

J N C A S R

**Jawaharlal Nehru Centre for
Advanced Scientific Research**

2020–21
ANNUAL REPORT


**JAWAHARLAL NEHRU CENTRE FOR
ADVANCED SCIENTIFIC RESEARCH**

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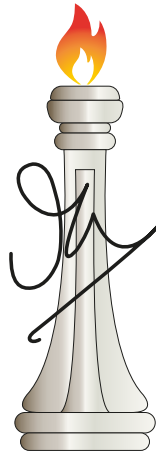
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2020–21 ANNUAL REPORT



J N C A S R

Jawaharlal Nehru Centre for Advanced Scientific Research

An Autonomous Institution under the
Department of Science and Technology,
Government of India; and an Institution
Deemed-to-be-University



FOREWORD



PROF. G. U. KULKARNI

President

Jawaharlal Nehru Centre for Advanced Scientific Research

With great satisfaction and pride, I present the 32nd Annual Report of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) for the year 2020–21. It was the year of the pandemic, and as the pandemic swept around the world, we decided to pull up our sleeves and make a difference in the fight against COVID-19. We established a state-of-the-art Diagnostic Training Centre at the Jakkur campus to train personnel in real-time polymerase chain reaction (PCR) testing and trained more than 30 clinical diagnostic personnel. JNCASR's spinoff company VNIR Biotechnologies Private Ltd., which is co-founded by Prof. T. Govindaraju and Dr. Meher Prakash, launched indigenous fluorescent molecular probes and PCR tests as part of COVID-19 test kits for carrying out reverse transcription-PCR (RT-PCR)-based detection assays. This sort of bold vision and quest for excellence ranked JNCASR as 8th among more than 200 Indian institutes, according to the Nature Index Institution Table 2021. In our efforts towards translational research, we also signed a number of agreements, including memorandums of understanding with Breathe Applied Sciences Private Ltd., a startup company from JNCASR. We also signed significant agreements with various corporate agencies and the University of Strasbourg in France.

In a difficult year, our faculty and

students stepped up to the mark and were recognized for their tireless efforts and resourcefulness. I would like to heartily congratulate Prof. C. N. R. Rao for being awarded the International Eni Award 2020; Profs. Anuranjan Anand and Kaustuv Sanyal for receiving the DST/SERB J. C. Bose Fellowship; Profs. Rajesh Ganapathy and Subi J. George on receiving the CSIR Shanti Swarup Bhatnagar Prize 2020; Prof. Santosh Ansumali for being awarded the Cray's Dr. A. P. J. Abdul Kalam HPC award by Hewlett Packard Enterprises; Profs. Kanishka Biswas, Subi J. George, and T. Govindaraju for becoming Fellows of the Royal Society of Chemistry; Prof. Kavita Jain for heading the International Journal of Genetics as an Associate Editor; Prof. Shobhana Narasimhan for receiving the Marshak Lectureship for 2021 by the American Physical Society; Prof. Sebastian C. Peter for winning the CRSI Bronze Medal from the Chemical Research Society of India; and Dr. Bivas Saha for receiving the Young Scientist Research Award from the Board of Research in Nuclear Sciences, Department of Atomic Energy (DAE). I myself am also very honored and humbled to be contributing to JNCASR's achievements alongside my colleagues with an Honorary Fellowship of the Karnataka Science and Technology Academy. These are just a few to name; a detailed list of awards is given in the following pages. I express my warmest congratulations to all our faculty colleagues

for receiving prestigious recognitions. Our students have also marked their presence in several academic fora and scored accolades. Congratulations to Mr. Pradeep K. R. for being awarded the prestigious Society for Research and Initiative for Sustainable Technologies and Institutions (SRISTI) Gandhian Young Technological Innovation Award 2020.

On the academic front, we admitted 69 new students, which took our student strength to 320. A total of 50 Ph.D., 18 M.S. (Int. Ph.D.), 8 M.S. (Engineering), and 3 P.G.D.M.S. degrees were awarded. Continuing the tradition of publishing high-quality science, the year 2020 witnessed 280 publications from our faculty members in high impact factor journals in the respective subject domains. We also received 12 patent grants during the financial year. Most of our science outreach programs and lectures took place online, which made it easier for school teachers and students to join in from anywhere in the country. National Science Day on 28 February 2021 was held in person at JNCASR and online, where Prof. Sebastian C. Peter, Dr. Bivas Saha, and Dr. N. S. Vidhyadhiraja presented lectures attended by 180 students and 31 teachers across India. We were also honored to host Dr. Jahnavi Phalkey, Director of the Science Gallery, Bengaluru, who delivered a lecture titled Why History of Science? as part of our International Women's Day celebration on 8 March 2021.

