KARNATAKA PHYSICS ASSOCIATION (R)

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KPA NEWSLETTER – 11 MAY 2026

Contents

Editor's Note

There are, as usual, a wide variety of articles in the newsletter. The first one deals with the celebration of the National Science Day in India, in memory of the official discovery of the Raman Effect in 1928, after sustained efforts of C V Raman and his associates for over seven years.

The distinguished Irish mathematician and physicist Sir. William Rowan Hamilton developed new techniques in mechanics in the 19th century that paved the way for the development of quantum mechanics in the next century. The next article gives a brief account of his work.

April 14th is celebrated as the World Quantum Day for the association of 4.14 with Planck's constant in the unit of eV-sec. We have here a delightful and factual account of the history and nature of the quantum theory in a poetic form.

Discussions about Quantum Computing seem to have reached every school, college and news media all over the world. It has become a buzzword no one can do without! The next article gives a qualitative idea of ten important concepts associated with Quantum Computing that everyone should know in the present world.

The year 2025 has been celebrated all over the world as the International Year of Quantum Science and Technology in recognition of the omnipresent role played by Quantum Science and its applications. The next article highlights the quantum science concepts with lots of illustrations.

Nuclei having a certain number of nucleons display great stability – they are called magic nuclei. The next article tries to explain the reasons for their 'magical' behaviour.

It is argued in the next article that we need to adopt a totally new approach in teaching and university for greater efficiency- the so-called upside-down approach. We should think about it.

People have been fascinated, terrified and curious about the long-tailed, fast-moving, transitory objects in the sky called comets for hundreds of years. The next article gives an account of their history, contents, orbits, origins, effects on Earth, etc.

India is building a gravitational wave detection laboratory called LIGO India with a huge investment. It is expected to be operational by 2030 after several delays. The next article gives its latest position.

Attempts are being made to understand the composition and distribution of matter in the universe to build a workable model. The next article describes, in brief, a novel proposal that there might be viscous fluid in space.

Albert Einstein held discussions with several leading proponents of quantum mechanics. He was not satisfied by the probabilistic interpretation of the same. The next article tells us the conversations he had with Werner Heisenberg, the ‘father’ of matrix mechanics.

The next article gives an account of historical deliberations that contributed in the development of quantum theory.

The climate of the earth – all over it - has been changing adversely ever since the Industrial Revolution in Europe. The next article, in Kannada, documents the evidence for it and the ill effects it is causing all over the globe

A summary of the academic activities of KPA members during the period February – April 2026 is documented next.

Lastly, a list of webinars held during February – April 2026 is presented in a tabular form.

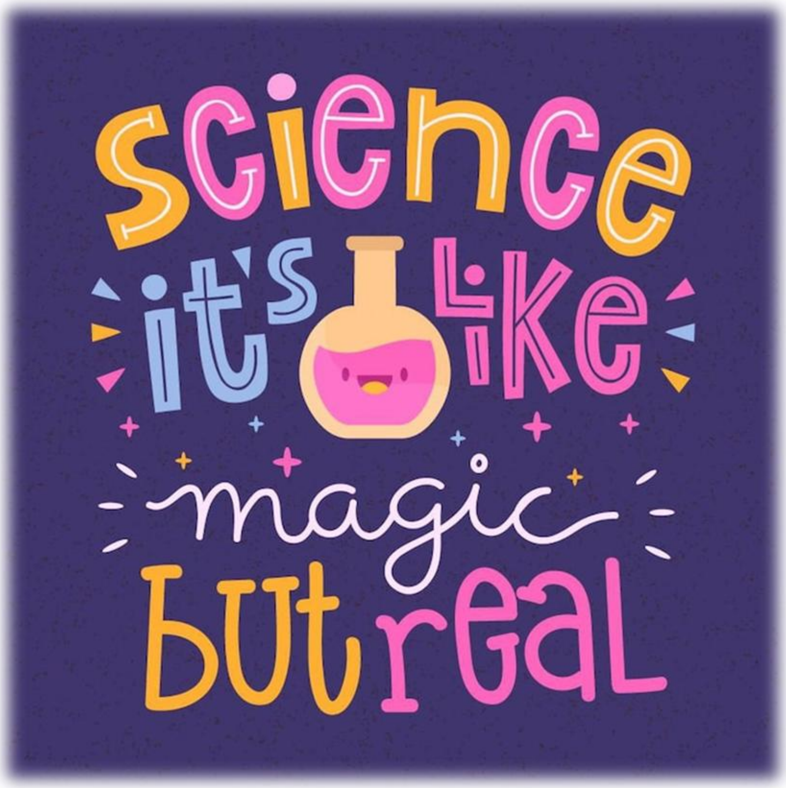
The editors thank the KPA members for their articles. We also thank the authors and publishers, whose open-source articles are included here for the benefit of our readers.

We wish to thank Dr Muktha B.Kagali for her editing and designing work for the newsletter, done free of charge for KPA at short notice.

We would like to hear from the readers about the various articles of this newsletter.

We appeal, once again, to KPA members as well as others to contribute write-ups for the next issue of the newsletter that is due to appear in August 2026.

Chief Editor



The National Science day is celebrated throughout India on 28th February every year. On this day in 1928, Sir. C.V.Raman discovered the 'Raman effect' and won the first Nobel Prize for India in 1930. C. V. Raman was the first `non-white', Asian and Indian to receive the Nobel Prize in physics for his work on the scattering of light and discovery of the Raman Effect.

Raman received the Nobel Prize in a record time of two years after his prize- winning discovery. Unlike other scientists, Raman was the only Indian scientist who pursued his research in India and won Nobel Prize. A lot of praise is showered on C.V. Raman on this day and our students are inspired for creative research in science. But unfortunately today our entire academic atmosphere lags behind in creativity in science. The objective of celebrating the National Science Day is to create an environment in which scientific creativity of students is identified and nurtured.

Science is nothing but a search for truth and beauty of nature. The discovery of Raman Effect had its origin in the wonderful blue colour of the Mediterranean sea. In 1921 C.V. Raman was nominated as one of the delegates to attend the Oxford University conference. While passing though the Mediterranean Sea, Raman was stuck by the deep blue appearance of its water. He conducted some basic experiments with the help of a Nicol prism and concluded that Rayleigh's explanation for the blue appearance of the sea water was inadequate. Rayleigh had thought that it may be due to reflection of light by sea water. Raman realized that the scattering and frequency shift of the light is due to molecules of sea water. There is an interaction between matter and radiation. Light consists of very tiny discrete particles called photons while the matter is made up of molecules and atoms. During the collision, the photon can give a part of the energy to the atom to raise it to a higher energy level thereby reducing its own frequency. On the other hand, if during a collision, the molecule is in excited state, it will give a part of its energy to the photon. The scattered photon will then have more energy, increasing its frequency. Thus in the spectrum of scattered light, the line spectrum is obtained on both sides of the line of the incident light; lower frequency lines are called Stokes lines and higher frequency lines are called Anti Stokes lines.

On a December evening in 1927, Raman was demonstrating his spectroscope to a visitor when a research student by name K.S. Krishnan entered the laboratory and said that A. H. Compton and C. T. R. Wilson received the 1927 Nobel Prize in physics for their work on scattering of x-rays. Raman told Krishnan that if Compton Effect is suitable for X-rays why it should not be suitable for sunlight. Raman performed series of experiments to verify what he thought. He found that when a beam of monochromatic light was passed through organic liquids such as benzene, toluene etc., and the scattered light contained other frequencies in addition to that of the incident light. This was a significant discovery by Raman which came to be known as ‘RAMAN EFFECT’.

The discovery of Raman Effect gave unprecedented powerful tool to understand molecular structure and bonding of several chemical compounds. The most surprising thing is that he made this discovery with equipment worth hardly two hundred rupees. He declared his discovery in the assembly of scientists at Bangalore on 16th March 1928. Raman’s discovery created new ripples in the world of science. Raman won the coveted Nobel Prize for his astounding discovery in the year 1930.

Apart from the Nobel Prize, Raman was honoured with a large number of honorary doctorates and memberships of scientific societies in India and in many renowned European universities. He was elected the fellow of Royal society in 1924 and was knighted in 1929. In 1958, he was awarded the Lenin Peace prize by the Soviet Union. He was made the National Professor of Physics in 1949 and in 1954 Raman was awarded ‘Bharat Ratna’.

Born on November 7, 1888, near Trichy in Tamil Nadu, Raman showed extraordinary intellectual abilities at an early age. He graduated from Presidency College, Chennai in 1904 winning first place and a gold medal in physics. His post-graduation was in physics and obtained the degree in 1907 at the tender age of 19, with the highest distinction. In 1933, Raman left Kolkata and shifted to Indian Institute of Science, Bangalore to become its first Director. His remarkable achievements brought international recognition and glory to Indian science. In 1934, he founded the Indian Academy of sciences in Bangalore and remained its president till his end. He built his own Raman Research Institute with Vikram Sarabhai and Homi Babha as his bright young colleagues. All in all, he published 475 papers and wrote five monographs on an incredibly wide range of topics. Raman strived hard for science development and delivered popular discourses on science in various institutions.

During the Nobel Prize receiving ceremony on 10th Dec 1930, he delivered lecture on the renunciation of Buddha and Mahatma Gandhi. During the function he declined to have an alcohol as he was a teetotaller. Many scientists requested him to show them ‘effect of alcohol on Raman’ and he politely said, I will gladly demonstrate all of you the Raman effect of alcohol in my laboratory but please release me from obligation to demonstrate the effect, he is known to have said.

Even when he was about to be pushing up daisies on 21st Nov 1970, he was found to be reading a book on science.

National science day is celebrated to commemorate the remarkable contribution of Raman to the field of science. Let’s make our resounding slogan as **‘Science for the progress of India, Science for the enhancement of human mind, Science for the walking on the path of progress and Science for the benefits of mankind’**. Otherwise merely celebrating

National science day would only be a formality and will never serve any National purpose. And to achieve this, India needs an innovation culture and India needs more persons like Raman.

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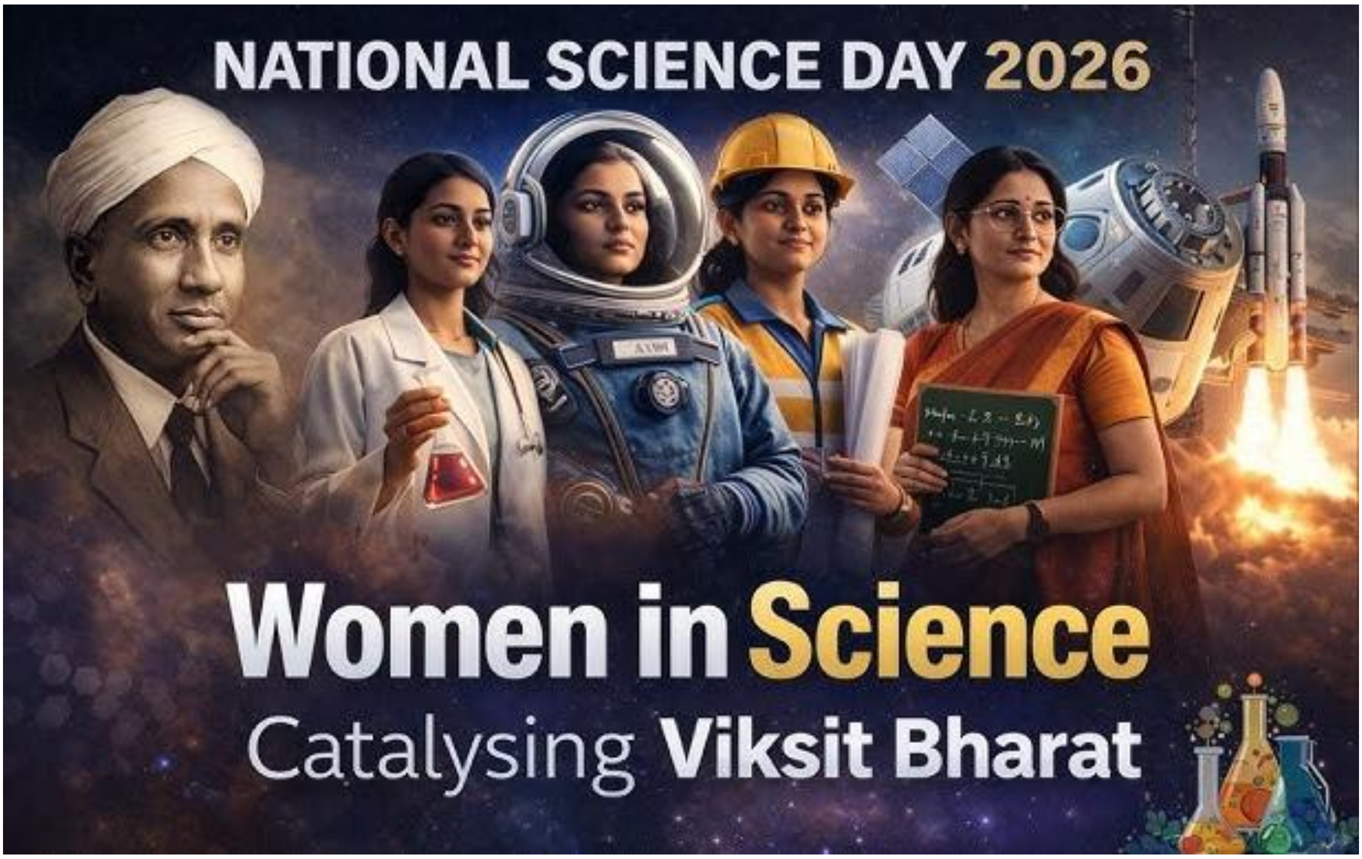

Hamilton's 19th-century insight connecting light and motion became a cornerstone of quantum mechanics and modern physics.

William Rowan Hamilton, the Irish mathematician and physicist born 220 years ago last month, is often remembered for an unusual act in 1843, when he carved a mathematical formula into the stone of Dublin's Broome Bridge.

During his own lifetime, however, Hamilton's standing rested on breakthroughs he made much earlier, in the 1820s and early 1830s, while he was still in his twenties. In that period, he introduced powerful new mathematical methods for analyzing the paths of light rays (or "geometric optics") and describing how physical objects move ("mechanics").

An intriguing feature of Hamilton's work was his use of an analogy between the trajectory of a light ray and the motion of a material particle. That comparison made sense if light were composed of particles, as Isaac Newton had argued. But it raised a deeper question if light behaved instead like a wave: why should the mathematics of waves and particles resemble one another at all?

The significance of this question would only become clear a hundred years later. As quantum mechanics emerged in the early twentieth century, physicists recognized that Hamilton's framework was not merely a clever analogy, but an early window into the fundamental structure of the physical world.

The puzzle of light

To understand Hamilton's place in this story, we need to go back a little further. For ordinary objects or particles, the basic laws (or equations) of motion were published by Newton in 1687. Over the next 150 years, researchers such as Leonard Euler, Joseph-Louis Lagrange, and then Hamilton made more flexible and sophisticated versions of Newton's ideas.

"Hamiltonian mechanics" proved so useful that it wasn't until 1925 – almost 100 years later – that anybody stopped to revisit how Hamilton had derived it.

His analogy with light paths worked regardless of light's true nature, but at the time, there was good evidence that light was a wave. In 1801, British scientist Thomas Young performed his famous double-slit experiment, in which two light beams produced an "interference" pattern like the overlapping ripples on a pond when two stones are dropped in.

Six decades later, James Clerk Maxwell realised light behaved like a rippling wave in the electromagnetic field.

But then, in 1905, Albert Einstein showed some of light's properties could only be explained if light could also behave as a stream of particle-like "photons" (as they were later dubbed). He linked this idea to a suggestion made by Max Planck in 1900, that atoms could only emit or absorb energy in discrete lumps.

Energy, frequency, and mass

In his 1905 paper on the photoelectric effect, where light dislodges electrons from certain metals, Einstein used Planck's formula for these energy lumps (or quanta): $E = h\nu$. E is the amount of energy, ν (the Greek letter nu) is the photon's frequency, and h is a number called Planck's constant.

But in another paper the same year, Einstein introduced a different formula for the energy of a particle: a version of the now-famous $E = mc^2$. E is again the energy, m is the mass of the particle, and c is the speed of light.

So here were two ways of calculating energy: one, associated with light, depended on the light's frequency (a quantity connected with oscillations or waves); the other, associated with material particles, depended on mass.

Did this suggest a deeper connection between matter and light?

This thread was picked up in 1924 by Louis de Broglie, who proposed that matter, like light, could behave as both a wave and a particle. Subsequent experiments would prove him right, but it was already clear that quantum particles, such as electrons and protons, played by very different rules from everyday objects.

A new kind of mechanics was needed: a "quantum mechanics."

The wave equation

The year 1925 ushered in not one but two new theories. First was "matrix mechanics", initiated by Werner Heisenberg and developed by Max Born, Paul Dirac, and others. A few months later, Erwin Schrödinger began work on "wave mechanics". Which brings us back to Hamilton.

Schrödinger was struck by Hamilton's analogy between optics and mechanics. With a leap of imagination and much careful thought, he was able to combine de Broglie's ideas and Hamilton's equations for a material particle, to produce a "wave equation" for the particle. An ordinary wave equation shows how a "wave function" varies through time and space. For sound waves, for example, the wave equation shows the displacement of air, due to changes in pressure, in different places over time.

But with Schrödinger's wave function, it was not clear exactly what was waving. Indeed, whether it represents a physical wave or merely a mathematical convenience is still controversial.

Waves and particles

Nonetheless, the wave-particle duality is at the heart of quantum mechanics, which underpins so much of our modern technology – from computer chips to lasers and fibre-optic communication, from solar cells to MRI scanners, electron microscopes, the atomic clocks used in GPS, and much more.

Indeed, whatever it is that is waving, Schrödinger's equation can be used to predict accurately the chance of observing a particle – such as an electron in an atom – at a given time and place.

That's another strange thing about the quantum world: it is probabilistic, so you can't pin these ever-oscillating electrons down to a definite location in advance, the way the equations of "classical" physics do for everyday particles such as cricket balls and communications satellites.

Schrödinger's wave equation enabled the first correct analysis of the hydrogen atom, which only has a single electron. In particular, it explained why an atom's electrons can only occupy specific (quantised) energy levels.

It was eventually shown that Schrödinger's quantum waves and Heisenberg's quantum matrices were equivalent in almost all situations. Heisenberg, too, had used Hamiltonian mechanics as a guide.

Today, quantum equations are still often written in terms of their total energy – a quantity called the "Hamiltonian", based on Hamilton's expression for the energy of a mechanical system.

Hamilton had hoped the mechanics he developed by analogy with light rays would prove widely applicable. But he surely never imagined how prescient his analogy would be in our understanding of the quantum world.

Reference

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In eighteen ninety-nine, a question stood in silence,
The radiation from a Black Body, filled with colours of defiance.

But who was responsible for those hues so bright?
Rayleigh-Jeans said, "Energy will flow with all its might."

In shorter wavelengths, it would rise without a bound,
The 'Ultraviolet Catastrophe' was the conclusion they found.

Then in nineteen hundred, Max Planck broke the ancient chain,
"Energy is shared in packets," he explained the grain.

His theory gave birth to a subject vast and deep,
'$E = h\nu$' was written, a new horizon to keep.

The first dawn of the Quantum world began to glow,
Einstein called the particle 'Photon', making the light-stream flow.

When electrons broke free from metal, the photoelectric effect was born,
Wave or Particle? Like a human, between two natures is torn.

"I am both at once," Light whispered with a smile,
The secret of the Double-Slit, hidden all the while.

Until observed, it refuses to choose a single way,
But under a watchful eye, the particle comes to play.

De Broglie then spoke, "Matter, too, must wave and dance,"
The electron spun like a ring, putting everyone in a trance.

The Davisson-Germer test gave the proof we sought,
As electrons hit the crystal, a wave-like pattern was caught.

You, I, every particle, and every stone we see,
'$\lambda = h/p$' – the wave dwells inside you and me.

Then Heisenberg drew a line, a limit to our sight,
"Position and momentum cannot be seen together in the light."

Delta x. Delta p is greater than h.cross/2, the math of the unknown,
Uncertainty, a companion since childhood, had grown.

Bohr said the universe holds a secret, deep and rare,
"Complementarity is the essence," at the atomic fair.

Schrödinger gave the wave a form, the symbol (Psi),
As Psi became the dancer, in Hilbert Space she'd fly.

Then Born crafted a rule, a law of chance and fate,
Psi^2 gave the probability of the particle's state.

A cat in a box, both dead and alive in a rhythmic loop,
Until you look, it stays in probability's soup.

Superposition is strange, yet a truth we can't deny,
In our phones and GPS, its hidden powers lie.

Entanglement arose, the EPR paradox in view,
Two particles, however distant, share a message true.

John Stewart Bell said, "Test the locality of the soul,"
When Alan Aspect tested, he saw the quantum whole.

Now in entangled particles, the deepest secrets reside,
Teleportation and secure keys, with nowhere left to hide.

Electrons don't orbit like planets in a line,
They dwell like clouds, in orbitals by design.

s, p, d, f – the shapes that Pauli did define,
"No two in one state," he drew a boundary line.

Like two sharp swords that in one sheath cannot stay,
Hund, Aufbau, and the Periodic Table led the way.

Quantum information turned bits into Qubits,
On the Bloch Sphere, 0 and 1 dance in perfect fits.

Quantum processing, computing's new design,
Changing the ways of life, refining every line.

The eye, a natural sensor, a wonder to behold,
The Rod cells whisper, "I know the stories light has told."

Catching even a single photon in the dark of night,
Perhaps even thoughts are ions, flashing with quantum light.

In the micro-tubules, the quantum pulse we find,
We laugh, we cry, we learn, leaving failures behind.

Quantum is in every breath, in every beat we take,
From Planck's tiny 'h' to the qubits that we make.

From chemical bonds to the structures of the soul,
The Quantum world is now our life, the part and the whole.

Not certainty, but probability is the law the cosmos keeps,
Life is uncertain, and that's why its beauty runs deep.

To every particle, every wave, every cycle we see,
To the Quantum world, we bow in gratitude and glee.

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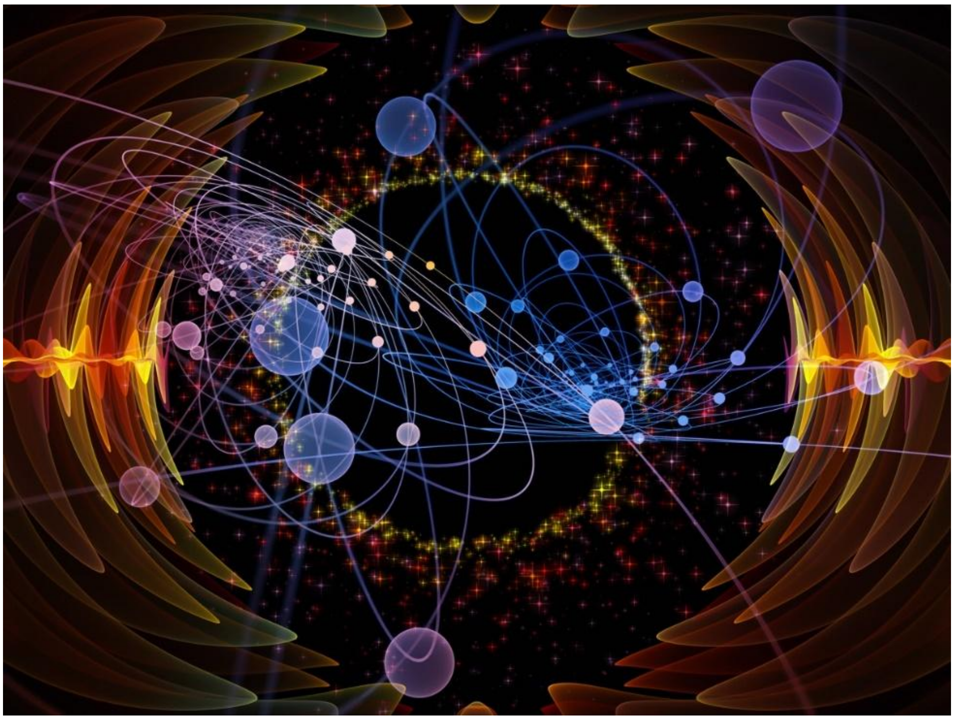


The Quantum World

Quantum computing has long felt like a perpetual promise — a mysteriously powerful technology that's always "about 10 years away." If you tuned it out, you weren't alone.

