18 SUSTAINABLE DEVELOPMENT

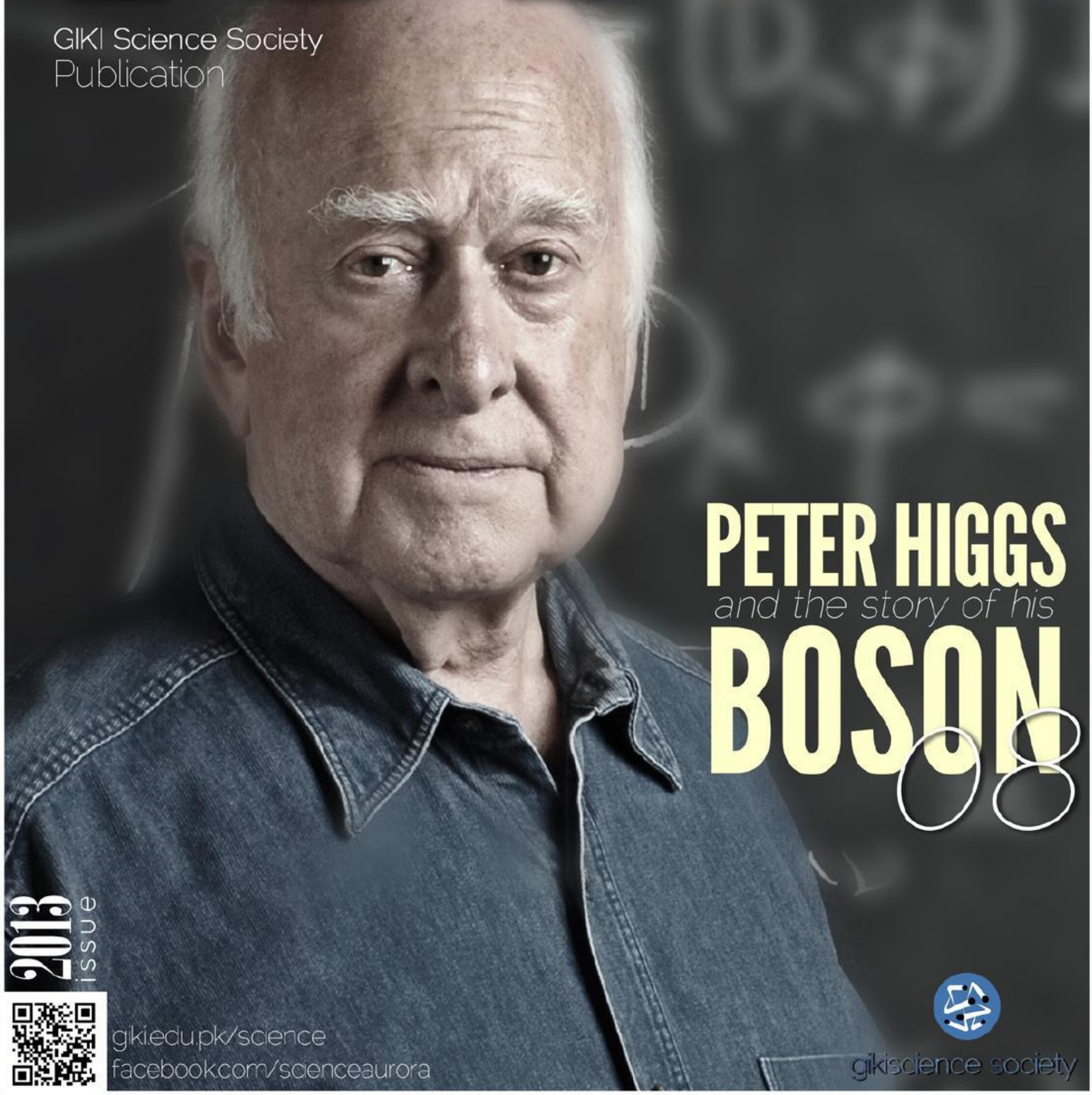
22 GOING MICRO
Microgeneration potential in Pakistan

27 Reinventing education
IVIES FOR ALL

SCIENCE AURORA

Exclusive Interview:
Dr. PERVEZ HOODBHOY
physicist, intellectual, activist

GIKI Science Society
Publication



PETER HIGGS
and the story of his
BOSON

2013 issue

giki.edu.pk/science
facebook.com/scienceaurora

gikiscience society

DECIPHER DISSEMINATE REVOLUTIONIZE

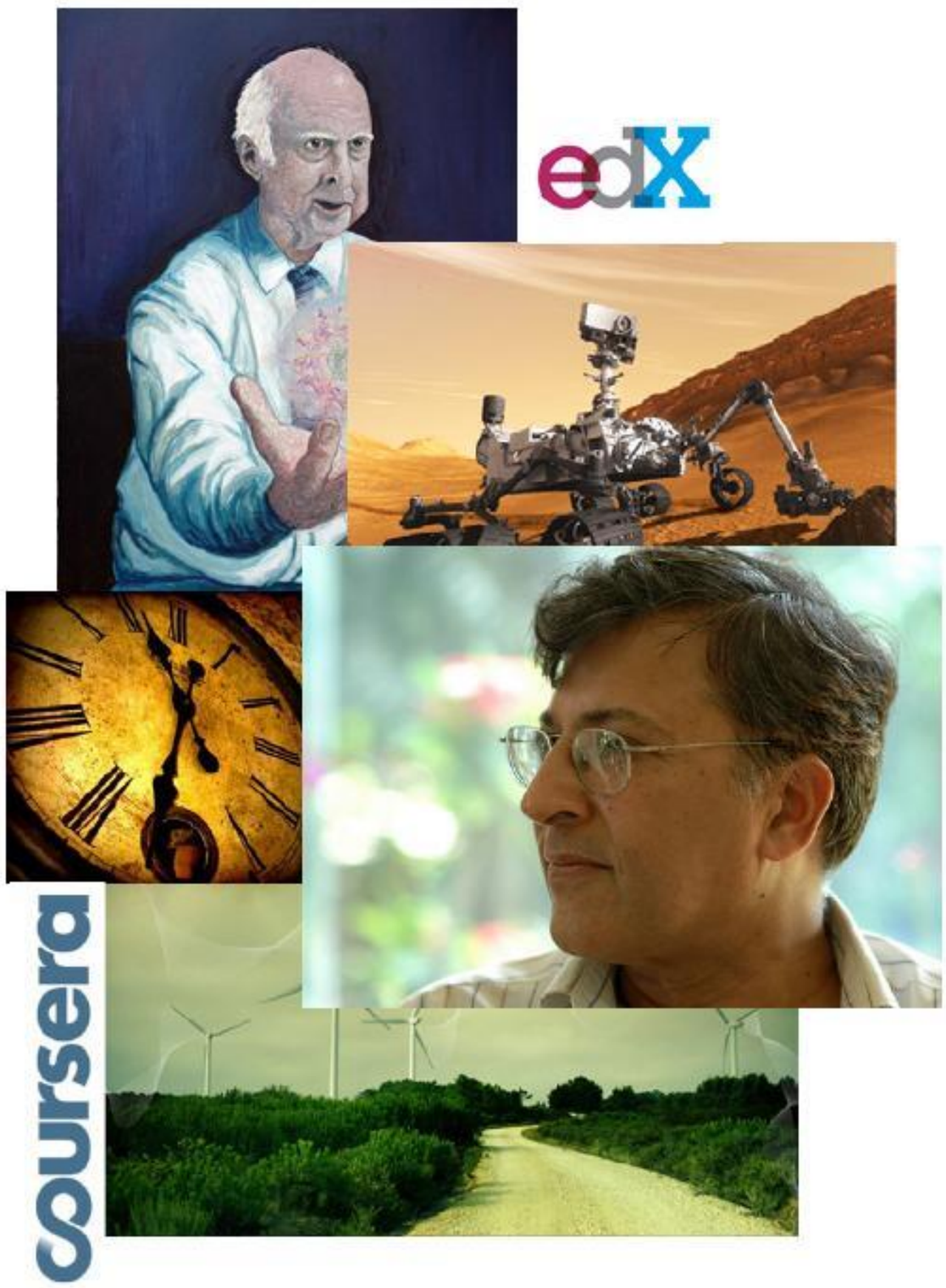
SCIENCE AURORA

ISSUE 2013

Science AURORA 2013

COVER STORY

08 The story of Peter Higgs and his boson



SCIENCE SOCIETY

Ghulam Ishaq Khan Institute of Engineering Sciences and Technology

EDITORIAL 02

MESSAGES 03

ARTICLES

A River Called Time 04

An interview with Prof. Pervez Hoodbhoy 12

Sustainable Development 18

Review: Science Fair 2013 21

Going Micro: Microgeneration Potential in Pakistan 22

Reinventing Education: Ivies For All 27

FEATURE:

Startup: KnowElectricity 30

SCIENCE NEWS 31

FINAL YEAR PROJECTS AT GIKI 35

GIKI SCIENCE SOCIETY ACTIVITIES 38

PROJECT FEATURE:

Hammerhead Arc 40

A **GIKI Science Society** Publication ©

www.giki.edu.pk/science
aurorathemag@gmail.com

EDITORIAL

Dear Friends in Science,

The year 2011-12 has been a remarkable one for the scientific community. One could easily make the argument, that few years go by that prove to be this fruitful for scientific endeavors, when humanity takes leaps in conquering both the final frontier of space and the bizarre little world of the smallest.

Some incredibly memorable events took place. It was a thrill to watch the *seven minutes of terror* and the eventual landing of the Mars rover Curiosity. For me, however, a very personal choice, the announcement of discovery of the Higgs boson took the prize. Giving final vindication to the work of an entire generation of great physicists, and falsifying the hypotheses of many others, the Large Hadron Collider rocked the world of theoretical physics like it had not been rocked for decades. Finding an awful little, in the popular literature, about the man behind the famous particle led me to write the cover story of the magazine. My colleagues, on the other hand, took stock of issues ranging from the incredible nature of time, to the hoopla surrounding sustainable energy, with 2012 being nominated the International Year of Sustainable Energy for All by the UN, to the free online education revolution that is taking place right now; what an exciting time to be a student this is.

And amidst such prosperous times, we still find ourselves a non-contributing nation to the good of mankind. Ignorance is at large and it's taking victims by the minute. A recent spectacle laid bare the extent of the situation when a charlatan took the media by a storm claiming to have overturned the very basic laws of physics. The real sorry sight was to see those considered the *crème de la crème* of our nation's intellect being taken for a ride by a poor con artist. As such, we thought it appropriate to ask questions of relevance to one few voices of reason in our society: Professor Pervez Hoodbhoy. In an exclusive interview with Prof. Hoodbhoy we take his comments on some recent events that have surfaced in the national media and his thoughts on how to improve the state of education in our country.

All in all, we have worked very hard to make this edition of Aurora worth your while to read, and we hope you find it the same.

Editor-in-Chief
Saim Sultan

President - GIKI Science Society
Ahmad Waleed

TEAM AURORA

Managing Editor
Kazi Sher Ahmed

GRAPHIC DESIGN TEAM

Hassaan Ahmed

Anas Siddiqi

MESSAGE FROM PRO-RECTOR

The Science Society has been amongst one of the most active technical societies of the GIK institute for the last decade. They organize a culmination of events for the student community of the Institute imparting scientific knowledge and new developments in a fun-oriented manner. Aurora, the magazine by the Science Society, has been compiled by its members through devotion, diligence and sincere hard work. I have found the magazine very informative and interesting. The interview of Dr. Pervez Hoodbhoy was by far the most interesting read of Aurora. I congratulate the members of the society on coming up with an excellent contribution to the GIKI campus life. I hope that you will enjoy reading Aurora as much as I have, or may be more.

Prof. Dr. Fazal Ahmed Khalid (SI)
Pro-Rector (Academics)

MESSAGE FROM ADVISOR

Undoubtedly, GIKI Science Society has been playing a commendable part in nurturing the extra-curricular culture in the institute. Organization of 13 All Pakistan events while providing a competitive platform to participants, from renowned schools and universities, is a success worth mentioning. Adding to it, the publication of Science Magazine Aurora is the evidence of society's highly committed and diverse nature.

Reading Aurora is always a stimulating experience. Topics ranging from free education ventures to International Year of Sustainable Energy for All have been comprehensively covered. Moreover, the feature on Peter Higgs provides an interesting insight into one of the most important discoveries of our time. It gives me immense pleasure to congratulate Aurora Team on publication of this enlightening literature.

Dr. M. Junaid Mughal
Advisor
GIKI Science Society

A RIVER CALLED TIME

A Journey Through the Fourth Dimension

Aliakber Kazmi

Despite rapid advances in science and technology, mankind still struggles to comprehend the nature of time. This in not a shortcoming of man's intellect; rather this lack of understanding could be more attributed to the complexity of time's nature. Time could best be described as a river; winding up and down, slowing down and sometimes accelerating. It is a variable that remains one of the biggest mysteries of the physical world.

The very first distinction that any discussion on time should incorporate is that of absolute and relative time. Not so long ago, Mankind believed that the nature of time was entirely absolute and scientists like Isaac Newton were proponents of this interpretation. But more recently, scientists like Einstein and Minkowski have showed us that time is more relative.

ABSOLUTE TIME:

The absolute interpretation of time leads to Newtonian mechanics: the mechanics we learn at university level. Every measurement and calculation occurs within an inertial frame. Also, mass is always a constant at all speeds. An inertial frame is such that when an object without any force interactions is viewed from it, it will appear either to be at rest or in a state of uniform motion in a straight line. This necessitates that inertial frames are non-accelerating, and therein lies the drawback of Newtonian mechanics. In everyday life, things do accelerate and at high speeds Newton's laws break down.

$$\mathbf{v} = \frac{\mathrm{d}\mathbf{r}}{\mathrm{d}t} \qquad \mathbf{a} = \frac{\mathrm{d}\mathbf{v}}{\mathrm{d}t}. \qquad \mathbf{F} = m\mathbf{a}$$

RELATIVE TIME:

The relative interpretation corrects the intrinsic errors of Newtonian mechanics. Newton's view on time kept it separate from space. When Albert Einstein introduced his Theory of Relativity in the early 20th century, however, he suggested that time wasn't separate from space but connected to it. Time and space combined to form space-time, and everyone measures his or her own experience in it differently because the speed of light (300,000 km per second) is the same for all observers. This is known as the limiting nature of light. In other words, if all observers have to agree on the speed of light being 300,000 km per second, then they can't agree on the time it takes for other objects to travel relative to them.

$$\mathbf{a} = \frac{1}{m_0}\left(\mathbf{F} - \frac{(\mathbf{v}\cdot\mathbf{F})\mathbf{v}}{c^2}\right)\sqrt{1-\frac{v^2}{c^2}}$$

Acceleration equation in relativistic mechanics

Notice that this expression for acceleration is vastly different from that of Newtonian mechanics. Two new features are m_0- relativistic mass - and c - the speed of light. Objects at high speed would experience an increase in mass, but would require an infinite mass to attain the speed of light; hence the limiting nature of light. Einstein also suggested that space-time wasn't flat, but curved or "warped" by the existence of matter and energy. Large bodies in space-time, like the Earth, aren't just floating in orbit. Instead, imagine a ball resting on a stretched out trampoline -- the weight of the ball warps the trampoline. If the Earth is a ball, then we can imagine the trampoline as the curved space-time. Larger the mass, greater the warping. Because of this warping, time slows down near more massive objects. In 1962, scientists placed two atomic clocks at the bottom and top of a water tower. The clock at the bottom, the one closer to the massive center of the Earth, was running slower than the clock at the top.

