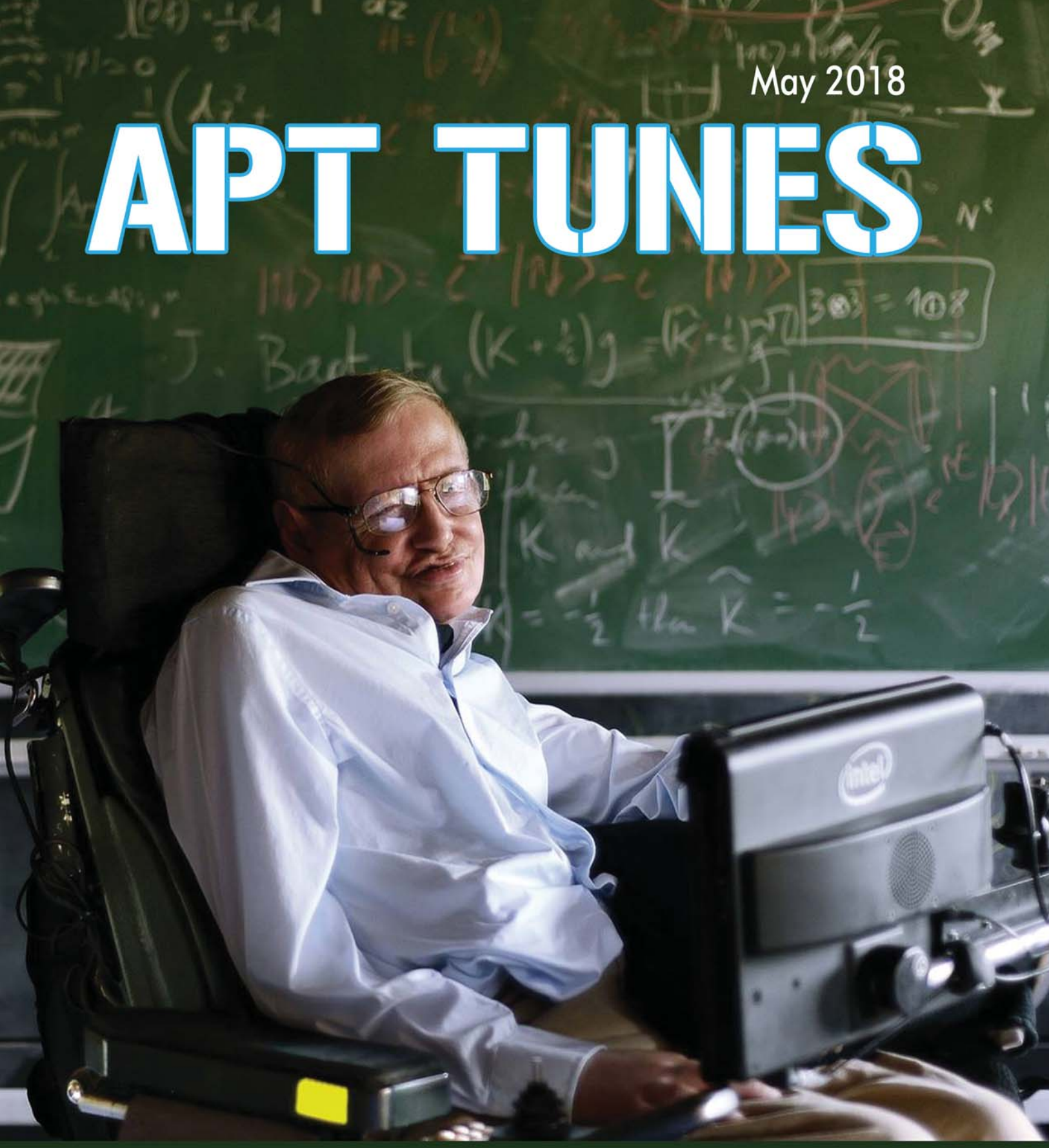
May 2018

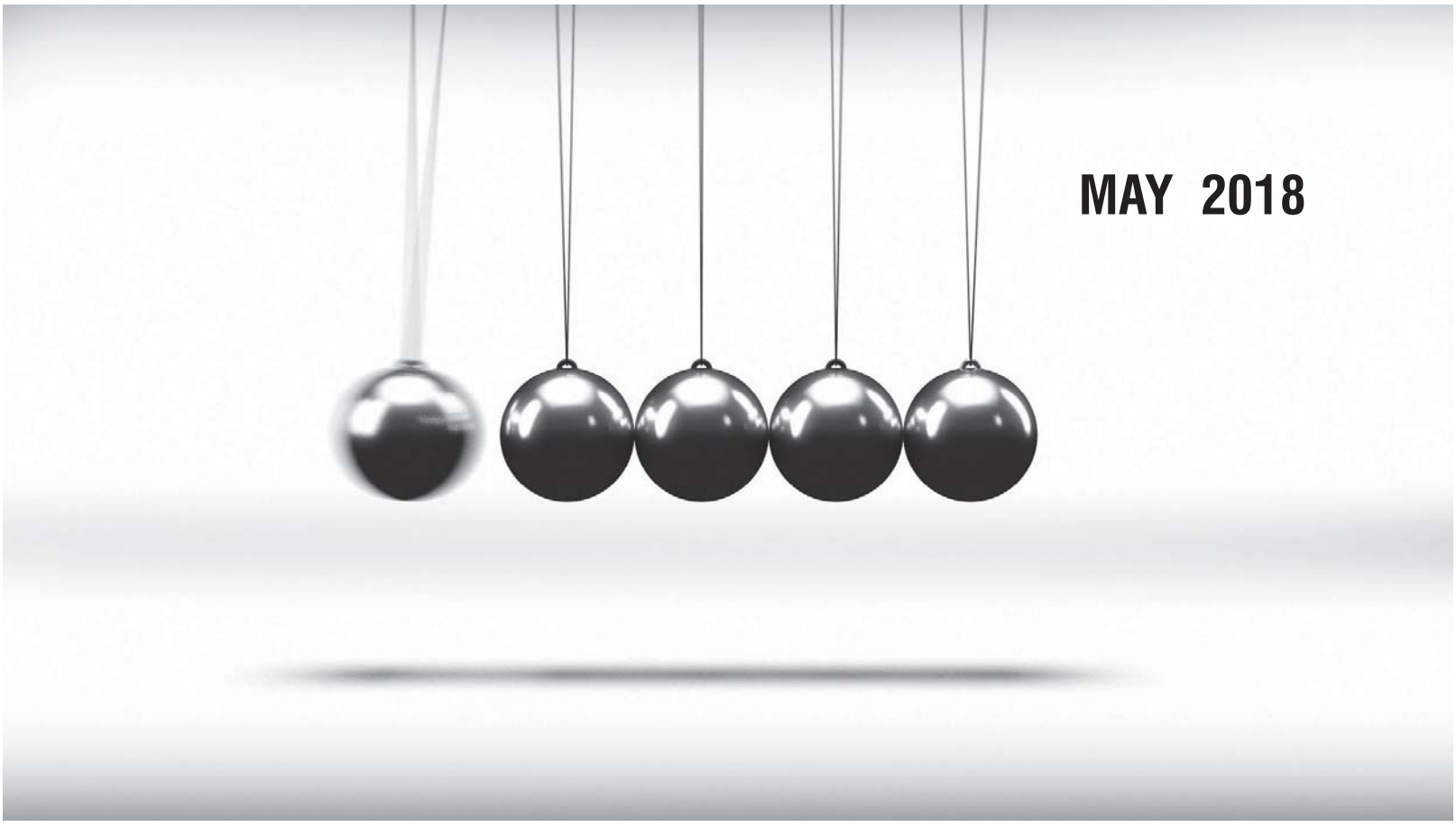
APT TUNES



Academy of Physics Teachers, Kerala

APT Workshop : Quantum Mechanics -I : 29-30 April 2017 - Mar Ivanios College, TVM

APT Workshop : Quantum Mechanics -I : 10-11 June 2017 - Assumption College, Changanassery



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Bulletin of

Academy of Physics Teachers, Kerala

Contents

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Editorial

Another issue of APT Tunes is in your hands. During the last few months the Academy has been very active organising a string of workshops in areas including Quantum Mechanics, Experimental methods and Astronomy. Detailed report and photographs are included in this issue. It is quite gratifying that young teachers continue to endorse these and get benefitted. On the long term this ongoing program is expected to change the scenario of physics teaching in the state. It is worth mentioning the support that we get from dedicated teachers like Dr. Satyanarayana of Pondicherry University, and other resource persons. We also have been organising a number of programmes such as talent tests, mock tests for JAM and NET during the last few months. On the occasion of the 150th birth anniversary of Marie Curie, the Academy organised various programmes including essay competition for college students. Some of the essays submitted for the essay competition are included in this issue.

Recently in India, we have been witnessing the launch of mega projects such as India based Neutrino Observatory (INO) and Gravitational Wave Observatory planned by IndIGO (Indian Initiative in Gravitational Wave Observations). Both these projects, when completed would provide big opportunities to young researchers and help Indian science in a big way.

The cover story is on the inspiring life and scientific contributions of the legendary physicist Stephen Hawking.

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Stephen Hawking - his life and science

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If one ask any common man to name the most famous scientists, they might start with the name of Newton, then add the name of Einstein. Issac Newton explained the behavior of the material world in terms of the fundamental laws. The most famous among them is the law of gravity, which explain the deep mystery regarding the motion of the planets. Einstein also famous due to his ideas on gravity, the general relativity theory, which lead to remarkable predictions like, the bending of light, expanding universe, the possible existence of exotic objects like black holes etc. The place of Stephen Hawking may be immediately next to Einstein. He is one who uncovered the mystery of black holes and challenged the age-old view that these objects emit nothing and anything going inside will be lost forever. His ingenious mind revealed that black holes can emit particles and eventually evaporate away.

Childhood and Schooling

Stephen Hawking was of born on the day of the 300th anniversary of the death of the great Galileo Galilei, as the firstborn to Frank Hawking and Isobel on January 8, 1942. In Hawking's own words, about two hundred thousand babies were born on the same day, so it is not such an amassing coincidence. He was born in Oxford near England during the middle of second world war. Hawking's parents were initially lived in Highgate, near northern London and were moved to Oxford to give birth to their baby, Stephen. During the turmoil of the war, Oxford was relatively safe, because there was a mutual agreement between the Hitler's army and Royal army that the cities, Oxford and Cambridge in England and Heidelburg and Gottingen in Germany were kept peaceful. Another attraction to Oxford was that both Frank and Isobel had done their college education there.

It was a middle-class family, where Frank basically belongs to a farmer's family, while Isobel was the daughter of a medical doctor. By profession, Frank was a doctor specialized in tropical diseases and Isobel was also undergone university education and was working as a secretary in a medical research institute during their marriage. After the war, Frank was appointed as the head of the parasitology division in a Medical research institute in St.Alban and the entire family was then shifted to that place. Stephen Hawking was eight years old when the family reached there. Frank, eagerly desired to send Stephen to the famous Westminster school, but without having a fellowship, the family was not able to support the large fees. Unfortunately, on the day of the entrance exam for the fellowship, the boy Stephen become ill and could able to sit for the exam. Consequently, Stephen was entered, the St.Alban school for his education.

In the school, Stephen was recognized by his teachers as a bright student. Apart from the usual study material Stephen was interested in extra activities like participating in music parties, where they usually listen to the classical music form BBC radio3 and also often went out in cycle rides in the countryside of the St.Alban school. During this period around 1950, the family with exception of Stephen, because of his studies, visited India for a long tour. At around this age, Stephen understood that mathematics was his favorite subject. He shows incredible talents in solving hard mathematical problems. He was spontaneous is spelling

the answers to puzzles. For instance, while in the sixth form, the teacher posed a question, that ``You have a glass of black tea and another glass of very hot milk. You want to get a mixture of tea and milk in a temperature safe to drink. What would you do to get a speedy cool mixture, would you add the milk to the black tea and allow the mixture to cool or you first allow the milk to cool itself before adding it to the black tea?." Stephen immediately delivered the answer, ``Ah the milk will be allowed to cool first because hot liquids will get cold faster". Stephen wanted to study Mathematics and Physics and go for research in that area but his father wanted him to follow his carrier in the field of medicine and insists him to study chemistry. After intensive dialogues, it was decided to study Mathematics, Physics, and Chemistry as major subjects. Further, the studies in the sixth form were the most enjoyable period in his school time. In School, Stephen was more influenced by his mathematics teacher, Dick Tartar. Around this time, in 1958, Stephen and his friends build a computer named LUCE, Logical Uniselector Computing Engine, when in entire Britain only the Ministry of defense and few University Departments have computers. This acquired them first newspaper applause, in the most celebrated daily at that time, the Herts Advertiser, their efforts in making the computer was covered in a great deal.

To Oxford University for a degree

In 1959, at the age of seventeen, Stephen wrote scholarship entrance examination for the degree courses at Oxford University. It was a two days examination consists of five papers on Mathematics, Physics and other subjects. Stephen won the examination to get a scholarship. On October that year, he has joined Oxford University college for B.A. honors. Despite its charm, the first year in Oxford was slightly boring. He had no good friends. In studies, he had not much to do, since he had very little difficulty in solving the physics and mathematics problems given by his tutors. He has to attend a few lectures and a tutorial in a week, hence have plenty of time for remaining form the classes. He was often appeared with his books in his hand, rather than mere textbooks. Once his tutor, Prof. Patrick Sanders gave them a set of problems form a book. Hawking came to the class without attempting a single of them. When asked why he pointed out a large number of errors in that book.

From the second year onwards, he found interested in rowing. Rowing was a long tradition in England and each year there occurred competition between universities in this boat race, in which Hawking took part actively. Their rowing coax, Mr. Norman Dix, later recalled that Hawking was a competent member of his team. Due to all these, he has eventually got the impression of a difficult student of the time. In the examination, he performed badly in subjects except in Mathematics and Physics, in which subjects he did exceptionally well. During viva examination, he declared that ``If you award me a first," he said, "I will go to Cambridge. If I receive a second, I shall stay in Oxford, so I expect you will give me a first". In fact, they did and he got a first class degree with which he went up further for research.

His doctorate and marriage

In the year 1962, Stephen joined Cambridge University for Ph.D., a university which has a great tradition from the twelfth century onwards. It was his longtime dream to do research in cosmology. He wanted to do it under Fred Hoyle, who had a worldwide reputation as the most eminent scientist in the field. But somehow Hoyle reluctant to take him, as he found him not up to his expectation. So he joined with Dennis Sciama, also a cosmologist but not so popular as Hoyle. Stephen Hawking was gradually becoming aware of an inner health crisis. Towards the last days at Oxford, he had begun to

find some difficulty in tying the shoelaces, a number of times he felt falling on his legs. Without a drink passing his lips he would, on occasion, find his speech slurring as though he were intoxicated. Sciama, his guide, understood that his student is exceptionally brilliant, but he has got some problem while speaking and also walking. In the 1962 Christmas vacation, he visited his parents in St.Alban. The parents instantly noticed that there is something wrong while he is speaking and walking. His father, a doctor in tropical medicine, had suspected that Stephen might have contracted some strange bug. They took him to the family doctor and he referred him to a specialist.

During his vacation period in 1962 at St.Alban, a mutual friend introduced to him a young woman, Jane Wild. The two began to talk each other and get into a close friendship. Jane was studying at Westfield College in London began to study modern languages. Jane found this 21-year-old man studying in Cambridge was so fascinating and was attracted towards him.

After returning to Cambridge his study place, he was taken to a series of medical tests to diagnose the disease. A short time later doctors declared that he was under the attack of an incurable disease, amyotrophic lateral sclerosis (nicknamed as Lou Gehrig's disease, after the basketball player who died of this disease) a severe case of motor neuron disease. This affects the nerves of the spinal cord and the parts of the brain that produce voluntary motor functions. The cells gradually degenerate over a period of time and cause paralysis. Apart from this, the brain is unaffected and functions such as thought and memory are also left unaffected. The end stage may be gradual immobility, followed by creeping paralysis, leading eventually to death. Fortunately, Stephen happened to study theoretical Physics for which only an inquisitive mind is all needed. However, doctors predicted only a few years more to Stephen on this Earth.