But something has shifted recently. Researchers are now talking years, not decades.

Yes, it's still early. Quantum systems are still fragile, complex and mostly confined to labs, which is why classical computers are still the more reliable workhorses. But quantum development has crossed a threshold where progress feels tangible, not theoretical.

This is the moment when you'll start hearing more about the concepts — and the vocabulary — because they'll start shaping things like how scientists simulate molecular behavior, explore new materials that could lead to longer-lasting batteries or cleaner chemicals, and grapple with other complex problems that could take today's computers millions of years to solve.

As the impact of quantum computing moves beyond research settings, so will its notoriously hard-to-grasp terminology. Here's a guide to help you understand the key ideas behind this emerging technology.

1. Quantum: more than its parts

Have you ever seen a flash mob, when a group of people suddenly break into a synchronized dance routine?

From a distance, you don't really notice individual dancers. What you see is everyone moving together — twirling and dipping as one in a wave of motion where each person's steps depend on those around them and only have impact as part of a larger pattern. Together, they create something no single dancer could pull off alone.

That's a useful way to think about quantum behavior. The word "quantum" refers to nature at its smallest scales, where atoms and electrons produce effects by behaving more like a coordinated group than like separate, independent objects.

The term shows up in many fields — quantum physics, quantum mechanics, quantum computing and so on — because they're all focused on that zoomed-in level, where the outcome can depend on how the pieces relate to one another. Quantumcomputingis an approach that harnesses those group behaviors to process information in new ways.

2. Qubits: the individual players

A qubit is the basic unit of information in a quantum computer — like one dancer in a flash mob.

In everyday computing, information is stored in bits, which behave as switches: 1 or 0, on or off. They're like individual dancers being told, "You always stand still" or "You always take one step" — one clear instruction and decision at a time. Computers work by stringing vast numbers of those bits together into patterns that represent data and instructions.

A qubitbehaves differently. It's a dancer trained for many moves — ready to stand, step or even jump depending on the cues from the troupe, and able to change as the routine unfolds. A qubit's power comes from how it works in concert with others, as part of a coordinated system.

Companies build qubits in different ways, using technologies ranging from tiny electrical circuits to individual atoms or particles of light. Some are about a centimeter across; others are so small that a million could fit on a chip smaller than your palm.

3. Superposition: holding options open

One of the reasons quantum computers are unique is how they approach problems. Instead of being stuck on a single step-by-step path like a classical computer, they stay flexible — able to explore many possibilities at once before settling into a final result.

That's called "superposition."

Shielded from noise, heat, vibration and the like, qubits can remain in this in-between state, where they haven't been forced to choose a direction yet and multiple outcomes are still possible — that is, until they're measured.

It's like a coin spinning inside a box. While it's spinning, the coin is neither heads nor tails and is open to either option, but the disruption of opening the box to check on it forces it to land on one side or the other, choosing a single outcome.

Superpositionlets quantum systems explore many possible paths at the same time — spinning long enough for the computation to run and be shaped toward a more useful answer.

4. Interference: amplifying what matters

In everyday language, interference means getting in the way. In quantum computing, it means something more useful.

When qubits are in superposition, a quantum computer is keeping track of many possible ways a calculation could unfold. Interferencedescribes how those possibilities combine. Some line up and reinforce each other, making certain outcomes more likely. Others cancel out, making those outcomes less likely.

It's like headphones that suppress sounds that don't match the pattern of a voice, which amplifies the tones you're actually trying to hear.

This is especially powerful for simulating nature, because molecules and materials follow the same rules — remember that "quantum" describes how nature behaves at its smallest scales, depending on how particles combine and cancel at the atomic level.

Classical computers have to approximate this behavior with painstaking, lengthy, linear decision trees. That's why interference matters: by using it to make patterns stand out, quantum computers will be able to help researchers predict how a molecule will behave or explore new materials — guiding smarter research decisions in the lab.

5. Entanglement: qubits in relationships

In classical computing, information lives in individual bits. In quantum computing, something called entanglementallows information to live in the relationships between qubits. Instead of working with isolated on or off switches, a quantum computer works with linked choices.

Real-world problems are often relationship problems — like finding a schedule or route where many factors must fit together. Classical computers test possibilities step by step, whereas entanglement lets a quantum computer consider multiple connected options at once, allowing combinations that fit together to become more likely while incompatible ones fade.

But — and this enters the realmofsci-fi— entangled qubits don't have to be physically intertwined. They're set up through a shared interaction that creates a state where you can't describe one without the other — like a pair of gloves, where knowing one is left tells you the other is right. Once joined, the relationship persists even if the qubits are far apart.

6. Gates: giving qubits their cues

Qubits are inherently delicate and dynamic. They don't naturally hold steady in neat, fixed states like bits do. To harness their behavior into a useful, repeatable calculation, a quantum computer needs a precise way to control how qubits change and interact. That's where gates come in.

A quantum gateis a controlled operation that changes a qubit's state or coordinates multiple qubits. Gates are the instructions that build a quantum program. A developer or researcher writes a program in terms of gates, and the machine carries out those actions using precise pulses of energy — often electromagnetic signals — that make qubits act in specific ways.

Developers sometimes write those directions as a kind of musical score, with horizontal lines for qubits and symbols marking when gates act — more like sheet music than traditional code. Without those cues, you don't get a performance. You get a cacophony.

Gates are what turn quantum behaviour into computation.

7. Error correction: keeping it together

Quantum systems are powerful, but they're also fragile.

Qubits are extremely sensitive to their surroundings, and tiny disturbances — a bit of heat, vibration, a stray electromagnetic signal — can knock them off course and scramble the patterns a quantum computer is trying to build. Researchers can even lose qubits entirely, as particles drift or disappear.

That's why so much effort goes into shielding and cooling quantum systems — and why errorcorrectionis needed, too, where information is spread across a group of qubits so an error in one doesn't derail the whole computation.

Back to dancing: It's like building a group routine with enough spacing that one dancer's stumble doesn't ripple through and ruin the performance. The formation absorbs the wobble without the whole sequence coming apart.

That matters because you can't correct qubits the way computers can detect a corrupted file, since any attempt to read a qubit will disturb it. An error correction system provides a way for quantum computers to hold it together long enough to actually finish a calculation.

8. Fault tolerance: staying on track

Quantum error correction is a toolkit. Fault-tolerant quantum computing is the stage you reach when that toolkit works well enough that the computer can run long computations reliably, even if small errors are happening along the way.

In other words, faulttolerancedoesn't mean "no mistakes." It means the system is built so those mistakes don't snowball. Errors get detected and corrected fast enough that the overall calculation stays on track.

Many of the complicated problems people hope quantum computers can eventually tackle require running a lot of operations in sequence — like simulating chemical reactions or how a new material might behave under different conditions. Each operation is another opportunity for small errors to creep in, which makes long computations especially demanding.

Without fault tolerance, the fragile quantum state tends to drift or collapse before the computation finishes. With fault tolerance, the system absorbs mistakes and keeps going on a path to running deeper, more useful algorithms.

9. Logical qubits: going the distance

The hard part isn't keeping qubits stable for a moment; it's showing they can perform a real computation while errors are being detected and corrected along the way. When that happens — when a group of qubits can carry out a calculation together — the system has crossed into the territory of logicalqubits. The key difference is that a logical qubit isn't just kept intact; it can stay stable throughout the computation.

Think of it like a coordinated performance. Mistakes are handled without stopping the show. From across the dance floor, you can see whether the dancers generally stay synchronized through to the end, even if someone is slightly off at some point. The troupe is performing the routine better than one dancer alone ever could.

When researchers talk about logical qubits, they're talking about a real milestone: demonstrating that quantum error correction and fault tolerance work well enough to support useful computations. It's the point where quantum hardware stops falling apart mid-calculation and starts behaving like a machine you can build on.

10. Topological qubits: stability by design

Much of today's quantum work focuses on fixing errors after they happen. There's a hardware approach, too: topological qubits, designed to be less sensitive to begin with.

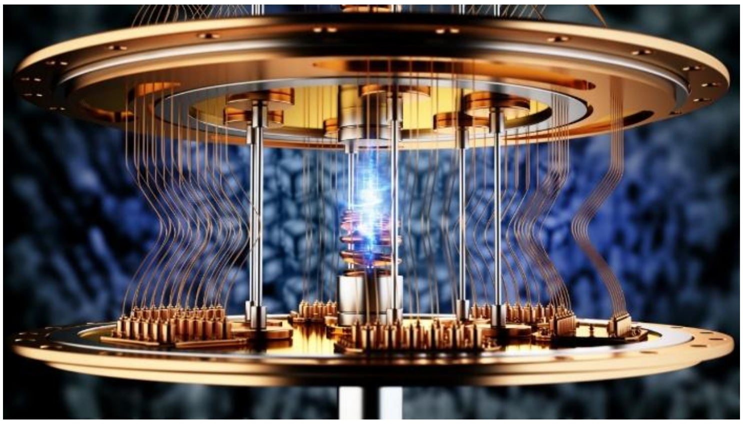
Topology is the math of shapes and connections, and in a topological qubit, information is spread across a system rather than stored in one easily disturbed particle — making qubits naturally more stable and harder to disrupt.

This is where Majorana1comes in. Named after Italian physicist Ettore Majorana, it's Microsoft's experimental quantum chip built to explore that idea — a research bet that stability can be built into the hardware itself, rather than relying solely on error-correction software. It's less about resolving missteps and more about designing the stage so bumps don't derail the performance in the first place.

There is more work to be done, but the goal is to make large quantum systems easier to control, using built-in protection to support machines robust enough to tackle the world's most complex problems.

Author: Susanna Ray

writes about AI and technology, with stories that show its real world impact and examine how innovation is reshaping work, business and society.



(A Quantum Computer)

The United Nation has declared 2025 as the International Year of Quantum Science and Technology (IYQ) to boost research and development in the emerging area.

Recognition of 100 years of Quantum Mechanics: The year 2025 was chosen as International Year as it recognizes 100 years since the initial development of quantum mechanics.

Matrix Mechanics: It marks 100 years since theoretical physicists Werner Heisenberg, Max Born and Pascual Jordan developed matrix mechanics, the first formulation to express quantum physics in mathematical form.

Schrödinger wave Equation: The year 2025 also marks 100 years, since Erwin Schrödinger postulated the Schrödinger equation that governs the wave function of a quantum-mechanical system – a landmark moment in quantum mechanics that proved to be seminal to the field. Werner Heisenberg, Max Born and Erwin Schrödinger all the three won Nobel Prizes in Physics for their contribution to the development of Quantum Mechanics.

Interdisciplinary Field: The Quantum Science and Technology is an interdisciplinary field that harnesses the principles of quantum mechanics to develop new technologies with potentially transformative capabilities.

Quantum Computing: It is a multidisciplinary field comprising aspects of computer science, physics, and mathematics that utilizes quantum mechanics to solve complex problems faster than on Classical Computers.

Fundamentals of Quantum Computing: There are four fundamentals of quantum computing – Qubit, Quantum Superposition, Quantum Entanglement and Quantum Decoherence.

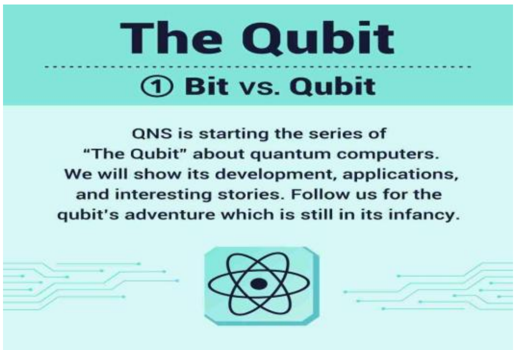
Quantum Superposition: It is the ability of a particle to hold two "states" at the same time. It is a fundamental principle where a quantum system can exist in multiple states simultaneously.

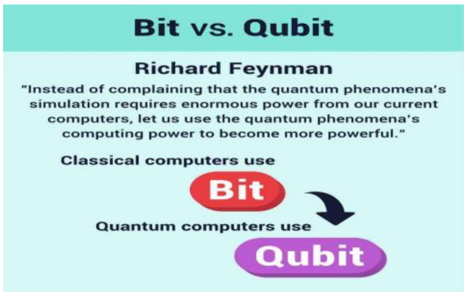
Quantum Entanglement: Quantum entanglement is the phenomenon wherein the quantum state of each particle in a group cannot be described independently of the state of the others, even when the particles are separated by a large distance. The topic of quantum entanglement is at the heart of the disparity between Classical physics and Quantum physics: Quantum Entanglement is a primary feature of quantum mechanics not present in classical mechanics. Quantum computing uses both of these principles — Quantum Superposition and Quantum Entanglement to solve certain types of problems much faster than Classical Computers, particularly for complex simulations, optimization, cryptography, and searching large databases. Quantum entanglement happens because quantum objects or particles exist in superpositions of states. When particles are occupying the same space, impact each other, or are the result of the same event, they are entangled. If particles existing in superpositions are entangled, then observing the state of one particle (and collapsing its superposition) reveals the state of the other particle(s).

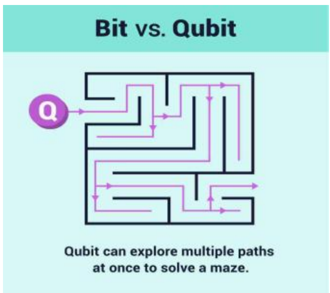
Qubit or Quantum Bit: It is the fundamental unit of information in quantum computing, representing a two-level quantum system. Unlike classical bits that are restricted to 0 or 1, qubits utilize quantum mechanics to exist in a superposition of both states simultaneously. This allows them to process complex, multi-state information exponentially faster. A major difference between Classical bits and Qubits lies in the processing power inherent for the latter case, whereas Classical bits can only represent one state at a time, Qubits can exploit the richness of Quantum mechanics to process a multitude of information simultaneously, offering revolutionary prospects for solving complex problems and simulating quantum phenomena. These intriguing properties of Qubits pave the way for a new era in quantum computing, promising significant advances in fields ranging from cryptography to sensing. Unlike the classical bits we use in conventional computers, which can only exist in a binary state of 0 OR 1 at a given moment, Qubits can simultaneously occupy states of 0, 1, or even a combination of the two, thanks to a quantum phenomenon known as Quantum Superposition. This unique property of Quantum Superposition allows Qubits to perform parallel calculations, offering revolutionary potential for Quantum Computing applications. In addition to Quantum Superposition, Qubits have another essential characteristic called Quantum Entanglement, which creates a quantum correlation between Qubits, even if they are separated by large distances.

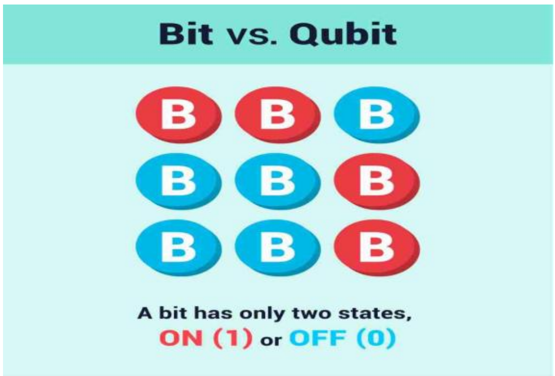
Quantum Decoherence: It is a process by which the quantum interference between the superposed states of a system is gradually lost as a result of its interaction with the external environment.

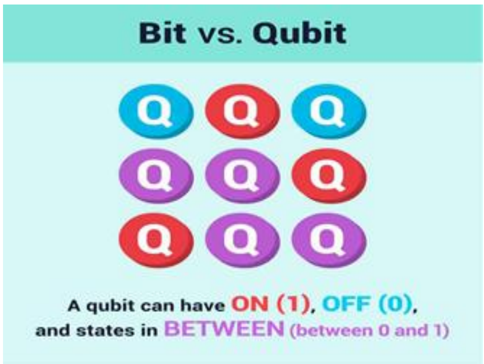
Episode 1: Illustration of Bit vs Qubit

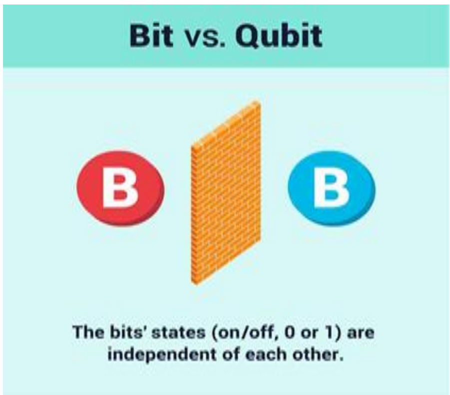


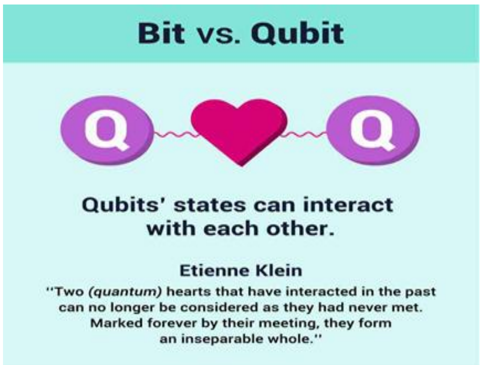


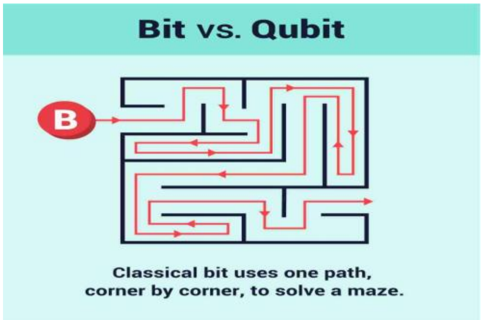












Courtesy: Dr. Massine Kelai, Center for Quantum Nanoscience (QNS))

Episode 2: Ilustratration of Schrödinger's cat representing Quantum Superposition

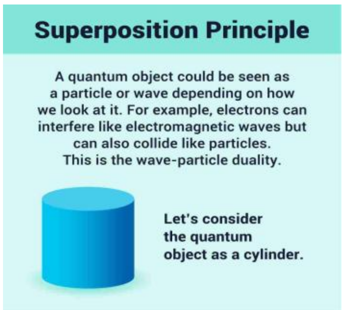
Erwin Schrödinger's famous thought experiment sheds light on Quantum Superposition represented by Schrödinger's cat. The scenario unfolds in a hypothetical setup featuring a sealed box containing a cat, a vial of poison, a Geiger counter (radiation detector) and a radioactive atom. According to the principles of Quantum mechanics, the atom can exist in a superposition state, simultaneously undergoing decay and remaining intact. If the atom decays, the Geiger counter detects the decay, triggering the mechanism that releases the poison into the box, killing the cat. If the atom does not decay, the poison is not released, and the cat stays alive. Consequently, until the atom's state is measured, the cat exists in a superposition, simultaneously alive and dead.

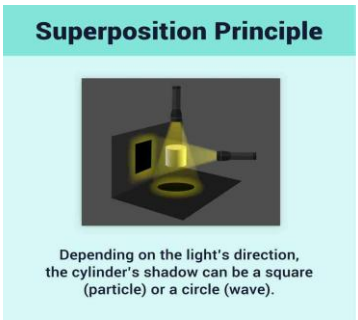
(**Courtesy:** Dr. Massine Kelai, Center for Quantum Nanoscience)

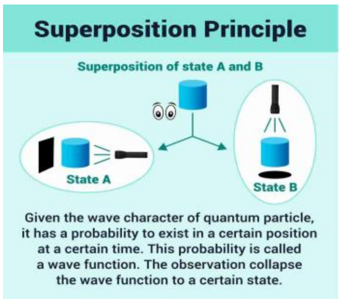
Episode 3 : Illustration of Superposition principle and Quantum Decoherence

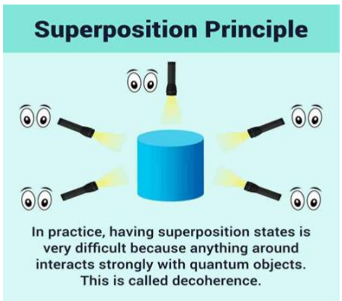
Louis de Broglie demonstrated that quantum entities (electrons, photons, neutrons, etc.) can manifest both wave and particle properties, depending on the experimental context. For instance, electrons can interfere like electromagnetic or sound waves (e.g., Young's slit) but can also collide (e.g., Compton effect, photoelectric effect). Given the wave character of quantum particles, they are then described by probability amplitudes with a certain spatial and temporal extensions; this is called the wave function.

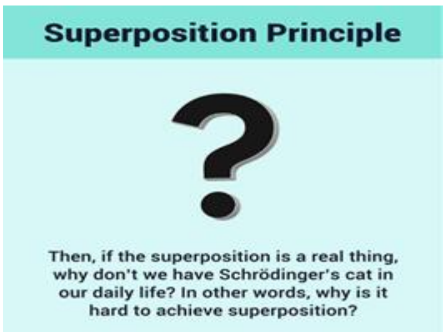
Coming back to the *Schrödinger's cat paradox* (see previous Episode 2), the radioactive atom inside the box and Schrödinger's cat states can be described as a distribution of probability amplitudes. Thus, Quantum Superposition allows the atom to explore several states simultaneously, opening up the possibility of the cat being both alive and dead until the state is observed. However, the *Quantum Decoherence* comes into play in this context. In the case of Schrödinger's cat, interactions with the outside world, such as air particles or light, can lead to the *loss of Quantum Superposition*, forcing the system to adopt a *specific state.*

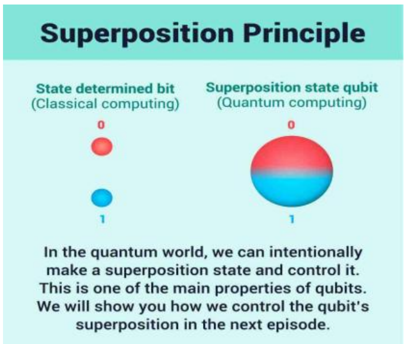








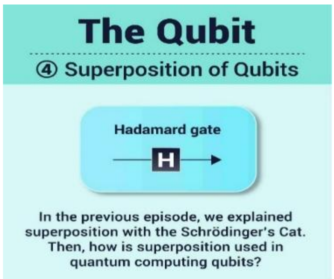


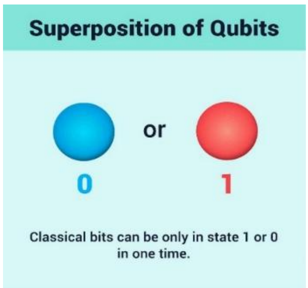


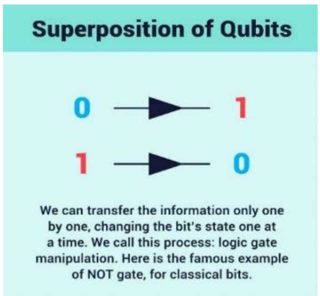
(**Courtesy**: Dr. Massine Kelai, Center for Quantum Nanoscience)

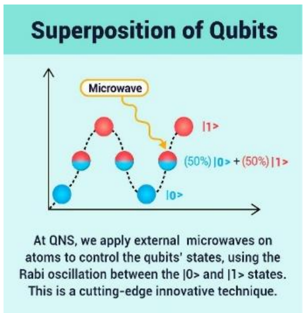
Episode 4: Illustration of Superposition of Qubits

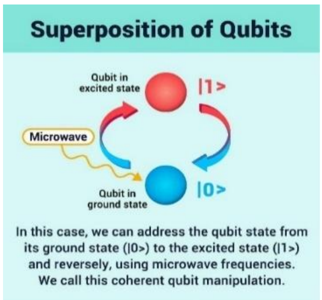
Qubits are sensitive to radio-frequency pulses that can cause them to oscillate coherently between 0 and 1 states, this effect is the so-called *Rabi effect*. Quantum logic gates play a fundamental role in carrying out operations on Qubits, equivalent to classical logic gates in conventional Classical Computers. The *Hadamard gate*, for example, is crucial for creating superpositions. By applying a Hadamard gate to a qubit initially in the $|0\rangle$ state, we obtain an equal superposition of $|0\rangle$ and $|1\rangle$, paving the way for simultaneous exploration of both states. The *CNOT (Controlled-NOT) gate* couples two Qubits. It acts in such a way as to invert the state of the target qubit (the "NOT") only if the control Qubit is in the $|1\rangle$ state. This operation is fundamental to the creation of quantum interleaving and , implementation of many quantum algorithms and development of Quantum Computing with the potential to solve complex problems exponentially faster than current Classical Computers.