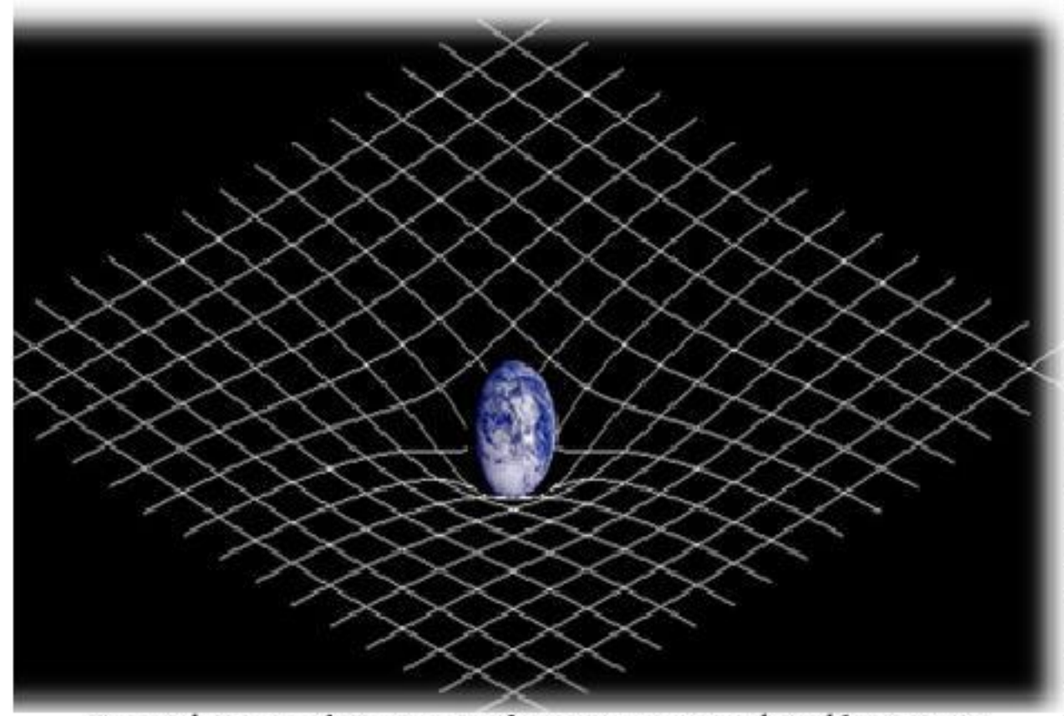


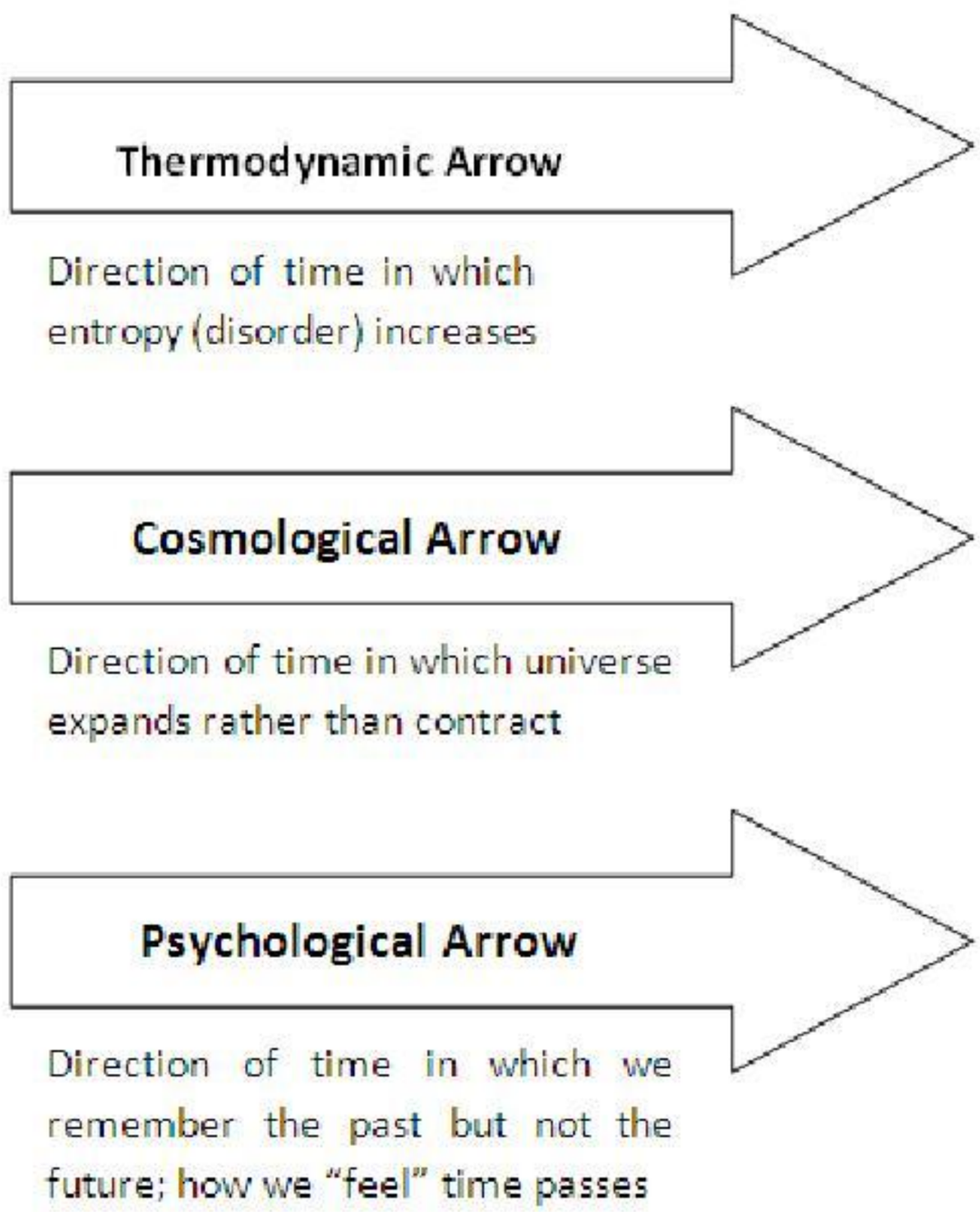
Figure depicting the warping of space-time as predicted by Einstein

THE ARROW OF TIME:

Having established that time is more relative than absolute, we can now tackle another oft-asked question, 'What is the direction of time'? The Curious Case of Benjamin Button tells the story of a man, played by Brad Pitt, who is born as an eighty-year old and grows younger as the years pass. The tale is obviously a fantasy—in reality, Brad Pitt is ageing. Angelina Jolie is ageing. You and I are ageing. As macroscopic objects, it's inevitable, and no amount of surgery can turn back the clock. But just why time only marches in one direction has long been a mystery. 'The answer is called the arrow of time, a term coined in 1927 by the British astronomer Arthur Eddington to describe the "one-way direction" or "asymmetry" of time. If time were perfectly symmetrical a video of real events would seem realistic whether played forwards or backwards. However, this is not so. Time is asymmetrical and moves only in the forward direction. It is not possible to unmix the contents of your coffee, to fix a broken glass, or as we already discussed, to age backwards. Different scientific perspectives explain this phenomenon in separate but the underlying conclusion is the same: the one-directional flow of time.

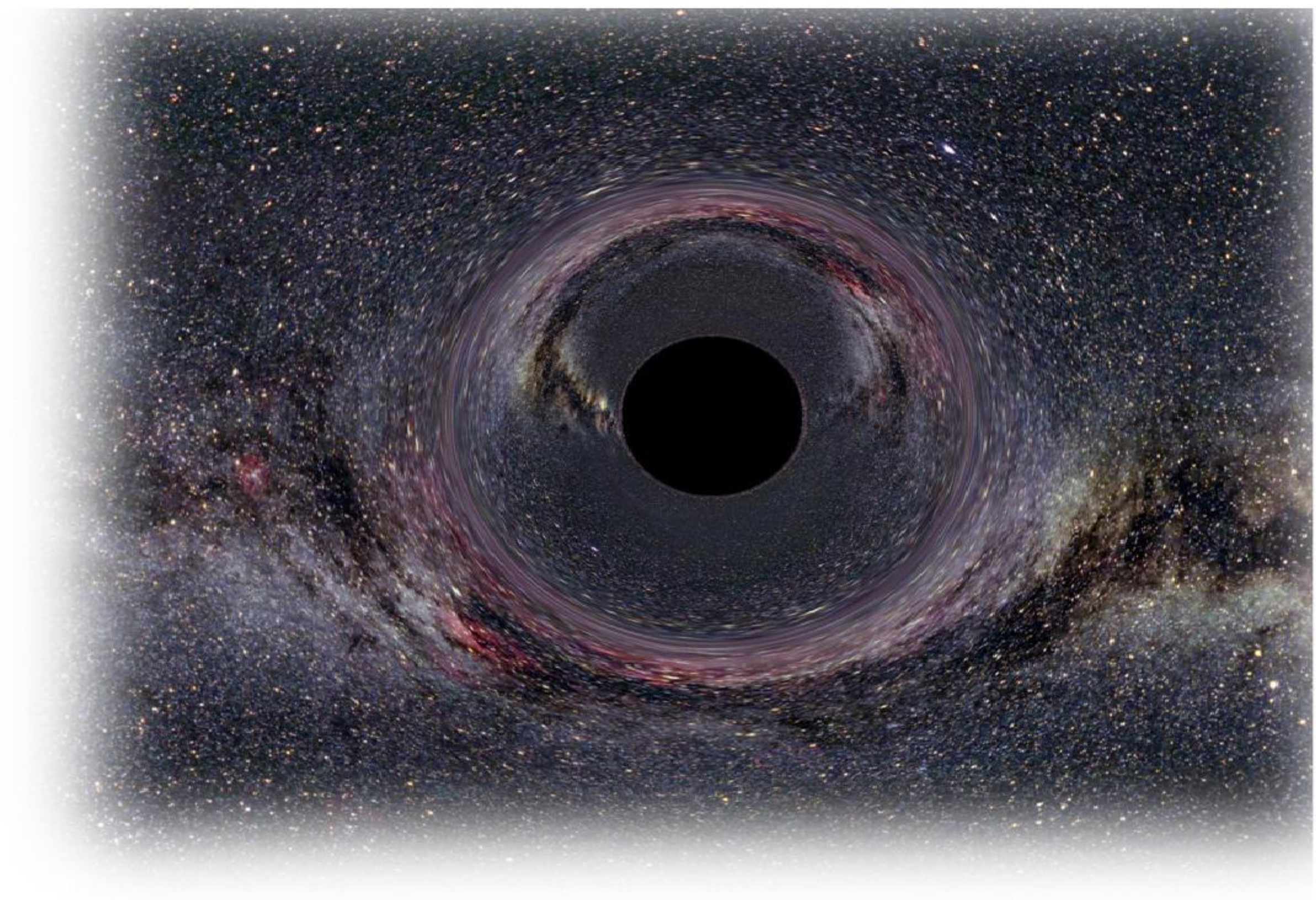
The thermodynamic arrow of time is provided by the Second Law of Thermodynamics, which says that in an isolated system,

entropy tends to increase with time. Entropy can be thought of as a measure of microscopic disorder; thus the Second Law implies that time is asymmetrical with respect to the amount of order in an isolated system: as a system advances through time, it will statistically become more disordered. This asymmetry can be used empirically to distinguish between future and past though measuring entropy does not accurately measure time. Also in an open system entropy can locally decrease with time: living systems decrease their entropy by expenditure of energy at the expense of environmental entropy increase. However, the total entropy in any system will continue to increase with time. The cosmological arrow of time points in the direction of the universe's expansion. It may be linked to the thermodynamic arrow, with the universe heading towards a heat death as the amount of usable energy becomes negligible.



TIME TRAVEL:

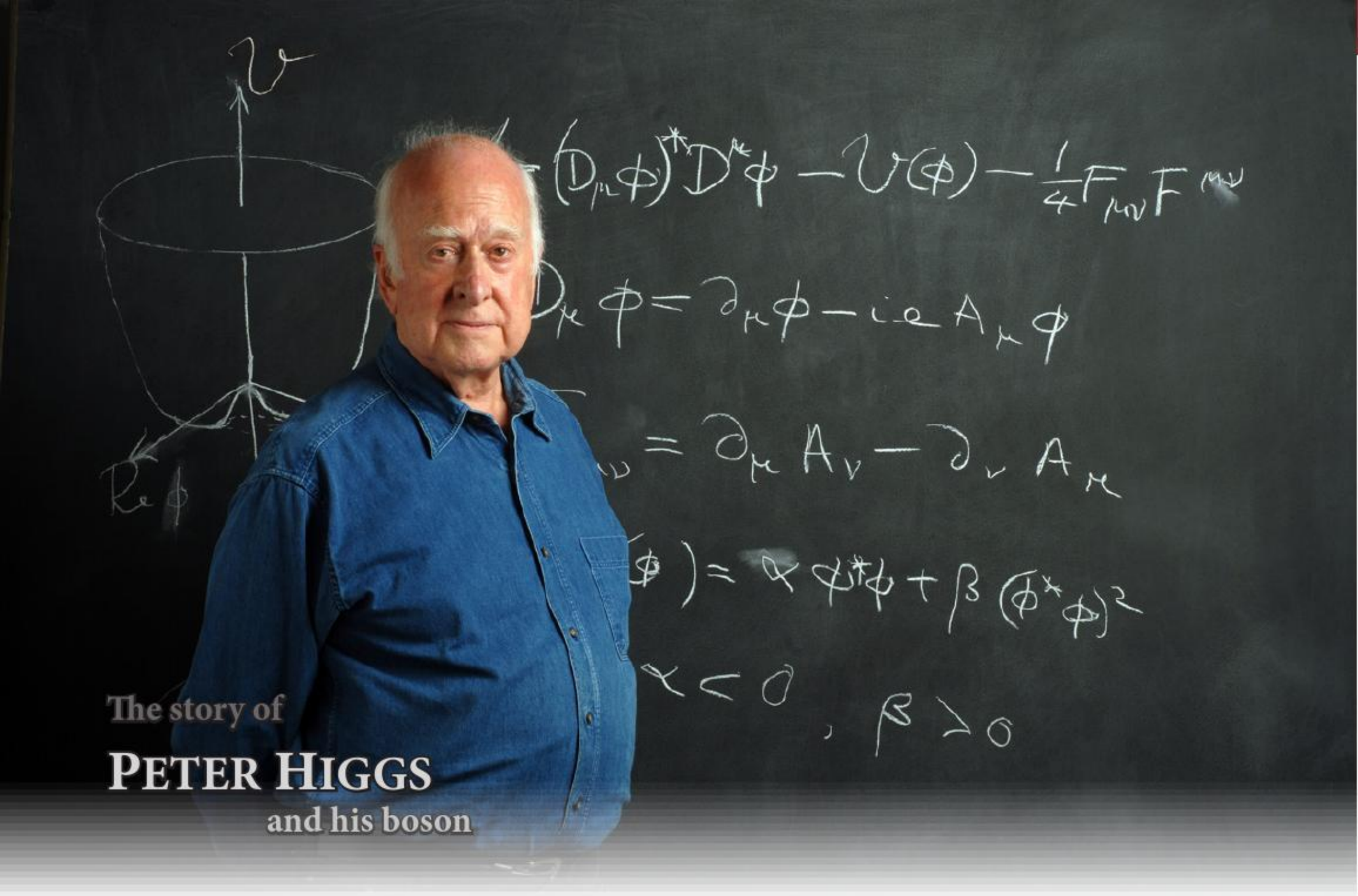
So time is a river, always flowing towards more entropy, but with varying rates. Imagine that you have a canoe, and you wanted to either go against the current or with it. This is a scenario reminiscent of time travel. Going against the current sounds hard and that is precisely why Time travel to the past, is considered impossible by many theoretical physicists. The occurrences of paradoxes and the law of causality, which states that effects occur after causes, act as barriers. One major paradox is the grandfather's paradox. Consider a man who somehow builds a time machine and travels back in time. Having travelled back, he, for no real reason, kills his grandfather. As a result, one of the traveller's parents (and by extension the traveller himself) would never have been conceived. This would imply that he could not have travelled back in time after all, which means the grandfather would still be alive, and the traveller would have been conceived allowing him to travel back in time and kill his grandfather. Thus each possibility seems to imply its own negation. It is therefore believed that past time travel is not a possibility. Future time travel is a more probable venture. This is like canoeing with the current of the river. Einstein's general theory is the cornerstone of future time travel. In Einstein' time, the idea that one could travel ahead of his time, was played down as ridicule but today, theoretical physicists concede that it is possible in theory. There are currently two theories. The weaker of the two theories and involves travelling at roughly the speed of light. As one approaches the light barrier, time slows down, hence maintaining the limiting nature of light. Consider a train, travelling at such a speed. If one was to spend a year in such a train, roughly five years would pass outside the train. The traveller would age only a year, while his fellow-beings would age five years. The problems here are obvious though. There is no train that travels at even a fraction of the speed of light, and even if one did, there would be the problems of friction and the resulting high temperatures inside the train. To engineer such a train is beyond contemporary technology.



Simulated view of a black hole

Heavy masses slow down time. This is the essence of Einstein's general relativity, in which he discusses space-time warping. The heaviest mass known to man is a black hole. If a spaceship was to revolve around a black hole (a remarkable feat) for a significant time, then time dilation would result. A year of revolution around a black hole, would equate to 50 earth years. If the residents of this spaceship were to travel back to earth, they would be greeted with a very strange sight. They would have aged 50 years relative to their fellow-beings. Then again, there are problems of practicality. To avoid being sucked in a black hole, is preposterous, and could only be done if the space-ship were to orbit it at nearly the speed of light.

Ancient civilizations considered Time to be the ultimate God: Everlasting, Unfathomable. Although the human generation has got wiser than their naïve ancestors, they still haven't put the dilemma to rest. One can only expect further developments in this field of science and hope that a complete explanation of time would soon materialize.



Anyone who can read a news paper today has probably gone through his name several times, and for those not affiliated with theoretical physics it can only sound eponymous to a "shrapnel" in the so-called "Big Bang experiment". Peter Higgs, the celebrity physicist of the Higgs boson renown - an elementary particle which seems to have over taken its theorist in fame.

While drinks are being named after Higgs boson (*Boson de Higgs* by Hopfenstark brewery, Montreal) and while it increasingly gains the status of an idiom in popular speech, in relation, rather naively, to its property of giving mass to stuff, the man behind the concept is rather little known to the general public.

