



We live in a world
in which science,
from mathematics
through to biology
and computer
science, affects us
all. By encouraging
the full development
of science across
disciplines we help
to shape the future.

—Michael Atiyah

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

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*ICTS is a wonderful research institution,
where truly transformative world class
research is being done.*

– **Juan Maldacena,**
Institute for Advanced Study, Princeton

*ICTS provides a beautiful and stimulating
environment for thinking, collaborating, and
experiencing the joy of doing science. I am
always looking forward to my next visit.*

– **Subir Sachdev,**
Harvard University





FROM THE DIRECTOR'S DESK

The edifice of science is not raised like a dwelling, in which the foundations are first firmly laid and only then one proceeds to construct and to enlarge the rooms. Science prefers to secure as soon as possible comfortable spaces to wander around and only subsequently,..., it sets about supporting and fortifying them. This is not a weakness, but rather the right and healthy path of development.

David Hilbert

I very much like how Hilbert visualises science as creating “comfortable spaces to wander around”. The wandering speaks to the forever restless and exploratory spirit which animates our research while the comfortable spaces are our provisional footholds on knowledge where we seek to pitch our tents as we scout the territory. Conversely, comfortable places to physically wander help create good science. In the ICTS campus, the architecture is designed to light the creative spark. Blackboards play an important role here - a theme I will let run through this report, giving a sense of the role it plays in the life at ICTS.

Blackboards are canvases where thoughts unspool from the mind, are reified and refined. Ideas incarnate as pictures, equations or “graphiti” as they attempt to leapfrog from one mind to another and trigger further neuronal cascades. From this ferment, a few ultimately survive, which then cohere into a scientific result or even more occasionally into the breakthroughs that change our conception of the world. We often get to know about the end product of this process but rarely about their fledgling beginnings.

When visitors come to ICTS, they are often struck by the profusion of blackboards on campus. Not just in offices and lecture halls (our Ramanujan auditorium has perhaps one of the longest blackboards in the world!) but in the public spaces, the “commons” if you wish. These boards, often green, also deep indigo (but never white), are in corridors, alcoves, in the garden (in Santiniketan spirit) and even the cafeteria. I observe their daily changing tableaux as I walk to my office or for lunch and to me it is a signifier of the health of the institution.

The health of ICTS, both literally and metaphorically, were important concerns as we began to emerge

in early 2022 from the trauma of the covid years. Fortunately, activities at ICTS rebounded with a vengeance. Our programs had overwhelming response and the number of proposals also shot up. As a result, we have kept a blistering pace of 35-40 programs and discussion meetings per year in the last couple of years. We had a number of very innovative workshops charting new directions whether in quantum metrology, climate and data sciences, soft as well as active matter or astronomy and astrophysics. As part of these events, we had the privilege of hosting some brilliant minds for our named lecture series.

On the academic front, we had a post-covid boom in our intake of PhD students. We had a record high of acceptances leading to thirty new students on campus last year. The number includes those in our new “Physics of Life” program jointly run with NCBS-TIFR. This is a program that will draw in students with undergrad degrees in science, maths and engineering into problems of biology creating a new generation of interdisciplinary researchers. We have had Akshit Goyal, microbial evolutionary biologist, join us from MIT as a Simons Young Researcher and Brato Chakrabarti, biophysical fluid dynamicist, from the Flatiron Institute, which has strengthened this program. I am very excited that we will have a new vibrant strand in the weave of ICTS.

Central to ICTS are the blackboards in the quadrangle, near our pantry. The coffee and the chalk are essential ingredients for the thrum of creativity. Here it is like music making in the park, with passersby listening in or daringly plunging into some heated discussion. The boards are an illegible scrum of scrawls and yet somehow everyone there is able to discern the different chords and chime in. Our continually changing set of program visitors also gravitate here and add their own tunes to the Antakshari. Magic happens. If there is such a thing as an institutional or collective mind in a place like ICTS, it is these spaces with their boards which bring it out and give expression to it.

A different kind of buzz is in the air whenever our campus fills with young minds (I mean ten to fifteen year olds) who have been thronging our outreach events. The last two years saw an amazing number of new outreach activities including a large number of hands-on science and maths events which you will read



about - like PRISM, MathSpark, science kit exhibition. The outreach team has also started new activities like a blog in addition to continuing with our public lectures and the maths circles which are gaining strength. A high point was the collective fashioning of a geosphere under the guidance of folks from CCL, IIT-Gandhinagar, which is now a striking addition to our Chandrasekhar foyer.

There is also whimsy in evidence, especially in the public areas, in the form of a slogan or a sketch splashed across a blackboard. Recently, ICTS has had its in-house Banksy, whose Manga style artwork materialises overnight. I find myself looking forward to spotting a new illustration as I enter the building each morning.

As ICTS grows and new activities sprout, our administrative and technical staff have given much more than duty demands. It is their selfless dedication to ICTS and sense of ownership in the institution that is such a source of strength to all of us. It is something to be watered at the roots so that it embeds into the institutional DNA. It has also been our privilege to have such a supportive advisory board. I would particularly like to acknowledge so many friends, far and near, who have supported the ICTS mission in ways both small and big. We look forward to your continued support. This brochure will give a bird's eye view of our activities. But it is no substitute for a visit to our campus and see for yourself our blackboards and beyond.

