

The background of the entire page is a solid black. On the left side, there is a dense, swirling mass of thin, vibrant lines in various colors including magenta, cyan, yellow, and red. These lines curve and loop, creating a sense of dynamic movement. Scattered throughout the black space are small, isolated dots and short strokes in the same color palette.

Encouraging the spirit of research

5th
Anniversary

INFOSYS SCIENCE FOUNDATION



R. A. Mashelkar

*National Research Professor; Chancellor,
Academy of Scientific and Innovative Research;
President, Global Research Alliance,
CSIR-National Chemical Laboratory*

Science is an endless frontier. It is a human activity without limits. Advancing this frontier requires intensive and extensive fundamental research. India's contribution to this endeavor in recent times has been a matter of much concern. With around 16% of the global population, India's share in the world output of scientific research publications is only 2%. Of course, some might say, that this 2% share is achieved with only 0.5% of global spend on R&D. But that is not of much comfort, since other countries have moved ahead much faster.

Let us consider, for instance, India and China. In 1980, the research papers from China were one-fifteenth of the research papers produced in India. By 2005, research papers from China had almost tripled! During 1995–2005, the papers from India increased by 2.5 times, China's had gone up ten-fold. The R&D spending by China had increased from 0.8% to 2% of GDP by 2011. India has continued to spend around 0.9% of GDP on R&D, over the past two decades.

"There is evidence to suggest that young Indian scientists from Cambridge, Harvard, MIT, Caltech and similar reputed institutions are returning to India. One is sensing a movement from brain drain to brain gain, to brain circulation, helped again by the attractive National Fellowships that have been set up to bring back our brightest scientists. But, I must say, one of the best news for Indian science has been the Infosys Prize."

India needs to recreate the magic of the 1920s and 1930s in Indian science, where we saw the likes of Srinivasa Ramanujan, C. V. Raman, Meghnath Saha, S. N. Bose, J. C. Bose, etc., scale new heights, which surpassed the best in the world. For this, we need to move on multiple fronts with speed and determination.

First, the future of science in India will depend on getting the best minds in India to opt for science. We have to place a very heavy emphasis on radical reforms in school science education, while changing the pedagogy of science teaching methods, creating exciting science curricula, attracting the best talent for teaching science with special incentives for the most inspiring science teachers.

Second, the best minds that study science should stay in science.

At the school-learning level, there is a great enthusiasm for science. Indian students out-perform those from advanced nations in international science olympiads, winning several gold medals.

Unfortunately, these gold medalists do not stay in science. We have to do everything possible to see that they continue to love science, live science and live for science.

Third, in science, technology and innovation, India has built physical as well as intellectual infrastructure but it needs to be made world-class. We need to create an environment which provides for flexibility and freedom to think and act. This means complete eradication of bureaucracy, elimination of mediocrity, worship of excellence and rewards for performance with world-class benchmarks.

Fourth, we should remind ourselves always that teaching without research is sterile. Education disseminates known knowledge, research converts money into knowledge and innovation converts knowledge into money. In the Indian context, this connect between Saraswati (Hindu goddess of learning) and Lakshmi (Hindu goddess of wealth) is missing. Every effort should be made to create that connect by linking education, research, innovation and entrepreneurship. This would mean some cultural shifts, where wealth creation through knowledge is valued and supported through instruments such as incubators, technology parks, 'ad'venture capital, innovation clusters, etc. These need to be provided on a scale and with a quality that will prove game-changing.

Although there are many concerns, there is plenty of good news too. The INSPIRE program launched by the Department of Science & Technology in India now draws close to a million bright young people into science, with schemes and very attractive incentives to ensure that they stay in science. For the first time, funding fundamental scientific research exclusively, a National Science and Engineering Research Board was created and it has begun functioning. Five new Indian Institutes of Science, Education and Research have been set up, with the hope of these becoming world-class centers of research. There is evidence to suggest that young Indian scientists from Cambridge, Harvard, MIT, Caltech and similar reputed institutions are returning to India. One is sensing a movement from brain drain to brain gain, to brain circulation, helped again by the attractive National Fellowships that have been set up to bring back our brightest scientists. But, I must say, one of the best news for Indian science has been the Infosys Prize.

I have been privileged to be a jury member for the Infosys Prize since the past four years. I have watched with pride this Prize grow and attain the status of a mini-Nobel prize. The selection is done by a selection committee comprising global leaders in science. With ₹55 lakh as a cash prize, not only is this the highest prize in rupee

value, but it is now the 'most valued prize' in India today. What is more, when there is an outcry that the corporate world does not do enough for science in India, Infosys as an iconic corporate leader, has been able to send a strong signal that Indian science matters to us and that we want to matter more to Indian science.

This book is valuable for several reasons. It provides us with the essence of the great work of the Infosys Prize laureates, in a language that is simple. It serves as a great inspiration for budding scientists, while giving them a feel about the very best in Indian science. Finally, it also projects before the rest of the world the best of Indian science done by its stars.

I congratulate all those who are responsible for this elegant and impressive creation. When the history of Indian science is written, one can look at this book as one with supreme archival and inspirational value.

Contents

Quest for beautiful minds.	2
Engineering and Computer Science	4
Ashutosh Sharma.	6
Kalyanmoy Deb	7
Ashish Lele	8
V. Ramgopal Rao	9
Humanities	10
Amit Chaudhuri	12
Sanjay Subrahmanyam	13
Ayesha Kidwai.	14
Nayanjot Lahiri.	15
Life Sciences	16
K. VijayRaghavan	18
Chetan E. Chitnis	19
Imran Siddiqi	20
Satyajit Mayor	21
Rajesh S. Gokhale	22
Mathematical Sciences	24
Ashoke Sen	26
Chandrashekhar Khare	27
Kannan Soundararajan	28
Manjul Bhargava	29
Rahul Vijay Pandharipande	30

Physical Sciences	32
Thanu Padmanabhan	34
Sandip Trivedi.	35
Sriram Ramaswamy.	36
A. Ajayaghosh.	37
Shiraz Naval Minwalla.	38
Social Sciences	40
Abhijit Banerjee	42
Upinder Singh	43
Amita Baviskar	44
Nandini Sundar	45
Pratap Bhanu Mehta	46
Raghuram G. Rajan	47
Arunava Sen	48
Aninhalli R. Vasavi	49
Of origins and journeys.	50
Bibliography	51



ISF@infosys.com

www.infosys-science-foundation.com

Quest for beautiful minds

Human enterprise and intellect has been celebrated by the Infosys Science Foundation through the Infosys Prize (the Prize), since 2009. The Prize has grown in stature and is fast becoming the most coveted award for researchers.



Trustees of ISF

Unwavering support from ISF trustees has helped the Prize reach its fifth year milestone.



Infosys Prize
@InfosysPrize

We honor those who've made the quest for knowledge their life's calling and scientific excellence their pursuit. **N. R. Narayana Murthy**,
Trustee of ISF and Executive Chairman, Infosys Limited
[#InfosysPrize2013](#)



Infosys Prize
@InfosysPrize

Exploring the world of ideas furthers our understanding of the universe. We endeavor to honor such remarkable minds. **Srinath Batni**,
President, Board of Trustees, ISF and Member of the Board, Infosys Limited
[#InfosysPrize2013](#)



Prof. Raghuram G. Rajan

"India, as it comes of age as an economic power has to also become an intellectual power," says Prof. Raghuram G. Rajan, winner of the Infosys Prize 2011 and Governor, Reserve Bank of India.

Awardees receive a gold medallion, a citation and a prize purse of ₹55 lakh (increased this year from the previous, ₹50 lakh). Prof. Aninhalli R. Vasavi says, "The Prize will make a difference. It's come at the right moment when our work needed recognition and the funds will give us some assurance and financial security."



Prof. Aninhalli R. Vasavi



Infosys Prize
@InfosysPrize

We want winners to benefit from the prize money. Indian government supported the Prize, making the sum, tax exempt. **V. Balakrishnan**,
Trustee of ISF
[#InfosysPrize2013](#)



Jury Chairs with Prime Minister Manmohan Singh

Jury Chairs with Infosys Prize 2012 winners. The Jury Chairs for the Prize includes stalwarts from various fields – Prof. Amartya Sen, Dr. Inder Verma, Prof. Pradeep Khosla, Prof. Kaushik Basu, Prof. Shrinivas Kulkarni, Prof. Srinivasa Varadhan and Prof. Subra Suresh (who stepped down after being nominated as Director of the National Science Foundation by U.S. President, Barack Obama).



Infosys Prize
@InfosysPrize

The wisdom, guidance and experience of our jury multiplies the inspirational power of the Infosys Prize. **T. V. Mohandas Pai**, *Trustee of ISF*
#InfosysPrize2013



Infosys Prize
@InfosysPrize

We engage with educational institutions, to involve the youth in an ongoing dialog about research. **K. Dinesh**, *Trustee of ISF*
#InfosysPrize2013

ISF also hosts insightful lectures and exciting events through the year. In her lecture, *Good to eat, good to think: Why we should study India's changing food culture*, Prof. Amita Baviskar, Associate Professor, Institute of Economic Growth, states, "The sociology and anthropology of changing agrarian economies still awaits our attention as does the study of self and personhood embodied in practices of consumption, as does the transformation of food into commodity forms."



Prof. Amita Baviskar



Prof. Michael J. Sandel

ISF works with academicians, researchers and students globally, to promote the spirit of enquiry. In his *Justice Lecture Series*, Michael J. Sandel, Anne T. and Robert M. Bass Professor of Government, Harvard University says, "Democracy involves a certain amount of cacophony. It is not neat and tidy. And yet, the arguments that we have do have a certain shape. We can identify certain philosophical principles and when we do, if we do, we can do a better job of respecting one another."



Infosys Prize
@InfosysPrize

Aspiring scholars need encouragement. The ISF Lecture Series lets them interact with laureates and learn more. **S. D. Shibulal**, *Trustee of ISF, CEO and Managing Director, Infosys Limited*
#InfosysPrize2013



Infosys Prize
@InfosysPrize

The Prize can inspire the next generation of thinkers. Support from academia, media and the public will make this possible.

K. Gopalakrishnan, *Trustee of ISF and Executive Co-Chairman, Infosys Limited*
#InfosysPrize2013

The Prize celebrates those who storm new frontiers, be it to create novel materials, find solutions, invent cures for deadly diseases or further discourse that enriches the standard of life and living. Speaking on the impact of the Prize, Prof. Ashish Lele, Scientist at the National Chemical Laboratories, Pune and Infosys 2012 winner says, "In the research that I'm doing on hydrogen fuel cells, when the media came to me after the Prize was announced, I talked about fuel cells. A lot of companies who read it came to me saying they would be interested in collaborating with us in developing this technology."



Prof. Ashish Lele

"Our future relies directly on how people who are young today are going to mature and become adults. How they are going to behave and what is it that they are going to do. We have to motivate them and to motivate them we need to have examples of people who have accomplished something."

Pradeep K. Khosla

Jury Chair, Engineering and Computer Science, and Chancellor, University of California, San Diego, U.S.





"We are probing materials at a deeper level, looking at how patterns arise in nature, and the inspiration for that comes from art, and we translate that question into the language of science, and we ask questions like — how do small-scale patterns form in nature and in technology?"

Ashutosh Sharma

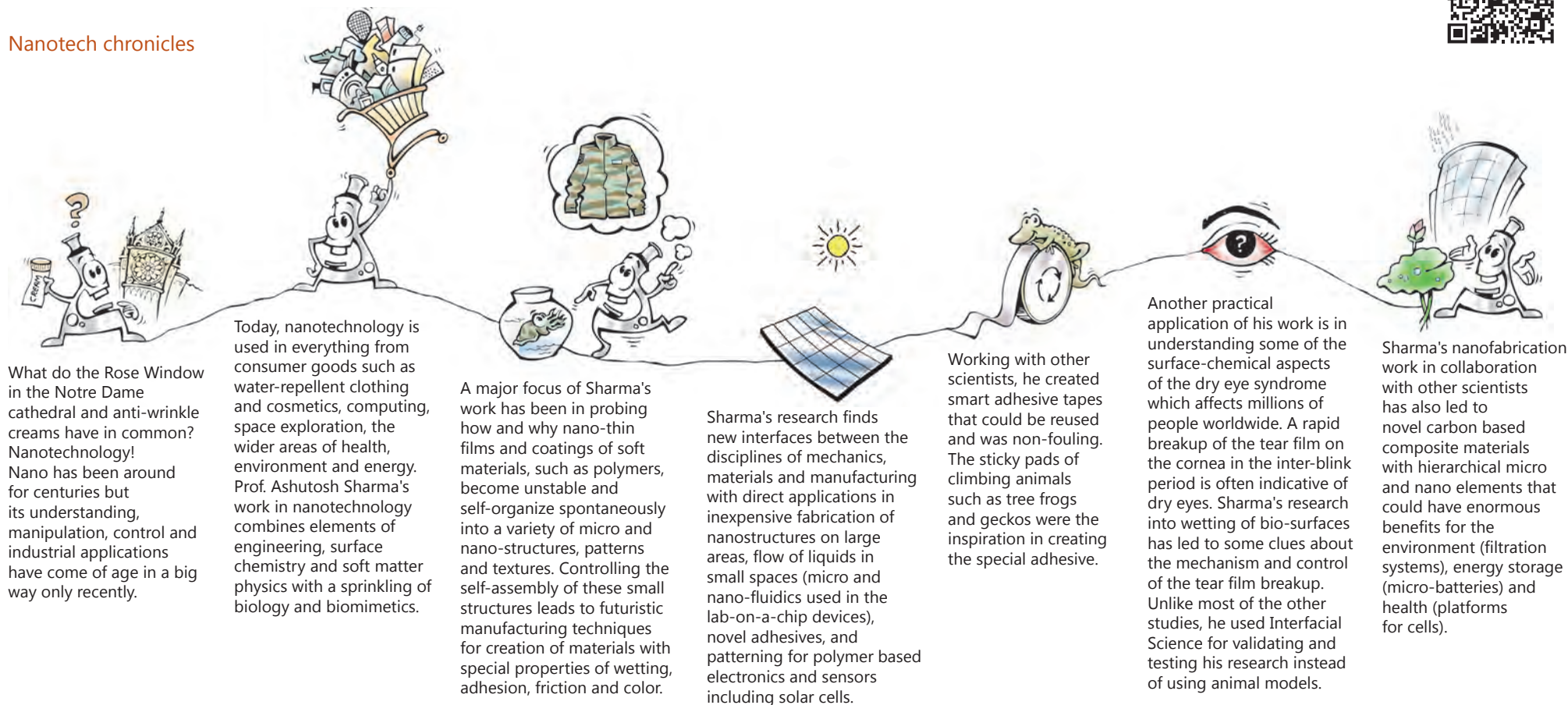
Institute Chair Professor and C. V. Seshadri Chair Professor and Coordinator, DST Unit on Nanoscience & Center for Environmental Science and Engineering, Indian Institute of Technology, Kanpur

- B.Tech. in Chemical Engineering from the Indian Institute of Technology, Kanpur
- M.S. in Chemical Engineering from Pennsylvania State University
- Ph.D. in Chemical Engineering from State University of New York, Buffalo

Prof. Ashutosh Sharma has made scholarly scientific contributions in the broad areas of nanoscale surface pattern evolution, instability, and the dynamics of thin liquid and solid films and soft matter. These scientific studies have provided fundamental contributions to the fields of surfaces and interfaces, adhesion, structure evolution, nanocomposites, and hydrodynamics.



Nanotech chronicles





"At some point, I think all of us should just stop and think — What is the big picture of my work? — And, when we do that, we come up with some really sweet spots that needed to be looked at. And then, the field progresses."

Kalyanmoy Deb

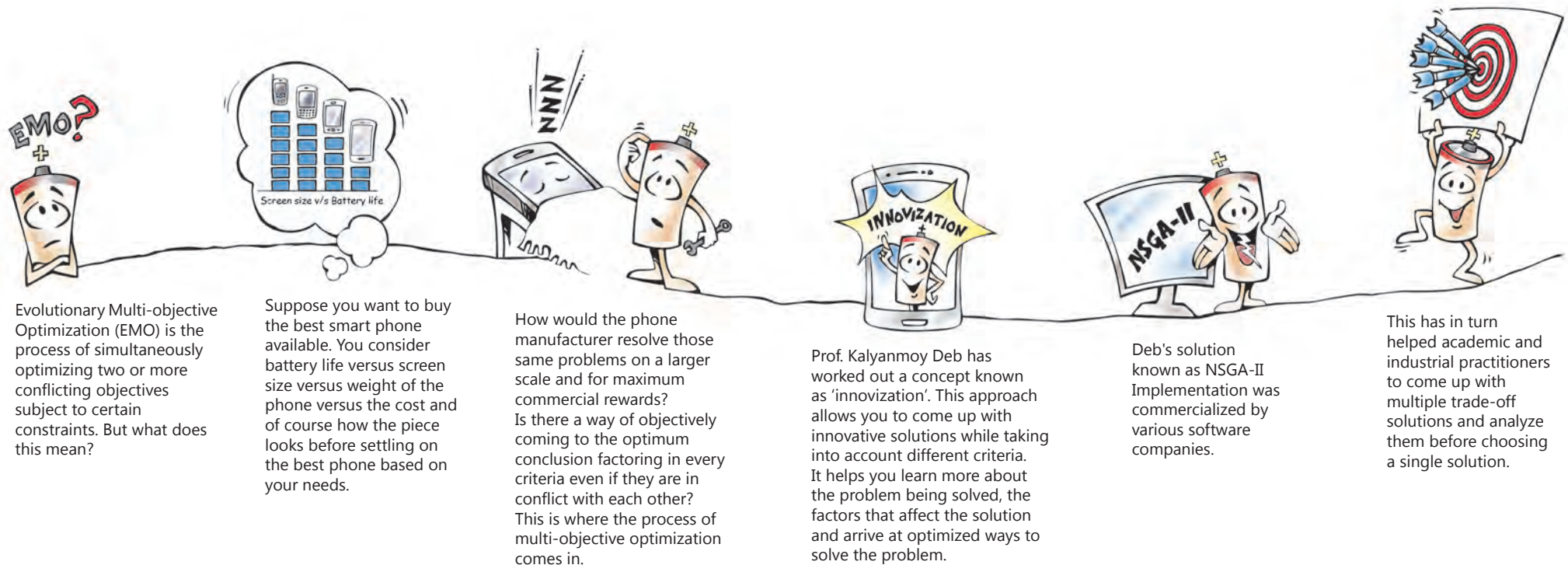
Professor and Koenig Endowed Chair, Electrical and Computer Engineering, Michigan State University

- B.Tech. in Mechanical Engineering from the Indian Institute of Technology Kharagpur
- M.S. in Engineering Mechanics from the University of Alabama
- Ph.D. in Engineering Mechanics from the University of Alabama

Prof. Kalyanmoy Deb has made fundamental contributions to the emerging field of Evolutionary Multi-objective Optimization (EMO), where his work has led to significant advances in the areas of non-linear constraints, decision uncertainty, programming and numerical methods, computational efficiency of large-scale problems and optimization algorithms.