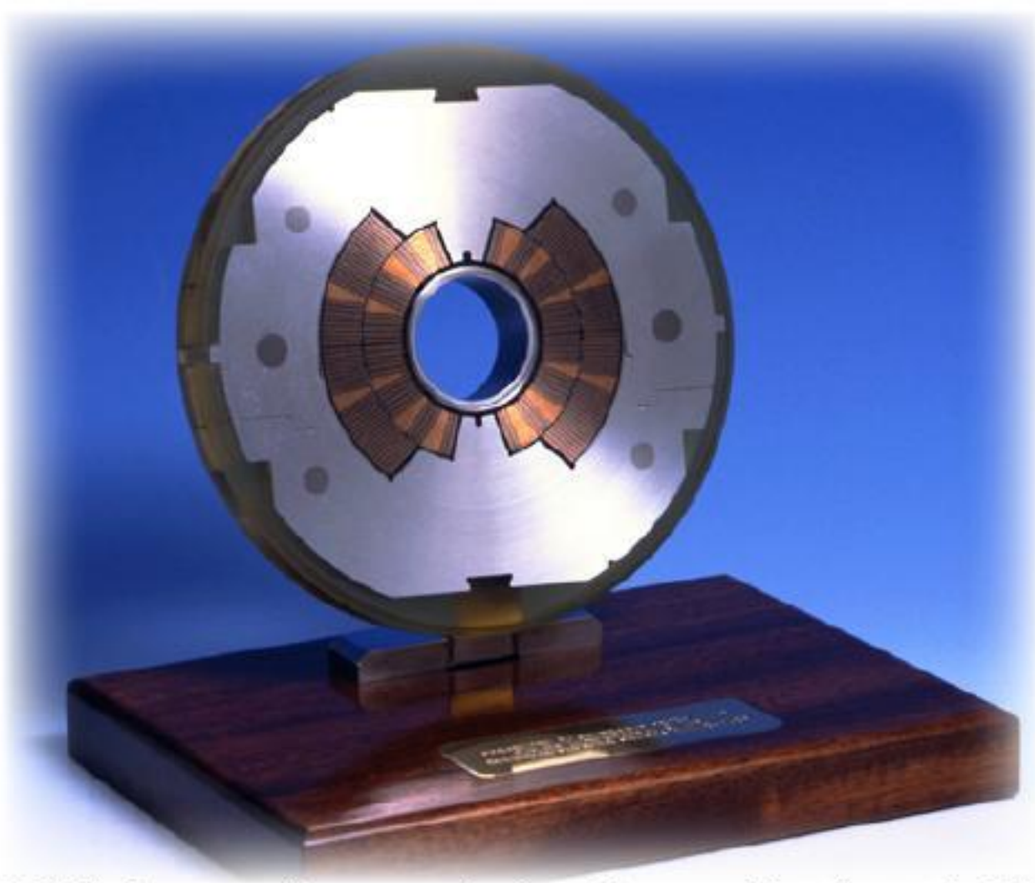
Peter Higgs was born in 1929, in Newcastle, England. By a stroke of great luck for the entire humanity, he attended Cotham Grammar School; the alma-matter of the legendary physicist Paul Dirac. A brilliant student from the get-go, he initially did not show any special interest or talent for physics. It was upon seeing several entries for Paul Dirac on the school's honor board and deciding to find out what his work was all about, that Higgs was fascinated by the world of theoretical physics.

After schooling, he joined King's College London to study Physics in 1947 and stayed there for his bachelor's, masters and doctorate degrees. Impressed by the city of Edinburgh on a hitchhiking trip, while at King's College, after his education he remained affiliated with the University of Edinburgh for the most part of his career. Rising from a lectureship in 1960 to a personal chair in Theoretical Physics in 1980, Higgs made some of the most important contributions in the field of particle physics during this time.

A young Higgs in the sixties; his most impactful years

Higgs' work is based largely on foundational work by Yoichiro Nambu in 1960, who used spontaneous symmetry breaking, the major idea underlying Higgs' work, in the context of condensed matter physics, and, later particle physics as well. It was, however, proven by Goldstone, Salam and Weinberg, in what is now known as the Goldstone theorem, that such a theory would imply the existence of certain massless particles which were nowhere to be found. In Higgs' own words;

> *"...such particles would easily have been discovered experimentally and, besides, they would upset the energy balance in stars, since stars would be able to radiate easily Goldstone bosons rather than photons."*



LHC dipole magnet slice presented to Peter Higgs upon his retirement in 1996

So the problem was somehow evading the restrictions imposed by the Goldstone theorem. In 1962, Philip Anderson suggested that such a thing might be possible but without rigorously working out most of the details. Most importantly, Anderson's work was entirely non-relativistic. Higgs entered the scene upon reading Walter Gilbert's views on the subject. A physicist turned biochemist, and later Nobel Laureate in Chemistry, Walter Gilbert held the view that Anderson's work could not be extended to the relativistic case. It was this

Peter Higgs' special 80th birthday cake, showing Feynman diagrams and the iconic wine-bottle potential

conclusion of Gilbert's that got Higgs thinking. It dawned upon him that he knew a theory with exactly the properties that Gilbert held were impossible, and thus came Higgs' groundbreaking papers on the Higgs mechanism. But they came with an interesting turn of events:

An evocative painting of Peter Higgs, by Ken Currie, prominently on display at the entrance to the School of Physics and Astronomy at the University of Edinburgh

Higgs immediately submitted a short note of his finding (24th June, 1964), providing Julian Schwinger's work as an already existing counter-example to Gilbert's claims. This was immediately accepted by the journal *Physical Letters*. A second paper detailing the entire Higgs mechanism was submitted a week later but was rejected by the same journal. Higgs' recalls:

> *"It was rejected, and I was rather shocked. I did not see why they would accept a paper that said this is a possible way to evade the Goldstone theorem, and then reject a paper that showed how you actually do it."*

Higgs believed the people at CERN, where the *Physics Letters* was reviewed, did not understand this kind of thing, so he revised his paper and only this time adding the experimental implications of the work and explicitly mentioning the particle that we now call the Higgs boson:

> *"The reference to the so-called Higgs boson would never have appeared in print if Physics Letters had accepted the original version."*

This time he submitted the paper to *Physical Review Letters*, where, by coincidence, his referee turned out to be Yoichiro Nambu. He informed Higgs that very similar ideas had been submitted by Robert Brout and Francois Englert in the month before, although they employed different

techniques and had trouble making some links, which Higgs' did not. Also, Brout and Englert never explicitly mentioned the existence of the Higgs particle as an implication of their work.

Incidentally, Higgs, as well as Brout and Englert, missed out on another great opportunity by never realizing the application of their work to the electroweak theory, which was then completed by Weinberg and Salam, independently in 1967 and 1968 respectively, unifying the entire structure of particle physics into a single entity, the Standard Model.

According to an interview with *Physics World*, in 2004:

"Higgs remained active in particle physics into the 70s but "got rather left behind" when Martinus Veltman and 't Hooft made the next big breakthrough in the field by showing that renormalization could be used to remove the infinities in the electroweak theory - a feat for which they shared the 1999 Nobel prize. Eventually Higgs decided that he was "getting on a bit for a theorist" and decided to concentrate on teaching and "one or two minor things" involving other types of symmetry in quantum mechanics."

Over the years Higgs won several awards and honors for his contributions including the fellowship of the Royal Society in 1983, Dirac Medal in 1997, Wolf Prize in Physics in 2004 and J.J. Sakurai Prize in Theoretical Physics in 2010, to name a few. He retired from the University of Edinburgh in 1996, becoming an Emeritus Professor.

Almost fifty years after Higgs' prediction of the particle, his most important contribution to science was finally confirmed by the Large Hadron Collider on 31st July 2012 with a confirmed observation of the Higgs boson. Chatter has already started whether Higgs' will be awarded this year's Nobel Prize at the age of 83. He has the vote of the inveterate gambler of the physics world, Stephen Hawking, who had bet Higgs $100 that the particle will never be found. Hawking is reported to have said:

> *"This is an important result and should earn Peter Higgs the Nobel Prize."*

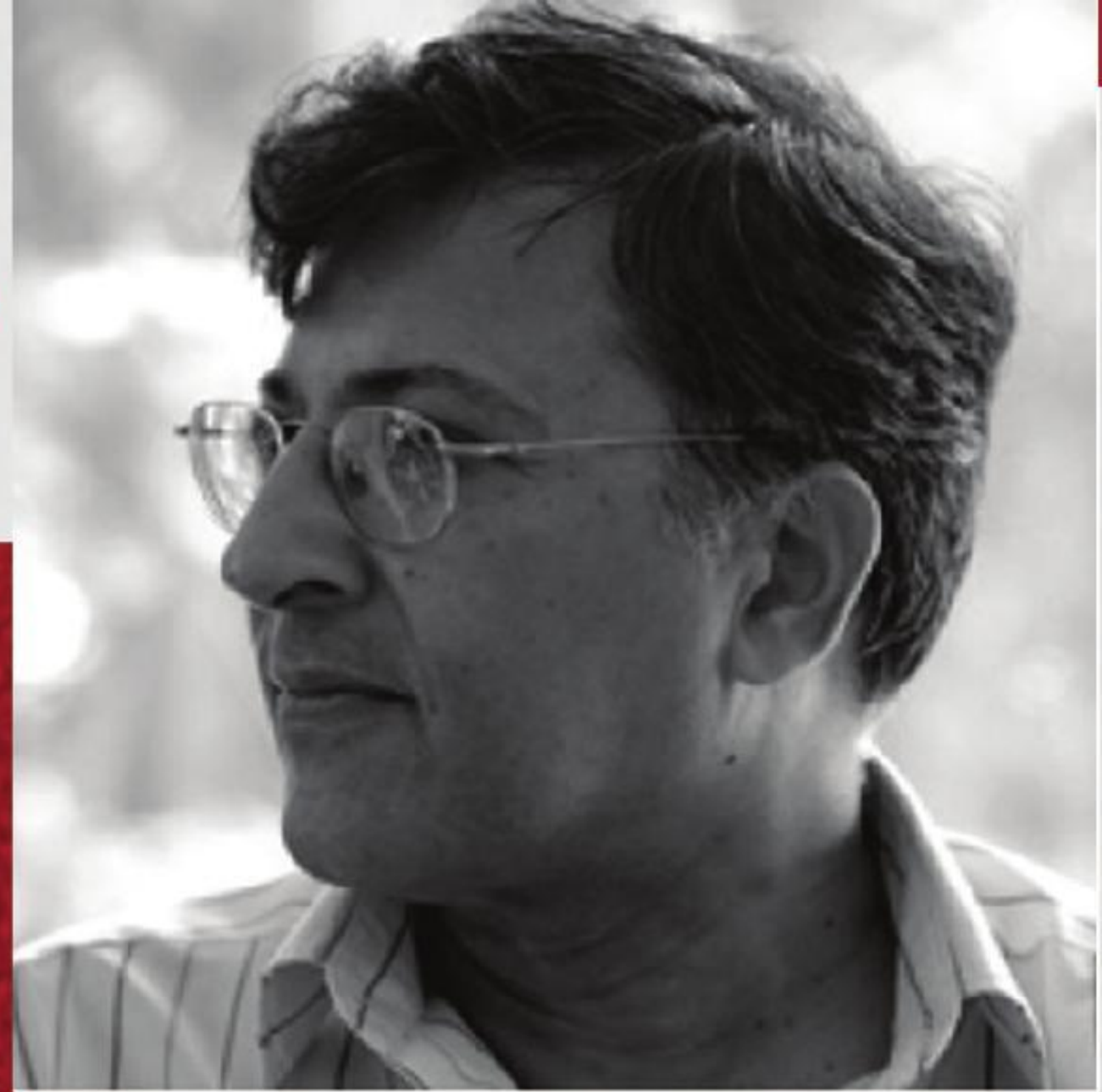
Higgs himself received the news of the discovery with tears of joy, remarking:

> *"It's really an incredible things that its' happened in my lifetime."*

Peter Higgs in the LHC tunnel (April 2008)

by Saim Sultan

EXCLUSIVE INTERVIEW WITH Dr. PERVEZ HOODBHOY



First get to know the facts in any dispute that you enter. Let reason, commonsense, and objectivity be the only criterion. If the issue is important enough, then fight for it even though the consequences may not be good for you. Remember what Faiz said: *bol keh lub azad hain teray (do speak, for your lips are free)...*

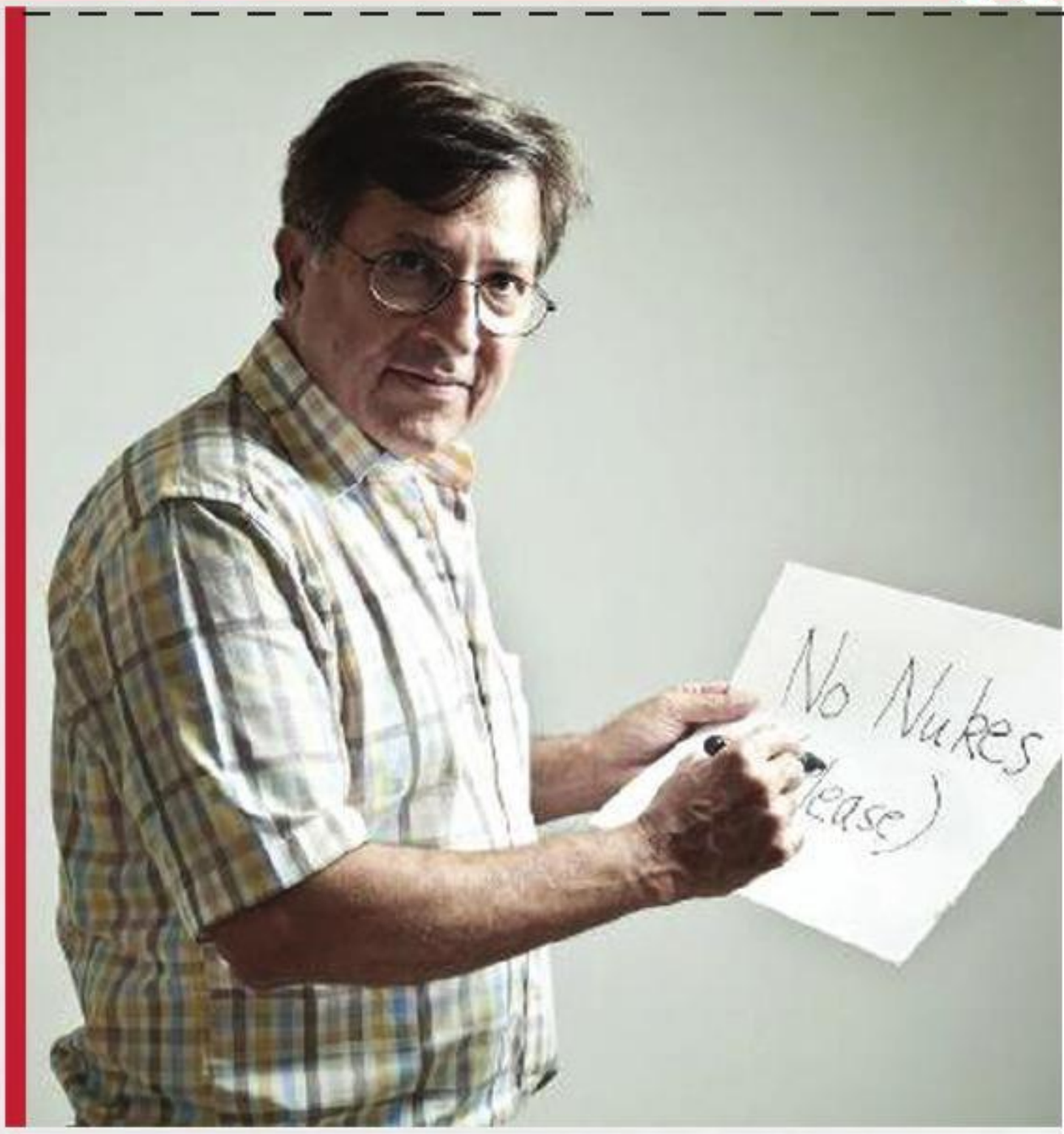
-Hoodbhoy

For this issue of Aurora, we have had the immense honor of interviewing one of the most influential contemporary Pakistani intellectual, Prof. Pervez Hoodbhoy. A physicist by trade, Pervez Hoodbhoy has made a name for himself in the world of science through his extensive research in fields as varying as solid state physics, quantum chromodynamics and string theory. He recently retired from his professorship at Quaid-e-Azam University and has held visiting professor positions at esteemed places like MIT, Carnegie Mellon, Stanford and LUMS. For his contributions the professor has various accolades to his name, including, the Baker Award for Electronics, the esteemed Abdus Salam Award for Mathematics and the Fullbright Award for research.

To the general public, however, Pervez Hoodbhoy is primarily known for his far reaching views on various academic, social and political issues. He is globally acclaimed for his signifcant contributions towards the spread of education in Pakistan. He has been a strong critic of nuclear weaponization globally, and, especially in Pakistan. His book "Islam and Science: Religious Orthodoxy and the Battle for Rationality" has recieved wide international acclaim and has been translated into more than six languages. He can often be seen on the national and international media debating policies on matters related to education, defence and foreign relations, among other things. For the youth he serves as an inspiration and a voice of rationality in a society riddled with illiteracy and dogmatic beliefs.

How and what got you interested in theoretical physics? What gave you the initial spark to go in this field?

As a boy, I had a great fascination for everything to do electricity and magnetism. So I'd play with batteries, coils, springs and make various gadgets. My first love was mechanical stuff – all sorts. Although few young people today know what they are, Meccano sets were once popular. All my time after school went into making trains, bridges, cranes, etc. Thereafter I became more involved with vacuum tubes and transistors. My interest developed to the point that I made my own crystal receivers, then constructed super heterodyne receivers, radio transmitters, etc. After doing my A-levels I went to MIT to pursue this passion. But there I was in for a surprise; the world turned out to be so much bigger and more interesting than I had ever thought. There I encountered teachers who were at the very cutting-edge of science and who had developed great ideas that one nowadays finds in text books. Electrical engineering, or any engineering for that matter, began to look so small and unimportant compared to pure physics. One exceptionally inspiring teacher was Prof. Philip Morrison, who had polio from childhood and came to lectures in his wheel-chair. He was among those scientists who had discovered how stars get their energy, why they blow up, why some turn into pulsars and black-holes etc. When he spoke on the nature of space and time, nothing seemed more profound. Engineering fast slipped out of my mind. I came to realization that physics is beautiful: beautiful because it is simple. One is able to write down fundamental laws governing every kind of physical phenomena in the form of just a few equations. Though they are complex and difficult to solve, nevertheless the very thought that the whole universe can be reduced to a few equations gives one a sense of enormous power. I was faced with a choice: should I spend my life understanding electrical devices and learning to make better ones? Or did I want to learn about something really grand? Ultimately I decided that that my life would be better spent doing physics.