On hearing the doctors diagnosis, Stephen was highly desperate and lost himself in hearing Wagoner's music and sometimes drinking too much. He found no point in continuing his Ph.D. as he was no log time ahead in life. He was never a believer in any religion or any thought of an afterlife. He suddenly realized that there were a lot of worthwhile things he could do if he were to be relieved from the disease. In another way he thought he could use his life to save others: "After all, if I were going to die anyway, it might as well do some good." Yes, he dragged himself out of depression, back to work again and back to Cambridge for research. Knowing Stephen's decision, his father Frank visited the guide Prof. Sciama and asked whether Stephen could able to complete the Ph.D. in less than three years. Even though Sciama is confident about his student, he replied that it is just impossible to finish within a time less than three years.

Stephen worked like any other student. Stephen along with other students of Sciama, George Ellis, a South African, Brandon Carter, Martin Rees formed a small research group of cosmologists in which each one is working on slightly different problems. They became good friends, often relaxing in one of the city's pubs in the evening or going to concerts, plays, and films together and discussing physics over a bottle of beer. They discussed issues other than their work. Ellis was always interested in politics and anti-apartheid. Jane also became a member of this gathering. Hawking and Jane become more and more attracted towards each other. The two of them would discuss anything, from the Vietnam War to Black Power. Jane often joined them on weekends, then the whole group would often go out together to eat or to picnic.

After the first year in Cambridge, the health conditions of Hawking become more verse, that he couldn't walk even a few steps without a supporting stick. His speech also become seriously affected. In spite of all these difficulties, he worked hard. To his relief, the visit of Jane was more frequent. Jane later recalled it, "I wanted to find some purpose to my existence, and I suppose I found it in the idea of looking after him. But we were in love." They were engaged. For Hawking, this was a very important thing that had ever happened to him: it changed his life, gave him something to live for, and made him determined to live.

It was around this time, Stephen met with Roger Penrose, form Birkbeck college, London who developed the singularity theory for black holes. The whole group of Sciama, often go to London to attend the talks and discuss with Penrose. On one occasion, when the team entered the railway station for London, the train had just begun to move. All of them suddenly ran and just managed to entrain. But meantime, Carter, a fellow scholar, immediately realized that Stephen was not with them inside the train. Carten looked out and saw the most pathetic situation, that Stephen was struggling with his sticks to get along with them. Carter and another friend jumped out of the train to help Stephen.

In the middle of the 1960's Stephen and Jane were planning to marry. But the problem was money. Stephen could first complete the Ph.D., but even for that, he needed a further fellowship and a Job. Stephen tried for a fellowship in Caius, a university college and the application for the same was filled up by Jane. Hawking put the names of Sciama, his Ph.D. guide and Herman Bondi, which he had met few times with Penrose, as referees. But to the surprise, Bondi replied, that he had not heard of Stephen Hawking, to the query from the college for the reference letter. At this point, his Guide Sciama come to his rescue. He contacted Bondi and briefed about Hawking. The result was an excellent reference letter and Hawking was selected for the fellowship.

Hawking and Jane got married in July 1965 in the Trinity Hall Chapel. Meantime they both knew that Stephen might die within a short period of time, but like any other couple, they also expected that they would make a successful and happy life. Jane was a final year student at Westfield College in London, visit Hawking in all weekends and on other days Stephen had to look after himself or by his friends and colleges. The Bursar of the college arranged a room in the student's hostel for the Hawking family for which Hawking has to pay double the usual rent because they were two to live. However, shortly after they took a rented house near DAMTP (Department of Applied Mathematics and Theoretical Physics - where Hawking did his Ph.D.). The House became the meeting place of the entire group of Sciama's students along with some other occasional friends. Hawking was invited to give a talk in Miami conference in the USA. By the time his speech became more slur and Hawking asked his colleague, George Ellis to deliver his talk. To this conference Jane also accompanied him. The matter presented at this conference is the cosmological singularity theorem, which acquired great attention in the conference. During the initial period of their marriage, Jane managed to make the weekend visits to their home in Cambridge and to continue with her studies and graduated in the summer of 1966. During the same time, she also typed up Stephen's Ph.D. thesis. Finally, in the summer of 1966, she finished her studies in London and came back to live with her husband throughout the week in their home on Little St.Mary's Lane in Cambridge.

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In later part of the 1960's Stephen's condition become more verse. Instead of sticks, he had to use crutches for walking. Meanwhile, Stephen's father was very suspicious about the doctors and decided to treat him in his own way. He did extensive study and research about the disease and finally advised Stephen to take a course of steroids and vitamins. In 1986,

Stephen's father Frank Hawking died. He found it very difficult to walk. Some days he took more than 15 minutes to go from his study room to the bedroom in the upstairs. He was very reluctant to take the help of anybody in walking as he wanted to do as anybody else. Sometimes this determination in Stephen's attitude was misunderstood or seen as arrogance to others including his wife, Jane. In a way, it may be this hard determination keep him going in life. In the middle of all these, his reputation was increased, especially because of his studies on the singularity at the beginning of the universe. During this time he started his study on black holes. People began to consider him even as the successor of Einstein. He attended all the seminars and asked deep penetrating questions, sometimes very arrogantly. Hawking's great personal quality is to consider his disabilities as a light one and always have a cheerful and positive outlook on life. In fact, the truth is that he was always thinking about the secrets of the universe and black holes, seldom get time to bother his physical disabilities.

The Hawking family had their first child, Robert born in 1967. This gave Stephen the unimaginable happiness and strive to live further in this world. But this added to heavy duties on the shoulder of Jane, to look after the baby and also Stephen. Jane later recalls this as `Nevertheless, I have to say I found it very difficult and very frustrating in those early years. I felt myself very much the household drudge, and Stephen was getting all the glittering prizes.'

After the coming of the newborn baby, Hawking decided to buy a House in St.Mary's lane near Cambridge. He approached the college Bursar for a loan, and it was rejected. But he could able get a partial loan form a building company. His parents and friends helped him, as a result, they had their own house.

In 1966 Stephen got a Ph.D. degree and also won the Adam's prize for his paper "Singularities and the Geometry of Spacetime." This work was the major part of his Ph.D. But the end of 1960's was a tragic period. Even with crutches, he was unable to walk. Due to doctor's advice, he has to take a wheelchair. With much discussion with his wife Jane and his coworkers, he decided to adopt a wheelchair. As Jain said later "Stephen doesn't make any concessions to his illness, and I don't make any concessions to him." During this time, Hawking was invited to take up a faculty position in Institute of Theoretical Astronomy, which was earlier headed by Fred Hoyle and left it at 1972. Later the institute changed its name as Institute of Astronomy, after the astronomer, Lyndel-Bell took over the charge of the institute.

Hawking family had their second child, Lucy in November 1970 and the third Tim. To add the happiness of the family Hawkins bags many awards, most of them for his works on Black holes. First was the Eddington Medal from the Royal Astronomical Society in London, the Pius XI Medal, bestowed by the Pontifical Academy of Science at the Vatican the Hopkins Prize, the Dannie Heinemann Prize from the USA, the Maxwell Prize, and the Royal Society's Hughes Medal. He became a celebrated scientist. But Jane was becoming increasingly confused with their life and her role in it. Often she played the role of a nurse, to support her husband

through his glittering career, and look after the entire family almost single-handedly. In the middle of all these, she had a growing feeling that she was being ignored. As an intelligent woman who was academically successful in her own right, Jane had given virtually no chances at all to continue her studies. While Hawking gaining prizes after prizes, Jane slowly got into a state of declining self-respect. As Jane herself put it, 'I felt very hurt. I saw myself single-handedly making everything possible for Stephen and bringing up the children at the same time. And the honors were all going to Stephen.' But according to Stephen's friends and colleagues, he has never failed to appreciate Jane's contribution to his success. He takes every opportunity to speak of the great efforts and sacrifices she has made in order to allow them to live as normal a life as possible. One of his great regrets is that he has been unable to play a greater role in helping to raise the children.

There was a difference between Hawking and Jane on religion. Jane was a strong follower of the Christian religion, while Hawking was not all a believer in religion. He was not an atheist but he found that the idea of faith is something which cant fit into his views on the universe. As he once said, We are such insignificant creatures on a minor planet of a very average star in the outer suburbs of one of a hundred thousand million galaxies. So it is difficult to believe in a God that would care about us or even notice our existence. But on the other hand, Jane's stand is just the opposite and is evident from her words, Without my faith in God, I have not been able to live in this situation. I wouldn't have been able to marry Stephen in the first place because I wouldn't have had the optimism to carry me through, and I wouldn't be able to carry on with it.

In 1985 Hawking visited CERN and spend a few days here in Geneva. Meantime Jane was making a tour in Germany. A full-time nurse

was appointed to assists and monitor the health of Hawking. One day, after very late in the midnight he caught some breathing problem. His conditions worsened quickly and was taken to the Cantonal Hospital in Geneva. He was put on a ventilator. He was suspected of suffering from pneumonia. The CERN authorities were tried to contact Jane, but as she was traveling, that was not so easy. Finally, they succeed in contacting jane. When she arrived, doctors informed her that, and urgent operation is needed, as hawking can able to breathe either through nose or mouth. But the problem was that the operation will take away completely his ability to speak and without operation, he couldn't survive. Jane decided to go ahead with the operation. After two weeks of the operation, Jane decided to take him back to Cambridge.

In 1985 he started writing the celebrated popular book, `The Brief History of Time.' He got a sizable amount as an advance for the book, which was needed for the treatment. The condition of Hawking was so serious that he needed continuous nursing assistance. Jain was so worried about these things. On one side they needed a nurse, as Jain is not a nurse and on the other side they had to meet the huge expense for the treatment. Apart from these, Jain wrote to many charitable institutions around the world for the treatment support of Hawking. An American foundation has agreed to donate 50,000 pounds every year for the treatment. During this time an American computer expert, Walt Woltosz made a programme for Hawking, by which using a switch, held on his hand, he can select words and sentences from among a choice of more 3000 words. This can be then sent to a voice synthesizer, which can speak for him. By 1988 he completed the book and it was published on the same year. The continued as the best seller for than a month. He became the most famous scientist in the world. He undertook lecture tours to many countries.

When he became increasingly popular throughout the world, the worst thing happened around was that the relation between Hawking and Jane became more and more strained. Jain had felt increasingly isolated. Many times she refuses to accompany Hawking during trips to somewhere. She gave more attention to her own studies and work, thinking that, Stephen become a public figure, and many are there to take care of him. There were rumors that Jane had engaged in an extramarital relationship. Some other says that there was a great difference in opinion between them regarding religion. As reported by some newspapers at that time, Hawking moved over to another apartment with his longtime nurse, Elaine Mason. Whatever may be the reason they were separated each other.

Jane had looked after Hawking for over twenty-five years, sacrificing many of her own personal hopes and ambitions along, but as he became famous their paths deviated. It appeared that they no longer needed each other. When they decided to depart, their son Robert, then twenty-three, had graduated in physics from Cambridge the previous year and was already started postgraduate studies; Lucy, nearly twenty, was at Oxford University studying modern languages. The young

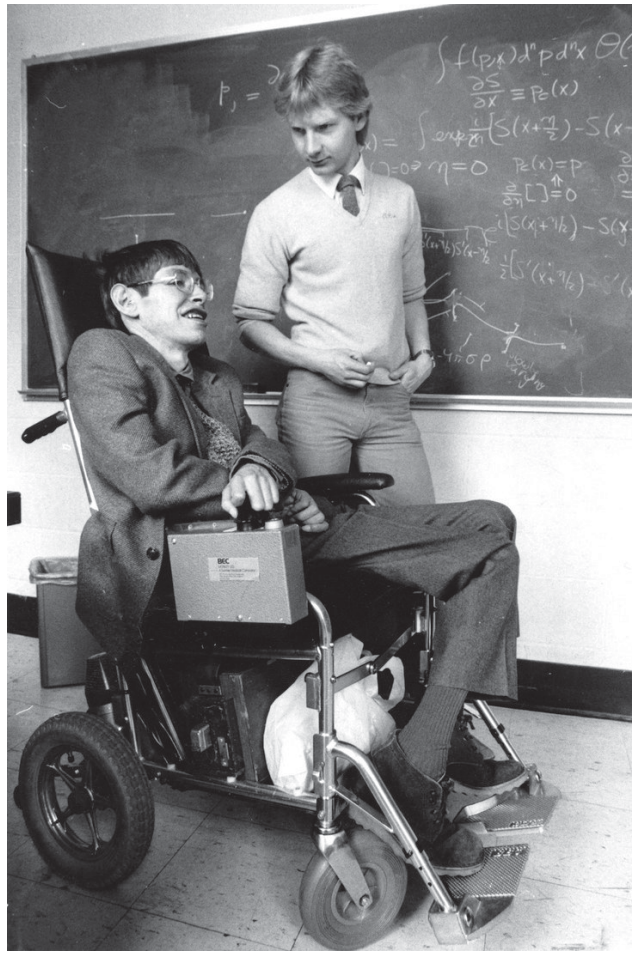
son, Timothy was just around the age thirteen. Stephen was very determined in this separation as if he might have thought that, this may give her time to complete her studies and to lead a life of her own. Finally, in 1995 the Hawking couple were separated.

Research and Contributions

In the Department of Applied Mathematics and Theoretical Physics (DAMTP) where Hawking worked, the big man was Fred Hoyle, who developed the Steady State model of the Universe along with Herman Bondi and Thomas Gold. He opposed the idea of expanding the universe. He ridiculed the expanding model by calling it, the big-bang theory, which ironically becomes the very name of the expanding universe model. Hoyle had a group of students to defend and popularize the steady-state model. Among them, the Indian student, Jayant Narlikar was the prominent name. Hawking was in the adjacent room to Narlikar, and often discuss with him on the cosmological theory. At that time Hoyle and Narlikar were working on a special problem, regarding the creation field, to give further support to the Steady-state model. Regarding this, Hoyle gave a talk before an elegant audience in the Royal Society of London. After the talk, while Hoyle was waiting for the questions, young Hawking stood up and said that ``The quantity you're talking about diverges''. The room was in pin drop silence. The gathered scientists saw that, if Hawking's assertion was right, then Hoyle's claim would be wrong. Hoyle was really disturbed and replied that ``of course it doesn't diverge.'' Hawking came forward strongly, ``it does''. Hoyle immediately asked ``How do you know that?'', Hawking replied ``Because I worked it out.'' Hoyle was indeed very furious. But later it was proved that Hawking was right. Hawking wrote a paper summarizing his findings in this regard. Through this Hawking gave a big blow to the steady-state model at around 1962. This created a respectable place for Hawking among the cosmological researchers. But Stephen was still looking for a suitable Ph.D. problem.

Singularity theorem in cosmology

The discovery that our universe is expanding was made by Edwin Hubble around 1929. A theoretical explanation of



this was possible for Einstein theory of gravity. The expansion was viewed as the recession of the galaxies away from each other. Then, if one goes backward in time, these galaxies were closer to each other, so that at sufficiently back in time, they might have concentrated at the same location with infinitely high density and temperature. It may be from this state the universe began to expand. The initial moment of infinite density is called big-bang, where the classical laws of physics will break down and it is the point of singularity.

The followers of the steady state theory argued that, there was no such moment called a singularity, which can effectively bypassed by the local motion of particles, by which they will not concentrate at a location, instead they cross each other without colliding and causes another expansion and in the created voids new matters were created to make the density remains the same throughout the expansion of the universe. Hawking along with his collaborator, Roger Penrose, was able to show that, with the peculiar motion, the so-called local motion, it is impossible to avoid the singularity. For the expanding universe, the singularity at the origin is inevitable. Which otherwise equivalent to a state that our universe has got an origin. This is considered to be a serious blow to the steady state model of the universe, which was propounded by Fred Hoyle.