Rajesh Gopakumar

Centre Director, ICTS–TIFR

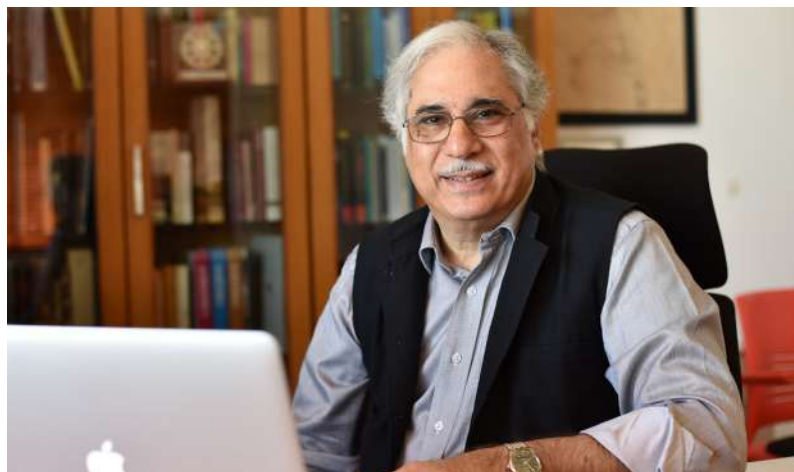
March 2024

THE ROAD TRAVELLED

The idea to create the ICTS was born in 2001, after the success of the Strings 2001 conference at TIFR Mumbai and a visit to the Infosys Campus in Bangalore. The former boosted our confidence based on our achievement in fundamental physics and the latter assured us that institutional infrastructure and management of the highest international quality was possible in India. The visit to the Infosys campus happened at the insistence of Edward Witten who was keen to visit the 'temples of modern India.' This combination of highest quality science within a modern state of the art campus, managed along modern thoughts inspired the basic idea of the ICTS. What made ICTS unique in India was that it was to be an international hub that would transform the ways of doing scientific research and advanced science education. I sent a proposal to Infosys Technologies but they were not ready to support this idea. In 2004, David Gross suggested that the core funding must come from the government and the way ahead.

The ICTS was approved by the TIFR Council in August 2007 to be a multi and interdisciplinary centre with 3 main goals: PROGRAMS that bring together physicists, astronomers, cosmologists, mathematicians, biologists, students and researchers from all over the world, under one roof, to work together to solve the most challenging questions posed by nature, to discover the underlying structures across the sciences and to strive for the unity of knowledge; In-house RESEARCH by highest quality faculty in the theoretical sciences; SCIENCE OUTREACH that stimulate and harness young minds of India and connects with members of the public who are interested in the latest scientific developments.

The next task was to create the Centre i.e. begin the programs and discussion meetings, find the government



resources and land to build the campus, work with the architect for a design suitable for the ICTS mission, see through the execution of the architectural design, create a modern administrative support system, choose the research areas and attract outstanding faculty within each! This complex task, of which the last was the most challenging, involved a collective effort by members of TIFR (most notably Avinash Dhar), the Indian science community, and the Govt of India. Besides basic government support it was significant that ICTS received generous and crucial support from the Airbus Corporate Foundation, the Simons Foundation, the Infosys Science Foundation and the Infosys Foundation.

The Centre as it grew benefited over the years from the advice and blunt scrutiny of an International Advisory Board of eminent scientists chaired by David Gross, and the strong support and guidance of CNR Rao, Anil Kakodkar, K. Kasturirangan, H.R. Krishnamurthy, K. VijayRaghavan, Kris Gopalakrishnan, Andy Millis, Ardhendu Pathak, Sudha Murty and N. R. Narayana Murthy.

The new ICTS campus in Bangalore was inaugurated on 20 June 2015 with an event "Science at ICTS." In Rajesh Gopakumar, ICTS has got a very capable new Director

since August 2015 who is taking the Centre forward with renewed vigour. During these past years ICTS has achieved very good success in its three missions. It is an international hub of science and its programs have had a significant impact on Indian science; its faculty has already made widely recognised contributions and its science outreach has become a fixture for science enthusiasts in Bangalore.

A successful institution like ICTS should grow unconstrained, expand the scope of its activities and continue to be an institution that integrates knowledge and human values. To this end ICTS will continue to need the support of government, private foundations and all the people who care for 'truth' and for an equitable future of humanity.

Spenta R. Wadia

Founding Director and Infosys Homi Bhabha Chair Professor, ICTS-TIFR, Emeritus Distinguished Professor, Tata Institute of Fundamental Research

March 2024

“

ICTS's tranquil and beautiful campus has inspired our conversations and allowed me to think more deeply about the scientific problems that we are tackling.

–Sarah Otto,
University of British Columbia

ICTS's influence is far reaching and highly consequential in shaping a new generation of physicists not only in India but world over.

–BS Satyaprakash,
Penn State University

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RESEARCH

The Centre is envisaged to have a high quality permanent faculty of modest size together with a large floating population comprising visitors, postdoctoral fellows and graduate students. The faculty members work in various areas of theoretical sciences. They carry out cutting-edge research, provide intellectual leadership and nurture a rich scientific culture. Their eminence attracts the brightest students and postdoctoral researchers as well as outstanding organizers and participants for the Centre's programs. ICTS also has a wide group of Associated Faculty, who are deeply involved in various activities of the Centre.

The in-house research is organized as a union of families of researchers. The scientific questions that drive the current ICTS faculty research are from the broad areas of Astrophysics and Relativity, Condensed Matter and

Statistical Physics, Biological Physics, Fluid Dynamics and Turbulence, String Theory, Applied and Computational Mathematics, Computer Science, Geometry and Physical Mathematics and Probability Theory.

