News Review

A Report on the Nobel Prize Awards in Physics, Chemistry and Medicine (or Physiology) in 2017.

The Nobel Prizes in Physics, Chemistry and Medicine (or Physiology) for the year 2017, were recently announced by Royal Swedish Academy of Sciences in early October.

Physics:

In Physics, this year the Nobel Prize was shared by three professors all from the United States of America. They are Professor Rainer Weiss from the Massachusetts Institute of Technology (MIT), Cambridge, USA, Professor Barry C Barish and Professor Kip S Thorne both from the California Institute of Technology (CALTECH), California, USA. They as a team discovered gravitational waves. This phenomenon has opened a door on the extreme universe.

Ripples in the fabric of space-time, first predicted by Albert Einstein in his General Theory of Relativity a century ago, created a revolution in astrophysics when early in 2016 their first detection was announced. The Nobel-winning scientists made their discovery in September, 2015 but made the formal announcement in February, 2016. It was a historic achievement and a major path-breaking discovery in astrophysics.

In the 1970s, Professor Weiss designed a laser-based device that overcame background noise that could disturb measurement of gravitational waves. He, Professor Thorne and Professor Barish, according to the Nobel announcement "ensured that four decades of effort led to gravitational waves being finally observed". The scientists created the Laser Interferometer Gravitational-Wave Observatory (LIGO) at the prestigious California Institute of Technology.

According to eminent physicists, the first ever direct observation of the gravitational wave was triggered due to the merger of super-dense black holes that took place 1.3 billion light years back. Though the signal that reached the Earth was extremely weak, still it revolutionised the approach of modern day astrophysics. Gravitational waves are an entirely new way of following the most violent events taking place in the space such as colliding black holes or collapse of stellar cores. Since 2015, the enigmatic ripples have been detected only three more times, twice more by LIGO and only once by VIRGO detector located at the European Gravitational Observatory (EGO) located in Cascina, Italy.

The Royal Swedish Academy of Sciences in a statement said: "This is something completely new and different, opening up unseen worlds. A wealth of discoveries awaits those who succeeded in capturing the waves and interpreting their messages."

Incidentally, Einstein was convinced that gravitational waves could never be measured. But the Nobel Committee stated that the three eminent Nobel Prize-winning physicists used

laser devices "to measure a change thousand times smaller than an atomic nucleus".

Chemistry:

Professor Jacques Dubochet from the University of Lausanne, Switzerland, Professor Joachim Frank from the department of bio-chemistry of Columbia University, New York, USA and Professor Richard Henderson from the MRC Laboratory of Molecular Biology, University of Cambridge, UK shared the Nobel Prize for Chemistry in 2017. They have discovered a revolutionary technique called "cryo-electron microscopy" to examine the tiniest structures of cells.

From the historical aspect, it may be noted that in the 1970s, the electron microscope was the only way to look into the cell and observe the minute beings that play such an important role in our lives. However the powerful beam of the electron microscope would destroy biological material. Hence it was believed that such microscopy could only reveal images of dead cells and dead organisms. Also it was then impossible to observe solutions as water would evaporate under the microscope's vacuum.

Professor Richard Henderson travelled to the best electron microscopes in the world to get the sharpest images. They all had their weaknesses but complemented each other. Finally in 1990, 15 years after he had published the first model, Professor Henderson was able to achieve his goal. He was successful in presenting a three-dimensional structure of a protein at atomic resolution. However, biological molecules got destroyed when the electron beam was focused on them at normal temperatures. So the problem of imaging them still remained unsolved.

Cryo, a short form of cryogenic means very low temperatures, something well below minus 150 degrees C. In the context of electron microscopy, it refers to the fact that the object to be imaged is frozen to such low temperatures to facilitate being studied under the beam of the electron microscope. This method is so effective that in recent times it has been used to image the elusive Zika virus. The question was whether the method could be generalised. Between 1975 and 1986, Professor J. Frank made it widely usable. He developed a method to transform the electron microscope's fuzzy two-dimensional images into sharp three-dimensional composites.

