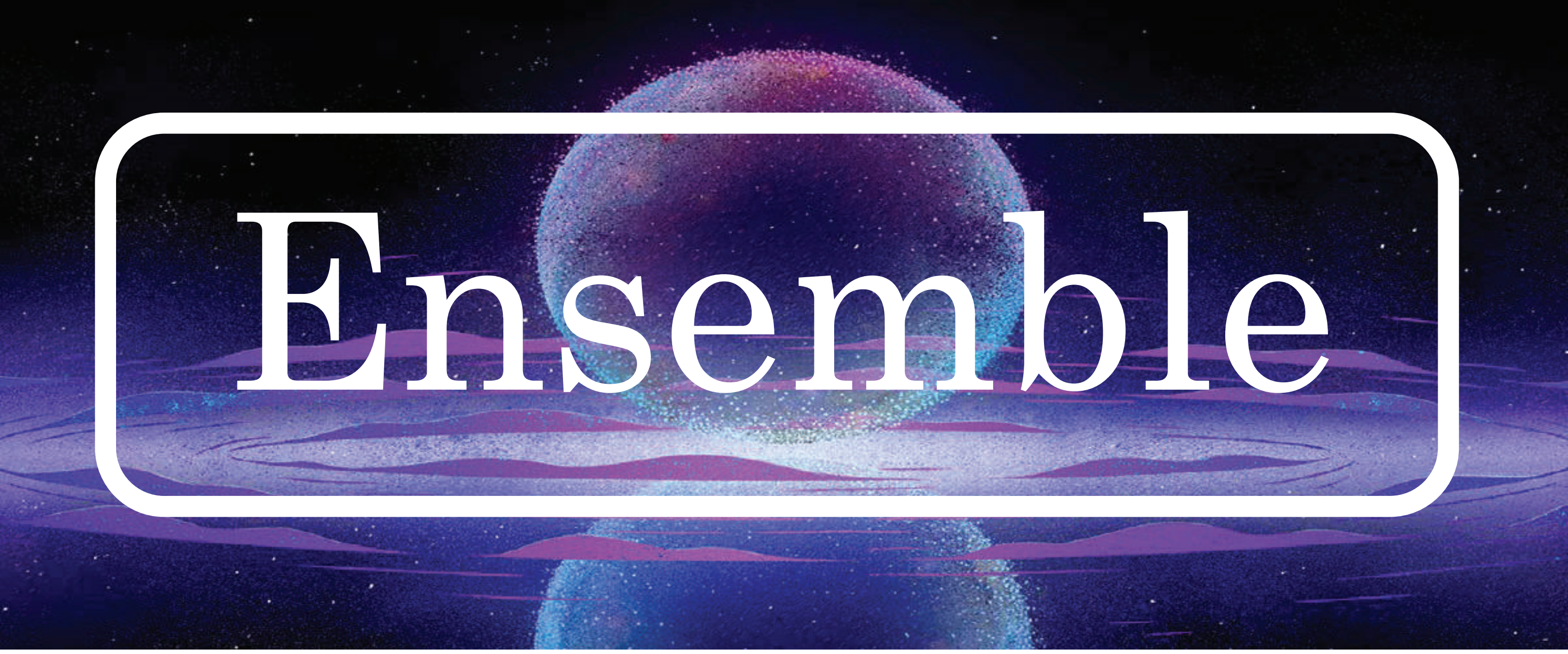
Ensemble



THE CONCEPTION

This Newsletter was conceived as part of our undergraduate physics club at IISc to keep the readers updated about the enthralling new findings in the field of physics. We hope to bring the current happenings in physics to the fingertips of our readers and make their journey of keeping up with the contemporary world of physics easier and a bit more fun!

Debadrito Roy
Co-convenor

Soumyadeep Sarma
Co-convenor

IN THIS ISSUE

Amisha Khedwal

Hey everyone, I'm Amisha Khedwal from St,. Xavier's College, Mumbai pursuing BSc. I'm currently in my second year. I have a passion for writing. I enjoy writin on a variety of topics expecially in physics and I take pleasure in immersing myself in learning about new and exciting ideas

Will Artificial Intelligence ever discover new laws of physics?

Artificial intelligence (AI) has revolutionized many fields, from healthcare to finance, and has made significant progress in advancing scientific research. AI systems are now being used to analyze vast amounts of data, simulate complex systems, and even make predictions about the behavior of physical systems. With these capabilities, it's natural to wonder if AI could go even further and generate new laws of physics.