PHYSICAL AND NATURAL SCIENCES

ASTROPHYSICS AND RELATIVITY

ICTS Faculty	Parameswaran Ajith ♦ <i>Gravitational-wave Physics and Astrophysics</i> Pallavi Bhat (Simons Visiting Professor) ♦ <i>Astrophysical Fluid Dynamics, Plasma Astrophysics</i> Bala Iyer (Simons Visiting Professor) ♦ <i>Gravitational-wave Physics, Analytical Relativity</i> Prayush Kumar ♦ <i>Numerical and Observational General Relativity</i> Rajaram Nityananda ♦ <i>Optical and Statistical Physics, Radio Astronomy</i>
Postdocs	Shalabh Gautam, Akash Kumar Mishra, Tushar Mondal, Krishnendu N V, Vaishak Prasad, Prasad R

BIOLOGICAL PHYSICS

ICTS Faculty	Brato Chakrabarti ♦ <i>Biophysical Fluid Dynamics</i> Akshit Goyal (Simons Young Researcher, Ramanujan Fellow) ♦ <i>Ecology and Evolution, Physical Biology</i> Vijaykumar Krishnamurthy ♦ <i>Physical Biology and Soft Condensed Matter Physics</i> Sriram Ramaswamy (Simons Visiting Professor) ♦ <i>Statistical and Condensed Matter Physics, Active Matter</i> Shashi Thutupalli (Joint Faculty with NCBS-TIFR, Bengaluru) ♦ <i>Physical Biology and Soft Condensed Matter Physics</i>
Postdocs	Tuhin Chakraborty

CONDENSED MATTER AND STATISTICAL PHYSICS

ICTS Faculty	Subhro Bhattacharjee ♦ <i>Condensed Matter Physics: Strongly Correlated Systems</i> Chandan Dasgupta (Simons Visiting Professor) ♦ <i>Condensed Matter Physics and Statistical Mechanics</i> Abhishek Dhar ♦ <i>Non-equilibrium Statistical Mechanics</i> Deepak Dhar (INSA Distinguished Professor) ♦ <i>Statistical Mechanics</i> Hulikal Krishnamurthy (Simons Visiting Professor) ♦ <i>Condensed Matter Theory</i> Manas Kulkarni ♦ <i>Condensed Matter and Statistical Physics</i> Anupam Kundu ♦ <i>Statistical Physics, Stochastic Process</i> Sumathi Rao (ICTS Endowed Senior Professor) ♦ <i>Condensed Matter Physics</i> Sthitadhi Roy ♦ <i>Condensed Matter Physics and Statistical Mechanics</i> Joseph Samuel (Simons Visiting Professor) ♦ <i>General Relativity, Quantum Information, Geometry and Topology in Physics</i>
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Postdocs Suman Dutta, Soumi Ghosh, Subhajit Paul, Dipankar Roy, Madhumita Saha

FLUID DYNAMICS AND TURBULENCE

ICTS Faculty Rama Govindrajan ♦ *Fluid Mechanics*
Samriddhi Sankar Ray ♦ *Turbulence, Non-equilibrium Statistical Mechanics, and Fluid Dynamics*
Debasis Sengupta (Simons Visiting Professor) ♦ *Oceanography, Monsoon Variability*
Jim Thomas (Joint Faculty with TIFR-CAM, Bengaluru) ♦ *Geophysical Fluid Dynamics*

Postdocs Prateek Anand, Subham Ghosh, Siddhartha Mukherjee, Sibaram Ruidas, Arun Kumar Varanasi

STRING THEORY AND QUANTUM GRAVITY

ICTS Faculty Rajesh Gopakumar ♦ *Quantum Field Theory, String Theory*
R. Loganayagam ♦ *String Theory, Black Hole Physics and Quantum Field Theory*
Raghu Mahajan ♦ *String Theory, Black Hole Physics and Quantum Field Theory*
Suvrat Raju ♦ *String Theory and Quantum Gravity*
Ashoke Sen (Infosys-ICTS Madhava Chair Professor) ♦ *String Theory*
Spenta R. Wadia (Infosys-ICTS Homi Bhabha Chair Professor) ♦ *String Theory, Quantum Gravity and Statistical Mechanics*

Postdocs Anupam A H, Asrat Demise, Victor Godet, Navaneeth Krishna Gaddam, Anurag Kaushal, Amiya Mishra, Athira P V, Naveen Prabhakar

“

Thank you so very much for inviting me into your beautiful island of greenery, nice breezes and stunning intellectual vibrancy. I have found stimulation and comfort here..

–**Michael Jordan**,
University of California, Berkeley

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I was very impressed by the young scientists at ICTS. Their deep knowledge, their enthusiasm and their devotion to physics reminded me of the happy days in Landau Institute.

–**Alexander Migdal**,
New York University, Abu Dhabi

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MATHEMATICAL SCIENCES

ICTS Faculty Amit Apte ♦ *Dynamical Systems and Data Assimilation*
Vishal Vasan ♦ *Partial Differential Equations, Dynamical Systems and their Applications*

Postdocs Sharath Jose

COMPUTER SCIENCE

ICTS Faculty Jaikumar Radhakrishnan ♦ *Theoretical Computer Science, Complexity Theory, Randomness and Computing, Quantum Information and Computation, Combinatorics, Information Theory*

GEOMETRY AND PHYSICAL MATHEMATICS

ICTS Faculty Rukmini Dey ♦ *Mathematical Physics and Geometry*
Pranav Pandit ♦ *Algebraic Geometry, Mathematical Physics*
TN Venkataramana (DAE-Raja Ramanna Chair) ♦ *Lie groups, Arithmetic groups*

Postdocs Anantadulal Paul, Sachchidanand Prasad, Savita Rani

PROBABILITY THEORY

ICTS Faculty Siva Athreya ♦ *Stochastic Analysis (Stochastic Partial Differential Equations and Stochastic Differential Equations), Random Walks Among Mobile Traps, Random Graphs, Tree-valued Processes, Computational Epidemiology*
Anirban Basak ♦ *Probability Theory and its Applications in Random Matrices and Graphs, Large Deviations, and Statistical Physics*
Riddhipratim Basu ♦ *Probability Theory and its Applications, First and Last Passage Percolation, Interacting Particle Systems, Models of Self-organized Criticality*

Postdocs Akshay Goel



There are few places where you instantly feel comfortable, and ICTS is one of those.