Evaporating black holes

The all-time important work of Hawking is in the area of black holes. Hawking began to study black holes at around 1970.

Black holes are not at all detectable directly detectable as they emit nothing. One only feel the great gravitational pull of it. But black hole in binary stars, which orbit around an ordinary star could make its presence highly visible. A black hole can accrete great amount of matter from the companion star, which would result in the emission of X-rays. But such X-ray emission could be possible not because of the black hole only, but it is possible even when the binary partner of the ordinary star is white dwarfs or neutron stars or even pulsars. Many observed X-ray emission from binary systems, traced back to the presence of white dwarfs or neutron stars. But the binary partner of the Cygnus binary star system was found to have a mass of about eight to ten solar masses. Definitely, the object is not a white dwarf. If it could be a neutron star, the mass to be around two to three times of the solar mass. So it was concluded that the unseen object in the Cygnus-I was a black hole. Even though Hawking was so sure about the black holes, he reluctant to accept the claim that, Cygnus-I was a black hole. He even bet with Kip Thorn of Caltech Institute, USA. But the overwhelming evidence was in favor of Thorn's side and finally, Hawking conceded the defeat.

Around the 1970s it was established that a black hole could rotate, but it could not pulsate. Hawking also took part in this work. The size and shape of a black hole depend only on its mass and the speed at which it rotates. The boundary of the black hole called the horizon, all that we can see from the outside of black hole, carries no identifying features that can tell us what the hole was made of. Physicists call this lack of identifying features the "no hair" theorem.

As nothing can get out of a black hole, its mass can never decrease. So the surface area of the horizon of the black hole will never decrease. Hawking and Penrose had come up with a practical mathematical definition of a black hole horizon in terms of the trajectories of light rays through space-time. With this definition, he realized, the surface area of the black hole would always increase if matter or radiation fell into the hole, and even if two black holes collided with one another and merged, the area of the new black hole would always be greater than the sum of area of the merged black holes.

Hawking idea of the non-decreasing horizon area was so outrageous and people immediately connected it thermodynamics, the science of heat and motion. They connect it with the concept of entropy, which also by definition should not decrease. So Hawking's realization that black holes surface area never decreases, coming with such force that evening in November 1970, was to lead to the idea that the law is equivalent to the law which says that the entropy of a closed system can only stay the same or it always increases. Actually, this connection was first realized by Jacob Bekenstein who was just a student at Princeton University, who boldly suggested that the area of the black is a measure of its entropy. This led to a series of investigations later on.

At first, Hawking was very much annoyed by Bekenstein's suggestion. Even a normal science student ought to have realized that entropy is directly connected with temperature so that if the area of a black hole were indeed a measure of entropy it would also be a measure of temperature and hence black holes must be hot. If so the black hole would radiate energy into the outer universe, which is very cold. As a result, Hawking first thought that there is a fatal flaw in Bekestein's suggestion. However, Hawking changed his mind immediately. It was due to one of his own work, he came to accept the Bekenstein idea.

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In around 1971, hawking was shown about the production of mini black holes during the very early stage of the universe. It was known if our Earth would become a black, it should shrink to size about a centimeter. In principle, anything can be a black hole if it is squeezed hard enough and the difficulty is that, the lighter the object you want to make into a black hole, the harder you would have to squeeze it. Hawking argued that as we look back in time toward the beginning of the beginning of the universe, the pressure was great enough to squeeze any amount into a black hole. But the problem is, if the universe is so uniform, then the entire universe itself become a black hole. However the Universe cannot have been perfectly smooth and uniform in the early stages, if it had, there would be no way of

forming structures like galaxies and clusters. The primordial black might have acted as the source of the formation of heavy structure like galaxies.

Around 1969, Penrose showed that rotating black holes can lose energy thus their speed of rotation decrease. In 1973, the Russian scientists, Yakove Zel'dovich and Alex Starobinsky have shown by using the quantum theory that rotating black holes can emit particles. Later Hawking did a perfect mathematical calculation of their argument and have convinced that they were right. Hawking extended his calculations to non-rotating black holes also, and found that they too can emit particles. The triumph of Hawking was that he was able to prove that, black holes emit particles just as a hot body with an effective temperature and the temperature was exactly same as the temperature corresponding the entropy of the black hole which is proportional to its surface area.

The radiation by black holes can be understood only with quantum uncertainty principles. This principle tells that, there is an element uncertainty in knowing the physical quantities with precise accuracy. It doesn't just mean that the instruments are not capable of measuring the quantities in a precise way. On the other hand, it is the very law of nature, which obeys quantum mechanics in the most fundamental level.

Classically the vacuum or empty space contains nothing. But according to quantum mechanics, here also there is an element of uncertainty that vacuum can actually contain a lot of energy. Quantum principles say that this energy can be borrowed form vacuum, for a time duration determined by the uncertainty in the measurement of time. This energy may be converted into particles. But the only way, by which the particles can be created out of the expense of vacuum energy is that they could be created in as particle-antiparticle pairs, which can be annihilated within the time duration permitted by the uncertainty. These particle pairs are thus called virtual particles. Hence it can visualize that vacuum is full of virtual particles.

In the vicinity of the black holes, outside its horizon, the virtual particles can be produced. As soon as they produced, one of them will be sucked into the black hole within the uncertainty time duration so that the companion particle would not see its counterpart to annihilate and it escapes so as to conserve the momentum. In fact, the energy expended in this process is actually coming from the gravitational energy of the black hole as a result, its energy being deteriorated gradually. effectively the black hole loses its mass. Hawking has shown that maybe with billions of years the entire black hole can evaporate away by emitting particles like this. The emitted radiation was named after him as Hawking's radiation. This highly speculative work need the observational support its verification. Unfortunately, the temperature calculated for such radiation is too small, around 10^{-30} K, that none of the present equipment can sense that.

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About Stephen Hawking and an analysis of his views on contacting aliens

Dr. Godfrey Louis Ph. D
Emeritus Professor of Physics, CUSAT, Kochi

Stephen Hawking and Albert Einstein

Stephen William Hawking was born on 8th January 1942 and died recently on 14 March 2018 at the age of 76. He was a theoretical physicist, a great thinker, and also a visionary. Great physicists and philosophers have the habit of thinking deeply over various problems and arrive at their own thought out conclusions. While philosophers mostly describe their thoughts and conclusions in words, physicists mostly represent their results in mathematical equations for the expert audience. There are some parallels between Albert Einstein and Stephen Hawking. Even though Albert Einstein was a theoretical physicist dwelling in the complexities of mathematical equations, he was readily available to public for popular science talks. This way he communicated with the common man. In many of his talks, Albert Einstein explained his complex theory to the common man in simple language so that laymen who are having no knowledge of Physics also could get some ideas about his theory. Stephen Hawking also had some similar qualities, with regard to the ability to communicate science to the public, which made him popular.

Albert Einstein is also famous for his thought experiments. These experiments are something which cannot be performed practically, but one can imagine the situation in mind. For example in one of his thought experiments he asked people to imagine the situation in which he or she is standing inside a lift and the rope of the lift is cut while the lift is in the topmost floor of a big multistory building. The lift will make a free fall greatly increasing its speed as it goes down under the acceleration due to gravity. The interesting thing is that for a short period of time the person inside the lift will feel weightlessness, he or she will feel as if they are floating in space because the download acceleration has cancelled the effect of gravity. Thus, he explained his equivalence principle which says that gravity and acceleration are the same. This is only one of the examples. Albert Einstein has come up with many other interesting thought experiments to explain his theory of relativity.

The basic requirement for doing a thought experiment is ability for logical and creative imagination. While Stephen Hawking was unfortunately not capable of normal physical activities due to a motor neuron disease which affected him, he was having an excellent intellectual ability. He was mostly confined to a wheelchair, and he was unable to speak like normal people. He spoke and communicated to the world through a computer which translated his finger movements into words. It is really an amazing fact that he was able to publish advanced papers In theoretical physics, despite his disabilities.

Stephen Hawking became very popular in the minds of common man because he wrote books which were addressed to the common man explaining many complex ideas to the public in understandable language and his books became best sellers throughout the world. Many people were

ready to compare him with Albert Einstein. Among the popular books Stephen Hawking published are his best seller A Brief History of Time, Black Holes and Baby Universes and Other Essays, The Universe in a Nutshell, The Grand Design and My Brief History.

One of the important contributions of Stephen Hawking to theoretical astrophysics is known after his name as "Hawking radiation". This contribution is related to black holes. Before the invention of Hawking radiation it was thought that "black holes "can only grow larger in size by devouring nearby matter and cannot get smaller by losing matter, because the gravitational field of a black hole is so intense, nothing including light cannot escape from it. Hawking showed that black holes can lose matter by a process called Hawking radiation. Black holes are usually born as the end product of a massive star that has reached the end of its life by exhausting all the nuclear fuel. Supermassive black holes having mass as great as million suns are also known to exist at the center of galaxies. The existence of black holes was predicted by Einstein's General Theory of Relativity. To predict this radiation he made use of two important but widely differing theories in physics like General Theory of Relativity and Quantum Mechanics. Theory of relativity shows that black holes have a spherical boundary in space called event horizon. Any object crossing this event horizon from outside cannot comeback, the object will be absorbed by strong gravity and it will become a part of the black hole. According to quantum theory, empty space or vacuum is not actually empty. Pairs of fundamental particles are constantly and spontaneously created and annihilated in empty space. In this pair one is matter particle and other is antimatter particle. In quantum physics this process of virtual particle production is called a quantum fluctuation or vacuum state fluctuation. Hawking argued that if particle pairs are produced near the event horizon of a black hole then the pair can separate without self-annihilation. While one particle is absorbed by the black hole the other can fly away. This particle separation is at the expense of the black hole's gravitational energy, so the black hole loses some energy or its equivalent mass. Thus black holes may ultimately evaporate by this mass loss process. The smaller the size of the black hole the faster it will evaporate by Hawking radiation.

Albert Einstein was awarded Nobel Prize for his research work on the theory of Photoelectric effect in which he proposed that the light waves carry energy in the form of quantized light particles called photons whose energy is proportional to the frequency of light waves. Even though Albert Einstein was famous for his special and the general theory of relativity these were not considered for the award of Nobel Prize. Stephen Hawking was not awarded a Nobel Prize. This is possibly because his theoretical findings have not yet been tested experimentally. Currently, there are also no astrophysical observations which can prove his theoretical findings on black holes.

Though Hawking was not a recipient of Nobel Prize, he received numerous other awards and honours. As early

as in 1974 he was elected a Fellow of the Royal Society (FRS). At that time, his nomination read as quoted below:

"Hawking has made major contributions to the field of general relativity. These derive from a deep understanding of what is relevant to physics and astronomy, and especially from a mastery of wholly new mathematical techniques. Following the pioneering work of Penrose he established, partly alone and partly in collaboration with Penrose, a series of successively stronger theorems establishing the fundamental result that all realistic cosmological models must possess singularities. Using similar techniques, Hawking has proved the basic theorems on the laws governing black holes: that stationary solutions of Einstein's equations with smooth event horizons must necessarily be axisymmetric; and that in the evolution and interaction of black holes, the total surface area of the event horizons must increase. In collaboration with G. Ellis, Hawking is the author of an impressive and original treatise on Space-time in the Large."

Concerns about contacting aliens

Considering the vastness of the universe, Stephen Hawking believed that aliens exist and considered alien life as a possible threat to humanity. He was always discouraging the activities to communicate with possible alien civilizations. He has cited the example of native Americans who suffered greatly when Christopher Columbus discovered America. Migrants from Europe enslaved the native people and ruled over them. Stephen Hawking considered that in a similar manner, aliens may not be friendly and they may pose a threat to human beings. Currently we have sent some high intensity radio waves with encoded messages into deep space in the hope that someone may receive the signals and respond to it. These messaging experiments take hopelessly long duration. It takes about 5 years for the radio waves to reach the nearest stars and if somebody sends a return message it will also take another 5 years to reach here so there is a minimum 10 year lag for communication. This is the case if some civilization exists near our nearest stars, for other possible distant stars the duration is hopelessly long and go beyond a human lifetime, but still a chance exist for contact with aliens. Stephen Hawking's advice is not to announce our presence here and invite trouble.

But the fact is that we have already announced our presence here. Ever since the invention radio and television we have been radiating communication and entertainment signals unintentionally into space. Our powerful military radars have been radiating powerful pulses of radio waves. We are beaming powerful radio signals from hundreds of earth stations to hundreds of satellites stationed all along the geostationary orbit. Any intelligent alien can pick up these signals and infer our presence here. So if some aliens are looking for a place to land, we have already given them a clue. Currently we have detected about 4000 extrasolar planets by detecting the wobbling of the stars produced by the orbiting planets or by using the dipping light curves of stars produced by transiting planets. Many of these planets are in the habitable zone around their host star. Next stage of investigation is to spectroscopically detect the atmospheric gas composition of some of these planets which may indicate the presence of life. If intelligent creatures are there in those planets they are likely to be looking back at us in a similar way and may have already inferred our presence here. At night our cities are well illuminated with bright lights which are nice to see from space. Ultra-powerful alien telescopes may easily pick up our unnatural night illumination. By analyzing the spectrum of our night illumination they may know that we have developed sodium vapor lamps and powerful light emitting diodes. We have already launched several earth orbiting satellites. An artificial ring of satellites are orbiting in the geostationary orbit. Intelligent aliens can possibly detect these artificial satellites and infer our presence here.

Search for extra-terrestrial intelligence (SETI) is of two types, active and passive. While passive SETI is just listening for possible intelligent signals from space, active SETI involves sending messages to space, hoping that intelligent aliens may receive the same and understand our presence on Earth.

Search for extra-terrestrial intelligence (SETI) is of two types, active and passive. While passive SETI is just listening for possible intelligent signals from space, active SETI involves sending messages to space, hoping that intelligent aliens may receive the same and understand our presence on Earth. Active SETI is also called METI (Messaging Extraterrestrial Intelligence). While there are many supporters for SETI many including Stephen Hawking strongly oppose METI.

The first intentional message for aliens was transmitted to space in 1974 from Arecibo

Radio Telescope in Puerto Rico, USA. It was transmitted toward the globular star cluster called Messier 13 which is about 25,000 light-years away. The message consisted of a pattern of binary numbers which contained information about the basic chemicals of life, the structure of DNA, Earth's place in our solar system and even a stick figure of a human. This can be considered as a safe message with no immediate threat because an attack or reply is not expected to reach here during next 50,000 years! Whether humans will be able to survive in planet Earth till such time is very doubtful. But this signal can also be picked up by some nearby aliens due to the beam spread of radio telescope. As on 2018 some 44 years have passed and we have not yet received any reply message.

After 1974 there were many other messages which were aimed at nearby stars. 'Cosmic Call' was the name of two sets of interstellar radio messages that were sent from RT-70 radio telescope in Yevpatoria, Crimea, Ukraine in 1999 (Cosmic Call 1) and 2003 (Cosmic Call 2) to various nearby stars. The messages were designed with noise-resistant format and characters. The Teen Age Message (TAM) was a series of interstellar radio transmissions sent from the Yevpatoria Planetary Radar to six solar-type stars during August-September 2001. The structure of the TAM was suggested by Alexander Zaitsev, Chief Scientist at Russia's Institute of Radio Engineering and Electronics. The message's content and target stars were selected by a group of teens from four Russian cities, who collaborated in person and via the Internet. Each transmission comprised three sections: a sounding, a live theremin concert, and digital data including images and text. TAM was aimed at stars at some 45 to 70 light years away and a reply can be expected only in future. Zaitsev's proposal for a musical message - the "First Theremin Concert for Extraterrestrials" - was earlier submitted to the Arecibo Observatory in July 2000. It was rejected amid concerns over the dangers posed by advertising the presence of humanity to unknown and possibly highly advanced civilizations.