Resolving the problem of conflicting goals





"I think the biggest challenge in my area of research is for scientists to leave their ivory towers and go out and see the real world, find relevant problems and apply their skills and expertise in material science to those problems."

Ashish Lele

Senior Principal Scientist, National Chemical Laboratory, Pune

- B.Chem. Eng. from the Department of Chemical Technology, University of Bombay
- Ph.D. in Chemical Engineering from the University of Delaware

Prof. Ashish Lele has made many novel and impactful contributions to polymer science and engineering. These include molecular tailoring of stimuli responsive smart hydrogels, new insights into the anomalous rheological behavior of complex fluids and the coupling of macromolecular dynamics and polymer processing.



Exploring the many uses of hydrogels



Imagine being able to wear eye glasses made of material that can self-repair scratches on their surface in response to light. Imagine being able to use a self-healing sticky substance to hold surgical implants in place instead of stitches. If you think this is science fiction, think again. Such substances are already found in nature and over the years, scientists have been trying to create them in laboratories.



Gels are materials composed of both a solid and a liquid component. When the liquid component is water, the gel is called a hydrogel. A hydrogel is usually composed of a polymer network. Polymers are large chain-like molecules made up of monomers which are smaller molecules. Hydrogels have super absorption capabilities, and are also highly flexible. They are similar to natural tissue.



Over the years hydrogels have found many uses in several areas especially in medical science. They are commonly used in cell culture, tissue engineering, and sustained release drug delivery systems. They are also used in everyday items such as disposable diapers to soak in more fluid.



Prof. Ashish Lele has worked extensively with hydrogels and has been probing the microstructures in polymeric materials at the molecular and mesoscopic (the intermediate length between microscopic and macroscopic) length scales.



Smart hydrogels are a type of hydrogel that have water swollen networks of cross-linked polymers that respond to stimuli such as temperature and electrical fields that leads to volume phase transitions. Prof. Lele's work revealed that under the influence of these stimuli, the cylindrical shape of the hydrogel changes spontaneously into a coconut-like structure, which is also reversible.



Prof. Lele's body of work has profound implications in the use of hydrogels as sensors and soft actuators, which are a type of motor for moving or controlling a mechanism or system. Soft actuators or organic actuators are made of organic materials such as hydrogels. These actuators are able to act on their external environment by changing input energy into mechanical work. These are extremely important in medical devices such as prosthetic limbs, as they improve their strength and performance.



"It is not always money which makes many people happy. There are of course people who may be happy seeing a huge bank balance. But for many of us the satisfaction is in doing something which can change lives, which can improve the life of a common man in our own country."

V. Ramgopal Rao

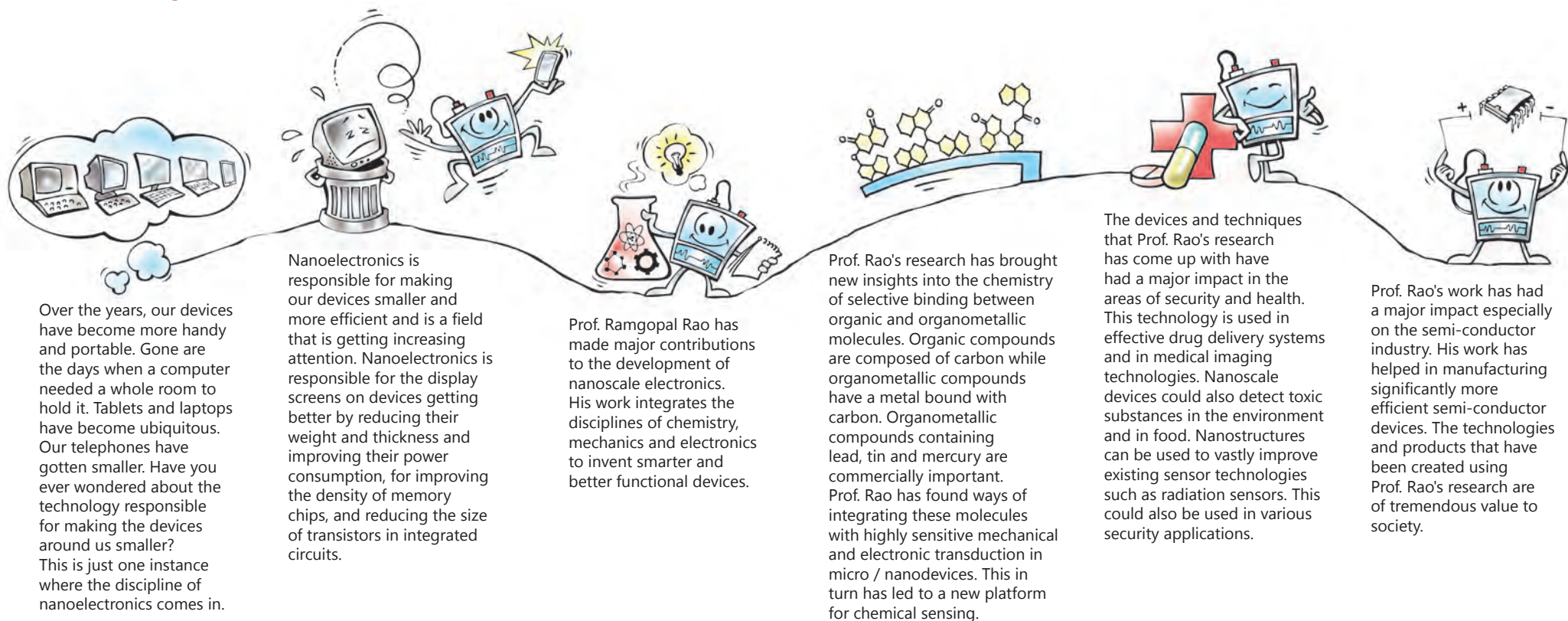
Institute Chair Professor in the Department of Electrical Engineering; and Chief Investigator, Centre of Excellence in Nanoelectronics, Indian Institute of Technology, Bombay

- B.Tech. from Kakatiya University, Warangal, Andhra Pradesh
- M.Tech. from the Indian Institute of Technology, Bombay
- Dr. Ingenieur from Universitaet der Bundeswehr, Munich
- Post-doctoral Fellow at the University of California, Los Angeles

Prof. V. Ramgopal Rao has made substantial contributions in the science and engineering of nanoscale electronic devices and their use in semiconductor integrated circuits, which has led to significant performance improvements and industrial impact. His leadership in nanoelectronics at the national level has enabled industry-academia partnerships that have led to growth of this industry in India.



Behind the magic of nanoscale electronics



Humanities



"The Humanities as a subject, a cluster of subjects complements the sciences. The sciences add to our knowledge in a more direct way and often translate into immediately realizable benefits in the long run. Humanities work rather more slowly. On the other hand, they also have a huge impact. First, to place science in the context of society and also to make people think about themselves and think about others in the context of themselves, and think about their country in the context of the world. And, in all these respects humanities have a very important role in broadening human life in a way that science has, but working in a somewhat different channel."

Amartya Sen

*Jury Chair, Humanities,
Thomas W. Lamont University Professor
and Professor of Economics and Philosophy,
Harvard University, U.S.*



Humanities – Literary Studies 2012



"The kind of criticism I write has gone against the grain of a lot of academic thinking about the role of criticism today – where the role of literature and criticism are seen to be important as a kind of adjunct almost to history and the social sciences and not primarily undertaken for literature itself. I have tried to grapple with this particular problem and also find an answer to it without ignoring it."

Amit Chaudhuri

Professor of Contemporary Literature, University of East Anglia, Norfolk

- B.A. in English from the University College London
- Ph.D. in Critical Theory and the poetry of D. H. Lawrence from Balliol College, Oxford

Prof. Amit Chaudhuri is one of India's foremost novelists and among its most widely-admired literary and cultural critics, and theorists. His literary research ranges from an early book on D. H. Lawrence to a recent book on Rabindranath Tagore, and a large number of critical essays on Indian and English Literature.



Explorations in literary criticism



Since the days of Plato, the field of literary criticism has seen the pleasure of language, form, content and style being studied and analyzed to better understand literature and the times we live in. Literary criticism goes to the heart of the question of what makes a piece of writing beautiful and allows us to appreciate that beauty better.



An internationally acclaimed novelist and literary critic, Prof. Amit Chaudhuri has been able to provide a deeper understanding of Indian and English literature to global readers. His literary criticism has been able to tease out the nuances, cultural contexts and complex literary sensibilities in works of literature.



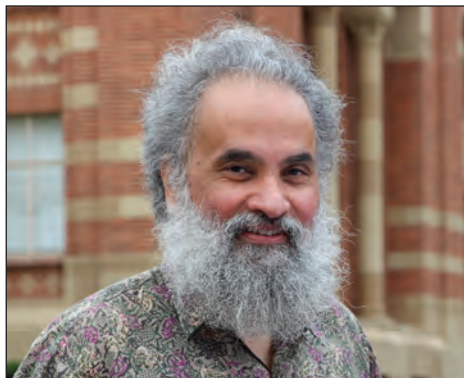
Prof. Chaudhuri takes particular interest in the pleasures of writing about the world we live in, whether he is writing a story, or writing about a story.



A widely-read essayist, Prof. Chaudhuri is persuasive in his writings, while using the creative medium to provide a scholarly understanding of what makes any form of literature engaging and effective. Prof. Chaudhuri began his endeavor as an original critic with a masterful exploration of the poetry of the English poet and writer D. H. Lawrence.



In his attempt to shed new light on Indian writing, Prof. Chaudhuri explored, among many other things, Rabindranath Tagore's poetry. Although Tagore's work had been studied and interpreted several times through the years, Prof. Chaudhuri helped us towards a new understanding of how the great poet remains imaginatively challenging today.



"I think it is very important to remember that first and foremost your history is a history as a human being. And, therefore your natural way of thinking of history should be of a human being living in the world, not as someone belonging to one country or another."

Sanjay Subrahmanyam

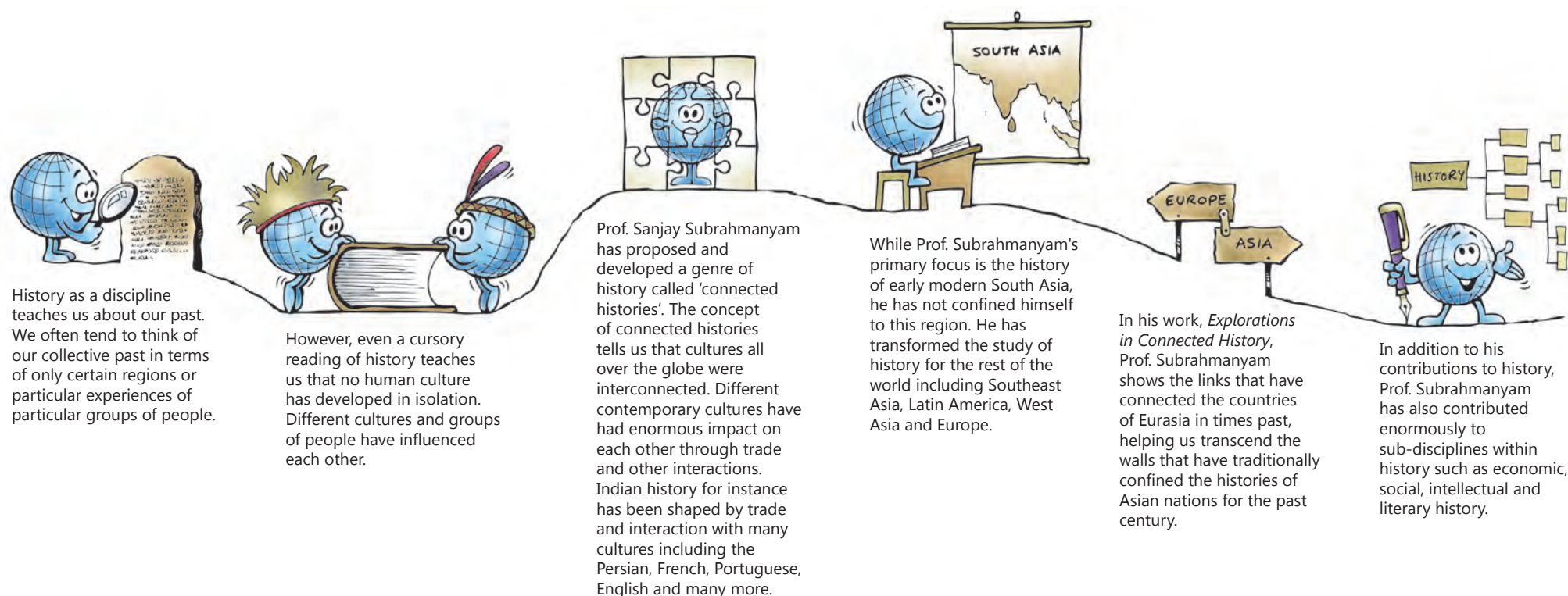
Distinguished Professor of History, and Navin and Pratima Doshi Endowed Chair, Pre-Modern Indian History, University of California, Los Angeles

- M.A. Economics from the University of Delhi
- Ph.D. in Economics from the Delhi School of Economics, University of Delhi

Prof. Sanjay Subrahmanyam has transformed the field of early modern history for South Asia, and for much of the rest of the world. His geographical reach extends from South Asia to Southeast Asia, West Asia, Europe and Latin America. He has also contributed to a wide array of historical sub-disciplines (economic, social, intellectual and literary history).



Framing the concept of connected histories





"My area of work is to look at the syntax of the world's languages, and living in India, it is to of course look at the syntax of Indian languages. By syntax we mean the arrangement of linguistic words or even units below the word, to be able to understand what underlies, or what constitutes the business of the human ability for language."

Ayesha Kidwai

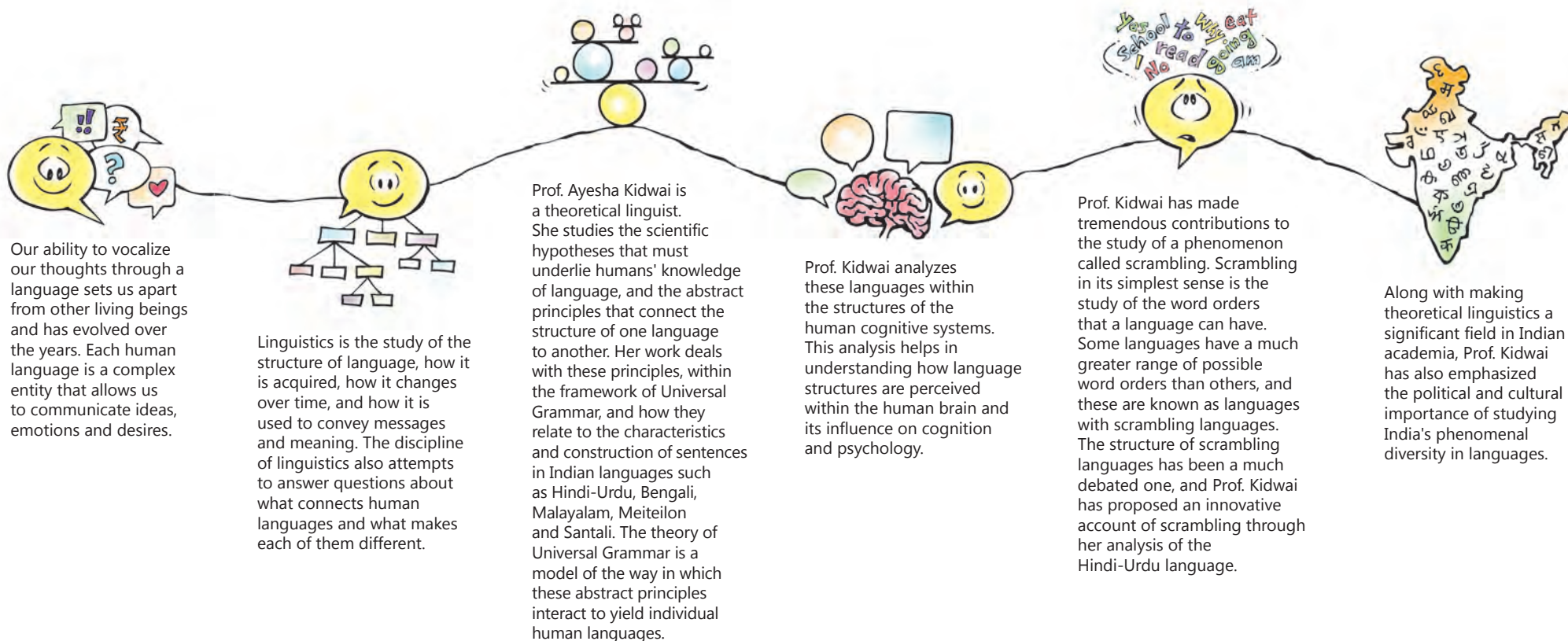
Professor, Centre for Linguistics, School of Language, Literature and Culture Studies, Jawaharlal Nehru University, New Delhi

- M.A. in Linguistics from the Jawaharlal Nehru University, New Delhi
- Ph.D. in Linguistics from the Jawaharlal Nehru University, New Delhi

Prof. Ayesha Kidwai is an outstanding theoretical linguist. Her work has earned recognition from leading international experts, as it relates the general theoretical framework of the principles of Universal Grammar to some of the particular syntactic features of Indian languages like Hindi-Urdu, Santali, Meiteilon, Bangla and Malayalam, analyzing these within the structures of human cognitive systems and their general properties.



