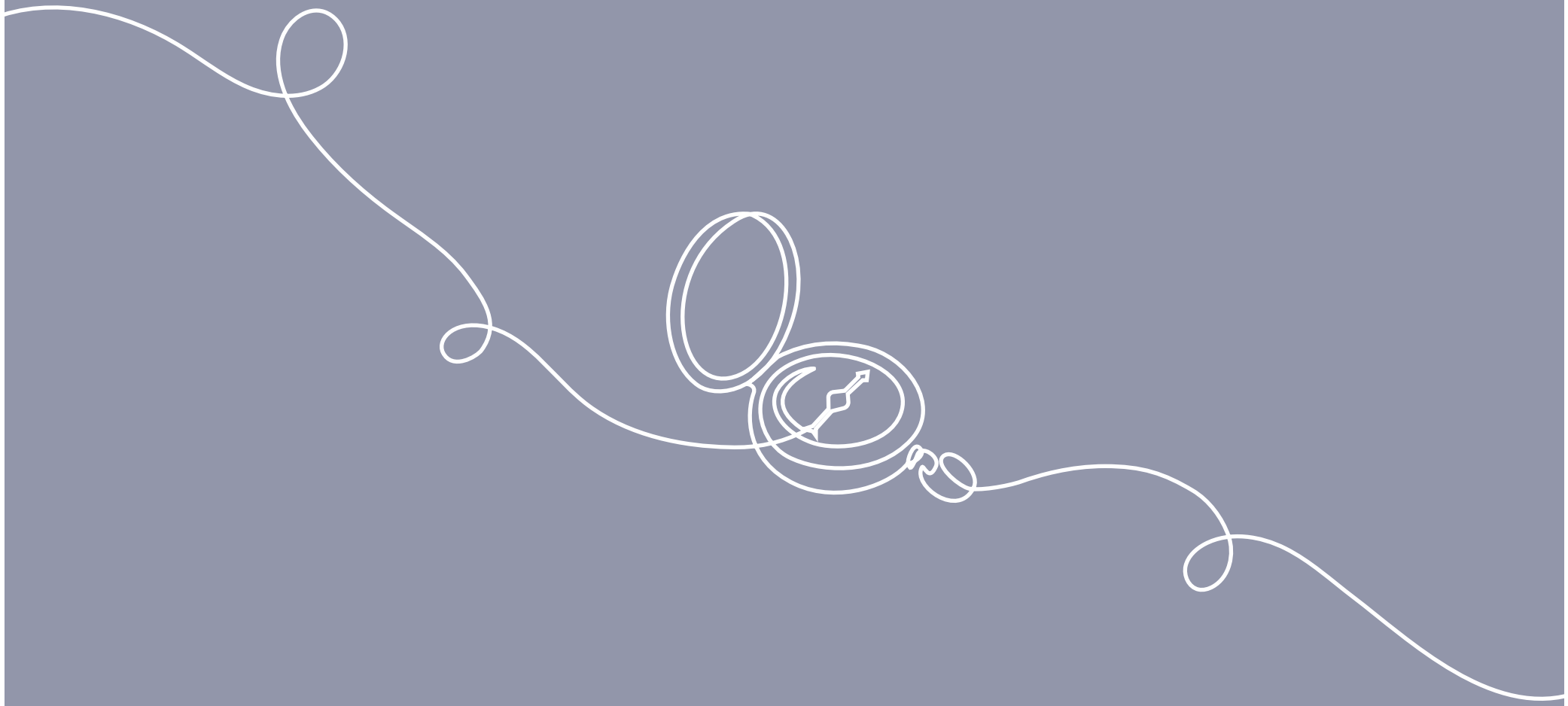
INFOSYS SCIENCE FOUNDATION

INFOSYS PRIZE 2024



Fair winds ahead for a brave new world

One of our laureates this year studies how merchant ships in the pre-modern era plied their trade in the Indian Ocean and how this led to changes in the places where they made landfall. The captains of those ships were masters at changing the direction of their vessels based on the direction and speed of the wind and on encountering unexpected stormy weather. They used sextants to measure the angles between celestial bodies and the horizon and compasses to make sure they stayed on course to their destinations.

Just as with those ships navigating the vast ocean, so too with organizations. As they mature and grow in an ever more complex world, a rethinking becomes necessary while staying true to the core founding principles. A quote that is often attributed to the philosopher Heraclitus of Ephesus is that change is the only constant. Individuals and organizations must change and adapt to changing conditions around them.

For 15 years the Infosys Prize recognized and awarded some of the most brilliant minds in research and scholarship. These mid-career scientists went on to win bigger awards like the Nobel and also became icons for generations of scholars. This was in keeping with the mandate of the Infosys Science Foundation—to inspire and encourage future generations of scientists and scholars. In 2024, we set out to reward early career researchers who are 40 years or younger. These changes indicate a commitment to seeking out extraordinary talent and ability early and providing them an opportunity to flourish.

So many of the existential dilemmas that we face today require creative thinking and the coming together of ideas. It is our hope that we have set in motion a process of rewarding brilliant young minds who will be the beating heart of a brave new world.

Meet our new laureates and here's wishing them fair winds in their voyages ahead.

Arun G. Chandrasekhar

Professor of Economics, Stanford University, USA

Arun Gautham Chandrasekhar is Professor of Economics at Stanford University. He became Associate Professor at Stanford University in 2020 and was promoted to full professor earlier this year. To be full professor, at a top university like Stanford, before one's 40th birthday is a notable achievement. He obtained his Ph.D. from MIT in Economics. Prof. Chandrasekhar did his B.A., majoring in mathematics as well as economics, from Columbia University and was summa cum laude. He has published in top journals, including *Econometrica, American Economic Review, Review of Economic Studies, Journal of the Royal Statistical Society: Series B, Proceedings of the National Academy of Sciences,* and *Science.* He has received major research grants, from organizations like the National Science Foundation and Russell Sage Foundation. Chandrasekhar has been an Associate Editor of *American Economic Review,* and the *Journal of the European Economic Association.*

Economics

The Infosys Prize 2024 in Economics is awarded to Prof. Arun Chandrasekhar for his contribution to the study of social and economic networks, using innovative data sets and drawing on theoretical methods from machine learning and computer science. His collection and mapping of networks data, from multiple Karnataka villages, provides a testbed for studying important questions in development economics.

Scope and impact of work

In developing countries, where formal institutions often do not work well, networks play a critical role by facilitating exchange that otherwise would not occur. Prof. Arun Chandrasekhar's research centers around the impact of networks on economic interactions in developing economies, with a focus on key areas like social learning, cooperation and informal institutions. His research investigates how information diffuses and aggregates through networks, examining the role of individual network positions in shaping outcomes. He also studies how networks promote cooperation and how the entry of formal markets affects network structures. His research is guided by theory and utilizes a variety of methodologies, including observational data collection, field and laboratory experiments, and structural and reduced-form modeling, to investigate these issues and produce policy insights.

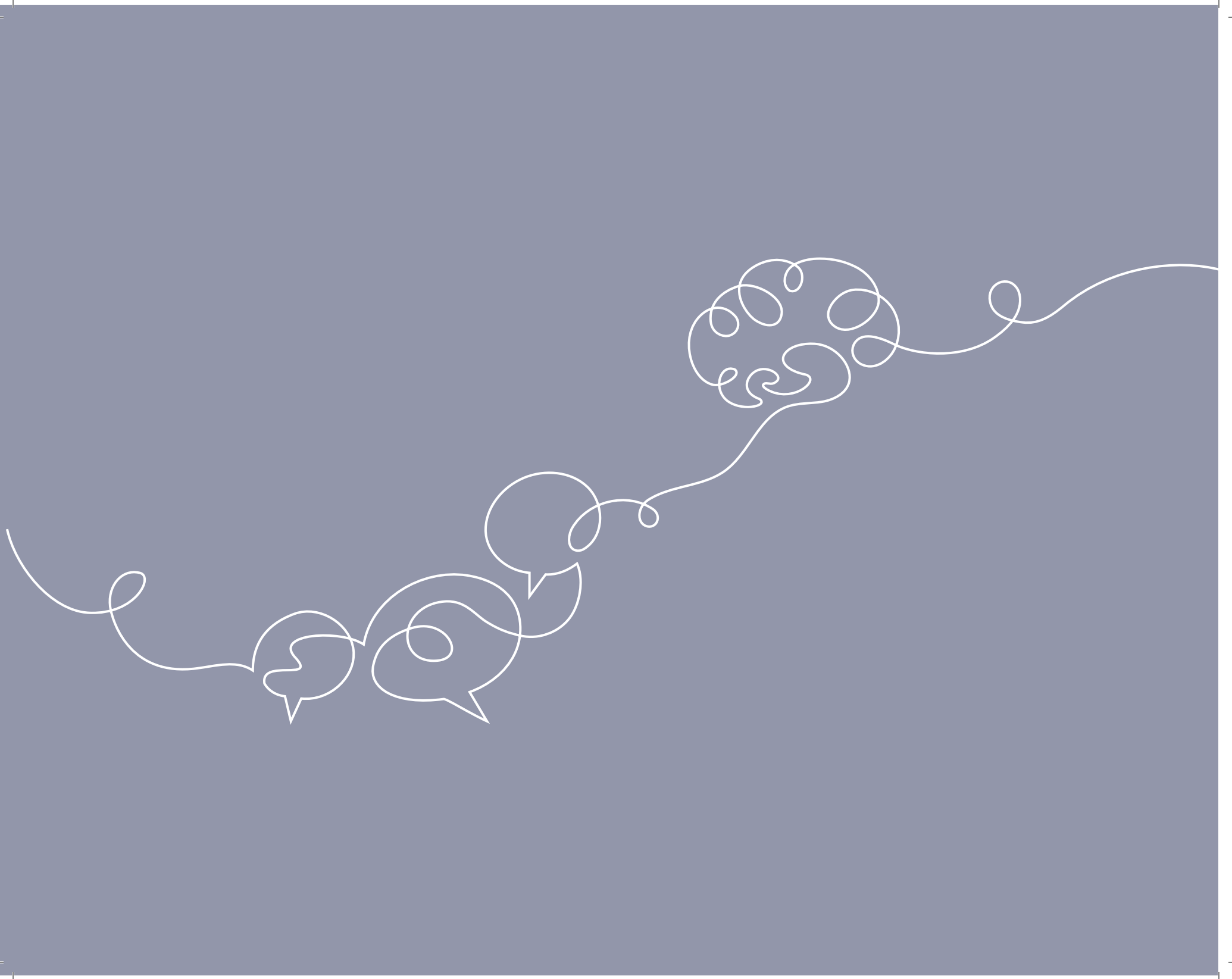
Prof. Chandrasekhar's research has substantial implications for policy design – informing effective strategies for information dissemination, promoting financial inclusion, and tackling poverty. He has also made significant methodological contributions to developing innovative and cost-effective methods for network analysis, enabling wider application of network science in social science research. He has published in leading journals, including *Econometrica, American Economic Review, Review of Economic Studies, Journal of the Royal Statistical Society: Series B, Proceedings of the National Academy of Sciences,* and *Science*. Arun Chandrasekhar has received major research grants, such as from the National Science Foundation and Russell Sage Foundation. His works have been widely cited, and is especially so for the paper, "The Diffusion of Microfinance", in *Science*, 2013. These are outstanding performance indicators for someone below age 40, and augurs well for what lies ahead.