To understand if this is possible, we first need to examine what laws of physics are and how they come about. Laws of physics are fundamental principles that describe the behavior of matter and energy in the universe. They are based on observations and experiments and are formulated as mathematical equations. These equations describe the fundamental forces that govern the behavior of particles and the interactions between them.

The process of discovering new laws of physics is a highly collaborative and iterative one that involves many scientists working together over many years. It typically involves a combination of theoretical calculations, experiments, and observations. Theoretical physicists propose new ideas based on existing knowledge, and experimental physicists test these ideas using sophisticated instruments.

The question then arises, can AI contribute to this process of discovery? In theory, AI could be used to simulate physical systems and perform calculations that are beyond the capabilities of human scientists. It could also be used to analyze large data sets, such as those generated by particle accelerators or telescopes, and identify patterns that might be difficult for humans to discern.

There have been attempts to discover new physics laws using AI. One notable example is the work done by researchers at Fermilab, who used machine learning algorithms to analyze data from particle collisions at the Large Hadron Collider (LHC) in search of new physics.

The researchers trained a neural network on simulated data from the LHC, and used it to search for anomalies in the real data that could be signs of new physics beyond the Standard Model. They found several events that were not consistent with the predictions of the Standard Model, and are currently investigating whether these could be evidence of new physics.

Another example is the work done by a team of researchers at the University of California, San Diego, who used machine learning algorithms to analyze data from gravitational wave detectors in search of new physics. The

researchers trained an AI to identify patterns in the noise of the detectors that could be caused by new physics phenomena, such as exotic particles or extra dimensions.
While these examples are still in the early stages and more research is needed to confirm any new discoveries, they demonstrate the potential of AI to help us explore new frontiers in physics and uncover new laws of nature.

However, there are limits to what AI can do. At its core, AI is a set of algorithms that are designed to perform specific tasks. It cannot generate new ideas or propose new theories on its own. It can only analyze and interpret data based on the algorithms and models that have been programmed into it.

Furthermore, the laws of physics are deeply interconnected and interdependent. A change in one aspect of the laws can have a significant impact on other areas of physics. This means that any new laws of physics must be consistent with existing ones, and this requires a deep understanding of the underlying principles.

In summary, while AI can be a valuable tool in the discovery of new physical laws, it is unlikely that it will generate these laws on its own. The process of discovery involves more than just data analysis and simulation. It requires creativity, insight, and the ability to synthesize information from different sources. These are skills that are uniquely human and cannot be replicated by machines.

In conclusion, the discovery of new laws of physics will continue to be the domain of human scientists for the foreseeable future. However, AI can play a valuable role in supporting this process by providing insights, analyzing data, and aiding in simulations. By working together, scientists and AI can unlock new insights into the fundamental workings of the universe and push the boundaries of our knowledge even further.

Krishna K S

"A simple science aspirant come crazy dreamer"

Black Light And Hidden Floral Patterns

Abstract

"Black light",the word itself might give you a creepy feeling . Because the words 'Black' and 'light' are at two sides of a page , they weren't supposed to meet at all , both of them could hardly exist in the eyes of a writer or a philosopher . In the point of view of science ,it is quite possible that we know the real meaning of "the apple is red or the sky is blue".I offer you a bundle of information which can enlighten you .This way you will able to taste the essence of "BLACK LIGHT" with more imagination that you can probably see a movie inside your brain with it (dream).UV photography was possible even years before but the hidden floral patterns in UV light and UV photography got popularized recently.I hope you too can see the beauty of flowers in UV with a camera , soon.

Keywords : UV spectrum , insects with UV vision , colors ,UV photography.

Black light isn't in the visible spectrum , it exists in the spectrum beyond the visible spectrum.It is called UV light , Infrared that are invisible to human eye even though this black produces light .But this word "Black light" got hardened to UV,gradually.The UV light is classified into 3 based on wavelength as UV-A ,UV-B,and UV-C.UV A has a wavelength of the range of 315-399 nm which consists of almost all the UV radiation reaching on earth's surface after confronting OZONE layer ,which prevents most of the harmful UV C radiations of wavelength 100 - 279nm and some UV B of 280- 314 nm wavelength radiation from reaching earth.So please stop worrying when you hear that the UV radiations are reaching earth along with visible light because it need not be UV-C or UV-B .

Scientists working with astronomical objects have a way of classifying UV as near UV ,middle UV and far UV .You might have heard about 'false colour composite' a word linked to photos taken by telescopes of celestial objects . Based on the wavelength these various UV radiations are denoted by different colours in the pictures of astronomical objects .