– **Hugo Duminil-Copin,**

Institut des Hautes Études Scientifiques, Paris

What an amazing institute – with tremendous talent, enthusiasm. Curiosity and commitment.

– **Jennifer Chayes,**

University of California, Berkeley



ASSOCIATES

ADJUNCT PROFESSOR

Swapan Chattopadhyay

Fermilab, Stanford University, USA
*Particle, Plasma and Beam Physics,
Particle Colliders, Synchrotron
Radiation Sources, Free Electron
Lasers, Quantum Sensors, Cavity
QED and Atomic Interferometers*

Sunil Mukhi

IISER Pune
*String Theory, Quantum Field
Theory, Particle Physics*

Ravi S Nanjundiah

Director, Indian Institute of
Tropical Meteorology, Pune
*Monsoon Physics, High-Performance
Computing (HPC), Algorithms
for Visualization, and Big-Data
Analytical Techniques*

INFOSYS VISITING PROFESSOR

Abhinav Kumar

Stony Brook University, USA
*Number Theory, Algebraic Geometry,
Combinatorics and Discrete
Geometry*

ICTS VISITING PROFESSOR

Tejaswi Venumadhav Nerella

Institute for Advanced
Study, Princeton, USA
Astrophysics and Cosmology

ASSOCIATED FACULTY

Rana Adhikari

Caltech, USA
*Gravitational-Wave Physics and
Astrophysics*

Adhip Agarwala

IIT Kanpur
Condensed Matter Physics

Bijay Agarwalla

IISER Pune
Non-equilibrium Statistical Physics

Mahesh M. Bandi

Okinawa Institute of Science
and Technology, Japan
*Experimental Nonlinear, Non-
equilibrium and Condensed Matter
Physics*

Sumilan Banerjee

IISc, Bengaluru
*Condensed Matter Physics,
Statistical Mechanics*

Kaushik Basu

University of California,
Berkeley, USA
*Physics and mathematics education,
problem solving pedagogy and
inquiry-driven curriculum
development*

Urna Basu

S. N. Bose National Centre
for Basic Sciences, Kolkata
*Soft Condensed Matter Physics,
Statistical Mechanics*

Lakshya Bhardwaj

University of Oxford, UK
*String theory and Physical
Mathematics*

Jeremie Bec

CNRS, CEMEF - MINES
ParisTech, France
*Fluid Dynamics, Statistical Physics,
Turbulence, Turbulent Transport*

Sumanta Chakraborty

Indian Association
for the Cultivation

of Science (IACS), Kolkata
*Black Hole Physics and Gravitational Wave
Astrophysics*

Poonam Chandra

NCRA-TIFR, Pune
Astrophysics

Shailesh Chandrasekharan

Duke University, USA
*Strongly Correlated Lattice Field
Theories, Quantum Critical Phenomena,
Phase Diagrams, Sign Problems,
Monte Carlo Algorithms, Quantum
Computation. Applications to Quantum
Chromodynamics, Fermi and Non-Fermi
Liquids, Magnetism, Superconductivity,
Quantum Impurities*

Debasish Chaudhuri

Institute of Physics, Bhubaneswar
*Biological Physics, Soft Condensed Matter
Physics, Nonequilibrium Statistical
Mechanics and Transport*

Kedar Damle

TIFR, Mumbai
Condensed Matter Physics

Sarang Gopalakrishnan

Princeton University, USA
*Condensed Matter Theory, Quantum
Information*

Subhajit Goswami

Institut des Hautes Études
Scientifiques, France
Probability and Mathematical Physics

Frank den Hollander

Leiden University, Netherlands
*Probability Theory, Statistical Physics,
Ergodic Theory, Population Genetics,
Complex Networks*

Yasir Iqbal

IIT Madras
Condensed Matter Physics

Shasvath Kapadia

IUCAA, Pune

*Gravitational-Wave Astronomy,
Astrophysics and Cosmology*

Amala Mahadevan

The Woods Hole

Oceanographic Institution
Physical Oceanography

Gautam Mandal

TIFR, Mumbai

Gauge Theory and String Theory

Narayanan Menon

University of Massachusetts

Amherst, USA

*Experimental Condensed Matter Physics,
Statistical Mechanics*

Adway Mitra

IIT Kharagpur

*Machine Learning, Data Science,
Complex System Modeling and
Simulation, Climate Informatics*

Subroto Mukerjee

IISc, Bengaluru

Theoretical Condensed Matter Physics

Gananpathy Murthy

University of Kentucky, USA

Condensed Matter Physics

Vidyanand Nanjundiah

Centre for Human Genetics, Bengaluru

*Developmental Biology (Pattern
Formation), Evolutionary Biology (Social
Behaviour), Theoretical Biology*

Praneeth Netrapalli

Google Research India, Bengaluru

Computer Science

Arun Paramakanti

University of Toronto, Canada

Quantum Mechanics

Onkar Parrikar

TIFR, Mumbai

*Quantum Gravity, AdS/CFT
correspondence, Quantum Field
Theory*

Jahnvi Phalkey

Bangalore Science Gallery

History of Science

Jason Picardo

IIT Bombay

*Computational Flow Modelling (CFD),
Fluid Mechanics and Stability, Heat
and Mass Transfer*