Expanded citation

Prof. Arun Chandrasekhar is one of the world's most accomplished researchers on social networks. Networks are interaction structures among individuals that shape human activity and can substitute and complement markets. Prof. Chandrasekhar uses different approaches from theoretical modeling to randomized control trials, drawing on techniques from computer science and statistics to answer questions pertaining to economic development. He has made seminal contributions to understanding how information diffuses through society and how individuals aggregate information received from others. This helps identify individuals who play a key role in the diffusion of ideas and technology through society. Another area of his research is how social learning occurs, and the role played by network geometry in the learning process. Arun Chandrasekhar's research has important implications for the design of institutions in a world where communication via social networks has become a part of everyday life.

"I would like to express my congratulations to Arun Chandrasekhar, the winner of the Infosys Prize 2024 in Economics. All jury members were taken in by the range of his research, from the meticulous gathering of data to the use of innovative methods for analyzing them. Arun's work sheds light on the role of networks in the functioning of a modern economy, and provides critical ingredients for better policy making, and hope for a better world."

– Kaushik Basu



The social network: Who you know could help you save more and other strange stories

In many developing countries, formal institutions while present are weak. In such places, people's social networks play a big role in economic outcomes. These networks act as sources of information, advice, credit and insurance. What are social networks? Imagine a scenario where you get recommended for and land a job through your friends and other connections. That's probably the simplest example of a social network having an economic outcome.

And it's not just jobs but networks through which we share information and trends and other data influence our economic choices. Take the example of social media influencers who 'influence' what we buy. These networks also affect access to markets. The sociologist Jacob Moreno was the first to study social networks by looking at interpersonal relationships. By the 1950s Moreno's methods of study was mathematically formalized and began to be used in disciplines like economics and other social sciences.

Prof. Arun Chandrasekhar studies the role that social networks play in economic development. He looks particularly at how information is disseminated through social networks and how the received information is used. The research also looks at how certain individuals play a key role in how and what sort of information and even technology is diffused through society.

Prof. Chandrasekhar's research centered around villages in Karnataka. The data gathered from looking at how informal networks in these areas function and affect economic outcomes was then analyzed using theoretical modeling, machine learning and other methods.

One of the studies that Chandrasekhar and his colleagues conducted was on the introduction of microcredit in 43 out of 75 villages in Karnataka and 51 out of 102 neighborhoods in Hyderabad. The studies showed that introducing microcredit in these places changed social networks, and in extant unintuitive ways. Those who were least likely to take up microcredit experienced the greatest losses in links, even among sets of friends in which no one was involved in microcredit. And this was accompanied by a loss in the ability to borrow from informal networks for those households.

In another study Chandrasekhar and his colleagues looked at whether individuals save more when their behavior is made observable to another member of the village by sharing with them their self-set savings goals. The idea was that the individual uses a savings account that has the property that it will share with the individual's 'monitor' information about how far they have come in reaching their goals. People who cared about how others perceived them would save more when randomly assigned 'central monitors' who more widely disseminate information and inform others in the network about the saver's progress.

Prof. Chandrasekhar's research has profound implications for policy design and helps inform how best to design strategies for disseminating information, increase financial inclusion, and thus more effectively tackle poverty.

Shyam Gollakota

Professor, Paul G. Allen School of Computer Science & Engineering, University of Washington

Shyam Gollakota is Washington Research Foundation and Thomas J. Cable Endowed Professor and leads the Mobile Intelligence Lab at the University of Washington's Paul G. Allen School of Computer Science and Engineering. His research addresses machine learning for mobile systems, mobile health, networking, human-computer interaction and battery-free computing, among others.

Prof. Gollakota is the recipient of the National Science Foundation CAREER Award, the Alfred P. Sloan Fellowship, the SIGMOBILE Rockstar award and the ACM Grace Murray Hopper Award, and was recently named a Moore Inventor Fellow. He was also named to the *MIT Technology Review's* 35 Innovators Under 35 list, twice to the *Forbes'* 30 Under 30 list and as one of the *Popular Science* 'Brilliant 10'. He graduated from IIT-Madras and MIT, where his Ph.D. dissertation won the ACM doctoral dissertation award.

Engineering & Computer Science

The Infosys Prize 2024 in Engineering and Computer Science is awarded to Prof. Shyam Gollakota for his impactful research and technology translation spanning multiple engineering domains in societally relevant areas such as smart-phone based affordable healthcare tools for low- and middle-income countries, battery-free computing and communication, and augmentation of human auditory sensing with artificial intelligence.

Scope and impact of work

Prof. Shyam Gollakota has done game-changing work on "programmable sound" that has impacted multiple diagnostics areas. His group introduced the idea of transforming smart devices into active sonar systems for contactless physiological sensing. This was a truly remarkable idea since before this the only way to do wireless contactless sensing was by using radio-frequency devices. Using microphones and speakers on smart devices, Prof. Gollakota demonstrated that he could create an active sonar system that emits inaudible sound signals from the phone and that analyzes the reflections to detect minute breathing motion. Since every commodity device has a microphone and a speaker, this method can scale to billions of devices using just software.

Shyam Gollakota has also pioneered the augmentation of human auditory perception with artificial intelligence. This technology will allow us to program our acoustic scenes so that we can focus on specific sounds or remove unwanted ones based on their semantic descriptions. This capability entails understanding and manipulating an acoustic scene, isolating each sound and associating a 2D spatial context or semantic meaning with each individual sound — a formidable challenge even for the human brain.