Discovering the intricacies of Indian languages



Humanities – Archaeology 2013



"What I've tried to do is to get a sense of the past from what appears on the ground, from artifacts, from monuments, from mounds and related aspects of the material past. Along with this, very crucial to my own work has been understanding how my area of study (archaeology) has actually evolved."

Nayanjot Lahiri

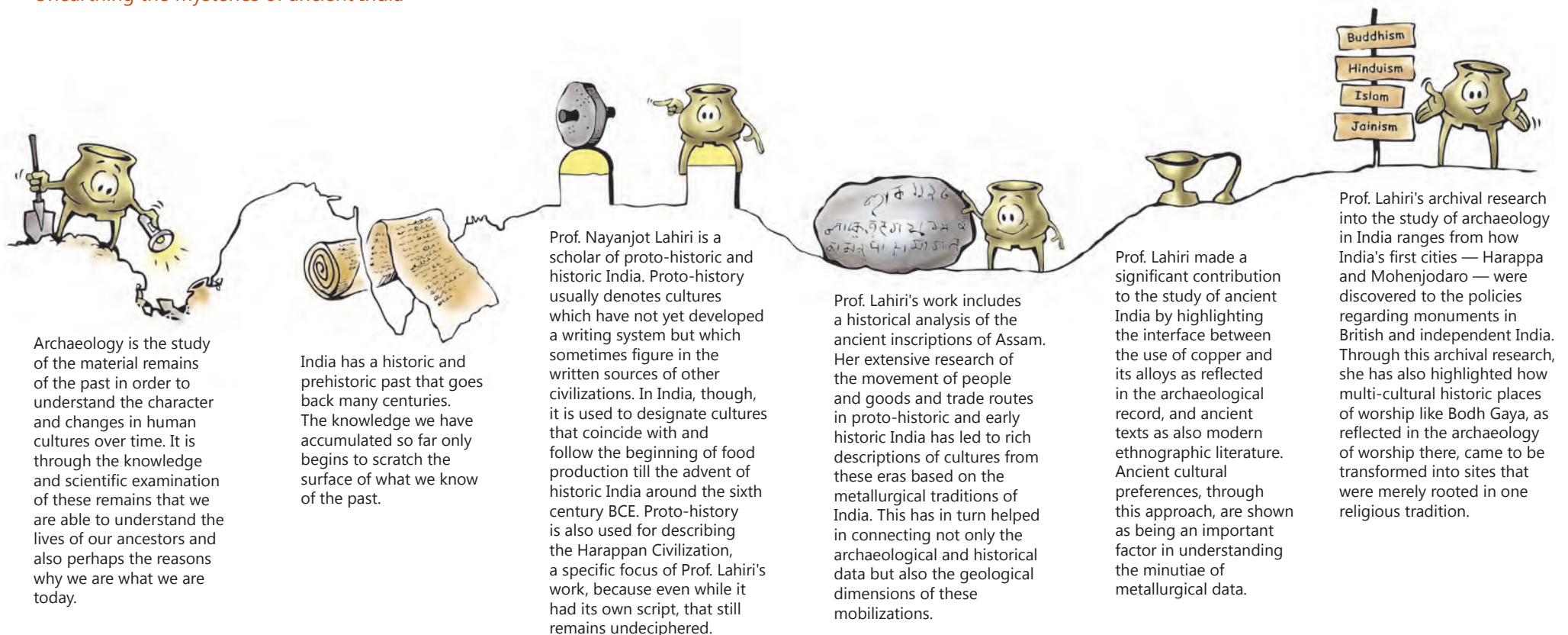
Professor, Department of History, University of Delhi

- M.A. in History from the University of Delhi
- M.Phil. in History from the University of Delhi
- Ph.D. in History from the University of Delhi

Prof. Nayanjot Lahiri is an exceptional scholar of proto-historic and early India, and her wide-ranging work on the past and present illuminates many aspects even of contemporary Indian life. Her work on resource mobilization and routes of access in proto-historic and early historic India (1992) deals with archaeological and historical data, and their geological dimensions and integration into the ethnographic aspects of their distribution.



Unearthing the mysteries of ancient India



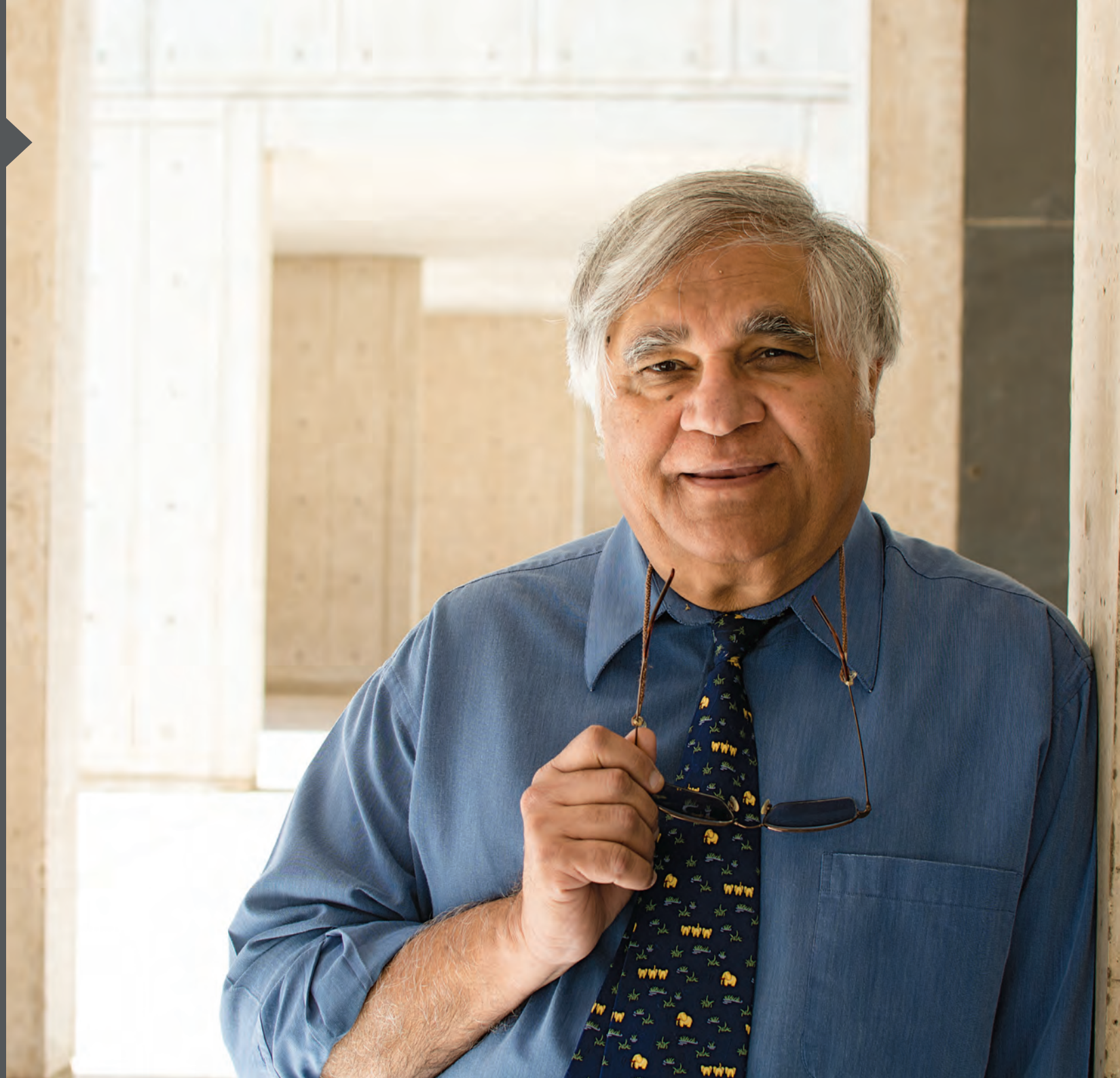
Life Sciences



"My experience as the jury chair for the life sciences has been the exposure that I gained into the wide variety of different sciences in biological sciences that is being carried out in India. It ranges from medical sciences to plant sciences to basic sciences to nanobiology and nanotechnology. And, I was very pleasantly surprised on the wide breadth of it."

Inder Verma

*Jury Chair, Life Sciences,
American Cancer Society Professor
and the first incumbent of the Irwin Mark
Jacobs Chair in Exemplary Life Sciences,
Laboratory of Genetics,
Salk Institute for Biological Studies, U.S.*





"My work has actually been the consequence really of keeping company far better than myself. My students, post docs, my collaborators in India and abroad have all been superb and have been a great stimulus to make science happen, to make good biology happen and also to make doing science fun and I'm really grateful to all of them."

K. VijayRaghavan

*Professor, National Centre for Biological Sciences, Bangalore and
Secretary, Department of Biotechnology, Government of India, New Delhi*

- B.Tech. in Chemical Engineering from the Indian Institute of Technology, Kanpur
- M.Tech. in Chemical Engineering from the Indian Institute of Technology, Kanpur
- Ph.D. in Molecular Biology from the Tata Institute of Fundamental Research, Mumbai
- Research Fellow and Senior Research Fellow at the California Institute of Technology, Pasadena

Professor VijayRaghavan is being recognized for his many contributions as an outstanding developmental geneticist and neurobiologist. His elegant work with *Drosophila* has revealed important principles and mechanisms that control the assembly and wiring of nerves and muscles during development, and he has recently begun to define how these neuromuscular circuits direct specific locomotor behaviors.



Unlocking the secrets of Hox genes

Most animals begin life as a mass of undifferentiated cells called embryos that then undergo specialization to form various organs and appendages. But what determines which section of the embryo forms which body part? What is it that determines if a fly becomes a fly or a mouse becomes a mouse?

Hox genes are genetic materials that determine the specialization of an embryo along the antero-posterior or the head-tail axis. These genes are in a sense the master code that unlocks the potential of the embryo. They implement the 'body plan' of an animal.

Once an embryo has differentiated into discrete segments, the Hox genes determine the structures formed at each segment. For example, antennae, wings, legs, vertebrae, etc., are formed at the direction of the Hox genes. These genes are so powerful that even small differences could bring about dramatic evolutionary changes.

Prof. VijayRaghavan's work defines how these powerful Hox genes function to create connections between the nerves and muscles and direct simple motor behaviors. He has used the fruit fly, *Drosophila melanogaster*, as the model for his study.

Using the tools and concepts from the fields of genetics, molecular biology, microscopy, developmental biology and behavioral biology, Prof. VijayRaghavan and his team are trying to unlock the secrets of this powerful genetic material.



Through his work on the development of sensory and motor organs in the fruit fly, Prof. VijayRaghavan sheds new light on the way target muscles develop their specific biomechanical connections through cell differentiation and division.



"We are making many new discoveries about how the malaria parasite works, and we're trying to use this information to develop new vaccines. It's a long process that could take 10 to 15 years, but if these vaccines work, then we can have an enormous impact on the lives of people."

Chetan E. Chitnis

Principal Investigator, Malaria Research Group, International Centre for Genetic Engineering and Biotechnology, New Delhi

- M.Sc. in Physics from the Indian Institute of Technology, Bombay
- M.A. in Physics from Rice University, Houston, Texas
- Ph.D. in Biophysics from the University of California, Berkeley

Dr. Chetan E. Chitnis is credited for the identification of the erythrocyte binding protein on malarial parasite that binds to the Duffy protein on the host blood cell. His work helped in narrowing the region of association and development of antibodies to prevent this association and infection. Clinical trials with vaccines that target malaria parasites are underway and offer hope for the development of a viable malaria vaccine.



Winning the battle against malaria

Today, 3.3 billion people, around half the world's population, are at risk of contracting malaria. In spite of the best efforts of researchers, a vaccine against malaria has proved elusive.

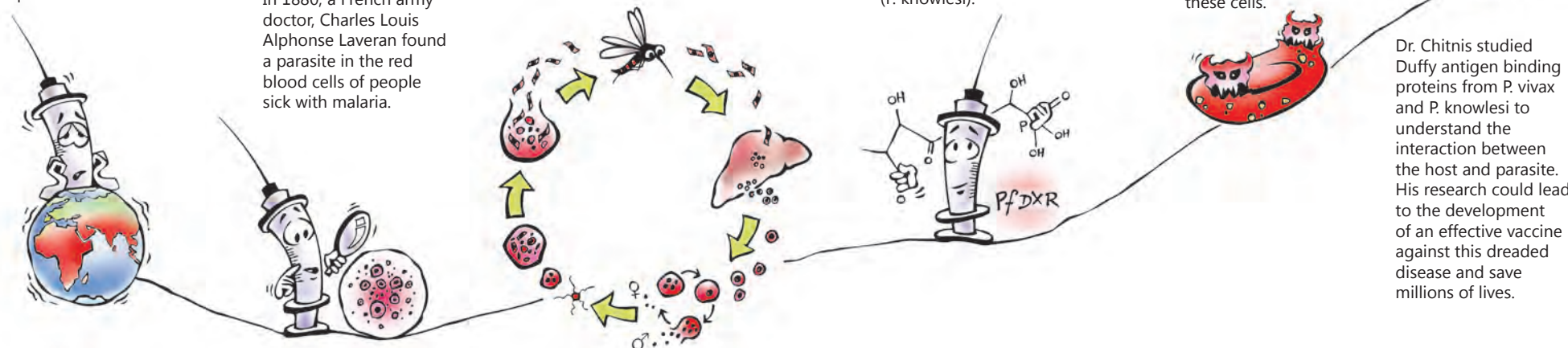
In 1880, a French army doctor, Charles Louis Alphonse Laveran found a parasite in the red blood cells of people sick with malaria.

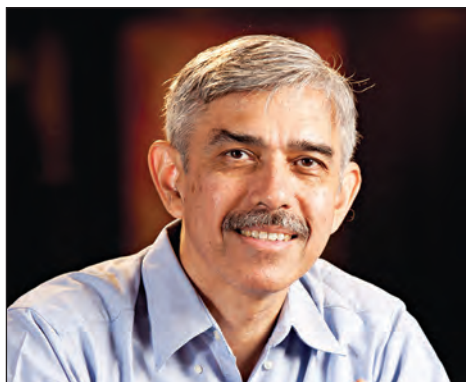
In 1898, a Scottish physician, Sir Ronald Ross, working at the Presidency General Hospital in Calcutta discovered the complete lifecycle of the malarial parasite in mosquitoes and since then researchers across the globe have been working relentlessly to combat this disease.

Dr. Chetan Chitnis has been working on understanding the molecular basis of how the malarial parasite invades red blood cells by using the malarial parasite *Plasmodium vivax* (*P. vivax*) and a closely related malarial parasite in monkeys called *Plasmodium knowlesi* (*P. knowlesi*).

Both parasites, *P. vivax* and *P. knowlesi*, invade the red blood cells by binding with a protein called Duffy antigen, found on the surface of these cells.

Dr. Chitnis studied Duffy antigen binding proteins from *P. vivax* and *P. knowlesi* to understand the interaction between the host and parasite. His research could lead to the development of an effective vaccine against this dreaded disease and save millions of lives.





"Our work is on the basic biology of plant reproduction, but it has important implications on developing new methods in plant breeding. These new methods have the potential to really revolutionize agriculture. The target beneficiary would be the farmer, particularly farmers in developing countries."

Imran Siddiqi

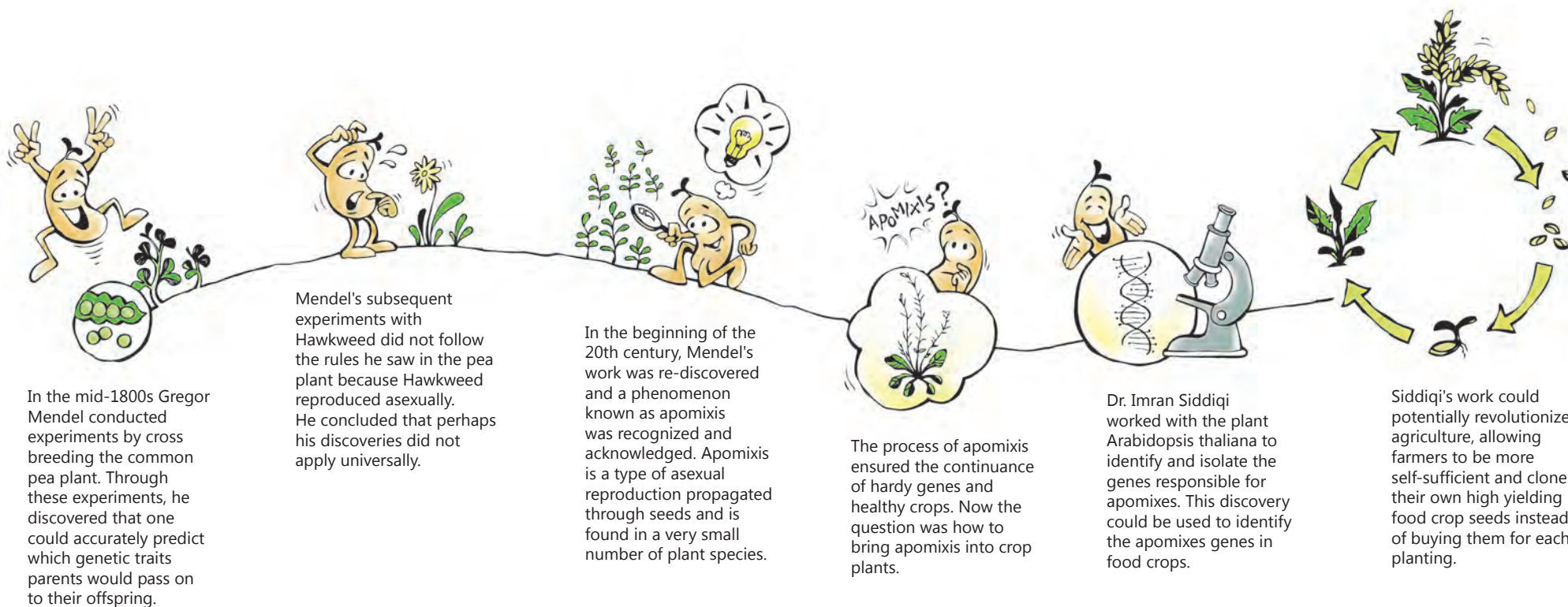
Chief Scientist, Centre for Cellular and Molecular Biology, Hyderabad

- M.Sc. in Chemistry from the Indian Institute of Technology, Bombay
- Ph.D. in Biology from the University of Oregon

Dr. Imran Siddiqi made breakthrough contributions to the basic understanding of clonal seed formation in plants. Apomixis (asexual reproduction) could revolutionize agriculture for poor farmers in developing countries.