In 1801 ,Johan Ritter did an experiment to investigate its presence knowing that photographic paper would turn black more rapidly in blue light than in red light .He exposed the paper to light beyond violet which turned it black. Young stars shine most of their light in UV wavelength and LAMP onboard the LUNAR reconnaissance orbiter can peer into permanently shadowed craters on the moon by sensing the faint reflections of UV light coming from distant stars . Seeing the UV isn't an unfamiliar thing to our scientific world . We already know its use in sterilizing lab instruments and samples in laboratories and for many other fields .But what about the beautiful

sight of AURORA that is seen on our planets magnetic poles , they are caused by high energy waves that travel along the poles where they excite atmospheric gasses and cause them to glow , photons of these high energy radiations bump into atoms of gases in atmosphere making them to excite to higher energy levels and to regain stability these atoms comes down to lower energy levels by emitting light , which is the beautiful aurora we see in the northern sky called northern lights.

Above information was almost expected and digested easily but I am bringing to you something new about UV light. There have been few humans who haven't appreciated the beauty of flowers that they are so vivid in color and pattern. We have been taught in our biology classrooms that flowers bloom this way to attract their corresponding pollinators, mostly the insects. We are also taught that most of the insects are color blind , not the actual color blindness but their compound eyes being numerous can only receive high energy UV radiations , as their tiny eyes give rise to diffraction effects ,which reduce resolution . But diffraction is reduced for shorter wavelengths so they end up in receiving UV radiations ,which provide them with good resolution. But the reason why flowers show these differences in UV light isn't scientifically verified yet.
Some humans too can see UV light , why not all humans ? If UV light is so energetic ,why can't we not see it ? UV is absorbed by the crystalline lens inside of our eye.But patients who have suffered from cataracts and replaced their lens with artificial lens could see UV light that would be normally invisible to most people.

The emerging trend of UV photography and UVIVF (Ultraviolet-induced visible fluorescence photography) opens up a chance to see that side of flowers like the insects . UV photography and UV induced visible fluorescence photography are pure science.

Most cameras, film or digital, are designed to provide a good reproduction of human vision (700 nm–400 nm) by intentionally excluding infrared and ultraviolet wavelengths.In old cameras UV photography were possible as photographic films were quite sensitive to UV light, which used to cause haziness or fogginess, and a bluish hue in color film . By making use of UV(300-400 nm) filters who intentionally exclude visible light nowadays our digital camera's give images similar to insect vision.

UV light radiates at shorter wavelengths than visible light and cannot be seen by the human eye. However, when UV light is absorbed by certain materials, it is reflected back towards the eye and has a longer wavelength of visible radiation, or visible light. This phenomenon is referred to as UV-induced visible fluorescence.This UVIVF provides images of flowers similar to the ones in pandora from James Cameroon's movie Avatar.

Hope this was new information to you that flowers seem entirely different under UV light or Black light , you will make sure whether it's UV - B or UV- C before you start worrying when you hear about the presence of UV and the distant astronomical objects doesn't only give out IR and low energy radiations , they produce UV radiations too which brightens up our northern sky sometimes and there are humans who can see black light.

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Shalini Bhattacharya

"Content writer but can't write a line about myself"

How random is "Random"

You bump into someone on your way to coffee, and surprisingly that someone is your high school bestie who you saw after literal decades. What a small world! Such a random thing to happen, right? WRONG.

Nothing you experience is random, nothing- that random song in the cab? Coin tosses? Spotify's random shuffle? Nothing. It's all a lie. It is next to impossible for anything to be random, then what are these seemingly "random" things? They are chaotic. Contrary to popular belief, chaotic and random events have a very important distinction. Random events are completely non-deterministic, whereas Chaotic events give the illusion of being random simply because of insufficient data, if all information about the initial conditions were made known, one can predict the outcome of any chaotic event. Every. Single. Time.

But Sharon, my decision yesterday to have pizza was utterly random! Except it wasn't. It might look like it, but if someone had every information about you and your experiences that led to the decision, it could very well be predicted. And since that is next to impossible, we as individuals are quite unpredictable. Now, things start getting interesting when we have to predict the behaviour of humans as a collective; turns out that even with completely unpredictable behaviours, when clubbed together, it's extremely easy to predict what an average person would do. And that is how high-density crowd management models are designed.