Across the Universe is an interstellar radio message (IRM) consisting of the song "Across the Universe" by The Beatles that was transmitted on 4 February 2008, by NASA in the direction of the star Polaris.This transmission was made using a 70-meter dish in the Deep Space Network's (DSN) Madrid Deep Space Communication Complex, located in Robledo, near Madrid, Spain. This IRM project has some significant defects in that the message was aimed at Polaris, which is 431 light years distant from us and whose planetary system, even if it exists, may not be suited for life, because it is a supergiant star. Clearly NASA had no intention to send this message to intelligent aliens.

A Message from Earth (AMFE) is a high-powered digital radio signal that was sent on 9 October 2008 towards Gliese 581c, a large terrestrial extrasolar planet orbiting within the Gliese 581 system, 20 light years from earth. The signal is a digital time capsule containing 501 messages that were selected through a competition on the social networking site Bebo. The message was sent using the RT-70 radar telescope. The signal will reach the planet Gliese 581c in early 2029.

On 13 February 2015, scientists at an annual meeting of the American Association for the Advancement of Science, discussed Active SETI and whether transmitting a message to possible intelligent extraterrestrials in the Cosmos was a good idea; That same week, a statement was released, signed by many in the SETI community, that a "worldwide scientific, political and humanitarian discussion must occur before any message is sent". However some scientists had a different view.

Voyager 1 is a space probe launched by NASA in 1977 to study the outer Solar System. Having operated for 40 years, 7 months and 16 days as of April 21, 2018, the spacecraft still communicates with the earth station to receive routine commands and return data. At a distance of 141 times earth sun distance (AU), approximately 21 billion kilometers from the Sun as of January 2, 2018, it is the farthest spacecraft and man-made object from Earth.

In addition to scientific instruments the Voyager space probe carries a gold-plated audio-visual disc called the "Golden Record, in case the spacecraft should ever be found by intelligent life forms from other planetary systems.

Timothy Ferris, the person who helped to compose the Golden Record says the following: "The Voyager's message is for the ages. It's a gold-plated copper disc, 12 inches in diameter, containing sounds of Earth, greetings in 55 languages spoken by 87 percent of the world's population, 115 analog-encoded photographs and 90 minutes of music ranging from the bell-pure tones of Pygmy girls singing in a forest in Zaire to Beethoven's Cavatina and Chuck Berry's "Johnny B. Goode." To facilitate playback, the aluminum case enclosing each record carries a ceramic phono cartridge plus a diagram showing how to use it. (The correct playback speed, 16 and 2/3 rpm, is diagrammatically

defined in terms of the fundamental transition time of the hydrogen atom.) The record's case also sports a pulsar map, showing Earth's location at the epoch of launch, and a patch of uranium-238 from whose half-life the time elapsed since launch may be inferred. The technology, though outdated, has the advantage of longevity. As Iron Age cuneiform inscriptions remind us, grooves cut into a stable medium can last a long time. The Voyager records should remain playable for at least a billion years before succumbing to erosion by micrometeorites and cosmic rays. A billion years is 5 times the age of the Atlantic Ocean, 5,000 times longer than Homo sapiens have existed."

Voyager 1 is expected to reach the theorized Oort cloud in about 300 years and take about 30,000 years to pass through it. (Oort cloud is a cloud of comets proposed to surround the Sun to as far as somewhere between 50,000 and 200,000 AU.) Though Voyager 1 is not heading towards any particular star, in about 40,000 years, it will pass within 1.6 light-years of the star Gliese 445. According to NASA, the Voyagers are destined, perhaps eternally, to wander the Milky Way.

Voyager and other similar space crafts which go beyond the solar system are like "message in a bottle". When people are stranded in a remote island after an unfortunate shipwreck, an hopeful way to send a message to the mainland is through a letter sealed inside a bottle. Such a bottle thrown into the sea may be carried by the waves and someday it may reach somebody. Aliens are most likely to spot the Voyager like space crafts if it reach somewhere near their space surveillance system because a spacecraft's morphology is very different from that of a wandering asteroid. Considering the vastness of space, it may take thousands of years for our voyager to be detected by an alien civilization. It may also happen soon if aliens are looking for such space crafts. We may also detect alien space crafts. Recently a large elongated object named 'Oumuamua', which was identified as coming from interstellar region, passed through our solar system. This evoked suspicion whether it could be a dead alien spacecraft. There are also unconfirmed reports of alien space crafts, like unidentified flying objects (UFO).

Stephen Hawking can be partly true about aliens because of what we find in nature, one species is seen always trying to dominate over the other. Predatory nature is built into many creatures and one animal becomes the food of another animal. This kind of a natural order can be seen around us. In that context what Stephen Hawking says has got some importance, all alien creatures need not be of higher civilization having high cultural values. They may not be like some Gods who will help us. It is very clear that Stephen Hawking assumes that aliens also have selfish motivations like we human beings. We consider ourselves as very evolved and developed civilization yet we are not free from defects. Nations around the world collects large inventory of arms and ammunitions, invents weapons and chemicals for mass destruction of people, keeps ready huge number of soldiers, ready to fight and kill each other. Human history is full of stories of wars perhaps more people in the world died due to wars than through natural disasters.

While Stephen Hawking can be correct about this view that aliens are possible threat to humanity, he can also be wrong. The aliens need not be always hostile; they could be of benefit to us. Universe is a vast area and exchange of lifeforms and ideas are probably taking place in the universe. The life forms in the universe may coexist without trouble. If one part is damaged the other part will survive, this can also be a rule of the universe. If the aliens are good we may get immense benefits like new knowledge about our universe and life. We may get a chance to learn better theories than General Relativity and Quantum mechanics. We may also understand the unknown secrets of life itself. We may get new technical knowhow. On the other hand, if some of the aliens are highly advanced, we may be of least consideration for them, just as we do not consider communicating with ants and teach them science.

While Stephen Hawking can be correct about this view that aliens are possible threat to humanity, he can also be wrong. The aliens need not be always hostile; they could be of benefit to us. Universe is a vast area and exchange of lifeforms and ideas are probably taking place in the universe.

While Stephen Hawking discourages contacting alien life forms he advocates that we should venture out of planet earth and establish colonies in other planets, because he thinks that human beings have only a limited period of existence inthis planet Earth. He has expressed his concern that life on Earth is at risk from a sudden nuclear war, a genetically engineered virus, perils of global warming or other dangerous humans have not yet aware of. Considering the social, political and environmental situation on earth he suspected how human race can sustain another 100 years in this planet. We need to wait and see what our future is.

Isaac Newton, man behind Newton's Laws

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It is highly essential for a Physics teacher to know the persons who contributed to the subjects.Then only he can present the subject matter with interest. When we teach Newton's laws of motion and planetary motion we should know the persons behind the inventions of this fundamental physical principles.

Let us see how Newton employing certain general principles of reasoning as Gate use the regularities of motion of solar system from Kepler's laws to arrive at the laws of gravitation and laws of motion. In order to understand the beauty of his invention, we should know Isaac Newton as a person.

Isaac Newton was born in a small village of Woolsthorpe in Lincolnshire on the Christmas day of 1642, the same year of Galileo's death. Newton was a sickly baby and not expected to live long. His father died before his birth and his mother married a wealthy man after Newton's birth. Newton was raised by his maternal grandmother. He hated his mother and it was likely a contributing factor to the psychological instabilities and sense of insecurity in his letter life. Newton had his schooling in his village. He matriculated at Trinity College Cambridge. Hey served as a waiter in the cafeteria to support his educational finances.

That time was the early part of scientific revolution initiated by Kepler, Galileo, and Descartes. But still, universities of England including Cambridge was teaching outmoded Aristotelian doctrines. Even though he respected Aristotelian philosophy he was much more impressed

Prof. Ittyachan one of the founders of APT, Kerala receiving a memento from HoD, CUSAT on behalf of APT

by the newly evolved thoughts. He wrote in his notebook, "Amicus Plato — amicus Aristoteles — magis amica veritas. (Plato is my friend — Aristotle is my friend — but my greatest friend is the truth.) Hhe was familiar with Isaac Barrow, Kepler Descartes, and Robot Boyle.

By the time he received his bachelor's degree in 1665 from Trinity College, he had discovered binomial theorem. By the time he began to develop his method of fluxions or calculus. Because of plague spreading in London he returned to his village in 1665.

When Cambridge opened in 1667 Newton was elected as a fellow of Trinity College. That year he wrote an article on analysis by equations unlimited to the number of their terms and send it to his professor Barrow. That year Barrow vacated his chair and offered it to his student. That was in 1669 on Newton's 27th birthday.

In the annual lectures of 1670, Newton selected his work on optics and in 1672 he communicated it in

writing to Robert Hooke, a senior member of the society, the man of Hooke's law. Hooke questioned Newton on main points and they became unfriendly for a very long time. Newton never liked criticism that is a black mark on him. In later years he was withdrawn to himself and refused to publish anything further. He suffered his first nervous breakdown during that period.

In 1679 Hooke posed the problem of determining the orbit of a Planet given that force acting on it vary inversely as the square of the distance of the planet from the sun. Hooke, Halley, and Wren work on this without success. In 1684 Halley happened to visit Newton at Cambridge and asked him if he knew the solution. Newton replied offhandedly that it is an ellipse, he further said he has proved it mathematically and put the paper somewhere. He was not interested in popularity. Newton published Principia in 1687. After Hooke, Newton was elected as the President of the Royal Society.

There was a major controversy with Leibniz over the questions of priority in inventing the calculus. It is clear that Newton formulated his version of Calculus first but did not publish it but waited until 1704 edition of 'Opticks.' Leibniz independently discovered and published it in 1684.

Another interesting incident in the life of Newton is the following. Bernoulli formulated a problem and gave the mathematicians of the world 6 months to solve it. In a single evening of 1697, Newton solved it and published it anonymously in the Transactions of The Royal Society. Bernoulli saw it and remarked 'the lion is known by its claw'.

Just before his death he remarked to his nephew "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

Newton lived as a bachelor. He died on March 21, 1727, and was buried in Westminster Abbey, London. Near him lay, Michael Faraday and James Maxwell.

APT Talent Search Examination 2017 - Report

Dr. Mini Krishna K
Vimala College, Thrissur,
State Co-ordinator.

The All Kerala Physics Talent Search Examination (TSE)is an initiative by APT held state-wide annually aimed at identifying and encouraging young talents in Physics. APT TSE2017 was conducted on 23rdSeptember 2017. 80 Colleges participated in the event and around 3000 students applied for the examination.Out of these,around 2070students appeared for the examination.

TheTSE exam consisted of two parts: a written examination and an interview. The preliminary written exam included 75 objective questions (Part A) and 10 descriptive problems (Part B).OMR sheets of Part A were evaluated with the help ofmembers of the Department of Physics, Vimala College, Thrissur. The Part B answer sheet of students who had scored more than 30 in part A were evaluated by the coordinator. Part B of 190 students was evaluated. 61 students who secured the top marks (Part A and Part B together) were called for interviewscheduledat five different zones in the state - Kozhikode, Kannur, Thrissur, Kottayam and Kollam.

Kozhikode on 20/1/2018 at Govt. Arts and Science College, Meenchanda, Kozhikode.

Thrissur on 20/1/2018 at St. Thomas College,Thrissur

Kottayam on 20/1/2018 at CMS College,Kottayam

Kollam on 20/1/2018 at SN College, Kollam

Kannur on 3/2/2018 at Nirmalagiri College,Koothuparambu

The interview board included experts from all over Kerala. Except for one student, all others attended the interview. The final rank list was prepared based on the marks in the interview and written examination taken together.

Theorganisers of APT TSE2017 are thankful to all regional as well as centre coordinators for the cooperation and support extended for the conduct of the examination and interview. The support from the college authorities is also gratefully acknowledged.

Once again, thanking you all for the cooperation and requesting your support for future endeavours.

TSE 2017 - Toppers

1. Aashique Unnikrishnan
Devamatha, Kuravilangad

2. Shivaprasad
M.G. College, Iritty

3.Pram Milan P Robin
TKM College, Karicode, Kollam

APT Workshop : Quantum Mechanics -V : 9-11 December 2017 - CMS College, Kottayam

APT Workshop : Quantum Mechanics -VI : 10-12 February 2018 - Providence Women's College, Kozhikode

APT Workshop : Physics Teaching Tools - I : 11-12 November 2017 - UC College, Aluva

APT Annual Genral Body - 29 April 2017

APT Workshop : Astronomy -III : 26-27 August 2017 - CMS College, Kottayam

APT Workshop : Astronomy -IV : 6-7 January 2018 - SH College, Chalakudy

APT Workshop : Physics Teaching Tools-II : 26-28 January 2018 - UC College, Aluva

APT - Physics Talent Search Examination - 2016 winners

SEELablet : A Technological Platform for Development of Innovative Experiments for Undergraduate Education

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The relevance of substantiating theory with experimental methods is integral to science. However, a variety of factors limit the availability of tools keeping up with modern technology in teaching labs, and this sties innovation.

In technology, Market forces dictate the pace of innovation as well as the cost of end products. A classic example would be modern day cellphones that pack the processing capabilities of desktop computers from a mere five years ago.

The downside of such an evolution is that several niche, yet critical products suffer from lack of suffcient R&D. Scientific equipment in particular, are priced with an exponential dependence on quality, and this prohibits quality hands-on education in undergraduate level teaching laboratories. The fundamental building blocks to both end-products - microprocessors, communication speeds, and storage technology - are however, similar , and several high quality scientific experiments keeping up with the latest can now be developed.

SEELablet is a platform that leverages the capabilities of a microcontroller with a fairly powerful set of peripherals, and complements it with a variety of analog and digital tools such as programmable gain amplifiers, waveform generators, LCR meter, CC sources etc. All functionality is controlled via a Python module that runs on the included Single Board Computer(SBC) to which the device is connected via USB. Digital communication ports allow addition of add-on boards. SBCs are designed to be cost and resource effective, while also being able to perform the same tasks as desktop computers. The SBC included in the SEELablet runs a linux based OS,

running various powerful data processing and visualization software such as Scipy and PyQtGraph that help extract meaningful parameters from the acquired data in order to enable students to explore experiments across the sciences.

I. BACKGROUND

A. The case for integration of experimental setups with PCs

Characteristic of a shift into the digital era, students have started to learn to code at an early age. However, most of the academic applications are centered around purely software based learning techniques such as simulations.

Software control of data acquisition equipment allows a much ner control over events that govern an experiment. Timing tasks that are impossible to achieve manually, can be easily taken care of with a few lines of code that control and measure parameters at precise intervals, as well as process the data on the y in order to dictate further events.