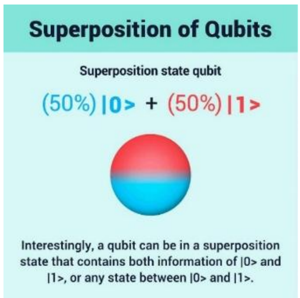


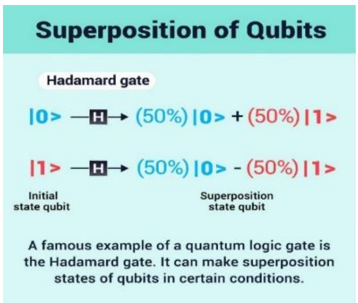






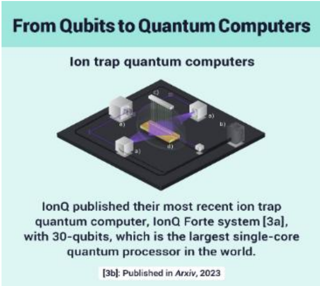


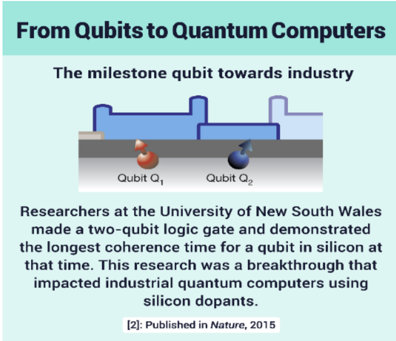


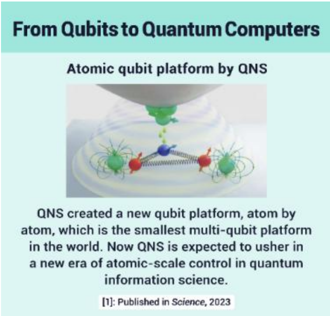


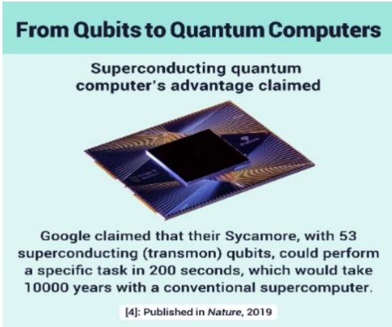
(**Courtesy:** Dr. Massine Kelai, Center for Quantum Nanoscience)

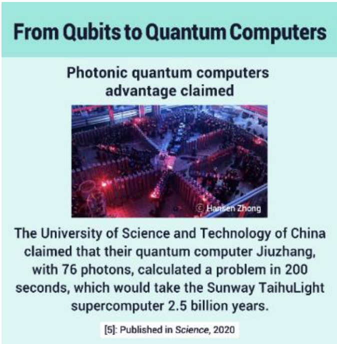
Episode 5: Illustration from Qubits to Quantum Computers

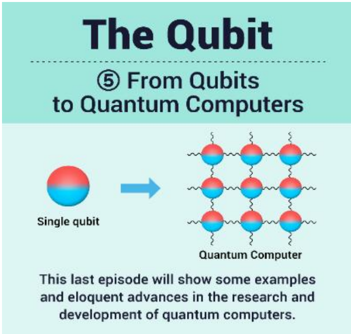


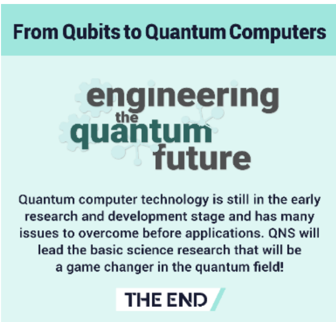


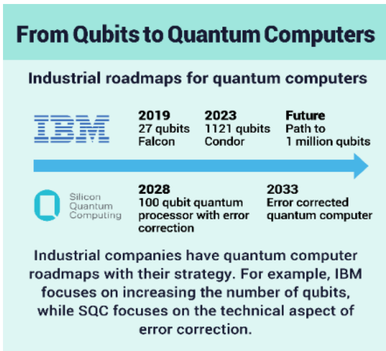










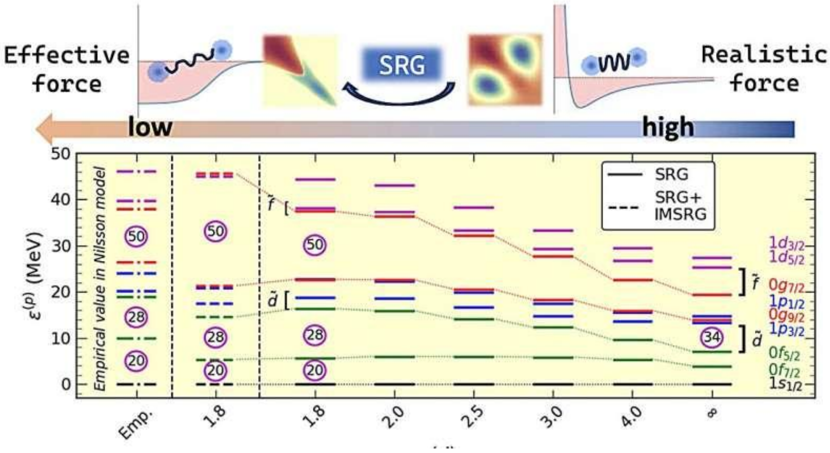


(**Courtesy**: Dr. Massine Kelai, Center for Quantum Nanoscience)

Author: Dr. Rudraswamy B.
Professor (retired), Dept. of Physics, Bangalore University

For the first time, physicists have developed a model that explains the origins of unusually stable magic nuclei based directly on the interactions between their protons and neutrons. Published in *Physical Review Letters*, the research could help scientists better understand the exotic properties of heavy atomic nuclei and the fundamental forces that hold them together.

While every chemical element is defined by a fixed number of protons in its atomic nucleus, the number of neutrons it contains is far less constrained. For almost every known element, there are at least two different nuclear configurations, or isotopes, which vary only in their number of neutrons.



However, if the number of protons and neutrons becomes too unbalanced in either direction, the nucleus becomes unstable. Since heavier elements tend to have fewer stable isotopes, these radioactive nuclei grow increasingly rare as this imbalance increases. Yet for certain specific numbers of protons and neutrons (collectively known as "nucleons"), some isotopes are found to be exceptionally stable, for reasons that physicists have struggled to fully explain.

The nuclear shell model and its limits

These unusually robust isotopes, known as "magic nuclei," are often described using the nuclear shell model. Much like the electron shell model used in atomic physics, this framework treats nucleons as occupying discrete energy levels, with transitions between levels accompanied by the absorption or emission of energy.

Despite its success in predicting which combinations of protons and neutrons give rise to magic nuclei, the shell model does not fully reflect the underlying physics of real atomic nuclei.

In particular, it can't explicitly account for the strong nuclear force—the powerful, short-range interaction that binds nucleons together, and allows positively charged protons to coexist within the same nucleus without flying apart. Capturing this force while still explaining the origins of magic numbers has long posed a major challenge for nuclear theorists.

In their study, researchers led by Chenrong Ding at Sun Yat-sen University approached this problem by revisiting a fundamental principle of quantum mechanics: the state of a system cannot be observed without altering it. As a result, physicists describe quantum systems using wave functions, which encode the range of possible states a system can occupy and the probability of each.

Wave functions reveal shell structure naturally

In atomic nuclei, neither the energy levels of individual nucleons nor the detailed interactions between pairs of nucleons can be observed directly. Instead, these features are captured collectively within a wave function describing the entire nucleus: one that can include strong interactions between pairs, and even trios, of nucleons.

To test their approach, Ding and colleagues focused on tin-132, a particularly stable isotope containing 50 protons and 82 neutrons. When they examined the nucleus's wave function at a lower resolution (emphasizing the collective behaviour of its interacting nucleons), they found that the familiar energy-level pattern of the nuclear shell model emerged naturally from the underlying proton–neutron interactions. Just as the shell model predicts, the magic numbers of protons and neutrons remained unchanged.

Linking nuclear models and future prospects

For the first time, the team's results bridge a long-standing gap between two major approaches to nuclear theory: phenomenological models that successfully describe nuclear behaviour, and first-principles methods that aim to derive that behaviour from fundamental forces.

Building on this success, Ding and her collaborators hope their framework will allow physicists to explore the poorly understood edges of the nuclear chart, ultimately shedding new light on the still-enigmatic properties of the heaviest and most exotic nuclei.

Reference:

C. R. Ding et al, From Spin to Pseudospin Symmetry: The Origin of Magic Numbers in Nuclear Structure, *Physical Review Letters* (2026).

Author: Sam Jarman, edited by Sadie Harley, and fact-checked and reviewed by Robert Egan

Reversing the flow of knowledge – so students, rather than established professors, drive enquiry – could help the next generation of scholars prepare society, and themselves, for the future, writes Robert Gibbs.

The goal of education at a research university is hotly debated right now, provoked by a growing concern that students are not learning what is most needed for the future. Learning the logic of enquiry should be at the centre of university education – for the rigour and the creativity it brings to discern new knowledge, invention and shaping what does not yet exist. By focusing on new ideas, we can change how we think about research universities and help guide changes now under way. Enquiry is the central idea, contrasting with the ideas of knowledge as settled and of critique, which unsettles that established knowledge.

Traditionally, the research enterprise flows downward, directed by senior faculty through postgraduates to undergraduates. I propose turning the university upside down, allowing enquiry to arise from the next generation – from students who bring passion and interest in the future. To do this, we must cultivate their curiosity, attend to the questions they bring to campus and teach them different ways of seeking new knowledge. Given the tens of thousands of undergraduates at major research universities, we must shift from replicating a small-scale research professoriate to multiplying the cohort of people who will engage in research in many contexts.

As inaugural director of the Jackman Humanities Institute at the University of Toronto, I was strongly encouraged by the dean of the Faculty of Arts and Science (a physicist) and the university's president (a public health doctor) to include undergraduates in our programmes. We created four stages of fellows: professors, postdoctoral fellows, PhD students and undergraduate students. Each undergraduate was supervised by a professor, often across disciplines. Unlike PhD students and postdocs, undergraduates had not yet been trained to ignore extra-disciplinary issues or research methods. Their flexibility and openness led to the greatest insight and creativity in research.

• What established academics can learn from ECRs
• How teachers can learn to lead
• Two ways to teach undergraduate students research skills

"I've had a real education," one undergraduate told me at the end of her first year. At first, she said, she felt intimidated and unprepared to comment on other fellows' presentations; she could only listen. But the mixed-generation environment showed her how to engage in discussion and raise questions based on her own perspective and research. She later learned how to make the best kind of comments, to ask questions that would help the presenter develop their work. In one year, she progressed from listening and absorbing information to critical questioning and genuinely collaborative enquiry.

But such research environments raise a serious question about how best to leverage the scale of large research universities. Instead of following an idea of replication where only a few promising undergraduates go on to become PhD students and perhaps professors, we must focus on the vast number of undergraduates who also can learn to do research, a skill they will bring into many sectors, such as medicine, IT, museums, government, NGOs, finance and politics.

To do this, PhD students should learn to conduct research by teaching the skills to undergraduate students. Instead of the professor presiding over a research team – as the only one who can truly create new knowledge – the professor should teach others how to teach and how to enquire into new knowledge. This idea of multiplication meets the needs of a society with questions – because it educates people to explore, innovate and create the future on a much greater scale.

In the lab, PhD students can teach undergraduates not only how to follow “cookbook” experiments but to develop their own questions, hypotheses, methods, data collection, analysis and ability to cope with failed results. In tutorials for large classes, graduate students can teach undergraduates how to generate their own questions and conduct research. This system cultivates the undergraduate’s research capacity and the PhD student’s ability to teach how to do research. Professors can do their own research while learning from undergraduate and PhD students. Questions for research come from all sides, and professors have multiple goals: to publish important work and to graduate two groups of researchers – those who have learned to enquire (undergraduates) and those who have learned to conduct, guide and teach research (PhD students).

Many courses and universities are already scaling up this process. In fact, teaching-stream faculty are most likely to design pedagogical practices for research skills. Our problem is twofold: we underestimate both the capacity of our students to conduct research and the benefits to society that could result from this practice. And we have not determined how to communicate the rewards of this “reverse flow” structure to government leaders, potential donors, colleagues, parents and, most importantly, our students.

Higher education has many goals reflecting different ideas: mastery of technical skills, formation, critical thinking and the logic of enquiry, but this last idea is the key to the future of our universities and for their role in society. We should educate the next generation to create the future knowledge we all will need.

Author: Robert Gibbs, professor of philosophy and religion and was the inaugural director of the Jackman Humanities Institute at the University of Toronto.

Comet observations have evolved from ancient superstitious records to modern in situ space explorations. While early civilizations viewed them as terrifying omens of doom, scientific breakthroughs over the last 500 years have revealed them to be "dirty snowballs" that are permanent members of our solar system.

For hundreds of years, comets were documented primarily for their supposed astrological significance. Chinese astronomers kept the most extensive and accurate ancient records, dating back to at least the 11th century BC. Chaldean astronomers also recorded comets on tablets from the last few centuries BC, possibly even recognizing the periodicity of what is now called Halley's Comet. Aristotle (4th century BC) famously argued that comets were "windy exhalations" from Earth's atmosphere, a view that dominated European thought for 2,000 years. Seneca (1st century BC) was a rare voice who correctly suspected they were celestial bodies similar to planets.

Ancient Vedic literature like the Rigveda includes personified descriptions of comets, later classified more scientifically in texts like the Brihat-Samhita.

Observational accuracy and mathematical modelling transformed comets from atmospheric mysteries into predictable celestial objects. By measuring the parallax of the Great Comet of 1577, Brahe proved that comets were at least four times farther away than the Moon, finally debunking Aristotle's atmospheric theory. In his famous 'Principia', Newton used the comet of 1680 to prove that comets follow orbits dictated by the law of universal gravitation. Halley used Newton's laws to predict that the comets seen in 1531, 1607, and 1682 were the same object. Its return in 1758 confirmed comets as repeat visitors to our solar system. Observations of light spectra allowed astronomers to identify dust and molecules like carbon and nitrogen in comet tails for the first time.

In the 20th century, the focus shifted to the physical nature and origin of comets. Fred Whipple proposed that comets are composed of frozen gases mixed with rock and dust. Jan Oort in 1950 and Gerard Kuiper in 1951 hypothesized that vast reservoirs of icy bodies at the edges of the solar system as the source of comets.

History of Comets in India

The history of comet observations in India dates back over 3,000 years, beginning with personified descriptions in ancient scriptures and evolving into rigorous astronomical catalogues.

The Rigveda and Atharvaveda contain early references to these objects that were called Dhumaketus. Some scholars suggest the Rigvedic description of a "heavenly fig tree" with roots in the sky was inspired by the hairy appearance of a comet's tail. Researchers propose that the story of King Nahusha in the Mahabharata—who ruled heaven before being cursed to fall as a serpent—is a mythological retelling of a bright comet crossing the constellation Ursa Major (Saptarishi) toward the star Canopus (Agastya). Ancient sages like Parashara and Garga recorded dozens of comets. Parashara classified 101 comets into groups such as the "Death group" (associated with calamities) based on their appearance and position.

During Siddhantic period, comets were systematically catalogued, often with a focus on their astrological portents. Varahamihira, in 6th Century AD, in his encyclopedic work Brihat Samhita, he dedicated Chapter 11 to comets (Ketu-cara). He classified them by their shapes (e.g., rod-like, spear-tipped) and colour, while acknowledging they were unpredictable and "beyond mathematics". Ballala Sena of 12th Century AD in the Adbhuta Sagara, compiled thousands of years of cometary lore from earlier seers, describing comets like Chala Ketu, which purportedly appeared once every 1,500 years.

During the rule of Akbar a prominent comet was observed in November 1577 while the emperor was in Punjab. Jahangir, known for his interest in nature, left detailed records of two bright comets seen in 1618.

Captain John Warren observed the "Great Comets" of 1807 and 1811, accurately computing their orbits using Kepler's laws from Madras Observatory. T.G. Taylor, independently, discovered the Great Comet of 1831 also from Madras. Norman Pogson discovered a comet 1872 I (the Klinkerfues-Pogson Comet) in December 1872.

Origin of Comets

Comets are ancient "leftovers" from the formation of our solar system approximately 4.6 billion years ago. They originated as icy 'planetesimals' in the cold outer regions of the 'protoplanetary' disk, where water and gases like carbon dioxide and methane froze onto grains of dust and clumped together.

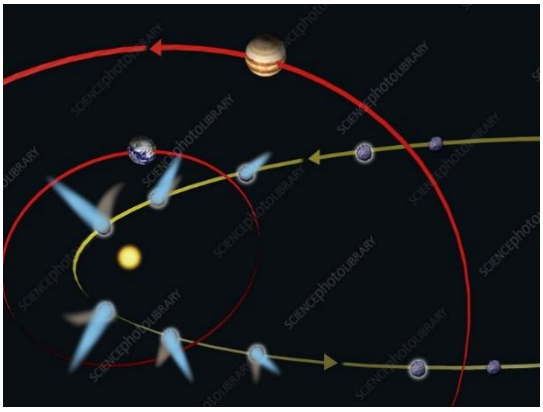
Today, these objects are stored in two primary "reservoirs" at the outer edges of the solar system, namely, the Kuiper belt and the Oort cloud.

Kuiper belt is a disc-shaped region extending from the orbit of Neptune (30 AU) to about 50 AU from the Sun. It is the source of most short-period comets, which take less than 200 years to orbit the Sun. These objects formed in situ (where they are now) or were nudged slightly outward as the giant planets migrated early in the solar system's history.

The Oort cloud is a vast spherical shell of icy bodies surrounding the solar system at distances between 2,000 and 100,000 AU. It is the source of long-period comets, which can take thousands or even millions of years to complete one orbit.

While most comets belong to our solar system, astronomers have recently identified interstellar comets (like 2I/Borisov) that originated from other star systems and are simply passing through our cosmic neighbourhood.

Orbits of Comets



Cometary orbits are typically highly eccentric ellipses that are much more elongated than the nearly circular orbits of planets. While a planet stays at a relatively consistent distance from the Sun, a comet's path takes it from the frozen outer reaches of the solar system to a very close pass (perihelion) near the Sun.

Most known comets follow elliptically closed, repeating loops, returning periodically. Some comets having parabolic trajectory typically pass the Sun once and are either captured into an elliptical orbit or ejected from the solar system. Comets with open and hyperbolic trajectories are found to be moving faster than the Sun's escape velocity and hence they pass through the solar system once and exit into interstellar space forever.

A comet's orbit is not permanent. It can be significantly altered by gravitational perturbations from giant planets, especially Jupiter. A close planetary flyby can lower a long-period orbit into a short-period one or accelerate a comet enough to "kick" it onto a hyperbolic escape trajectory, ejecting it from our solar system.

Comets can also orbit planets, though they are usually only temporary visitors. When a planet's gravity "captures" a comet, the comet becomes a satellite of that planet rather than just the Sun. In 1993, astronomers discovered Shoemaker-Levy 9 (SL9), the first comet ever observed orbiting a planet. It was likely captured by Jupiter's massive gravity around 1929. During a close pass in 1992, Jupiter's tidal forces ripped the comet into at least 21 fragments. These fragments famously collided with Jupiter in July 1994, leaving dark scars in the atmosphere larger than the diameter of Earth.

Many scientists believe that comets play a major role in the formation and behaviour of planetary rings. Planetary orbits for comets are generally unstable.

Composition of Comets

Comets are often described as "dirty snowballs" or "icy dirt balls," a model first proposed by Fred Whipple in 1950. They are primarily composed of frozen gases (volatiles) and solid grains (dust). Ices make up the majority of a comet's mass. When a comet approaches the Sun, these ices sublimate (turn directly into gas), creating the coma and tail.

Water Ice is the most abundant component, accounting for about 80% of the volatile content. Carbon monoxide and Carbon dioxide - common "dry ices" that sublimate even at very cold temperatures far from the Sun may be there. Small amounts of ammonia and methane are also present.

The solid material is embedded within the ice matrix of silicates - sand-like grains and rocky minerals similar to those found in Earth's crust. Organic molecules like complex carbon-based compounds (hydrocarbons) are also found. The Rosetta mission famously detected glycine, an amino acid, on Comet 67P, suggesting comets may have delivered the building blocks of life to Earth. Trace amounts of iron, nickel, and magnesium are also detected.

Structure of Comets

Comets have a nucleus - the solid core that is surprisingly dark (reflecting less light than asphalt) but very porous. It is not a solid rock but more like a fragile, low-density sponge.

Then there is the coma which forms a fuzzy atmosphere of gas and dust around the nucleus.

Then there are tails - Ion Tail (Blue) which is made of electrified gas (plasma) pushed directly away from the Sun by solar wind. And the Dust Tail (White/Yellow) which is made of solid grains curved by the comet's motion and pushed by light pressure.

Observing Comets

Observing comets is a rewarding but patient process, as they typically appear as faint, fuzzy "stars" rather than the bright streaks seen in professional photography. Because their brightness and visibility change daily, successful observation depends on timing and the right tools.

Light pollution from cities will wash out a comet's faint tail. Bright moonlight acts like a giant streetlight. The best time to observe is during a New Moon or when the Moon is not in the sky. Allow at least 20–60 minutes for your eyes to fully adjust to the darkness.

While some "Great Comets" are visible to the naked eye, most require optical aid. Binoculars are often the best tools for beginners because they provide a wide field of view, making it easier to see the entire tail. A small telescope with a low-power eyepiece (25mm to 40mm) is best for finding comets. For closer looks at the nucleus, larger apertures (6 to 8 inches) are recommended.