But amid all this activity, it saddens me to say that we also lost three faculty members: Prof. Shri Krishna Joshi in May 2020, Prof. K. S. Valdiya in September, and Prof. Roddam Narasimha in December. They made several prominent contributions to the Centre and were a pleasure to work with. On behalf of the Centre, I express my heartfelt condolences to their families and pray that their souls rest in peace.

The following pages provide a snapshot of our achievements in a tumultuous year. I would like to thank every member of JNCASR for upholding the institutions' objectives and values and thereby making this yet another successful year. I also want to use this opportunity to thank the Department of Science and Technology (DST) at the Government of India for their continued support. DST's efforts for highlighting our research in national print, digital, and social media are praiseworthy. I wish everyone good health and kindness and look forward to another vibrant academic year ahead.





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01

INTRODUCTION

Thirty-two years ago, under an initiative by the Department of Science and Technology of the Government of India to establish a multidisciplinary research institute that would strive for excellence in science and engineering, the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) was formed. Today, it has grown from a plot of land in Bengaluru to a huge campus that hosts 9 different research units and numerous educational outreach activities. Having 320 students currently, the Centre is pushing the frontiers of science and knowledge. This is reflected in the numerous publications, patents, awards, and achievements the faculty members of this Centre have accumulated since its inception. Its mission to innovate and collaborate remains firm and its pursuit of excellence continues to shape the spirit of its academicians.

ABOUT JNCASR

The Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) was established in 1989 to commemorate the birth centenary year of the first prime minister of India, Pandit Jawaharlal Nehru. Brainchild of the Government of India's Department of Science and Technology (DST), JNCASR's main campus was built on a 15-acre plot of land gifted to the cause by the Government of Karnataka, in Jakkur. The Centre was built with the purpose to promote scientific inquiry at the highest level, strive to be at the forefront of science and engineering, and foster interdisciplinary collaboration. Since its inception, a tie-up with one of India's oldest and well-respected research institutes, the Indian Institute of Science (IISc), was undertaken to guide JNCASR's growth. Founding President Prof. C. N. R. Rao, who held the position from 1989 to 1999 and was awarded the Bharat Ratna, India's highest civilian award, in 2014, was instrumental in the setting up of the institute. He continues to be a part of JNCASR as Honorary President. The current President, since January 2020, is Prof. G. U. Kulkarni.

Now in its 32nd year, JNCASR has 9 well-known research units: the Chemistry and Physics of Materials Unit (CPMU), Engineering Mechanics Unit (EMU), Evolutionary and Integrative Biology Unit (EIBU), Geodynamics Unit (GDU), International Centre for Materials Science (ICMS), Molecular Biology and Genetics Unit (MBGU), Neuroscience Unit (NSU), New Chemistry Unit (NCU), and Theoretical Sciences Unit (TSU). The most recent addition is the School of Advanced Materials (SAMat), which has been set up to provide a more efficient materials science program.

It is made up of the ICMS, NCU, and TSU faculties. Among the academic programs on offer at the Centre are Ph.D., Integrated Ph.D., and Masters programs in various disciplines.

JNCASR's goal to be the pinnacle of scientific inquiry in India has never wavered. To this end, the Centre provides state-of-the-art experimental, computational, and infrastructural facilities, and ensures that they all remain up to the mark so that staff and students can carry out top-notch research. This determination, coupled with hard work and a resolute vision, has earned the Centre a number of plaudits, the latest of which is being ranked the 8th best institution in India among more than 200 universities, in the 2021 Nature Index. JNCASR's academicians have been awarded patents and have collaborated with a number of corporations and government departments to advance scientific research. Because the research being undertaken by JNCASR's faculty members is at the frontiers of their fields, many research projects have also received funding from several national and international government agencies and corporate bodies; there are 40 new sponsored projects (grants amounting to ₹7.99 cr.) and 141 ongoing sponsored projects (grants amounting to ₹24.58 cr.). In addition, research work has been published in high impact factor journals (average impact factor 5.42), contributing to the Centre's rising institutional ranking every year.

One of the principal objectives of the Centre is to make science accessible to society. It has hosted several outreach programs by organizing workshops and

ABOUT JNCASR

festivals where citizens can connect with science and understand how enmeshed it is with daily life. School teachers and students are invited to visit the Centre to attend talks and conduct experimental demonstrations. The Student Buddy programme, where school students make a day-long visit to the Centre to experience the life of a researcher, has been well received.