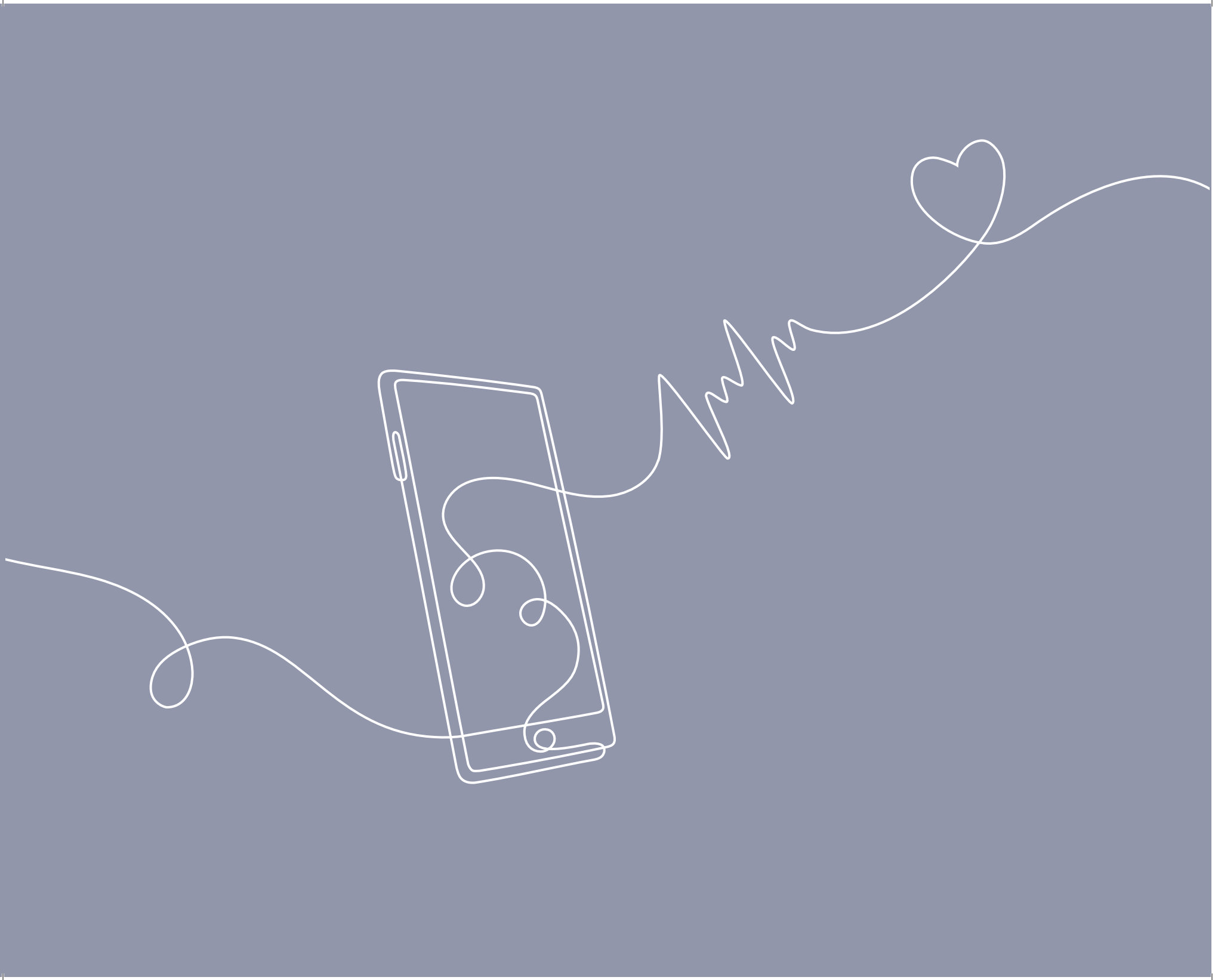
Gollakota has been a pioneer of battery-free communications using ambient backscatter. Here, wireless devices reflect ambient signals to communicate, reducing energy consumption. This work has enabled battery-free devices ranging from cell phones and cameras to underwater Wi-Fi and powerline networks and has created completely new research directions in mobile and wireless communication.

Expanded citation

Prof. Shyam Gollakota is a pioneer in mobile systems whose work has been intellectually deep, highly influential in the research community, and hugely impactful in society at large. He has done foundational work in using ambient backscatter to develop battery-free wireless communications that has established new directions for the wireless and mobile community. Prof. Gollakota has turned the smartphone into a powerful device for medical diagnostics and his work on contactless physiological sensing is used by millions of patients. Most recently, he has worked on augmenting the human auditory sense with artificial intelligence, enabling the user to amplify specific environmental sounds and muting others. Such extraordinary capabilities may well become commonplace in billions of earbuds and hearing aids in the years to come. Shyam Gollakota is a proven thought leader, and his work will continue to transform computing.

"Congratulations to Prof. Shyam Gollakota on winning the Infosys Prize 2024 for Engineering and Computer Science. His work on mobile and wireless communications is game-changing. Particularly impressive is his work on active sonar systems for physiological sensing, battery-free communications and the use of AI to selectively tailor acoustic landscapes. These innovations will continue to benefit humanity for years to come."

— Jayathi Murthy



Flying computers and life-saving smart phones: The magic of translational research

Imagine a world where flying battery-less wireless sensing computers that float like dandelion seeds are ubiquitous. Or a world where tiny origami shape-changing solar-powered microfliers help monitor pollution levels and airborne diseases. Or a robotic acoustic swarm that can isolate a specific person's speech in a room of hundreds who are all speaking at once. Imagine your smartphone being able to detect a fatal blood clot.

This is science fiction made fact.

These are just some of the inventions that Prof. Shyam Gollakota's lab is working on. Prof. Gollakota's work spans different domains of engineering and disciplines. Gollakota and his colleagues have developed several societally relevant devices using interdisciplinary methods. While origami microfliers and battery-less flying computers are exciting inventions, the most important ones use smartphones as affordable diagnostic tools.

As healthcare costs skyrocket around the world, there is a need for quick and affordable diagnostics. Gollakota's devices are helping millions of people to use computing tools for monitoring irregular heart rhythm, blood clots, testing for ear infections and hearing in newborns.

Cost-effective devices to detect hearing impairment in newborns become increasingly essential as WHO figures show that 5.3% of the world's population suffers from debilitating hearing loss. Much of this can be mitigated with early detection. Gollakota's lab devised low-cost wireless earbuds that can help screen for hearing impairment by detecting otoacoustic emissions which are faint sounds emitted by the cochlea (a small spiral organ in the inner ear that converts sound waves into electrical impulses that the brain interprets as sound). The low-cost earbuds are combined with wireless sensing algorithms and help to identify the emissions and detect hearing problems.

Blood clots can be life-threatening. And for people who are on medicines like warfarin, frequent testing is essential. However, these tests can be expensive and wait times can be long. Prof. Gollakota's lab devised a way to use smartphones to detect blood clots. Their technique uses the vibration motor and camera on smartphones to track micro-mechanical movements of copper particles and to calculate frequent prothrombin time (PT) and international normalized ratio (INR) which will help determine blood clots.

Sleep apnea is a condition that affects millions around the world. It is a condition that leads to hypertension, diabetes, stroke and other conditions. Diagnosing sleep apnea can be an expensive and time-consuming process. The app invented by Gollakota's lab, uses smartphones to detect apnea events. They transformed a smartphone into an active sonar system that emits frequency-modulated sound signals and listens to their reflections. Gollakota and his colleagues developed algorithms that identify various sleep apnea events from these sonar reflections.

From flying computers and microfliers to smartphones as diagnostic tools, Prof. Gollakota's inventions run the gamut of translational research. These inventions will benefit people around the world for decades to come.

Mahmood Kooria

Lecturer, School of History, Classics and Archaeology, University of Edinburgh, UK

Prof. Mahmood Kooria is one of the world's leading scholars of Indian Ocean Islam, or maritime Islam generally, particularly in the pre-modern and early modern periods. He is an expert in Arabic and Malayalam texts of many kinds, with a special interest in the corpus of Shafi'i legal thought produced in or for scholars and readers in Kerala.

Prof. Kooria completed his B.A. in History and Islamic Studies at Darul Huda Islamic Academy and the University of Calicut. He did his M.A. in Ancient History at Jawaharlal Nehru University in Delhi and his M. Phil. in History and Landscape Archaeology. He completed his Ph.D. in Global History at Leiden University, Institute for History in 2016.

Kooria is the author of many published essays and book chapters; the pathbreaking volume *Islamic Law in Circulation: Shafi'i Texts Across the Indian Ocean and the Mediterranean* (2022); three edited volumes, *Malabar in the Indian Ocean: Cosmopolitanism in a Maritime Historical Region,* with Michael N. Pearson (2018) and *Islamic Law in the Indian Ocean: Texts, Ideas and Practices,* with Sanne Ravensbergen (2022); and *Narrating Africa in South Asia* (New York: Routledge, 2023). Mahmood Kooria teaches at Edinburgh University and has also taught at the Ashoka University, Leiden University, University of Bergen, and the National Islamic University Jakarta.

Humanities & Social Sciences

The Infosys Prize 2024 in Humanities and Social Sciences is awarded to Prof. Mahmood Kooria of the University of Edinburgh for his truly outstanding and seminal contributions to the study of maritime Islam in a global perspective, with particular focus on Kerala in the pre-modern and early modern eras. His pioneering studies have revealed the role of Islamic law in shaping economic, political, and cultural transformations on the Indian Ocean littoral.

Scope and impact of work

Prof. Mahmood Kooria's historical scholarship has enriched, in fact radically revised, the study of maritime Islam in general and of the Islamic communities and cultures of Kerala in particular. Prof. Kooria's range is spectacular: from East Africa, the Middle East, to South Asia and Indonesia and Malaysia, also including the colonial powers of the Netherlands, Great Britain, and Germany. He has produced an intellectual and cultural history of Shafi'i Islam in the Indian Ocean and brought to life the controversies and debates among Kerala-based Muslim jurists, poets, and scholars in the contexts of changing social, economic, agrarian, and ritual life in pre-modern and early modern Malabar.

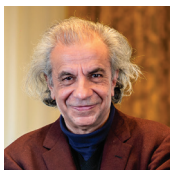
Kooria has also created an active community of historians whose work embraces the entire physical space of the Indian Ocean coasts and the longue durée of Islamic cultures throughout that global, though always locally inflected, space. His book, *Islamic Law in Circulation: Shafi'i Texts Across the Indian Ocean and the Mediterranean* (2022), gives us not only a narrative prosopography of all the major Kerala authors and texts, in Arabic and Malayalam, but also subtle analyses of this large corpus in terms of its historical presence and meaning.