Thara Prabhakaran

Indian Institute of Tropical

Meteorology, Pune

Fluid Dynamics

Shiroman Prakash

Dayalbagh Educational Institute, Agra

Gauge Theory and String Theory

Archak Purkayastha

IIT Hyderabad

*Non-equilibrium Quantum Statistical
Physics*

Mythily Ramaswamy

ICTS-TIFR, Bengaluru

*Partial Differential Equations, Control
Theory and Fluid Flow Problems*

Sujatha Ramdorai

University of British

Columbia, Canada

*Algebraic Theory of Quadratic
Forms, Arithmetic Geometry of
Elliptic Curves, Study of Motives and
Noncommutative Iwasawa Theory*

Kabir Ramola

TIFR, Hyderabad

*Classical and Quantum Statistical
Mechanics, Soft Matter Physics,
Condensed Matter Theory,
Computational Physics*

Sanjib Sabhapandit

RRI, Bengaluru

Statistical Physics

BS Sathyaprakash

The Pennsylvania

State University, USA

*Gravitational-Wave Physics and
Astrophysics*

Arnab Sen

Indian Association

for the Cultivation of

Science (IACS), Kolkata

*Strongly Correlated Systems and
Statistical Mechanics*

Ramachandran Shankar

Institute of Mathematical

Sciences, Chennai

*Condensed Matter Physics, Glaciers
and Climate*

Herbert Spohn

Technical University

of Munich, Germany

Condensed Matter Physics

Mukund Thattai

NCBS-TIFR, Bengaluru

Computational Cell Biology

Dario Vincenzi

CNRS, Université

Côte d'Azur, France

*Numerical Modeling and Fluid
Dynamics*



PROGRAMS

ICTS provides a platform for researchers working on diverse subjects to congregate during high-quality programs of varying durations. These highly interactive sessions endorse research areas that are especially contemporary, important and intellectually challenging. The programs contribute to transforming the way people approach research, venture into unexplored directions, nurture new frontiers of science and encourage collaborations. They also encourage the interaction between experimentalists and theorists.

ICTS long programs, with an embedded conference, have a large educational component. They aim to provide an introduction to current problems in an emerging research area. There is a fair balance of international and national participation. The lecturers are carefully chosen and are distinguished scientists. The participants are mainly graduate students, postdocs, and young faculty.

The short programs are focused discussion meetings on a recent exciting development in a given field. They are also often organized around a leading lecturer on a

theme related to her/his work. These meetings usually include a research-oriented participation and are frequently organized in conjunction with one of the following three lecture series – *Chandrasekhar* (Physical Sciences), *Ramanujan* (Mathematics) and *Turing* (Biology, Computer Science and Engineering).

ICTS also organizes programs in collaboration with other international research institutes. Examples include the 'ICTP-ICTS Biology Program' and the 'Asian Winter School in Strings, Particles and Cosmology'.

A SAMPLE OF ICTS PROGRAMS AND DISCUSSION MEETINGS

- **Field Theory and Turbulence** ♦ 18-22 December 2023
- **Condensed Matter Meets Quantum Information** ♦ 25 September-6 October 2023
- **Rational Points on Modular Curves** ♦ 11-22 September 2023
- **Gravitational Wave Astrophysics** ♦ 24 July-4 August 2023
- **Mathematical Modeling of Climate, Ocean, and Atmosphere Processes** ♦ 26-30 June 2023
- **Lunar Gravitational-Wave Detection** ♦ 17-20 April 2023
- **Less Travelled Path to the Dark Universe** ♦ 13-24 March 2023
- **Probabilistic Methods in Negative Curvature** ♦ 27 February-10 March 2023
- **Horizons in Accelerators, Particle/Nuclear Physics and Laboratory-based Quantum Sensors for HEP/NP** ♦ 14-17 November 2022
- **Statistical Biological Physics: From Single Molecule to Cell** ♦ 11-22 October 2022
- **Tipping Points in Complex Systems** ♦ 19-30 September 2022
- **Nonperturbative and Numerical Approaches to Quantum Gravity, String Theory and Holography** ♦ 22 August-2 September 2022
- **Physics with Trapped Atoms, Molecules and Ions** ♦ 9-13 May 2022
- **Kavli Asian Winter School (KAWS) on Strings, Particles and Cosmology** ♦ 10-23 January 2022
- **Quantum Fields, Geometry and Representation Theory** ♦ 5-23 July 2021

A FEW ABDUS SALAM MEMORIAL LECTURES

- **The Future of the Indian Space Programme** ♦ **A. S. Kiran Kumar** (*ISRO, Bengaluru & Member of the Space Commission, Govt of India*) ♦ 18 April 2023
- **Networks and Mycobacterium Tuberculosis** ♦ **Shekhar C. Mande** (*Director General of the Council of Scientific and Industrial Research (CSIR) & Secretary, Department of Scientific and Industrial Research (DSIR), Govt of India*) ♦ 30 April 2019



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Beautiful, quiet, peaceful, and full of remarkable colleagues. ICTS is a really wonderful place for science.
–Marc Mézard,
 École Normale Supérieure, Paris

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A FEW INFOSYS-ICTS CHANDRASEKHAR LECTURES

- **How Materials Can Learn by Themselves** ♦ **Andrea J Liu** (*University of Pennsylvania, USA*) ♦ 21-23 August 2023
- **The Future of Cosmology** ♦ **Joseph Silk** (*The Institut d'Astrophysique de Paris, France & Johns Hopkins University, USA*) ♦ 1-2 May 2023
- **Multiple Phase Transitions in a System of Hard Core Rotors on a Lattice** ♦ **Deepak Dhar** (*IISER Pune*) ♦ 19-21 December 2022
- **Looking into the Future of High-energy Particle Physics** ♦ **Gian Giudice** (*CERN, Switzerland*) ♦ 21-23 November 2022