In 1978, Professor J. Dubochet was recruited at the European Molecular Biology Laboratory at Heidelberg to solve another basic problem of the electron microscope: how biological samples dry out and are damaged when exposed to a vacuum. Professor Dubochet realised that if he could freeze the water to form a glassy state, called 'vitrified water', it would not dry up when excited by the beam. In the early 1980s, Professor Dubochet cooled water very rapidly so that it solidified in its liquid form around a biological sample, allowing the bio-molecules to retain their natural shape even in a vacuum. In 1984, he published the first images of a number of different viruses, which are clearly shown in sharp contrast against the background of vitrified water.

According to the Nobel committee, "researchers can now freeze bio-molecules mid-movement and visualise processes they have never previously seen. ....The method has been decisive for the understanding of the life's chemistry as well as for the development of the pharmaceuticals."

The ultra-sensitive imaging method, as explained earlier, allows molecules to be flash-frozen and studied in their natural form, without using dyes. It has unfolded before us tiny protein machines that run all cells. It was never seen before. This is the greatest contribution of the team effort of the three international scientists leading to the discovery of the "cool method".

Medicine (or Physiology):

Three geneticists of USA, Professor Jeffrey C Hall of the University of Maine, Professor Michael Rosbash of the Brandeis University and

Professor Michael W Young of the Rockefeller University shared the Nobel Prize for Medicine (or Physiology) for the year 2017. They won the coveted prize for their discoveries about the body's daily rhythms, opening up new fields of research and raising awareness about the importance of getting proper sleep. They were successful in isolating a gene that controls the body's normal daily biological rhythm. Circadian rhythms adapt the working of the body to different phases of the day, influencing sleep, behaviour, hormone levels, body temperature and metabolism.

The Nobel Committee said: "Their discoveries explain how plants, animals and humans adapt their biological rhythm so that it is synchronised with the Earth's revolutions". All life on the Earth is tuned to the rotation of our planet. For a long time, it was known to the scientific community that living organisms, including human beings, have an internal time-keeper that helps them to anticipate and adapt to the rhythm of the day.

The Nobel jury said that the Nobel-winning scientists "were able to peek inside our biological clock and elucidate its inner working". The circadian clock is what causes jet lag – what happens when our internal clock and external environment move out of synchronisation as we change time zones. It also regulates sleep, which is essential for normal brain function. Circadian malfunction is responsible for depression, bipolar disorder, cognitive function, memory formation and some neurological diseases. Studies have revealed that a chronic mismatch between our lifestyle and circadian clock- may be associated with increased risk for cancer, neurodegenerative diseases, metabolic disorder and inflammation. The Nobel committee said that scientists are working hard on discovering methods to alter the rhythms of errant clocks as a means to "improve human health".

Using the fruit fly as a model organism, the Nobel Laureates of 2017 in medicine isolated a gene that controls the daily biological rhythm called the 'period gene'. According to the Nobel committee, "They showed that this gene encodes a protein that accumulates during the night and is then degraded during the day. Subsequently they identified additional protein components of this machinery, exposing the mechanism governing the self-sustaining clockwork inside the cell".

Professor Michael Hastings, a scientist at the United Kingdom Medical Research Council said to the Associated Press, that the discoveries had opened up a whole new field of study for biology and medicine. He said "Until then, the body clock was viewed as a sort of black box. We knew nothing about its operation. But what they did was get the gene that made the body clock, and once you've got the genes, you can take the field wherever you want to.....It's a field that has exploded massively, propelled by the discoveries by these guys."

The Nobel committee in the prize statement said "The paradigm-shifting discoveries by the laureates established key mechanisms for the biological clock".

Acknowledgent:
The information has been gathered by the reporter from various press releases.

Photographs of this year's Nobel Prize winners of Physics, Chemisty and Medicine (*or Physiology*) *are in front cover.*

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