The stack of achievements that JNCASR has amassed since it began more than 3 decades ago continues to grow. Major discoveries, successful innovations, challenging times, fruitful collaborations—the Centre has seen it all. With the quality of its research and people geared towards excellence, the Centre is continuously striving to make a difference to people's lives, enhance planetary wellbeing, and go boldly where none have gone before.



Objectives

- Establish and conduct world-class research in science and engineering
- Foster interdisciplinary and collaborative research
- Establish state-of-the-art laboratories and computational and infrastructural facilities to facilitate scientific research
- Build capacity through high-quality Ph.D.s in science and engineering
- Increase awareness about science and research among school and college students through extensive science outreach, and novel fellowships and extension programs
- Take research from the laboratory to society by making a conscious effort to connect with people

Reservation, official language, and implementation of the judgments/orders of the CAT

The Centre follows the national policy on reservation and official language as per the rules and orders issued by the Government of India, with necessary guidelines from the Council of Management being implemented from time to time.

During the year 2020–21, there were no cases pertaining to the Centre that appeared before the CAT.

YEAR AT A GLANCE

AWARDS AND ACHIEVEMENTS



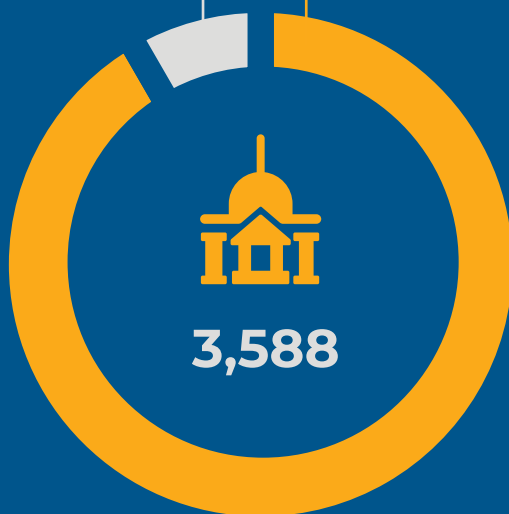
PARTICIPANTS IN SCIENCE OUTREACH PROGRAMMES CONDUCTED BY EDUCATION TECHNOLOGY UNIT

460

TEACHERS

3,128

STUDENTS



PUBLICATIONS



FACULTY FELLOWSHIPS



PATENTS GRANTED



NEW ADMISSIONS

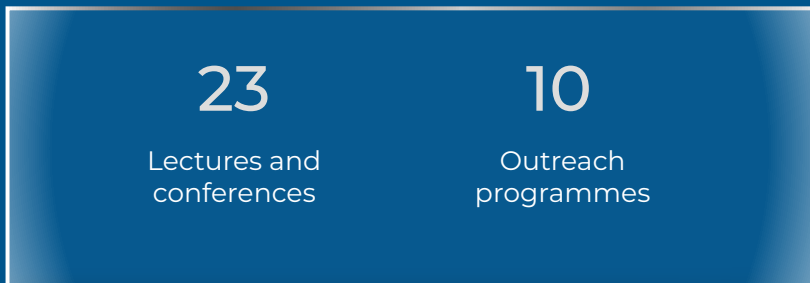


DEGREES AWARDED



YEAR AT A GLANCE

EVENTS IN 2020-21



TOTAL NUMBER OF FACULTY PUBLICATIONS IN 2020



APPOINTMENTS (ON CONTRACT)

