The Neutrino Journal

Club Neutrino

The Physics Club

Sanskriti School

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Special Focus: Nanotechnology

Contents

Letter to the reader

Dear Reader

With the school year gathering momentum with increasing academic intensity, we hope each one of you is finding interest in the process of learning all the various subjects offered in the curriculum.

It is not surprising, however, to find a subject like Physics mathematically intense and often hard to grasp, due to the vast extent of abstract thinking involved in learning more about the subject. Keeping this in mind, we at Club Neutrino, aim to bridge the gap between any student with interest in the discipline, and the awe-inspiring world of Physics.

The month of August brings us the opportunity to release the second issue of the Neutrino Journal, the club's quarterly publication. Through this issue, we invite you to inspect the universe at its most elementary levels, through the fast developing field of Nanotechnology. From sub-microscopic particles to quantum computers, we seek to explore the dynamics of an entire system of matter that has been invisible to us for centuries, yet has impacted nature in the most basic and most incredible ways possible.

Once again, we hope you shall enjoy reading this issue of our journal, and we extend our heartfelt gratitude to each and every reader.

May the passion for learning stay eternal.

Warm regards

Niharika Mukherjee

(Editor, The Neutrino Journal)

Neutrino Focus: An Introduction to Nanotechnology

By Animish Murthy and Abdishay Murthy

Nanotechnology is the science and technology of small things, in particular, things that are less than 100nm in size. Nanotechnology is hailed as having the potential to increase the efficiency of energy consumption, help clean the environment, and solve major health problems. It is said to be able to massively increase manufacturing production at significantly reduced costs. Products of nanotechnology will be smaller, cheaper, lighter yet more functional and require less energy and fewer raw materials to manufacture, claim nanotech advocates. Most applications are limited to the use of "first generation" passive nanomaterials which includes titanium dioxide in sunscreen, cosmetics, surface coatings, and some food products; Carbon allotropes used to produce gecko tape; silver in food packaging, clothing, disinfectants and household appliances; zinc oxide in sunscreens and cosmetics, surface coatings, paints and outdoor furniture varnishes; and cerium oxide as a fuel catalyst.

Further applications allow tennis balls to last longer, golf balls to fly straighter and even bowling balls to become more durable and have a harder surface. Trousers and socks have been infused with nanotechnology so that they will last longer and keep people cool in the summer. Bandages are being infused with silver nanoparticles to heal cuts faster. Video game consoles and personal computers may become cheaper, faster, and contain more memory thanks to nanotechnology.

Nanotechnology may have the ability to make existing medical applications cheaper and easier to use in places like the general practitioner's office and at home. Cars are being manufactured with nanomaterials so they may need fewer metals and less fuel to operate in the future.

Example of nanotechnology’s brilliant uses: A "nano-needle" with a tip about one-thousandth the size of a human hair pokes a living cell, causing it to quiver briefly. Once it is withdrawn from the cell, this ORNL nanosensor detects signs of early DNA damage that can lead to cancer. This nanosensor of high selectivity and sensitivity was developed by a research group led by Tuan Vo-Dinh and his coworkers Guy Griffin and Brian Cullum. The group believes that, by using antibodies targeted to a wide variety of cell chemicals, the nanosensor can monitor in a living cell the presence of proteins and other species of biomedical interest.

The Elementary Particles

By Abhayraj Samir palande

Everything around us is made up of atoms. These atoms are so small, they can't be seen with the naked eye but they do have a world of their own. This branch is science which deals with the world of atoms and their functioning is called quantum physics.

Let us start from the biggest member of the family -atom. It is made up of electrons, protons (they give charge to the atom) and neutrons(it is responsible for the mass of the atom). So why can't neutrons stay independent like an atoms, Neutrons can stay independent but they rapidly beta decay (they explode to form proton, electron and Anti neutrino) so they group themselves with protons to make them stable. Not with electrons due to a factor known as mono charge.

But hey there is even something smaller than these sub atomic particles. They are called quarks. Like any sub atomic particle they are spherical and always vibrating with energy. These quarks come in six 'flavours'(that’s the term physicist use)- up , down , top ,bottom , charm and strange(see no more Greek or Latin in science)

So a neutron is made up of 3 quarks up, up and down (uud).
Let's discuss one more interesting aspect of q physics. Just like in fiction (or reality) you have an evil twin, every particle in q physics has an 'evil' twin. They are called anti particles. Like the opposite of an electron is not

a proton but a positron. A theory goes by that during the creation of the universe (big bang) there were equal numbers of particles and antiparticles. But in the universe in which we live (if you not happen to be an alien reading my article) we don't come across anti particle. That's what scientists are doing at CERN (the hadron collider). They make 2 particles collide, which are moving at an enormously high velocity. The result of the collision is that high amount of energy is released and some amount of antiparticles and sub atomic particle called neutrino. Recent research has shown that neutrino might be the future of telecommunications as the mass is almost negligible and size is small, and it doesn't carry any charge. Scientist shot a group of neutrinos which travelled through 718 feet of rock without interacting with its surroundings.