A FEW ICTS DISTINGUISHED LECTURES

- **Statistical Mechanics of Mutilated Sheets and Shells** ♦ **David R. Nelson** (*Harvard University, USA*) ♦ 18 August 2023
- **Putting Order into Disorder: An Application to the Chronology of my Works** ♦ **Giorgio Parisi** (*Sapienza University, Rome, Italy*) ♦ 16 December 2021
- **Residual Intersections in Geometry and Algebra** ♦ **David Eisenbud** (*Mathematical Sciences Research Institute and UC Berkeley, USA*) ♦ 13 December 2019
- **Computational Complexity in Theory and in Practice** ♦ **Richard M. Karp** (*University of California, Berkeley, USA*) ♦ 18 October 2019
- **The Making of High-Precision Gravitational Waves** ♦ **Alessandra Buonanno** (*Max Planck Institute for Gravitational Physics (Albert Einstein Institute, Germany)*) ♦ 19 August 2019

A FEW INFOSYS-ICTS ALAN TURING LECTURES

- **An Alternative View on AI: Collaborative Learning, Incentives, Social Welfare, and Dynamics** ♦ **Michael I. Jordan** (*University of California, Berkeley, USA*) ♦ 4-6 July 2023
- **How Stable is the Earth's Climate?** ♦ **J. Srinivasan** (*Indian Institute of Science, Bengaluru*) ♦ 1 & 3 March 2022
- **Artificial Intelligence: Success, Limits, Myths and Threats** ♦ **Marc Mézard** (*Ecole normale supérieure - PSL University*) ♦ 6-8 January 2020

A FEW INFOSYS-ICTS RAMANUJAN LECTURES

- **Critical Phenomena Through the Lens of the Ising Model** ♦ **Hugo Duminil-Copin** (*Institut des Hautes Études Scientifiques, France & University of Geneva, Switzerland*) ♦ 9-13 January 2023
- **Exploring Moduli** ♦ **Carlos Simpson** (*Université Nice-Sophia Antipolis, France*) ♦ 10-14 February 2020
- **Some New Results on Rationality** ♦ **Claire Voisin** (*College de France, France*) ♦ 1-5 October 2018
- **Locally Symmetric Spaces, and Galois Representations** ♦ **Peter Scholze** (*The University of Bonn, Germany*) ♦ 25-28 March 2014
- **Mathematical Perspectives on Clouds, Climate, and Tropical Meteorology** ♦ **Andrew J. Majda** (*Department of Maths & Courant Institute, New York University, USA*) ♦ 22-26 January 2013

A FEW HIGHLIGHTS FROM OUR PROGRAMS

SOFT AND LIVING MATTER: FROM FUNDAMENTAL CONCEPTS TO NEW MATERIAL DESIGN

7-25 August 2023

From the food we eat to the shampoo and lotion we use for personal care or a collection of bacteria swimming in constrained environments, soft materials and complex fluids are ubiquitous in our daily life. Despite occupying a myriad of unrelated systems and settings, they share several overlapping properties and behaviour. This diversity renders soft matter physics fantastically interdisciplinary, for it borrows tools from various branches of physics, e.g. dynamical systems, fluid dynamics, condensed matter and statistical physics etc. and applies them to systems and problems far afield, including but not limited to, biology, earth & atmospheric science, engineering, and food and cosmetics industry among many others.

The SLM2023 School and Workshop on Soft and Living Matter hosted global experts who delivered pedagogical lectures on a subset of this broad field to students and young researchers. The topics were representative of the breadth of this field, such as geometry and mechanics, collective phenomena, suspensions and particulate systems, liquid crystals, biological matter and non-equilibrium physics.

MACHINE LEARNING FOR HEALTH AND DISEASE

24 July-4 August 2023

This program brought together machine learning experts, statisticians, clinicians, and public health experts to discuss how to harness modern mathematical and computational techniques to better understand health-related data across multiple domains. Basics of various machine learning techniques, including logistic regression, tree-based methods, support vector

machines, Bayesian methods, and deep networks were covered with examples of their applicability in biomedicine and health. Applications included predicting outcomes for individual patients from clinical and lifestyle parameters, analysing patient data such as X-rays, ultrasound images and ECG measurements, genomic variant analysis, and inferring patterns in heterogeneous large-scale data. Speakers from both computational/statistical and clinical backgrounds participated.

INTRODUCTION TO PRECISION MEASUREMENTS AND QUANTUM METROLOGY

10-21 July 2023

Quantum physics has come a long way since its inception 120 years ago to the application of quantum effects in day-to-day life in the form of quantum technologies that are emerging rapidly across multiple fields. This school aimed at building knowledge and awareness on precision measurements and quantum metrology among young students who will be the future researchers in this area and be part of the National Quantum Mission in India. The lectures in this school covered the theory of precision measurements, theory of estimation, classical and quantum metrology, atomic and optical physics techniques used for quantum metrology and precision measurements, precision measurements using atoms/ions/ molecules, photons, NV-centers.

DATA SCIENCE: PROBABILISTIC AND OPTIMIZATION METHODS (DISCUSSION MEETING)

3-7 July 2023

This workshop was focused on the analytic and algorithmic side of data science. The current boom in

data science, in reality an umbrella term for diverse but loosely connected activity, has been brought about by rapid advances in techniques for collection, storage and dissemination of data, along with increased computational abilities to process it. It is on the scale of the industrial revolution except that it is now the abstract symbols rather than energy and material that is being generated, stored and distributed. This is affecting the older sciences as well where pure model-based approaches are being combined with purely data driven ones, to get the best of both worlds. The major action, however, is on a different front - that of fast processing tools for the enormous data that is being generated, sometimes at a high speed.

This workshop opened a window to some of the leading themes in this sphere and exposed the participants to both their underpinnings and to the new directions they are headed for, with a focus on probabilistic and optimization techniques.