Pakistan and India have come to blows so many times that a nuclear war in this century is a real possibility. The safest way to avoid catastrophe is to give up these insane toys, which all militaries love.
-Hoodbhoy

You studied in one of the dream institutes of any scientifically motivated student (MIT). What was it like and how would you say that experience differs from that of a student studying in a Pakistani institution?

Pakistani institutions are considered good if they succeed in transferring knowledge from teacher to student. Of course, very few of them actually do a good job at even that. But institutions like MIT see their success in pushing forward the frontiers of knowledge; their goal is to create a breed of student which is constantly seeking to analyze, create, and innovate. Of course, knowing the existing state of a field is crucial to this. But knowing the present is not enough.

Incidentally, there is a bit of confusion over which department you are exactly affiliated with currently. Are you still a part of Quaid-e-Azam University and how associated are you with LUMS SSE?

I retired from QAU two years ago after crossing sixty but I still have an office there and continue to supervise some thesis students. Having taught there for 38 years, it is not that easy to break off. Currently I am a visiting professor at SSE LUMS.

What are your comments about the discovery of the Higgs particle? How do you see this development and what is the future of physics now that we have found the Higgs boson?

Now that the Higgs particle has been discovered, we can say with confidence that we have a precise picture of the smallest building blocks of matter and the forces between them. There has been a long-standing puzzle about why some particles, like the particle of light called the photon, have zero mass but other particles, like the electron, do have mass.

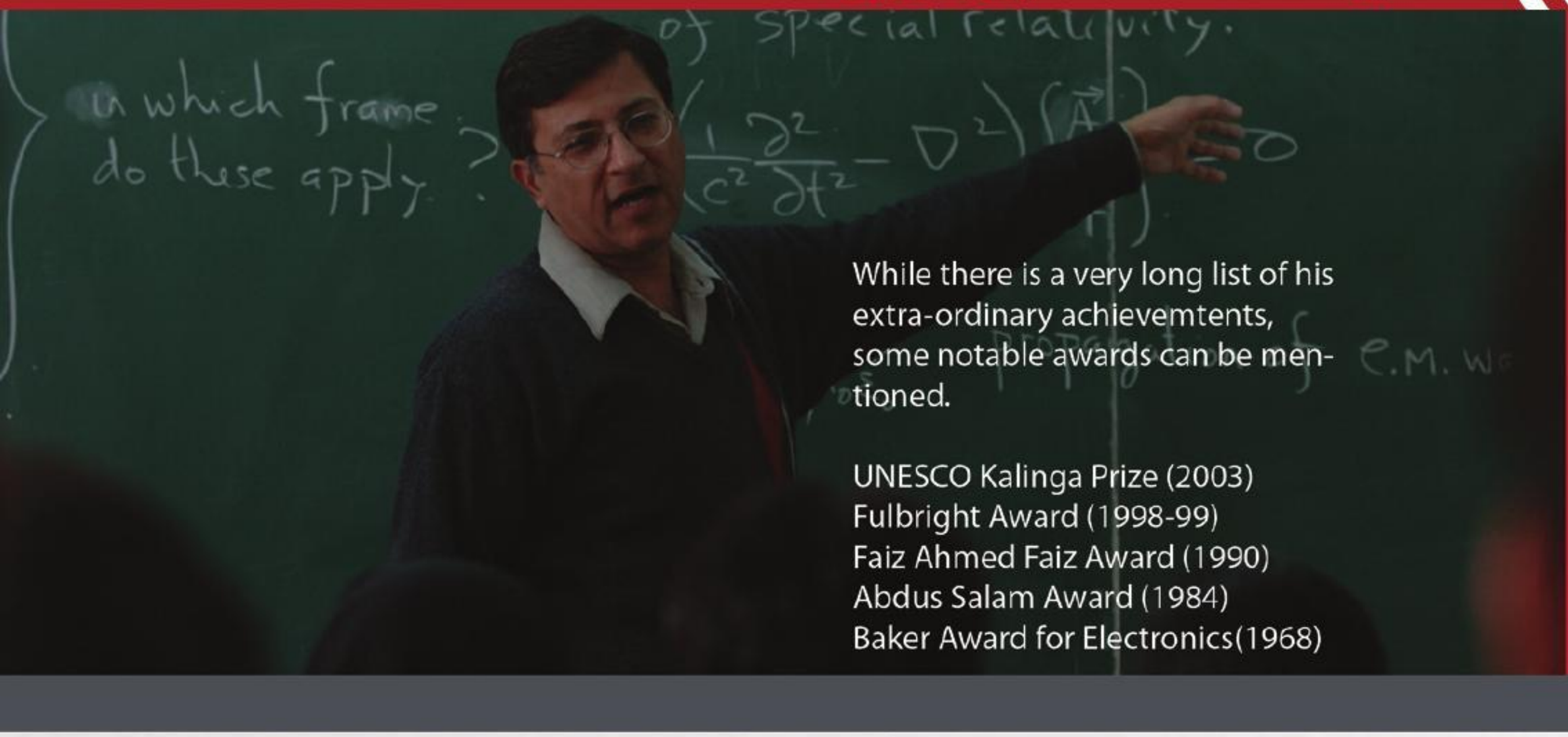
Image Credit: The Institute for Global Leadership, Tufts University.

Pervez Hoodbhoy at The Institute for Global Leadership, Tufts University.

What do you think about LUMS SSE; its present and future?

Relative to most Pakistani universities, it has good teaching standards and few disruptions. The students are mostly from elite schools but a few have made it from less privileged backgrounds as well, a trend that hopefully will grow. Good faculty remains a serious constraint for future growth; LUMS has still a long way to go before coming close to even a middle-level U.S. university or a good Indian one. Success will be possible only if it is run so that political and ideological pressures, which have ruined other Pakistani universities, can be successfully resisted. Let's see.

So, yes all the fuss – and the $10 billion that went into building the world's largest atom smasher – was well worth it. The discovery was nice because the last piece of the Standard Model – the name given to the theory developed by Steven Weinberg, Abdus Salam, and Sheldon Glashow – has been found more or less where it was expected to be. But we still don't understand how the fortce of gravity fits into the picture, or why some quarks are heavy and others are light. We also suspect the existence of an entirely different set of particles called supersymmetric particles. There is a whole lot more to know.



While there is a very long list of his extra-ordinary achievemtents, some notable awards can be mentioned.

UNESCO Kalinga Prize (2003)
Fulbright Award (1998-99)
Faiz Ahmed Faiz Award (1990)
Abdus Salam Award (1984)
Baker Award for Electronics(1968)

You are an outspoken proponent of nuclear disarmament. What do you think are the necessary steps for stability, or maybe even survival, of the subcontinent, in this regard, from both Pakistani and Indian sides?

Pakistan and India have come to blows so many times that a nuclear war in this century is a real possibility. The safest way to avoid catastrophe is to give up these insane toys, which all militaries love. But for that it is necessary to have peace, and peace will come only if we stop spewing hatred and venom against each other. Europe has set such a terrific example of former enemies uniting to everyone's benefit. How I wish the borders could be opened up and Pakistanis and Indians could freely go back and forth!

Recently, there has been a circulation of some email exchange between several notable Pakistani academics, including yourself, two Nobel Laureates in physics and HEC authorities. Would you like to explain the situation to our readers?

This is about a physics thesis that was guided by an "HEC meritorious professor", and with the resulting publications paid for by the HEC. The thesis title was "A quantitative study on chromotherapy" and it contained equations that made it look respectable. But it was complete nonsense. Several notable Pakistani physicists, who actually know their subject, said so too. After months of trying we failed to convince the HEC, which even now refuses to reveal the names of the referees. As a last-ditch effort, I sent a copy to two distinguished physicists who I have known for many years. One was the physics Nobel Prize (1979) winner, Steven Weinberg, and the other was the physics Nobel Prize (1988) winner, Jack Steinberger.

Weinberg wrote a point by point criticism which ended up saying: "I am appalled by what I have seen. The thesis shows a lack of understanding of the fundamentals of physics. This thesis is not only unworthy of a PhD, it is positively dangerous, since it might lead patients with severe illnesses to rely on 'chromotherapy' rather than on scientific medicine. I find it difficult to understand how this thesis could have earned its author any academic degree".

Steinberger was equally shocked: "a reasonable physics department should not have accepted anything like this work....Following world news this past decade, I have been very unhappy about the Pakistani political instability and social problems, but I had imagined that its cultural level was better than what I now see".

Has there been any development from the HECs' side on this issue since those emails were made public on social media?

Unfortunately there wasn't the slightest apology or admission of wrong doing by the HEC. They will continue to do what they have done in the past – i.e. support spurious research that the world considers to be rubbish, but which gets published in some odd "foreign" journal. The obsession with publications, and lack of scientific judgment, means that the HEC is unlikely to play a role commensurate with the huge funding it has been provided by the government for a decade.

It will probably be old news by the time this goes to print, but, what do you think about the whole Agha Waqar Ahmed fiasco?

This episode shows how desperate we are for good news. This man promised a new Pakistan with limitless energy, no need for petrol or gas, and no more load-shedding. For an energy starved nation, it was a vision of paradise and nobody cared that the laws of physics would have to be violated for water to be used as a fuel. Lacking commonsense and good judgment, politicians and media anchors went ballistic. Of course, months later there is no water car and nobody talks about it anymore. But this kind of outrageous stupidity will occur again and again. To prevent that, ordinary people must know at least some science. More importantly, they must know that science works from facts and principles. It is not magic.

What does it say about the state of education in Pakistan?

It says as much about our culture of servility and obedience. If you play the system, you rise. Else you make it to the boondocks. I know of at least one intelligent colleague who knew the water car was a total fraud. But he is ambitious and didn't want to contradict what the "great" scientists of Pakistan were saying in support of this idiocy. So he lent his support on a TV program for the idea, qualifying it slightly so that he could save a little bit of his conscience.

(January 13, 2010 - Source: David Goldman/Getty Images North America

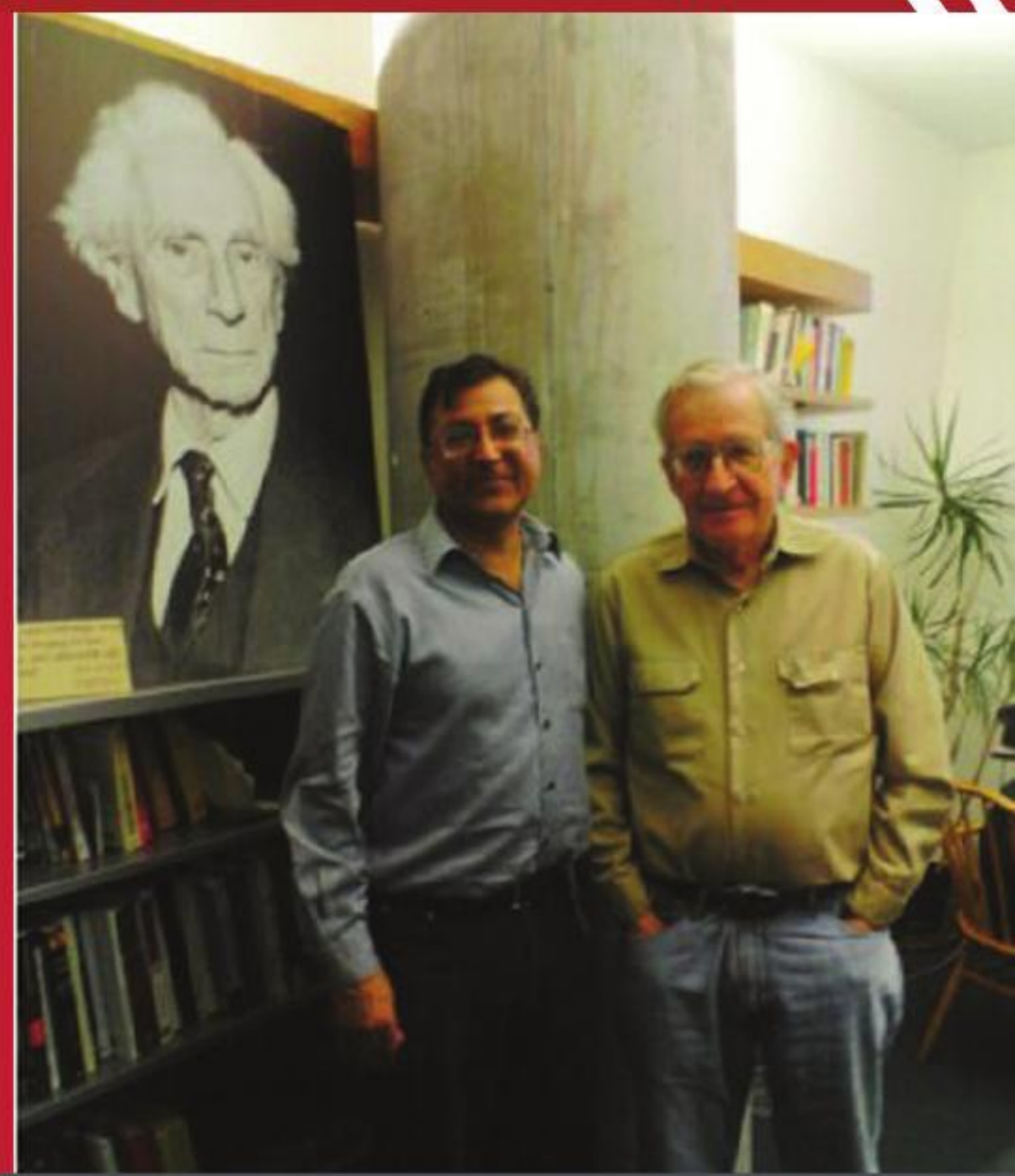
Pervez Hoodbhoy at a press conference of Bulletin of the Atomic Scientist, announcing the adjustment of the "Doomsday Clock" by one minute back on January 14, 2010 in New York City

What concrete steps do you think HEC ought to take to improve the state of affairs of our higher education?

HEC's past record and the inability of its leaders to understand elementary things does not inspire confidence. But here is what I consider to be key for having a working university system – improve the quality of students and teachers. So there must be national entrance examinations for choosing the best students for entrance into public universities. Equally, university and college teachers should go through tests for basic competence before being selected. We have far too many teachers who have big degrees but know nothing. They must be relentlessly weeded out of the system because they cause standards to degenerate. Ditto for many university vice chancellors; they are incompetent political appointees who flout all norms of decency and know they will get away with it. Can you imagine what that university is like whose head buys Viagra using money actually meant for library books and furniture? That's the specific situation for Sind University, but such abominations are not infrequent elsewhere as well.

What do you think, in general, about these free education startups from giants like, your alma matter (MIT) or others like Stanford, Harvard, Berkeley, and many others? Will these have far reaching effects on education of the future?

I think they are quite thrilling. Today any highly-motivated student can go online and find lectures of various lengths and have access to class materials that was once the prerogative of only a very few privileged people. I also see Khan Academy as making a terrific contribution, albeit at a more basic level. So, yes, the delivery of education has changed in the West and it will keep changing. But will all Americans, Europeans, Japanese, etc. benefit from this? The answer is no! Only those who have gone to good schools, or have some strong inner motivation (for whatever reason) will gain.



Pervez Hoodbhoy with Noam Chomsky

What promise do you think such projects hold for a country like ours'?

Not very much for now. There will be some bright kids at GIKI, LUMS, or NUST who will find these on-line materials interesting and actually try to follow some courses. But it's supplemental stuff and will not be used by most university or college teachers. There's also the language and cultural barrier for most. Public university students in Pakistan generally can't follow that kind of English and manner of speaking. We really need good stuff in Urdu.

What would you say a group of students like us can do to further help the spread of scientific way of thinking?

First get to know the facts in any dispute that you enter. Let reason, commonsense, and objectivity be the only criterion. If the issue is important enough, then fight for it even though the consequences may not be good for you. Remember what Faiz said: bol keh lub azad hain teray (do speak, for your lips are free)...

SUSTAINABLE DEVELOPMENT

FOCUSSING ON ***INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL*** AND ***RIO+20 CONFERENCE.***

How plausible is the scenario of a calamity faced by a generation which is left with almost no natural resources by the former one? Undoubtedly, we are plundering the planet at a pace which surpasses its capacity to support life.

Humans dwell in one great interdependent system. Unrestrained use of natural resources to meet our needs may bring an untold misery to the future generations. According to experts, if this practice continues, seas will become empty of fish, forests will be destroyed and freshwater supplies will become polluted and scarce. Life, as we know it, will meet a catastrophe.

Fossil fuels are arguably the main resource being utilized for energy requirements, causing an unprecedented damage to the ecosystem. Sustainable development is our only option to prevent this damage and develop a carbon-free energy infra-structure.

by Kazi Sher Ahmed

SUSTAINABLE DEVELOPMENT

The often-quoted definition is from 1987 Brundland Report:

"It is the development that meets the needs of present without compromising the ability of future generations to meet their own needs."

It was stressed that development and environment were inseparable. Political action followed with Earth Summit in Rio de Janeiro in 1992, where world leaders met for the first time to address the issue.