Mahmood Kooria is also the first historian of Kerala to describe in depth the impact of maritime Islam—not only merchant-sailors but also itinerant scholars, poets, and thinkers—on the agrarian landscape of north Malabar in the seventeenth and eighteenth centuries. His two edited volumes—*Malabar in the Indian Ocean: Cosmopolitanism in a Maritime Historical Region* (with Michael Naylor Pearson) and *Islamic Law in the Indian Ocean World: Texts, Ideas and Practices* (with Sanne Ravensbergen)—open up a formidable menu of case studies. We note his sensitivity to novel ideas (evident in the name of the latter volume) as intrinsic to the historical study of hard-core socio-economic and political processes.

Expanded citation

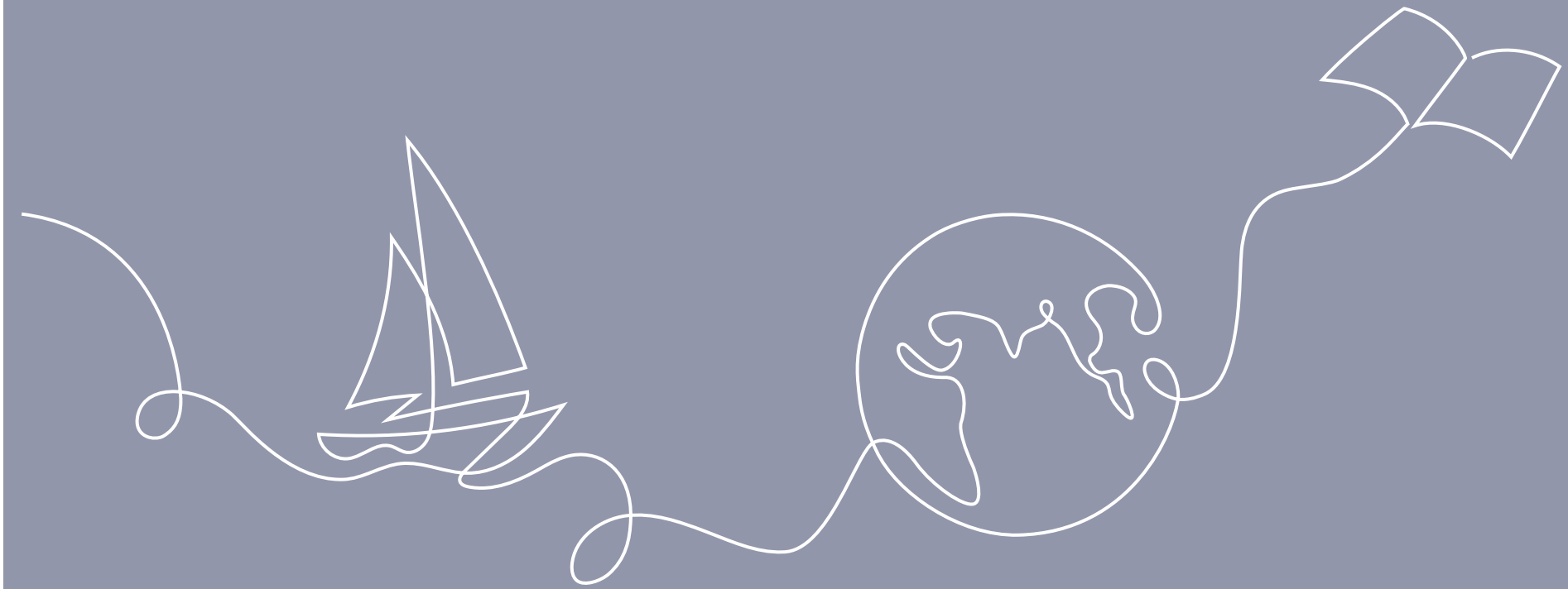
The Infosys Prize 2024 in Humanities and Social Sciences is awarded to Prof. Mahmood Kooria for pioneering research into the history of maritime Islam in the Indian Ocean, with special emphasis on the Malabar Coast in Kerala in the pre-modern and early modern eras. His many works reveal an astonishing historical scope and depth, an impressive interdisciplinary methodology, and critical creative insights into the cultural and material impact of Islamic (in particular, Shafi'i) law on Kerala society and beyond.

Prof. Kooria's scholarship has opened up, indeed effectively created, a hitherto largely unexplored field of study—that of the Kerala Islamic communities and the rich corpus of legal, literary, and historical texts, in Arabic and Malayalam, that Muslim authors composed in or for Kerala over the last seven centuries. Mahmood Kooria's book, *Islamic Law in Circulation: Shafi'i Texts Across the Indian Ocean and the Mediterranean (2022),* offers a brilliant picture of these communities in times of profound social and economic change.



"My warm congratulations to Mahmood Kooria on his being awarded the Infosys Prize 2024 in Humanities and Social Sciences for his remarkable contributions to the historical study of Islamic legal texts and the wide circulatory influence they have achieved, through maritime travel, in distant lands. I am very glad to have had the chance to read almost all the work that his prodigious learning and questing mind has produced on this and other related subjects that link West Asia, Africa, India, and South-East Asia. I very much hope that the prize will spur him to new heights of scholarship and historical insight and expect that one day he will have the same reputation and impact on Ocean Studies in the East that Bernard Bailyn has had on what has come to be called Atlantic History."

– Akeel Bilgrami



The Indian Ocean: An archive of history

The Indian Ocean has been of interest to historians for a long time. Powered by the monsoon winds, the Indian Ocean became a hub of trade. Unlike the Atlantic where the winds blow in one direction year-round, the monsoon winds that reverse direction in different seasons powering ships, ensured that the Indian Ocean became the world's oldest long-distance trans-oceanic trading arena. It is often called the cradle of globalization. For thousands of years, this trade formed networks between South Asia, the Middle East, East Africa, Southeast Asia and East Asia.

But along with commercial goods, there was also cultural exchange that happened between the people in these regions. Merchant ships also carried wandering scholars, writers, and thinkers. After the founding of Islam in the 7th century, the Indian Ocean trade routes also became a channel for the spread of Islam. The texts of Islam, Islamic law and other major disciplines were carried by Muslim itinerants from the 9th century onwards. So prevalent was this circulation of knowledge, traditions and communities that many scholars referred to the Indian Ocean as the Islamic Sea. Arab, Persian, Indian, Swahili, Malay, Abyssinian and Javanese communities traversed these ocean routes, and shaped the customs and traditions of the people they mingled with on the shores where they made landfall.

Prof. Mahmood Kooria studies the Indian Ocean from the point of view of maritime Islam in the Indian Ocean and specifically the Malabar Coast in the pre- and early-modern eras. This is an area of rich historic significance, with a long and storied history of trade dating back centuries prior to the arrival of Europeans. Prof. Kooria's research shows how Islamic law and traditions have impacted life in places like southern India. He looks particularly at the Shafi'i school of Muslim jurisprudence (one of four Sunni schools, the others being Hanafi, Maliki, and Hanbali), which is followed by the communities in places like Kerala.

The Shafi'i school named after the jurist Idris al-Shafi from the 8th century is particularly interesting for having found its way from the Middle East to places as far away as Mozambique and Indonesia. The spread of Islamic law along these coastal areas and how they influenced communities and legal traditions in these regions forms a significant part of Prof. Kooria's research. He examines in depth the intellectual and cultural history of Shafi'i Islam in the Malabar coast through the debates among Kerala's Muslim jurists, authors, and scholars in the pre- and early modern eras. His book, *Islamic Law in Circulation: Shafi'i Texts Across the Indian Ocean and the Mediterranean,* examines a few major works by authors in Kerala in Arabic and Malayalam and provides an analysis of this body of work and its historical significance. Kooria's focus lies not just in Kerala but other areas around the Indian Ocean such as East Africa, the Middle East, and Southeast Asia. Prof. Kooria's work has huge significance in the historical study of the shaping of socio-economic, legal and political processes across this vast ocean.

Siddhesh Kamat

Associate Professor, Department of Biology, Indian Institute of Science Education and Research, Pune

Siddhesh Kamat is Associate Professor in the Department of Biology at IISER, Pune. He completed his B.Tech. from UDCT, Mumbai and his Ph.D. from the Department of Chemistry, Texas A&M University, before joining IISER in 2016. As a young scientist he is well recognized internationally and nationally. He is a recipient of a Swarnajayanti Fellowship from the DST and has been appointed as an EMBO Young Investigator. Dr. Kamat has been awarded a DBT-Wellcome Trust India Alliance Intermediate Fellowship, and he has received a Young Scientist medal from the Indian National Science Academy and the Merck Young Scientist Award in Biological Sciences. He serves as Chairperson, National Facility for Gene Function in Health and Disease, at IISER Pune. In addition to his scientific leadership, as evident in his team's outstanding record of publications, he has developed one of India's most advanced mass-spectrometry and lipidomics facilities and enabled important collaborative research.

Life Sciences

The Infosys Prize 2024 in Life Sciences is awarded to Dr. Siddhesh Kamat for his discoveries concerning bioactive lipids and their receptors, and their metabolic and signaling pathways. His research using advanced methods to understand the function of lipids, a key component of cells, has important implications for understanding the role of these molecules in a range of cellular functions and human diseases.

