiety, depression, etc.

Widge said that this method is innovative as instead of looking for a method of suppressing symptoms, people may control their minds with already provided tools.

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WHAT IT LOOKS LIKE WHEN A BLACK HOLE SNACKS ON A STAR

BY NIKOLOZ GIGIBERIA

Black holes are one of, if not the most interesting, yet mysterious celestial bodies in our universe. Their unusual properties allow us to expand our knowledge on the universe simply by observing them.

Black holes are much like toddlers when it comes to eating – they tend to leave a messy trail after they are done with their meals. Unlike toddlers, black holes don't leave stains of pasta or yogurt; they leave mind-blowing images.

When black holes consume stars, they produce tidal disruption events. Tidal disruption events are caused by stars that approach sufficiently close to a supermassive black hole and are torn apart by the black hole's tidal force [a gravitational effect caused by the difference in strength of the gravitational fields of two bodies, stretching one along the line towards the center of mass of another], thus experiencing spaghettification – which, as the name suggests, is the process of vertically stretching or horizontally compressing a body (Wednesday).

The light around a black hole is produced by stolen matter from stars circling towards a black hole, like water flowing down a drain. Friction heats the matter up to a temperature where it can outshine stars themselves. The end of this process concludes with an outburst of radiation that has the potential to outshine all of the light from stars in the black hole's host galaxy combined, for months or even years.

This illustration shows a glowing stream of material from a star, torn to shreds as it was being devoured by a supermassive black hole. The feeding black hole is surrounded by a ring of dust, not unlike the plate of a toddler is surrounded by crumbs after a meal.

In September of this year, a paper was published in The Astrophysical Journal by a team of astronomers from the University of Arizona, led by Sixiang Wen, a postdoctoral research associate. The x-rays which were emitted by J2150, a tidal disruption event, were used by the team of astronomers to formulate measurements of both the black hole's mass as well as its spin [the angular momentum of the black hole]. This allowed the research team to observe a previously unobservable black hole event.

According to Ann Zabludoff, a university of Arizona professor of astronomy and co-author of the research paper, "The fact that we were able to catch this black hole while it was devouring a star offers a remarkable opportunity to observe what otherwise would be invisible. Not only that, by analyzing the flare we were able to better understand this elusive category of black holes [intermediate- mass black holes], which may well account for the majority of black holes in the centers of galaxies."

The team re-analyzed x-ray data used to observe the J2150 tidal disruption flare, and compared it with highly developed theoretical models. The results showed that the flare without a doubt came from an interaction between an intermediate-mass black hole and an unlucky star. The black hole in question is relatively small for a black hole, only weighing 10,000 times the mass of our sun.

This new breakthrough is significant in our understanding of the universe. While observing the centers of large galaxies which are home to supermassive black holes, astronomers have been able to spot dozens of tidal disruption events. However, smaller galaxies might contain even smaller, intermediate black holes. The data before was not detailed enough to prove past tidal disruption events were caused by intermediate black holes, now, J2150 has changed this.

An artist's impression of a white dwarf star (left) in orbit around a black hole and so close that much of its material is being pulled away. Inset is an observation of the host globular cluster, 47 Tucanae, captured by NASA's Chandra X-ray Observatory. The system (known as X9) is indicated by the arrow. Credit: X-ray: NASA/CXC/University of Alberta/A.Bahramian et al.; Illustration: NASA/CXC/M.Weiss.

Thanks to modern technology, astronomers have concluded that almost all galaxies the same size, or larger than the Milky Way have a supermassive black hole in the center. These black holes range from 1 million to 10 billion times the mass of our sun.

"We still know very little about the existence of black holes in the centers of galaxies smaller than the Milky Way," says co-author Peter Jonker of Radboud University. "Due to observational limitations, it is challenging to discover central black holes much smaller than 1 million solar masses."

The measurement of J2150's spin could hold clues to how black holes grow and new facts about particle physics. Additionally, the data recorded from J2150 allows astrophysicists to test their hypotheses about the nature of dark matter, which is believed to make up a large majority of our universe, as well as hypothesize about the billions of dwarf galaxies in the universe (University of Arizona).

Personal Thoughts: I chose this topic to write about because I am fascinated by astrophysics and how the universe works. Specifically, I think black holes are such a mysterious, but fascinating part of the universe, therefore, I enjoy reading about them. Upon reading the article, I learned so much which was previously unknown to me. I learned about how black holes consume stars and how scientists observe black holes.

Overall, I enjoyed writing about this article as, not only was it a way for me to show the amazing nature of black holes to others, but it was also a way for me to gain a deeper understanding of black holes and the universe.

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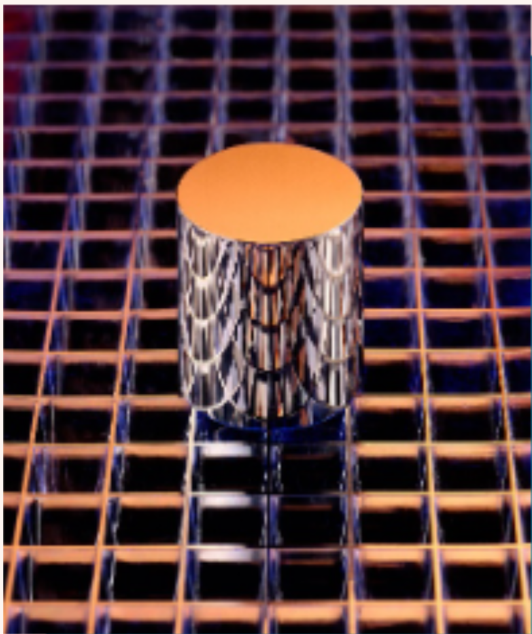
THE DEATH OF BIG K

BY STEFAN VOLNITCHI

In this article, I will discuss the recent change that took place, which effectively changes our definition of a kilogram, a fundamental unit of measurement that is being used by each of us in everyday life. What fascinates me is the fact that something that seems so simple, so elementary, like the unit of measuring mass, can have such a large discussion and debate surrounding it. I also think that a look into this topic may fuel our understanding of how science evolved over time and significantly change our perspectives of the universe alongside our standards in all the fields of science.