Take for example an evacuation model where there's only one large exit; everyone will swarm up to that one exit point, resulting in stampedes. An effective model would have multiple exit points, which compels the crowd to choose and thus break the crowd into more manageable groups. This is the premise on which the study of crowd dynamics is based.

This scenario can be applied to most chaotic systems, and is best described by a quote by Sir Francis Galton, "Whenever a large sample of chaotic elements are taken in hand and marshalled in the order of their magnitude, an unsuspected and most beautiful form of regularity proves to have been latent all along."

But that begs the question, is there anything truly random? The only example of true randomness is seen in quantum mechanical-based systems, like radioactive decay. We know that an atom is going to decay but there is no way to predict which particular atom is going to decay and when, but when we see it on a larger scale we can determine how much time it's going to take for half of the atoms present in the specimen to decay.

We know that an atom is going to decay but there is no way to predict which particular atom is going to decay and when, but when we see it on a larger scale we can determine how much time it's going to take for half of the atoms present in the specimen to decay.

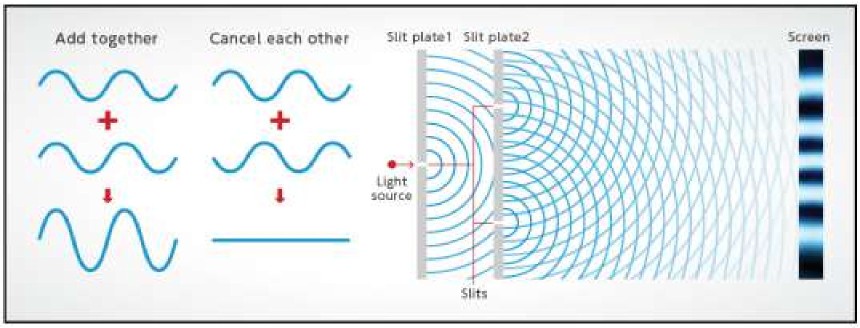
The beauty of our universe is truly depicted with just randomness, even though none of our choices, techniques and the equipment we design to be random can ever truly be random, we are constituted and governed by elements and phenomena which at their core are perfectly random.

Mohd Uvais

"Hello, Mohd here! I am pursuing my Bsc in Physics from Aligarh Muslim University. Always curious t learn and write aboutnew topics of physics"

WAVE-PARTICLE DUALITY

In 1807, an English physicist named Thomas Young asserted that light has the properties of a wave in an experiment called Young's Interference Experiment. This Young's interference experiment showed that lights (waves) passing through two slits (double-slit) add together or cancel each other and then interference fringes appear. This phenomenon cannot be explained unless light is considered as a wave.



Young's Double Slit Experiment

Is light a particle? - Einstein's light quantum hypothesis

Albert Einstein was a physicist whose life spanned the countries of Germany, Switzerland and America. In 1905 he succeeded in explaining the photoelectric effect which had been unexplainable if one only considers light as a wave. Einstein asserted that light is a particle containing energy corresponding to their wavelength.

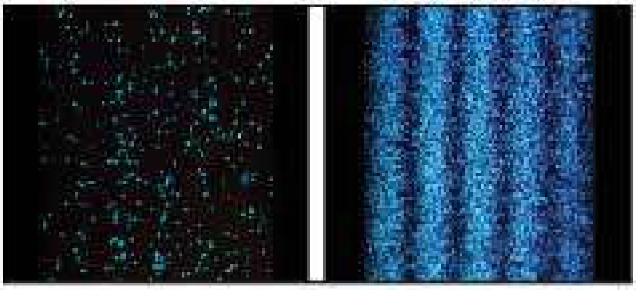
The photoelectric effect is a phenomenon where irradiating a blue light on metal emits electrons from it. However, red light does not cause electron emission from metal no matter how long or how intense the light is applied. To understand this effect, you should think of photon as (clusters of) particles containing energy. Blue light is particles having high energy capable of emitting electrons. Red light is particles containing low energy not capable of emitting electrons.

So light in this way came to be called "photons (light quanta)" since it has the properties not only of a wave but also of a particle.

The duality of photons

"Light is not only a wave but also a particle" An experiment was performed to deepen our understanding of this concept. This is Young's Interference Experiment or Double-slit Interference Experiment. This experiment was carried out using technology to detect individual light particles to investigate whether interference fringes

appear even if the light is drastically weakened to the level having only one particle. Resultsfrom the experiment confirmed that one photon exhibited an interference fringe.