Comets are often brightest when close to the Sun, meaning they appear very low on the eastern horizon before sunrise or the western horizon after sunset.

The Most Iconic Comets

The following are very well-known comets.

(1). (Halley's Comet): it is arguably the most famous comet, its periodic return every 75–76 years proved that comets orbit the Sun. It has been recorded since at least 240 BC.

(2). C/1995 O1 (Hale-Bopp): one of the most widely observed comets in history, it was visible to the naked eye for an unprecedented 18 months in 1996–1997. Its large, active nucleus made it visible even from light-polluted cities.

(3). C/1996 B2 (Hyakutake): known for its exceptionally long tail, which stretched over 300 million miles—the longest ever observed. It passed very close to Earth in 1996, creating a spectacular display with blue and green streamers.

(4). Shoemaker-Levy 9: famous for its dramatic collision with Jupiter in 1994. It broke into over 20 fragments that slammed into the planet, leaving dark scars in Jupiter's atmosphere larger than Earth.

(5). C/2006 P1 (McNaught): the "Great Comet of 2007," it was the second-brightest comet since 1935. It reached a peak magnitude of –5.5, making it visible during broad daylight in the Southern Hemisphere.

Comets around other stars

Astronomers have confirmed the existence of comets around other stars, which are scientifically referred to as "exocomets." Since the first discovery in 1987, these "alien comets" have been detected in dozens of star systems, revealing that cometary bodies are likely a common by product of planet formation throughout the galaxy.

Because exocomets are too small and far away to be imaged directly, scientists use two main indirect methods to detect them:

(1) Spectroscopy (Gas Absorption method): as a comet passes in front of its star, the gases in its tail absorb specific colours of starlight. This creates "dips" in the star's spectrum that shift in wavelength as the comet moves.

(2) Photometry (Transit Dips): high-precision space telescopes like NASA's TESS (Transiting Exoplanet Survey Satellite) and Kepler can detect the slight dimming of a star's light as a comet's dusty tail blocks it. These dips are typically asymmetric—steeper at the start and tapering off slowly—which matches the shape of a comet's tail.

Studies show that exocomets have similar sizes (typically 1 to 14 km in diameter) and likely form through the same collisional processes as those orbiting our Sun. They represent "icy reservoirs" that may play a crucial role in delivering water and organic molecules to exoplanets, much like they may have done for early Earth.

Life and Comets

While there is no direct evidence that life currently exists on comets, they are considered "reservoirs" for the essential building blocks of life.

Scientific exploration has revealed that comets contain the right ingredients, and some theories suggest they could even serve as temporary incubators for microorganisms. Missions like Rosetta and Stardust have confirmed that comets carry complex organic molecules. Scientists found glycine, the simplest amino acid used to build proteins, in the dust of comets Wild 2 and 67P.

Phosphorus, which is a key element for DNA and cellular energy was detected on Comet 67P for the first time in 2016. Over 16 different organic molecules, including alcohols, sugars, and precursors for life, have been identified on cometary surfaces.

Though the surface of a comet is a frozen, radiation-blasted vacuum, the interior might offer better conditions. Some theories propose that radioactive decay in a comet's core could melt ice, creating subsurface liquid pools that could last for millions of years. Experiments on the International Space Station (ISS) have shown that certain Earth bacteria and archaea can survive in the vacuum of space for years, especially if shielded by dust or rock.

The “Panspermia” hypothesis suggests that life did not start on Earth but was delivered here by comets or meteorites.

Most scientists believe comets are too extreme to support active, thriving life because they lack consistent liquid water, stable temperatures, and energy sources like sunlight. Instead, they are seen as "cosmic delivery trucks" that likely provided the raw materials for life to begin on more hospitable planets like Earth.

Cometary collisions

Comets can and do collide with other celestial bodies, including planets, the Sun, and even each other. While the vastness of space makes such events rare, they have been directly observed and have played a major role in the evolution of our solar system.

Planets, especially gas giants like Jupiter, act as "cosmic vacuum cleaners" by attracting comets with their massive gravity. Shoemaker-Levy 9 (1994), the most famous example, after being torn into 21 fragments by Jupiter's tidal forces, the comet smashed into the planet's atmosphere. It was the first time humans directly witnessed a collision between two solar system objects.

While rare today, comets frequently struck the early Earth. Many comets, known as sungrazers, follow orbits that take them extremely close to the Sun. Most of these evaporate due to intense solar heat. In 1998, two comets were observed plunging into the Sun in close succession, though they vaporized before making physical contact with the solar surface.

Hazards from Comets

Comets pose a real but extremely low-probability danger to Earth. While asteroid impacts are more frequent, a comet impact would likely be far more destructive due to its massive size and high velocity. Comets are considered "high-consequence, low-probability" hazards. Scientists track them as ‘Potentially Hazardous Objects’ (PHOs) if their orbits bring them within 0.05 astronomical units (~7.5 million km) of Earth.

Comets travel at speeds of 30–70 km/s, roughly double or triple the speed of typical asteroids. Because impact energy increases with the square of velocity, a comet can pack 50–100 times more energy than an asteroid of the same size. Long-period comets arrive from the outer solar system with very little notice—sometimes as little as 9 to 22 months before they reach the inner solar system.

Many Earth-crossing comets, such as Halley's Comet or Swift-Tuttle, are significantly larger (10–30 km) than most known near-Earth asteroids.

An impact from a comet larger than 1 km could cause a global catastrophe. A large comet would create a shockwave capable of flattening forests and buildings over thousands of square kilometres. Dust and soot lofted into the stratosphere would block sunlight, potentially causing global crop failures and mass starvation. An ocean impact (72% probability) would generate 'mega tsunamis' devastating coastlines worldwide. However, a major comet impact is estimated to occur only once every 10 million to 100 million years.

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A remote 174-acre tract of land in central India is about to become one of the most sensitive listening posts in the universe

A design rendering of the LIGO-India site at Aundh, Maharashtra

After nearly a decade of planning, lobbying, and fine-tuning, the Indian government has green lighted the full-scale construction of the Laser Interferometer Gravitational Wave Observatory-India (LIGO-India), a world-class gravitational wave observatory, With a formal tender for civil and vacuum works issued this week and a ₹1600 crore (~$190 million USD) construction budget now unlocked, India's contribution to the global hunt for gravitational waves is shifting from blueprints to brick and steel. "This is a defining moment," said Sanjit Mitra, physicist at Inter-University Consortium for Astronomy and Astrophysics (IUCAA) in Pune and science spokesperson for the LIGO-India project. "After years of groundwork, feasibility studies, and administrative coordination, the dream will finally be built."

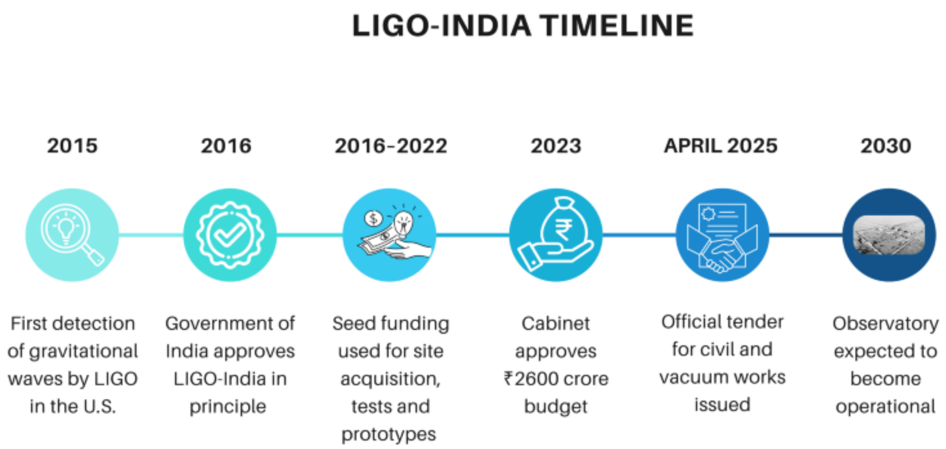
The quiet revolution in spacetime

Gravitational waves — ripples in the fabric of spacetime predicted by Einstein a century ago — were first directly detected in 2015 by twin observatories in the United States, in Hanford, Washington, and Livingston, Louisiana. Since then, these colossal L-shaped detectors have "heard" dozens of cosmic collisions: black holes merging, neutron stars dancing toward annihilation. Currently, the U.S.-based LIGO detectors and Virgo in Pisa, Italy provide limited sky coverage. Adding a third LIGO detector in a geographically distant location like India is a critical mission. "Having this detector on Indian soil, on the other side of the world from the American observatories, will dramatically improve our ability to localize the sources of gravitational waves," said Somak Raychaudhury, astrophysicist and vice-chancellor of Ashoka University and part of the LIGO-India team. Better localization means

Telescopes can be swiftly directed to those parts of the sky — unlocking insights not just into gravity, but into the matter and radiation associated with these cosmic events. "We want to know not just that two black holes collided, but where, when, and what else was going on," Raychaudhury added. "That's the foundation of multi-messenger astronomy."

The long road from 'in principle' to in situ

LIGO-India was first approved 'in principle' by the Indian cabinet in February 2016. But the full budgetary sanction — a prerequisite for construction — only came seven years later, in April 2023.



In the intervening years, teams from the Raja Ramanna Centre for Advanced Technology (RRCAT), IUCAA, Institute for Plasma Research (IPR), and the Directorate of Construction, Services and Estate Management (DCSEM) worked through the complex pre-construction phase. This included identifying and acquiring a low-noise seismic site in Aundha, Maharashtra, conducting geotechnical surveys, and building full-scale prototypes of critical vacuum components to be manufactured in India. "Gravitational wave detection is an incredibly delicate science," Souradeep explained. Even the faintest ground vibration from traffic, wind or wildlife can disrupt a signal. "The site selection near Aundha in Maharashtra was guided by rigorous noise measurements and geological surveys.

"Key components for the observatory, such as the L-shaped 4-kilometer vacuum tubes, have already been fabricated and tested on a prototype scale within India. These tubes will be essential for the laser interferometry that underpins gravitational wave detection. At the heart of each LIGO observatory is this pair of vacuum tubes, where lasers bounce between mirrors to detect the minuscule distortions caused by passing gravitational waves — distortions as small as one-thousandth the diameter of a proton. Reproducing that feat in rural Maharashtra will require engineering muscle and micrometre precision. That includes civil infrastructure, architectural detailing, and fabrication of ultra-high-vacuum (UHV) chambers, cryogenic pumps, gauges, and control systems. India has fabricated beam tube segments and tested them for vacuum performance. The LIGO-India team conducted a year-long, five-station seismic study, extensive geotechnical surveys, installed an all-weather monitoring station, and constructed and estate and maintenance Building, which will serve as the on-site headquarters during the build phase, Mitra said.

A global scientific partnership

LIGO-India is the result of a trilateral collaboration: between the U.S. National Science Foundation, which funded the original LIGO detectors; the LIGO Laboratory at Caltech and MIT, which provides technical and design expertise; and Indian science agencies under the Department of Atomic Energy (DAE) and Department of Science and Technology (DST).

The U.S. will start transferring hardware from the decommissioned Hanford interferometer to India in the coming years matching the progress of construction at the site. The Indian team will handle integration and operations. More than 60 Indian institutes and hundreds of scientists, engineers, and students are expected to contribute.

Once operational — targeted for 2030 — LIGO-India will work in unison with the LIGO detectors in the U.S., the Virgo observatory in Italy and the Kamioka Gravitational Wave Detector (KAGRA) in Japan.

The project is expected to catalyse local industry in precision manufacturing, vacuum engineering, and advanced optics. It will also seed a new generation of physicists trained at the frontier of observational cosmology. “This isn’t just about building an observatory,” said Mitra. “It’s also about building scientific capacity across the country.”

Eyes on the 2030s

Scientists at the LIGO-India testing and training facility at RRCAT, Indore

The formal notice inviting tender by the Department of Atomic Energy on 16 April 2025 suggests a planned build time of 48 months. If that schedule holds, the first gravitational waves could be detected from Indian soil before the end of this decade.

“The technology used in LIGO-India is going to be more advanced than that in some of the earlier detectors,” said Raychaudhury. “By the early 2030s, this observatory will not only be joining the network, it may well be leading it.”

Scientists also see LIGO-India as a cornerstone for a broader ecosystem of multi-messenger astronomy, where gravitational wave detections are followed up with electromagnetic and neutrino observations.

“We’re entering an era where we don’t just observe the sky — we listen to it, we feel it,” said Souradeep. “India will soon be launching the Daksha satellite to monitor high-energy transients. Ground-based projects like the Square Kilometre Array and the Rubin Observatory will complement these efforts. “LIGO-India will be right at the centre of this international coordination,” he said.

The project is also expected to elevate Indian capabilities in vacuum engineering, precision optics, and large-scale data science, offering long-term benefits beyond astronomy – in cryogenics to civil engineering to artificial intelligence for data analysis.

“When LIGO-India begins operating in the early 2030s, many of the current detectors may no longer be in service,” said Raychaudhury. “It could become one of the dominant players of the next era.”

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Author: Subhra Priyadarshini

EXPERT VIEW

“My congratulations to the LIGO team on their discovery of gravitational waves. It is a result that is at least as important as the discovery of the Higgs Boson. It includes the first observation of gravitational waves, and of two black holes colliding and merging. With LIGO's increased sensitivity, we can expect many more detections, all improving our knowledge about how the universe works.

These experimental observations are consistent with my theoretical work on black holes in the 1970s. As a theoretical physicist, I have spent my life contributing to our understanding of the universe. It is thrilling to see predictions I made over 40 years ago such as the black hole area and uniqueness theorems being observed within my lifetime.”

— Stephen Hawking

A new physics model attempts to explain puzzling measurements of how fast galaxies are moving away from us, proposing that empty space behaves like a fluid with built-in drag

Fresh distance measurements from the Dark Energy Spectroscopic Instrument (DESI) revealed a small mismatch in results that otherwise track cosmic history well.

Targeting that tension, Muhammad Ghulam Khuwajah Khan at Indian Institute of Technology Jodhpur, (IIT Jodhpur) built a model adding drag.

In a new preprint, Khan at IIT treated expanding space as something that resists stretching, then eases off later.

If the tension holds up, the next step is to explain what kind of physical resistance empty space could have.

What viscosity changes

Resistance in empty space would oppose expansion, making the universe a bit “stickier” than a perfect vacuum.

Physicists call this bulk viscosity, resistance to volume change during expansion, and it shows up as extra pressure.

Bulk viscosity pushes back only when space changes size, so faster expansion produced more pressure than slower expansion.

That makes viscosity tempting as a patch for cosmic data, but calling space a “sticky fluid” still demands a real cause.

Dark energy assumptions

Most cosmology models explain the universe’s speeding-up by adding a smooth ingredient that behaves the same everywhere.

Cosmologists call it dark energy, an unknown source of pressure that speeds cosmic expansion, even as matter pulls inward.

For decades, many analyses assumed this push stayed constant over time, so one number could describe it.

That constant option is the cosmological constant, a fixed energy in empty space, and the tension pressures it.

Space can vibrate

To create that turning-on pressure, Khan gave space an internal way to wobble as it expanded. In materials science, phonons, collective vibrations moving through a solid, carry energy without carrying matter.

Khan extended that idea to the vacuum, describing longitudinal ripples that travel through space and create resistance.

As those ripples respond to expansion, the model links small-scale motion inside space to the large-scale speed of galaxies.

When drag turns

Drag in Khan's universe did not run at full strength forever, and his equations made it temporary.

Instead, pressure lagged behind expansion by a built-in delay, so the resistance peaked during certain eras.

Early on and far in the future, the model settled back toward a near-constant behaviour, leaving only a mid-era increase.

Such a time-windowed effect can mimic a changing acceleration, but it also makes the idea easy to falsify.

Matching the pattern

DESI's strongest clues come from a repeating separation pattern in galaxies, which provides a standard distance scale for cosmic maps.

Cosmologists call that signal baryon acoustic oscillations, a leftover pattern from early-universe sound waves, and DESI measured it across time.

At IIT, the team tuned his fluid equations until that scale landed where DESI saw it, across several eras.

Because the model chased observations rather than building from particle physics, it stands or falls on future surveys.

Predictions in data

Other sky measurements track expansion in different ways, and a viscous universe would need to agree with them too.

Supernova distance markers and the growth of galaxy clusters both respond to the expansion rate, so drag changes both.

Light bending by gravitational lensing, warping of images by mass, also depends on how structure grows under drag.

Failing any one of those cross-checks would leave viscosity as a clever curve-fit, not a property of space.

Limits of the idea

Caution matters here because Khan posted the work before peer review, and the idea could fail basic checks.

In ordinary fluids, viscosity comes from particles exchanging momentum, so an empty vacuum needs a believable source.

A recent paper laid out how bulk viscosity models can run into internal contradictions when tuned too hard.

Until a physical mechanism explains the drag and other datasets agree, the model remains an interesting placeholder.

Yes. You can keep the focus on the test rather than the instruments. Here is a cleaner version that avoids naming multiple telescopes:

New model for universe expansion

More observing time will decide whether the tension survives, and the next decade offers the clearest verdict.

Ongoing galaxy surveys will keep measuring how fast space expands across different eras of cosmic history. Future maps of billions of galaxies will show whether the expansion truly changes in the way a viscous model predicts.

If those independent measurements line up, the case for cosmic drag strengthens, but if they conflict, the idea likely fades.

Khan's model turns an abstract mismatch into a clear claim that empty space pushes back when it expands.

If upcoming galaxy surveys confirm the same drag pattern, cosmologists may replace a fixed dark energy picture with a time-changing one, though only after careful checks.

Author: Adrian Villellas

Earth.com staff writer
The study is published in *arXiv*.

This discussion is described by Heisenberg in his book 'Physics and Beyond', talks about the discussion he personally had with Einstein in the spring of 1926, soon following his discovery of Quantum Mechanics in the preceding year.

He says, "University of Berlin has been considered as the strong-hold of physics in Germany. It was here that, Planck had discovered quantum; it was here that Einstein had formulated his general theory of relativity and his theory of gravitation in 1916. The most important scientific activity that keeps going on regularly here was the so-called 'physics colloquium' (physics seminars), which was generally attended by the entire staff of the physics department.

In the spring of 1926, I was invited to address this distinguished body on the new quantum mechanics, and since this was my first chance to meet so many famous men, I took good care to give a clear account of the concepts and mathematical foundations of what was then a most unconventional theory. I apparently managed to arouse Einstein's interest, for he invited me to walk home with him so that we might discuss the new ideas at greater length." About Heisenberg's talk expounding his ideas about the new mechanics, Einstein started the conversation with a question that weighed on the philosophical background of Heisenberg's work.

"What you have told us sounds extremely strange. You assume the existence of electrons inside the atom, and you are probably quite right to do so. But you refuse to consider their orbits, even though we can observe electron tracks in a cloud chamber. I should very much like to hear more about your reasons for making such strange assumptions."

Heisenberg clarified by telling, "We cannot observe electron orbits inside the atom but the radiation which an atom emits during discharges enables us to deduce the frequencies and corresponding amplitudes of its electrons. After all, even in the older physics wave numbers and amplitudes could be considered substitutes for electron orbits. Now since, a good theory must be based on directly observable magnitudes, I thought it more fitting to restrict myself to these, treating them, as it were, as representatives of the electron orbits."

Einstein wasn't agreeable to it and retorted, "But you don't seriously believe that none but observable magnitudes must go into a physical theory?"

Heisenberg, as if surprised by Einstein's query, responded "Isn't that precisely what you have done with relativity? After all, you did stress the fact that it is impermissible to speak of absolute time, simply because absolute time cannot be observed; that only clock readings, be it in the moving reference system or the system at rest, are relevant to the determination of time."

A question on a question drove Einstein to his own defence. Nevertheless, it was a fact that Heisenberg had pointed out. Einstein admitted the objection, telling,

“Possibly I did use this kind of reasoning, it is nonsense all the same. Perhaps I could put it more diplomatically by saying that it may be heuristically useful to keep in mind what one has actually observed. But on principle, it is quite wrong to try to found a theory on observable magnitudes alone. In reality, the very opposite happens. It is the theory which decides what we can observe.”

Heisenberg worked at Leipzig in Germany. By 1931, Einstein had escaped to the USA, and Hitler had led Germany into the Second World War.

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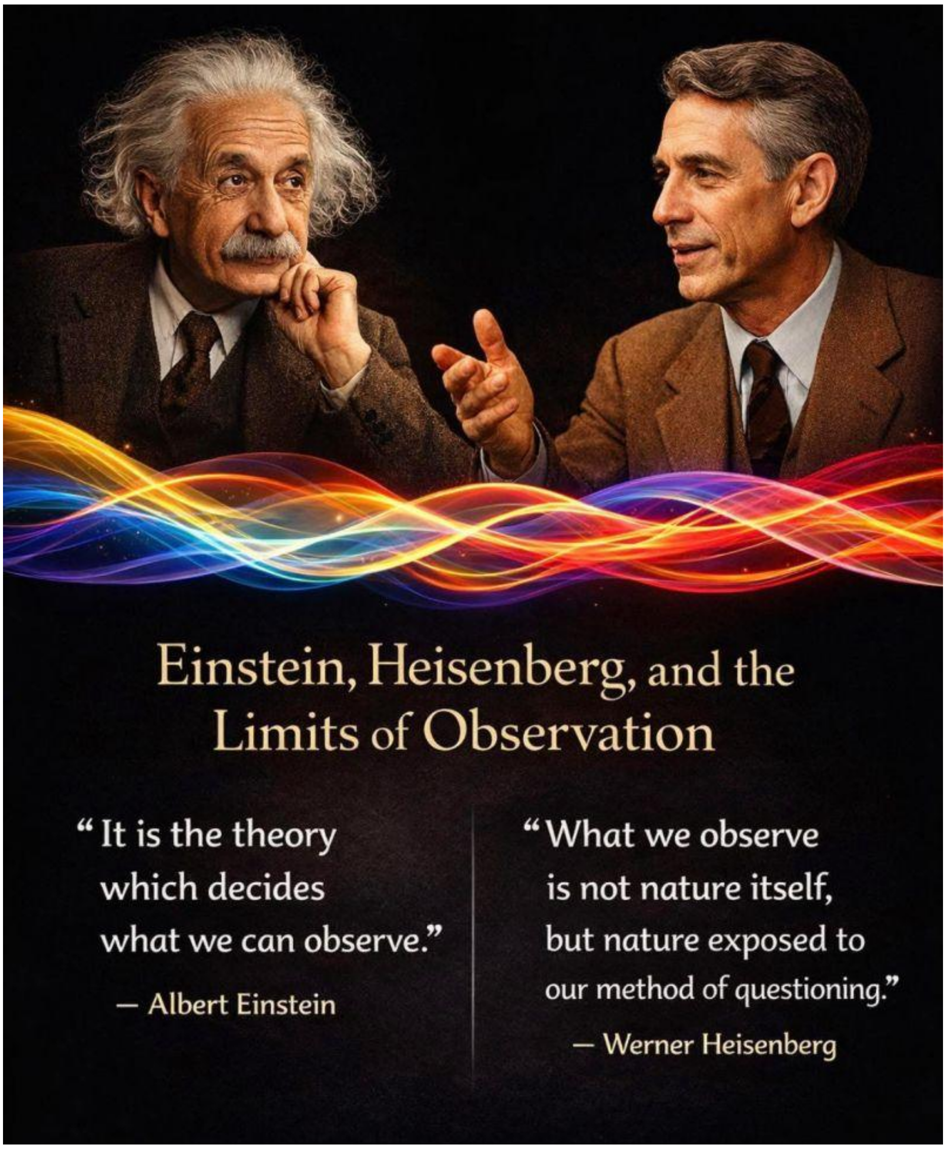

After winning the 4th Anglo-Mysorean war in the year 1799, the East India Company was virtually in possession of entire India except a small region at the extreme South western part of it. Although the company allowed most of the individual provinces (more than 500 of them across India) to be governed by the local monarchs (like the Wodeyars of Mysore) with the company's own support under the overall supervision monitored by its own men (called Residents), the Company anyway kept the governance of the important provinces namely, Calcutta, Bombay and Madras directly under its own control which came to be called the presidencies (namely, the Calcutta presidency, the Madras presidency and the Bombay presidency). Calcutta was its capital. All 3 were situated on the respective seashores. Those were the good old days some 180 years ago! Bombay had a beautiful port and also there was a British Naval military. In order to strengthen its Navy, the company started a naval training center. A capable person by name, John James Waterston from Edinburgh was appointed as naval instructor to train the East India Company's cadets at Bombay. Waterston came down from Edinburgh (Scotland) & joined the Navy at Bombay. Waterston had a deep interest in studying Physics but, after coming down from Edinburgh where he can get that facility to study here in Bombay? During those days, there were no libraries or institutions available to people in general even in big cities. Well, to his great surprise and satisfaction, Waterston found that, there was a Grand Old missionary college by name Wilson College (whose recent photo which I secured today the 15th April 2026, is reproduced here. But what a lovely college it looks like, o my goodness!) located right on the seashore at the Marine Drive (We know, Marine Drive is a road-line adjacent to the Mumbai seashore.) While he continued his studies (of course as an outsider) in Physics in the library of this institution in his leisure hours, he developed some new ideas of his own about the behavior of gas molecules.