The ability to easily access multiple control and

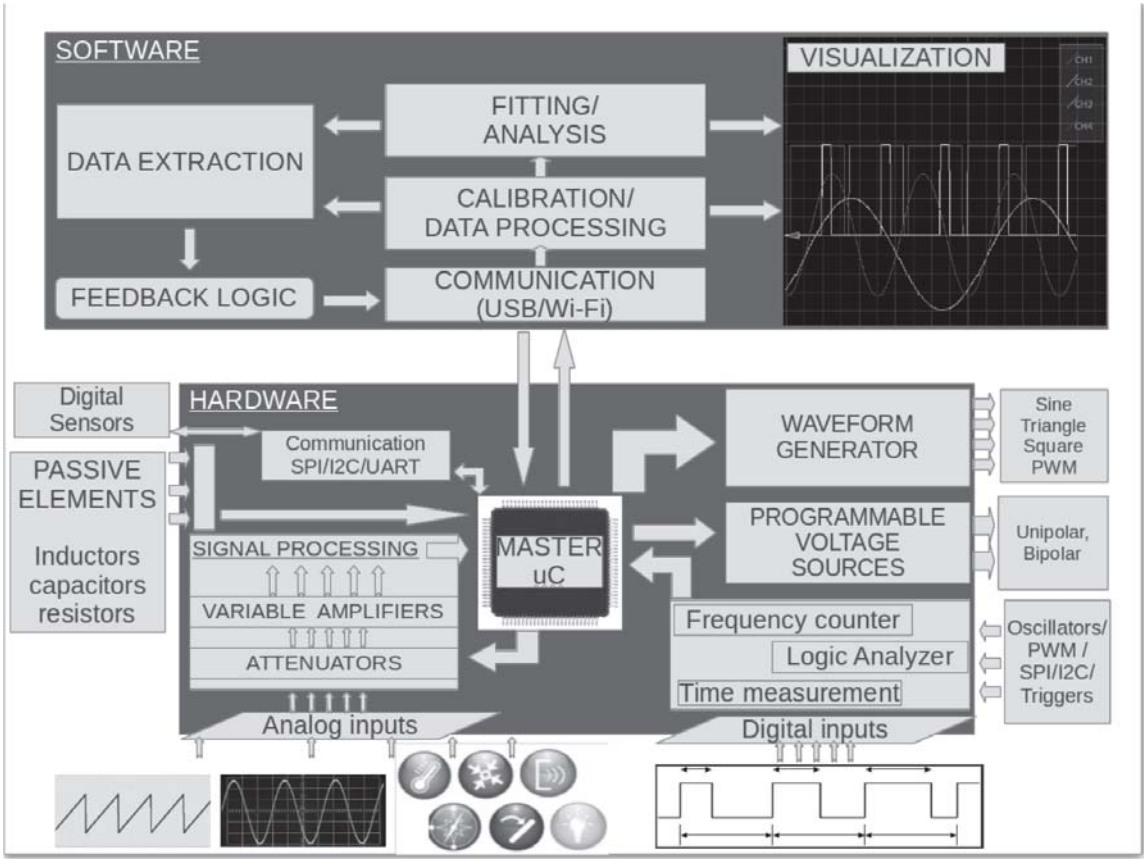

FIG. 1: System design of the SEELablet. All real time tasks are handled by the microcontroller, and complex mathematical and visualization tasks are done by the PC.

measurement tools as well as analyze the results from one common platform (such as is common in advanced research labs) enables users to design new experiments and further the spirit of science.

B. Development of data acquisition hardware

Inexpensive microcontrollers, most of which are capable of nanosecond response times, and feature numerous communication channels, are aptly suited for deploying more sophisticated control over scientic data acquisition and control tasks . When used in conjunction with appropriate analog circuitry, they are capable of measuring a wide variety of parameters pertaining to science experiments such as voltages, capacitances, frequencies, and time intervals.

A wide array of sensors dealing with physical parameters such as temperature, pressure, acceleration, luminous intensity etc. can also be easily incorporated using appropriate digital communication protocols such as I2C/SPI/UART etc. These protocols are implemented in hardware on most modern day microcontrollers.

The architecture of the SEELablet consists of a state machine that listens for data packets sent by the PC based Python Library and executes relevant tasks. Many functions such as wave generation, and timing measurement calls are ooaded to independent peripheral modules that are part of the microcontroller, but free up the Central Processing Unit(CPU) to process further events. Many of these peripherals are also equipped with Direct Memory Access(DMA), and can write measured data to certain memory locations without CPU intervention.

C. Development of data acquisition Software

Computers possess a lot more processing capabilities than microcontrollers, and are therefore the most useful platform for visualizing the extracted data, and extracting meaningful parameters from it. The comunication library encodes functions called by the user into appropriate data packets , and relays it to the hardware. Since the hardware is only running a single state machine , it is far more capable of handling time critical tasks. The microcontroller used on the SEELablet runs at a 64MHz clock, and therefore can execute instructions at precise intervals of 1/64e6 (15nS) each.

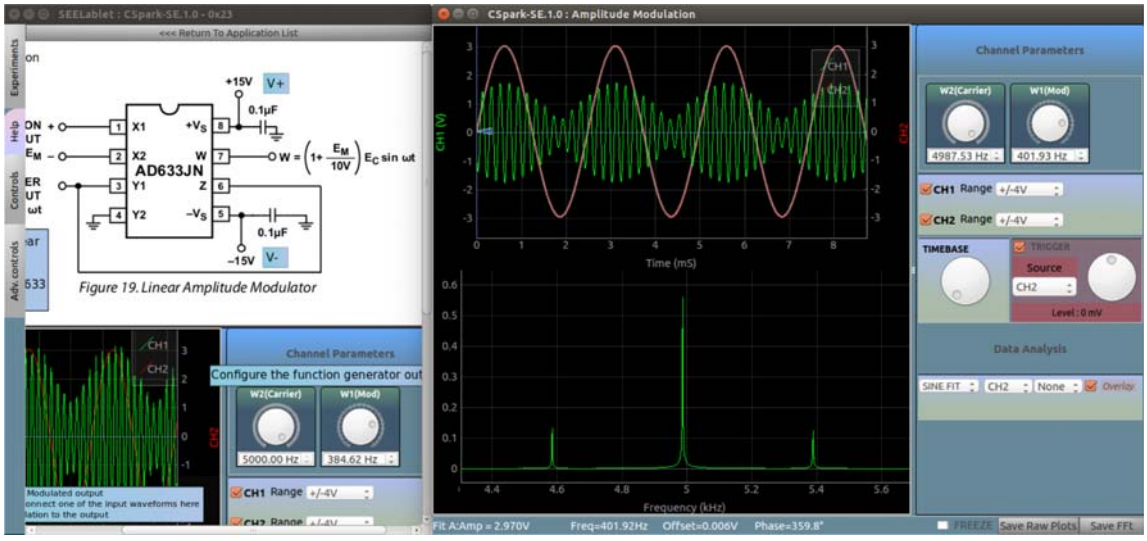

FIG. 2: Graphical interface for the amplitude modulation experiment performed using an AD633 analog multiplier.

D. Some novel instruments and their potential applications

- **Amplitude modulation using an analog multiplier** - Using the available wave form generators, one can be assigned as the carrier waveform, and the other can serve as the modulation input. A fourier transform of the output reveals a peak centered around the carrier frequency, and sidebands on either side at a distance equal to the modulation frequency.
- **Inductance measurement for position sensing** - The inductance of a solenoid is dependent on the nature of its core. Introducing a ferromagnetic material increases it, while a diamagnetic material decreases it. This principle was applied to make a position sensor whose resolution was calculated to be<10um. It can be applied to measure oscillations of mass spring systems with minimal interference, but high resolution.
- **Wireless bridges for physical sensors** - Wired communication pathways may not be feasible for certain experiments. These bridges have been demonstrated by studying the motion of mechanical systems.

E. A real-time curve tracer that measures the IV characteristics of various diodes

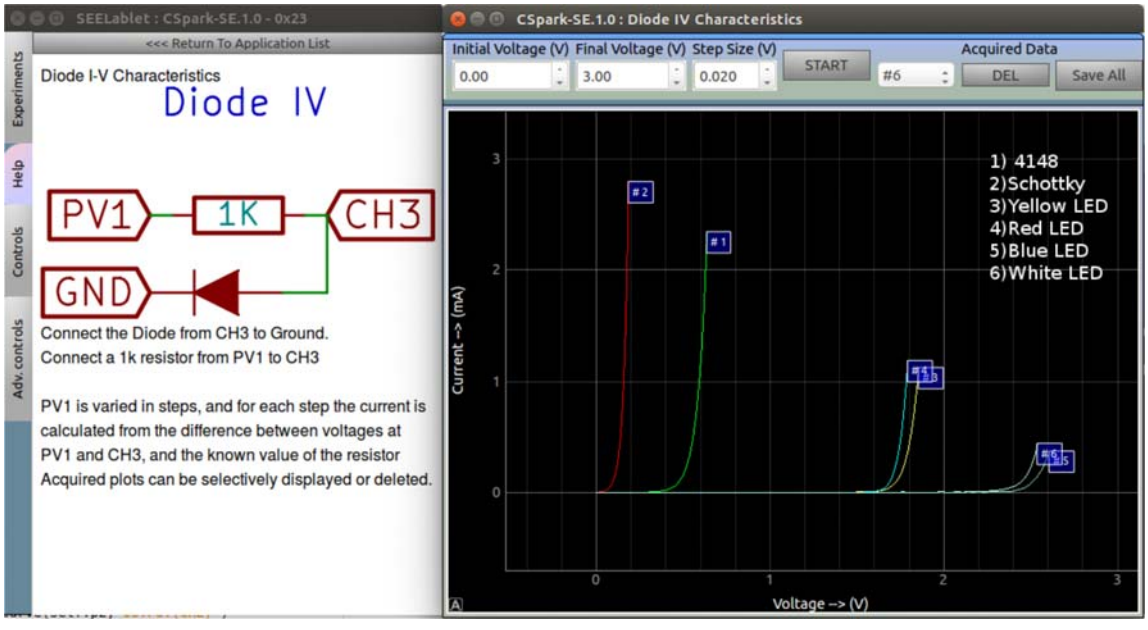

FIG. 3: IV characteristics of various diodes

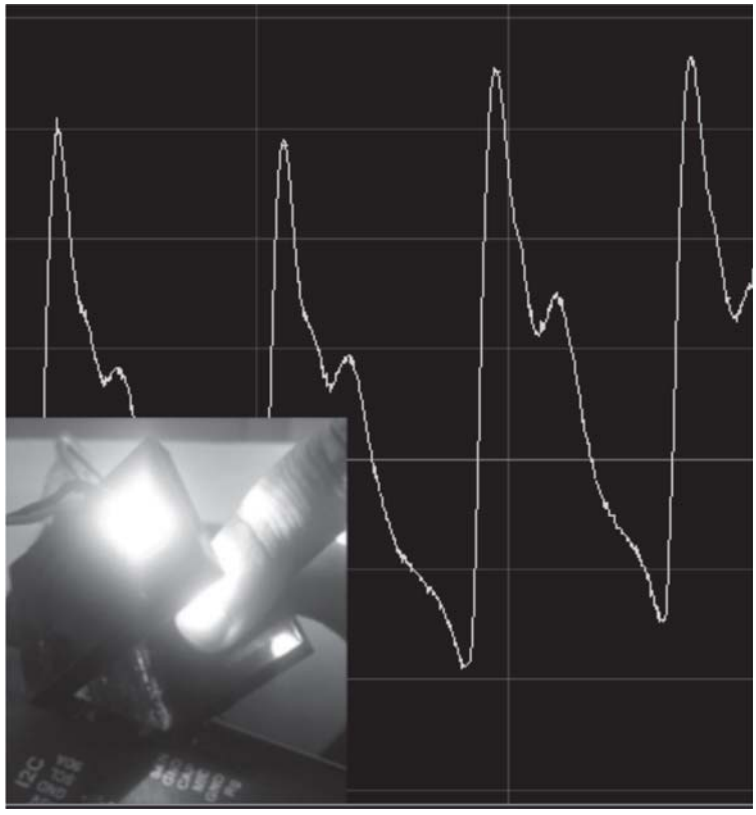

FIG. 4: Pulse sensing using light sensors

PPN Junctions in the forward biased conguration typically start conducting only beyond a certain potential dierence that is proportional to its band gap, as opposed to the denition of an ideal diode. In order to measure this voltage, also known as the knee voltage or the forware threshold voltage, the potential dierence across the diode is gradually increased using one of the voltage outputs, and the current is monitored via a series shunt resistor. The results of IV curves of various diodes are shown in the gure. It can be observed that the knee voltage of the diode is directly proportional to the frequency emitted by the diode as a consequence of recombination of holes and electrons.

The same setup can also be used to show that the band gap, and therefor the knee voltage, is inversely proportional to the temperature of the diode by simply heating the diode and observing the reduction in the threshold voltage.

F. Measuring heart rate using photo sensors

Blood circulation in mammals is carried out by the heart that pumps in a pulsed manner. This also means that the blood pressure uctuates along with each heart beat, and corresponding diameter changes occur in the blood vessels. In order to observe these uctuations, and light sensor such as a photo transistor is placed on one side of either the earlobe, or a nger, and the other side is illuminated by a bright light source. The diameter uctuations of the blood vessels causes changes in the opacity, and therefore the light transmitted across the nger also uctuates. A time domain plot of these intensity uctuations measured by the light sensor reveals the overall heart rate as well as the systole and diastole. The time domain information can be used to identify irregularities such as arrhythmia.

G. Studing the oscillations of a physical pendulum using an inertial measurement unit

To study the oscillations of a physical pendulum, and observe the relation of its angle to its velocity, an external sensing IC commonly found in smartphones for measuring tilt angle and rotation speed is used.

The picture shows an MPU-6050 (3-Axis accelerometer + 3-Axis Gyroscope) hooked up to the I2C communication port via thin guage copper wires designed to cause minimal perturbation to the oscillations of the pendulum. The IC is positioned at the pivot so that the accelerometer can be used to measure the angle of the pendulum accurately using the vertical compoenent of earth's gravitational pull.The gyroscope's values for the axis

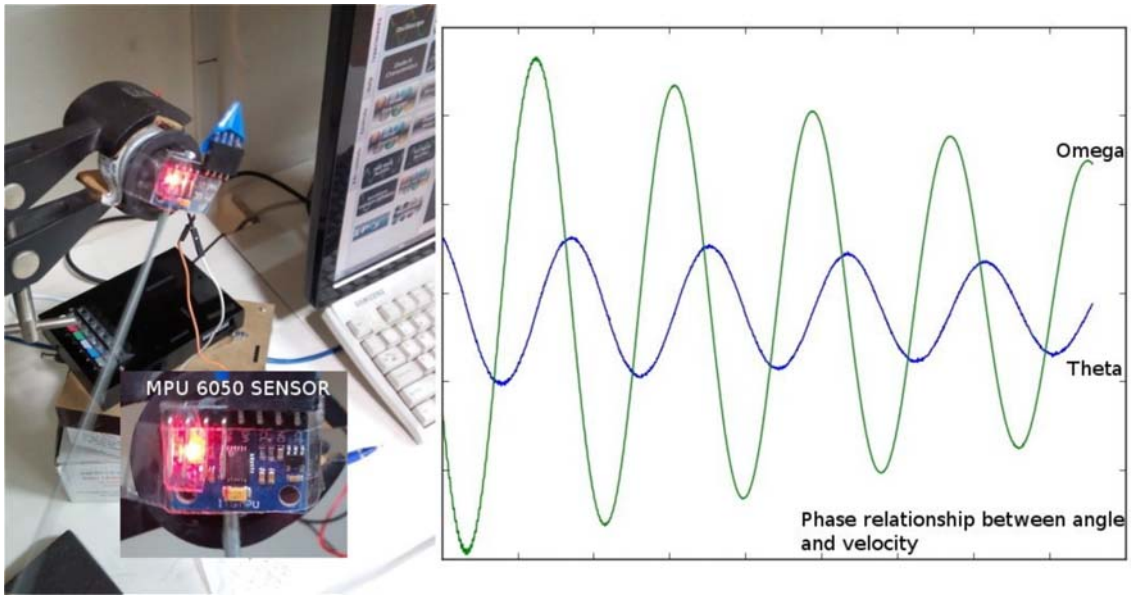

FIG. 5: Studying a simple pendulum using an accelerometer and a gyroscope

parallel to the pendulum's pivot are also recorded.

It can be observed that the velocity is maximum at the mean, and zero at the extremities.

H. An example of a simple thermodynamics experiment using external sensors

Consider the adiabatic compression of nitrogen using a glass syringe. Going by the theory, the parameters involved are pressure, Volume, temperature, and the degrees of freedom of nitrogen (known).

A wireless pressure+temperature sensor should be placed inside the syringe, followed by which the syringe can be squeezed by a known amount with the nozzle blocked.

This causes the pressure to rise, and since glass is a poor conductor of heat, the process can be considered pseudo-adiabatic, and a rise in the gas temperature can also be observed. The temperature will however equilibriate over time and cause an associated drop in the pressure.

The real-time data plots of such an experiment, as well further data analysis can give a much deeper understanding rather than mere theoretical knowledge. With a preset compression ratio, and measured pressure and temperature data, the degrees of freedom of the gas can be calculated with reasonable accuracy.