Scope and impact of work

The major theme of Dr. Siddhesh Kamat's research is to understand how bioactive lipids communicate signals in health and disease. While there are several bioactive lipids in an organism, Dr. Kamat has focused on lyso-phosphatidylserine (lyso-PS). His work has revealed that dysregulation in lyso-PS, caused by deleterious mutations in the enzyme involved in its metabolism, is an underlying reason for the pathology associated with specific neurodegenerative diseases.

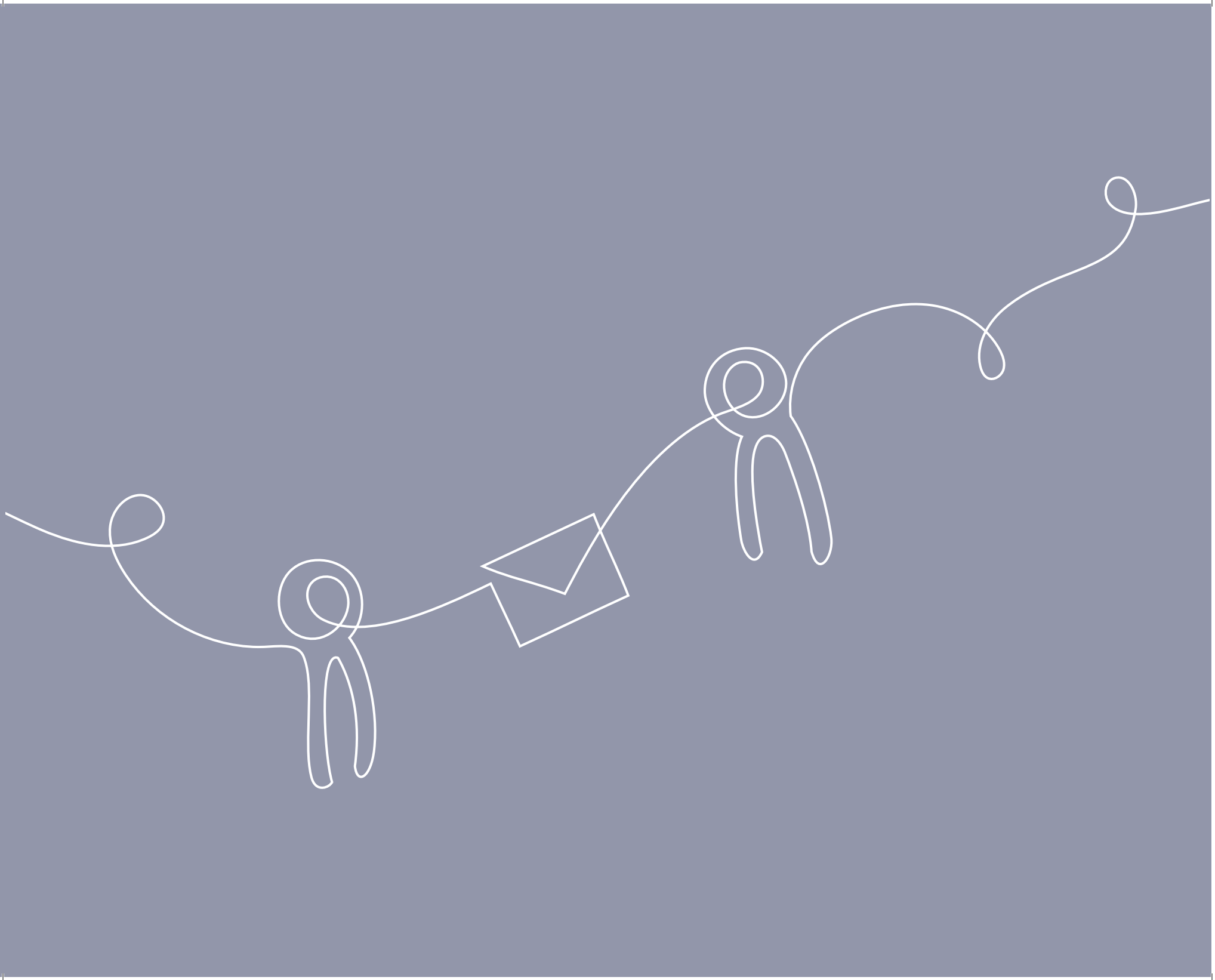
Using a chemical biology and a chemical synthetic approach coupled with the development of an advanced lipidomics platform, Kamat has shown that lyso-PS with very long lipid tails act through a Toll-like receptor, TLR2, in the mammalian brain, and elevation of their levels in the brain exacerbates the neuroinflammation associated with PHARC, a rare autosomal neurodegenerative disease. Using sophisticated liquid chromatography combined with mass spectrometry (LC-MS) approaches he has shown that bioactive lipids also regulate critical processes in the immune system such as the clearance of pathogens via phagocytosis, or release of histamine in response to allergens, revealing a potential crosstalk between the nervous and immune systems in human neurological disorders. His work has identified how the deleterious effects of lipid oxidation are mediated by the metabolism of oxidized PS. Together, Siddhesh Kamat's work has established him as an emerging leader in the field of lipid signaling and metabolism and its role in human diseases.

Expanded citation

Dr. Siddhesh Kamat has made significant contributions towards our understanding of bioactive lipid signaling. Lipids, together with proteins and carbohydrates, are a fundamental constituent of living cells. As a postdoctoral fellow, Dr. Kamat identified a new mechanism for generation of a class of lipids, lyso-phosphatidylserine (lyso-PS). At IISER Pune, his laboratory has focused on lyso-PS signaling, using advanced lipidomics and mass spectrometry technologies to discover receptors and enzymes involved in lyso-PS reception and metabolism, and identify the role of lyso-PS in neurological and autoimmune diseases. His work has expanded our understanding of lipid pathways in immunity, identifying novel lysine deacetylases for metabolic regulation and the regulation of oxidized lipids due to reactive oxygen species production. Kamat's expertise has enabled insightful collaborative research in lipid homeostasis, mycobacterial lipid synthesis, and triglyceride secretion, and his cutting-edge facilities are a vital resource for scientists across India. Siddhesh Kamat's pioneering work in chemical biology has the potential to provide new therapeutic approaches to treating neurodegenerative disorders and metabolic diseases.

"On behalf of the jury, I congratulate you on receiving the Infosys Prize 2024 in Life Sciences. The prize recognizes your pioneering research on the bioactive lipid lyso-PS, including its metabolism, reception and signaling, and its role in neurological and immunological function and disease. The jury also recognizes you for the development of leading-edge mass spectrometry and lipidomics facilities which have had an invaluable impact on collaborative research in multiple areas of biology."

– Mriganka Sur



Bioactive lipids: The hidden superheroes

When we talk about lipids, we usually think of dietary triglycerides and cholesterol and their association with cardiovascular disease. But lipids are so much more than a cause for another health concern. Did you know that lipids play a very important role in cell metabolism and cell function in general? The story of the study of lipids is a long and interesting one that dates back to the 15th century. In the 20th century several Nobel Prizes have gone to scientists working on various interesting aspects of lipids.

The word lipid has its origins in the Greek term lipos, meaning fat. The term was first introduced by a French pharmacologist, Gabriel Bertrand. Lipids play an important role in the body. They help in storing energy, are a crucial structural component of cell membranes, and help in signaling (which is how a biological cell responds to external stimuli).

Dr. Siddhesh Kamat works specifically with bioactive lipids, which are important compounds that help in regulating various important functions in the human body. Bioactive lipids are compounds that bind themselves to important cellular proteins (e.g. receptors, channel proteins) and help in bringing about biological effects dealing with the cell's metabolism and signaling. Any disruption in the homeostatic levels of these bioactive lipids in the human body often leads to diseases. The focus of Dr. Kamat's work is trying to understand how the bioactive lipids communicate signals in normal health and why dysregulation in their metabolism causes diseases.

Dr. Kamat's lab works with a particular type of bioactive lipid called lysophosphatidylserine or lyso-PS. His work has helped identify how the disruption of lyso-PS leads to various neurological and autoimmune disorders and especially worked out how this lipid causes a human neurodegenerative disorder called PHARC (an acronym for Polyneuropathy, hearing loss, ataxia, retinitis pigmentosa, and cataract). His work on lyso-PS lipids has also shed light on how this bioactive lipid is important in the functioning of our immune system. Additionally, Dr. Kamat's lab has also shown how bioactive lipids are involved in eliminating disease-causing pathogens and various allergens from the human body. Overall, his lab's work on lyso-PS lipids has led to the interesting conclusion that there is potential crosstalk happening between the brain and the immune system in the body.

Lipidomics began emerging as a discipline in 2003 and as the name suggests, it involves the comprehensive study of all cellular lipids on a large scale using analytical chemistry principles and technologies such as mass spectrometry. Besides studying bioactive lipids, from a technological standpoint, Dr. Kamat's lab has also developed cutting edge mass spectrometry based lipidomics technologies to profile the complete array of cellular lipids. These lipidomics technologies are now becoming very popular across various disciplines of biology to quantitatively measure diverse lipids and understand their association with human health and disease.