As part of the program, Michael I. Jordan (Pehong Chen Distinguished Professor, UC Berkeley) delivered the Infosys-ICTS Turing Lectures.

LARGEST COSMOLOGICAL SURVEYS AND BIG DATA SCIENCE

1-12 May 2023

The tremendous success of Cosmic Microwave Background (CMB) observations, by WMAP and Planck, have heralded an era in precision cosmology. This program aimed to expose young researchers to the forefront of cosmology research in the areas that are poised to dominate the field in the next decade and initiate, strengthen and extend collaborations between active early career scientists with the researchers from the top-most CMB and LSS research groups. The program was unique by its very different focus and methods. It brought expert knowledge, through hands-on short projects, to early career researchers who are

poised to grasp complex details of multi-messenger cosmology. The key idea was to provide the very valuable “insider insight” which is crucial when working with large survey data. There was a strong focus on presenting complex ideas effectively by various talks students will have to give during the two weeks period.

TOPICS IN HIGH DIMENSIONAL PROBABILITY

2-13 January 2023

The focus of this program was on several interconnected themes in modern probability theory, which can broadly be brought under the umbrella of high dimensional probability. The particular themes covered included (i) random matrices and random operators, (ii) geometric functional analysis and high dimensional convex geometry, (iii) point processes and interacting particle systems, and (iv) spin glasses and Gaussian free fields.

The program also featured two mini-courses by Subhroshekhar Ghosh and Mark Rudelson. An Infosys-ICTS Ramanujan lecture series (five one hour lectures) was delivered by Hugo Duminil-Copin and a Distinguished Lecture by Ofer Zeitouni.



It is thrilling to see the new campus completed so beautifully. More importantly, the intellectual success of ICTS is awe-inspiring.

–Peter Saulson,
Syracuse University

Not only nature, but also the fundamental research at ICTS is blooming.

–Herbert Spohn,
Technical University of Munich





We all recognize the ability of fundamental science to transform lives. The knowledge of it is priceless and unparalleled. It is important for experts working in various areas of science to share new exciting developments and discoveries with the entire community.

ICTS regularly organizes public lectures, given by eminent visitors. In 2015, as part of the centenary celebration of Albert Einstein's General Theory of Relativity, the Einstein Lectures were introduced. Through Vigyan Adda, scientists from ICTS and other similar institutes and universities can explain their work to broader audiences.

The monthly Kaapi with Kuriosity lectures is organized in collaboration with the Jawaharlal Nehru Planetarium. In 2021, a virtual exhibition named CosmicZoom was launched, which aimed at taking visitors for a trip through

the Cosmos - both through the smallest and largest scales in the Universe.

ICTS is leading a pan-TIFR effort to seed Maths Circles for talented middle school students across the country. In early 2022, the in-person ICTS-RRI Maths Circle sessions, in collaboration with the Raman Research Institute, were started. The School Outreach initiative by ICTS aims to foster a scientific temper within children. ICTS can be found across social media platforms. The ICTS Blog on the website has regular features on the latest scientific developments.

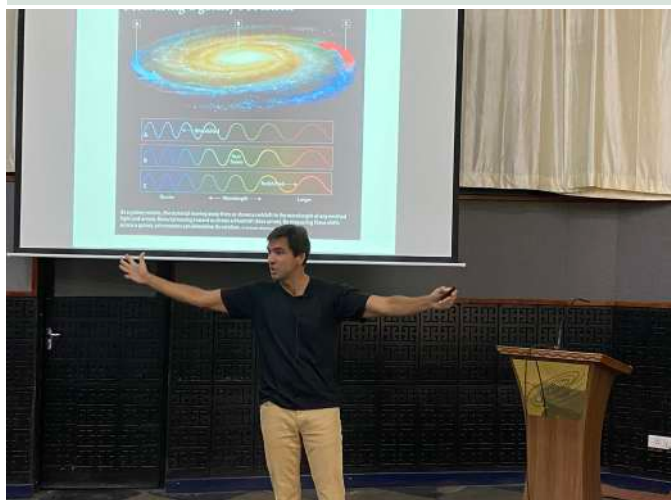
A SAMPLE OF ICTS PUBLIC LECTURES

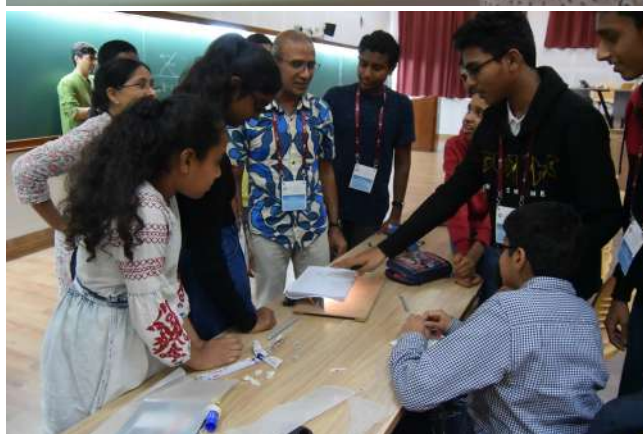
- **On Quarks and Turbulence** ♦ **David Tong** (*University of Cambridge, UK*) ♦ 20 December 2023
- **Technology & Cosmic Frontiers** ♦ **Kip S. Thorne** (*Caltech, USA & Nobel Laureate in Physics, 2017*) & **Rana Adhikari** (*Caltech, USA*) ♦ 19 August 2021
- **What is Common Between Falling Cats and the Quantum Hall Effect?** ♦ **Alexander Abanov** (*Stony Brook University, New York, USA*) ♦ 10 August 2018
- **Black Holes and the Structure of Spacetime** ♦ **Juan Maldacena** (*IAS Princeton, USA*) ♦ 25 May 2018
- **Can Evolution be Understood Quantitatively?** ♦ **Daniel Fisher** (*Stanford University, USA*) ♦ 6 March 2018
- **The Usefulness of Useless Knowledge** ♦ **Robbert Dijkgraaf** (*IAS Princeton, USA*) ♦ 7 January 2018
- **Deciphering the Workings of Molecules, Building Blocks of Life, with the Electron Microscope** ♦ **Joachim Frank** (*Columbia University, USA & 2017 Nobel Laureate in Chemistry*) ♦ 1 November 2017
- **Particles, Gravity and Strings** ♦ **Nima Arkani-Hamed** (*IAS Princeton, USA*), **Ashoke Sen** (*HRI, Allahabad*), **Nathan Seiberg** (*IAS Princeton, USA*), **Andrew Strominger** (*Harvard University, USA*), **Cumrun Vafa** (*Harvard University, USA*) ♦ 27 June 2015
- **Poetry, Drumming and Mathematics** ♦ **Manjul Bhargava** (*Princeton University, USA*) ♦ 20 June 2015
- **Structure and Randomness in the Prime Numbers** ♦ **Terence Tao** (*UCLA, USA*) ♦ 23 February 2012