II. CONTROL AND MEASUREMENT EQUIPMENT SPECIFICATIONS

Feature	Description	Socket Labels	Range
Analog Inputs	Up to 6 analog inputs with various voltage ranges.		
	Programmable gain control.	CH1, CH2	16V olts
	12-bit voltage measurement. Up-to 2MSPS sampling.	CH3	3:3V olts
	3:3V Voltage Reference	MIC	15mV V
		SEN	0 3:3V
Analog Outputs	Programmable Voltage Sources (12-bit)	PVS1	5V
		PVS2	3:3V
		PVS3	0 3:3V
	Programmable Constant Current Source	PCS	0 3:3mA
	4 x TTL compatible digital Inputs.		
	Logic Analyzer	ID1 - ID4	0 5 V

Digital Inputs	Frequency Counter (0-16MHz), time measurement routines f 30ppm;12MHz Reference oscillatorg	 Fin	 0 5V
Waveform Generators	Wavegen 1 (Sine/Triangle/Arbitrary) -Frequency -Amplitude. Manually attenuable Wavegen 2 (Sine/Triangle/Arbitrary) {Frequency -Amplitude. Fixed 4 x Phase Correlated Square Waves -Frequency -Phase dierence maximum resolution -Duty Cycle maximum resolution -Also functions as simple state selectable output. -servo/stepper motor control supported	W1 W2 SQ1 - SQ4	5 5KHz 3V 5 5KHz 3V 0 5V olts 10Hz - 16MHz 15nS 15nS .
Data Buses	I2C : Master Commonly Used by numerous sensor ICs SPI : Master -Chip Select pins UART	SCL,SDA SCK,SDI,SDO CS1 , CS2	
Expansion Slot	20 - pin Socket designed to accommodate add-on modules. -Selection includes SPI,I2C,Analog input,Digital IO, 16MHz TTL output, and a bipolar power supply.		
Wireless Nodes	Battery Powered add-on units. Power Source -Acts as a wireless bridge for various sensors 3 Byte unique address -10 bit ADC , Digital I/O	. Cell/Adapter	. 3.7-4.2 V

III. LIST OF EXPERIMENTS WITH GRAPHICAL USER INTERFACES

- **Introductory Experiments and common Test and measurement tools**

- 4-Channel Oscilloscope with Analytics for tting and data extraction
- 4-channel Logic analyzer
- Generic Data Logger for all measurement call that return numeric values such as voltage, time, resistance etc.
- Acquire and plot data from I2C sensors. Wired as well as wireless.
- Flow based programming. PyQtgraph's owchart utility has been adapted to enable hardware control via congurable graphical blocks that can be dragged around and interlinked to generate a control ow for experiments.
- iPython Console for interactive usage.

- **Introductory Experiments**

- Dierence between AC and DC
- Make a Lemon cell
- Simple electromagnetic induction with a coil and magnet
- AC generator with a coil and magnet
- Measure electrical capacitance
- Study the discharge curve of a capacitor
- Resistors in Series and Parallel
- Ohms Law

- Measure the resistance of the human body
- Measure the AC and DC resistance of water
- Study a light dependent resistor

- **Electronics Experiments**
- RLC transient response
- Capacitive Reactance
- Inductive Reactance
- Capacitive Phase shift
- Inductive Phase Shift
- RLC steady state response
- RC Integrals and Derivatives
- NFET Output Characteristics
- NFET Drain-Source Characteristics
- BJT common base Characteristics
- BJT Common Emitter Characteristics
- BJT input Characteristics
- BJT transfer Characteristics
- BJT amplier
- IV Characteristics of a PN junction
- IV Characteristics of a zener diode
- Clamping circuit using a diode
- Clipping circuit using a diode
- Halfwave rectier using a diode
- Fullwave rectier using two diodes
- Inverting Amplier using an opamp
- Non - Inverting Amplier using an opamp
- Linear ramp generator from a step signal
- AC and DC Summing Junction
- Precision halfware rectier
- 555 timer : Astable Mode
- Colpitts oscillator
- Phase Shift oscillator
- Wein Bridge oscillator
- Monostable mode oscillator
- Amplitude modulation using AD633
- Bode Plots : Frequency and phase response
- Voltage controlled low pass lter

- **Physics Experiments**
- Measure time period of a pendulum using the logic analyzer
- Randomply sample waveforms and plot histograms
- Measure speed of sound
- Plot the oscillations of a pendulum
- Measure the frequency response of a piezo buzzer
- Study the oscillations of a pendulum using a intertial sensing unit
- Measure speed of sound
- Study sound waves using fourier transforms
- Study the waveforms from a piezo buzzer
- Study the beat phenomenon
- Measure distance using sound pulses

- **Using Add-on modules for Experiments**
- Control Up to 4 servo motors via SQR1-4.
- Control a stepper motor via SQR1-4 . Stepper motors are precise mechanical instruments capable of rotating backwards/forwards in precise angles as low as 1 degree.
- Acquire data from a TCD1304 Linear camera with 3648 pixels. This sensor can be used for spectrometry in combination with a diraction grating.
- The measured data can be transmitted via the internet via servers such as things-peak , and PubNub. Acquisition tasks can also be controlled remotely.
- Monitor 2.5pm dust concentration using a DSM501 sensor
- Access a 128*64 SSD1306 OLED display
- Fade random hues on wireless RGB lights
- Read/Write Smart Cards using MFR522
- Set color of up to 3 daisy chained RGB LEDs(WS2812B) connected to SQR1

IV. CONCLUDING REMARKS

The SEELablet aims to provide a complete, cost-eective solution for budding scientists and engineers. It tries to move away from kit based solutions being currently employed, and instead encouraged students to enhance the prescribed experiments via the various modular tools provided.

It can be purchased from csparkresearch. in, and the additional requirements are a monitor, keyboard and mouse.

1] http://seelablet.csparkresearch.in

2] https://scipy.in/2014/static/uploads/jithinbp/attachment/abs.pdf

3] https://hackaday.io/project/12552-seelablet-instrument-cluster-for-laboratories

Statement on INO from the three Indian science academies:
The Indian National Science Academy, New Delhi
The National Academy of Sciences, India , Allahabad
Indian Academy of Sciences, Bengaluru

The India-based Neutrino Observatory (INO) is a mega-science research project planned to be undertaken by scientists from more than 25 Indian Central and State Universities and Research Institutes. It is a purely scientific research project of fundamental significance, and one that has been supported and approved by the Government of India.

The Science Academies of India are strongly supportive of the establishment of such an experimental facility for its intrinsic scientific value. In addition to enabling Indian researchers to make a unique contribution to our understanding of several fundamental problems of physics, a major effort on this scale will also contribute significantly to the development of education and research infrastructure in Tamil Nadu. The site selected for INO is in the Bodi West Hills and has been chosen after an extensive nationwide site survey. All environmental regulations will be adhered to and no residents will have to be relocated.

The INO will help us learn more about neutrinos which are elementary particles that have no charge and almost no mass and therefore do not affect anything they pass through. They are naturally produced in the atmosphere of the Earth and are present around us at all times, causing no damage. The INO experiment is a pure science experiment that will lead to the creation of a new Inter-Institutional Educational and Research Centre for High Energy Physics at Madurai. These benefits are not just for the short term: the INO is one of a set of major experiments that can consolidate our position as a leading scientific nation.

The Science Academies hereby appeal to people of the district, state, and country to support this educational and research project wholeheartedly. A successful INO experiment will be a major technological and scientific national achievement.

Annual Report of the activities of APT, Kerala 2016-2017

Dr. Shaju K.Y.
Christ College, Irinjalakuda
Secretary, APT

Respected President of APT, Prof.M.K.Jayaraj, Respected Principal of Mar Ivanios college, Rev.Dr. Gigi Thomas, Our Chief guest Dr.SVM Satyanarayana, respected office bearers and Executive Committee members, respected honorary members and life members and my dear friends

Let me present before you the report of the academy activities for the year 2016-17. Academy of Physics Teachers, Kerala is a unique Professional body of University and College teachers in Kerala. Our aim is to nurture Physics education in the state of Kerala. The various activities of APT, held during 2016-17 are given below.

Talent Search Examination 2016-17

All Kerala Talent search examination was conducted for the year 2016-17 with a record number of participation from students. APT expresses sincere gratitude to the state coordinator, Dr.Reshmi R., U.C.College, Aluva and all the regional coordinators for their sincere effort to make the event a successful one. Dr.Reshmi R.. will present a brief report of the Talent search exam.

Regional Programs

APT has 4 regional coordinators, corresponding to 4 universities.

* For Kannur University, Dr.Devadhasan K.V., M.G.College Iritty.

* For Calicut University, Prof.G.Harikrishnan, Govt.college, Madappally

* For M.G.University, the regional coordinator is Dr.Ison V. Vachipurackal, St.Thomas College, Palai.

* For Kerala University, the regional coordinator is Prof. Vipin Das, University College, Thiruvananthapuram. APT allotted Rs.5000 each to all the 4 regions to conduct suitable academic programs.

Website

Our website www.aptkerala.org is managed by Prof.Godfrey Louis and we thank him for spending his valuable time for maintaining and updating the website.

WhatsApp group

Our WhatsApp group with 220 members are active in academic discussions. I request all the members to restrict the posts related to Physics and teaching.

National Workshop Series

The theoretical and practical physics workshop series, completed 2 years. The national workshops will be continued for few more years. Thanks to Dr. G. Harikrishnan for sustaining his keen interest in coordinating the workshop series. We also thank the resource persons Prof.Satyanarayana from Pondicherry Central University and Prof.Joseph Prabhakar, Loyola College, Chennai. I advice the Physics teachers of Kerala to make use of this unique opportunity of updating yourself.

Video Library

APT now has a large collection of video lectures, which are also uploaded on youtube. We have a plan to give links to these videos in our website.

Life Memberships

The life memberships obtained in 2014-15 was 84. In 2015-16, it was 93. In last year we got 56 new life members. Thanks to all those who cooperated to increase the life memberships. Total life

memberships now is 285. I request all the life members help to join at least one new member in next year. The life member details are uploaded in the website.

Finance

Dr.Issac Paul, S.B.College, Changanachery, Treasurer of the Academy will present the audited accounts-receipts and payments for the year 2015-2016 and 2016-17. The audited report will incorporate with this report after the General body meeting passing the accounts. I also thank Prof.Issac Paul taking the pain of maintaining the account of APT and for renewing the registration of APT.

APT Tunes

We are going to release APT Tunes journal in this meeting. I appreciate the efforts taken by Dr. N. Shaji and Dr.Santhosh Potharay and thank all those cooperated by giving articles.

Online Model JAM test

This was the highlight of the year. We have conducted online model JAM test two times, before the actual test. The students are benefitted by this. Thanks to Dr.Noble P Abraham for the proper execution of exam and Principal of Marthoma college, Thiruvalla for providing their website.

Examination Committee

We have formed the examination committee to prepare the questions and to conduct more examinations in coming years. The committee is decided to conduct online Model NET exams, just before the actual NET exam in June and December of every year.

Limitations

We could not publish the APT Tunes last year, due to deficiency of articles. The edutainment tour to Bangalore also postponed/canceled due to the lack of participants. The website could not be managed up to the expectations. More youngsters has to be active in order to assume the official posts of APT. Even though APT offered financial assistance to start JAM coaching in each district, we could not start the programs in other districts than Thrissur.

Future plans

We have lot of plans for the coming years.

- State level Presentation Contest for P.G. and U.G. Students,
- State level Quiz programs for U.G.Students,
- Poster/Project competition for P.G. Students,
- Article/Essay writing for P.G.Students,
- IIT-JAM coaching for U.G.Students,
- NET coaching for P.G.Students,
- Interactive sessions with Plus Two teachers
- A three-day residential entrance workshop will be conducted for the final year Degree students on December 28,29 and 30, 2017

In the next year, a combined effort is needed to realize these programs.

Conclusion

My heart-full thanks to Prof.M.K.Jayaraj, the president of the Academy, who continuously supported and guided me so that we could have another fruitful year for the Academy. I also congratulate Prof.M.K.Jayaraj for achieving the Mid-career award from UGC. I also thank the other office bearers and executive members for their involvement in discussions, during the executive meetings. I also express sincere thanks to all its members for their constant support for the year 2016- 17 and expect the same for the coming years.

Thanking you,

Thiruvananthapuram	Dr.Shaju K.Y.	Prof. M.K. Jayaraj
29-04-2017	Secretary	President

APT National Workshop Series : A Review - 2018

Dr. G. Harikrishnan
State Coordinator,
Govt. College, Madapally.

APT National Workshop Series for the teachers was launched in November 2014. Until February 2018, in a span of 40 months, 31 workshops were completed. Out of these 22 were in Theoretical Physics series, 3 in Experimental Physics series, 4 in Astronomical Data Analysis series and 2 in Designing Physics Teaching Tools series. Except for the 4 workshops in Astronomical Data Analysis series, organized in collaboration with IUCAA, Pune and KSCSTE all the other workshops were organized without any financial aid from Govt. or private agencies. Each of these workshops were on cost-sharing basis, using the registration fee of the participating teachers. The workshops are being conducted at different colleges in Kerala, but the participation is not limited to teachers from the state. These workshops are regularly being conducted on holidays to avoid the loss of teaching hours of the participants. APT National Workshop Series is unique in the country as this could be the only series of its kind being regularly conducted outside the demands of the service regulations, and the directives and funding of Govt. or private agencies. The model is being sustained by the continuing support of the participating teachers, the dedicated efforts of the local organizers of the hosting colleges, and the commitment of the resource persons.

2017-2018

In 2017-18 six bimonthly workshops in Quantum Mechanics series, two workshops in Astronomical Data Analysis series and two workshops in the newly launched Designing Physics Teaching Tools serieswere conducted.

APT National Workshops in 2017-2018

Sl No.	TOPIC	VENUE	DATES	RESOURCE PERSON
1	Genesis of Quantum Theory	Mar Ivanios College, Thiruvananthapuram	29-30 April 2017	Dr. S.V.M. Satyanarayana, Pondicherry University
2	Wave Mechanics	Assumption College, Changanasserry	10-11 June 2017	Dr. S.V.M. Satyanarayana, Pondicherry University
3	Conceptual and Mathematical Structure of Quantum Mechanics	Vimala College, Thrissur	12-14 August 2017	Dr. S.V.M. Satyanarayana, Pondicherry University
4	Astronomical Spectroscopy	CMS College, Kottayam	26-27 August 2017	Experts from IIA-Bangalore and Christ University, Bangalore
5	Angular Momentum : Hydrogen Atom Problem	KMM Govt. Women's College, Kannur	14-15 October 2017	Dr. S.V.M. Satyanarayana, Pondicherry University
6	Designing Physics Teaching Tools	U.C. College, Aluva	11-12 Nov 2017	Ravishankar C S, Chennai
7	Time-Independent Perturbation Theory - Variational Method - WKB Approximation	CMS College, Kottayam	9-11 December 2017	Prof. M. C. Valsakumar, IIT-Palakkad

8	Optical and UV Astronomical Data Analysis	Sacred Heart College, Chalakudi	6-7 January 2018	Dr. P. Sreekumar, Director, IIA-Bangalore, and other experts from IIA-Bangalore.
9	Designing Physics Teaching Tools – Optics	U.C. College, Aluva	26-28 January 2018	Dr. AlokSharan, Pondicherry University
10	Spin - Emergence of Periodic Table from Quantum Mechanics	Providence Women's College, Kozhikode	10-12 February 2018	Dr. S.V.M. Satyanarayana, Pondicherry University

2018-2019

In 2018-19 the following 9 workshops have been scheduled.