Revolutionizing agriculture through clonal seed formation





"I believe that unless basic research is supported and recognized in our country, we'll have nothing to translate into technologies. So I'm very happy that this Prize (Infosys Prize) is being given to us for the basic research that we do."

Satyajit Mayor

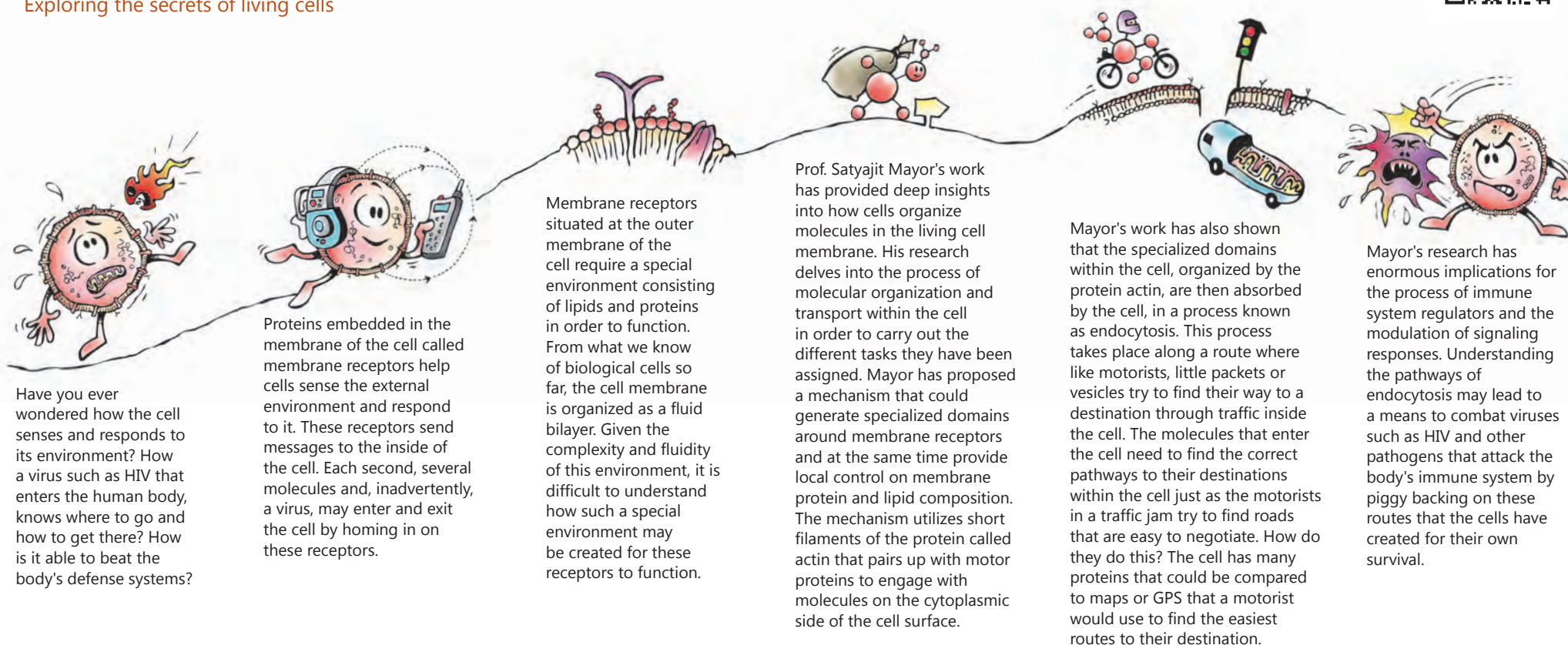
Director of the National Centre for Biological Sciences, Bangalore

- M.Sc. in Chemistry from the Indian Institute of Technology, Bombay
- Ph.D. in Life Sciences from the Rockefeller University, New York

Prof. Satyajit Mayor defined the nanoscale organization of GPI-linked proteins using fluorescence anisotropy, showing that these proteins exist in small (tens of nanometers) clusters. He showed that these microdomains are organized by actin and are endocytosed by a novel pathway that is clathrin- and dynamin-independent and regulated by CDC42 — a newly discovered pathway that is also responsible for a significant fraction of the micropinocytosis (fluid-phase uptake) by cells.



Exploring the secrets of living cells





"...So my group for almost a decade now, we've been interested in looking at an organism called Mycobacterium tuberculosis that causes TB in humans. I think the work that we have done has a tremendous future in terms of either diagnoses or medical treatment you would do for a tuberculosis patient."

Rajesh S. Gokhale

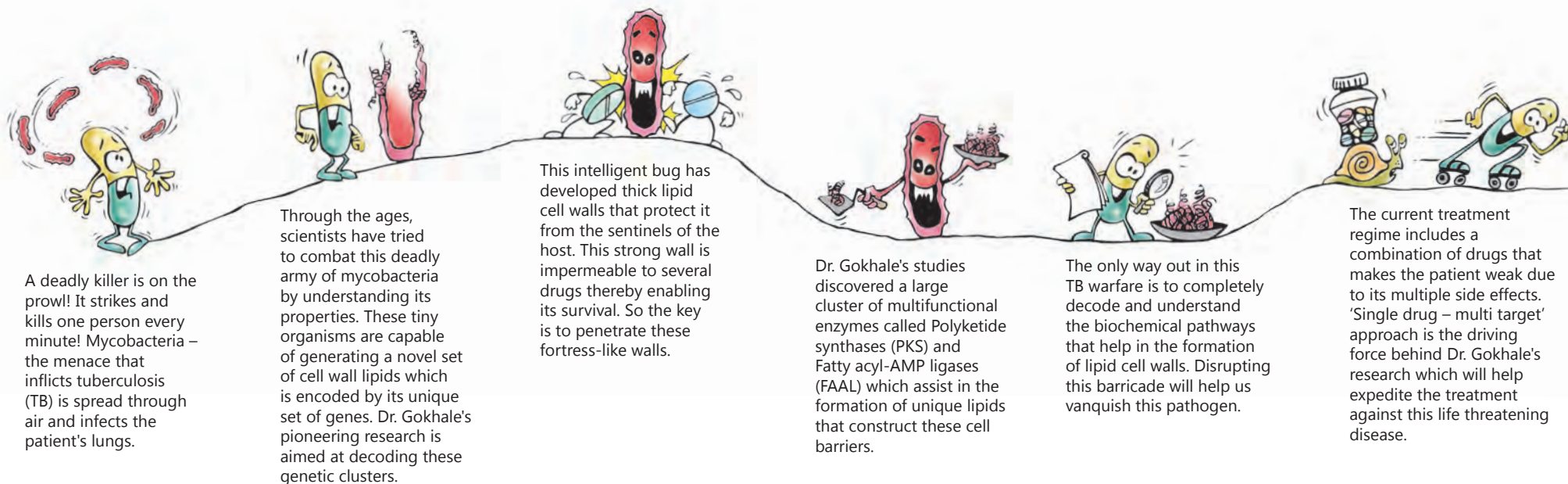
Director, CSIR – Institute of Genomics and Integrative Biology, New Delhi

- M.Sc. in Biotechnology from the Indian Institute of Technology, Bombay
- Ph.D. in Molecular Biophysics from the Indian Institute of Science, Bangalore

Dr. Rajesh S. Gokhale is a leader in the study of the enzymology of polyketide synthases in tubercle bacilli. He discovered fatty acyl AMP ligases in tubercle bacillus, their role in the generation of the lipid components of its cell wall and of their existence in other organisms, where they play a role in biosynthesis of complex molecules.



Battling the tuberculosis menace



Mathematical Sciences



"Mathematics is a bit different from other sciences in the sense that most of the work done tends to be abstract. They have a huge impact, but the impact is in several layers. Mathematics impacts physics, physics impacts engineering and engineering impacts other things. So the ideas in mathematics may not be immediately useful, but over the long run they do exert an influence and are very useful to society."

Srinivasa S. R. Varadhan

*Jury Chair, Mathematical Sciences,
Professor of Mathematics and
Frank J. Gould Professor of Science at the
Courant Institute of Mathematical Sciences,
New York University, U.S.*





"I think this Prize (Infosys Prize) will go a long way in attracting young talent to science and that's what we need to build a strong country...Whatever I've done is built on the work of many others and my work should really be thought of as a tiny piece of a vast effort that is going on, in trying to understand the basic laws of nature."

Ashoke Sen

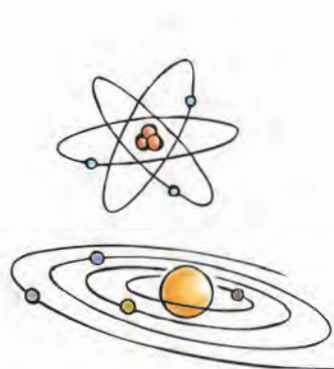
Professor, Harish-Chandra Research Institute, Allahabad

- B.Sc. in Physics from Calcutta University
- M.Sc. in Physics from the Indian Institute of Technology, Kanpur
- Ph.D. in Physics from the State University of New York, Stonybrook
- Post doctoral research at Fermilab, Batavia, and at SLAC, Stanford

Prof. Ashoke Sen is being recognized for his important contributions to String Theory, which is a vital part of Mathematical Physics. Among his contributions is his work on S-duality that established links between weak and strong coupling regimes of certain String Theories. This made it possible to make inferences concerning the behavior of the system in the strong coupling regime by a perturbative analysis of the system in the weak coupling regime.



Unifying gravity and quantum mechanics



For many years now, scientists have been trying to work out the composition of our universe. They first discovered that the world around us was made up of atoms and these in turn were made up of even tinier particles such as electrons, protons, neutrons, quarks and others. These particles interact via four different types of forces. These are gravity, electromagnetism, weak nuclear forces and strong nuclear forces.



So, what was the nature of particles and forces? Several theories came up, including String Theory. According to this theory all particles and forms of energy are arranged in the form of strings. These hypothetical strings had only the dimension of length.



The theory suggested that these strings vibrate (known as 'excitations') and depending on how they vibrate they form different particles. Many advances have been made in proving String Theory. The string theories have been classified according to whether the strings are open or closed and are further classified according to the allowed modes of vibration of the string. At one time, string theorists believed that each of the string theories were distinct and could exist without the other. Soon they realized that these theories are connected to each other and these connections came to be known as 'dualities'.



Prof. Ashoke Sen's landmark contribution to string theory has been his work on dualities. Sen has worked out a surprising connection between weak and strong coupling regimes of a String Theory. Coupling regimes refer to the strength of interaction in string theories. The coupling constants in the string theories are controlled by particular oscillation modes of the string called dilatons and they exhibit symmetry, which is called S-duality.



Prof. Sen's research attempts to unify the theories of gravity and quantum mechanics and to complete the task that Einstein had begun. His work on entropy function formalism has helped provide a statistical interpretation of Bekenstein-Hawking entropy of black holes. He has also made other important contributions to String Theory, including the construction and study of time dependent solutions that has led to cosmological models.



"Pure mathematics does not have a direct impact on people's lives, because we think of the questions for themselves, and are not motivated by their applications. But like with any good idea, these too will add value in their own way, and eventually impact the way the subject is taught."

Chandrashekhar Khare

Professor, Department of Mathematics, University of California, Los Angeles

- B.A. in Mathematics from the University of Cambridge
- M.A. in Mathematics from the University of Cambridge
- Ph.D. in Mathematics from the California Institute of Technology

In collaboration with J. P. Wintenberger, Prof. Chandrashekhar B. Khare settled the Serre conjecture, formulated by mathematician, Jean-Pierre Serre, in the affirmative. Prof. Khare's work is a major breakthrough in the field with many spectacular consequences, and many new ideas introduced in it are expected to dominate the field for years to come.



Unlocking puzzles in number theory



Number theory is widely considered to be one of the most challenging and exciting fields of mathematics. Among the many challenging puzzles in number theory, a long standing one has been the Serre conjecture.

The Serre conjecture is named after the French mathematician Jean-Pierre Serre who formulated it in the 1970s. The conjecture essentially postulated a surprising connection between solutions of some polynomial equations and analytic functions with symmetry properties. Put simply, the former are equations that contain positive integers with operations such as addition, subtraction and multiplication but not division while analytic functions are functions that are given by a convergent power series and can be thought of as bridges between polynomials and general functions.

Mathematicians spent the next couple of decades grappling with the solution to the conjecture. In 2009, Prof. Khare along with his French colleague J. P. Wintenberger solved the Serre conjecture.

The connection between solutions of polynomial equations and symmetry was first discovered in the 19th century by Evariste Galois who interestingly enough died in a duel at the age of 21 and wrote down his ideas the night before he died. He developed the idea of the symmetry group of a polynomial. Groups are a technical term which represents a group of permutations. Groups are one of the central objects of current mathematics.

The Serre conjecture implies the truth of Fermat's last theorem, a notoriously puzzling conundrum that had mathematicians flummoxed until it was solved by A. Wiles in 1993, more than three hundred years after it was first formulated. The conjecture builds a bridge between algebra and geometry on one hand and analysis on the other.

Though number theory and the idea of groups may seem very abstract, it is these theories that were used to invent things like public key cryptography which is used to ensure information security when you use credit cards on the internet.



"A large part of doing research is to be stuck and to be confused and to feel like one doesn't make progress. But then, every once in a while you make progress. Then something comes out, a light turns on and that insight or feeling of discovery, of finding something new, carries with it such joy that you go back and are willing to be frustrated yet again."

Kannan Soundararajan

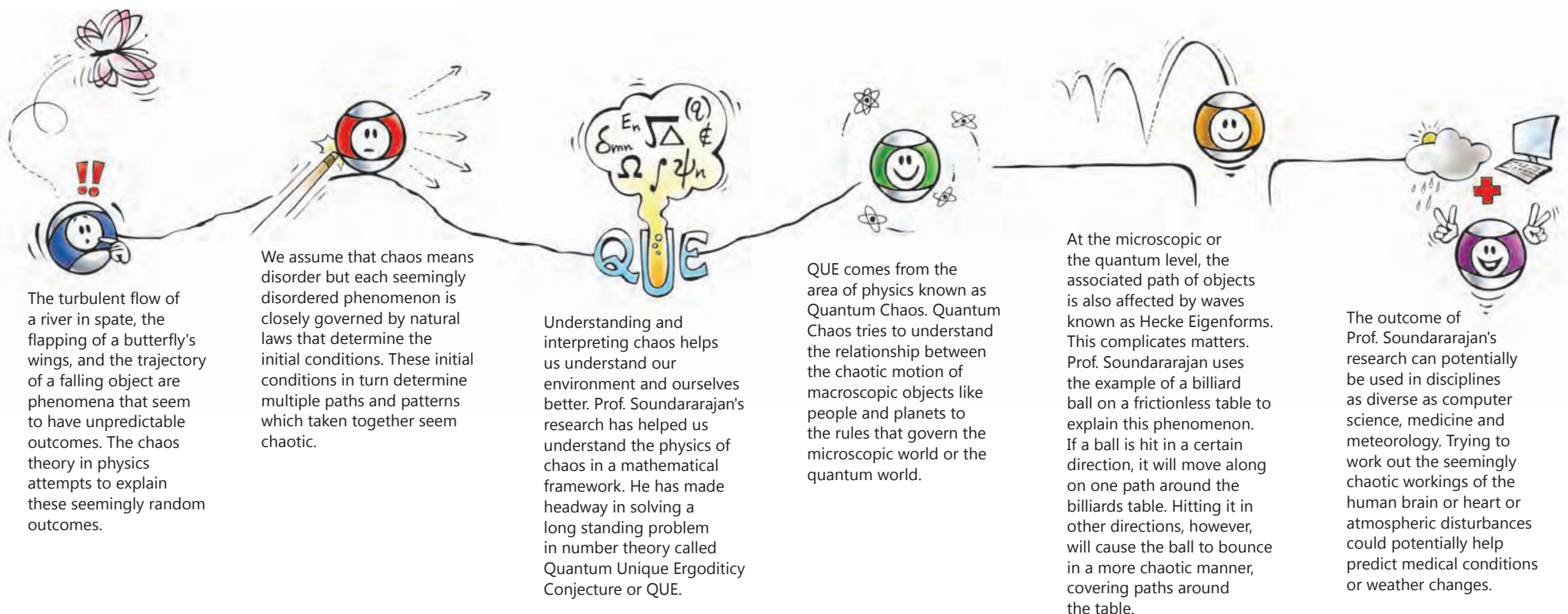
Professor of Mathematics, and Director, Mathematics Research Center, Stanford University

- B.S. in Mathematics from the University of Michigan
- Ph.D. in Mathematics from Princeton University

Prof. Kannan Soundararajan has made fundamental contributions to analytic number theory. His recent development of new unexpected techniques to study the critical values of general zeta functions has led to the proof of the Quantum Unique Ergodicity Conjecture for classical holomorphic modular forms.



Finding order in chaos with number theory





"Doing scientific research is quite an amazing feeling. You feel like an explorer, like an artist trying to find patterns in places where people previously thought there was chaos. So doing science is like a big adventure. It is a lot of fun and is also very important for the world."