You know, some extraordinary people like the mathematical genius Ramanujan possess some kind of insight which others normally can't have. That's a gift which they possess by birth (which cannot be acquired by others no matter how much efforts they may make to get that capability). Somehow they possess a mind that is capable of seeing certain hidden phenomenon which they alone can see it. They comprehend the peculiarity or the special features in the phenomenon and then they give it along with the explanation of what they have observed to the world. Such people are the gifts of nature to us; and remain as gifts to humanity. This man Waterston is one like that. His idea was broadly like this. When a gas attains thermal equilibrium, the average energy of its constituent molecules moving in any direction is the same. This applies even if there are molecules of different sizes. A larger molecule moves with lesser velocity but possesses the same average kinetic energy and things like that. Later, this came to be known as the "**equipartition theorem**."

WILSON COLLEGE as seen today (Credit to Sri Gurucharan Karmakar)

In 1843 he published a book in which he had put forward and discussed his idea. But unfortunately, it seems, no physical scientist ever read his book. Reason? Its title.

The title of the book was **"Thoughts on the Mental Functions"** which sounds more like the title of a Philosophy book than that of a Physics book. A totally misleading title for a Physics Book! It seems, there is no surviving copy anywhere. But I guess, if there is any surviving copy, then it must be there in the library of Wilson College in Mumbai. (I am hinting upon the possibility that, anyone in this KPA group who has a good friend in Mumbai, may give a try to get it checked in the library of Wilson college to know, whether that book exists! If the copy has been discarded at one or the other time in these 180 years because of non-usage, then I think, it's gone forever. However, it is the only possibility of the book's existence now.)

Two years later i.e., in 1845, Waterston submitted to the Royal Society of London, a long manuscript, presenting a detailed account of his ideas about the kinetic theory. In the meeting of Royal Society, it was read but rejected for publication by the Society's referee. It was because, the referee didn't agree with the assumptions that Waterston had made. The non-acceptance of the paper was intimated to him by post. However, as was the practice in those days in the publication aspects of the Royal Society, Waterston's rejected manuscript was not returned to him but instead, it became the property of the Royal Society and was deposited in its archives. Unfortunately, Waterston had not made another copy of this complex manuscript and was unable to reconstruct it in sufficient detail to submit it for publication elsewhere. By the time he realized it would not be published by the Royal Society, his interest had passed on to the physical chemistry of liquids and gases.

Times passed and Waterstone went back to his native place Edinburgh in 1857. Just the next year, i.e., in 1858, he published a paper on the speed of sound in gases. In that paper he made a reference to his earlier work that went unpublished by the Royal Society of London in 1845. There is no news about what he did later.

In Edinburgh, there is a waterfront. See the figure here.

One day, Waterston went for a walk alongside the waterfront and he was never seen again later. Not even his body was found. His disappearance remains a mystery till to date.

Many years passed by in between. It became 1891. Then something happened at Royal Society to Waterstone's unpublished work after 46 years. Lord Rayleigh was the Secretary of Royal Society in that period. At that time, he was writing his celebrated book, 'Theory of Sound'. While he was thoroughly going through the various published data, he happened to come across the Waterston's 1858 paper.

Look at the way the luck hits!

In that paper, he saw Waterston's reference to his rejected paper that was supposed to have been compiled in the Royal Society's archives. Rayleigh became enthusiastic & thought of getting it retrieved searching through the old files. Being the Secretary, it was possible for him to do that job. Thank god, it was there! Seeing the paper, he could recognize its significance at once. He proudly wrote an introduction to it and saw that, Waterston's paper got published in Philosophical Transactions of Royal Society. According to some experts, this delay in the Publication of Waterston's work, must have retarded the progress of the related topics by at least a decade or possibly even two.

Soon after this took place, came the year 1900. The theory for Blackbody Radiation was progressing at break-neck speed at the University of Berlin in Germany. Lord Rayleigh extended the application of the principle of equi-partition of energy, from the case of gases on to the case of Blackbody. In the summer of 1900, he derived a law on the basis of equi-partition principle in Thermodynamics and published it. But by some oversight, he had left out the final step divided by a factor 8, as only an octant of the spherical volume under consideration in his theory accounted for the contribution to energy density. This was promptly reported to him by another British Physicist-philosopher sir James Jeans. Rayleigh incorporated his suggestion for correction in the theory and added his name as a co-author for the paper.

As we all know, Rayleigh – Jean's theory was successful partially in the sense that, it could explain the longer wavelength side of the Blackbody spectrum but had no connection whatsoever with the curve on the shorter wavelength part.

In a matter of few months, Planck gave his law which was triumphant in explaining the entire spectrum and made Physics enter into the world of Quantum Mechanics. In this perspective, we can say, the Wien's law and Rayleigh – Jean's law took us to the very gates of quantum mechanics. (The last sentence is inspired by what, Max von Laue wrote in the obituary of Wien; he wrote, 'Wien's work took us to the very gates of Quantum Mechanics'.)

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ಭೂಮಿಯ ಹವಾಮಾನದ ಮೇಲೆ ದೀರ್ಘಕಾಲದಲ್ಲಿ ಸಂಭವಿಸುವ ಮಹತ್ವದ ಬದಲಾವಣೆಗಳೇ ಜಾಗತಿಕ ಹವಾಮಾನ ಬದಲಾವಣೆ ಎನ್ನಬಹುದು. ಇದರಲ್ಲಿ ಭೂಮಿಯ ತಾಪಮಾನ ಹೆಚ್ಚಾಗುವುದು, ಮಳೆ ಬೀಳುವ ಮಾದರಿಗಳಲ್ಲಿ ವ್ಯತ್ಯಯವಾಗುವುದು, ಬಿರುಗಾಳಿ-ಬರ ಪ್ರವಾಹಗಳಂತಹ ಹವಾಮಾನ ಘಟನೆಗಳು ಸಂಭವಿಸುವುದು, ಧ್ರುವಗಳಲ್ಲಿ ಹಿಮನದಿಗಳು (glaciers) ಕರಗುತ್ತಿರುವುದು ಮತ್ತು ಸಮುದ್ರ ಮಟ್ಟ ಏರಿಕೆ, ಸಾಗರದ ಬಿರುಗಾಳಿಯ ತೀವ್ರತೆ, ಅಲ್ಲಿನ ಜೀವ ವೈವಿಧ್ಯತೆ ನಾಶ ಮುಂತಾದವು ಸೇರಿವೆ. ಜಾಗತಿಕ ಹವಾಮಾನ ಬದಲಾವಣೆ ನಾವು ಎದುರಿಸುತ್ತಿರುವ ದೊಡ್ಡ ಸವಾಲಾಗಿದೆ. ಪ್ರತಿಯೊಬ್ಬರೂ ತಮ್ಮ ಮಟ್ಟದಲ್ಲಿ ಪರಿಸರವನ್ನು ಕಾಪಾಡುವ ನಿಟ್ಟಿನಲ್ಲಿ ಕ್ರಮ ಕೈಗೊಂಡರೆ ಭವಿಷ್ಯದ ಪೀಳಿಗೆಗೆ ಭೂಮಿಯನ್ನು ಸುರಕ್ಷಿತವಾಗಿ ಉಳಿಸಬಹುದು.

ಜಾಗತಿಕ ತಾಪಮಾನ ಹೆಚ್ಚಾಗಲು ಕಾರಣವಾಗುವ ಮಾನವ ನಿರ್ಮಿತ ಸಮಸ್ಯೆಗಳು:

ಹಸಿರುಮನೆ ಅನಿಲಗಳು (Greenhouse Gases):

ಕಲ್ಲಿದ್ದಲು, ಪೆಟ್ರೋಲ್ ಮತ್ತು ಡೀಸೆಲ್ ಮುಂತಾದ ಭೂಮಿಯಲ್ಲಿ ದೊರೆಯುವ ಪಳೆಯುಳಿಕೆ ಇಂಧನಗಳನ್ನು ಸುಡುವುದರಿಂದ ಇಂಗಾಲಾಮ್ಲ (ಅಂ_೨), ಮೀಥೇನ್, ಇತ್ಯಾದಿ ಅನಿಲಗಳು ವಾತಾವರಣಲ್ಲಿ ಬಿಡುಗಡೆಯಾಗುತ್ತವೆ. ಇವು ಅಲ್ಲಿ ಗೋಡೆಯಂತೆ ಹಸಿರುಮನೆ ನಿರ್ಮಿಸಿ ಸೂರ್ಯನಿಂದ ಬಂದ ಬೆಳಕು ಮತ್ತು ಶಾಖವನ್ನು ಮಾತ್ರ ಭೂಮಿಗೆ ತಲುಪಿಸುತ್ತದೆ, ಆದರೆ ಯಾವ ಬಗೆಯ ಶಾಖವನ್ನೂ ಭೂವಾತಾವರಣದಿಂದ ಹೊರಹೋಗಲು ಬಿಡದೆ ವಾತಾವರಣದಲ್ಲೇ ಬಂಧಿಸಿಟ್ಟು ಭೂಮಿಯನ್ನು ತಾಪವನ್ನು ಏರಿಸುತ್ತಿವೆ.

ಅರಣ್ಯ ನಾಶ: ನಗರ, ರಸ್ತೆಗಳನ್ನು ವಿಸ್ತರಿಸಲು ಕಾಡಿನ ಗಿಡಮರಗಳು, ರಸ್ತೆಯ ಬದಿಯ ಗಿಡಮರಗಳನ್ನು ಕಡಿಯುತ್ತಿರುವುದರಿಂದ ಇಂಗಾಲಾಮ್ಲವನ್ನು ಹೀರಿಕೊಂಡು ಆಮ್ಲಜನಕವನ್ನು ಬಿಡುಗಡೆ ಮಾಡುವ ಮರಗಳು ಕಣ್ಮರೆಯಾಗುತ್ತಿವೆ.

ಇಂಧನದ ಅತಿಯಾದ ಬಳಕೆ: ವಾಹನಗಳು, ಕಾರ್ಖಾನೆಗಳು, ವಿದ್ಯುತ್ ಉತ್ಪಾದನೆ ಮುಂತಾದವುಗಳಿಗೆ ಹೆಚ್ಚಾಗಿ ಜೈವಿಕ ಇಂಧನಗಳಾದ ಕಲ್ಲಿದ್ದಲು, ಪೆಟ್ರೋಲ್, ಡೀಸೆಲ್‌ಗಳನ್ನು ಬಳಸಲಾಗುತ್ತಿದೆ. ಇದರಿಂದ ಇಂಗಾಲಾಮ್ಲ ಮತ್ತು ಇತರ ಹಸಿರುಮನೆ ಅನಿಲಗಳು ವಾತಾವರಣಕ್ಕೆ ಬಿಡುಗಡೆಯಾಗಿ ಹಸಿರುಮನೆ ಗೋಡೆಯು ದಪ್ಪನಾಗುತ್ತಿದೆ. ಆಗ ಸೂರ್ಯನಿಂದ ಭೂಮಿಗೆ ಬಂದ ಶಾಖ ವಾತಾವರಣದಲ್ಲೇ ಉಳಿದು ಭೂಮಿಯು ಹೆಚ್ಚು ಹೆಚ್ಚು ಬಿಸಿಯಾಗುತ್ತಿದೆ.

ಕೈಗಾರೀಕರಣ ಮತ್ತು ಕಾರ್ಖಾನೆಗಳ ಮಾಲಿನ್ಯ: ಕಾರ್ಖಾನೆಗಳಿಂದ ಹೊರಬರುವ ಇಂಗಾಲಯುಕ್ತ ಹೊಗೆ, ವಿಷಕಾರಿ ಅನಿಲಗಳು, ವಾತಾವರಣವನ್ನು ಕಲುಷಿತಗೊಳಿಸಿ ಹವಾಮಾನ ಸಮತೋಲನವನ್ನು ಹಾಳುಮಾಡುತ್ತಿವೆ. ಕೈಗಾರಿಕೆಗಳಿಂದ ಹೊರಬರುವ ಘನತ್ಯಾಜ್ಯಗಳೂ ಭೂಮಿ ಮತ್ತು ನೀರನ್ನು

ಕಲುಷಿತಗೊಳಿಸುತ್ತಿವೆ. ಕೈಗಾರಿಕೆ ಮತ್ತು ನಗರೀಕರಣದಿಂದ ಕಾರ್ಖಾನೆಗಳಿಂದ ಬಿಡುಗಡೆಯಾಗುತ್ತಿರುವ ಹೊಗೆ, ವಾಹನಗಳ ಸಂಖ್ಯೆ ಹೆಚ್ಚಾಗಿ, ಅವುಗಳ ಹೊಗೆಯಿಂದ ಹಸಿರುಮನೆ ಅನಿಲಗಳು ವಾತಾವರಣದಲ್ಲಿ ಸೇರಿ ಜಾಗತಿಕ ತಾಪಮಾನ ಹೆಚ್ಚಾಗಲು ಕಾರಣವಾಗುತ್ತಿದೆ.

ವಾಹನಗಳ ಹೆಚ್ಚಳ: ಬಸ್ಸು, ಕಾರು, ಲಾರಿ, ಬೈಕ್‌ಗಳಿಂದ ಇಂಗಾಲಾಮ್ಲ, ನೈಟ್ರೋಜನ್ ಆಕ್ಸೆöÊಡ್ ಮುಂತಾದ ವಿಷಾನಿಲಗಳು ಬಿಡುಗಡೆಯಾಗಿ ಗಾಳಿಯ ತಾಪಮಾನ ಹೆಚ್ಚುತ್ತಿದೆ. ಉದಾಹರಣೆಗೆ ದೆಹಲಿ ಮತ್ತಿತರ ನಗರಗಳಲ್ಲಿ ಅತೀವ ವಾಹನಗಳ ಸಂಚಾರದ ಪರಿಣಾಮವಾಗಿ ತೀವ್ರ ವಾಯು ಮಾಲಿನ್ಯ, ಪರಿಸರ ಹಾನಿಯುಂಟಾಗಿ ವಿಷಕಾರಿ ಹೊಗೆಯಿಂದ ಗಾಳಿಯ ಗುಣಮಟ್ಟವು ಅತ್ಯಂತ ಕಳಪೆಯಾಗಿ ಸಾರ್ವಜನಿಕರು ಅನಾರೋಗ್ಯ ಉಸಿರಾಟದ ಮುಂತಾದ ಸಮಸ್ಯೆಯನ್ನು ಎದುರಿಸಬೇಕಾಗಿದೆ. ವಾತಾವರಣವು ಹೊಗೆಯಿಂದ ಕೂಡಿ ವಾಹನ ಚಾಲನಾ ಸಮಸ್ಯೆಯೂ ಉಂಟಾಗುತ್ತಿದೆ.

ಪ್ಲಾಸ್ಟಿಕ್ ಬಳಕೆ: ಒಂದು ಬಾರಿ ಬಳಸಿದ ಪ್ಲಾಸ್ಟಿಕ್ ಭೂಮಿಯೊಳಗೆ ಹೋದರೆ ಅದು ಬೇಗ ಕರಗುವುದಿಲ್ಲ, ಕರಗಲು 50ರಿಂದ 500 ವರ್ಷಗಳು ಬೇಕಾಗುತ್ತವೆ. ಒಂದು ವೇಳೆ ಸುಟ್ಟರೆ, ವಿಷಕಾರಿ ಅನಿಲಗಳು ಹೊರಬಂದು ಪರಿಸರ ಮತ್ತು ಹವಾಮಾನಕ್ಕೆ ಹಾನಿಯುಂಟುಮಾಡುತ್ತವೆ. ಇದರ ಬಳಕೆಯು ಭೂಮಿಯಲ್ಲಿ ಕರಗುವ ಬಯೋಪ್ಲಾಸ್ಟಿಕ್ ಮುಂತಾದವುಗಳಿಗೆ ಬದಲಾವಣೆಯಾಗಬೇಕಿದೆ.

ಕೃಷಿಯಲ್ಲಿ ರಾಸಾಯನಿಕ ಗೊಬ್ಬರ ಮತ್ತು ಕೀಟನಾಶಕಗಳು: ಕೃಷಿ ಚಟುವಟಿಕೆಗಳು: ರಾಸಾಯನಿಕ ಗೊಬ್ಬರಗಳು ಹಾಗೂ ಪಶುಸಂಗೋಪನೆಯಿAದ ಇಂಗಾಲಾಮ್ಲ ಹಾಗೂ ಮೀಥೇನ್ ಅನಿಲ ಭೂವಾತಾವರಣದಲ್ಲಿ ಹೆಚ್ಚುತ್ತಿದೆ. ಅಮೋನಿಯಂ ನೈಟ್ರೇಟ್, ಯೂರಿಯಾ ಮುಂತಾದ ನೈಟ್ರೋಜನ್ ಆಧಾರಿತ ರಾಸಾಯನಿಕ ಗೊಬ್ಬರಗಳನ್ನು ಮಣ್ಣಿಗೆ ಹಾಕಿದಾಗ ಮಣ್ಣಿನಲ್ಲಿರುವ ಸೂಕ್ಷ್ಮಜೀವಿಗಳು ನೈಟ್ರಸ್ ಆಕ್ಸೈಡ್‌ಅನ್ನು ವಾತಾವರಣಕ್ಕೆ ಬಿಡುತ್ತವೆ. ನೈಟ್ರಸ್ ಆಕ್ಸೈಡ್‌ಅತಿ ಶಕ್ತಿಶಾಲಿ ಹಸಿರುಮನೆ ಅನಿಲವಾಗಿದ್ದು, ಇಂಗಾಲಾಮ್ಲಕ್ಕಿಂತ ಸುಮಾರು 300 ಪಟ್ಟು ವಾತಾವರಣದಲ್ಲಿ ಉಷ್ಣತೆಯನ್ನು ಹಿಡಿದಿಟ್ಟುಕೊಳ್ಳುತ್ತದೆ, ಅಲ್ಲದೆ ಅತಿನೇರಳೆ ಕಿರಣಗಳಿಂದ ನಮ್ಮನ್ನು ರಕ್ಷಿಸುತ್ತಿರುವ ಓಝೋನ್ ಪದರಕ್ಕೂ ಹಾನಿಮಾಡುತ್ತದೆ. ವಿಶೇಷವಾಗಿ ನೀರು ನಿಂತಿರುವ ಗದ್ದೆಗಳಲ್ಲಿ ಗೊಬ್ಬರ ಬಳಕೆಯಿಂದಾಗಿ ಮೀಥೇನ್ ಅನಿಲ ಬಿಡುಗಡೆಯಾಗುತ್ತದೆ. ಈ ಮೀಥೇನ್ ಇಂಗಾಲಾಮ್ಲಕ್ಕಿಂತ 25-30 ಪಟ್ಟು ಹೆಚ್ಚು ತಾಪಮಾನ ಹೆಚ್ಚಿಸುವ ಶಕ್ತಿಯನ್ನು ಹೊಂದಿದೆ.

ಬಹುತೇಕ ಕೀಟನಾಶಕಗಳು ಪೆಟ್ರೋಲಿಯಂ ಉತ್ಪನ್ನಗಳಿಂದ ತಯಾರಾಗುತ್ತವೆ. ಅವುಗಳ ಉತ್ಪಾದನೆ, ಸಾಗಣೆ, ಬಳಕೆ ಎಲ್ಲಾ ಹಂತಗಳಲ್ಲೂ ಇಂಗಾಲಾಮ್ಲವು ಬಿಡುಗಡೆಯಾಗಿ ಹಸಿರುಮನೆ ಸೇರುತ್ತವೆ. ಕೀಟನಾಶಕಗಳು ಕೇವಲ ಕೀಟಗಳನ್ನು ಮಾತ್ರವಲ್ಲ, ಮಣ್ಣಿನಲ್ಲಿರುವ ಗಿಡಗಳಿಗೆ ಬೇಕಿರುವ ಬ್ಯಾಕ್ಟೀರಿಯಾಗಳು, ಎರೆಹುಳುಗಳನ್ನೂ ನಾಶಮಾಡಿಬಿಡುತ್ತವೆ. ಇದರಿಂದಾಗಿ ಮಣ್ಣು ಇಂಗಾಲವನ್ನು ಹೀರಿಕೊಳ್ಳುವ ಶಕ್ತಿಯು ಕಡಿಮೆಯಾಗುತ್ತವೆ. ಕೀಟನಾಶಕಗಳನ್ನು ಸಿಂಪಡಿಸುವಾಗ ಸೂಕ್ಷ್ಮ ರಾಸಾಯನಿಕ ಕಣಗಳು ಗಾಳಿಗೆ ಸೇರಿ, ಗಾಳಿಯ ಮಾಲಿನ್ಯವೂ ಹೆಚ್ಚಾಗುತ್ತದೆ.

ಒಟ್ಟಾರೆ ಹೇಳುವುದಾದರೆ ರಾಸಾಯನಿಕ ಗೊಬ್ಬರ ಮತ್ತು ಕೀಟನಾಶಕಗಳ ಅತಿಯಾದ ಬಳಕೆಯಿಂದ ಹಸಿರುಮನೆ ಅನಿಲಗಳ ಪ್ರಮಾಣ ಹೆಚ್ಚಾಗಿ ಹವಾಮಾನದ ತಾಪ ಹೆಚ್ಚಾಗಲು ಕಾರಣವಾಗುತ್ತದೆ. ಇದಕ್ಕೆ ಪರಿಹಾರವಾಗಿ ಜೈವಿಕ ಗೊಬ್ಬರಗಳಾದ ಪ್ರಾಣಿಗಳ ಉತ್ಪನ್ನ, ಕಂಪೋಸ್ಟ್ ಗೊಬ್ಬರಗಳು ಉತ್ತಮ ಆಯ್ಕೆಯಾಗಿದೆ. ಜೈವಿಕ ಕೀಟನಾಶಕಗಳಾದ ನೀಮ್, ಟ್ರೆöÊಕೋಡರ್ಮ ಮುಂತಾದವುಗಳನ್ನು ಸಿಂಪಡಿಸಬಹುದು.