Sustainable development is usually assessed by reference to its three pillars:

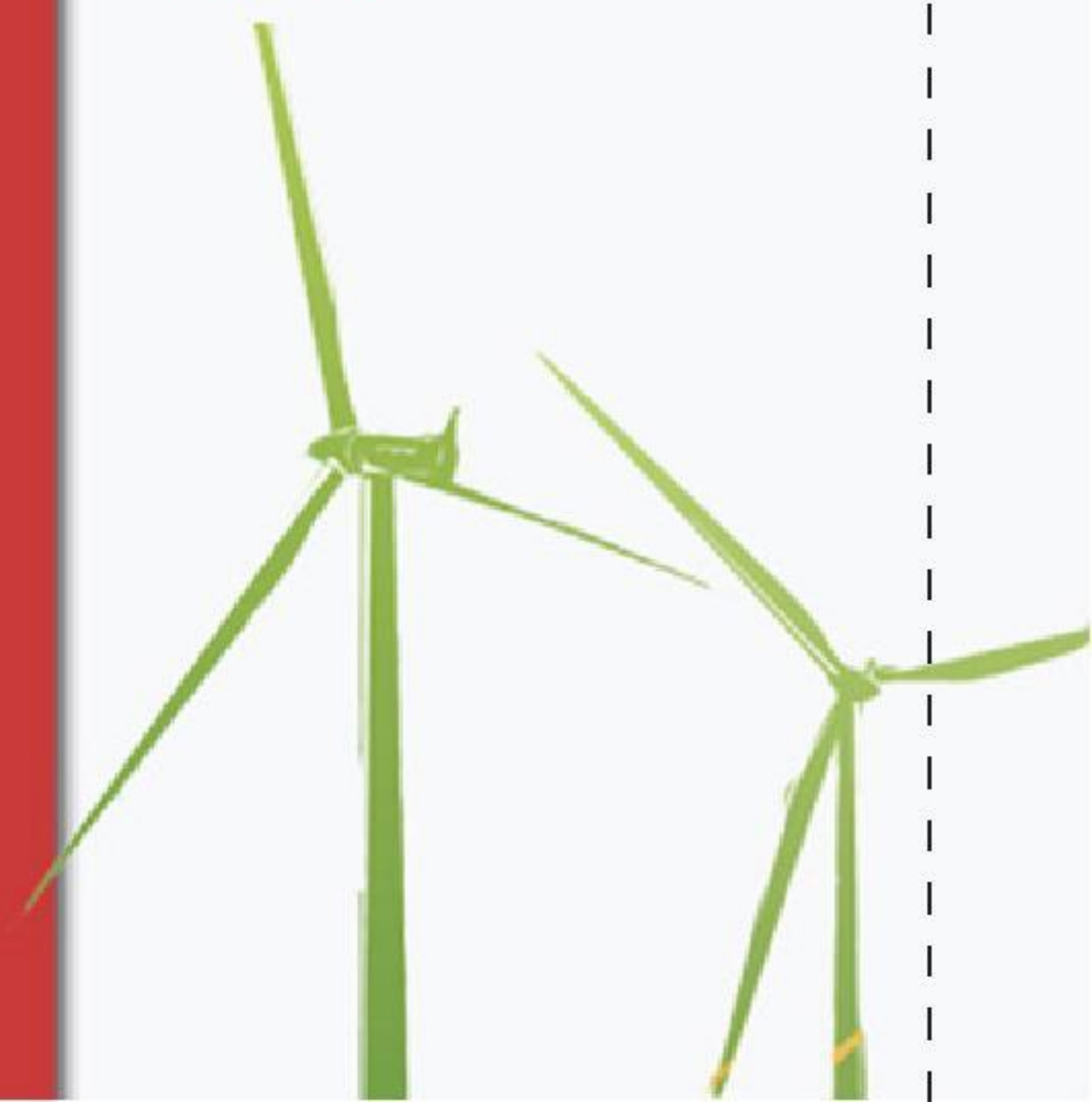
- Economic Sustainability
- Social Justice
- Environmental Protection

The complex problems related to these domains cannot be addressed the way they were created. Aforecited three pillars are interconnected. We cannot have it all. A harmony and viable approach are what we are looking for.

Economic development combined with sustainable transport systems paves the way towards economic growth. While billions are living in extreme poverty, initiatives in this regard have not been very successful.

In the quest to build a sustainable community, social justice tops the agenda. Participation of all stake holders is to be made necessary to achieve impartiality, empowerment, social mobility and cultural preservation. Conclusively, a better quality of life for all humans is the goal.

Environmental sustainability comes into play when we interact with nature in a way to keep it as pure as possible. It will remain a distant dream unless we do not refrain from using natural resources faster than they can be replenished. For a healthy ecosystem, every action is influenced to protect the biodiversity and to maintain clean air and water access.



It is the question of concern that reaches out to all the living and non-living things of the earth.

RIO+20:

50 PLUS COUNTRIES

50 BILLION DOLLARS PROMISED FOR UN'S "SUSTAINABLE ENERGY FOR ALL" INITIATIVE.

"Sustainable energy is the golden thread that weaves together the economy, the environment and equity."

UN Secretary General Ban-Ki Moon

INTERNATIONAL YEAR OF SUSTAINABLE ENERGY FOR ALL

Sustainable development is impossible without sustainable energy. Two years back, 2012 was declared as the "International Year of Sustainable Energy for All" by United Nations. The initiative is aimed to attain universal energy access, energy efficiency improvement and increase in renewable energy usage.

Consequently, National Coordinating Committees and networks have been developed to drive the activities and programs.

It is worth mentioning that the initiative is being undertaken by 20 UN agencies. Regulating energy consumption has also been a concern. In this regard, a social enterprise, launched by GIK Institute's Alumni Wardah Inam and Faizan Rasool, is focusing on energy education.

RIO+20 CONFERENCE

The RIO+20, United Nations Conference on Sustainable Development, was held in Rio de Janeiro, Brazil on 20-22 June, 2012. In retrospect, it was the third conference on the issue with the following themes:

- A green economy in the context of sustainable development poverty eradication.
- The institutional framework for sustainable development.

Several thousands of individuals from private and government organisations attended the conference to discuss and plan for a sustainable future and development.

Intelligent species do not engineer their collapse. We must not be planning devastation.

REVIEW

14TH GIKI ALL PAKISTAN SCIENCE FAIR 2013

National ICT R&D Fund

GIKI Science Society endeavors to blend entertainment and extracurricular activities with a slight dose of science. Its undertakings in this regard have been very fruitful as it conducts a series of events like All Pakistan Science Fair, Science Kasoty, Science Marathon, Eureka, Project Exhibition, and more.

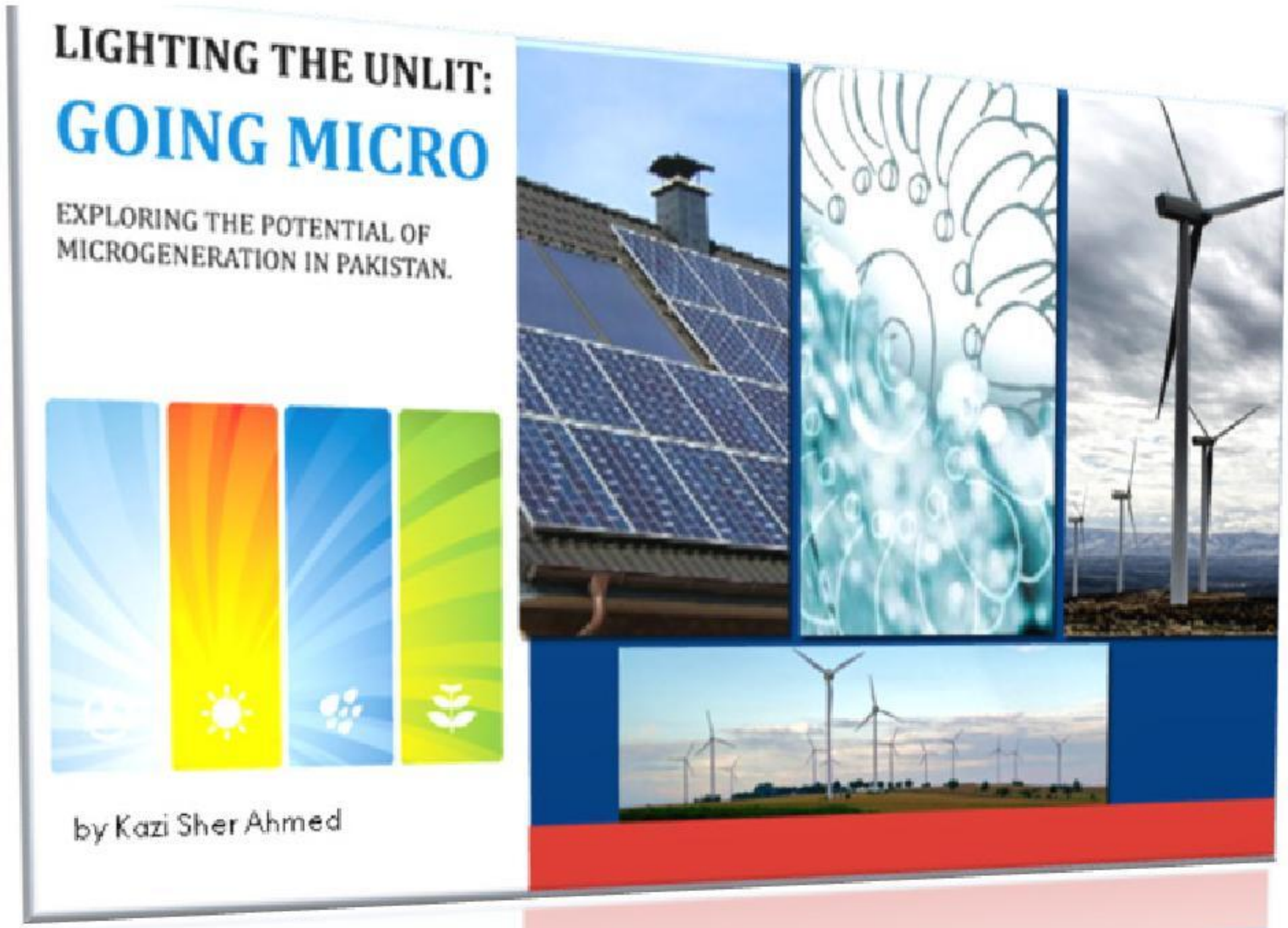
In addition to stimulating events, publication of Science Aurora Magazine depicts the journalistic and literary potential of its members. The magazine brings the spectacular scientific developments in a single publication.

Founded over a decade ago, GIKI Science Society annually organizes All Pakistan Science Fair. This year, the event hosted more than 300 students from renowned institutes of the country. Event started off with an official orientation ceremony, followed by a seminar on electricity conservation. The three-day event comprised of modules and activities carefully tailored to impart scientific knowledge and to induce interest towards learning.

NATIONAL ICT RESEARCH AND DEVELOPMENT FUND

It is worth mentioning that 14th GIKI All Pakistan Science Fair was sponsored by National ICT Research and Development Fund, which aims to transform Pakistan's economy into knowledge based economy. It aspires to do this by promoting efficient and sustainable ICT initiatives thorough synergic development of industrial and academic resources.

Continuing to make a difference, National ICT R&D Fund provides scholarships in ICT related disciplines for 4-year undergraduate programmes. It has been involved with industry and academia since its inception. Along with initiating many projects, it has also facilitated a large number of projects in academia.

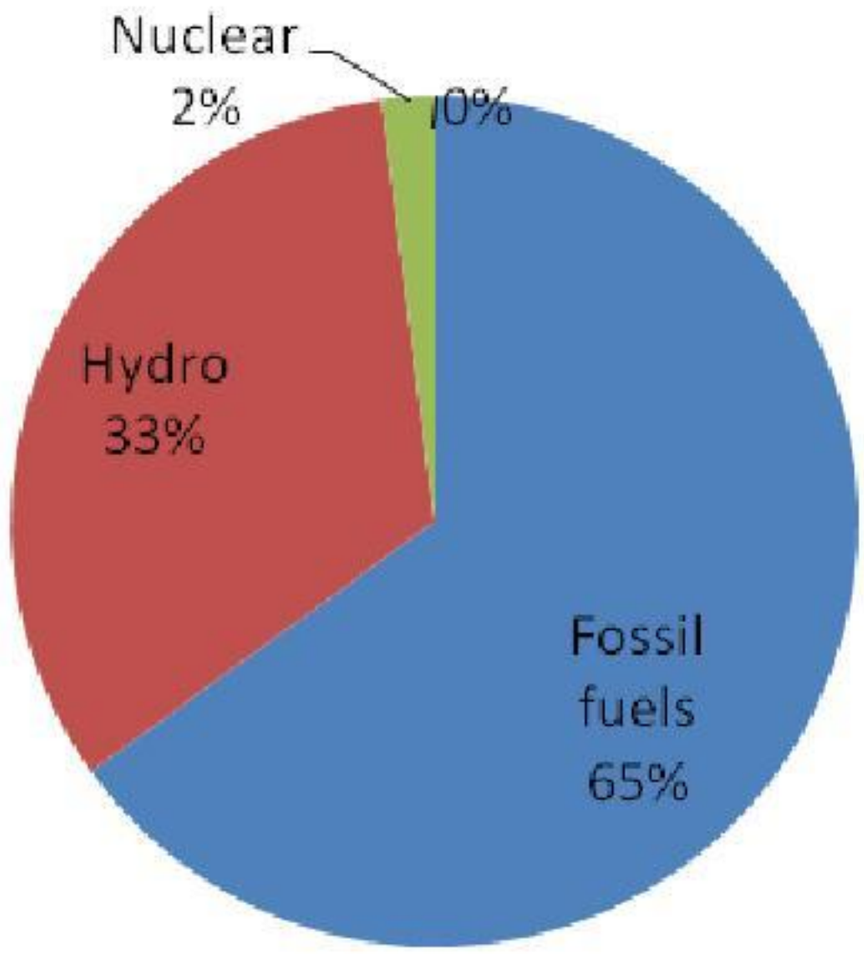


More than 130 years since Thomas Edison's success with the artificial light, there still remain thousands of communities in the dark.

While the world celebrates 2012 as the **International Year of Sustainable Energy for All**, nearly a quarter of world's 7 billion population lives without electricity, a majority of which resides in least developed countries of South Asia and Africa.

"They carry heavy loads of water on their backs because they don't have transport. They cook over wood fires that damage their health, not with electricity, gas or oil," said UNDP's director of development planning, Olav Kjorven.

Incompetent governments, lack of funding, and rising demands for power worsen the crisis. More than 130 years since Thomas Edison's success with the artificial light, there still remain thousands of communities in the dark. As we focus our attention on Pakistan, we have to acknowledge the fact that other than the acute electricity shortfall, more than 50 million people have no access to the national grid of the country. Connecting far-off and scattered localities to an already overburdened national grid will be very costly. Therefore, the only way to light the areas in darkness is to divert our focus and energies to microgeneration. Overreliance on fossil fuels is extremely unproductive.



Sources of Electricity generation in Pakistan

Indoor pollution, caused by cooking and heating homes using wood and coal, kills 1.6 million people every year
Image: ISTOCKPHOTO/DORINS

MICROGENERATION

Microgeneration can be best described as the decentralized small-scale generation of heat and electric power by communities for their own needs. It serves as an alternative to centralized national grids. We cannot agree more to the fact that microgeneration is also a catalyst for cultural change. Although the term 'microgeneration' encompasses many latest technologies, we limit our focus on the most viable of them:

- Photovoltaic solar micro grids
- Micro hydropower
- Micro wind turbines

PHOTOVOLTAIC SOLAR MICRO GRIDS

These systems use solar cells for the conversion of sunlight into electricity. These cells are positioned at an optimal angle on a support. Cells are composed of one or two layers of semi-conducting material. Electric fields across the layers are created when cells are exposed to the sunlight.

By connecting the generation point to a micro grid, electricity can be distributed in a limited area. The scenario seems feasible as we witness the falling costs of solar cells and LEDs.

One such implementation is seen in India where MeraGao Power' project has deployed microgrids powering dozens of villages. The grids use 24-volt DC power throughout which has permitted the use of less expensive aluminum wiring instead of copper wiring. To further 'maximize the efficiency, the village is carefully mapped. Consequently, each house receives 0.2 amps for seven hours a

night for a prepaid monthly fee of 100 rupees. However,currently the system supports lighting only; innovators are finding ways to increase the power output.

Another example is of a village in Nepal, where solar powered water pumps have been proven a blessing for the villagers, putting a halt to their long distance travels for water.

A solar powered home

In Pakistan, The Alternative Energy Development Board (AEDB) has completed programs under which 3000 solar home systems have been installed in 49 villages of Sindh. In a similar project, solar cookers were also provided to the villagers, due to which, an 80 percent decrease in deforestation was reported.

Pakistan has sunlight in abundance and is ideally located to harness solar energy. With the latest breakthroughs in solar technology, it should come as no surprise that one day, fossil fuels will find no place to be used for power generation.

MICRO-HYDRO POWER

Micro-hydro power is the small scale harnessing of natural flow of water to produce up to 100 kilowatts of energy. These installations are usually 'run-of-the-river' systems which do not require dams or storage capacities to be constructed.

Water is usually diverted from natural stream, river or sometimes a waterfall and made to pass through the turbine using penstock pipes. Pelton wheel turbines are used for these systems which not only work well with slow flow situations but also absorb most of the energy of moving water. The more the difference between velocities of water entering and leaving the turbine, the better the efficiency is. It is an inexpensive way to produce power and units can be set up in great numbers. Presence of abundant water flows and hilly terrain, especially in the province of Khyber Pakhtunkhwa, makes the idea practicable. These small-scale systems are decentralized and locally managed. A 50-kilowatt power station can produce electricity for over a hundred households.