Manjul Bhargava

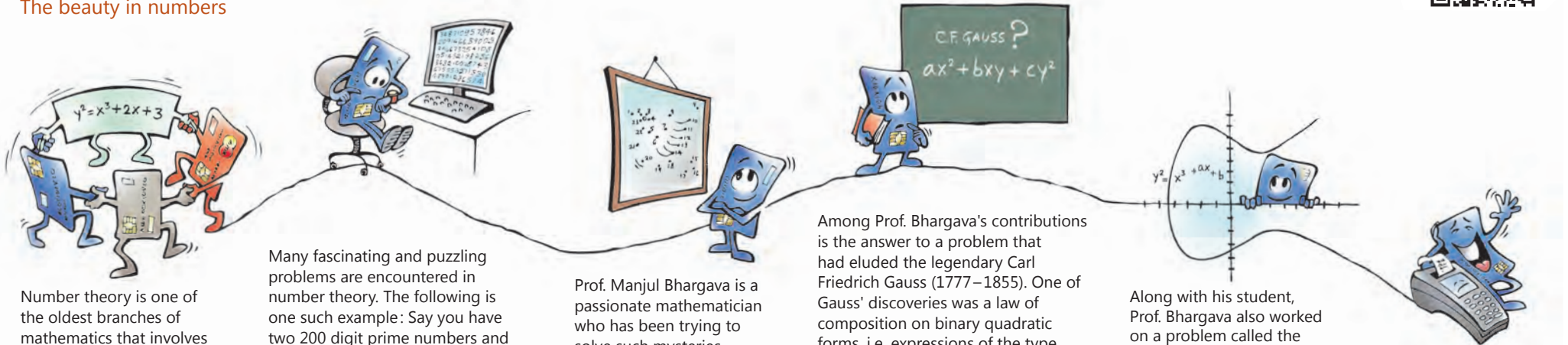
Professor of Mathematics, Princeton University

- A.B. in Mathematics from Harvard University
- Ph.D. in Mathematics from Princeton University

Prof. Manjul Bhargava has proved a series of beautiful theorems that greatly enhance our understanding of number fields and algebraic curves, two of the most studied topics in number theory. In particular, he showed how to count quartic and quintic number fields, and proved that the average rank of elliptic curves over the rational numbers is less than 1.



The beauty in numbers



Number theory is one of the oldest branches of mathematics that involves the study of whole numbers and how they relate to one another. It deals with finding patterns in whole numbers such as prime numbers and squares. Number theory helps in developing theories that allow one to find whole number solutions to equations such as $y^2 = x^3 + 2x + 3$.

Many fascinating and puzzling problems are encountered in number theory. The following is one such example: Say you have two 200 digit prime numbers and you feed these numbers into a computer which multiplies these numbers and gives a 400 digit number. If this 400 digit number is then fed into a computer in order to work backwards to arrive at the original two 200 digit numbers, it would take billions of years for even the most advanced computer to come up with the solution. However, no one knows why this is so. Therefore, this property is used in security related measures such as encryption schemes on the internet.

Prof. Manjul Bhargava is a passionate mathematician who has been trying to solve such mysteries. He thinks of mathematics as art. Prof. Bhargava's research in number theory deals specifically with the development of novel techniques to count objects that were previously considered inaccessible.

Among Prof. Bhargava's contributions is the answer to a problem that had eluded the legendary Carl Friedrich Gauss (1777–1855). One of Gauss' discoveries was a law of composition on binary quadratic forms, i.e. expressions of the type $ax^2 + bxy + cy^2$, with a , b and c being whole numbers that are fixed, and x and y being the variables. It was an open question as to whether this was isolated or part of a bigger theory. Prof. Bhargava showed that quadratic forms were not the only forms with such composition, but that other forms such as cubic forms also have such composition. He was also able to show that the Gauss composition is in fact only one of at least 14 such laws.

Along with his student, Prof. Bhargava also worked on a problem called the Birch and Swinnerton-Dyer conjecture, which is basically a problem in advanced calculus but which has deep implications in number theory as well. The conjecture involved elliptic curves or equations of the form $y^2 = x^3 + ax + b$.

The real world implications of the problems that Prof. Bhargava works on are not immediately evident. However, they have profound implications in areas such as encryption schemes, credit card security and internet applications.



"Research has one very nice aspect to it, which is that you wake up in the morning, you can think about questions that interest you the most. The difficult side is that often you don't make very much progress on it. So it is psychologically sometimes difficult. But I find it is a great career."

Rahul Vijay Pandharipande

Professor, Department of Mathematics, Eidgenössische Technische Hochschule (ETH), Zurich

- A.B. in Mathematics from Princeton University
- Ph.D. in Mathematics from Harvard University

Prof. Rahul Pandharipande is a leader in the field of algebraic geometry. During the last 15 years, he has made profound contributions to the Gromov-Witten theory. This theory introduced in the 1990s has forged deep connections between many areas of mathematics including algebraic geometry, symplectic geometry, representation theory, etc. He excels in doing explicit computations and in finding beautiful formulae and rich structures within these theories.



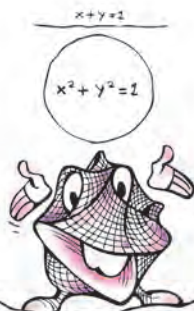
Uncovering the relationships between invariants



In mathematics, an invariant is a quantity which remains unchanged under certain classes of transformations. Invariants are extremely useful for classifying mathematical objects because they usually reflect the intrinsic properties of the object being studied.



A circle can be drawn on a sheet of paper and is a geometric object. But a circle of radius r can be described as those points (x,y) on the plane that satisfy the quadratic equation $x^2 + y^2 = r^2$. Similarly, polynomial equations are algebraic objects but their solutions represent geometric objects. So, a curve in a plane is described by one equation but in space, a surface is defined by solutions of one equation and a curve is defined by solutions of two simultaneous equations.



As the degree of the polynomials that define the equations increase, the curve or the surface tends to be more twisted. For example $x + y = 1$ is a straight line while $x^2 + y^2 = 1$ is a circle. In mathematics, often spaces of dimensions larger than three have to be studied. For a seven dimensional space, four equations define a surface of three dimensions. Each equation reduces the dimension by one. The geometry of the resultant object has to be understood in terms of the algebraic structure of the equations that define it. Two surfaces that are presented differently can be very similar.



Invariants help in identifying similar objects or even the same object that appears in a different disguise. A circle is determined by its radius. An ellipse by its major and minor axes. There could be more than one set of invariants for the same set of objects. A triangle can be determined by either the lengths of its three sides or by one side and the three angles that add up to 180 degrees. Trigonometry provides a relation between the two sets of data.



The objects in Prof. Rahul Pandharipande's work are Calabi-Yau '3-folds' that are geometric shapes of keen interest in mathematics and theoretical physics. They are determined by algebraic equations, typically of degree equal to the number of variables. There are two sets of invariants associated with them. The Gromov-Witten invariants 'count' the number of different maps of standard curves of varying types into a Calabi-Yau '3-fold'. The Donaldson-Thomas invariants are intrinsically defined through an algebraic construction on the same "3-fold" and provide a different set of 'counts'. The MNOP conjecture of Maulik-Nekrasov-Okounkov-Pandharipande predicted a deep and unexpected relation between the two, providing in particular an explicit recipe for computing one set from the other.

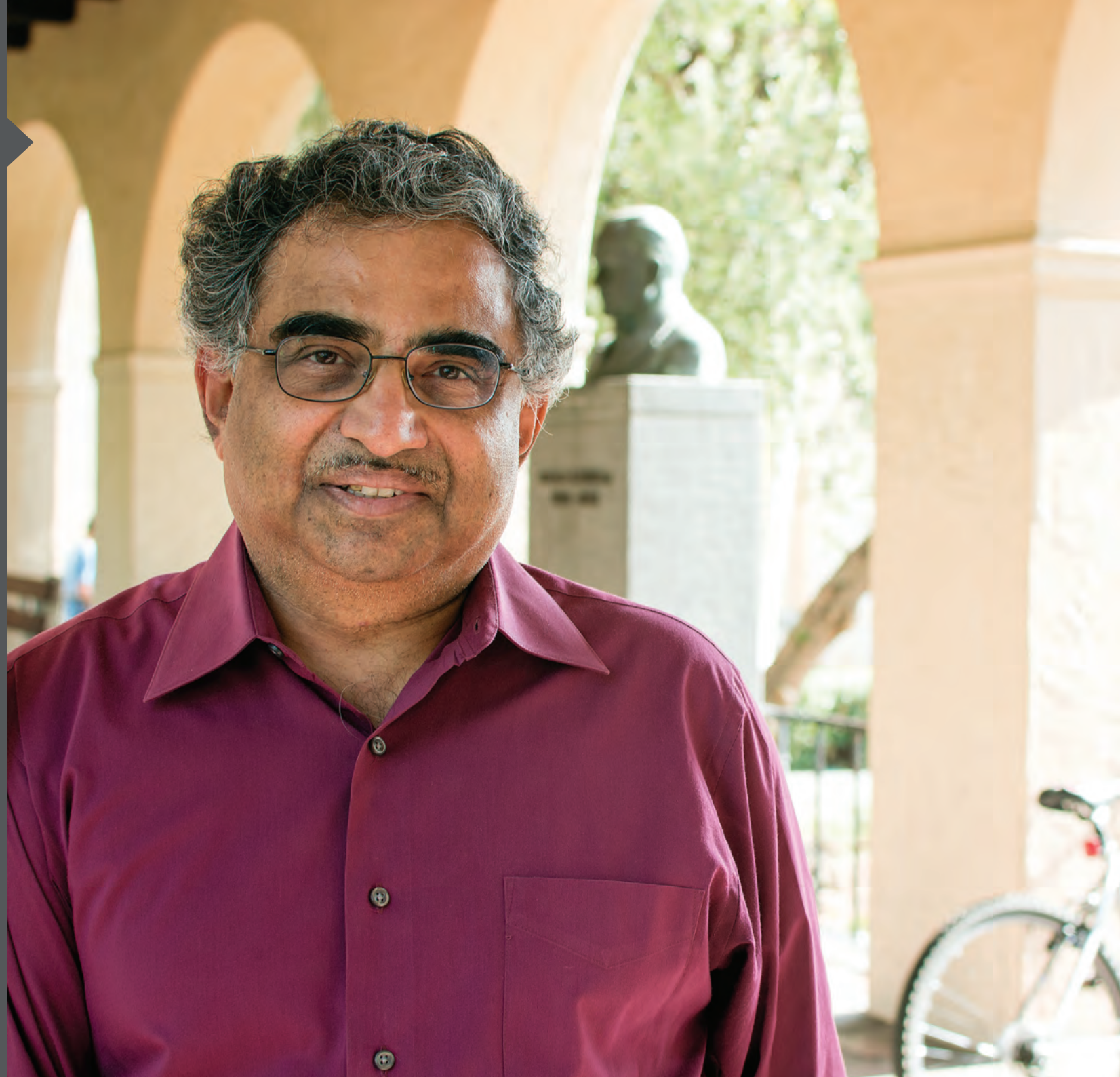


Recently, Prof. Pandharipande and his student Aaron Pixton proved this conjecture. The results are important because of their connection to string theory which is supposed to be the theory of everything!

"The joy of doing research is very clear, especially in the sort of research which I do, to discover new kinds of cosmic or celestial sources. The rush one feels on discovering something new is incomparable; there are no words to describe that experience. In order to make these discoveries you have to go through a very long process of modest failures, tries, repeated tries, then hopefully with some luck one makes a discovery."

Shrinivas Kulkarni

*Jury Chair, Physical Sciences,
John D. and Catherine T. MacArthur
Professor of Astronomy and
Planetary Science,
California Institute of Technology, U.S.*





"The kind of awards they (the Infosys Science Foundation) have instituted I'm certain is going to go a long way in instilling a sense of belonging in this country. And, also to feel what we achieve here will be duly recognized and it is more appropriate because of the kind of international standing which these awards are destined to occupy very soon."

Thanu Padmanabhan

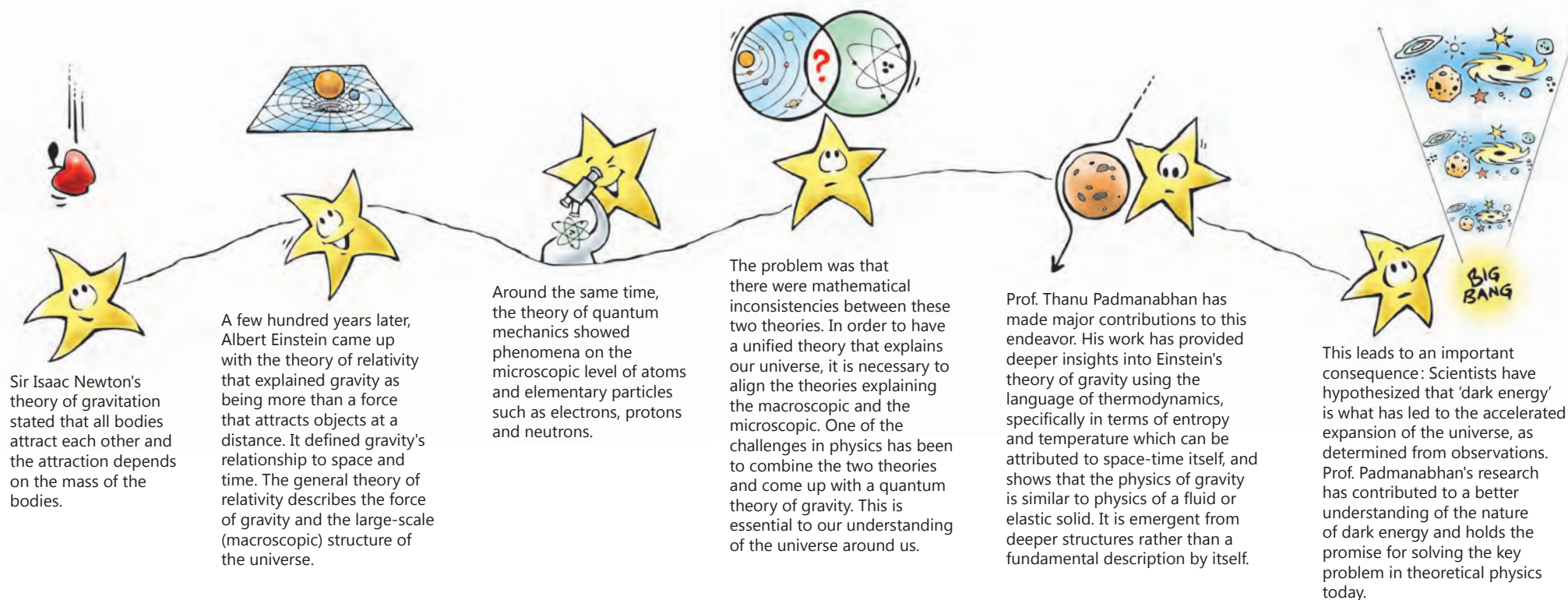
Professor and Dean of Core Academic Programs of Inter-University Center for Astronomy and Astrophysics (IUCAA), Pune

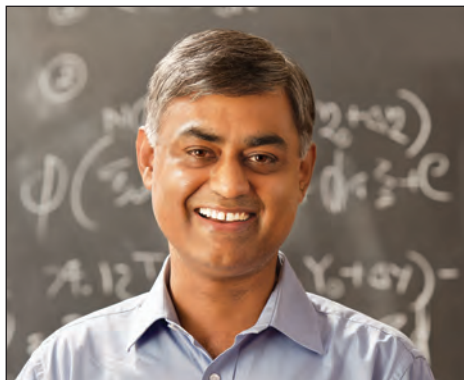
- B.Sc. in Physics from Kerala University
- M.Sc. in Physics from Kerala University
- Ph.D. in Physics from the Tata Institute of Fundamental Research, Mumbai
- Post doctoral research at the Institute of Astronomy, University of Cambridge

Professor Padmanabhan has distinguished himself with fundamental contributions to several areas of theoretical astrophysics. Through a series of papers, he has shown that the link between Einstein's Theory of General Relativity and thermodynamics is far deeper than suggested by the early work done in the 1970s. This work opens a new perspective on gravity as an emergent phenomenon and is expected to provide fresh insights into the nature of dark energy in the universe.



Tackling the origins of the universe





"To fulfil the basic human need to understand the universe and its workings, to understand how it all began, how it may end, what lies in the future for us... it is in understanding these basic kind of questions that I think my work can contribute, and these questions are of importance or of interest to common people."

Sandip Trivedi

Professor, Theoretical Physics Department,
Tata Institute of Fundamental Research, Mumbai

- M.Sc. in Integrated Physics from the Indian Institute of Technology, Kanpur
- Ph.D. in Theoretical Physics from the California Institute of Technology, Pasadena
- Post Doctoral Research Associate at the Institute for Advanced Study, Princeton, New Jersey

In recent years, physicists have pursued the possibility of achieving a unified account of all the known forces of physics using concepts of Superstring Theory. It was difficult to construct solutions of the equations of Superstring Theory that did not contain massless particles of a kind not observed in nature, and that describes an accelerating or inflating universe, which seem to be required by cosmological observations. Through an ingenious construction that introduced several theoretical innovations, Prof. Sandip Trivedi showed that these difficulties are connected, and can be overcome simultaneously.



Tackling the mysteries of Superstring Theory



How did our universe begin? How does it work? Over the years, scientists have put forward many theories that attempt to answer these questions. In recent years, String Theory has been a much studied field and is a promising attempt in this direction. Superstring Theory or Supersymmetric String Theory is an attempt to define all the particles and fundamental forces in nature as the vibrations of microscopic supersymmetric strings.

Superstring Theory is different from other versions of String Theory because it includes fermions and the concept of supersymmetry. Fermions include particles such as quarks and leptons. Bosons are another kind of particle which include the photon and the recently discovered Higgs Boson. Supersymmetry is a symmetry that relates fermions and bosons.



In recent years, physicists around the world have been pursuing the possibility of achieving a unified theory of all the known forces of nature including gravity, strong forces, weak forces and electromagnetic interactions. They have been trying to achieve this using the concepts of Superstring Theory.



However, this has proved difficult to do and so far the only solutions to the equations of Superstring Theory that physicists have constructed involve massless particles of the kind not seen in nature. Prof. Trivedi, with collaborators, has shown a way of overcoming this problem by using an ingenious construction that introduced several theoretical innovations.



Through his work, Trivedi has also been able to find a way of solving an outstanding puzzle in Superstring Theory regarding the origin of dark energy in the universe. In cosmology and astronomy there is increasing evidence that the universe is dominated by a form of dark energy which is thought to contribute to its expansion.