What really is a kilogram? I think that every person reading this article knows that a kilogram is a fundamental unit of measuring mass in the International System of Units. In all aspects of our daily lives, from the bathroom scales we use to weigh ourselves and the scales we use in stores to buy food; to measuring with astounding precision the doses of medicine one has to take and making precise measurements at the cutting edge of physics and medicine, the kilogram is our trusty old friend who helps us get the job done. Up until recently, a kilogram used to be defined by a platinum and iridium cylinder, called Le Grande K, or Big K, stored under three layers of glass, in a temperature-controlled vault in the International Bureau of Weights and Measurements in Sèvres, France. (Wei-Haas, “The Kilogram Is Forever Changed. Here’s Why That Matters.”)



This is an exact replica of the International Prototype of the Kilogram, stored at the National Institute of Standards and Technology in Gaithersburg, Maryland, which was used for all weigh calibrations in the United States.

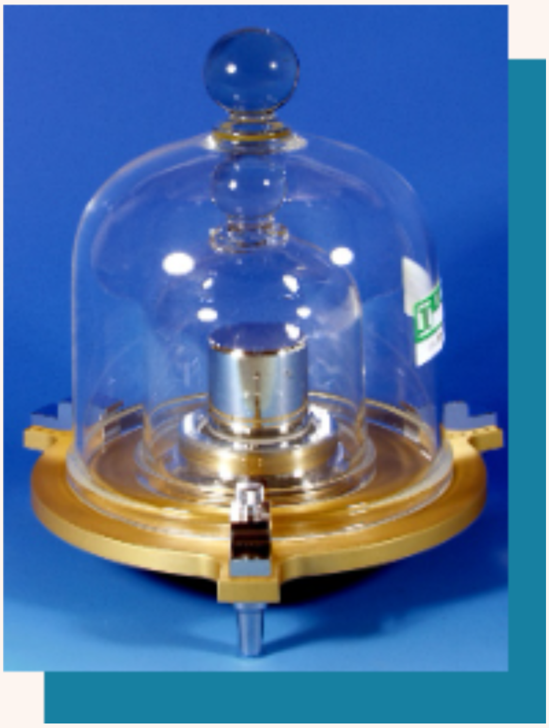
What exactly was the change in determining the kilogram? The kilogram will no longer be based on a physical object, but rather a fundamental constant of the universe - Planck's constant. This constant is equal to approximately 6.63 x 10^-34 m2kgs-1. It's a fundamental constant because it describes the behavior of photons (fundamental packets of light) in everything that surrounds us, from a lit candle on our desk to all the stars in the depth of the cosmos. Stephan Schlamminger, the leader of the National Institute of Standards and Technology, who worked to refine Plank's constant in preparation for the redefinition of the kilogram, claims that "The fundamental constant is woven into the fabric of the universe". A big motivation for the change was the fact that the value for Plank's constant will remain the same everywhere in the universe, for all time. (Wei-Haas, "The Kilogram Is Forever Changed. Here's Why That Matters.")

How did this change take place? The representatives from over 60 countries unanimously voted for the change of the definition of a kilogram. This took place on November 16, 2018, during the 26th meeting of the General Conference on Weights and Measures in Versailles, France. However, it was not only until the 20th of May 2019 that the change actually took effect. There were various propositions on how the change would be facilitated. One of these was for scientists to use a Kibble balance (a balance that uses the electromagnetic force, rather than the gravitational force to balance the mass) in order to measure, with high precision, Planck's constant. The other method was measuring Planck's constant, with high accuracy, using Avagadro's number (the number of atoms in a mole of a substance, approximately 6.022 x 10^23 atoms). Scientists have calculated, with extremely high accuracy, the number of atoms in an almost perfectly round sphere of silicon, which is exactly one kilogram. (Wei-Haas, "Elusive Quest for One True Kilogram Finally Pays Off")

The world's roundest sphere, that is exactly one kilogram.

Is the kilogram the only fundamental measure to be redefined in this way? No, actually the contrary is true. All other measures in the International System of Units have had their definitions changed to a more precise variant, tied to the fundamental constants of the universe. The kilogram was the only unit remaining that was still defined by a physical object, and thus it was only a matter of time before it was changed too. (Wei-Haas, "The Kilogram Is Forever Changed. Here's Why That Matters.")

Why was the kilogram changed? Big K has had several copies of it made, which were used for calibration in all the other parts of the world. When all of these copies were brought next to the original, it was discovered that the original had lost a bit of weight - around 50 micrograms (the mass of a grain of salt). Although this doesn't seem significant for daily life, it makes a great difference in the fields like medicine and engineering, where the smallest error can cause catastrophic outcomes. The newly defined kilogram only has an uncertainty of one part in 100,000,000 (about a quarter of the weight of an eyelash). (Wei-Haas, "The Kilogram Is Forever Changed. Here's Why That Matters.")



This is Big K, the original cylinder, representing a kilogram, under 3 layers of glass

Does this change affect our daily lives? The change of the kilogram has no effect on our daily lives and how we measure ourselves or the things around us. It only impacts scientific fields, such as medicine, where it influences the quantities of different substances added to medicine and the amount of medicine prescribed to a certain person or different fields of engineering. (Wei-Haas, "The Kilogram Is Forever Changed. Here's Why That Matters.")

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