Quantum Nano-Computers

By Ojas Anand

Niels Bohr, the Danish physicist who helped to invent the field of Quantum Physics, said, “Anyone who can contemplate quantum mechanics without getting dizzy hasn’t properly understood it.” This article is an attempt to explain the concept of quantum nano computers without making you dizzy!

In order to understand Quantum Nano Computers one must understand a bit of nano technology, a bit of computers and then finally a bit of Quantum Physics. So let’s get started.

There’s Plenty of Room at the Bottom! : Understanding Nanotechnology

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers.
The ideas and concepts behind nanoscience and nanotechnology started with a talk entitled “There’s Plenty of Room at the Bottom” by physicist Richard Feynman at an American Physical Society meeting at the California Institute of Technology (CalTech) on December 29, 1959, long before the term nanotechnology was used. The transcript of the talk is freely available on the internet and I would encourage everyone to read it. Interestingly, while at the time of the speech, computer science was still in its infancy and mainframe computers Physicist Richard Feynman, the filled up an entire room, Feynman proposed building father of nanotechnology and nano computers. K. Eric Drexler, another noted

scientist, later took the Feynman concept further in his 1986 book Engines of Creation: The Coming Era of Nanotechnology. In it Drexler talked in some detail about his vision of nano computers. As per him nano computers need not be electronic devices at all but instead could be mechanical devices also, much like the computation engine designed by Charles Babbage all those years ago.

Logically Speaking: Understanding Computers through Logic Gates

Logic gates are any devices that will give an output based upon an input. The Irish logician George Boole showed in the 19th century that any complex logical or arithmetic task could be accomplished using combinations of three simple Logic Gate operations: NOT, COPY and AND. A NOT gate will give an output that will be the opposite of the input e.g. If the input is 1 (voltage is present) the output will be 0 (voltage not present) and vice versa. Think of it as a typical teenager who does the opposite of what he is told! A copy gate will write the same input at another location e.g. if voltage is present in circuit A (1), COPY gate will switch circuit B to also have voltage (1). AND gate has two inputs and its output depends upon these two inputs. If both inputs are 1 the output of AND gate will be 1 and if either input is zero or if both inputs are 0, the output will be 0. A modern semiconductor based processor in a computer can perform operations from the simple (2+2=?) to the complex (Calculate Log 2^999) using these three basic logical operations. Thus any system that can perform these logical operations can function as a computer.

The Cat that is both Dead and Alive: Understanding Quantum Physics

For a brief period in history, the lives of Physics students were filled with happiness and contentment. It was widely believed that the world was governed by Newton's equations and all that students had to do was the memorise them. However as we know all too well, there are some people in a Physics class who are just not happy till they are truly miserable. So

along came M/s Einstein and Max Planck who pointed out that while Classical physics could generally explain the various phenomena we see in the world around us, it fails to explain the world at the atomic level. It was found that at the atomic level particles could act like both particles (no surprise) and waves (surprise surprise). This was called the wave – particle duality and it became one of the key concepts in development of a new field of physics called Quantum Mechanics. In order to understand the word at the nano particle level we need the support of Quantum Mechanics. One of the weird concepts of Quantum Mechanics is the principle of Superposition. Unfortunately it is also the key concept behind quantum computers and so we do need to understand it! In simple terms it means that if a quantum particle can exist in one of two states (0 and 1 or ground state and excited state) then it can also exist in a combination of these two states. In classical computing, a bit is a single piece of information that can exist in two states – 1 or 0. Quantum computing uses quantum bits, or 'qubits' instead. These are quantum systems with two states. However, unlike a usual bit, they can store much more information than just 1 or 0, because they can exist in any superposition of these values. Thus quantum computers will be able to store much more information and do much more complex calculations than conventional computers.

Putting it all Together: Building a Quantum Computer Using Nano Technology

We have seen that a computer is any device that carries out complex logical or arithmetic tasks, using combinations of three simple operations: NOT, COPY and AND. In fact, atoms, or any other quantum system, can perform these operations and can therefore be used to build a quantum Nano-computer. An atom in its electronic ground state could represent a 0 and in an excited state, a 1. NOT involves nothing more than bit flipping,: if A is 0, make it a 1, and vice versa. With atoms, this can be done by applying a pulse whose energy equals the difference between A’s ground state (its electron is in its lowest energy level, shown as the inner ring) and its excited state (shown as the outer ring). Unlike conventional NOT

gates, quantum ones can also flip bits only halfway. Likewise it can be shown that these atomic quantum systems can perform COPY and AND operations.

Dark Matter

By Devyani Koshal

In the early 1990s, one thing was fairly certain about the expansion of the universe. It might have enough energy density to stop its expansion and recollapse, it might have so little energy density that it would never stop expanding, but gravity was certain to slow the expansion as time went on.