Trivedi's work helps to make important links between the fields of Superstring Theory, cosmology and particle physics. His research has made important contributions to the study of superstring cosmology, flux compactifications (a particular way to deal with the additional dimensions required by string theory), black hole physics and supersymmetry breaking.



"Eventually our work on active matter will be relevant to a complete understanding of the mechanics and statistical properties of cells, tissue and organisms. The field involved in this case is biology which is a fantastic source of problems for physicists to think about."

Sriram Ramaswamy

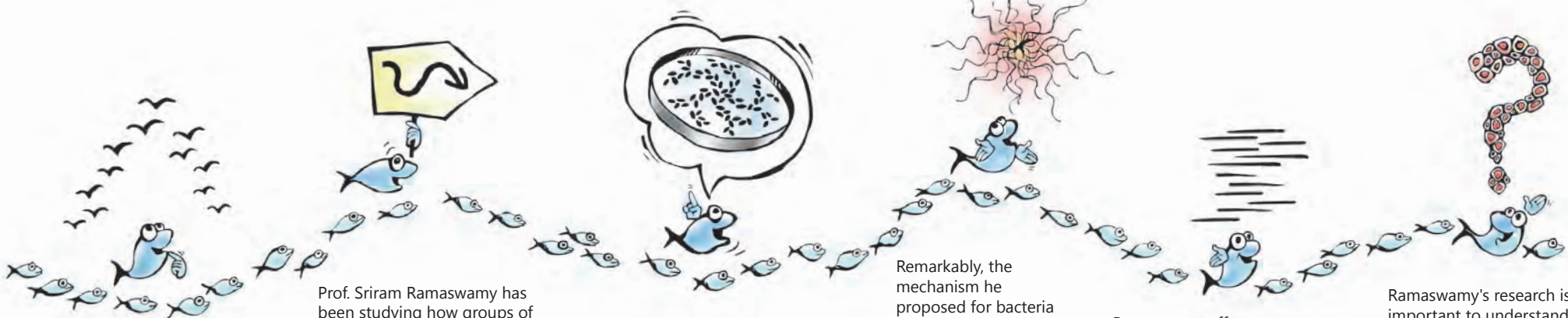
Senior Professor and Centre Director, TIFR
Centre for Interdisciplinary Sciences, Hyderabad

- B.S. in Physics from the University of Maryland
- Ph.D. in Physics from the University of Chicago

Prof. Sriram Ramaswamy's work on the mechanics and statistics of active matter has given birth and shape to this rapidly growing field. He used simple yet powerful arguments based on symmetry and conservation principles to uncover the strange laws governing the collective behavior of active particles in a medium, which could be motor proteins walking on cytoskeletal filaments, or schools of fish swimming in an ocean and forming a pattern.



Studying the mechanics and statistics of Active Matter



In our everyday lives we often encounter natural phenomena that are symmetrical and follow interesting patterns. Flocks of migratory birds, schools of fish, tessellations in a honeycomb, and the wildebeest migration – all follow set patterns. These patterns are subject to a certain order that we often do not understand.

Prof. Sriram Ramaswamy has been studying how groups of living things move together. Specifically, he wanted to understand how groups of living things move together in a fluid. When groups of living matter move in a liquid medium, a disturbance is created, which then affects the movement of others in the group.

Ramaswamy's research not only explores the movement on a macroscopic scale as in the case of schools of fish but also microscopic movements as in the case of bacteria. In the latter, he discovered that the movement of bacteria created subtle ripples in the fluid in which they moved, which in turn led to the colony arranging itself in complex patterns.

Remarkably, the mechanism he proposed for bacteria moving through fluids applied on even smaller scales, to the filaments in a single living cell. In addition, he showed how to create artificial flocks in a layer of bits of metal wire.

Ramaswamy offers new insights into the collective movements of these self-propelled organisms using Active Matter physics. His research elucidates how Active Matter takes in free energy and is consumed at the level of each particle, leading to systematic movements. His research is attempting to uncover the laws that govern the collective movements of living creatures that seem to follow some sort of order.

Ramaswamy's research is important to understand how the collections of living cells and tissues develop and grow. It could also potentially help us understand how bacteria form colonies. If we understood these movements fully, we could even manufacture small objects that can move by themselves, such as little gadgets that follow chemical traces or scents.



"The types of materials that we create are highly fluorescent and they are very sensitive to their ambience or surroundings. So we are trying to use this for diagnostic purposes, mainly for the detection of certain diseases at an early stage. And this is a dream project which we are now trying to pursue."

A. Ajayaghosh

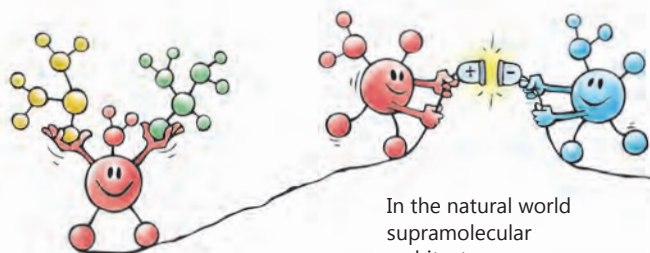
CSIR Outstanding Scientist, National Institute for Interdisciplinary Science and Technology, Thiruvananthapuram

- M.Sc. in Chemistry from Calicut University
- Ph.D. in Chemistry from Calicut University

Dr. Ajayaghosh's landmark research in advanced supramolecular chemistry, most specifically in investigations that have led to the design and synthesis of molecular assemblies called organogels (pi-gels), a new class of materials with great potential for photonic and electronic applications. He has demonstrated that these self-assembled nano materials can be used to control the electronic energy transfer processes, paving the way for the development of superior light harvesting devices.

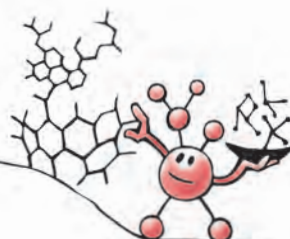


Discovering the secret language of molecules

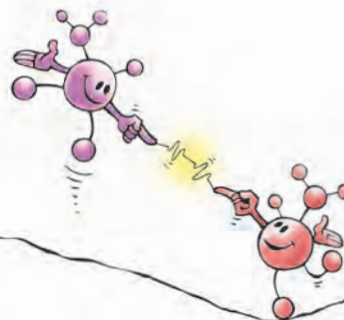


When we hear of magical materials that repair or clean themselves or spontaneously emit light, it may sound very like a Harry Potter novel, but it turns out that scientists are like wizards who can create such magic material by harnessing the properties of molecules. For example, organic electronics has been used to invent novel devices after extensive research in supramolecular structures, which are made of large molecules formed by grouping or bonding smaller molecules together.

In the natural world supramolecular architectures are created by non-covalent interaction of molecules. Non-covalent interactions between molecules utilize weak electronic forces such as hydrogen bonding, pi-stacking and electrostatic forces. When different types of molecules of different sizes and shapes are put together, they are able to 'communicate' with each other.



Prof. A. Ajayaghosh's research on supramolecular structures is trying to create molecular architectures of different sizes and shapes using a special class of molecules that are electronically and photonicly active. He has been studying how they interact in nature to create these architectures and if these can be mimicked in the laboratory.



Prof. Ajayaghosh's research is uncovering the process of how these connections could be converted to signals, which can then be used for certain kinds of applications.



There are many types of highly sensitive materials such as fluorescent materials which can be used for sensing other molecules. Such 'magic material' would be enormously useful in electronic devices and in creating security labels which are made of substance selective optical sensing materials for documents and currency.



An important and enormously useful application of Prof. Ajayaghosh's work would be for the early detection of diseases such as cancer. This could potentially be used as an important diagnostic tool and help with providing treatment in a timely manner.



"It is a completely remarkable fact about the world we live in that everything appears to function according to mathematical laws. Moreover these laws seem to be accessible to our limited human thought. It seems like a natural — and perhaps the most important — endeavor for human beings to try to understand these laws. To try to figure out what the rules of existence are."

Shiraz Naval Minwalla

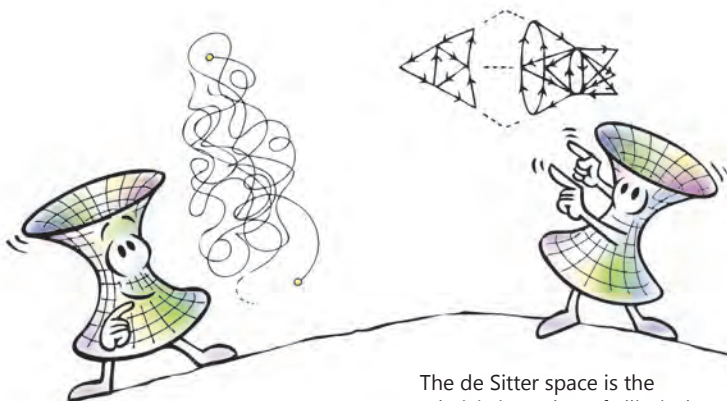
Professor, Department of Theoretical Physics, Tata Institute of Fundamental Research, Mumbai and IBM Einstein Fellow and Visiting Professor, Institute for Advanced Study, Princeton

- M.Sc. in Physics from the Indian Institute of Technology, Kanpur
- Ph.D. in Physics from Princeton University

Prof. Shiraz Naval Minwalla is a leader in quantum gravity research. He has made deep contributions in the field of string theory, in particular to the study of the AdS / CFT correspondence. Prof. Minwalla uncovered an unexpected connection between the equations of fluid and superfluid dynamics and Einstein's equations of general relativity.



Understanding gravity within the framework of quantum mechanics



There are four known fundamental forces in nature: the gravitational force, electromagnetic force, strong force and weak force. Physicists have a satisfactory mathematical description of the last three of these within the framework of quantum field theory. The only theory currently available for gravitational force, however, is Einstein's classical theory of general relativity. A satisfactory quantum theory of gravitation is not currently available.

The de Sitter space is the relativistic analog of Elliptical space and Anti-de Sitter space (AdS) is the hyperbolic space that follows the tenets of the theory of relativity. A conformal field theory is a special kind of quantum field theory, one which has no dimensionful constants. The conformal field theories of most relevance to string theory often also enjoy invariance under supersymmetry, a symmetry that ensures that every particle has a corresponding super particle partner with opposite statistics.

Several years ago, Prof. Juan Maldacena discovered the Anti-de Sitter / Conformal Field Theory (AdS / CFT) correspondence which is a conjectured holographic relation between gravitational theory in the bulk of Anti-de Sitter space and a conformal quantum field theory that resides on its boundary. Since then scientists have tried to understand the significance of this correspondence, which provides an in-principle complete description of at least some quantum theories of gravity.



Prof. Shiraz Naval Minwalla established that, in the long wavelength hydrodynamic limit, a black hole in Anti-de Sitter space is governed by exactly the same equations as the nonlinear Navier-Stokes equations of a fluid. This AdS / CFT-like holographic view of fluid dynamics is called the fluid / gravity map.



Prof. Minwalla's work unifies two of the best-studied nonlinear partial differential equations in physics. Using the fluid / gravity map, Prof. Minwalla established a connection between the classical area theorems of black hole physics and the positivity of the divergence of the entropy current in fluid dynamics.

Social Sciences



"Within the social sciences, and the range is very big, from the more technical ends of the social sciences to the non-technical social sciences, there are different contributions you can make to the development of a society. It changes the way human beings think, the way human beings interact with one another, the way we participate in discourse and in the end, the ideas that fructify and take a nation further."

Kaushik Basu

Jury Chair, Social Sciences, Chief Economist and Senior Vice President, World Bank and Professor of Economics and the C. Marks Professor of International Studies, Cornell University, U.S.





"This Prize is particularly special to me because on both sides...one of the first pieces of empirical research I did in India was on the software industry and that was facilitated massively by Mr. Murthy."

Abhijit Banerjee

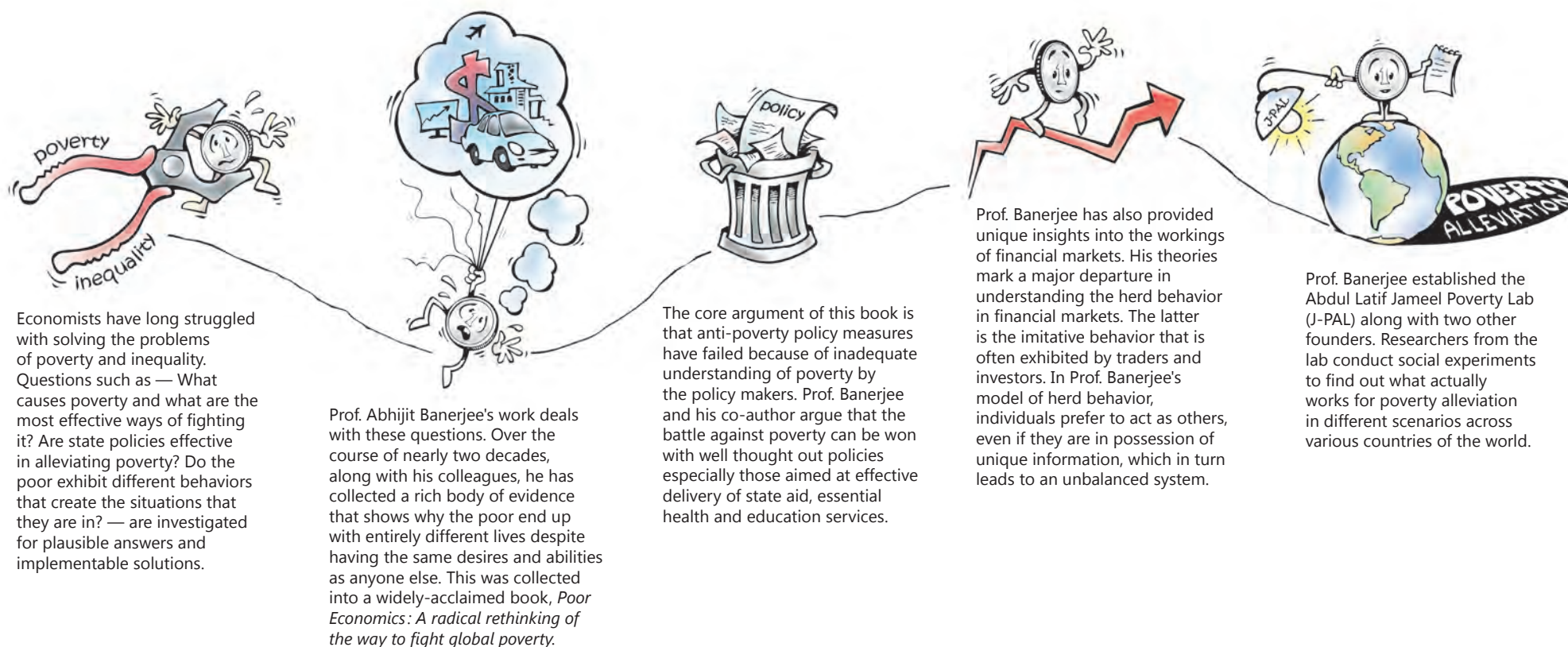
Professor, Department of Economics,
Massachusetts Institute of Technology, Cambridge

- B.Sc. in Economics from University of Calcutta
- M.A. in Economics from Jawaharlal Nehru University
- Ph.D. in Economics from Harvard University

Professor Abhijit Banerjee has long been recognized for his outstanding contributions to the economic theory of development, and for his pioneering work in the empirical evaluation of public policy. In widely cited contributions to the former, Banerjee has presented his novel departures in the understanding of herd behavior in financial markets, and also his analysis of occupational distribution in conditions when the poor find it difficult to raise credit.



Analyzing the economics of poverty alleviation





"I know that it (Infosys Prize) will be a source of great inspiration for my future research and writing. I would like to add that I think it is wonderful that the Infosys Science Foundation has thought of this way of making a statement that the world of academics, research and teaching counts. That our universities and research institutions count; that science, the social sciences, history, even ancient history matters."

Upinder Singh

Professor, Department of History, and Reader, University of Delhi

- M.A. in History from the University of Delhi
- M.Phil. in History from the University of Delhi
- Ph.D. in History from McGill University, Montreal

Professor Upinder Singh is being recognized for her contributions as an outstanding historian of ancient and early medieval India. She has been a pioneer in supplementing literary sources with an impressive array of archaeological, epigraphic and numismatic evidence to reconstruct early Indian history brilliantly. The vast chronological span of her scholarship stretches across millennia from the Palaeolithic and Mesolithic ages to 1200 CE.



Rediscovering ancient Indian history



History is about keeping records about our past. It is also about putting events in the past in a context that's relevant to our present. From the Stone Age to a modern day India, the nation's history has often been studied and interpreted by scholars from various schools of thought. These analyses were often colored or shaped by several factors — be they political, cultural, religious or economic.



Prof. Upinder Singh's work is an exciting and challenging exploration of ancient Indian history. Her work not only attempts at giving us a deeper understanding of Indian history, but also evokes intellectual inquiry and debate that form a standard part of learning history for university students and general readers.



Prof. Singh's work has covered different regions in India and looked at the roles people have played in shaping the country's history. She has used sources such as texts, currency, inscriptions and other objects from various periods unearthed by archaeologists to build a strong account of ancient India.



This liberal historian also contributed to the study of ancient cities in India with a detailed study of the city of Delhi through the ages.



Working meticulously, Prof. Singh has attempted a modern rediscovery of ancient India. Her intense study, connecting elements in archaeology and history, while also drawing on relevant literary sources, has made her works commendable.



"Research to me is important because it is a way of illuminating what often seems to be either very obvious and commonsensical or so difficult that it seems impossible to understand."

Amita Baviskar

Associate Professor, Institute of Economic Growth, Delhi

- B.A. in Economics from the University of Delhi
- M.A. in Sociology from the University of Delhi
- Ph.D. in Development Sociology from Cornell University

Prof. Amita Baviskar is widely recognized as the premier sociologist of social movements involving environment and development in contemporary India. Her studies have shown how major government interventions for rural and urban development in India often adversely affect the ability of socially disadvantaged groups to secure access to natural resources, livelihoods and democratic rights.