A SAMPLE OF KAAPI WITH KURIOSITY

- **The Extreme Physics of Zombie Stars** ♦ **Nils Andersson** (*University of Southampton, UK*) ♦ 8 October 2023
- **Conway's Tangles** ♦ **Michael Lacey** (*Georgia Institute of Technology, USA*) ♦ 2 July 2023
- **Is Clay a Solid or a Liquid?** ♦ **Ranjini Bandyopadhyay** (*Raman Research Institute, Bengaluru*) ♦ 17 June 2023
- **Ways of Computing** ♦ **Jaikumar Radhakrishnan** (*ICTS-TIFR, Bengaluru*) ♦ 26 February 2023
- **Chance and Chaos: How to Predict the Unpredictable** ♦ **Jens Marklof** (*University of Bristol, UK*) ♦ 11 December 2022
- **Finding Our Place Among Stars** ♦ **Sarita Vig** (*Indian Institute of Space Science and Technology, Thiruvananthapuram*) ♦ 11 September 2022
- **Tilings** ♦ **Mahuya Datta** (*Indian Statistical Institute, Kolkata*) ♦ 27 March 2022
- **The Story of Climate Change** ♦ **R Shankar** (*The Institute of Mathematical Sciences, Chennai*) ♦ 9 January 2022
- **To Paint the Lily, Mathematically** ♦ **L. Mahadevan** (*Harvard University, USA*) ♦ 12 December 2021
- **Science of the Indian Kitchen** ♦ **Krish Ashok** (*Author of 'Masala Lab'*) ♦ 17 October 2021
- **Can We Learn From Insect Societies?** ♦ **Raghavendra Gadagkar** (*Indian Institute of Science, Bengaluru*) ♦ 20 June 2021
- **The Neutrino Story: From Impossible Dreams to Unreachable Stars** ♦ **Srubabati Goswami** (*Physical Research Laboratory, Ahmedabad*) ♦ 23 May 2021
- **Agents of Change: The Role of Catalysts in the Modern World** ♦ **Shobhana Narasimhan** (*Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru*) ♦ 26 September 2020
- **Soft and Squishy Materials and How to Think About Them** ♦ **Gautam Menon** (*Ashoka University & IMSc, Chennai*) ♦ 19 July 2020
- **Automating Mathematics?** ♦ **Siddhartha Gadgil** (*Indian Institute of Science, Bengaluru*) ♦ 17 May 2020





“

ICTS is a wonderful institute, really a perfect environment for thinking deep thoughts about mathematics.

– Allan Sly,
Princeton University

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ORGANISATION

ICTS is guided, nurtured and managed by three committees.

The *International Advisory Board*, chaired by David Gross, is unique in its existence among scientific institutions in India. It comprises distinguished people whose advice and guidance pertains to all aspects of ICTS. The ICTS Director submits a quarterly activity report to the Advisory Board.

The *Management Board*, chaired by the TIFR Director, oversees the overall administration and scientific direction of the Centre.

The *Program Committee* of ICTS consists of acknowledged leaders in different areas of theoretical sciences and interdisciplinary areas. Program proposals received by the Centre are circulated among its members for their views and advice.

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*String Theory, Quantum Gravity,
Statistical Mechanics*

*What a wonderfully complete and
lovely village of math and physics.
A great development for TIFR –
and India!*

– David Eisenbud,

University of California, Berkeley



CAMPUS

The ICTS campus is spread over 78,000 square metres amidst the rustic surroundings of Hesaraghatta village in north Bengaluru. The open corridors and foyers provide a conducive environment for research and learning. The campus is self-contained and includes academic housing and recreational facilities. It is equipped with a modern library, state-of-the-art computing and networking infrastructure, lecture halls with enough capacity for meetings with hundred plus participants, an auditorium, recreation spaces, childcare facilities and comfortable living quarters for staff and visitors.



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The support from our donors through the years has been significant in ICTS-TIFR accomplishing its goals. It is their continued support that sustains our mission. We are thankful for their contributions.

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It is wonderful to see the dreams we had of establishing a Centre for Theoretical Physics in India being realized. I am very impressed with the remarkable developments since the inauguration in 2009. Visiting the site I could see a beautiful facility where cutting edge theory is being pursued with dynamic leadership at the top, with an initial first-rate faculty – nothing can stop this from happening. For those of us who have tried to help from afar these developments make us proud.

–David Gross,
KITP, Santa Barbara

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