Neena Gupta

Professor, Theoretical Statistics and Mathematics Unit, Indian Statistical Institute, Kolkata

Neena Gupta earned her Ph.D. from the Indian Statistical Institute in Kolkata in 2012, where she is now a professor. Her contributions have been widely recognized: she received the prestigious Shanti Swarup Bhatnagar Prize in Mathematical Sciences in 2019, making her one of its youngest recipients and one of the few women to receive this honor.

Prof. Gupta received the Nari Shakti Puraskar from the President of India for the year 2021, and the DST-ICTP-IMU Ramanujan Prize in 2021. She was an invited speaker at the International Congress of Mathematicians in 2022 and received the 2023 TWAS-CAS Young Scientist Award for Frontier Science.

Most recently she has been selected to deliver the AWS-AMS Noether Lecture in January 2025 at the annual meeting of the American Mathematical Society.

Mathematical Sciences

The Infosys Prize 2024 in Mathematical Sciences is awarded to Prof. Neena Gupta for her work on the Zariski Cancellation Problem, a fundamental problem in algebraic geometry, a version of which was first posed in 1949 by Oscar Zariski, one of the founders of modern algebraic geometry. In 2014 she proved the striking result that a 3-dimensional affine variety constructed by Asanuma yields a negative answer to the Zariski Cancellation Problem in positive characteristic.

Scope and impact of work

Prof. Neena Gupta's solution of the Zariski Cancellation Problem is a landmark achievement in affine algebraic geometry. Affine algebraic geometry explores what at first sight might look like very simple objects, namely collections of polynomials in variables: 3X^2+5YZ+W^3 is an example of a polynomial in the variable X, Y, Z, W. Zariski's problem revolves around the cancellation property for polynomials, essentially asking whether an algebraic object (a quotient of a polynomial ring), that becomes isomorphic to the polynomial ring in variables X_1,.., X_n after adding a variable, is itself such a polynomial ring in some variables. In more geometric terms the problem asks: if two geometric objects have the same structure after adding a dimension to them (which is like considering cylinders over them), then do the objects themselves have the same structure?

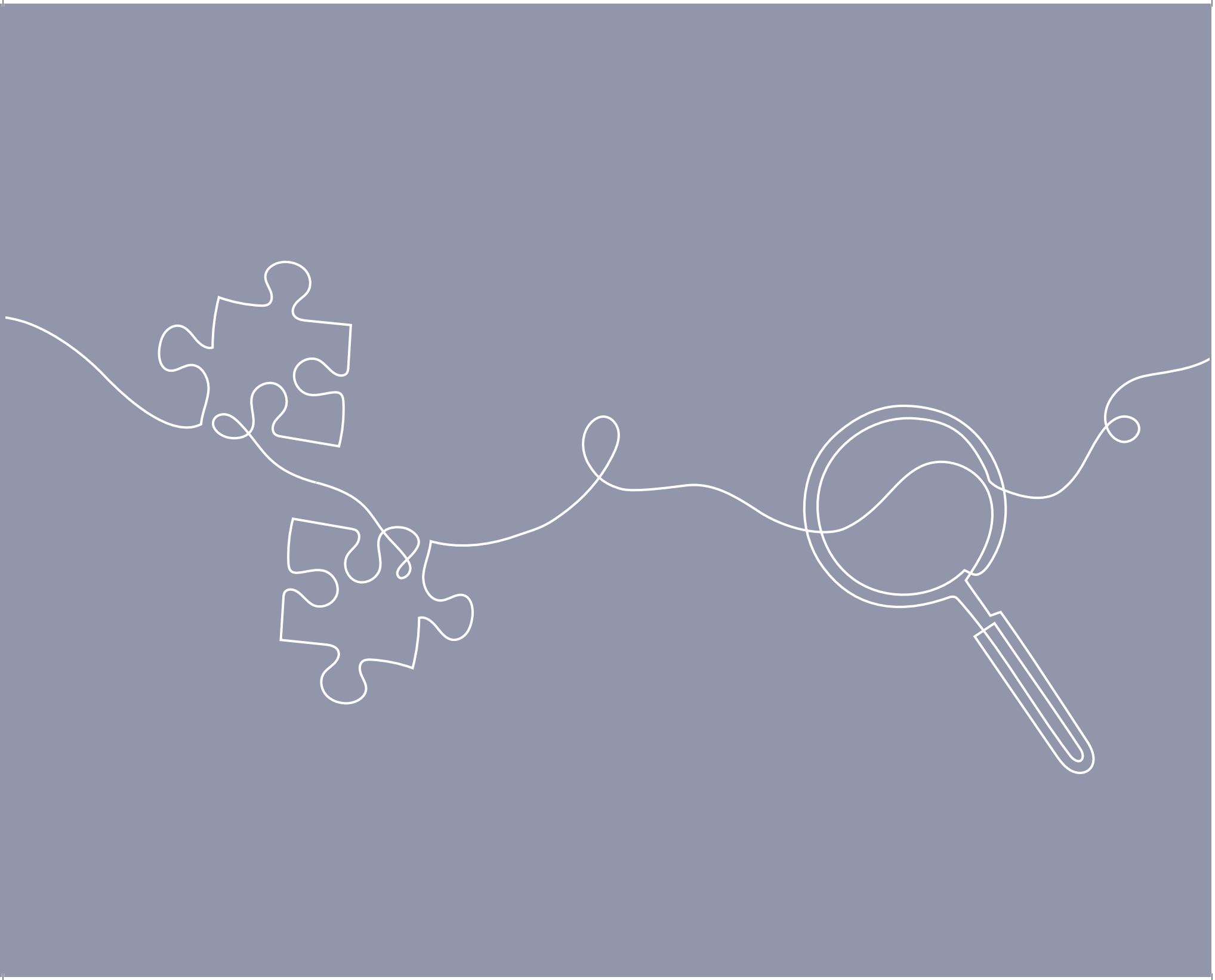
Prof. Gupta's work not only resolved a long-standing problem in the case of positive characteristic, by answering the question in the negative, but also presents a theory that brings out unexpected connections between several concepts in the area. Her solution also had a striking elegance and made a great impact in the mathematical community. Her work has had a significant and lasting impact on algebraic geometry and commutative algebra, areas that are central to modern mathematics.

Expanded citation

Prof. Neena Gupta's work has had a big impact in the field of algebraic geometry, particularly through her solution to the long-standing Zariski Cancellation Problem. Her work answers a very basic question which can be informally described as: if two geometric objects have the same structure after adding a dimension to them, can one deduce that they are in fact the same? In her breakthrough work she showed that, in positive characteristic, contrary to what one might expect, the answer is in the negative. Thus, the innocuous looking move of adding a dimension can destroy information. Prof. Gupta's intricate proof shows that a specific 3-dimensional affine variety constructed earlier by Asanuma yields a counterexample to Zariski's problem in positive characteristic. In a follow-up work, she revealed surprising connections of this problem with other fundamental problems and concepts on affine spaces. In subsequent work with her collaborators, she has established further striking results in commutative algebra and algebraic geometry.

"I extend my heartfelt congratulations to Prof. Neena Gupta for her remarkable work, particularly her solution to the Zariski Cancellation Problem. Her work has had a big impact on the closely related fields of commutative algebra and algebraic geometry. She has done all her work in India and is a role model for many young people wanting to pursue fundamental research in the pure sciences in the country."

– Chandrashekhar Khare



The Zariski Cancellation Problem: Solving one of math's greatest problems

Algebraic geometry looks at geometric shapes arising from solutions of a system of polynomial equations. Oscar Zariski, the Russian-born American mathematician, was one of the most influential mathematicians of the twentieth century who brought rigor in classical algebraic geometry and laid the foundation of modern algebraic geometry.

In 1949, Zariski posed a version of what came to be called the Zariski Cancellation Problem. This fundamental problem in mathematics asks if a geometric object has the structure of an affine space after adding a dimension to it, is then the geometric object similar to an affine space?

During the 1970s as an outcome of research of several mathematicians including S.S. Abhyankar, P. Eakin, W.J. Heinzer, M. Miyanishi, T. Sugie, T. Fujita, and P. Russell, the two-dimensional case was successfully resolved affirmatively. After that it had remained an open problem in higher dimension. It acquired a formidable reputation as one of the most difficult problems on affine spaces.

From the 1980s several mathematicians tried to solve the higher dimensional cases. In 2014, Prof. Neena Gupta published a breakthrough proof that showed that for 3-dimensional spaces adding a dimension destroys information and that the structure does not remain the same. Prof. Gupta used an example constructed by the Japanese mathematician Teruo Asanuma to prove this. Later she extended his example in higher dimensions too.

In subsequent work with her collaborators Neena Gupta has established further striking results in commutative algebra and algebraic geometry.

Prof. Gupta's work, a seminal achievement in the study of "affine algebraic geometry'', has opened up new horizons and is inspiring young researchers to look into other open conjectures and unsolved problems in mathematics.

Vedika Khemani

Associate Professor, Physics Department, Stanford University, USA

From her days as a graduate student in Princeton, Prof. Vedika Khemani has stood out as exceptional in her ability to collaborate with senior colleagues on equal terms to explore, synthesize, and inform. She has the rare mastery of theory and experiment, an ability to engage both groups in pursuit of new phenomena and deeper understanding of known ones.