ತ್ಯಾಜ್ಯ ವಿಲೇವಾರಿ ಸಮಸ್ಯೆ: ತೆರೆದ ತ್ಯಾಜ್ಯಗಳನ್ನು ಸ್ಥಳಗಳಲ್ಲಿ ಹಾಕಿದರೆ ಅಥವಾ ಸುಟ್ಟರೆ ಅದರೊಳಗಿನ ಜೈವಿಕ ತ್ಯಾಜ್ಯಗಳಿಂದ ಮೀಥೇನ್ ಅನಿಲ ವಾತಾವರಣ ಸೇರುವುದಲ್ಲದೆ, ಇಂಗಾಲಾಮ್ಲವು ವಾತಾವರಣವನ್ನು ಕಲುಷಿತಗೊಳಿಸಿ ಹಸಿರುಮನೆ ದಟ್ಟವಾಗಲು ಕಾರಣವಾಗುತ್ತದೆ. ಲ್ಯಾಂಡ್‌ಫಿಲ್‌ಗಳು ಹವಾಮಾನ ಬದಲಾವಣೆಗೆ ಪ್ರಮುಖ ಕಾರಣಗಳಲ್ಲಿ ಒಂದಾಗಿವೆ.

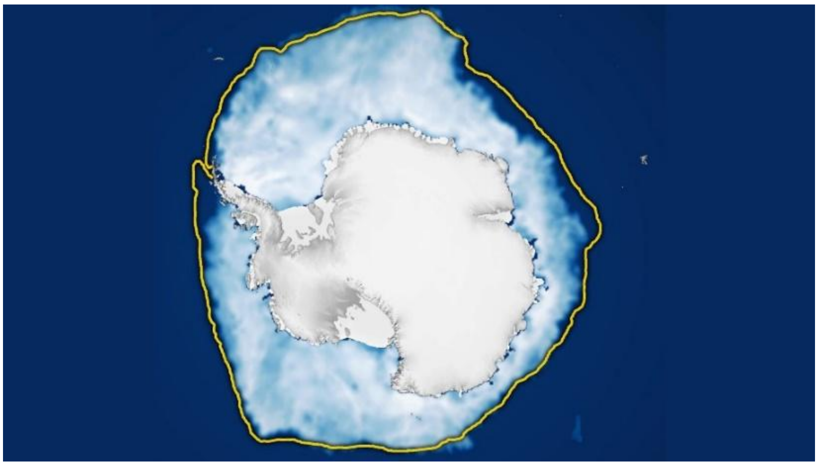
ಜಾಗತಿಕ ಹವಾಮಾನ ಬದಲಾವಣೆಯ ಇತಿಹಾಸ:

ಜಾಗತಿಕ ಹವಾಮಾನ ಬದಲಾವಣೆಯ 6ರಿಂದ 8 ಲಕ್ಷ ವರ್ಷಗಳ ಹಿಮಯುಗದ ಇತಿಹಾಸವನ್ನು ವಿಜ್ಞಾನಿಗಳು ತೆರೆದಿಟ್ಟಿದ್ದಾರೆ. ಇದು ಕೆಲವು ಬಾರಿ ನೈಸರ್ಗಿಕ ಚಕ್ರದಂತೆ ಕಂಡರೂ, ಬದಲಾವಣೆಯ ವೇಗ ಮತ್ತು ಕಾರಣಗಳು ಸಂಪೂರ್ಣ ಭಿನ್ನವಾಗಿವೆ. ಈ ಹಿಮಯುಗದಿಂದ ಹೊರಬರಲು ಭೂಮಿಯು ಸುಮಾರು 5000 ವರ್ಷಗಳನ್ನು ತೆಗೆದುಕೊಂಡಿತು. ಕಾಲ ಕಳೆದಂತೆ ಹವಾಮಾನ ಬಿಸಿಯಾಗುತ್ತಾ ಹೋಗಿ ಹಿಮ ಕರಗುತ್ತಾ ಸಮುದ್ರಮಟ್ಟವು ನಿಧಾನವಾಗಿ ಏರಿತು. ಆ ಸಮಯದಲ್ಲಿ ಸಮುದ್ರ ಮಟ್ಟವು ಸುಮಾರು 120 ಮೀಟರ್‌ನಷ್ಟು ಏರಿಕೆಯನ್ನು ಕಂಡಿದೆ ಎಂದು ಭೂವಿಜ್ಞಾನಿಗಳ ಸಂಶೋಧನೆಯಿAದ ತಿಳಿದುಬಂದಿದೆ.

ಪ್ರಸ್ತುತ ಜಾಗತಿಕ ಹವಾಮಾನ ಏರಿಕೆಯು ಕೇವಲ ಒಂದು ಶತಮಾನದ ಅವಧಿಯಲ್ಲಿ, ಐತಿಹಾಸಿಕ ನೈಸರ್ಗಿಕ ದರಕ್ಕಿಂತ ಕನಿಷ್ಠ 10ರಿಂದ 20 ಪಟ್ಟು ವೇಗವಾಗಿ ಸಂಭವಿಸುತ್ತಿದೆ. ಇದಕ್ಕೆ ಕಾರಣ ಹಿಂದಿನ ಹವಾಮಾನ ಬದಲಾವಣೆಗಳು ಹೆಚ್ಚಾಗಿ ಭೂಕಕ್ಷೆಯ ಬದಲಾವಣೆಗಳು, ಸೂರ್ಯನ ಶಕ್ತಿಯ ಉತ್ಪಾದನೆಯಲ್ಲಿ ಏರಿಳಿತಗಳು ಮತ್ತು ಜ್ವಾಲಾಮುಖಿ ಮುಂತಾದ ಚಟುವಟಿಕೆಗಳಂತಹ ನೈಸರ್ಗಿಕ ಅಂಶಗಳಿಂದ ಉಂಟಾಗಿವೆ. ಆದರೆ 1800ರ ನಂತರ ನೈಸರ್ಗಿಕ ಬದಲಾವಣೆಗಳ ಜೊತೆಗೆ, ಕೈಗಾರಿಕಾ ಕ್ರಾಂತಿಯ ಪ್ರಾರಂಭದಿಂದ ಕಲ್ಲಿದ್ದಲು, ತೈಲ, ಅನಿಲ ಮುತಾದವನ್ನು ಸುಡುವುದರಿಂದಾಗಿ ಪ್ರಸ್ತುತ ಹವಾಮಾನ ಬದಲಾವಣೆಯು ಇಂಗಾಲಾಮ್ಲ, ಮೀಥೇನ್ ಮುಂತಾದ ಹೆಚ್ಚು ಹೆಚ್ಚು ವಿಷಾನಿಲಗಳನ್ನು ವಾತಾವರಣದ ಹಸಿರುಮನೆಗೆ ಬಿಡುತ್ತಿವೆ. ಹಿಮಪದರಗಳಿಂದ ಪಡೆದ ದತ್ತಾಂಶದಂತೆ ಕಳೆದ 8 ಲಕ್ಷ ವರ್ಷಗಳಲ್ಲಿ ವಾತಾವರಣದ ಇಂಗಾಲಾಮ್ಲದ ಮಟ್ಟವು 300 ಪಿಪಿಎಮ್ (ಮಿಲಿಯನ್ ಭಾಗ ಗಾಳಿಯಲ್ಲಿ 300 ಭಾಗ) ಮೀರಿರಲಿಲ್ಲ. ಆದರೆ ಪ್ರಸ್ತುತ ಕ್ರಿ.ಶ. 1800ರಿಂದ ಈ ಮಟ್ಟವು 400 ಪಿಪಿಎಮ್‌ಗಿಂತಲೂ ಹೆಚ್ಚಾಗಿದೆ. ಇದರಿಂದ ಹವಾಮಾನ ಬದಲಾವಣೆಯು ಹಿಂದೆಂದಿಗಿAತಲೂ ಹೆಚ್ಚು ವೇಗವಾಗಿ ಸಂಭವಿಸುತ್ತಿದೆ. 1901-1971ರ ಮಾಹಿತಿಗೆ ಹೋಲಿಸಿದರೆ ಇತ್ತೀಚಿನ ಸಮುದ್ರಮಟ್ಟ ಏರಿಕೆಯು ಸುಮಾರು ಮೂರು-ನಾಲ್ಕು ಪಟ್ಟು ಹೆಚ್ಚಾಗಿದೆ. ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆ, ಸಮುದ್ರದ ನೀರು ಹೆಚ್ಚು ಆಮ್ಲೀಯವಾಗುತ್ತಿರುವುದು, ಪರ್ವತ ಮತ್ತು ಧ್ರುವಗಳ ಹಿಮನದಿಗಳು ಶತಮಾನಗಳಿಂದ ಕರಗುತ್ತಿರುವುದು ಮುಂದುವರೆದಿದೆ.

ಮಂಜುಗಡ್ಡೆ ಪದರಗಳಲ್ಲಿ ಹುದುಗಿರುವ 60 ಲಕ್ಷ ವರ್ಷದ ಗಾಳಿಯ ಗುಳ್ಳೆಗಳು:

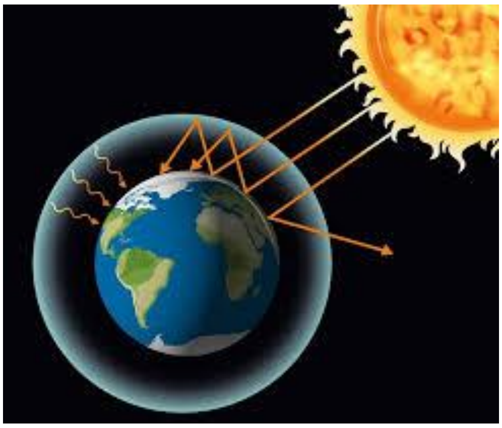
2025ರಲ್ಲಿ ಅಂಟಾರ್ಟಿಕಾ ಪೂರ್ವದ ಅಲನ್ ಹಿಲ್ಸ್ ಎಂಬಲ್ಲಿ ಮಂಜುಗಡ್ಡೆ ಒಳ ಪದರಗಳಲ್ಲಿ ಹುದುಗಿರುವ ೬೦ ಲಕ್ಷ ವರ್ಷಗಳಷ್ಟು ಹಳೆಯದಾದ ಗಾಳಿಯ ಗುಳ್ಳೆ(Air Bubbles)ಗಳನ್ನು ಅಧ್ಯಯನ ಮಾಡಿದ ವರದಿ ಅಚ್ಚರಿ ತರುತ್ತಿದೆ. ಈ ವರದಿಯು ಇದುವರೆಗೆ ಕಂಡುಬAದ ಅತ್ಯಂತ ಹಳೆಯ ಹವಾಮಾನ ದಾಖಲೆಗಳನ್ನು ಹಿಂದೆ ತಳ್ಳುತ್ತದೆ. ಈ ಗಾಳಿಯ ಗುಳ್ಳೆಗಳನ್ನು ಅಧ್ಯಯನ ಮಾಡಿದಾಗ ಪ್ರಾಚೀನ ಕಾಲದ ವಾತಾವರಣವು ಇಂಗಾಲಾಮ್ಲ, ಮೀಥೇನ್, ಮತ್ತು ಆಮ್ಲಜನಕದಿಂದ ತುಂಬಿತ್ತೆಂದು ಆ ಕಾಲದ ಉಷ್ಣಾಂಶ ಮತ್ತು ವಾತಾವರಣ ಪರಿಸ್ಥಿತಿಗಳು ಅರಿವಾಗುತ್ತವೆ. ಈ ಹವಾಮಾನದ ಇತಿಹಾಸವು ಹಿಂದಿನ ಹಸಿರುಮನೆ ಅನಿಲದ ಸಾಂದ್ರತೆ ಮತ್ತು ವಾತಾವರಣವು ಆಗಿನ ಕಾಲದ ಹಿಮನದಿಗಳ ಚಕ್ರಕ್ಕೆ ಹೇಗೆ ಸ್ಪಂದಿಸುತ್ತದೆ ಎಂಬುದು ತಿಳಿದು ಬರುತ್ತದೆ.



ಅಲನ್ ಹಿಲ್ಸ್ ಎಂಬಲ್ಲಿ ಮಂಜುಗಡ್ಡೆ ಪದರಗಳಲ್ಲಿ ಹುದುಗಿರುವ 60 ಲಕ್ಷ ವರ್ಷದ ಗಾಳಿಯ ಗುಳ್ಳೆ

ಜಾಗತಿಕ ತಾಪಮಾನಕ್ಕೂ ವಾತಾವರಣದಲ್ಲಿನ ಇಂಗಾಲಾಮ್ಲಕ್ಕೂ ಸಂಬಂಧ:

ಇಂದಿನ ದಿನಗಳಲ್ಲಿ ಹಿಂದಿಗಿಂತ ವಾತಾವರಣದಲ್ಲಿ ಇಂಗಾಲಾಮ್ಲ ಅತ್ಯಂತ ಹೆಚ್ಚು ಪ್ರಮಾಣದಲ್ಲಿ ಸೇರ್ಪಡೆಯಾಗಿದೆ. ಈ ಇಂಗಾಲಾಮ್ಲದಿಂದ ಹಸಿರುಮನೆ ನಿರ್ಮಾಣವಾಗಿದೆ. ಈ ಹಸಿರುಮನೆಯು ಸೂರ್ಯನ ಬೆಳಕು ಮತ್ತು ಶಾಖವನ್ನು ತನ್ನ ಮೂಲಕ ಭೂಮಿಗೆ ಬಿಡುತ್ತದೆ. ಹಸಿರುಮನೆಯು ಭೂಮಿಯ ಸುತ್ತ ಒಂದು ಟೊಳ್ಳಾದ ಗಾಜಿನಂತೆ ಗೋಳಾಕಾರದಲ್ಲಿ ಭೂಮಿಯನ್ನು ಆವರಿಸಿಕೊಂಡು ಬಿಟ್ಟಿದೆ. ಇದರ ಮೂಲಕ ಬೆಳಕು ಮಾತ್ರ ಹಿಂದಿರುಗಲು ಸಾಧ್ಯ, ಆದರೆ ಶಾಖವು ವಾತಾವರಣದಲ್ಲಿ ಹಿಂದಿರುಗಲು ಸಾಧ್ಯವಿಲ್ಲದೆ ವಾತಾವರಣದಲ್ಲೇ ಉಳಿದುಕೊಂಡುಬಿಡುತ್ತದೆ. ಈ ಹಸಿರುಮನೆ ಗುಣವನ್ನು 1959ರಲ್ಲಿ ಐರಿಷ್ ಭೌತವಿಜ್ಞಾನಿಯಾದ ಜಾನ್ ಟಿಂಡಾಲ್ John Tyndall) ಕಂಡುಹಿಡಿದರು.



ಹಸಿರುಮನೆ ಪರಿಣಾಮ

1959ರಲ್ಲಿ ಐರಿಷ್ ಭೌತವಿಜ್ಞಾನಿಯಾದ ಜಾನ್ ಟಿಂಡಾಲ್ (John Tyndall) ಕಂಡುಹಿಡಿದರು. ಇದು 'ಟಿಂಡಾಲ್ ಎಫೆಕ್ಟ್' ಎಂದೇ ಪ್ರಸಿದ್ಧಿಯಾಗಿದೆ. ಹಾಗಾದರೆ ಈ ಇಂಗಾಲಾಮ್ಲವು ವಾತಾವರಣಕ್ಕೆ ಹೇಗೆ ಬಂದಿದೆ ಎಂಬ ಪ್ರಶ್ನೆ ಎದುರಾಗುತ್ತದೆ. ಮೊದಲು ಈ ಇಂಗಾಲಾಮ್ಲವು ಸ್ವಲ್ಪ ಪ್ರಮಾಣದಲ್ಲಿ ಇದ್ದು ಭೂಮಿಯ

ಧ್ರುವಪ್ರದೇಶಗಳನ್ನು ಹೊರತುಪಡಿಸಿ ಉಳಿದೆಡೆಯಲ್ಲಿ ಮಾನವನಿಗೆ ಉಷ್ಣಾಂಶವು ಸರಾಸರಿ ಸರಿಹೊಂದುವAತೆ ಇತ್ತು. ಸ್ವಿಡಿಷ್ ವಿಜ್ಞಾನಿಯಾದ ಸ್ವಾಂಟೆ ರ್ಹಿನಸ್ (Svante Arrhenius) ಅವರ ಸಂಶೋಧನೆಯಂತೆ 1900ರ ಮೊದಲಲ್ಲಿ ಪ್ರಾರಂಭವಾದ ಕೈಗಾರಿಕಾ ಕ್ರಾಂತಿಯು ಪ್ರಾರಂಭವಾದ ನಂತರ, ಅನೇಕ ಕೈಗಾರಿಕೆಗಳಲ್ಲಿ ಕಲ್ಲಿದ್ದಲನ್ನು ಉರಿಸಲು ಪ್ರಾರಂಭಿಸಿದರು. ಇದರಿಂದ ಬಿಡುಗಡೆಯಾದ ಇಂಗಾಲ, ಮೀಥೇನ್ ಮುಂತಾದ ವಿಷಾನಿಲಗಳು ವಾತಾವರಣಕ್ಕೆ ಬಿಡುಗಡೆಯಾಗಿ ಅಲ್ಲಿನ ಆಮ್ಲಜನಕದೊಡನೆ ರಾಸಾಯನಿಕ ಕ್ರಿಯೆ ನಡೆದು ಇಂಗಾಲಾಮ್ಲವಾಗಿ ಪರಿವರ್ತನೆ ಹೊಂದಿ ಭೂವಾತಾವರಣವು ಬದಲಾವಣೆ ಹೊಂದುತ್ತಾ ತಾಪಮಾನ ಹೆಚ್ಚುತ್ತಾ ಹೋಯಿತು. ಈಗಿನ ವಾತಾವರಣದಲ್ಲಿ ಇಂಗಾಲದ ಜೊತೆಗೆ ಅದರ ಐಸೋಟೋಪ್ ಕೂಡಾ ಸೇರುತ್ತಿವೆ. ಜಗತ್‌ಪ್ರಸಿದ್ಧ ಭೌತವಿಜ್ಞಾನಿ ಆಲ್ಬರ್ಟ್ ಐನ್‌ಸ್ಟೀನ್ ಹೇಳುವಂತೆ 'ನಾವು ನಮ್ಮ ಸಮಸ್ಯೆಗಳನ್ನು ಸೃಷ್ಟಿಸಿದಾಗ ಬಳಸಿದ ಅದೇ ಆಲೋಚನೆಯಿಂದ ಅವುಗಳನ್ನು ಪರಿಹರಿಸಲು ಸಾಧ್ಯವಿಲ್ಲ, ಹವಾಮಾನ ಬದಲಾವಣೆಯು ಭೂಮಿಯ ಪರಿಸರ ಸ್ಥಿತಿಗಳನ್ನೊಳಗೊಂಡಿರುತ್ತದೆ' . ಈಗ ಈ ಹವಾಮಾನ ಬದಲಾವಣೆಯಿಂದ ಉಂಟಾದ ಸಮಸ್ಯೆಯನ್ನು ಸವಾಲಾಗಿ ಸ್ವೀಕರಿಸಿ ಬಗೆಹರಿಸಬೇಕಾಗಿದೆ.

ವಿಶ್ವ ಪ್ರಸಿದ್ಧ ಉದ್ಯಮಿ ಹಾಗೂ ಆವಿಷ್ಕಾರಕ ಎಲಾನ್ ಮಸ್ಕ್ ಪ್ರಕಾರ 'ಹವಾಮಾನ ಬದಲಾವಣೆಯು ನಿಜ, ತುರ್ತಾಗಿ ನಾವು ಪರಿಹರಿಸಬೇಕು, ನಾವು ಇತಿಹಾಸದಲ್ಲಿ ಅತ್ಯಂತ ಅಪಾಯಕಾರಿ ಪ್ರಯೋಗವನ್ನು ನಡೆಸುತ್ತಿದ್ದೇವೆ, ವಾತಾವರಣವು ಎಷ್ಟು ಇಂಗಾಲಾಮ್ಲವನ್ನು ನಿಭಾಯಿಸಬಲ್ಲದು ಎಂಬುದನ್ನು ನೋಡಬೇಕು. ಅಂದರೆ ವಾತಾವರಣದಲ್ಲಿನ ಇಂಗಾಲಾಮ್ಲ ಮುಂತಾದವನ್ನು ತೆಗೆದುಹಾಕುವ ಜೊತೆಗೆ ಅದು ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ವಾತಾವರಣ ಸೇರದಂತೆ ಮಾಡುವುದಕ್ಕೆ ಪ್ರಯತ್ನ ಮಾಡಬೇಕಿದೆ. ಸಾರಿಗೆ ಸಂಬಂಧಿತ ಹೊರಸೂಸುವಿಕೆಯನ್ನು ತಡೆಯಲು ಎಲೆಕ್ಟ್ರಿಕ್ ವಾಹನಗಳನ್ನು ಅಭಿವೃದ್ಧಿ ಮಾಡುತ್ತಿದ್ದಾರೆ, ಸೌರಶಕ್ತಿಯನ್ನು ಕೈಗೆಟುಕುವ ಮತ್ತು ಸುಲಭವಾಗಿ ಸಿಗುವಂತೆ ಮಾಡಿ ಪಳೆಯುಳಿಕೆ ಇಂಧನಗಳನ್ನು ದೂರ ಸರಿಯುವಂತೆ ಮಾಡುವ ಪ್ರಯತ್ನ ನಡೆದಿದೆ. ಈಗ ವಾತಾವರಣದ ಇಂಗಾಲಾಮ್ಲವನ್ನು ಹೊರತೆಗೆಯಲು ಹೊಸದಾದ ತಂತ್ರಜ್ಞಾನ ಅನ್ವೇಷಣೆಯಲ್ಲೂ ಇದ್ದಾರೆ.

ವಾತಾವರಣದಲ್ಲಿ ಹಸಿರುಮನೆ ಅನಿಲ ಹೆಚ್ಚಾಗಿ, ತಾಪಮಾನ ಏರಿಕೆಗೆ ಮುಖ್ಯ ಕಾರಣಗಳಾದ 1)29% ವಿದ್ಯುತ್ ಉದ್ಯಮ, 2) 21% ಕೈಗಾರಿಕಾ ದಹನ ಮತ್ತು ಪ್ರಕ್ರಿಯೆಗಳು 3) 15% ಸಾರಿಗೆ ಕ್ಷೇತ್ರಗಳು ಇವೆ. ಇವುಗಳನ್ನು ತಾಪಮಾನ ಏರಿಕೆಯನ್ನು ತಡೆಯುವ ನಿಟ್ಟಿನಲ್ಲಿ ಹೇಗೆ ನಿಯಂತ್ರಿಸಬೇಕೆನ್ನುವುದು ಸವಾಲಾಗಿದೆ.

ಜಾಗತಿಕ ಹವಾಮಾನ ಬದಲಾವಣೆಯ ಪರಿಣಾಮಗಳು:

ಜಾಗತಿಕ ಹವಾಮಾನ ಬದಲಾವಣೆಯು ಭೂಮಿಗೂ, ಮಾನವ ಸಮಾಜಕ್ಕೂ ದೊಡ್ಡ ಅಪಾಯಕರವಾಗಿದೆ. ಭೂಮಿಯ ಸರಾಸರಿ ತಾಪಮಾನ ಏರಿಕೆಯಿಂದಾಗಿ ತೀವ್ರವಾದ ಉಷ್ಣ ಅಲೆಗಳು ಹೆಚ್ಚುತ್ತಿವೆ. ಇದರಿಂದ ಮಾನವನ ಆರೋಗ್ಯ, ಕೃಷಿ, ಮತ್ತು ಪ್ರಕೃತಿಗೆ ಹಾನಿಯಾಗುತ್ತಿದೆ. ಈ ಪರಿಣಾಮವನ್ನು ಕೆಳಗಿನಂತೆ ನೋಡಬಹುದು.