- 5 workshops in Quantum Mechanics series, completing the series
- 2 workshops in Astronomical Data Analysis
- 1 workshop in designing physics teaching tools, completing the series
- A prelude to General Relativity in Prof. ThanuPadmanabhan's workshop

APT National Workshops in 2018-2019

Sl. No.	TOPIC	VENUE	DATES	RESOURCE PERSON
1	Time dependent Perturbation Theory	U.C. College, Aluva	28-29 April 2018	Dr. S. Sivakumar, IGCAR, Kalpakkam
2	Designing Physics Teaching Tools	U.C. College, Aluva	19-20 May 2018	Prof. T S Natarajan, IIT-Tirupati
3	X-Ray Astronomy – Advanced Training	Providence Women's College, Kozhikode	22-26 May 2018	Faculties from IUCAA, Pune
4	Quantum Theory of Scattering	Christ College, Irinjalakuda	23-24 June 2018	Dr. Govind S. Krishnaswami, CMI, Chennai
5	Why is gravity described by space-time curvature	Govt. Arts and Science College, Kozhikode	1-2 September 2018	Prof. ThanuPadmanabhan, IUCAA, Pune
6	Relativistic Quantum Mechanics	SB College, Changanassery	13-14 Oct.2018	Dr. S. Sivakumar, IGCAR, Kalpakkam
7	Solar Astronomy	St. Xavier's College, Aluva	10-11 Nov. 2018	Faculties from ISRO and IIA, Bangalore
8	Introduction to Quantum Field Theory	CUSAT	8-10 December 2018	Dr. S V M Satyanarayana, Pondicherry University
9	Quantum Information Theory	Vimala College, Thrissur	9-10 Feb 2019	Dr. S V M Satyanarayana, Pondicherry University

എന്തുകൊണ്ട് ഞാനൊരു ഭൗതിക ശാസ്ത്രജ്ഞയാകാൻ അഗ്രഹിക്കുന്നു?

ശ്രീലക്ഷ്മി ടി
രണ്ടാം വർഷ B.Sc. ഫിസിക്സ്
വിമല കോളേജ്, തൃശൂർ

തേജസിജന മണ്ഡലങ്ങളുടെ വിശാലതയ്ക്കും അണു ഘടകങ്ങളുടെ സൂക്ഷ്മതക്കും മുന്നിൽ ആശ്ചര്യം പൂണ്ട് അതിനെ തൊട്ടറിയാൻ ശ്രമിക്കുന്ന എന്റെ മനസ്സിലെ ജിജ്ഞാസയാണ് ഒരു ഭൗതികശാസ്ത്രജ്ഞയാകാൻ പ്രേരിപ്പിക്കുന്നത്. എന്നിലെ ലോകത്തേയും എനിക്ക് ചുറ്റുമുള്ള ലോകത്തെയും എനിക്കപ്പുറമുള്ള ലോകത്തെയും ചൂണ്ടിക്കാണിച്ചു തന്നത് ഭൗതികശാസ്ത്രത്തിലേയ്ക്കുള്ള എന്റെ കൊച്ചു കൊച്ചു പടവുകളാണ്.

കാര്യങ്ങളെ വിലയിരുത്തുന്നതിന് മുമ്പേ നോക്കിക്കാണാൻ എന്നെ പഠിപ്പിച്ചത് ഭൗതികശാസ്ത്രമാണ്. വാനത്തിൽ മിന്നിത്തിളങ്ങുന്ന നക്ഷത്രങ്ങളെ കാണിച്ചുതന്നുകൊണ്ട് പ്രപഞ്ചത്തിന്റെ വിശാലതയ്ക്കു മുന്നിൽ എനിക്ക് ഒരു മണൽത്തരിയുടെ പരിവേഷം തന്നുകൊണ്ട് ജീവിതത്തെ സ്നേഹിക്കാൻ എന്നെ പഠിപ്പിച്ചു. ഈ ചെറിയ ജീവിതത്തിലെ സുഖദുഃഖങ്ങളെ കീറി മുറിച്ചു പരിശോധിക്കാതെ ജീവിതത്തിന്റേയും പ്രപഞ്ചത്തിന്റേയും അനന്തതയിലേക്ക് ജിജ്ഞാസയോടെ നോക്കി നിൽക്കാൻ പ്രേരിപ്പിച്ചതും ഭൗതികശാസ്ത്രം തന്നെയാണ്. അനന്തതയുമായി അഭേദ്യമായി ബന്ധപ്പെട്ടിരിക്കുന്ന ഒരു കണിക നമ്മുടെ ഈ കുഞ്ഞു ഹൃദയത്തിലുമുണ്ടെന്ന് ഞാൻ വിശ്വസിക്കുന്നു. അനന്തതകളിൽ നിന്ന് ഉദ്ധരിച്ചെടുത്ത നമ്മിലും അനന്തതയുടെ അംശങ്ങൾ ഒളിച്ചു കിടക്കുന്നുണ്ട് എന്നതു തീർച്ചയുള്ള വസ്തുതയാണ്. ആ അനന്തതയിലേക്കുള്ള ഒരു എത്തിനോട്ടമാണ് എന്റെ ഈ യാത്ര – ഭൗതിക ശാസ്ത്രത്തിന്റെ അടിത്തട്ടുകളിലേക്ക്...

അറിയുന്നതിനേക്കാൾ മനസ്സിലാക്കുന്നതിനും കഴിവിനേക്കാൾ ജിജ്ഞാസയ്ക്കും പ്രാധാന്യം കൊടുത്തിട്ടുള്ള ഈ യാത്രയിൽ അറിവില്ലായ്മയുടെ ഭയത്തെ ജിജ്ഞാസ കൊണ്ട് തോല്പിക്കാൻ ഭൗതിക ശാസ്ത്രം എന്നെ പഠിപ്പിച്ചു. എന്നും നമ്മെ പുതിയ പാതകളിലേക്കു നയിക്കുന്ന മനസിന്റെ കാമമായ ജിജ്ഞാസയെ തൊട്ടറിയുമ്പോൾ ലഭിക്കുന്ന സന്തോഷം വാക്കുകൾക്കതീതമാണ്.

ജീവിതത്തിലൊന്നിനേയും ഭയപ്പെടാതെ എല്ലാറ്റിനേയും മനസ്സിലാക്കാൻ പഠിപ്പിച്ച മാഡം ക്യൂറിയുടെ ജീവിത സംഘർഷങ്ങളും എനിക്കീ യാത്രയിൽ ഇന്ധനമായി മാറുന്നു. സ്ത്രീയായി ജനിച്ചതിന്റെ പേരിൽ സർവ്വകലാശാലയിൽ നിന്ന് പുറത്താക്കപ്പെട്ട ഈ സ്ത്രീരത്നത്തിന് ഭൗതിക ശാസ്ത്രത്തിൽ നോബേൽ സമ്മാനം ലഭിച്ചത് എന്നും എന്റെ ആത്മവിശ്വാസത്തെ ശക്തമാക്കുന്നു.

മാഡം ക്യൂറി

വിശ്വവിജ്ഞാനത്തിന്റെ വാതായനങ്ങൾ ഇരുണ്ട ദ്രവ്യത്തിലേക്ക് തുറക്കപ്പെട്ടത് വേരാ റൂബിൻ എന്ന സ്ത്രീരത്നം കാരണമാണ്. വലയം വെച്ചു കൊണ്ടിരിക്കുന്ന ന്യൂട്രോൺനക്ഷത്രങ്ങൾക്കിടയിലുള്ള രശ്മി കേന്ദ്രങ്ങളെ കുറിച്ചറിഞ്ഞത് ജോസ്ലിൻ ബെൽ ബെർണലാണ്. കൗതുകത്തിന്റെ നാമ്പുകൾ എന്നും നമ്മിലുണർത്തുന്ന പ്രപഞ്ചത്തിന്റെ മനോഹര ചിത്രങ്ങൾ പകർത്താനുള്ള ടെലസ്കോപ്പിനെ സജ്ജമാക്കിയത് സാന്ദ്ര ഫേബറായിരുന്നു. ചെറുപ്പം മുതൽക്കേ നക്ഷത്രങ്ങളുടെ സഖിയായിരുന്ന സാന്ദ്ര, ആ മായാലോകം സാധാരണ ജനതക്കു മുന്നിലും തുറന്നിട്ടു.

ഓരോ സെക്കൻഡിലും $3x10^8$ മീറ്ററുകൾ താണ്ടുന്ന പ്രകാശരശ്മിയുടെ വേഗതയെ എന്നും കൗതുകത്തോടെയാണ് ഞാൻ നോക്കിക്കണ്ടി

ലിസ് മെയ്റ്റ്നർ

വേരാ റൂബിൻ

ട്ടുള്ളത്. ആ രശ്മിയുടെ വേഗതയെ 1999ൽ ഒരു സൈക്കിൾ വേഗതയിലേക്ക് മാറ്റി, പിന്നീട് 2001 ൽ അതിനെ നിശ്ചലമാക്കി കാണിച്ചു ത ന്ന ലീൻ ഹൗവിന് എങ്ങനെയാണ് മനസ്സിൽ സ്ഥാനം കൊടുക്കാതിരിക്കുക?

മണൽ പളുങ്കുപാത്രത്തിനു മേലെ വെക്കുക യും ആ പാത്രത്തിന് കമ്പനം ഉണ്ടാകുമ്പോൾ ആ മണൽ തരികൾ ഒരു പ്രത്യേകരീതിയിൽ അവയെത്തന്നെ ക്രമീകരിക്കുന്നു എന്ന മഹ ത്തായ ആശയം പറഞ്ഞു തന്ന സോഫി ജെർമെയ്ൻ ഇലാസ്തികത എന്ന ആശയം ലോകത്തിന് മുന്നിൽ സമർപ്പിച്ചു. എന്നാൽ ഒ രു സ്ത്രീയായി ജനിച്ചതിന്റെ പേരിൽ അവളു ടെ സംഭാവനയും നിരാകരിക്കപ്പെട്ടു.

പരമാണു വിഘടനത്തെ കണ്ടുപിടിച്ചതിന് ലോ കം ഓട്ടോ ഹാനിനെയാണ് ആദരിച്ചത്. എ ന്നാൽ അതിനു പിന്നിലും ഒരു വനിതയുണ്ടാ യിരുന്നു. ലിസ് മെയ്റ്റ്നർ. സ്ത്രീയായതിന്റെ പേരിൽ അവൾക്ക് നോബേൽ പുരസ്കാരം ല ഭിച്ചില്ല.

ലോകത്തിന്റെ വലിയ ചോദ്യങ്ങൾക്കും കൗ തുകങ്ങൾക്കും ഉത്തരമേകിയ ഈ വനിതകൾ തന്നെയാണ് എന്നും എന്റെ കരുത്ത്. പ്രതിസന്ധികൾക്കിട യിലും ശാസ്ത്രത്തെ പ്രണയിച്ച ഇവർ തന്നെയാണ് എന്റെ ഈ യാത്രയിലെ വിൺമറഞ്ഞ ദൈവങ്ങൾ.

ലോകം തിരസ്കരിച്ച ഇവരെ ലോകത്തിന് വീണ്ടും കാണി ച്ചു കൊടുക്കാനാണ് ഞാനൊരു ഭൗതിക ശാസ്ത്രജ്ഞയാ വാൻ ആഗ്രഹിക്കുന്നത്. സ്ത്രീയെന്ന പദവും ശാസത്രവു തമ്മിലെ പൊരുത്തക്കേട് തുന്നിച്ചേർത്ത ഈ സമൂഹത്തിന് മുന്നിലേക്ക് കൽപ്പനാ ചൗളയുടേയും ഉർസുലഫ്രാങ്ക്ളിന്റെ യും മറ്റും വാക്കുകൾ മാത്രമേ എനിക്കു നൽകാനുള്ളൂ.

എന്നാൽ വർത്തമാനത്തിൽ നിന്നു കൊണ്ട് ഈ ലോകത്തി ന് മുന്നിൽ ഇവരെ ന്യായീകരിക്കാൻ ഞാൻ എന്നെത്തന്നെ ആയുധമാക്കി മാറ്റേണ്ടതുണ്ട്. എന്നും സ്വപ്നങ്ങൾ കണ്ടു കൊണ്ടിരിക്കുന്ന എന്റെ ഉള്ളിലെ കൊച്ചു പെൺകുട്ടിക്ക് സ്വന്തം ചിന്താഗതികളുള്ള സ്ത്രീയുടെ പരിവേഷവുമുണ്ടെ ന്ന് ഈ ലോകത്തിന് മുന്നിൽ എനിക്ക് കാണിച്ച് കൊടു ത്തേ മതിയാകൂ. ഉയരാൻ ഉറച്ച സ്ത്രീയെ, പറക്കാൻ ആഗ്ര ഹിച്ച സ്ത്രീയെ, അവളുടെ സ്വപ്നങ്ങളെ ഇല്ലാതാക്കാൻ ലോകത്തിലെ ഒരു ശക്തിക്കും സാധിക്കില്ല. ലോകത്തിന് സ മ്മാനമായി മാറുന്ന അവളെ ഉയർത്താൻ ഈ പ്രപഞ്ചശക്തി കൾ എന്റെ കൂടെ നിൽക്കും എന്ന ഉറച്ച വിശ്വാസവും ഭൗ തിക ശാസ്ത്രജ്ഞയാവാനുള്ള ഈ യാത്രയിൽ എനിക്കു പിന്തുണയാകുന്നു.

Women in science

It's now upto you... Achieve it ...

Silpa Wilson
II BSc. Physics
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It's always a sharp question that "Why do we hear lesser names of women scientists?. If we ask our science students they may only know a Marie Curie and for more an Irie Curie?. What does it indicate?. And so it's relevant to think about the topic 'Women in Science' in the context and the pursuit of above questions.

Let us analyse the role of women in science from ancient period onwards. We know that science persuaded and pierced into the people during the period of 'Enlightenment' after renaissance. And we have Isaac Newton as the exponent of scientific development during this period. It's hard to hear about any female scientific personality before or after this line of enlightenment. And we have a fair answer to this issue. Women were denied even social freedom and she had fewer opportunities. So to be an eminent figure in science would have been a mammoth task then.

When years passed, women gained more freedom than the past days. But still the contribution to science remained flowing sluggish. Women could not shine in science and those who were in the field were not given enough recognition. The story of Rosalind clarifies this. When the double helix model of DNA revolutionised biological science with Watson ad Crick as the exponents, Rosalind who made a remarkable work on it was forgotten. She was not even remembered when Watson and Crick were awarded Nobel Prize. Being women was not the only reason for neglect, but the issue reflects much. But Mary Curie came up as a well known women scientist.

Why do women make fewer contributions to science?

We can answer the question easily. But along with that spontaneous answer, we have to think about the historic, physical, social and psychological reasons. As mentioned earlier, women had to face social shackles earlier and hence she could not do well. But now society has changed. And what can be the reasons now? To compare with man, a woman has less exposure to surroundings. Men being free to wander anywhere find it interesting to observe and learn. Thus they can gain much common sense and technical knowledge. We can easily clarify this statement. Take a girl child and a boy child living in same house and watch the differences in the ways they observe the various phenomena. Thus lack of exposure is a major problem.

Gazing into the physical factors, man is fit than women and can give much of their physical and mental potential to research in activities. [The limitation can definitely

overcome by mental strength and will power]. Though this cannot be regarded as a serious retarding factor, this too affects the contribution of women. Similarly the issues of pregnancy and related problems add to the issue.

Certain blind social norms also drawback women from being a potential scientist. Looking after a family, taking care of children, to be always inferior to man etc., are some of them. The lack of safety to women in public places, wrong and indecent approaches etc. also create challenges.

All the above mentioned problems can be related to psychological aspects. The physical and social reasons tend to make women at least a little weaker. [But it is possible to overcome these issues].

Why should women be brought to Science

Fewer number of women scientist does not mean fewer brain capacity. It is indeed time to prove the potential of women. It is highly useful to society also.

Once a women make scientific achievements that can be correlated with consensus and compassion. Marie Curie, who discovered Radium gave it to public use and ignored the patent for it. Knowing the use of Radium in cancer treatment, she did such a great thing. Thus science can be build upon humanitarian basis, if women involve it. [It does not mean men are not].

"If you educate a man, you educate an individual, but if you educate a woman, you educate a village". It's an African usage and it reveals a lot and so as it reflects the need of making women aware and experts of science because she moulds a generation.