When the politicians are obsessed with the politics over Kalabagh Dam, some have sanity left among them. Progress in micro-hydro power generation is indeed encouraging. Undoubtedly, being green seems like a new normal.

Micro-hydropower plant in Mardan installed by DoST with the coordination of GIK Institute.
Image:DoST, Khyber Pakhtunkhwa

When the politicians are obsessed with the politics over Kalabagh Dam, some have sanity left among them. Progress in micro-hydro power generation is indeed encouraging. Undoubtedly, being green seems like a new normal.

What is worth mentioning is the contribution GIK Institute has made. Directorate of Science and Technology, Khyber Pakhtunkhwa, in collaboration with GIK Institute has installed a micro-hydro power plant on a canal in a district in Mardan. Dr. Javed Ahmad Chattha is the Principal Investigator of the project and Mr. Muftoohur-Rehman, research associate in FME, serves as Co-Principal Investigator. The Electronic Load controller, which is responsible for maintaining desired frequency and voltage at turbine in response to changing loads, was developed in Faculty of Electronic Engineering, GIK Institute.

Hundreds of micro-hydro power plants have been set up in Punjab and Khyber Pakhtunkhwa which are also being used to run industrial units. The Pakistan Council for Renewable Technologies (PCRET) has installed nearly 300 such plants with a capacity of 3.5 megawatts. Moreover, turbines which cost millions of rupees if imported are being manufactured locally. Active community participation is being observed. Nevertheless, a proper government support and funding can significantly increase the number of inhabitants benefiting from micro-hydro power.

Initial costs for setting up a unit usually depend upon its scale and may be high. But once the plant starts working, it provides power for years without any purchase of fuel. Beneficiaries can be charged a small amount which can be used to replace the unit at the end of its useful life.

MICRO WINDTURBINES

It was between 500 and 900 AD when a vertical axis wind mill was developed in Persia to grind grain and pump water. Today, thousands of megawatt of power is being produced from wind turbines.

Wind turbines generate electricity by converting wind energy into mechanical energy. Rotor blades are designed aerodynamically to take optimal energy from wind. Output varies considerably with the speed of winds. Micro wind turbines have low power output when compared to commercial full-scale wind turbines. They can be housed on rooftops.

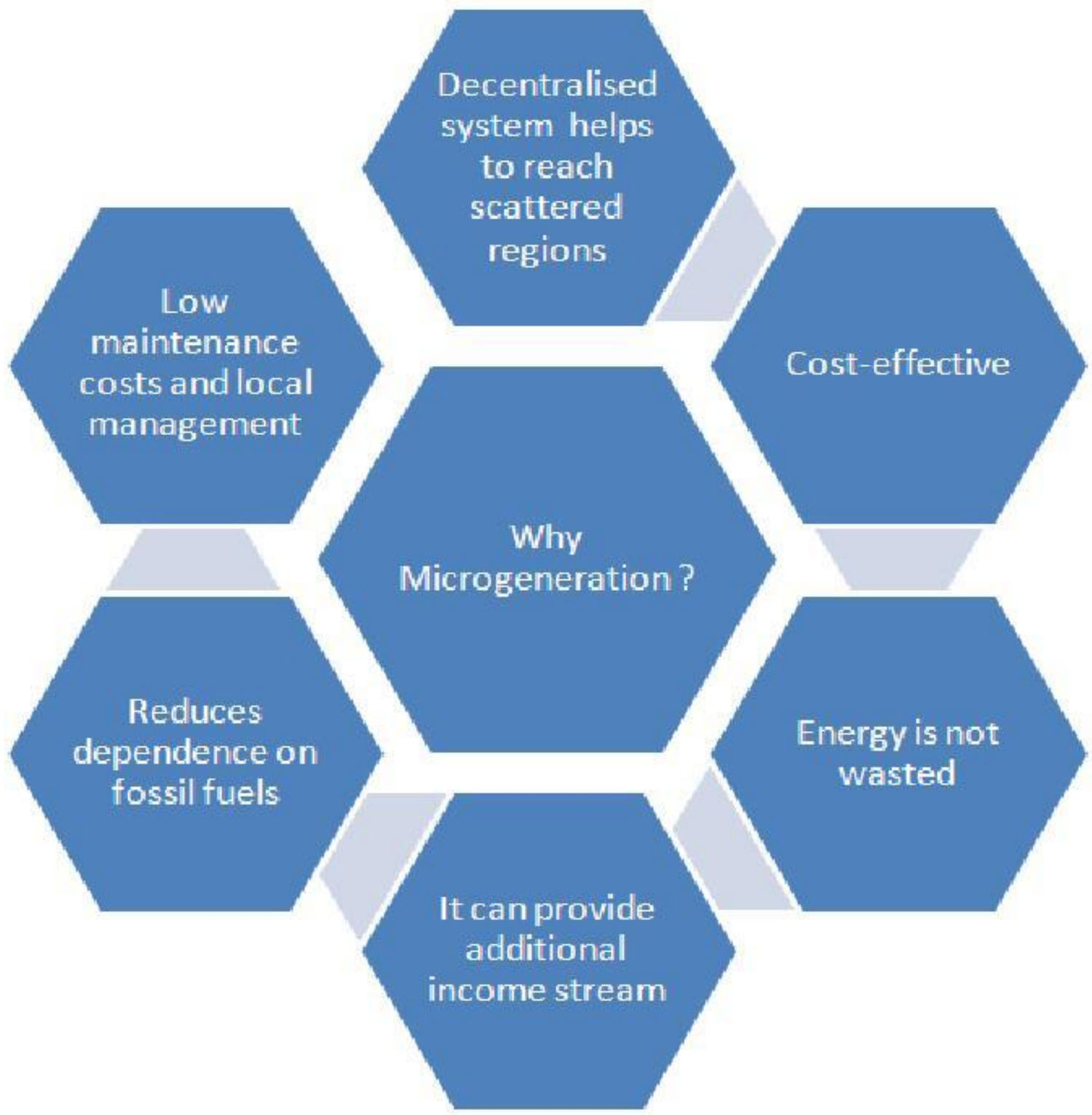
Dubbed as 'The Great German Experiment' , Germany has decided to close down its nuclear plants and complement the power gap by wind and solar energy.
Image: Technology Review Magazine

According to World Wind energy Association, China has around 300,000 small wind turbines generating electricity.

Pakistan is blessed to have high wind speeds and at least 50,000 megawatts of wind energy potential. Several hundred units can be deployed locally and power can be utilized independently. Owing to the inability to connect remote regions to the national grid, these units can transform millions of lives.

Talking about the successes, 85 micro wind turbines have been installed to power 356 homes in Mirpur Sakro. Similarly in Kund, 40 turbines are powering 111 homes.

Wind energy is playing a promising role and becoming a leading source for renewable energy.



WHERE WILL IT LEAD US TO ?

In the coming years, these technologies will enable the villagers to start small businesses to support their living. Their homes will have electricity and saved time will help them focus on other areas of their lives.

The reality of people living in dark is very much different from that of others. Bringing light to deprived lands is no less than revolutionizing the populace. It leads to significant improvements in poverty reduction, education, sanitation, healthcare and overall standard of living.

Public awareness campaigns have to be initiated to engage greater participation. Individual and cooperative efforts can accomplish what we have failed to do in decades.

How about initiating one?

REINVENTING EDUCATION: IVIES FOR ALL

CLASSROOMS REDEFINED

They say universities are as good as their professors are. Every year, thousands of students from all over the world apply to world-class universities for seats which are many times less in proportion to their quantity. Financial and geographical aspects combined with fierce competition make these universities a distant dream to a majority of applicants.

We have had our encounter with open courseware materials. But it was not even within a shouting distance to a real class room experience in Ivies. Fortunately, the recent online learning startups have done exceptionally great to fill the gap.

The academic axis is witnessing the launch of online learning platforms which are providing free courses from the leading universities of the world. Thousands, potentially millions of students have access to education material of very high quality compared to that of local standards. The combination of technology, world class teachers, and high quality content makes you end up with a class of more than 44,000 students at Stanford.

'MOOCs (massive, open, online courses)' is what they call them. The launch of spectacular initiatives like Udacity, Coursera and edX demands us to step beyond traditional teaching methods. Already millions of dollars have been invested. They not only favor huge outreach but also are free. Anyone in the world with a computer and internet connection can be a part of class taught by Ivy League professors. Unlike other developments in the past, they are not just the recorded lectures. What differentiates them from others is:

- Real-time streaming
- Increased interactivity
- Include regular assignments and multiple choice questions
- Grading of humanities classes through crowd-sourcing

MOOC TRINITY

Coursera

It was launched last year by two Stanford professors Daphne Koller and Andrew Ng. Nearly 350,000 people signed up for the first three computer science courses offered, which made it one of the largest experiment in online education. Videos pause momentarily and students are quizzed while their responses are graded. They are also expected to submit homework and meet deadlines. Statements of accomplishment are provided without any official credit.

Coursera now partners with 12 major research universities. Currently, it has 680,000 students in 43 courses and around 1.5 million enrolments.

Remember 'flip the classroom' approach of Khan Academy's Salman Khan ?It means lectures are given as homework and the class time is utilized in hands-on instruction and group work. This is what Coursera plans to practice in every course it offers.

Udacity

Sebastian Thrun, leading robotics expert, has given up teaching at Stanford University to change the way people teach and are taught. Last year, he co-founded 'Udacity' to teach free online courses. His first online class attracted 160,000 students from almost 200 countries. It was encouraging that 23,000 students cleared the course while taking the same tests given to enrolled Stanford students. Thrun remarked,

"After that I could never teach at Stanford again."

Furthermore, students get access to a heavily-trafficked forum where they can have discussion with their peers. On course completion, certificates are awarded.

The seven week courses include hour long videos with pauses. Udacity plans to offer six more courses in the month of April.

According to the founder, the enterprise has started with computer sciences but will include other subjects also.

edX

May 2, 2012 was the day when Harvard University along with MIT announced edX, a 60 million dollar venture and signalled to start courses in Fall of 2012. It will not only include engineering courses but also humanities ones, which will require crowd-sourcing and natural language software for grading. On successful completion, grades and certificates will be provided. Unlike others, it is a not-for-profit project. University of California at Berkeley has recently joined the bipartite.

Anant Agarwal, president of edX, termed the initiative a 'revolution.'Our goal is to educate 1 billion people around the world,' he enthusiastically said. It is worth mentioning that a prototype course attracted a whopping 120,000 enrolments. Seven courses in different disciplines will start this fall.

Daphne Koller speaks at TED Global in Edinburgh.
(TED Conference/flickr)

I will describe pedagogical foundations for this type of teaching, and the key technological ideas that support them, including easy-to-create video chunks, a scalable online Q&A forum where students can get their questions answered quickly, sophisticated auto graded homeworks, and a carefully designed peer grading pipeline that supports the auto scale grading of more open-ended homeworks, such as essay questions, derivations, or business plans.

- Koller

Andrew Ng
Stanford University

I have actually had several professors tell me they were previously thinking of writing a new textbook, and they decided instead to teach an online course on Coursera. It turns out to be less work, and your reach is likely greater. Not to mention that it's so much more interactive. I certainly think students learn better by taking an online course than by reading a textbook.

- Ng

Undoubtedly, these ventures cannot be substitutes for well-rounded university education, but they have revolutionized our teaching methods. The smart will get smarter for free. It is when classes do not end at the walls of campuses. We better should update our definitions of classrooms.

Apart from the afore-cited benefits, this free access to education will engineer the same revolution which freeing up research results has achieved in science.

There is this amazing block of talent we have discovered outside the normal system.

- Thrun

KNOWELECTRICITY

DEMYSTIFYING **ELECTRICITY** CONSUMPTION

MITIGATING THE ELECTRICITY CRISIS THROUGH ENERGY EDUCATION

Crippled industry, lengthy power cuts, and public agony are some of the outcomes of energy crisis engulfing the country. In response to a need of 22 GW of electricity, our available capacity is 18 GW. This demand-supply gap results in frequent power outages. While few people resort to protests and others criticize the government, some have got brighter ideas.

Freshly out of college, two exceptional minds, Wardah Inam and Faizan Rasool undertook an initiative to address the issue. The duo successfully launched a social enterprise to help mitigate the energy crisis. In less than a year, it has grown to a team of highly committed individuals with worth mentioning successes.

Though no immediate solution is available to end the electricity shortfall, energy consumption attitudes and intelligent selection of appliances can reduce the suffering.

KnowElectricity aims to create an educated consumer base that will employ all the possible means to conserve electricity. It is focussed on adoption of energy efficient products and practices and is reaching out to consumers to demystify electricity consumption. It is also making good use of social media to engage consumers.

THE PROGRESS

The one year old enterprise has achieved numerous milestones including being an invitee to MIT Global Startup Workshop, formation of partnerships with schools and universities, linkages with an electric supply company and National Energy Conservation Center (ENERCON).

KnowElectricity was showcased at **MIT Global Startup Workshop 2012** in Turkey, an annual event dedicated to fostering entrepreneurship and building such ecosystems globally.

It is working with **Lahore Electric Supply Company (LESCO)** and **ENERCON** to spread awareness about consumption issues. One important aspect of its activities is the engagement of youth in modifying the consumption trends. In this regard, it has conducted several sessions and mentor meetings in eight renowned schools and universities while establishing chapters to execute further activities.

KnowElectricity has also received support and grants from **MIT Legatum Center for Development and Entrepreneurship**, **Seeds of Peace**, and **MIT Public Service Center**.

ACTIVITIES AND PROGRAMS

Currently, the startup is engaged in four ongoing projects, ranging from solar applications to demystifying house-hold appliances' consumption.

Students Engagement Program is the most significant one to be mentioned. It is aimed at high school students to induce a sense of responsibility for careful consumption. School founders, facilitators, action teams, and mentors play key roles in it. Progress in this project is quite encouraging.

Products for Sustainability Program focusses on sustainable advantages and financial benefits to persuade consumer to buy suitable products.

Electricity Auditing maps the electricity consumption of a house-hold and provides recommendations for minimizing the wastage of electricity.

Solar Program is engineered to present solar applications as a feasible option in the current scenario when prices of solar panels have been significantly reduced.