ಹಿಮನದಿಗಳು ಕರಗಿ ಸಮುದ್ರಮಟ್ಟ ಏರಿಕೆ:

ಧ್ರುವ ಪ್ರದೇಶಗಳ ಮಂಜುಗಡ್ಡೆ ಪದರಗಳು ಮತ್ತು ಹಿಮನದಿಗಳು ಕರಗುತ್ತಿದ್ದು, ಸಮುದ್ರಮಟ್ಟ ಏರಿಕೆಯಾಗುತ್ತಿದೆ. ಇದರಿಂದ ಕರಾವಳಿ ಪ್ರದೇಶಗಳು ಮತ್ತು ದ್ವೀಪಗಳು ಮುಳುಗುವ ಅಪಾಯವನ್ನು ಎದುರಿಸುತ್ತಿವೆ. ಭೂಮಿಯ ಧ್ರುವಗಳಲ್ಲಿ ಪ್ರತಿ ಚಳಿಗಾಲದಲ್ಲೂ ಧ್ರುವದ ಸಮುದ್ರಗಳ ಮೇಲೆ ಅನೇಕ ಅಡಿಗಳ ತನಕ ಅಗಾಧವಾದ ಮಂಜುಗಡ್ಡೆಯಿಂದ ತುಂಬಿ ಬೇಸಿಗೆಯಲ್ಲಿ ಬಹುತೇಕ ಮಂಜುಗಡ್ಡೆ ಕರಗಿ ನೀರು ಹರಿದುಹೋಗುತ್ತದೆ. ಹೀಗೆ ಎಷ್ಟು ಹಿಮನದಿಗಳು ಕರಗಿ ನೀರಾಗಿ ಹೋಗುತ್ತದೆ ಎನ್ನುವುದರ ಮೇಲೆ ಭೂಮಿಯ ಉಷ್ಣಾಂಶ ಎಷ್ಟು ಹೆಚ್ಚಾಗಿದೆ ಎನ್ನುವುದನ್ನು ಕಂಡುಹಿಡಿಯುತ್ತಾರೆ. 2012ರಲ್ಲಿ ನಾಸಾದ ಸ್ಯಾಟಲೈಟ್‌ನಿಂದ ವೀಕ್ಷಿಸಿದಂತೆ, ಉತ್ತರ ಧ್ರುವದ ಆರ್ಕ್ಟಿಕ್ ಸಾಗರ ಪ್ರದೇಶದಲ್ಲಿ 3.41 ದಶಲಕ್ಷ ಚದರ ಕಿ.ಮೀ. ವಿಸ್ತೀರ್ಣದ ಮಂಜುಗಡ್ಡೆ ಪ್ರದೇಶವಿತ್ತು. ಇದಕ್ಕೆ ಹಿಂದೆ 2007, 2005, 2002 ಮತ್ತು 1995ರಲ್ಲಿ, ಹೀಗೆ 1953ರಿಂದಲೂ ಪ್ರತಿ ಕೆಲವು ವರ್ಷಗಳಿಗೊಮ್ಮೆ ಮಂಜುಗಡ್ಡೆ ಪ್ರದೇಶದ ವಿಸ್ತೀರ್ಣಗಳನ್ನು ದಾಖಲಿಸುತ್ತಾ ಬಂದಿದ್ದಾರೆ. ಅದರಂತೆ 2018ರಲ್ಲಿನ ಅಧ್ಯಯನದಂತೆ ಬೆಳಕಿಗೆ ಬಂದ ವಿಷಯವೆಂದರೆ-ಆರ್ಕ್ಟಿಕ್ ಸಮುದ್ರದಲ್ಲಿ ಮಂಜುಗಡ್ಡೆಯ ಪ್ರದೇಶವು ತನ್ನ ವಿಸ್ತೀರ್ಣವನ್ನು ಸುಮಾರು 66% ನಷ್ಟು ಕಳೆದುಕೊಂಡಿದೆ ಎಂದು ತಿಳಿದುಬರುತ್ತದೆ.

ಇದೇ ರೀತಿ ಗ್ರೀನ್‌ಲ್ಯಾಂಡ್ ಮಂಜುಗಡ್ಡೆ ಪದರದ ಗುರುತ್ವ ಕ್ಷೇತ್ರವನ್ನು ನಾಸಾದ ಅವಳಿ ಸ್ಯಾಟಲೈಟ್ ಆದ 'ಗ್ರಾವಿಟಿ ರಿಕವರಿ ಅಂಡ್ ಕ್ಲೈಮೇಟ್ ಎಕ್ಸ್ಪರಿಮೆಂಟ್' (GRACE) ವೀಕ್ಷಿಸಿದಂತೆ 'ಜಾಗತಿಕವಾಗಿ ಹಿಮನದಿಗಳು ತಮ್ಮ ದ್ರವ್ಯರಾಶಿಯನ್ನು ಸ್ಥಿರವಾಗಿ ಕಳೆದುಕೊಳ್ಳುತ್ತಿವೆ' ಎಂದು ತಿಳಿಸುತ್ತದೆ. ಇದು ಭೂಮಿಯ ಇತರ ವೀಕ್ಷಣೆಗಳಿಗೂ ಹೊಂದಾಣಿಕೆಯಾಗುತ್ತದೆ ಎಂದು ದೃಢಪಟ್ಟಿದೆ. ಹೀಗೆ ಧ್ರುವಗಳ ಮಂಜುಗಡ್ಡೆ ಕರಗುತ್ತಿದ್ದರೆ ಭೂಮಿಯ ತಾಪಮಾನ ಹೆಚ್ಚಾಗುತ್ತಿದೆ ಎಂದು ನಿರ್ಧಾರವಾಗುತ್ತದೆ. ಜಾಗತಿಕ ಹವಾಮಾನ ಸಂಸ್ಥೆಯು ಈಚೆಗೆ ವರದಿ ಸಲ್ಲಿಸಿರುವಂತೆ ೨೧ನೇ ಶತಮಾನವು ಅತ್ಯಂತ ಹೆಚ್ಚು ತಾಪಮಾನ ತುಂಬಿದ ವರ್ಷವಾಗಿವೆ. ಇದರಿಂದ ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆ ಮುಂದುವರೆಯುತ್ತಿದೆ ಎಂದು ಹವಾಮಾನ ವಿಜ್ಞಾನಿಗಳು ಅಭಿಪ್ರಾಯಪಡುತ್ತಾರೆ.

ಹವಾಮಾನ ಬದಲಾವಣೆಯು ಸಾಮಾಜಿಕ ಮತ್ತು ರಾಜಕೀಯ ಸಮಸ್ಯೆ:

ಇಂಗಾಲಾಮ್ಲವು ಹಸಿರುಮನೆಗೆ ಸೇರ್ಪಡೆಯಾಗಲು ಕಲ್ಲಿದ್ದಲನ್ನು ಉರಿಸುವುದು, ಸ್ವಾಭಾವಿಕ ಅನಿಲ ಮತ್ತು ಆಧುನಿಕ ನಾಗರೀಕತೆಯ ಕುರುಹಾದ ಪೆಟ್ರೋಲ್‌ಅನ್ನು ಉರಿಸುವುದರಿಂದ ವಾತಾವರಣದಲ್ಲಿ ಇಂಗಾಲಾಮ್ಲ ಸೇರ್ಪಡೆಯಾಗುತ್ತಿದೆ ಎಂದು ಎಲ್ಲರಿಗೂ ತಿಳಿದಿದೆ. ಈ ಪರಿಣಾಮವನ್ನು ಸಾರ್ವಜನಿಕರು ಮತ್ತು ರಾಜಕೀಯ ವ್ಯಕ್ತಿಗಳು ತಳ್ಳಿಹಾಕಿದರೂ ವೈಜ್ಞಾನಿಕವಾಗಿ ಋಜುವಾತಾಗಿದೆ.

ಹವಾಮಾನ ಬದಲಾವಣೆಯನ್ನು ವಿವರಿಸುವುದು ಒಂದು ಕ್ಲಿಷ್ಟಕರವಾದ ಕ್ಷೇತ್ರ. ಅನೇಕ ವೈಜ್ಞಾನಿಕ ಕ್ಷೇತ್ರಗಳಲ್ಲಿ ಹರಡಿಕೊಂಡಿದ್ದು ಭೌತ, ರಾಸಾಯನಿಕ, ಭೂಗರ್ಭ, ಜೀವ, ಸಾಗರ, ಸಂಖ್ಯಾ ವಿಜ್ಞಾನ ಮತ್ತು ರಾಜಕೀಯ ವಿಜ್ಞಾನ ಮುಂತಾದ ವಿಷಯಗಳ ಮೇಲೆ ಅವಲಂಬಿತವಾಗಿದೆ. ಯೂರೋಪಿನ ಕೆಲವು ಕಡೆ ಚಳಿಗಾಲದಲ್ಲಿ ಅತಿಯಾದ ಮಂಜುಗಡ್ಡೆಯುಂಟಾಗುತ್ತದೆ ಮತ್ತೆ ಕೆಲವು ಕಡೆ ಉಷ್ಣತೆಯು ಏರಿಕೆಯಾಗುತ್ತದೆ. ಆದ್ದರಿಂದ ಹವಾಮಾನ ಏರಿಕೆಯು ಜಾಗತಿಕವಾಗಿ ಆಗುತ್ತಿಲ್ಲ ಎಂದು ಕೆಲವು ವಿಜ್ಞಾನಿಗಳು ನಿರ್ಣಯಕ್ಕೆ ಬಂದಿದ್ದಾರೆ. ಅದರಂತೆ ಮುಂದಿನ ದಿನಗಳಲ್ಲಿ ಜಾಗತಿಕವಾಗಿ ಎಲ್ಲಾ ಕಡೆಯೂ ಏಕಮುಖನಾಗಿ ತಾಪಮಾನ ಏರಿಕೆಯಾಗದೆ, ಅಸಮಾನ

ಹವಾಮಾನವನ್ನು ಎದುರುಸುತ್ತಿದ್ದೇವೆ ಎನ್ನುತ್ತಿದ್ದಾರೆ. ವಿಶ್ವದಲ್ಲಿ ಎಲ್ಲಾ ಕಡೆಯೂ ಸ್ಥಳೀಯವಾಗಿ ವಾಯುಗುಣದ ಬದಲಾವಣೆಯನ್ನು ನೇರವಾಗಿ ಎದುರಿಸುತ್ತಿದ್ದೇವೆ.

ಆದರೆ ಜಾಗತಿಕವಾಗಿ ಹವಾಗುಣದ ಬದಲಾವಣೆಯು ಅಷ್ಟೇನೂ ವ್ಯತ್ಯಾಸವಾಗದೆ ಅದು ನೇರವಾಗಿ ಜನತೆಯನ್ನು ಬಾಧಿಸುತ್ತಿಲ್ಲ, ಆದ್ದರಿಂದ ಎಲ್ಲಾ ದೇಶಗಳ ಜನತೆ ಹವಾಮಾನ ಬದಲಾವಣೆಯನ್ನು ಗಂಭೀರವಾಗಿ ತೆಗೆದುಕೊಳ್ಳುತ್ತಿಲ್ಲ. ಆದರೂ ಈಗಾಗಲೇ ಅನೇಕ ದೇಶಗಳಲ್ಲಿ ವಾತಾವರಣ ಬದಲಾವಣೆಯ ವಾಸ್ತವಿಕತೆಯು ಅಲ್ಲಲ್ಲಿ ಅನುಭವವಾಗುತ್ತಿದೆ. ಅಸಮಂಜಸವಾಗಿ ಹಿಮಪಾತ(Snow fall) ವಾಗುವುದು. ಉದಾಹರಣೆಗೆ ಈಚೆಗೆ ಮರುಭೂಮಿ ಪ್ರದೇಶವಾದ ಮಧ್ಯಪ್ರಾಚ್ಯ ಪ್ರದೇಶಗಳಲ್ಲಿ ಮಳೆ ಹಿಮಪಾತವಾಗಿರುವುದು, ಅನೇಕ ಕಡೆ ಅಸಮಂಜಸವಾಗಿ ಹವಾಮಾನ ಬದಲಾವಣೆಯಿಂದ ಬೇಸಿಗೆಯಂತೆ ಸೆಕೆಯಾಗುವುದು ಆಗುತ್ತಿದೆ. ಅಂತೆಯೇ ಹವಾಮಾನ ವೈಪರೀತ್ಯದಿಂದ ಚಂಡಮಾರುತಗಳು, ರಣಬಿಸಿಲಿನ ಅಲೆ (Heat wave) ಮುಂತಾದ ಜಾಗತಿಕ ತಾಪಮಾನದ ಕೊಡುಗೆಯನ್ನು ನೀಡುತ್ತಿವೆ.

ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಯ ಪ್ರಮುಖ ಪರಿಣಾಮಗಳು:

ಬಿಲ್ ಗೇಟ್ಸ್ ಹೇಳುವಂತೆ "ಹವಾಮಾನ ಬದಲಾವಣೆಯ ಬಗ್ಗೆ ಅನೇಕರ ದೃಷ್ಟಿಕೋನವು ತಪ್ಪಾಗಿದೆ ಮತ್ತು ಇತರ ಪ್ರಮುಖ ವಿಷಯಗಳ ಪ್ರಗತಿಗೆ ಅಡ್ಡಿಯಾಗುತ್ತಿದೆ. ಹವಾಮಾನ ಬದಲಾವಣೆಯು ಗಂಭೀರ ಪರಿಣಾಮಗಳನ್ನು ಬೀರುತ್ತಿದೆಯಾದರೂ ಮಾನವನ ಅವನತಿಗೆ ಕಾರಣವಾಗುವುದಿಲ್ಲ" ಎಂದು ಅವರು ವಾದಿಸುತ್ತಾರೆ.

ಭಾರತದಂತಹ ದೇಶಗಳಲ್ಲಿ ಹೆಚ್ಚು ತೀವ್ರವಾದ ಶಾಖದ ಅಲೆಗಳು ಆಗಾಗ್ಗೆ ಸಂಭವಿಸುತ್ತವೆ. ಇದರಿಂದ ಹೊರಗಡೆ ಕೆಲಸ ಮಾಡುವವರಿಗೆ ಗಂಭೀರ ಪರಿಣಾಮ ಎದುರಿಸಬೇಕಾಗುತ್ತಿದೆ. ಈ ಉಷ್ಣವಲಯದ ಚಂಡಮಾರುತಗಳಿಂದ ಗಾಳಿಯ ತೀವ್ರತೆ ಮತ್ತು ಕೆಲವು ಕಡೆ ಮಳೆಯ ಪ್ರಮಾಣ ಹೆಚ್ಚುತ್ತಿದೆ. ಇದರಿಂದ ಪ್ರವಾಹದ ಅಪಾಯ ಮತ್ತೆ ಕೆಲವೆಡೆ ನೀರಿನ ಅಭಾವದಿಂದ ದೀರ್ಘಕಾಲದ ಬರಗಾಲದ ಪ್ರದೇಶವಾಗಿದೆ. ವಿಶೇಷವಾಗಿ ಅಂತರ್ಜಲ ಮಟ್ಟವು ಕಡಿಮೆಯಾಗುವುದರಿಂದ ನೀರು ಸರಬರಾಜು ವ್ಯವಸ್ಥೆಯಲ್ಲಿ ವ್ಯತ್ಯಯವಾಗಬಹುದು. ಬೆಳೆಯುವ ಬೆಳೆಗಳ ಪೌಷ್ಟಿಕಾಂಶದ ಗುಣ ಮಟ್ಟವೂ ಕಡಿಮೆಯಾಗುತ್ತದೆ. ಹೆಚ್ಚು ಶಾಖ ವಾಯುಮಾಲಿನ್ಯದಿಂದ ಸಾಂಕ್ರಾಮಿಕ ಮತ್ತು ಇತರ ಆರೋಗ್ಯ ಸಮಸ್ಯೆಯುಂಟಾಗುವ ಸಾಧ್ಯತೆ ಹೆಚ್ಚು. ವಿಶ್ವ ಆರೋಗ್ಯ ಸಂಸ್ಥೆಯ ಪ್ರಕಾರ 2030ರಿಂದ 2050 ನಡುವೆ ಹವಾಮಾನ ಬದಲಾವಣೆಯಿಂದ ವಿಶ್ವಾದ್ಯಂತ ಸುಮಾರು 2.5 ಲಕ್ಷಕ್ಕೂ ಹೆಚ್ಚು ಸಾವು ಸಂಭವಿಸಬಹುದೆAದು ಲೆಕ್ಕ ಹಾಕಿದೆ. ಹವಾಮಾನ ಬದಲಾವಣೆಯಿಂದ ಭೂಮಿಯು ಜೀವವೈವಿಧ್ಯದ ನಷ್ಟವನ್ನು ಅನುಭವಿಸಬೇಕಾಗುತ್ತದೆ. ಇದರಿಂದ ಸಸ್ಯ ಮತ್ತು ಸಮುದ್ರಗಳಲ್ಲಿ ಪ್ರಾಣಿ ಪ್ರಭೇದಗಳು ತಮ್ಮ ನೈಸರ್ಗಿಕ ವಾಸಸ್ಥಾನವನ್ನು ಕಳೆದುಕೊಳ್ಳುವುದಲ್ಲದೆ, ಅನೇಕವು ಅಳಿವಿನ ಅಪಾಯವನ್ನು ಎದುರಿಸಬೇಕಾಗುತ್ತದೆ. ಮೂಲ ಸೌಕರ್ಯಗಳ ಹಾನಿ, ಕೃಷಿ ಉತ್ಪಾದನೆಯಲ್ಲಿ ನಷ್ಟ ಮತ್ತು ಆರೋಗ್ಯ ವೆಚ್ಚಗಳ ಹೆಚ್ಚಳದಿಂದಾಗಿ ಆರ್ಥಿಕ ನಷ್ಟವನ್ನು ತೆರಬೇಕಾಗುತ್ತದೆ. ಈ ತೀವ್ರ ಪರಿಣಾಮಗಳನ್ನು ತಪ್ಪಿಸಲು ಹಸಿರುಮನೆ ಅನಿಲಗಳ ಹೊರಸೂಸುವಿಕೆಯನ್ನು ಆದಷ್ಟು ವೇಗವಾಗಿ ಮತ್ತು ದೊಡ್ಡ ಪ್ರಮಾಣದಲ್ಲಿ ಕಡೆಮೆ ಮಾಡಬೇಕೆಂದು ವಿಜ್ಞಾನಿಗಳು ಎಚ್ಚರಿಸಿರುತ್ತಾರೆ.

ಹೀಗೆಯೇ ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಯು ಮುಂದುವರೆದರೆ 21ನೇ ಶತಮಾನದ ಅಂತ್ಯದ ವೇಳೆಗೆ ಸಮುದ್ರದ ಮಟ್ಟವು 2 ಮೀಟರ್‌ನಷ್ಟು ಏರಬಹುದೆಂದು ವಿಜ್ಞಾನಿಗಳು ಲೆಕ್ಕಹಾಕಿರುತ್ತಾರೆ

ತೀವ್ರ ಹವಾಮಾನ ಘಟನೆಗಳು:

ಈಚೆಗೆ ಚಂಡಮಾರುತಗಳು, ಭೂಕಂಪ, ಭೀಕರ ಮಳೆ, ಪ್ರವಾಹ, ಬರ ಮತ್ತು ಕಾಡ್ಗಿಚ್ಚುಗಳು ಹೆಚ್ಚಾಗಿ ಸಂಭವಿಸುತ್ತಿವೆ. ಇದರಿಂದ ಜೀವಹಾನಿ, ಆಸ್ತಿಹಾನಿ ಉಂಟಾಗುತ್ತಿವೆ. ಪರಿಸರ ವ್ಯವಸ್ಥೆ ಮತ್ತು ಜೀವ ವೈವಿಧ್ಯತೆಗೆ ಹಾನಿಯುಂಟಾಗುತ್ತಿದೆ. ಈ ವೇಗವಾದ ಜಾಗತಿಕ ತಾಪಮಾನ ಹೆಚ್ಚಳದಿಂದ ಅನೇಕ ಸಸ್ಯ ಮತ್ತು ಪ್ರಾಣಿಗಳು ಹೊಂದಿಕೊಳ್ಳದೆ ಅದರ ತಳಿ ಹಾಳಾಗುತ್ತಿವೆ. ಉದಾಹರಣೆಗೆ ಕೋರಲ್ ರೀಫ್‌ಗಳು ಬಣ್ಣ ಬದಲಾಯಿಸುತ್ತಿವೆ, ಕೆಲವು ಕಡೆ ವಿನಾಶದ ಅಂಚಿನಲ್ಲಿವೆ. ತಾಪಮಾನ ಏರಿಕೆ ಮತ್ತು ಮಳೆಯ ಮಾದರಿಗಳ ಬದಲಾವಣೆಯಿಂದಾಗಿ ಅನೇಕ ಕಡೆ ಬೆಳೆ ಉತ್ಪಾದನೆ ಕಡಿಮೆಯಾಗುತ್ತಿದೆ. ಇದರಿಂದಾಗಿ ಆಹಾರ ಕೊರತೆ ಮತ್ತು ಬೆಲೆ ಏರಿಕೆಯನ್ನು ಎದುರಿಸಬೇಕಾಗುತ್ತದೆ. ಮಳೆಯ ಅಸಮಾನತೆ ಮತ್ತು ಹಿಮನದಿಗಳು ಕಡಿಮೆಯಾಗುತ್ತಿರುವುದು ಅನೇಕ ಪ್ರದೇಶಗಳಲ್ಲಿ ನೀರಿನ ಕೊರತೆಯುಂಟಾಗುತ್ತಿದೆ. ಉಷ್ಣಾಂಶ ಹೆಚ್ಚಾಗುತ್ತಿರುವುದು, ಸೊಂಕುರೋಗಗಳು ಹೆಚ್ಚಾಗುತ್ತಿರುವುದು, ಅನೇಕ ಕಡೆ ಪೋಷಣೆಯ ಕೊರತೆ ಮತ್ತು ಉಸಿರಾಟದ ಸಂಬಂಧಿತ ಸಮಸ್ಯೆಗಳು ಹೆಚ್ಚಾಗಿ ಮಾನವನ ಆರೋಗ್ಯದಮೇಲೆ ಪರಿಣಾಮ ಉಂಟಾಗುತ್ತಿದೆ. ಮೂಲಸೌಕರ್ಯಗಳಿಗೆ ಹಾನಿ, ಜೀವನೋಪಾಯ ಕಳೆದುಕೊಳ್ಳುವಿಕೆ ಮತ್ತು ಹವಾಮಾನ ವಲಸೆ ಹೆಚ್ಚಾಗಿ ಸಾಮಾಜಿಕ ಸಮಸ್ಯೆಗಳು ಹೆಚ್ಚಾಗುತ್ತಿವೆ. ಆಧುನಿಕ ತಾಪಮಾನ ಏರಿಕೆಯು ಮಧ್ಯಕಾಲೀನ ಕಾಲದ ಏರಿಕೆಗಿಂತ ಅಂದರೆ 1400 ವರ್ಷಗಳ ಹಿಂದಿಗಿಂತ ಭಿನ್ನವಾಗಿದೆ. ಹೀಗೆ ಆರ್ಥಿಕ ಮತ್ತು ಸಾಮಾಜಿಕ ಪರಿಣಾಮಗಳ ಮೇಲೆ ನೇರವಾದ ಪ್ರಭಾವ ಬೀರುತ್ತಿದೆ.