Women empowerment can be achieved through building up scientific temper among women. It is in a way solution to many problems faced by them. They will be capable of fighting the challenges by their own by the weapon of science.

Today we have many eminent female figures in the field of science. Tessy Thomas the 'Missile woman' of India is an awakening light and inspiration to India and Indian women. Ms.Anuradha a senior most

official in NASA also peaks up the expectations. Kalpana Chawla, Anandhi Bhai and other prominent women too were in our history.

What should women realise and how can they be brought int the mainstream of science.

It's only by the hard work and strong will of women that they can be into the mainstream. Along with that women require support from society.

Women those who develop scientific temper must try to get good exposure through internship programmes. Special focus must be given to such upcoming women by the government. Scholarships and other fellowship programmes must be given to support women. Safer research centres that are allied with facilities for physical care must be set up. More opportunities should be given.

And apart from these, women must realise this potential. They should know about the opportunities and work accordingly. Dear women, it's your share of work that can bring about a difference... Do not wow for equality but try to make it come true. Do not blame man for your failures bur work and be the you. Seize opportunities. Make use of the facilities that government provides you.

Thus let the day come where women have their wonderful faces in science, their serious contributions in the field. Family isn't a limiting factor but is a supporting factor. Change it as such to hold your hands. You can make the difference. It's now up to you... achieve it.

Groundbreaking inventions of the 21st century

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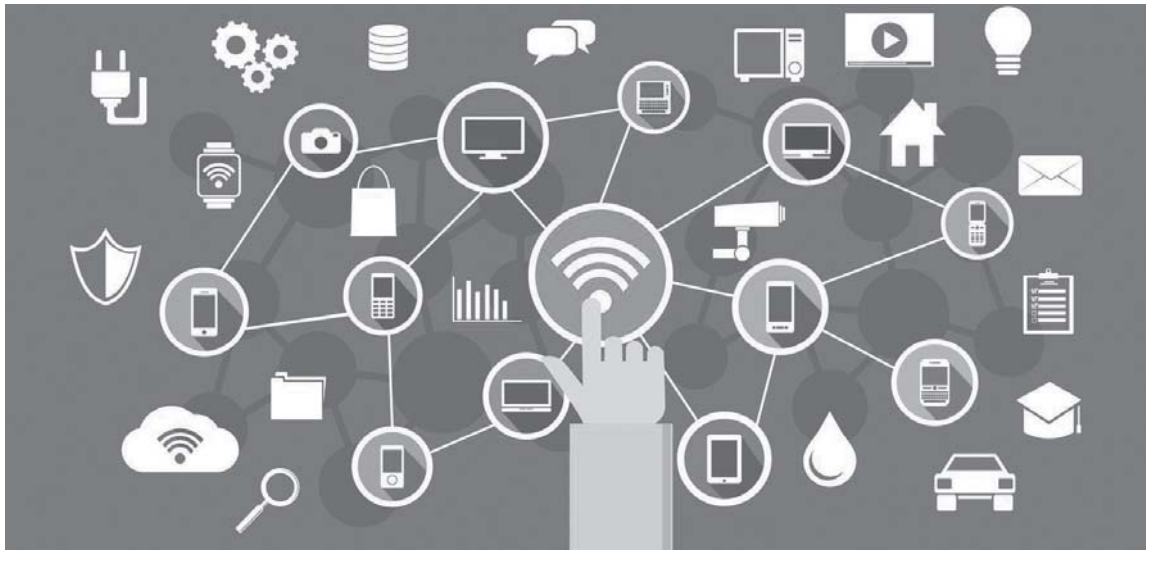
Science has grown gradually through all these years. From the starting of human history there have been many discoveries and inventions that changed the human lifestyle. From the discovery of fire to the invention of the smartphones that we use now has changed our lives drastically. Science plays a very crucial role in our daily life. Our life depends on the technology we use. We cannot even imagine even a day without hours smartphones.

The inventions that took place in 21st century changed our lives. There have been many achievements that our science field had achieved from the starting of the 21st century till now. There are many inventions to point out like our mobile phones, internet, LED monitors etc. In the starting of the 21st century technology also started to develop. Latest take the case of the smart phones. The first telephone was invented by Graham Bell. From that ill today they have undergone many changes. Telephones were modified to smaller mobile phones which can be carried with us which made talking with people easier. This mobile phones were upgraded and features like camera, games, calendar, clock, alarm etc. added. These phones were upgraded to smartphones which are actually mini computers. Cell phones now a days use various softwares like Android iOS Microsoft etc. Which smartphone has special features on the basis of their camera resolution,phone calls, messaging and internet access. We can expect even more developed smartphones through the coming years. Since each year every new industry is releasing a new smartphone with the more advanced features.

The next thing that is advanced through the 21st century is the internet. The Internet access was limited until the 3G



internet came. Everyone experienced a new level of Internet access with the 3G experience. Then the 4G internet came. These are the fastest now a days. 4G Internet opened new gates in the world of technology. Any information can be found on the fingertip. With the combination of the smartphone and the Internet sociable networking sites are also growing a lot. Connection between people are lasting longer as the communication continues even if they are away. Human beings are in a world where technology has made lives easier. Every task can be done using a touch. From picking groceries to medicines all are available in the Internet.. it also helps connecting people globally. This is actually very beneficial economically as the money transfer has become simpler using credit and debit cards. There are applications like 'Paytm' that help us to pay.

As technologies improved in the field of mobile phones and Internet there are other changes that happened. In the area of space research India has launched a satellite to Mars. We are now observing planet Mars with our satellite.

There are many inventions in the case of robotics as well. Well developed humanoid robots are created these days. One such robot is Sophia. Sophia is a humanoid robot which can talk and see. She can recognize people and reply to what they are saying. Human beings are developing a lot of technologies nowadays.

Medical field has also developed a lot. The new technologies in the medical field helps in finding the problem within minutes. There are advance devices for scanning and checking the internal organs. It is easier to detect any problem with the internal organs and resolving them. Surgeries have become less complicated. The keyhole surgeries are easier and heals faster. Laser technologies and radiations are used for treating cancers. As the technology rises there are advances in the medical field as well. We can expect gradual increase in the quality of treatment provided in the coming years.

The technology has raised a lot that we human beings are taking over the world. As the technology increases there is a gradual change in human behaviour as well. We prefer to do all our works using the technology rather than getting it done ourselves. We the human beings took over the Earth and damaged the pure land we got. We have to be careful about everything we are doing to our mother Earth. It is very important that we use the technology to protect the Earth from all the pollution and disturbances that we are causing. We are actually damaging it a lot that there is chance that towards the end of 21st century human beings won't exist on the Earth. From the air we breathe, the water we drink, the land we walk, all are polluted with our own activities. We should be the ones protecting all the resources that we have. The greed we humans have, keeping it aside and trying to make our Earth a place suitable for living like it was before and give it to the future generations is something we should achieve through the technology. The technology is something that should be benefit in all ways. Using all the resources we have we can take a step in making the world a better place with green technology. A place where science can change the world in a better way.

Commemorating 150th Birth Anniversary of Madame Marie Curie State level Essay Competition - Report

Dr. Santhosh Potharay Kuruvilla,
Associate Professor of Physics,
BPC College,Piravom

Madame Curie (1867 - 1934) discovered two chemical elements, polonium and radium, and she coined the term "radioactivity". She was the first woman to win a Nobel Prize, the first person and only woman to win twice, the only person to win a Nobel Prize in two different sciences, and was part of the Curie family legacy of five Nobel Prizes. She was also the first woman to become a professor at the University of Paris. Marie Curie is undeniably a pioneer who helped pave the way for women in science.

APT, in connection with Madame Curie's 150th birth anniversary, organised a state level essay competition for UG/PG students of universities and affiliated colleges in Kerala in association with SPIE, CUSAT. There were five topics, medium of writing being English/ Malayalam;

1. Social relevance of academic research - Indian Scenario.
2. Ground breaking inventions of 21st century.
3. Kerala contribution to science.
4. Why I want to become a physicist?
5. Women in Science.

Institution level competitions were conducted during February 2017 and the best essays were forwarded by the convenors. Academy received 32 essays from various colleges across the state.

The winners are

1st. Rs.3000 +Books +Certificate - Ms. Sreelakshmi T, Vimala College, Thrissur.

2nd. Rs. 2000+Books +Certificate - Ms. Silpa Wilson, Christ College, Irinjalakkuda.

3rd. Rs. 1500+Books +Certificate - Ms. Meghana Shaji, S N College, Cherthala.

Academy is thankful to SPIE, CUSAT Chapter for sponsoring Rs. 6000/- as prize money. Best essays were also selected for publishing in the latest APT Tunes. In addition to the top three, seven more essays by the following students were also selected for special prizes of Rs. 1000 + Books and Certificate.

1. Ms. Amrutha T S,
   S N College, Cherthala.
2. Ms. Arya Prasad,
   St. Joseph's College, Alappuzha.
3. Ms. Gayathri S. Ajith,
   B P C College, Piravom.
4. Ms. Jayalakshmi K,
   Vimala College, Thrissur.
5. Ms. Vani Gireesh,
   Sree Krishna College Guruvayur.
6. Mr. Sreedarsh V S,
   S N College, Cherthala.
7. Ms. Anakha Joy,
   Christ College, Irinjalakuda.

Academy extends special thanks to the convenors who took the initiative of conducting the institution level competitions. Certificate of appreciation will also be given to them. APT is happy to consider this as a great opportunity to reach out to the general academia of the State and congratulates all the participants and winners. Finally, let me extend my sincere feeling of gratitude to the office bearers and all the members of the Academy for the timely support.

Simple method for coating nanoparticles and thin film semiconductors / metal oxides

Dr. R. Sreekumar
Postdoctoral fellow,
Centre of Excellence in Advanced Materials,CUSAT.

Spray pyrolysis is a simple and cost effective method used for coating compound semiconductor and metal oxide thin films since 1960's. It involves the coating of material by spraying precursor solution (aerosol) on to a substrate kept at a high temperature (300 - 550°C). Chemical decomposition at the surface of the substrate results in the formation of required material on the substrate. The main advantages of the method are the process of doping semiconductor material and/or alloying to produce binary, ternary or quaternary compounds are comparatively easy by controlling the nominal concentration of chemical precursor in the starting precursor solution. One of the other advantages is the scalability, as it does not require sophisticated instrumentation and high vacuum. Spray pyrolysis method is used for coating thin films of compound semiconductors/metal oxides, nanoparticles and various nanostructures that can be used in various optoelectronic devices and for coloured decorative glass coatings.

There is a huge drive towards the adoption of Spray Pyrolysis method by leading R & D centers/institutes and Universities working on material science worldwide, on the basis of numerous publications in scientific journals based on Spray Pyrolysis (20,000 publication in the last 20 years). Major works reported were using home made Spray Pyrolysis Set-up, without automation, which has issues regarding repeatability/ reproducibility. Hence this particular method, Spray pyrolysis is not matured enough for industrial scalable production of compound semiconductor or metal oxide thin films. The repeatability issues could be addressed by performing the experiment in a controlled inert atmosphere and by the use of correct spray nozzles to generate aerosol spray of narrow size distribution. With the intension to tackle repeatability/reproducibility issues related to the spray pyrolysis method, the Science and Engineering Research Board (SERB), Dept. of Science & Technology, Govt. of India have sanctioned a research proposal in 2014, in the frame work of Young Scientist fast track scheme. Under this project an advanced Spray Pyrolysis machine has been designed. Research output obtained during the past 3 years at the laboratory where the SERB fast track project was implemented, proved that compound semiconductor and Transparent conductive oxide (TCO) coatings obtained using this machine has better quality and reproducible in comparison with the experiment conducted using conventional Spray Pyrolysis machine or homemade set-up at ambient conditions. TCO's are materials which are mainly used in solar cells and other optoelectronic devices as a transparent electrode.

Realization of cheap and device quality TCOs will be an added advantage for the photovoltaic industry and futuristic transparent electronics/devices.In this era of aesthetically build high-rise buildings that use glazing require a lot of energy to cool (or vise versa) the ambient. Smart windows and semi-transparent thin film solar cell decorated windows are smart alternatives for the existing glazing, which provides high cost savings on electricity without compromising the aesthetic of the building. In the case of energy saving smart windows, where the electro-chromatic and/or thermo-chromatic material sandwiched between double-glazed TCO coated glasses are used. However the existing technology for the production of TCO's are not cost effective. Thus it contributes to the high cost of solar cells and other optoelectronic devices. Solar cells on roof and wall tiles are another interesting way of harvesting energy. On behalf of the prior mentioned applications namely (a) semi-transparent thin film solar cells, (b) smart windows and (b) solar cells on roof and floor tiles, TCO coatings are required as transparent electrode on a larger area and hence the method of coating have to have a high throughput. Taking this into consideration, the Advanced Spray Pyrolysis Method has the capability for large area coatings and high throughput. Systematic research work using the newly invented machine by the R & D centers/institutes and Universities will lead us towards aost effective compound semiconductor thin film, Tco Coatings and thus cost competent Photovoltaics in the near future.With the introduction of the spray pyrolysis machine developed herewith, which reduces the repeatability issues, one could expect a huge Technological and Industrial impact. Taking this into account a Start up has been formulated and incubated at Center for Innovation, Technology Transfer & Industry Collaboration (CITTIC), an Incubator at CUSAT campus. One of the mottos of the Start-up is to popularize spray pyrolysis method in the grass root level of academic research. The start-up provides standard Spray pyrolysis experimental set-up to grow nanoparticles as well as thin films of semiconductors, metal oxides and facilitate training and support to fulfill PG level research projects.

APT Workshop : Quantum Mechanics -III : 12-14 August 2017. Vimala College, Thrissur

APT Workshop : Quantum Mechanics -IV : 14-15 October 2017 - KMM Govt. Women's College, Kannur

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About us:

Delgado Coating & Technology Solutions Pvt Ltd. is a Spin-Off from the academic counter part, where the Company Director conducted his Doctoral and Postdoctoral research. Inspiration from my research career drove me to constitute a Start-up especially to popularize the versatile Spray Pyrolysis method/Ultrasonic spray pyrolysis method that can be used for the growth of metal oxide nanostructures (quantum dots, nanorods), and thin films of compound semiconductors, metal oxides, transparent conductive oxides, polymer films etc. The start-up initially incubated at Center for Innovation, Technology Transfer & Industry Collaboration (CITTIC), an Incubator at CUSAT. Later the Start-up got opportunity to be featured at Maker Village, Technology Innovation Zone, KINFRA Hi-Tech Park, Kochi, Kerala, India 683503.

R. Sreekumar (Ph.D)
Director

Motto:

1. Popularize Spray Pyrolysis in the grass root level of academic research
2. Nurture young talents to research
3. Martials for energy saving & harvesting solar energy

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4. Hot air oven, Muffle furnace, Electronic balance

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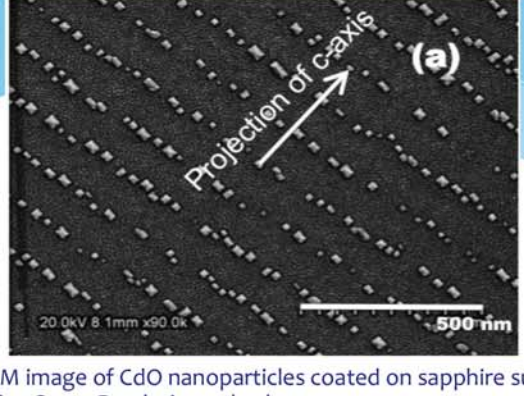

SEM image of CdO nanoparticles coated on sapphire substrate using Spray Pyrolysis method

Photograph of Al:ZnO Transparent conductive oxide coated on glass substrate over an area of 15 cm x 15 cm using Spray Pyrolysis

Delgado Coating & Technology Solutions Pvt. Ltd., Center for Innovation, Technology Transfer & Industry Collaboration , CUSAT, Kochi 682022, Kerala, India.