When light weakened to an extreme brightness limit and projected on a screen is detected, it behaves like a particle as seen on the left. However when the recordedparticle count increases, an interference fringe appears as seen on the right. One can see from this that light also behaves as a wave.

When one of the two slits in the experiment is closed so that one photon particlecan only pass through the other slit, then no interference fringe appeared. This demonstrated that in the double-slit interference experiment, one photon particle simultaneously passed through the two slits and interfered by itself. These experiments show that while a photon was detected as having the properties of a particle, interference appeared like that of a wave while simultaneously passing through the double-slit, revealing that the photon has the dual properties of aparticle and a wave.

The nature of photon

Based on Einstein's light quantum hypothesis, the duality of the photon was confirmed through quantum-mechanical experiments and examination. The photon is now regarded as a particle in fields related to the interaction of material with light that is absorbed and emitted; and regarded as a wave in regions relating to light propagation.

Well then how is it that the photon simultaneously possesses two completely different properties? What exactly is a photon anyway?

It is known that among the four forces constituting the universe, the photon serves to convey electromagnetic force. The other three forces are gravitational force, strong force, and weak force. The photon plays an important role in the structure of the world where we live and is deeply involved with sources of matter and life.

By knowing the nature of the photon, we can utilize light more effectively and create an innovative new society that exceeds our imagination. If we could make this happen through the fresh sensitivity, imagination, and enthusiasm of those viewing this newsletter, then it would be wonderful.

Significance of Wave-Particle Duality

The major significance of the wave-particle duality is that all behavior of light and matter can be explained through the use of a differential equation which represents a wave function, generally in the form of the Schrodinger

equation. This ability to describe reality in the form of waves is at the heart of quantum mechanics.The most common interpretation is that the wave function represents the probability of finding a given particle at a given point. These probability equations can diffract, interfere, and exhibit other wave-like properties, resulting in a final probabilistic wave function that exhibits these properties as well. Particles end up distributed according to the probability laws and therefore exhibit the wave properties. In other words, the probability of a particle being in any location is a wave, but the actual physical appearance of that particle is not.

While the mathematics, though complicated, makes accurate predictions, the physical meaning of these equations are much harder to grasp. The attempt to explain what the wave-particle duality "actually means" is a key point of debate in quantum physics. Many interpretations exist to try to explain this, but they are all bound by the same set of wave equations... and, ultimately, must explain the same experimental observations.

CMB- The Most Ancient Known Artefact of the Universe

Rupsa Dasgupta

A sleep-deprived physics student who never stops talking about the universe and her love for Taylor Swift, books, her guitar and Real Madrid.

Have you ever seen static signals on an old television screen while switching channels? Have you ever wondered if we can look back in time, closer to the Big Bang? These two questions may seem completely unrelated, but they are both answered by the same three words- cosmic microwave background.

Cosmic microwave background or CMB is essentially leftover radiation from the time of the Big Bang. When the universe first started forming post the Big Bang, it underwent rapid inflation, spreading and cooling in all directions. The CMB was all the heat and radiation left over from the Big Bang.

Even though we cannot see CMB with our naked eye, it is everywhere in the universe. This radiation falls in the invisible part of the electromagnetic spectrum, in the microwave region, with its temperature being just 2.725 degrees above absolute zero.

In the early stages of the universe, it was extremely hot- around 273 million degrees above absolute zero. At this temperature, atoms disintegrated into protons and electrons and the photons from the CMB radiation were scattered off the electrons. Around 380,000 years after the Big Bang, the universe was cool enough for hydrogen to form, but since the photons were unaffected by it, they could still travel in straight lines throughout the universe. Thus there is a 'surface of last scattering' where the radiation from CMB last struck matter, and this means that with the help of CMB we can look back up till just 380,000 years after the Big Bang, from when the universe was opaque to radiation.

But how did we get to know and confirm the existence of this unique radiation? CMB was first predicted by American cosmologist Ralph Apher in 1948, when he was working on finding the elements produced after the Big Bang (except hydrogen). But it was actually discovered completely by accident in 1965, when Arno Penzias and Robert Wilson were creating a radio receiver with Bell Telephone Laboratories and were confused by a strange "noise" the receiver was picking up. They then realised this noise was being received uniformly from all over the sky.
At the same time, some researchers from Princeton University, led by Robert Dicke, were in an active effort to detect CMB. When they heard about the Bell Telephone discovery, they connected the dots and realised it was indeed CMB being detected.