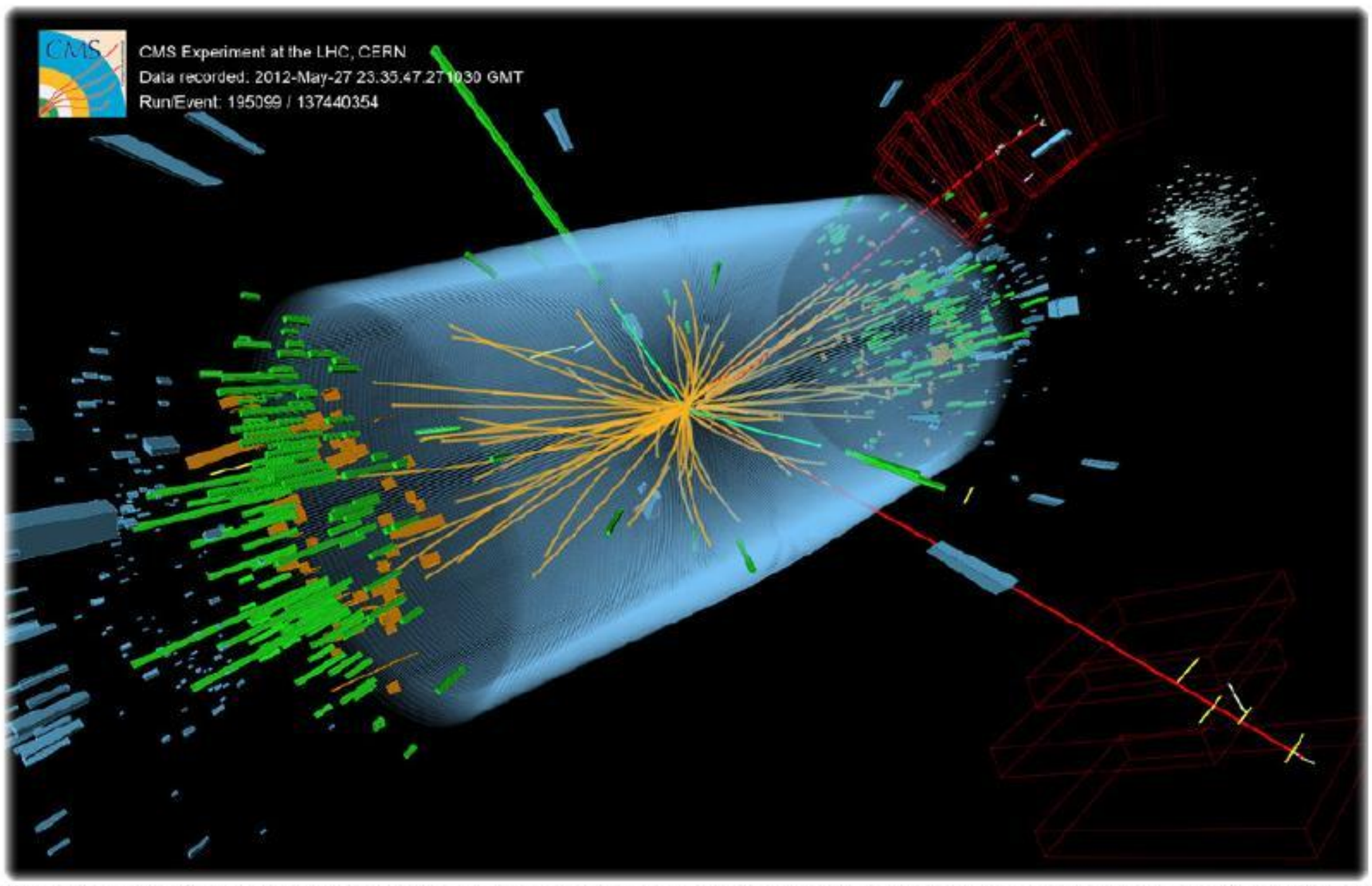
ACTIVITIES OF STUDENTS ENGAGEMENT PROGRAM

SAINT ANTHONY
Talk on Understanding the Electricity Crisis

KINNAIRD COLLEGE
School Coordinator Recruitment session

Science News

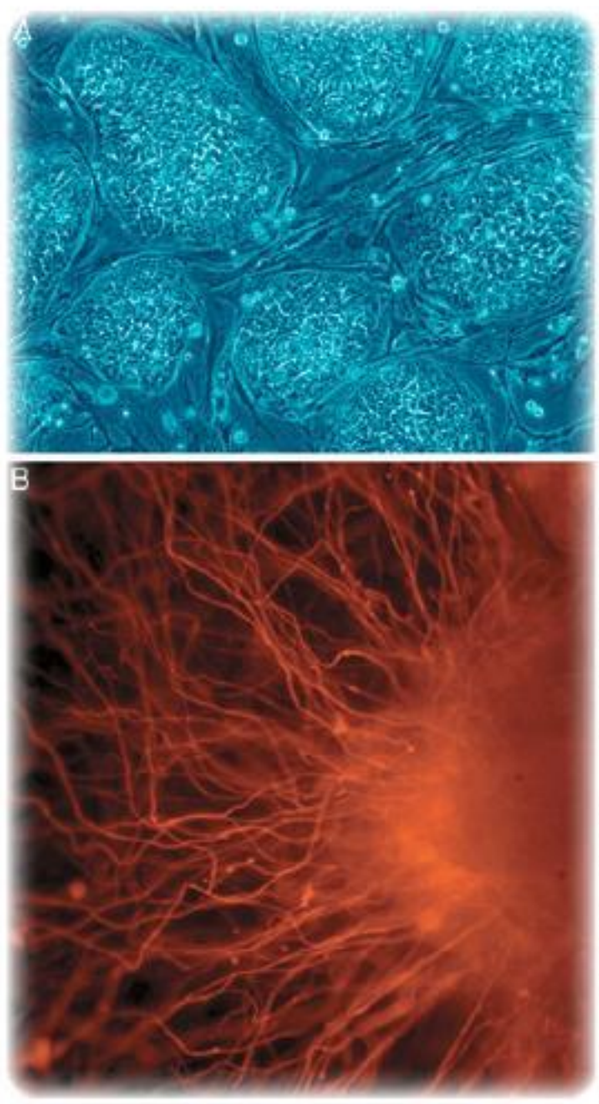
A 50 year long hunt for the last piece of the physics', most remarkable and nearly complete description of the universe, the Standard Model, came to a remarkable end when the Higgs particle finally showed up in the Large Hadron Collider. One of the major purposes of the six-billion dollar apparatus was to look for the elusive Higgs boson, which was the only particle that has been predicted by the Standard Model, all the way back in the 60s, but, had eluded discovery until now. Even after the detection of the particle by the "A Toroidal LHC Apparatus" (ATLAS) and "Compact Muon Solenoid" (CMS) at LHC, the process of confirming the discovery turned out be a rather tedious one, keeping physicists and enthusiasts all around the world at the edge of their seats, for almost an entire month. Following a seminar conducted by CERN to discuss the latest finding at LHC on 22nd June, 2012, which was also attended by Peter Higgs, the rumor mill took over the media and skepticism, the physicists. Having been witness to many such episodes before, it was suspected by the physics community that this too will eventually turn out to be either just another rumor or, at best, another discovery of a weak signal, with no formal discovery. However, on 4th July both CMS and ATLAS announced the discovery of a boson which looked strikingly like



Event recorded with the CMS detector in 2012 at a proton-proton centre-of-mass energy of 8 TeV. The event shows characteristics expected from the decay of the SM Higgs boson to a pair of Z bosons, one of which subsequently decays to a pair of electrons (green lines and green towers) and the other Z decays to a pair of muons (red lines). The event could also be due to known standard model background processes. *Image: CMS LHC*

the Higgs boson, with an accuracy just short of the established standards for the announcement of a confirmed discovery. The two teams had been working 'blinded', that is, without any exchange or discussion of findings between them, providing an additional layer certainty between them. Going a step further, on 31st July both ATLAS and CMS improved their analyses exceeding the required level of accuracy for a discovery, by a large margin.

Stem-cell research has long been at the forefront of regenerative medicine. It promises to provide an unparalleled ability to replace or regenerate cells, tissues and organs to reestablish their normal functioning in the human body. There had been, until, now no way to know whether a stem cell in the body will take the form of a specific cell type or remain unchanged as a stem cell. This difficulty arose from the fundamentally incomplete understanding of the mechanisms of stem cell differentiation process. Now a team of molecular biologists at the University of Georgia have for the first time provided a complete and consistent picture of how stem cells are wired to respond to the external signalling molecules to which they are constantly exposed. Led by Dr. Stephen Dalton, Georgia Research Alliance Eminent Scholar of Molecular Biology and Professor of Cellular Biology at University of Georgia, Franklin College of Arts and Science, the group's findings reconcile years of conflicting results from labs across the world, giving scientists the ability to precisely control the development, or differentiation, of stem cells into specific cell types. The previous paradigm held that individual signalling molecules acted alone to set off a linear chain of events that control the fate of cells. Dalton's study, on the other hand, reveals that a complex interplay of several molecules controls the "switch" that determines whether a stem cell stays in its undifferentiated state or goes on to become a specific cell type, such as a heart, brain or pancreatic cell. Dr. Marion Zatz at the National Institute of Health (NIH) says,



Human embryonic stem cells
A: Cell colonies that are not yet differentiated
B: Nerve cell
Image: Wikimedia

"This framework ultimately should not only advance a fundamental understanding of embryonic development, but facilitate the use of stem cells in regenerative medicine".

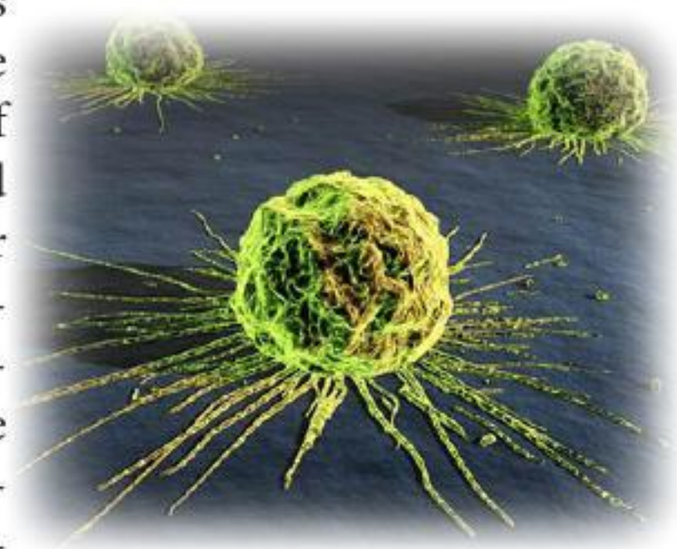
Curiosity, NASA's fourth unmanned mission to Mars, successfully landed on its surface on 6th August, 2012, around 10 am PST. This exceedingly advanced piece of machinery started its journey from Cape Canaveral on 11th November, 2011, abroad the Mars Science Laboratory spacecraft. In terms of capability and scope of investigation Curiosity leaves it predecessors far behind. Carrying with it 80 kilograms of scientific instruments, almost 10 times as massive as its immediate predecessor, the Mars Exploration Rovers,

sent in 2003, the equipment on board is not only plentiful but also the most advanced payload ever carried to Mars. Constituting an advanced analytical laboratory, the equipment includes 17 cameras, a gas chromatograph, mass, tunable laser and X-ray spectrometers, X-ray diffraction and fluorescent instruments, and a laser vaporizing "gun", among many other instruments. Powered by the energy given off in the radioactive decay of the radioisotope plutonium-238 carried aboard, this energy source will give Curiosity a whole Martian year (687 Earth days) of mission lifespan. These gadgets will allow Curiosity to perform geological tests, chemical tests of the atmosphere and geological samples collected and acquire high definition photographs and video sequences of characteristics features on the Martian surface. The overarching science goal of the mission is to assess whether the landing area has ever had or still has environmental conditions favorable to microbial life, both its habitability and its preservation.

A new strain of genetically engineered mosquitoes is being developed at a British insect control company named Oxford Insect Technologies (Oxitec), the project holds immense potential for improving hundreds of millions of lives. The engineered mosquitoes are made to transmit a gene during the reproductive cycle which kills its own offspring. Upon release in an environment, these mosquitoes mate with the females mosquitoes in the area, transmitting along the "defective" gene, thus bringing an end to their entire population in the region. Such strains have already been introduced in the Cayman Islands, Malaysia and Brazil on an experimental basis and have proved to be remarkably effective. Now the technique is being adapted to control the population of Aedes aegypti, the primary carrier mosquito of the virus that causes dengue fever. There are, however, grave of concerns in the educated circles, about these modified insects being released into the open. It is being asked, what would the adverse effects be, associated with the flow of such newer genes into the wild population, the possible effects on human health, the potential for viruses to evolve into more virulent forms, the impacts on human immunity and hence cases of disease, whether other species of mosquito (transmitting the same or different diseases) might occupy the ecological niche vacated by a falling population of the target species, etcetera. Probably anticipating such apprehension, and complete opposition from the anti-genetic modification "lobby", the field tests for the mosquitoes were conducted in secret, only being announced a year after the fact. Such secrecy in scientific trails only damaged Oxitec's credibility further, sparking an international controversy and debate, looking into the intentions behind the project and its direct and indirect consequences.

A genetically engineered mosquito
Image: Oxitec

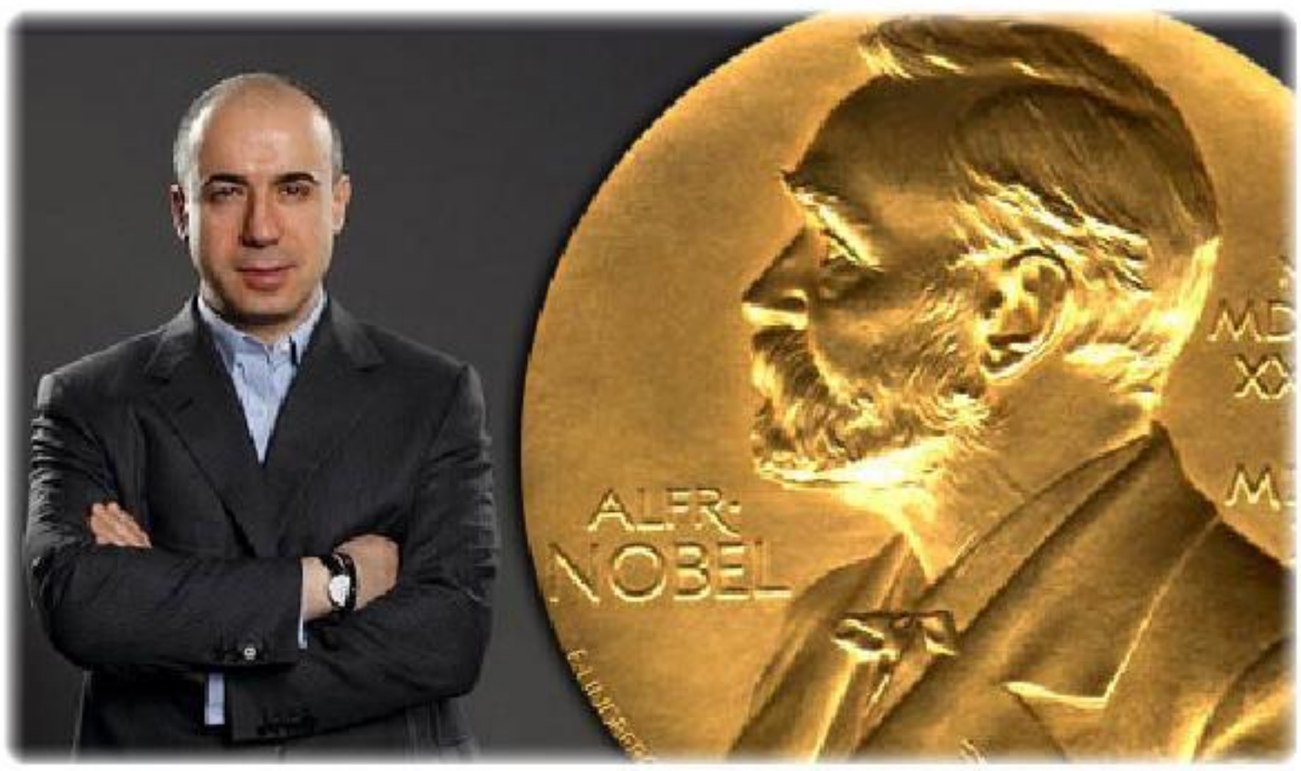
New research by professors from Tel Aviv, Rice, and Johns Hopkins universities has opened up a new avenue in the field of cancer research. The researchers have suggested targeting the cancer cells' 'social network' in order to disrupt communication within the cancer mass. In a study that draws parallels between the behaviour of bacteria and that of cancer cells, the authors have adumbrated the role that mutual communication and cooperation play in cancer progression. For example, it was found that 'spy' cells are sent out to corral information about distant tissues. The spread of



A "social" network of cancer cells

metastases is then planned with the help of this information. Also, cancer cells can enslave nearby healthy cells, forcing them to do the disease's bidding — providing physical support, protecting them from the immune system, and more. Cancer cells can also become dormant when they sense danger, such as chemotherapy chemicals, then reactivate at will. The researchers suggest the cancer cell social network may provide a useful target for novel therapeutic approaches, such as a drug that targets cell-to-cell communication. Moreover, breaking the communication code for awakening dormant cells could help researchers learn how to reactivate them on purpose — and be ready to kill them as soon as they "awaken." Another aspect of cancer activity with the potential to be exploited is 'cancer cannibalism', whereby when cancer cells run out of resources, they start consuming each other. Signals that trigger such behaviour could be sent out artificially, according to the researchers.

This seems to be a great year for physicists, and especially the theorists. As if a discovery of the decades was not enough, it seems now, theorists will be rolling in the riches. Dwarfing the established giants of awards in physics like the Nobel Prize, Kavli Prize and the Shaw Prize, a Russian, Silicon Valley billionaire, by the name of Yuri Milner has established a new Fundamental Physics Prize with a winning purse worth a whopping 3 million US dollars for each winner. On 31st July, 2012, the Milner Foundation announced the launch of a not-for-profit organization, the Fundamental Physics Prize Foundation, with the stated objective of:



Yuri Milner standing along side an englarged picture of the Nobel Prize gold medal

"advancing our knowledge of the Universe at the deepest level by awarding annual prizes for scientific breakthroughs, as well as communicating the excitement of fundamental physics to the public".

Yuri Milner, a theoretical physicist turned entrepreneur, venture capitalist, and, a billionaire, Milner says theoretical physics has always remained "close to my heart" ever since his days as a graduate student working on quantum chromodynamics, first at the Moscow State University and later at the Russian Academy of Sciences. In its inaugural year, Milner chose the nine recipients of the award himself, only later adding the legendary Steven Weinberg to the board of the foundation. The list of awardees includes theorists who have made fundamental and groundbreaking contributions in the field but have not be awarded the Nobel as of yet. Milner says past recipients of the Fundamental Physics Prize will form the Selection Committee to select recipients of future prizes. The foundation also announced a "New Horizons for Physics Prize", worth $100,000, for young researchers which can be awarded at any time in the year but only in exceptional cases. Distinctive features of the award include no requirement of experimental proof for the award, no age restrictions and nominations open to all.

Final Year Projects

Laser Eavesdropping

Introduction

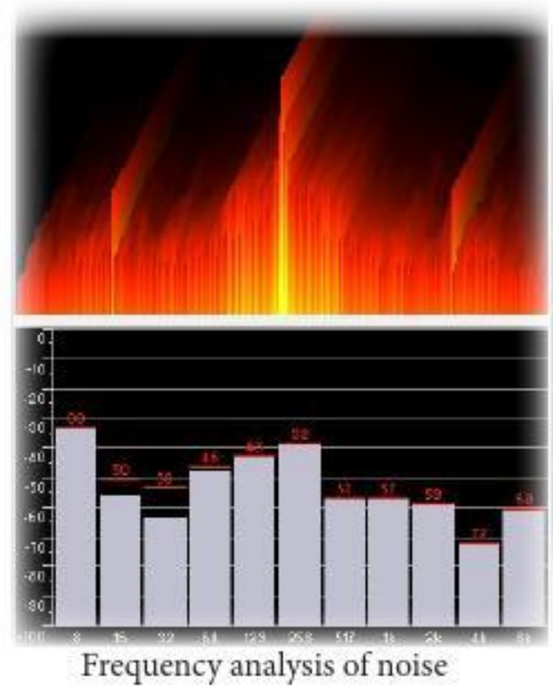
The purpose of this project was to create a device which along with other things can act as an eavesdropping device that operated by pointing a laser beam at a window and reconstructing the audio of a conversation on the other side of the window.