Working for environmental and social justice



Have you paused to think how our fetish for instant food and an easy lifestyle is altering the ecological balance? Have you wondered where the water and electricity in your city comes from and where your sewage goes? The true cost of our comfortable lives is being paid by others, usually poor villagers and the land, rivers and forests that they depend upon.

India's economic growth has benefited some of us at the expense of others. This injustice has often been worsened by government policies that have displaced or deprived indigenous and other poor people of their rights. The same policies have also depleted our natural resources, affecting other species and the fate of future generations.

Mining for coal, iron and bauxite, building large dams and other projects has displaced more than 50 million people in India since independence. Many of them who come to cities in search of work are forced to live in slums, without clean water or toilets. Denied legal rights, they struggle to survive in a hostile environment.

Prof. Amita Baviskar has been examining the social and ecological impacts of unequal economic growth in India. She has focused on the ill effects of industrial and urban development and has analyzed how poor people are fighting to defend their rights and resources.

An important part of Prof. Baviskar's work has been to analyze how poor people in rural and urban India come together to protect their lives and livelihoods. Her research has shown that poor people overcome their lack of power by building alliances with other social groups. She also shows how social movements fight for justice by mobilizing their cultural heritage to win support from the media and the judicial systems.

Prof. Baviskar is a premier sociologist of current social movements in India. Her work has highlighted many social inequality and resource conflict issues that need to be resolved. Her work has exposed the critical need to mobilize civil society, especially in a democratic country like ours.



Nandini Sundar

Professor, Department of Sociology, Delhi School of Economics

"Anthropology, and anthropological research, allows you to enter worlds that are different from your own, in a comparative perspective as well as a very detailed analysis of particular communities. What keeps me going is the opportunity of combining fieldwork with theoretical reading."

- B.A. in Philosophy, Politics and Economics from Oxford University
- M.A. in Anthropology from Columbia University
- M.Phil. in Anthropology from Columbia University
- Ph.D. in Anthropology from Columbia University

Prof. Nandini Sundar is an outstanding social anthropologist of South Asia, who has made major and original contributions to our understanding of environmental struggles, of the impact of central and state policies on tribal politics, and of the moral ambiguities associated with subaltern political movements in contemporary India. Prof. Sundar has placed her detailed studies of tribal politics in Central India in the broader frame of studies of the law, bureaucracy and morality in modern India.



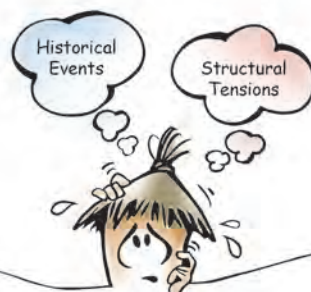
Analyzing indigenous identity and inequality



Prof. Nandini Sundar's work deals with the changing social identities and the politics of knowledge in modern India. Anthropologists are often accused of wanting to keep tribal groups or indigenous people as museum pieces, away from mainstream culture. Prof. Nandini Sundar feels that these communities have never been outside the 'mainstream' of history. Instead, the mainstream has been built by using their resources and appropriating their culture.



Nandini Sundar also studies violence by both state and non-state actors and the question of accountability for crimes committed. She has managed to bring impartiality to controversial subjects in which social scientists encounter the conflicting interests of policy-makers, activists and political parties.



Prof. Sundar has contributed to our understanding of environmental struggles, the impact of central and state policies on tribal politics, and the moral ambiguities associated with subaltern political movements in contemporary India. These contributions are anchored in her deep grasp of the legacies of colonial rule for cultural politics in contemporary India, and in her theoretically innovative understanding of the relationship of major historical events to persistent structural tensions in Indian society.



Prof. Sundar has placed her detailed studies of tribal politics in Central India in the broader frame of studies of the law, bureaucracy and morality in modern India. In so doing, she has combined innovative empirical and ethnographic methods and cutting-edge approaches to those sociological debates which link the study of social change in modern India to central debates in comparative social theory. She has also contributed significantly to international debates on theory and research methodology.



Even as she has the ability to speak to different audiences in the public and policy sphere, Prof. Sundar has made invaluable scholarly contributions to social scientific research at an international level.



Prof. Sundar has also written on the politics of knowledge ranging from schooling to the history of academic disciplines. She has had a major impact on a new generation of scholars of sociology and anthropology all over the world.



"My own conviction is that Indian democracy needs honest brokers. By honest brokers, I mean people who can impartially and objectively assess different kinds of arguments. And, if my writing can be a small contribution to that, I think I'll take some satisfaction."

Pratap Bhanu Mehta

President and Chief Executive, Centre for Policy Research, New Delhi

- B.A. in Philosophy, Politics and Economics from St. John's College, Oxford University
- Ph.D. in Politics from Princeton University

Dr. Pratap Bhanu Mehta has established himself as one of India's finest scholars and public minds, who has inspired a new generation of intellectual enquiry. He has contributed to not only political philosophy and social theory in general, but has also addressed urgent issues of Indian politics and public policy.



Role of intellectual inquiry in a democracy



Ever since Plato's *Republic* examined the nature of justice and what makes a just society, political theorists have delved into how democratic societies can approach an ideal of justice so that their citizens can realize their full potential.



What is the nature of good governance? How can a democratically elected government and its institutions be made accountable and transparent? How can these societies achieve the idea of justice? These are some of the questions that Dr. Pratap Bhanu Mehta has been trying to answer over the years through his research.



Dr. Mehta's work however is not confined to the academic space. His insightful and critical analysis of India's politics and policy has resulted in broadening the sphere of public debate. Political discourse in the public sphere is an important part of nation building and Dr. Mehta has initiated many debates by successfully challenging the many reigning orthodoxies.



A prolific writer, Dr. Mehta's scholarly works cover a wide range of subjects such as Indian political thought, constitutional law, Indian society and India's role in international affairs. His non-academic writing as a columnist captures the zeitgeist of the moment and encourages citizens to ask the right questions on the most urgent issues facing the nation.



In addition to his work in academia and in the public sphere, Dr. Mehta has contributed to institution building with his leadership of the Center for Policy Research (CPR) which has become the foremost non-partisan center for research into public policy and democratic institutions.



Dr. Mehta's research in political philosophy and social theory has inspired a new wave of intellectual enquiry in political science and theory in India.



"I think the field of economics, the field of business is extremely exciting. Partly because we've seen that sometimes economies seize up, they don't work. And, the old answers we had explaining these kinds of things, we find they don't work so well. So there's an enormous amount of work to be done to understand what has happened and what kind of changes we need."

Raghuram G. Rajan

Governor, Reserve Bank of India, and Eric J. Gleacher Distinguished Service Professor of Finance, Graduate School of Business, University of Chicago

- B.Tech. (Electrical) from the Indian Institute of Technology, Delhi
- M.B.A. from the Indian Institute of Management, Ahmedabad
- Ph.D. in Finance from the Massachusetts Institute of Technology

Prof. Raghuram G. Rajan's work has analyzed the contribution of financial development to economic growth, and its potentially harmful effects of dysfunctional incentives that lead to excessive risk-taking. He presented convincing evidence of the possibility of a global financial crisis in 2005, well before the actual crisis occurred during 2008–09.



Predicting a financial meltdown



In the 1950s and 60s, the economies in the West enjoyed a tremendous growth buoyed by the end of the war, the reconstruction boom, and the resurgence of trade. By the 1970s, this rate of growth slowed leading to a massive slump in the western economies. To counter this, in the 1980s and 1990s deregulation of trade became the norm. This led to a rise in new entrepreneurial ventures.



As trade barriers came down, competition between companies increased. In order to perform better, they needed increased financing. This was provided by banks which became the cornerstone of the economy. Bankers went from being boring and safe to taking on increasingly risky ventures. A so-called 'bonus culture' where you were rewarded no matter what, rewarded them for actions that could destroy their own institutions or even the entire system.



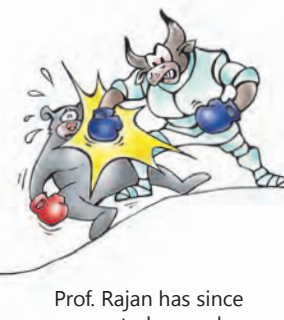
Prof. Raghuram Rajan's work mainly focused on financial institutions and their role in the growth stories of nations. He pointed out that the structure of financial sector compensation was such that bankers were given huge cash incentives to take tremendous risks with other people's money, while imposing no penalties for any losses incurred.



As early as 2005, Prof. Rajan predicted a meltdown based on his extensive research of global financial systems.



In 2008, a catastrophic meltdown hit the global economy and most people were caught unawares.



Prof. Rajan has since suggested several safeguards to financial markets including a plan to create a form of financial catastrophe insurance that banks could buy into.



"If we have to progress as a country, we really need far higher numbers of people contributing ideas. And, I think that's what the Prize (Infosys Prize) will do. It will make research not just respectable but attractive and inspirational for younger people."

Arunava Sen

Professor, Planning Unit, Indian Statistical Institute, New Delhi

- Ph.D. in Economics from Princeton University
- M.Phil. in Economics from Oxford University
- M.A. in Economics from the Delhi School of Economics, University of Delhi

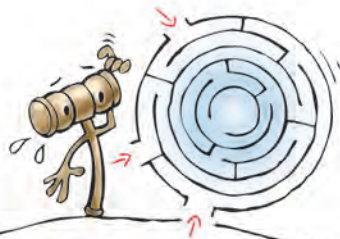
Prof. Arunava Sen's research recognizes that information pertinent to economic policy design is held by individuals who may benefit by misrepresenting it, and that policy implementation is constrained by the freedom of individuals to act. Therefore, it has large implications on real-world policy-making. His main contribution (in joint work with Prof. Dilip Abreu) shows that any social choice rule can be approximated by one that is a Nash equilibrium of such individual interaction.



Examining individual strategic behavior



Have you ever wondered how individuals decide who to vote for in an election and how this affects the outcomes in a democracy? How does one understand and analyze outcomes in events such as the Indian Premier League auctions? Economists use game theory for this purpose. Game theory is the formal analysis of strategic behavior. It considers situations where several agents mutually affect each other and tries to predict outcomes.



Mechanism design is a sub-field of game theory that allows economists to analyze and compare the way in which markets or institutions, such as a government, can efficiently allocate goods and services always allowing for the possibility that the buyers and sellers are privy to information that the other is not aware of.



The theory of mechanism design can be applied to practical problems such as auctioning of resources such as oil, setting rules for voting in elections and even deciding the number of public goods that the government should provide. Similarly, the area of social choice theory is the philosophical and mathematical study of the types of conclusions that can be drawn from studying individual preferences as a whole to produce a social welfare function.



Prof. Arunava Sen's research centers around game theory, mechanism design, social choice, and auction design. His work has been at the purely theoretical level. However, his work could have profound implications for the way policies are formulated by the government. Prof. Sen has done extensive research in social choice theory and builds on the work of Kenneth Arrow and Amartya Sen in this field.



One of the areas in which Prof. Sen's work could be applied to is the issue of land acquisition in the Special Economic Zones (SEZs) or for other industrial developments. His findings reveal that it may be impossible to achieve the kind of voluntary participation, efficiency and incentive compatibility that is required for government policies to work. He outlines other alternatives that the government could implement.



Prof. Sen's work can be used to design the best outcomes or desirable outcomes, where individuals realize that they have strategic power. His research recognizes that information applicable to designing economic policy is held by individuals who may benefit from misrepresenting it, and the implementation of this policy is restricted by the ability of individuals to act independently based on their information.

Social Sciences – Sociology and Anthropology 2013



"I've tried to do social anthropology at three levels. Basically research and teaching related to contemporary issues in India, but I've also tried to take some of this research to the field. I've tried to see how people who are not in academics engage with and understand some of these issues. I'm also now trying to set up a new initiative, which is an alternative learning program for rural youth."

Aninhalli R. Vasavi

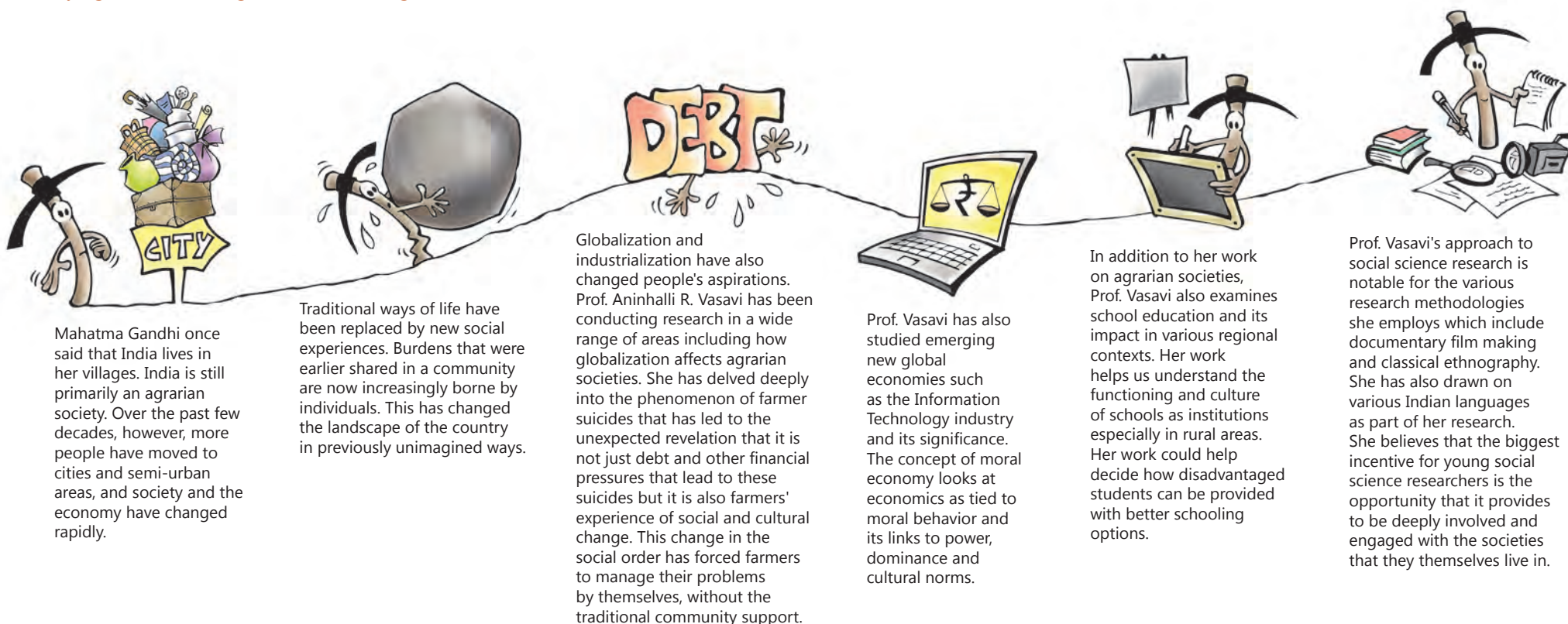
Senior Fellow, Nehru Memorial Museum and Library, New Delhi

- M.A. in Sociology from the University of Delhi
- M.Phil. in Sociology from the University of Delhi
- Ph.D. in Social Anthropology from Michigan State University

Prof. Aninhalli R. Vasavi's wide-ranging, distinctive and pioneering research spans four fields: agrarian society as the intersection of economy, culture and environment; school education in varied regional contexts; moral economy of globalized, glamorized occupations like the IT industry, and interface between (western) social sciences and (vernacular) intellectuals in India. Her two most important contributions enrich our understanding of farmer suicides and rural schooling.



Studying the effects of globalization on agrarian societies



Of origins and journeys

2008

A Prize is set up

Infosys and the National Institute of Advanced Studies (NIAS) awarded the first Infosys Mathematics Prize to Prof. Manindra Agrawal from the Department of Computer Science and Engineering at the Indian Institute of Technology, Kanpur. On February 18, 2009, before the Prize ceremony commenced at NIAS, the Prize purse was increased from ₹10 lakh to ₹50 lakh.

2009

Infosys Science Foundation is born

The Infosys Science Foundation (ISF) was established as a trust with six trustees and N. R. Narayana Murthy as its President. The Prize corpus fund which stands at ₹100 crore today was just ₹20 crore. What started as a Prize for Mathematics expanded to include the larger field of sciences: Engineering and Computer Science, Life Sciences, Mathematical Sciences, Physical Sciences and Social Sciences.

2010

Eminent experts appointed as Jury Chairs

The founding Jury Chairs of the Infosys Prize, some of the best minds in academia, committed to extend their tenure to five years. The Jury Chairs comprise Prof. Amartya Sen, Dr. Inder Verma, Prof. Subra Suresh, Prof. Shrinivas Kulkarni and Prof. Srinivasa Varadhan. Prof. Subra Suresh left the jury to join as the Director of the National Science Foundation in the U.S. Prof. Pradeep Khosla, Chancellor, University of California, San Diego, U.S. was then appointed as the Jury Chair for Engineering and Computer Science.

2011

Lecture Series begins

ISF instituted the Infosys Science Foundation Lecture Series to inform and inspire the youth to consider careers in research. The laureates and jurors through their lectures demystify the world of academia and research. This intervention provides insights for the student community especially about the advances in their respective fields.

2012

The Year of Mathematics

The Government of India declared 2012 as the Year of Mathematics. ISF organized lectures, contests and events to observe this special year.

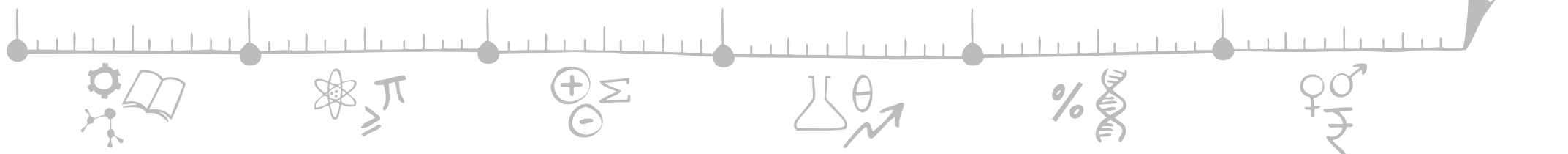
Humanities category added

The Humanities was added as a new category and the Infosys Prize in 2012 for Humanities was awarded in the areas of History and Literary Studies. Prof. Kaushik Basu, Chief Economist at the World Bank and former Chief Economic Adviser to the Government of India was appointed as the Jury Chair for the Social Sciences category and Prof. Amartya Sen became the Jury Chair for Humanities.