Following Prof. Khemani's Ph.D. at Princeton she was admitted to the Harvard Society of Fellows where she continued her meteoric rise, joined the Stanford faculty and in three short years, obtained a tenured position. As a junior faculty, Khemani has won major fellowships and awards: Sloane Fellowship (2020), the McMillan Prize (2020), Packard Fellowship (2021), and Young Investigator Award (2023). For her work on time crystals, she won the Breakthrough New Horizons Prize in 2022.

Today Vedika Khemani is a leading condensed matter theorist who mentors a group of extremely talented students and postdocs. She is in great demand as a speaker, having spoken in over 100 conferences including at the American Physical Society, German Physical Society, Aspen Center for Physics, International Centre for Theoretical Physics (ICTP), Max Planck Institute, Kavli Institute for Theoretical Physics (KITP), International Centre for Theoretical Sciences (ICTS), and Solvay Conference (2022). Prof. Vedika Khemani has lectured at the Cargese, Les Houches, Boulder, Princeton, and ICTP summer schools.

Physical Sciences

The Infosys Prize 2024 in Physical Sciences is awarded to Prof. Vedika Khemani, who has made wide-ranging and groundbreaking contributions to theoretical and experimental non-equilibrium quantum matter, most notably the discovery of time-crystals.

Scope and impact of work

Prof. Vedika Khemani works in the area of non-equilibrium many-body physics. Here are some of the fundamental questions she has addressed and answered. With Immanuel Bloch's experimental group, she established the existence of the pre-thermalization phase which precedes actual thermalization. Other inquiries include the following: How does hydrodynamics emerge in such quantum systems? How does one describe the frequency dependent conductivity of MBL (many-body localized) states? How do systems transition from ergodic to localized behavior? Conventional conservation laws divide phase space into "sectors" with different values of the conservation law, and a large part of the physics of many body localization comes from the emergence of unusual local conservation laws that continue to exist under small perturbations. In several papers, mostly with other relatively junior scientists, Prof. Khemani has studied intermediate possibilities where the dynamics of a system break into a large number of sectors for reasons other than conservation laws.

In the interest of brevity only the time crystal will be discussed in any detail because it is the most fascinating and easiest to describe. Can a quantum system break time-translation symmetry the way ordinary crystals break translations symmetry by forming a lattice starting with the continuum? A pendulum clock seems to be an answer, because it breaks the time continuum into periods of length T. The problem is that eventually it will reach equilibrium with the outside world and lose its energy by equipartition. On the other hand, the time crystal oscillates at a period equal to twice that of the driving field, never heats up, and being a non-equilibrium state to begin with, can go on forever. The key to this is many-body localization. The absence of heating, not just at one point in parameter space but over a range is the signature of this phenomenon. In a *Nature* paper in collaboration with Google's AI group, Khemani and collaborators describe a realization of the time-crystal: the system of spins flipping back and forth between two many-body localized states.

Expanded citation

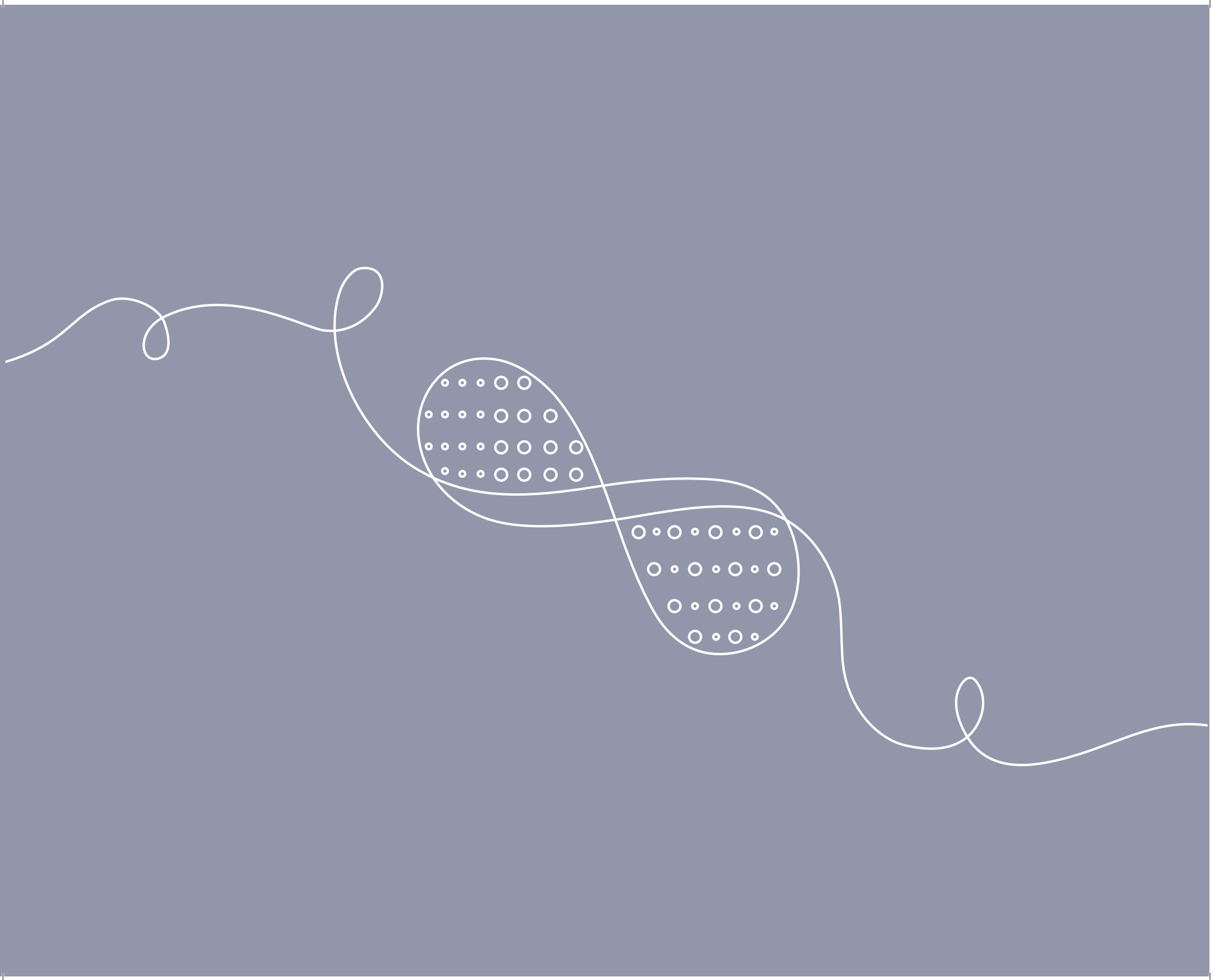
Prof. Vedika Khemani has made extensive contributions to the broad area of non-equilibrium many-body systems. With her unique command of both theory and experiment, she has managed to spearhead their symbiosis, attacking and solving a wide array of problems from both ends.

Prof. Khemani has investigated fundamental theoretical issues such as thermalization and the hydrodynamic description of quantum many body systems. She and her collaborators showed how to unify traditional hydrodynamics and a recently elegant explanation of how a closed quantum system manages to dissipate. Another landmark contribution of Khemani is the discovery of a new mechanism for ergodicity breaking, now called Hilbert space fragmentation.

Vedika Khemani's work has led to a deeper understanding of the many-body-localized (MBL) phase and most importantly in realizing that periodically driven MBL systems provide a paradigm for realizing time crystals. She collaborated with the scientists at Google to use their quantum processor to provide a working model of a time crystal.

"Congratulations Prof. Vedika Khemani! Your work addressed a fundamental topic in physics: Crystals. Ordinary crystals are periodic in space and last forever. For a long time, physicists have wondered about the temporal equivalents, time crystals. With your deep theoretical knowledge and a keen awareness of practicality you teamed up with experimentalists and demonstrated time crystals—systems which are periodic in time and lasting forever. The jury panel noted not only your fundamental contribution to physics but also your unique approach to fundamental quantum mechanics."

– Shrinivas Kulkarni



The quest for time crystals: A new phase of matter

The quantum world is an unexplored frontier for scientists. It is a world where the laws of classical physics that we hold inviolable don't apply. Albert Einstein famously was not in favor of quantum physics precisely because the theory defied all commonsense notions of classical physics. It should come as no surprise then that time crystals, objects that defy the second law of thermodynamics exist in the quantum world. It is a world strange enough to make a perpetual motion machine possible—something impossible in the world we live in thanks to friction.

When we think of crystals in the general sense of the word, we usually think of diamonds or other types of crystals. For physicists, crystals are objects of symmetries and the breaking of those symmetries. And time crystals (until recently) were hypothetical structures that move in regular repeating patterns without requiring energy. These structures manage to be both stable and ever-changing at the same time.

Time crystals also defy what we know about phases of matter. For example, water can remain water or become ice, meaning that their thermal equilibrium remains stable and the atoms that make them up remain at the lowest possible energy permitted by the temperature of their environment. A time crystal on the other hand is a phase of matter that remains both at equilibrium and in an excited and evolving state at the same time.

The idea of the time crystal was first posited by the Nobel laureate Frank Wilczek in 2012.