Objectives

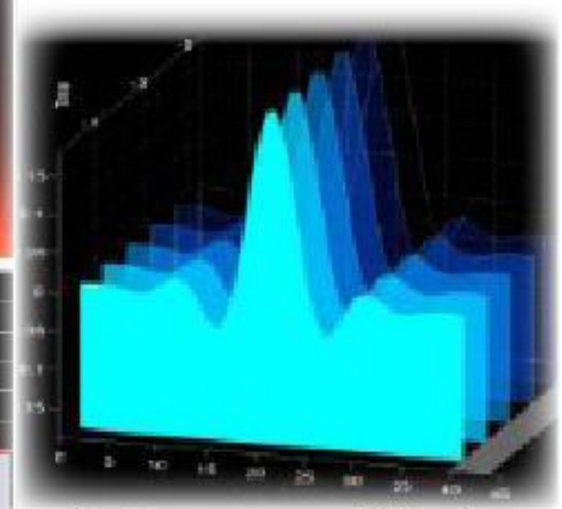
The core objective of this project was to create a remote audio surveillance device, such a device which would allow the user to listen to a remote conversation, without ever having to infiltrate the premises. Thus the objective of this project was to design and implement a mechanism which would use the surfaces close to speaker as a microphone and based on the changes detected on the surface because of sound, is able to read the changes and is able to reproduce the original sound causing that surface to vibrate.

Strategy

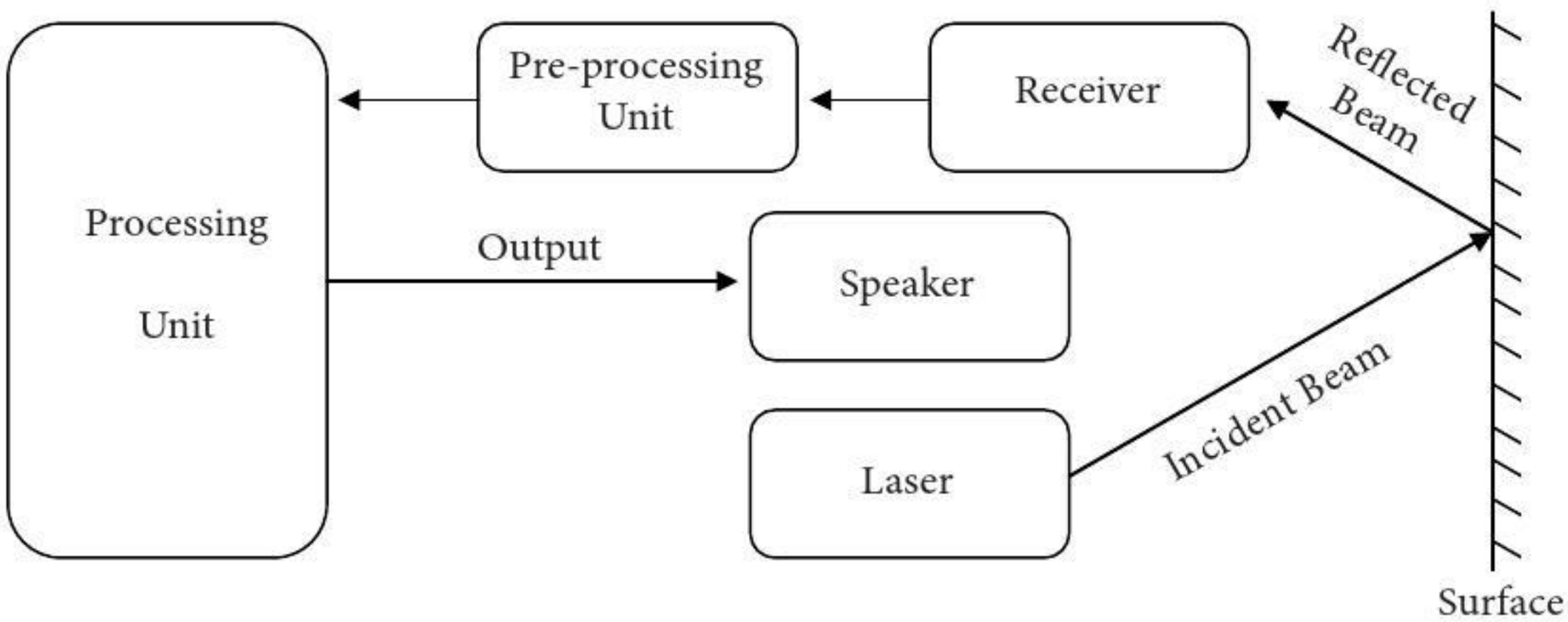
Light may function as a detector for acoustic waves by detecting inflections of a reflective surface near the source of speech, such as a mirror, or more commonly a window. The window functions as the membrane of a typical microphone. Microphones use a membrane to translate the acoustic waves as a product of speech into an electrical signal, either through changes in capacitance of the membrane (condenser) , physical movement of the membrane (dynamic microphones) or by using a piezoelectric device. Similarly when a laser beam is incident on a surface vibrating because of sound, the incident angle keeps on changing. This change in the angle of incidence results in displacement of reflected beam about a mean position. Measuring this displacement and the change in beam's intensity can be used to regenerate the desired sound.



Frequency analysis of noise



Frequency response of adapative filter



Group Members:
Ahtisham Sikandar
Amaid Zia
M. Waqar Chugtai

Advisor:
Dr. M. Junaid Mughal

Co-advisor:
Dr. Adnan Noor

Final Year Projects

Semi-autonomous quad rotor

Introduction

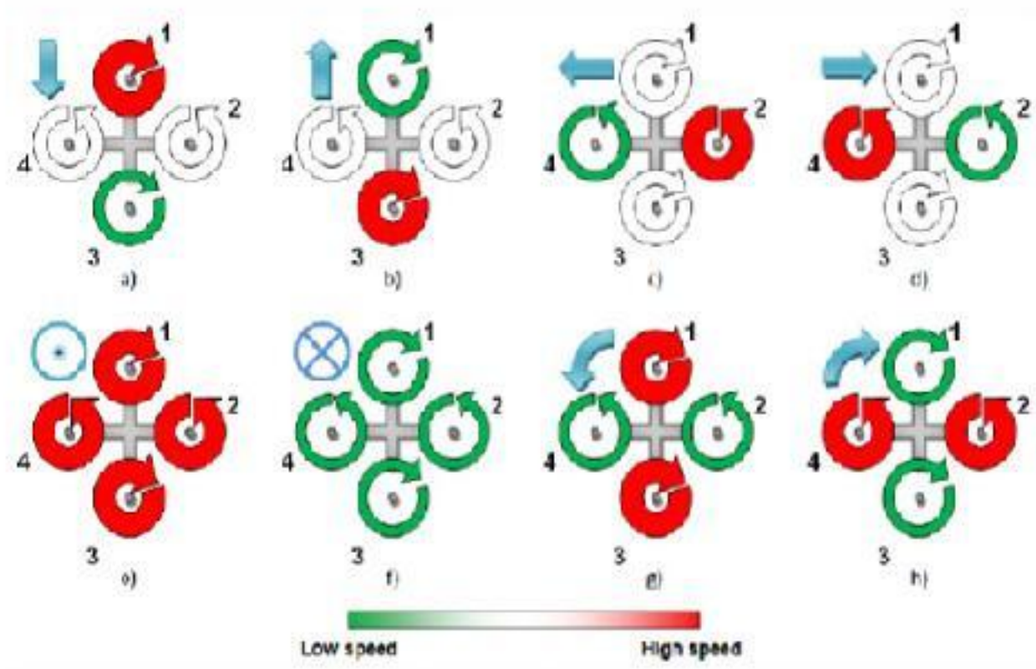
The project was aimed at creating a semi-autonomous quad-rotor Unmanned Aerial Vehicle (UAV), which is an aircraft capable of flight without an on-board operator. Such vehicles can be controlled by an operator on ground (semi-autonomous mode) or via a pre-programmed flight path (fully autonomous mode).

Objectives

The primary objective of the project was to develop a quad rotor and its control system to maintain its stability for conditions including hovering and basic translational motion. The goals of the project were the selection and acquisition of appropriate components, integration of various components, data acquisition from sensors, Kalman filtering and implementation of PID Control System. Ultimately, a quad rotor was an intricate blend of mechanical, electrical, sensing, and control systems.

Design

The quad rotor consists of a carbon fiber hub with four aluminum arms, and is infused with an Inertial Measurement Unit (IMU) and a range finding sensor. Incorporated in the vehicle is a closed loop, proportional control system which measured in-flight dynamics using a tri-axial gyroscope and tri-axial accelerometer, both part of the IMU.



Various movements of a Quad rotor

Strategy

Each rotor in a quad rotor is responsible for a certain amount of thrust and torque about its center of rotation, as well as for a drag force opposite to the rotorcraft's direction of flight. Propellers of the quad rotor are divided in two pairs, two pusher and two puller blades, that work in contra-rotation. As a consequence, the resulting net torque can be null if all propellers turn with the same angular velocity, thus allowing for the aircraft to remain still around its center of gravity. Moreover, contrary variation of speeds in propellers can lead to forward, backward and lateral translations. Yaw is induced by mismatching the balance in aerodynamic torques. Data provided by on-board sensors is fed into the microcontroller which guides the quad rotor accordingly. PID control system was implemented on the Arduino microcontroller to stabilize the quad rotor during flight.

Group Members:
Anwar Farid
Arslan Ghazi
Ashar Nisar
Muneeb Mansoor
Shaheer Latif

Advisor:
Dr. Nisar Ahmed

Co-advisor:
Dr. Suleman Ashraf
(Director SATUMA)

GIKI Science Society

The seed of GIKI Science Society was laid to disseminate structured knowledge while stirring up the scientific curiosity of youth. It is one of the most active societies in Ghulam Ishaq Khan Institute of Engineering Sciences and Technology. It has always played an important role in the extra-curricular culture of the institute.

GIKI SCIENCE SOCIETY'S ACTIVITIES

The seed of GIKI Science Society was laid to disseminate structured knowledge while stirring up the scientific curiosity of youth. It is one of the most active societies in Ghulam Ishaq Khan Institute of Engineering Sciences and Technology. It has always played an important role in the extra-curricular culture of the institute.

ALL PAKISTAN SCIENCE FAIR

Every year, society hosts one of the most anticipated events of the country. All Pakistan Science Fair attracts participants from across the nation. 14th organization of the event witnessed the launch of several new modules. Participants compete for the coveted trophy in a multitude of challenges designed to test their knowledge and understanding of history, theory and practical applications of science. Science Exhibition adds more diversity by showcasing unique projects designed by participating teams.

SCIENCE KASOTY

Teams are supposed to guess the personality and invention while being provided the hints needed. The more hints a team demands, the less marks it gets for a successful guess. Moreover, it also includes Dumb Charades, in which a member is required to communicate to other team members the name of an invention or scientific phenomenon without using the vocal ability. Further levels include category and speed rounds.

SCIENCE EUREKA

Undoubtedly, all the great minds in science loved experiments. The module is aimed at challenging and enhancing contestants' experimental skills. This is a team based event where each team comprises of three students. Each team is given a problem for which it has to design an experiment using simplest approach and minimum apparatus is used. The winner is decided on the basis of approach used towards the problem and the viva taken by the judges.

GIKI SCIENCE SOCIETY AT A GLANCE

SCIENCE MARATHON

The revamped Science Marathon strikes with a story line, which may be based on historical facts and figures. Alternatively, it may leap into the mysterious world of future. Each clue guides participants to the next destination and unlocks the riddle to demystify the final puzzle. While exploring the scenic views of GIKI, contestants end up having a great experience.

SCIENCE AURORA MAGAZINE

GIKI Science Society publishes the magazine you are reading, named "Aurora". It contains articles and essays not only specific to the general sciences but also caters the latest inventions, scientific theories and upcoming technological developments. It also contains research papers of renowned professors, an interview of an eminent Pakistani scientist and final year project abstracts of students in GIKI. It is not only distributed among the students of institute but also to the major universities and R&D organizations of the country.

ASTRONOMY NIGHT

Astronomy Night is one of the most interesting events organized by GIKI Science Society. Telescopes make their way to the institute to provide students with the eyes to witness the beauty of astronomical objects in space. Informative lectures on astronomy and space sciences are also arranged which are delivered by renowned space scientists of the country. An active participation of students is seen in this event.

PROJECT HAMMERHEAD ARC

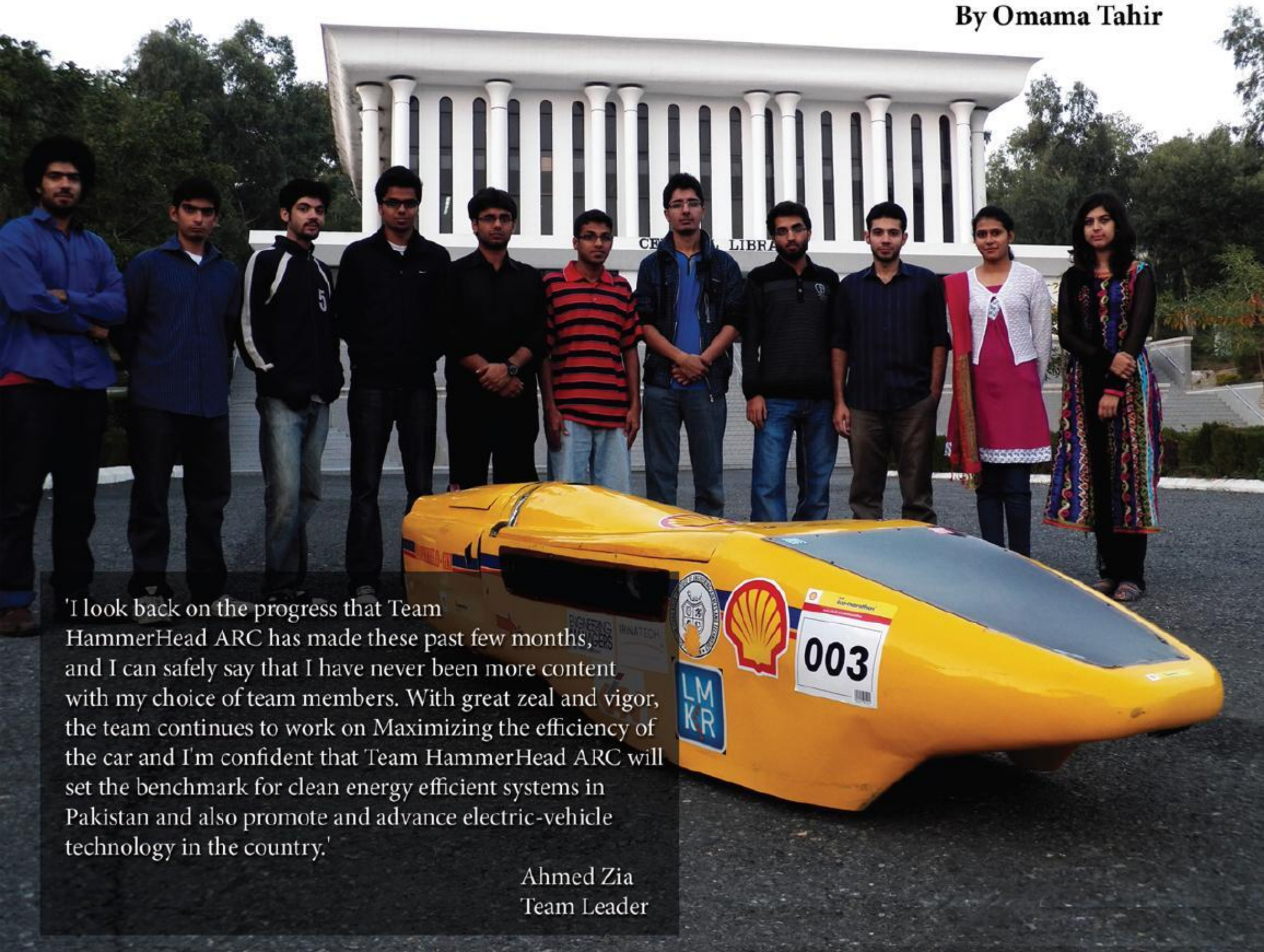
Knowing the health hazards that are faced due to increase in pollution caused by greenhouse gas, team Hammerhead Arc decided to build an electric car rather than conventional internal combustion engine automobile. The car uses electric battery. It has simple but efficient design. The framework which supports this piece of engineering is a custom-made lightweight aluminum chassis which weighs only 4.5 kilograms. Two-way Joystick Steering Mechanism ensures improved maneuverability and greatly enhances visibility from inside the car. This simple car is not more than 40kg and can achieve speed as high as 48km/hr. It may not be very high when compared with the cars using combustion engine, but when considering the simplicity of its design and the need of competition, it is sufficient.

Electric Cars In Pakistan

Pollution in Pakistan is increasing day by day which is causing serious health problems. Pakistan being developing country cannot afford to spend billions on importing medicines for the disease which can be prevented just by taking small measures. Moreover, we are suffering from shortage of natural resources. In such scenario, it is not smart to keep going on the same track.

It is the need of the hour to introduce electric cars in this region for fulfilling the requirements of the large population residing here. Team Hammerhead Arc consisting of responsible members of the community, decided to work on this project. And they proved that using electric cars is not only practical but economical too. In fact it is the best solution one can have for saving fuel as well as the environment.

By Omama Tahir



'I look back on the progress that Team HammerHead ARC has made these past few months, and I can safely say that I have never been more content with my choice of team members. With great zeal and vigor, the team continues to work on Maximizing the efficiency of the car and I'm confident that Team HammerHead ARC will set the benchmark for clean energy efficient systems in Pakistan and also promote and advance electric-vehicle technology in the country.'

Ahmed Zia
Team Leader

GIKI SCIENCE SOCIETY

SCIENCE

AURORA

GIKI Science Society

Send us your feedback and suggestions | aurorathemag@gmail.com