2013

Prize grows bigger

ISF celebrates its fifth year anniversary announcing an increase in the Prize purse from ₹50 lakh to ₹55 lakh and a study on research careers in India.



Bibliography

Books

Hawking, Stephen. (2001). *A Brief History of Time from the Big Bang to Black Holes*. Bantam.

Audio

Mehta, P. B. (2011). Interview with CNN-IBN.

Ramaswamy, Sriram. (2011). Interview with CNN IBN

Online sources

A. Ajayaghosh profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2012/ajayaghosh.asp>

Analytic function. (n.d.). Retrieved from http://www.princeton.edu/~achaney/tmve/wiki100k/docs/Analytic_function.html

Arunava Sen profile. In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2012/arunava-sen.asp>

Ashish Lele profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2012/ashish-lele.asp>

Ashoke Sen profile. (n.d.). In *Wikipedia*. http://en.wikipedia.org/wiki/Ashoke_Sen

Ashoke Sen profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2009/ashoke-sen.asp>

Ashutosh Sharma faculty profile. (n.d.). In *IIT Kanpur*. Retrieved from <http://www.iitk.ac.in/che/as.htm/as5.htm>

Ayesha Kidwai faculty profile. (n.d.). *Jawaharlal Nehru University*. Retrieved from <http://www.jnu.ac.in/SLLCS/CL/FacultyProfile.asp>

Banerjee, Abhijit and Duflo, Esther. (2011). *Poor Economics: A radical rethinking of the way to fight global poverty*. Retrieved from <http://pooreconomics.com/about-book>

Banerjee, Abhijit. (1992). A Simple Model of Herd Behavior. *The Quarterly Journal of Economics*. Retrieved from <http://www.jstor.org/stable/2118364>

Banerjee, Abhijit. (n.d.). *Pieces in Popular Press*. Retrieved from <http://economics.mit.edu/faculty/banerjee/pieces>

Baviskar, Amita. (2010). Good to Eat, Good to Think: Why we should study India's changing food cultures. *Infosys Science Foundation Lectures*. Retrieved from <http://www.infosys-science-foundation.com/lectures/videos/index.asp>

Baviskar, Amita. (2010). Good To Eat: Gandhi And The Ethics Of Food. *Ahimsa Day Lecture*. Retrieved from <http://www.gandhitopia.org/profiles/blogs/good-to-eat-gandhi-and-the>

Baviskar, Amita. (2012). Sweat of Shiva's Back. *Outlook India*. Retrieved from <http://www.outlookindia.com/article.aspx?279397>

Chandrashekhar Khare profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2010/chandrashekhar-khare.asp>

Chandrashekhar Khare. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Chandrashekhar_Khare

Cognitive science. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Cognitive_science

Compactifications (physics). (n.d.). In *Wikipedia*. Retrieved from [http://en.wikipedia.org/wiki/Compactification_\(physics\)](http://en.wikipedia.org/wiki/Compactification_(physics))

Definition of Game Theory. (n.d.). In *Investopedia*. Retrieved from <http://www.investopedia.com/terms/g/gametheory.asp>

Definition of Mechanism Design Theory. (n.d.). In *Investopedia*. Retrieved from <http://www.investopedia.com/terms/m/mechanism-design-theory.asp>

Definition of Social Choice Theory. (n.d.). In *Investopedia*. Retrieved from <http://www.investopedia.com/terms/s/social-choice-theory.asp>

Évariste Galois. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/%C3%89variste_Galois

- Fluid bilayer model.(n.d.). *Biology online*. Retrieved from http://www.biology-online.org/dictionary/Fluid_bilayer_model
- Freiberger, Marianne. (2005). Another proof for Fermat's last theorem. *Plus Magazine*. Retrieved from <http://plus.maths.org/content/os/latestnews/jan-apr05/serre/index>
- Gel. (n.d.). In *Wikipedia*. Retrieved from <http://en.wikipedia.org/wiki/Gel>
- Google Scholar citations. (n.d.). Ashutosh Sharma. Retrieved from http://scholar.google.co.in/citations?sortby=pubdate&hl=en&user=MmjJMLIAAAAJ&view_op=list_works
- Gurukkal ,Rajan. (2012, February 21). Archaeo-metallurgy of Indus civilization. *The Hindu*. Retrieved from <http://www.thehindu.com/todays-paper/tp-features/tp-bookreview/archaeometallurgy-of-indus-civilisation/article2914336.ece>
- Hox Genes. (n.d.). *Evolution 101: Understanding complexity*. Retrieved from <http://evolution.berkeley.edu/evosite/evo101/IIC6cComplexity2.shtml>
- Jon. W. and Barnes P. (2007). Biomimetic Solutions to Sticky Problems. *Perspectives*. Retrieved from <http://www.iitk.ac.in/che/downloads/as/Perspective.pdf>
- K. VijayRaghavan profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2009/vijay-raghavan.asp>
- K. VijayRaghavan profile. (n.d.). *National Center for Biological Sciences*. Retrieved from <http://www.ncbs.res.in/vijay>
- Kerstens, Johan; Ruys, Eddy; Zwart, Joost. (ed.) (n. d.). *Lexicon of Linguistics*. Retrieved from <http://www2.let.uu.nl/UiL-OTS/Lexicon/>
- Knordlun. (2005). *Introduction to Nanoscience*. Retrieved from <http://beam.acclab.helsinki.fi/~knordlun/nanotiede/nanosc7nc.pdf>
- Koppes, Steve. (2011). Universal solvent no match for new self-healing sticky gel. *UChicago News*. Retrieved from <http://news.uchicago.edu/article/2011/01/27/universal-solvent-no-match-new-self-healing-sticky-gel>
- Langley, Adam. (2010). Elliptic curves and their implementation. *Imperial Violet*. Retrieved from <https://www.imperialviolet.org/2010/12/04/ecc.html>
- Linguistics. (n.d.). What is Linguistics? *University of California, Santa Cruz*. Retrieved from <http://linguistics.ucsc.edu/about/what-is-linguistics.html>
- Little, Daniel. (2008). "Moral economy" as a historical social concept. *Understanding Society*. Retrieved from <http://understandingsociety.blogspot.co.uk/2008/07/moral-economy-as-historical-social.html>
- Manjul Bhargava profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2012/manjul-bhargava.asp>
- Manjul Bhargava. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Manjul_Bhargava
- Medical Device and Diagnostic Industry. (2002). *Composite Organic Materials Could Yield Stronger Artificial Muscles*. Retrieved from <http://www.mddionline.com/article/composite-organic-materials-could-yield-stronger-artificial-muscles>
- Molecular Cell Biology. (n.d.). In *NCBI Bookshelf*. Retrieved from <http://www.ncbi.nlm.nih.gov/books/NBK21607/def-item/A7679/>
- Moskowitz, Clara. (2009). *What is dark energy?* Retrieved from <http://www.space.com/6619-dark-energy.html>
- Mukunth, Vasudevan. (2013, November 2013). Research in India happens in a few elite institutions. *The Hindu*. Retrieved from <http://www.thehindu.com/opinion/interview/research-in-india-happens-in-a-few-elite-institutions/article5347654.ece>
- Murayama, Hitoshi. (2000). *Introduction to Supersymmetry*. Retrieved from http://hitoshi.berkeley.edu/public_html/susy/susy.html
- Myers, PZ. (2008). Hox Genes in Development: The Hox Code. *Nature Education*. Retrieved from <http://www.nature.com/scitable/topicpage/hox-genes-in-development-the-hox-code-41402>
- Nanoelectronics. (n.d.). *Database of articles in Phys.org*. Retrieved from <http://phys.org/search/?search=nanoelectronics>

Nanotechnology in electronics. (n.d.). In *UnderstandingNano.com*. Retrieved from <http://www.understandingnano.com/nanotechnology-electronics.html>

News Medical. (n. d.). *Dry Eye News and Research*. Retrieved from <http://www.news-medical.net/?tag=/Dry+Eye>

Non-covalent bonds. (n.d.). In *NCBI Bookshelf*. Retrieved from <http://www.ncbi.nlm.nih.gov/books/NBK21726/>

Non-covalent interactions. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Non-covalent_interactions

Nordquist, Richard. (n. d.). Universal Grammar. In *About.com grammar & composition*. Retrieved from <http://grammar.about.com/od/tz/g/unigramterm.htm>

O'Neill, Nick. (2010). The Maldacena Duality. *Fine Structure*. Retrieved from <http://www.finestructure.com/2010/01/the-maldacena-duality/>

O'Neill, Nick. (2010). What is conformal field theory? *Fine Structure*. Retrieved from <http://www.finestructure.com/2010/01/what-is-conformal-field-theory/>

O'Neill, Nick.(2009). Understanding Anti de-Sitter space. *Fine Structure*. Retrieved from <http://www.finestructure.com/2009/05/understanding-anti-de-sitter-space/>

Organic Actuators. (n.d.). Encyclopedia of Nanotechnology. In *SpringerReference*. Retrieved from <http://www.springerreference.com/docs/html/chapterdbid/339916.html>

Organometallic compounds. (n.d.). In *Encyclopedia Britannica online*. Retrieved from <http://www.britannica.com/EBchecked/topic/432186/organometallic-compound>

Padmanabhan, Thanu. (2012). *Emergent perspective of Gravity and Dark Energy* (PDF document). Retrieved from <http://arxiv.org/pdf/1207.0505v1.pdf>

Padmanabhan, Thanu. (2011). Grappling with Gravity (PDF document). *Scientific American India*. Retrieved from <http://www.iucaa.ernet.in/~paddy/research/SAfinalarticle.pdf>

Plato's Ethics and Politics in The Republic.(2009). *Stanford Encyclopedia of Philosophy*. Retrieved from <http://plato.stanford.edu/entries/plato-ethics-politics/>

Polymer definition. (n.d.). In *About.com Chemistry*. Retrieved from <http://chemistry.about.com/od/chemistryglossary/g/polymerdef.htm>

Pratap Bhanu Mehta profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2011/pratap-bhanu-mehta.asp>

Pratap Bhanu Mehta profile. (n.d.). In *Center for Policy Research*. Retrieved from <http://www.cprindia.org/users/pratap-bhanu-mehta>

Protohistory. (n.d.). In *Wikipedia*. Retrieved from <http://en.wikipedia.org/wiki/Protohistory>

Quantum Field Theory. (n.d.). *Encyclopedia Britannica online*. Retrieved from <http://www.britannica.com/EBchecked/topic/486221/quantum-field-theory>

Raghuram G. Rajan profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2011/raghuram-rajan.asp>

Rajan, Raghuram G. (2012). The true lessons of the recession (PDF document). *Foreign Affairs*. Retrieved from <http://macromon.files.wordpress.com/2011/04/the-true-lessons-of-the-recession.pdf>

Ramaswamy, Sriram. (n.d.). Matter out of Equilibrium. *ISF Lecture*. Retrieved from <http://www.infosys-science-foundation.com/lectures/videos/index.asp>

Rosiak, Janusz M. (n.d.). Radiation formation of hydrogels for biomedical applications. *IAEA Report*. Retrieved from http://www.mitr.p.lodz.pl/biomat/raport/2_radiation_hydrogels.html

Sandip Trivedi Homepage. (n.d.). In *Tata Institute of Fundamental Research*. Retrieved from <http://theory.tifr.res.in/~sandip/>

Sandip Trivedi profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2010/sandip-trivedi.asp>

Sandip Trivedi. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Sandip_Trivedi

Sanjay Subrahmanyam profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2012/sanjay-subrahmanyam.asp>

Satyajit Mayor profile. (n.d.). In *Infosys Science Foundation*. Retrieved from <http://www.infosys-science-foundation.com/prize/laureates/2012/satyajit-mayor.asp>

Satyajit Mayor profile. (n.d.). *National Center for Biological Sciences*. Retrieved from <http://www.ncbs.res.in/mayor>

Scrambling (linguistics). (n.d.). In *Wikipedia*. Retrieved from [http://en.wikipedia.org/wiki/Scrambling_\(linguistics\)](http://en.wikipedia.org/wiki/Scrambling_(linguistics))

Sen, Ashoke. (n.d.). *String Theory and Einstein's Dream* (PDF document). Retrieved from <http://www.hri.res.in/~sen/current2.pdf>

So, what is string theory then? (n.d.). *The Official String Theory Website*. Retrieved from <http://superstringtheory.com/basics/basic4.html>

Strassler, Matt. (2011). Of Particular Significance. *Conversations About Science with Theoretical Physicist Matt Strassler*. Retrieved from <http://profmattstrassler.com/articles-and-posts/some-speculative-theoretical-ideas-for-the-lhc/supersymmetry/supersymmetry-what-is-it/>

Sundar, Nandini. (n.d.). *Nandini Sundar blog*. Retrieved from <http://nandinisundar.blogspot.in/>

Sundar, Nandini. (2002). 'Indigenise, nationalise and spiritualise' – an agenda for education? (PDF document). Retrieved from <http://people.du.ac.in/~nandini/NWISSJ396P.pdf>

Supersymmetry breaking. (n.d.). In *Wikipedia*. Retrieved from http://en.wikipedia.org/wiki/Supersymmetry_breaking

Thanu Padmanabhan profile. (n.d.). In *Infosys Science Foundation*. <http://www.infosys-science-foundation.com/prize/laureates/2009/thanu-padmanabhan.asp>

About J-PAL. (n.d.). *The Abdul Jameel Poverty Action Lab*. Retrieved from <http://www.povertyactionlab.org/about-j-pal>

The Official String Theory Website. (n.d.). Retrieved from <http://superstringtheory.com/index.html>

Unified Field Theory. (n.d.). *Encyclopedia Britannica online*. Retrieved from <http://www.britannica.com/EBchecked/topic/614522/unified-field-theory>

Vasavi, A.R. (n.d.). *Suicides and the Making of India's Agrarian Distress* (PDF document). Retrieved from <http://www.yale.edu/agrarianstudies/colloqpapers/04vasavi.pdf>

Weiler, N. Hans (2009). *Whose Knowledge Matters? Development and the Politics of Knowledge* (PDF document). Retrieved from http://www.stanford.edu/~weiler/Texts09/Weiler_Molt_09.pdf

What is indigenous knowledge? (n.d.). *The World Bank Group*. Retrieved from <http://www.worldbank.org/afr/ik/basic.htm>

Bhargava, Manjul. (2004, October 18). Manjul Bhargava: An Artist of Music and Math. *NPR*. Retrieved from <http://www.npr.org/templates/story/story.php?storyId=4111253>

Jayaraman, T. (2005, April 25). Going beyond Fermat's last theorem. *The Hindu*. Retrieved from <http://hindu.com/2005/04/25/stories/2005042506530100.htm>

Unknown. (2008, October 17). Mathematicians Illuminate Deep Connection Between Classical And Quantum Physics. *Science Daily*. Retrieved from <http://www.sciencedaily.com/releases/2008/10/081010081650.htm>

Overbye, Dennis. (2010, July 12). A Scientist Takes On Gravity. *The New York Times*. Retrieved from <http://www.nytimes.com/2010/07/13/science/13gravity.html?pagewanted=all>

Debroy, Bibek. (2010, August 15). The disappearing Indian village. *Financial Express*. Retrieved from <http://www.financialexpress.com/news/the-disappearing-indian-village/660376>

Zhang, Justine. (2012, February 6). Man of Mathematics. *The Stanford Daily*. Retrieved from <http://www.stanforddaily.com/2012/02/06/man-of-mathematics/>

Unknown. (2012, June 20). Researchers create self-assembling nanodevices that move and change shape on demand. *Wyss Institute*. Retrieved from <http://wyss.harvard.edu/viewpressrelease/35/researchers-create-selfassembling-nanodevices-that-move-and-change-shape-on-demand>

Kurup, Deepa. (2012, July 20). State must reclaim its role. *The Hindu*. Retrieved from <http://www.thehindu.com/news/cities/bangalore/state-must-reclaim-its-role/article3658903.ece>

Special Correspondent. (2012, July 31). Prize for Indian chasing Einstein's dream. *The Telegraph*. Retrieved from http://www.telegraphindia.com/1120801/jsp/nation/story_15798328.jsp#.UkVrdNKnPCY

Chaudhary, Juhi. (2012, December 31). Infosys award winner Dr Arunava Sen decodes auction mechanism. *IBNLive*. Retrieved from <http://ibnlive.in.com/news/infosys-award-winner-dr-arunava-sen-decodes-auction-mechanism/313175-3.html>

Cimons, Marlene. (2013, April 5). Mathematics is the Pursuit of Beauty. *Live Science*. Retrieved from <http://www.livescience.com/28508-numbers-manjul-bhargava-nsf-bts.html>

Radford, Tim. (2013, August 2). Fermat's Last Theorem by Simon Singh – book review. *The Guardian*. Retrieved from <http://www.theguardian.com/science/2013/aug/02/fermats-last-theorem-simon-singh-review>

Johnson, Eric Michael. (2013, September 23). Human Nature and the Moral Economy. *Scientific American*. Retrieved from <http://blogs.scientificamerican.com/primate-diaries/2013/09/23/human-nature-and-the-moral-economy/>

Unknown. (2013, October 4). Nanodevices for a 'More than Moore' world. *Phys.org*. Retrieved from <http://phys.org/news/2013-10-nanodevices-world.html>

Mishra, Pankaj. (2013, November 21). Which India Matters. *The New York Review of Books*. Retrieved from <http://www.nybooks.com/articles/archives/2013/nov/21/which-india-matters/>

INFOSYS SCIENCE FOUNDATION

Infosys Campus, Electronics City, Hosur Road, Bangalore 560 100
Tel: 91 80 2852 0261 | Fax: 91 80 2852 0362 | Email: ISF@infosys.com
www.infosys-science-foundation.com

Creative concept and design by Communication Design Group, Infosys Limited.

© 2014 Infosys Science Foundation, Bangalore, India. The Infosys Science Foundation acknowledges the proprietary rights in the trademarks and product names of other companies mentioned in this book.