Prof. Vedika Khemani is a condensed matter physicist who helped demonstrate that a time crystal was not just a hypothetical state of matter but something that was actually possible. Prof. Khemani and her collaborators used the quantum computer at Google to experimentally demonstrate the existence of time crystals.

Prof. Khemani's original work on many-body localization is what helped her demonstrate time crystals. The many-body localization theory posits that a one-dimensional chain of quantum particles can get stuck in a fixed state—a state known as many-body localization. This was the first component of a time crystal. The next phase of the experiment was to see what happens when a many-body localized system is hit with a laser. Khemani and her collaborators found that it moves between two different many-body localized states in a repeating cycle without using up or expending energy. In 2019, Google announced that the Sycamore quantum computer had completed a task in 200 seconds that would take a normal computer 10,000 years to complete. Quantum computers are made up of qubits which are quantum particles that can be controlled. Google's qubits are made of superconducting strips of aluminum, which have two possible energy states. Khemani's collaborators at Google used a chip with 20 qubits that could be programmed for different strengths of interactions, making the time crystal possible.

The practical applications of time crystals remain to be seen.

Jury Chairs

Economics

Kaushik Basu

Kaushik Basu is Professor of Economics and the C. Marks Professor of International Studies at Cornell University. He is a former Chief Economist and Senior Vice President of the World Bank. Prior to joining the World Bank, he served as Chief Economic Adviser to the Government of India. A Fellow of the Econometric Society, he has published widely in the areas of Development Economics, Industrial Organization, Game Theory and Welfare Economics. His books include *Analytical Development Economics* (1997), *Prelude to Political Economy: A Study of the Social and Political Foundations of Economics* (2000), *Of People, Of Places: Sketches from an Economist's Notebook* (1994), *Beyond the Invisible Hand: Groundwork for a New Economics* (2011), *An Economist's Miscellany* (2011), and *The Republic of Beliefs* (2018). In May 2008, he was awarded the Padma Bhushan by the Government of India.

Jurors

Danny Quah

Li Ka Shing Professor in Economics and Dean, Lee Kuan Yew School of Public Policy, National University of Singapore

Sudipta Sarangi

Professor & Department Head, Department of Economics, Virginia Tech

Seema Jayachandran

Director of RPDE, Professor of Economics and Public Affairs, Princeton University

Tridip Ray

Professor, Economics and Planning Unit, Indian Statistical Institute, Delhi

Eliana La Ferrara

Professor of Public Policy, Harvard Kennedy School

Engineering & Computer Science

Jayathi Y. Murthy

Prof. Jayathi Murthy is the President of Oregon State University. Prior to joining Oregon State, Murthy served as the first woman dean of the UCLA Henry Samueli School of Engineering and Applied Science. She led the effort to establish Women in Engineering at UCLA – a program that supports the full participation of women in engineering. While at UCLA, she was active in helping raise more than $330 million in philanthropy. Prof. Murthy is a member of the National Academy of Engineering (NAE), foreign fellow of the Indian National Academy of Engineering (INAE), fellow of the American Society of Mechanical Engineers (ASME) and the recipient of many honors, including the ASME Heat Transfer Memorial Award in 2016, the ASME Electronics and Photonics Packaging Division Clock Award, and ASME Kate Gleason Award in 2023.

Jurors

Kaushik Bhattacharya

Howell N. Tyson, Sr., Professor of Mechanics and Materials Science; Vice Provost Department of Mechanical and Civil Engineering, California Institute of Technology, USA

Dhananjaya Dendukuri

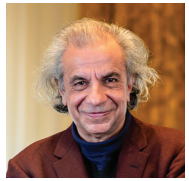
CEO & Co-Founder, Achira Labs Pvt. Ltd., Bengaluru

Ashutosh Sharma

Institute Chair Professor, Department of Chemical Engineering, Indian Institute of Technology, Kanpur

Sunita Sarawagi

Institute Chair Professor, Computer Science and Engineering, Indian Institute of Technology, Bombay



Humanities & Social Sciences

Akeel Bilgrami

Akeel Bilgrami is the Sidney Morgenbesser Professor of Philosophy and Professor, Committee on Global Thought, Columbia University. He is the author of the books *Belief and Meaning, Self-Knowledge and Resentment,* and *Secularism, Identity, and Enchantment.* At Columbia he has been the Chairman of the Philosophy Department from 1994-98, the Director of the Heyman Centre for the Humanities from Dec 2003-2010, and the Director of the South Asian Institute from 2013-2016. He was elected Cullman Fellow at the New York Public Library, held the Radhakrishnan Chair in India, visiting professorships at Oxford University and Yale University, and has been the recipient of fellowships and grants from the Mellon Foundation, Ford Foundation, National Endowment of the Humanities, as well as the Luce Foundation. He is also the President of the Trustees and the Executive Editor of *The Journal of Philosophy*.

Jurors

Kalpana Kannabiran

Distinguished Professor, Council for Social Development, New Delhi

David Shulman

Professor Emeritus, Hebrew University, Jerusalem and Member of the Israel Academy of Sciences and Humanities

Janet Gyatso

Hershey Professor of Buddhist Studies, Harvard Divinity School, USA

Niraja Gopal Jayal

Professor, Avantha Chair, King's India Institute, King's College London

Prachi Deshpande

Associate Professor of History, Centre for Studies in Social Sciences, Kolkata

Life Sciences

Mriganka Sur

Mriganka Sur is the Newton Professor of Neuroscience; Director, Simons Center for the Social Brain; and Investigator, Picower Institute for Learning and Memory, at the Massachusetts Institute of Technology. He was head of the MIT Department of Brain and Cognitive Sciences for 15 years. The McGovern Institute for Brain Research was founded under his leadership. At MIT, Sur received the Hans-Lukas Teuber Scholar Award in the Brain Sciences (1997), the Sherman Fairchild Chair (1998), and the Newton Chair (2008). He is an elected Fellow of the Royal Society (UK), the US National Academy of Medicine, the American Academy of Arts and Sciences, and the Indian National Science Academy.

Jurors

Lalita Ramakrishnan

Professor of Immunology and Infectious Diseases, University of Cambridge, UK

Imran Siddiqi

Emeritus Scientist, Centre for Cellular and Molecular Biology, CSIR, Hyderabad

Gagandeep Kang

Director, Enterics, Diagnostics, Genomics and Epidemiology-Global Health, Bill and Melinda Gates Foundation, USA

Satyajit Mayor

Leverhulme International Professor, Centre for Mechanochemical Cell Biology, Warwick University, UK

Paola Arlotta

Chair, Harvard Department of Stem Cell and Regenerative Biology Golub Family Professor of Stem Cell and Regenerative Biology, Harvard University, USA

Mathematical Sciences

Chandrashekhar Khare

Chandrashekhar Khare is Professor & David Saxon Presidential Term Chair in Mathematics, University of California, Los Angeles, USA. He is a number theorist and works on the connection between modular forms and Galois representations. Prof. Khare's work with Jean-Pierre Wintenberger gave a proof of a celebrated conjecture of J.-P. Serre in the subject. He has received a number of honors and awards in recognition of his work. Khare received the Humboldt Research Award in 2011, Cole Prize in 2011, Infosys Prize in 2010, Guggenheim fellowship in 2008, Fermat Prize in 2007, and the INSA Young Scientist Award in 1999. In 2012, Prof. Khare was elected as a Fellow of the Royal Society.

Jurors

Meena Mahajan

Professor, The Institute of Mathematical Sciences, Chennai

Siddhartha Mishra

Professor, Department of Mathematics, ETH Zürich

Hélène Esnault

Einstein Professor (Emeritus), Institute of Mathematics, Free University, Berlin

Dipendra Prasad

Professor, Department of Mathematics, IIT-Bombay

Physical Sciences

Shrinivas Kulkarni

Shrinivas Kulkarni is the George Ellery Hale Professor of Astronomy and Planetary Science at the California Institute of Technology (Caltech), USA. His primary interests are the study of compact objects and the search for extra-solar planets through interferometric and adaptive techniques. He serves as the Interdisciplinary Scientist for the Space Interferometry Mission (SIM) and is co-Principal Investigator of the Planet Search Key Project (also on SIM). He has been awarded the Alan T. Waterman Prize of the NSF, a fellowship from the David and Lucile Packard Foundation, a Presidential Young Investigator award from the NSF and the Helen B. Warner award of the American Astronomical Society and the Jansky Prize of Associated Universities, Inc. He was also elected a Fellow of the American Academy of Arts and Sciences (1994), Fellow of the Royal Society of London (2001) and Fellow of the National Academy of Sciences (2003) and foreign member of the Royal Netherlands Academy of Arts and Sciences (2016). He was awarded the Dan David Prize (2017) and the Shaw Prize (2024).

Jurors

Jin-Quan Yu

Bristol Myers Squibb Endowed Chair in Chemistry, Frank and Bertha Hupp Professor of Chemistry, Scripps Research, San Diego

Yamuna Krishnan

Louis Block Professor, Department of Chemistry, The University of Chicago

Ramamurti Shankar

Josiah Willard Gibbs Professor of Physics, Yale University, USA

Spenta Wadia

Infosys Homi Bhabha Chair Professor and Founding Director, International Centre for Theoretical Sciences of TIFR, Bengaluru

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General Manager, Infosys Science Foundation

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