The slowing had not been observed, but, theoretically, the universe had to slow. The universe is full of matter and the attractive force of gravity pulls all matter together. Then came 1998 and the Hubble Space Telescope (HST) observations of very distant supernovae that showed that, a long time ago, the universe was actually expanding more slowly than it is today. So the expansion of the universe has not been slowing due to gravity, as everyone thought, it has been accelerating.

It turns out that roughly 68% of the universe is dark energy. Dark matter makes up about 27%. The rest - everything on Earth, everything ever observed with all of our instruments, all normal matter - adds up to less than 5% of the universe.

Scientists have a few ideas for what dark matter might be. One leading hypothesis is that dark matter consists of exotic particles that don't interact with normal matter or light but that still exert a gravitational pull. Several scientific groups, including one at CERN's Large Hadron Collider, are currently working to generate dark matter particles for study in the lab.

Dark matter could also explain certain optical illusions that astronomers see in the deep universe. For example, pictures of galaxies that include strange rings and arcs of light could be explained if the light from even more distant galaxies is being distorted and magnified by massive, invisible clouds of dark matter in the foreground-a phenomenon known as gravitational lensing.

Dark energy is even more mysterious, and its discovery in the 1990s was a complete shock to scientists. Previously, physicists had assumed that

the attractive force of gravity would slow down the expansion of the universe over time. But when two independent teams tried to measure the rate of deceleration, they found that the expansion was actually speeding up. One scientist likened the finding to throwing a set of keys up in the air expecting them to fall back down-only to see them fly straight up toward the ceiling.

Scientists now think that the accelerated expansion of the universe is driven by a kind of repulsive force generated by quantum fluctuations in otherwise "empty" space. What's more, the force seems to be growing stronger as the universe expands. For lack of a better name, scientists call this mysterious force dark energy.

One explanation for dark energy is that it is a property of space. Albert Einstein was the first person to realize that empty space is not nothing. Space has amazing properties, many of which are just beginning to be understood. The first property that Einstein discovered is that it is possible for more space to come into existence.

Then one version of Einstein's gravity theory, the version that contains a cosmological constant, makes a second prediction: "empty space" can possess its own energy. Because this energy is a property of space itself, it would not be diluted as space expands. As more space comes into existence, more of this energy-of-space would appear. As a result, this form of energy would cause the universe to expand faster and faster.

Unfortunately, no one understands why the cosmological constant should even be there, much less why it would have exactly the right value to cause the observed acceleration of the universe.

But that explanation still leaves scientists clueless as to why the strange force exists in the first place.

From the lab: Physics News

By Preksha keshri and Gouri nair

1.*Is there an end to the periodic table? Professor explores its limits*

As the 150th anniversary of the formulation of the Periodic table of chemical elements looms, a professor probes the table's limits. In 2016, four new elements were added to it : ninonium , moscovium , tennessine and oganesson . It took a decade and worldwide effort to confirm these last four elements. And now scientists wonder: how far this table can go ?

1. Chameleon- inspired nanolaser changes colours.

On June 20,2018 , the Northwestern University says that Chameleons change colour by controlling the spacing among nanocrystals on their skin.The nanolaser changes colour similarly –by controlling the spacing among metal nanoparticles.

1. Building bridges with water molecules.

Researchers have managed to uncover the mystery behind the structure of water molecules on iron oxide surfaces, and their work has revealed that water molecules can form of complex structures reminiscent of bridges, which play a significant role when it comes to chemical reactions on the surface.

1. Graphene forms electrically charged crinkles.

On June 27, 2018 ; The Brown university states that gently compressed stacks of graphene form sharp crinkles that carry an electric charge, which could be useful in nanoscale self-assembly and other applications.

1. Sodium- and potassium-based batteries hold promise for cheap energy storage.

New batteries could be key for smart grid of the future. Researchers have found new evidence suggesting that batteries based on sodium and potassium hold promise as a potential alternative to lithium-based batteries.

In other news,

- Plasma-spewing quasar shines light on universe's youth, early galaxy formation: July 9
- 'Cataclysmic' collision shaped Uranus' evolution: July 2
- Milky Way-type dust particles discovered in a galaxy 11 billion light years from Earth: July 3

Club Day Activity by Club Neutrino: Physics quiz

Text by Abhayraj Samir Palande

On 8th August 2018, on the occasion of Club Day, Club Neutrino organized 'Physics Bowl 2018'. It was an inter house quiz conducted for the students of class 8.

The quiz contained questions from different areas of physics like astronomy and mechanics. The first stage of the quiz was the astronomy round. Participants had to recognize different constellations and heavenly bodies. The second stage of the quiz was based on practical and applied physics. The buzzer rounds brought forth a lot of excitement from both participants and audience alike.

The event was conducted smoothly by the members of Club Neutrino. As a result the teachers as well as the students who came to attend the event appreciated and applauded it. It was a humble effort by the club to make children inquisitive about the wonderful world of Physics. The winning house was Prakriti, followed by Prakash and Pratigya in the second and third places respectively.