Since then, scientists have also found out that in old cable TVs, the cable receiver would pick up CMB radiation and it would be manifested as a static signal in between switching channels. It is indeed so fascinating to think

that we could grasp an artefact from the oldest depths of the universe in our own TVs! And yes, CMB is a very interesting and useful artefact, or tool, to study the history and the beginnings of the universe. It is mostly at a uniform temperature, with tiny fluctuations only detectable through powerful telescopes. These fluctuations give scientists a lot of information about the origins of galaxies and other features of the early universe.

A very detailed mapping of the CMB was conducted by the Wilkinson Microwave Anisotropy Probe (WMAP) whose work first declared the universe's age to be around 13.8 billion years. They also revealed that the oldest stars in the universe formed around 200 million years after the Big Bang, much earlier than anticipated.

In 2013, the European Space Agency's Planck Space Telescope released data showing that the fluctuations in the CMB at high angular scales did not match the predicted values. This eventually led to the proof of the existence of dark matter- a mysterious and largely unknown form of matter existing in the universe, which does not interact with electromagnetic radiation.

Thus, cosmic microwave background or CMB is a fascinating piece of the universe and it helps us study and understand the very beginnings of everything known to man. If we want to look back in time and unlock the door to learning about the origins of the universe, then CMB holds the very key we need.

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Santhra Jojan

Heyy there ! I'm just a friendly Slytherin.

BLACK HOLES, DARK ENERGY, AND THE EXPANSION OF THE UNIVERSE ARE THE NEW AMAR AKBAR ANTHONY IN TOWN

The universe has been expanding for nearly a hundred years now which is to say, the space between the galaxies is stretching. The farther we look the faster the expansion seems to take place, this means that space has stretched more than expected over the time that light from the galaxies has been traveling to us. Do we know for sure that black holes could be causing them, not really, not yet but we do know that 26% of universe energy went into creating dark matter, 5% to normal matter and then powering the accelerated expansion, 70% is down to dark energy.

Now comes the question that boggles and scares the life out of an astrophysicist usually in a good way because it's largely uncanny of us to name something and know nothing about it, nothing at all.

WHY THEN THIS TITLE AT ALL !? WHY TO EVEN DISCUSS SOMETHING AS CLUELESS AS THIS DARK ENERGY !?

Blackholes are suspected to be causing the accelerated rate of expansion due to the inquisitiveness surrounding what happens beyond an Event Horizon, fact check, it's a point of no return where you'd have to be faster than the speed of light to escape it which is impossible under the laws of physics. The best model that represents this is Kerr's model which solves Einstein's equation of general relativity for a spinning black hole, this model describes a black hole as all the mass squished down into a single point known as the singularity. We can't be sure if what causes resistance to be crushed by gravity is a singularity or vacuum energy inside a black hole. Vacuum energy is inherent energy in space which is in the order of nano joules every cubic meter. Assuming that black holes resist the crush of gravity due to vacuum energy inside the event horizon, black holes also expand, gaining more vacuum energy as the universe expands. Since $E=mc^2$, it means that the insides of the event horizon are gaining mass though none of it is even going close to it.

Due to the conservation of energy, this can't be true, only if there was no dark energy involved. As the black hole grows in mass, space-time fabric gets diluted which gives a negative pressure pushing outwards which would be dark energy that accelerates the universe, thus giving us the idea that dark energy and blackholes are cosmologically coupled. All this sounds theoretically beautiful but how do you prove this since we don't acquire any data from the dearth of the event horizon?

Farrah et al. and the team decided to do this by tracking the growth of a supermassive black hole over time. But it ain't that easy to do because a blackhole could be expanding due to the merging of galaxies, or due to the gas release during the merger. The team argued that all these could be neglected if you chose elliptical galaxies to be the reference point. These are huge blob-like galaxies that form when star orbits are scrambled up in mergers and are assumed to be the end stage of galaxy evolution. On plotting the total mass of stars in the galaxy to the total mass of a supermassive black hole at the center they found that those blackholes nearby elliptical galaxies are 7 times heavier than predicted, than those elliptical galaxies which were at redshift 1 (6 billion years ago in the universe) and 20 times heavier than galaxies which were at redshift 2.5 (nearly 11 billion years ago). Thus claiming there is an increase in the mass of the black hole. Now, this whole thing could be just a be a desperation call to give an apt definition to dark matter or energy since so much of this paper is based on major assumptions, glossed over facts, and more over the uncertainty around blackholes in general. But who knows if it could stand more tests and observational data, this could be a major breakthrough.