ಮಾನವ ಸಮಾಜದ ಕೊಡುಗೆ: ಜಾಗತಿಕ ಹವಾಮಾನ ಏರಿಕೆಗೆ ಅಗಾಧ ಕೊಡುಗೆಯಾಗಿ ಮಾನವ ಸಮಾಜ. ಇಲ್ಲಿ ನಾವು ಒಂದಲ್ಲಾ ಒಂದು ರೀತಿಯಲ್ಲಿ ಹವಾಮಾನ ಏರಿಕೆಯನ್ನು ತಡೆಯಲು ಜೀವನ ಶೈಲಿಯನ್ನು ಆಯ್ಕೆಮಾಡಿಕೊಳ್ಳಬೇಕಾಗಿದೆ. ಅತಿಯಾದ ವಿದ್ಯುತ್ತಿನ ಅಗತ್ಯವಿಲ್ಲದೆಡೆ ಬಳಕೆಯು ಶಕ್ತಿಯ ದುರುಪಯೋಗವಾಗುತ್ತದೆ. ಇಂಗಾಲದ ಹೊರಸೂಸುವಿಕೆಯನ್ನು ತಡೆಯಲು ಅಥವಾ ಕಡಿಮೆ ಮಾಡಲು ಅಗತ್ಯ ಕ್ರಮ ಕೈಗೊಳ್ಳಬೇಕಾಗಿದೆ. ಇದು ರಾಜಕೀಯ, ಆರ್ಥಿಕ ಪರಿಣಾಮ ಮತ್ತು ಸಾರ್ವಜನಿಕ ಸಂಪರ್ಕವನ್ನು ಅವಲಂಬಿಸಿದೆ. ಅನೇಕ ವೇಳೆ ಸಾರ್ವಜನಿಕ ಸಂಪರ್ಕಗಳ ಮೇಲೆ ವೈಜ್ಞಾನಿಕ ನಿರ್ಧಾರಗಳು ಅವಲಂಬಿತವಾಗಿ ಬಿಡುತ್ತವೆ. ಸಾರ್ವಜನಿಕರಲ್ಲಿ ಅನಕ್ಷರಸ್ಥರೇ ಹೆಚ್ಚು ಇರುವ ಕಡೆ ಅವರು ಎಷ್ಟೇ ಬುದ್ಧಿವಂತರಾಗಿದ್ದರೂ, ಹವಾಮಾನ ಬದಲಾವಣೆಯ ಬಗ್ಗೆ ಮನಸ್ಸಿಗೆ ನಾಟುವುದು ಕಷ್ಟವಾಗುತ್ತದೆ. ಅವರಿಗೆ ವಾತಾವರಣದ ಬದಲಾವಣೆ ಅದರ ವೈಜ್ಞಾನಿಕ ಅರಿವು, ಅದರ ಕಾರಣ ಅರ್ಥವಾಗದೆ, ಅದರ ಬಗ್ಗೆ ಕಾಳಜಿ ತೆಗೆದುಕೊಳ್ಳುವುದಿಲ್ಲ. ಅದಿರಲಿ ವಿದ್ಯಾವಂತರೂ, ಅದರ ಅರಿವು ಇರುವವರೂ ಕೂಡಾ ವಾತಾವರಣ ಬದಲಾವಣೆ, ಜಾಗತಿಕ ತಾಪಮಾನದ ಬಗ್ಗೆ ಅಸಡ್ಡೆ ತೋರುತ್ತಿದ್ದಾರೆ.

ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಯನ್ನು ನಿಯಂತ್ರಿಸಲು ತೆಗೆದುಕೊಂಡ ಕ್ರಮಗಳು:

ಯೂರೋಪ್, ಅಮೆರಿಕ ಮತ್ತು ಅನೇಕ ದೇಶಗಳು ಮುಖ್ಯವಾಗಿ ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಯನ್ನು ನಿಯಂತ್ರಿಸಲು ಹಲವಾರು ಮಹತ್ವದ ಕ್ರಮಗಳನ್ನು ತೆಗೆದುಕೊಂಡಿವೆ. 1. ಯೂರೋಪಿಯನ್ ಗ್ರೀನ್ ಡೀಲ್‌ನಂತೆ ಗಾಳಿ ಮಾಲಿನ್ಯ ಕಡಿಮೆ ಮಾಡುವುದು, ಪರಿಸರ ಸಂರಕ್ಷಣೆ ಮುಖ್ಯ ಉದ್ದೇಶ. 2050ರೊಳಗೆ ವಾತಾವರಣದ ಕಾರ್ಬನ್ ನ್ಯೂಟ್ರಲ್ ಮಾಡುವ ಗುರಿ ಹೊಂದಿದೆ. 2. ಸ್ವಚ್ಛಸಾರಿಗೆ ವ್ಯವಸ್ಥೆಯಲ್ಲಿ ವಿದ್ಯುತ್ ವಾಹನಗಳಿಗೆ ಉತ್ತೇಜನ, 2025ರೊಳಗೆ ಪೆಟ್ರೋಲ್ ಮತ್ತು ಡೀಸೆಲ್ ಕಾರುಗಳನ್ನು ನಿಲ್ಲಿಸುವ ಯೋಜನೆ, ಸಾರ್ವಜನಿಕ ಸಾರಿಗೆ ಮತ್ತು ಸೈಕಲ್ ಬಳಕೆಯನ್ನು ಉತ್ತೇಜಿಸುವುದು. 3. ಕಾರ್ಖಾನೆಗಳು ಹೊರಸೂಸುವ ಇಂಗಾಲಕ್ಕೆ ತೆರಿಗೆಯನ್ನು ಪಾವತಿಸಬೇಕು ಎಂಬ ಕಾರ್ಬನ್ ತೆರಿಗೆಯನ್ನು ಜಾರಿಗೊಳಿಸಿ ಹಸಿರುಮನೆ ಸೇರುತ್ತಿರುವ ಇಂಗಾಲವನ್ನು ನಿಯಂತ್ರಿಸುವ ಯೋಜನೆ ಹಾಕಿಕೊಂಡಿದ್ದಾರೆ. 4. ಅರಣ್ಯ ಸಂರಕ್ಷಣೆ ಅಂಗವಾಗಿ ಹೆಚ್ಚು ಮರಗಳನ್ನು ನೆಡುವುದು, 5. ಮನೆಗಳು ಮತ್ತು ಇತರ ಕಡೆಗಳಲ್ಲಿ ಇಂಧನ ಬಳಕೆ ಕಡಿಮೆ ಮಾಡುವುದು. 6. ಹವಾಮಾನ ಹೊಂದಾಣಿಕೆ ಯೋಜನೆಯಲ್ಲಿ ಪ್ರವಾಹ, ಬರ, ಸಮುದ್ರಮಟ್ಟ ಏರಿಕೆ ಮಂತಾದ ವೈಪರೀತ್ಯಗಳಿಗೆ ಮೊದಲೇ ಯೋಜನೆಗಳನ್ನು ತಯಾರಿಸಿಕೊಳ್ಳುವುದು. ಒಟ್ಟಿನಲ್ಲಿ ಜಾಗತಿಕ ಸಮಸ್ಯೆಯನ್ನು ಗಂಭೀರವಾಗಿ ತೆಗೆದುಕೊಂಡು ಪರಿಸರ ಸ್ನೇಹಿ ನೀತಿಗಳನ್ನು ಜಾರಿಗೊಳಿಸುತ್ತಿದೆ.

2015ರಲ್ಲಿ ಪ್ಯಾರಿಸ್‌ನಲ್ಲಿ ನಡೆದ ಸಂಯುಕ್ತರಾಷ್ಟ್ರಗಳ ಶೃಂಗಸಭೆಯಲ್ಲಿ ಯೂರೋಪ್, ಅಮೆರಿಕ ಮತ್ತು ಭಾರತ ಸೇರಿದಂತೆ ಬಹುತೇಕ ರಾಷ್ಟ್ರಗಳು ತೆಗೆದುಕೊಂಡ ನಿರ್ಣಯದಂತೆ '2050ರೊಳಗೆ ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಯನ್ನು 1.5 ಡಿಗ್ರಿ ಸೆಲ್ಸಿಯಸ್ ಮೀರಬಾರದು ಮತ್ತು ವಾತಾವರಣಕ್ಕೆ ಸೇರುವ ಇಂಗಾಲಾಮ್ಲ ಪ್ರಮಾಣವು ಶೂನ್ಯವಾಗಬೇಕೆನ್ನುವುದು' ಯೋಜನೆ ಹಾಕಿಕೊಳ್ಳಲಾಗಿದೆ. ಪ್ರಪಂಚವು ಈಗಾಗಲೇ 1.1-1.3 ಡಿಗ್ರಿ ಸೆಲ್ಸಿಯಸ್ ಮಟ್ಟದ ಏರಿಕೆಯನ್ನು ಕಂಡಿದೆ. ಈ ವೇಗದಲ್ಲಿ ಮುಂದುವರಿದರೆ 1.5 ಡಿಗ್ರಿ ಸೆಲ್ಸಿಯಸ್ ಗುರಿಯನ್ನು ಮೀರುವ ಸಾಧ್ಯತೆ ಇದೆ. ಆದ್ದರಿಂದ ವಿಶ್ವಸಂಸ್ಥೆಯ ಸಮಾವೇಶದ ಉದ್ದೇಶ ಹವಾಮಾನ ವ್ಯವಸ್ಥೆಯಲ್ಲಿ ಮಾನವನಿಂದ ಆಗುತ್ತಿರುವ ತಾಪಮಾನ ಏರಿಕೆ ತಡೆಯುವ ನಿಟ್ಟಿನಲ್ಲಿ ವಾತಾವರಣದ ಹಸಿರುಮನೆ ಅನಿಲ ಸಾಂದ್ರತೆಯನ್ನು ಸ್ಥಿರಗೊಳಿಸಲು ಕ್ರಮ ತೆಗೆದುಕೊಳ್ಳಲಾಗಿದೆ.

ಜಾಗತಿಕ ಹವಾಮಾನ ಕುರಿತ ಸವಾಲುಗಳು:

ಹವಾಮಾನ ಬದಲಾವಣೆ ದಂತಕಥೆಯೋ ಅಥವಾ ವಾಸ್ತವಿಕತೆಯೋ ಎಂಬ ಅನುಮಾನ ಛಾಯೆ ಅನೇಕರಲ್ಲಿ ಉಂಟಾಗಿರಬಹುದು. 'ಹೆವನ್ ಅಂಡ್ ಅರ್ತ್' ಎಂಬ ಪುಸ್ತಕದಲ್ಲಿ ಲೇಖಕರಾದ ಅಯಾನ್ ಪ್ಲಿಮರ್ ಅವರು ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆ ಕುರಿತು ವಿಭಿನ್ನ ಅಭಿಪ್ರಾಯಗಳನ್ನು ನೀಡಿದ್ದಾರೆ. ಸವಾಲುಗಳೆಂದರೆ ಇಂಗಾಲಾಮ್ಲ ಹೊರಸೂಸುವುದರ ಮೂಲಕ ಮಾನವನಿಂದ ಹವಾಮಾನ ಬದಲಾವಣೆ ಆಗುತ್ತಿದೆ ಎಂಬ ಅಭಿಪ್ರಾಯವನ್ನು ಪ್ರಶ್ನಿಸಲಾಗಿದೆ. ಹವಾಮಾನ ಬದಲಾವಣೆಯ ಚರ್ಚೆ ವಿಜ್ಞಾನಕ್ಕಿಂತ ರಾಜಕೀಯ ಮತ್ತು ಭಾವನಾತ್ಮಕ ಪ್ರಭಾವದಿಂದ ನಡೆಯುತ್ತಿದೆ ಎಂದು ಹೇಳಲಾಗಿದೆ. ಜಾಗತಿಕ ತಾಪಮಾನಕ್ಕೆ ಕಾರಣವಾದ ಪ್ರಾಕೃತಿಕ ಪ್ರಕ್ರಿಯೆಗಳಾದ ಸೂರ್ಯ, ಭೂಮಿಯ ಕಕ್ಷೆ, ಭೂಮಿಯ ಟೆಕ್ಟಾನಿಕ್ಸ್ ಪ್ಲೇಟ್‌ನ ಚಲನೆ ಮುಂತಾದ ಅಂಶಗಳನ್ನು ಹೆಚ್ಚು ಗಮನಿಸುತ್ತಿಲ್ಲ ಎಂದು ವಾದಿಸಲಾಗಿದೆ. ಅವರ ಪ್ರಕಾರ ಭೂಮಿಯ ಹವಾಮಾನ ಸದಾ ಬದಲಾಗುತ್ತಲೇ

ಇದೆ. 19ನೇ ಶತಮಾನದಲ್ಲಿ ಆದ ಕೈಗಾರಿಕಾ ಕ್ರಾಂತಿಯ ಸಮಯದಿಂದ ಇಂದಿನವರೆಗೆ ಆಗುತ್ತಿರುವ ಮಾನವ ಹಸ್ತಕ್ಷೇಪದ ಮುಂಚೆಯೇ ಸುಮಾರು 11ರಿಂದ 12.5 ಲಕ್ಷ ವರ್ಷಗಳ ಕಾಲದಲ್ಲಿ ತಾಪಮಾನ ಏರಿಕೆಯ ಕಾಲವೆಂದೂ ಅದನ್ನು 'ಇಂಟರ್ ಗ್ಲೇಸಿಯಲ್' ಕಾಲವೆಂದು ಕರೆದರು. ಆ ಸಮಯದಲ್ಲಿ ಈಗಿನದಕ್ಕಿಂತ ತಾಪಮಾನದ ಏರಿಕೆ ಕಂಡುಬಂದಿತ್ತು ಎಂದು ತಿಳಿದುಬಂದಿದೆ. ಇಂಗಾಲಾಮ್ಲ ಮತ್ತು ತಾಪಮಾನ ಏರಿಕೆ ನಡುವಿನ ನೇರ ಸಂಬAಧ ಇಲ್ಲ ಎಂದು ವಾದಿಸುತ್ತಾರೆ. ಹವಾಮಾನ ಬದಲಾವಣೆಯಲ್ಲಿ ಸೂರ್ಯನ ಶಾಖ ಪ್ರಮುಖ ಪಾತ್ರ ವಹಿಸುತ್ತದೆ ಎಂದು ಹೇಳಲಾಗಿದೆ. ಹಸಿರುಮನೆ ಪರಿಣಾಮದಲ್ಲಿ ಇಂಗಾಲಾಮ್ಲಕ್ಕಿಂತ ನೀರಾವಿ ಪ್ರಮುಖ ಪಾತ್ರ ವಹಿಸುವುದು ಎಂದು ವಾದಿಸುತ್ತಾರೆ. ಹವಾಮಾನ ಬದಲಾವಣೆ ಪ್ರಕೃತಿಯ ಸಹಜವಾದ ಪ್ರಕ್ರಿಯೆ, ಇದನ್ನು ತಪ್ಪಿಸಲು ಸಾಧ್ಯವಿಲ್ಲ ಎಂದು ವಾದಿಸಲಾಗಿದೆ.

ಅಯಾನ್ ಪ್ಲಿಮರ್ ಬರೆದಿರುವ ಮತ್ತೊಂದು ಪುಸ್ತಕವಾದ 'ನಾಟ್ ಫಾರ್ ಗ್ರೀನ್ಸ್…….' ಎಂಬ ಪುಸ್ತಕದಲ್ಲೂ ಕೂಡ 'ಕೆಲವು ಪರಿಸರ ಸಮಸ್ಯೆಗಳನ್ನು ಅತಿಯಾಗಿ ಹೆಚ್ಚಿಸಿ ಹೇಳಲಾಗುತ್ತಿದೆ, ಜಾಗತಿಕ ತಾಪಮಾನದ ಬಗ್ಗೆ ಇರುವ ಭಯ ಅತಿರೇಕವಾಗಿದೆ ಮಾನವನ ಪ್ರಭಾವ ಮುಖ್ಯ ಕಾರಣವಲ್ಲ' ಎಂದು ವಾದಿಸಲಾಗಿದೆ. ಮುಂದುವರೆದು ಪರಿಸರ ಮತ್ತು ನವೀಕರಿಸಬಹುದಾದ ಶಕ್ತಿ ಇವುಗಳ ನೀತಿಗಳು ಆರ್ಥಿಕತೆಗೆ ಹಾನಿಮಾಡಬಹುದು ಎಂದು ಹೇಳುತ್ತಾರೆ.

ಆದರೆ ಬಹುತೇಕ ವಿಜ್ಞಾನಿಗಳು ಮಾನವ ಕ್ರಿಯೆಗಳು ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಗೆ ಪ್ರಮುಖ ಕಾರಣವೆಂದು ಒಪ್ಪುತ್ತಾರೆ. ಭಾರತವೂ ಸೇರಿದಂತೆ ಇತರ ಕೆಲವು ಪರಿಸರ ವಿಜ್ಞಾನ ಲೇಖಕರು ಬೇರೆಯದೇ ಅಭಿಪ್ರಾಯಗಗಳನ್ನು ನೀಡುತ್ತಾರೆ. ಹವಾಮಾನ ಬದಲಾವಣೆ ನಿಜ ಮತ್ತು ಗಂಭೀರವಾಗಿದೆ. ಇದು ಕೇವಲ ವಿಜ್ಞಾನವಾಗಿರದೆ ಸಾಮಾಜಿಕ, ಇತಿಹಾಸ ಮತ್ತು ರಾಜಕೀಯ ಸಮಸ್ಯೆ ಕೂಡಾ. ಲೇಖಕಿ ವಂದನಾ ಶಿವ ಬರೆದಿರುವಂತೆ ಜಾಗತಿಕ ತಾಪಮಾನ ಏರಿಕೆಯು ಕಾರ್ಖಾನೆಗಳು, ಕೃಷಿ ವಿಧಾನಗಳು, ಮಾನವನು ಬಳಸುವ ಪ್ಲಾಸ್ಟಿಕ್, ಕಾಡಿನ ಸಂಪತ್ತಿನ ನಾಶ ಮುಂತಾದವುಗಳು ಕಾರಣವಾಗಿವೆ. ಲೇಖಕ ರಾಮಚಂದ್ರ ಗುಹರ 'ಹೌ ಮಚ್ ಶುಡ್ ಎ ಪರ್ಸನ್ ಕನ್ಸೂಮ್' ಪುಸ್ತಕದಲ್ಲಿ ಹೆಚ್ಚು ಉಪಭೋಗಗಳಿರುವುದು ಹವಾ ಬದಲಾವಣೆಗೆ ಮತ್ತೊಂದು ಕಾರಣ, ಸರಳ ಜೀವನ ಅಗತ್ಯವೆಂದು ಹೇಳುತ್ತಾರೆ. ಅವರ ಈ ಹೇಳಿಕೆ ಅಕ್ಷರಶಃ ಸತ್ಯವೇ. ಸರಳವಾಗಿ ಹೇಳುವುದಾದರೆ ಹವಾಮಾನ ವಿಜ್ಞಾನ ಲೇಖಕರು ಹವಾಮಾನ ವೈಪರೀತ್ಯ ಮತ್ತು ಪರಿಹಾರಕ್ಕೆ, "ಪ್ರಕೃತಿ ಉಳಿಸಿ ಭವಿಷ್ಯ ಉಳಿಸಿ" ಎಂದು ಹೇಳುತ್ತಾರೆ.

ಲೇಖಕರು: ಡಾ ಶಾರದಾ **ನಾಗಭೂಷಣ**

Academic Activities Report (Feb – Apr 2026)

H. D. Ananda

- **18 Feb 2026:** Delivered an invited talk at **PES University**, Hosakerahalli, Bengaluru on *"Quantum Computing & applications in Bio-Technology, Space Biology and Drug Discovery."*
- **24 Feb 2026:** Attended **SJBIT**, RR Nagar, Bengaluru as Chief Guest for National Science Day. Delivered a talk and video demonstration on *"Physics in play at Satellite control stations - Master Control Facility - ISRO Hassan."*
- **27 Feb 2026:** Served as Chief Guest for National Science Day at **Govt First Grade College**, HSR Layout, Bengaluru. Presented an *"Overview of Indian space program"* featuring a video demonstration.
- **09 Mar 2026:** Conducted a talk on *"Mission planning, analysis and orbits of small satellites"* during a 3-day workshop at **Rajarajeshwari College of Engg**, Bengaluru.
- **09 Mar 2026:** Attended **IGNITE AI 2026** at Don Bosco Institute of Technology, Bengaluru as Chief Guest. Presented *"Quantum Computing & applications in AI, ML and DL"* with a video demonstration.
- **11 Mar 2026:** Delivered invited talks at **Jyothi Institute of Technology**, Bengaluru. Conducted a morning session for CS students and an afternoon session for AI & ML students on *"Quantum Computing & applications."*
- **12 Mar 2026:** Presented *"Physics in play at Satellite control stations"* with a video demonstration for E&C students at **Jyothi Institute of Technology**.
- **16–17 Mar 2026:** Participated as a Renowned Speaker and Session Chair at the **National Conference on Interdisciplinary Research and Innovation (NCIRI-2026)**, Shivamogga. Topics included *"Overview of Indian space program"* and *"Physics in play at Satellite control stations."*
- **26 Mar 2026:** Invited as Chief Guest for National Science Day at **Sri Shankar Anand Singh First Grade College**, Hosapete. Delivered two sessions: *"Overview of Indian space program"* and *"Quantum Computing & applications."*
- **27 Mar 2026:** Served as Chief Guest and speaker at **Vijayanagar College**, Hosapete, on the *"Overview of Indian space program."*
- **28 Mar 2026:** Attended the **Department Advisory Board (DAB)** meeting at **RNSIT**, Bengaluru, as a newly appointed member for the Computer Science Department.
- **31 Mar 2026:** Conducted a one-day workshop on *"Quantum Computing & applications"* at **Govt First Grade College**, HSR Layout, including a video show and an MCQ evaluation.
- **02 Apr 2026:** Delivered an invited talk at **Vijaya College**, Basavanagudi, Bengaluru, on *"Quantum Computing & applications."*

Dr. Paniveni Uday Shankar

- **05 Feb 2026:** Conducted an educational session for 10th Standard students at **Vivekananda School**, Mooganhundi village, Mysore, explaining the *"Fundamentals of the Theory of Refraction."*

Dr. B. Rudraswamy

- **28 Feb 2026:** Served as the Resource Person for the **National Science Day Celebration** at **SJR Degree College for Women**, Rajajinagar, Bengaluru.

List of Webinars held

Sl. No	Date	Speaker	Title
1	01/02/26	**Dr Vijay Sai**	Nuclear Radiations and their Applications
2	08/02/26	**Dr T S Pranesh**	Physics of Clouds – An Introduction
3	15/02/26	**Dr R. Prabhu**	Quantum States and their Applications
4	22/02/26	**Dr Y C Kamala**	Women in Science
5	08/03/26	**Dr Ramya Sethuram**	Galaxy Formation
6	15/03/26	**Dr Rajaram Nityananda**	Faces of Entropy
7	29/03/26	**Sri B S Girish**	Visiting the Arctic Lab for Studying the Birth of First Stars
8	05/04/26	**Dr H Ashwathaman**	Quantum Computing from a Hardware Perspective
9	19/04/26	**Dr Ashok M Raichur**	Biomaterials for Targeted Drug Delivery
10	26/04/26	**Dr B.C. Prabhakar**	Earth Tremors and the Forces Responsible for Them