- Mr. Vinayak Pattar
- Mr. M. G. Narayan

PROMOTIONS

Professor

- Prof. Subi J. George
- Prof. T. Govindaraju
- Prof. Kavita Jain

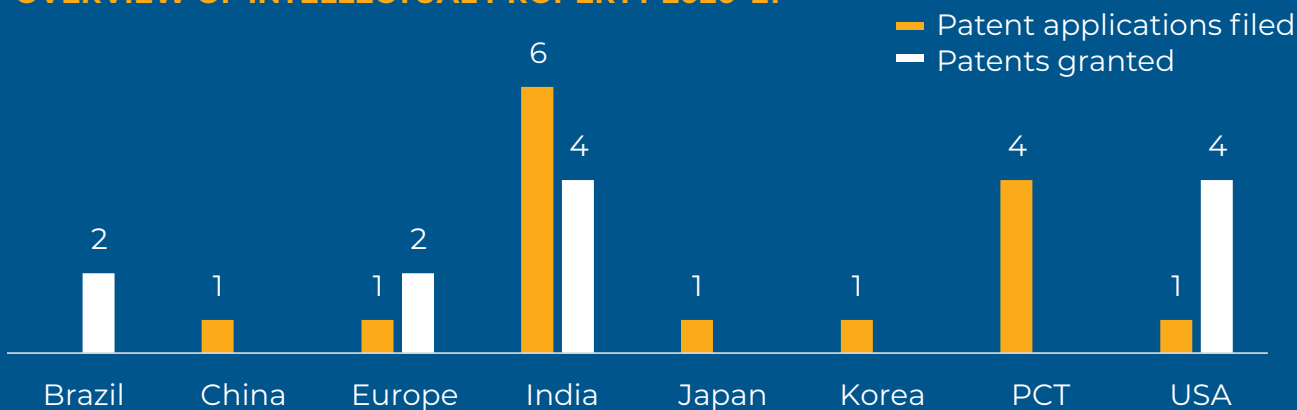
Associate Professor

- Prof. James P. C. Chelliah

AVERAGE IMPACT FACTOR



OVERVIEW OF INTELLECTUAL PROPERTY 2020-21



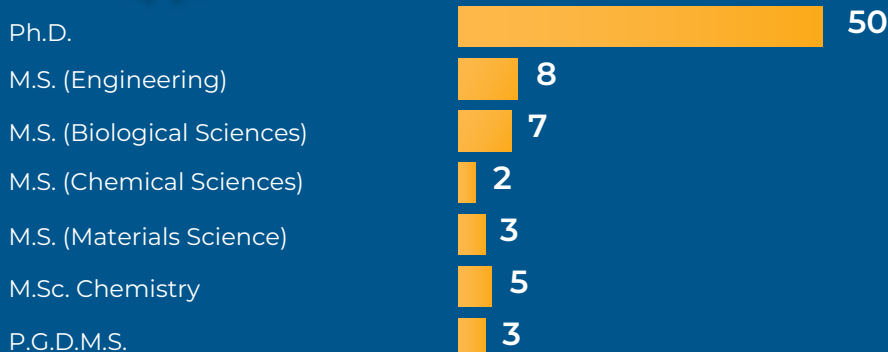
YEAR AT A GLANCE

STUDENTS REGISTERED ACROSS COURSES IN 2020-21

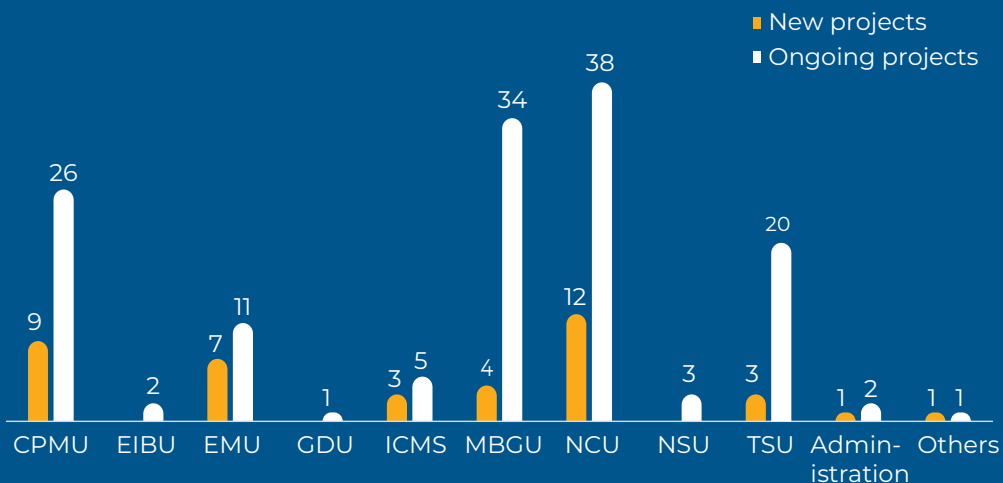


DEGREES AWARDED 2020-21

78 Total degrees



UNIT-WISE NUMBER OF NEW AND ONGOING PROJECTS IN 2020-21



New sponsored projects 2020-21

40

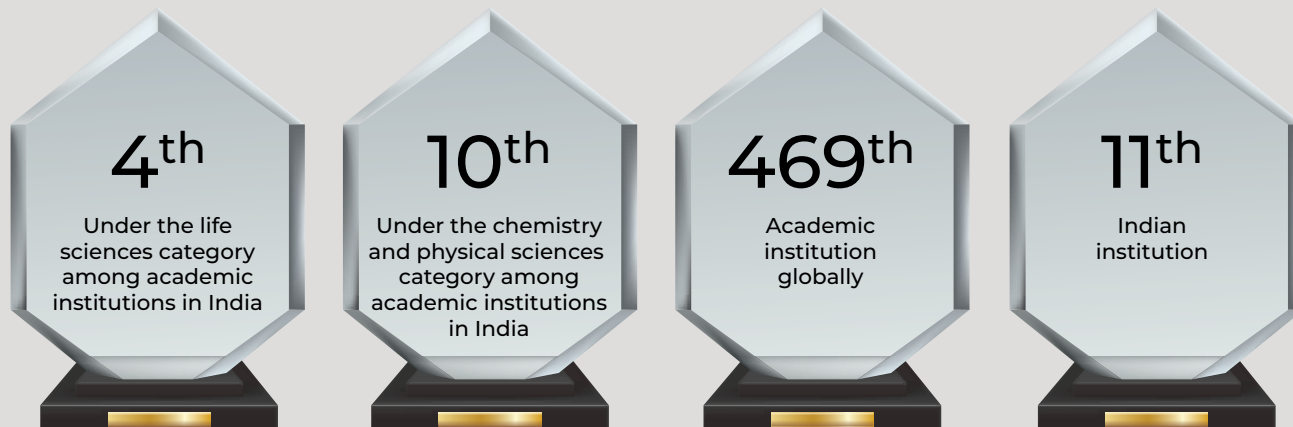
Ongoing sponsored projects 2020-21

141

AWARDS AND ACHIEVEMENTS

INSTITUTIONAL ACHIEVEMENT

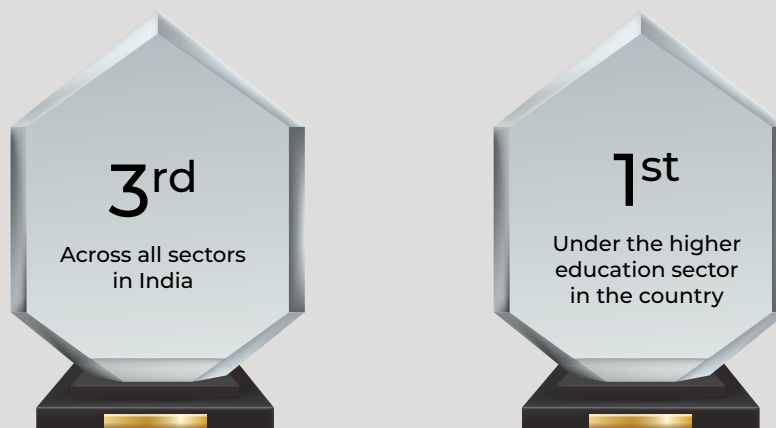
NATURE INDEX—ANNUAL TABLES 2020 RANKED JNCASR



NATURE INDEX—ANNUAL TABLES 2021 RANKED JNCASR



IN SCIMAGO INSTITUTIONS RANKING 2020 JNCASR STOOD



AWARDS AND ACHIEVEMENTS

FACULTY ACHIEVEMENTS

AWARDS

Prof. Amitabh Joshi

- Received the Silver Jubilee Professorship donated by the C. N. R. Rao Education Foundation
- Research from Prof. Joshi's group, the only work from a non-western group, was included among 65 important breakthroughs in evolutionary ecology since Darwin to the present time (LD Mueller, 2020: *Conceptual Breakthroughs in Evolutionary Ecology*, Elsevier)
- A newly described ant species from Kerala was named *Ooceraea joshii* in honour of Prof. Joshi in the year 2021

Dr. Bivas Saha

- Received the Young Scientist Research Award from the Board of Research in Nuclear Sciences (BRNS) of the Department of Atomic Energy (DAE), India

Prof. C. N. R. Rao

- Received the National Youth Day Award 2021 from Bharat Seva Samvad, Surat, Gujarat
- Received a Honoris Causa Doctorate from the Assam Royal Global University, Guwahati
- Received the International Eni Award 2020 for research into renewable energy sources and energy storage

Prof. Jayanta Haldar

- Received the Indo-US Virtual Networks for COVID-19 by IUSSTF

Prof. Ranjani Viswanatha

- Featured in Womens' Perspectives in the Energy Materials Focus issue in *Journal of Physics: Materials* (2021)
- Guest edited a Festschrift along with Prof. Prashant Kamat and Prof. A. K. Cheetham in *The Journal of Physical Chemistry C*

Prof. Ravi Manjithaya

- Received the S. Ramachandran National Bioscience Award for Career Development, 2020–21

Prof. Santosh Ansumali

- Received the Cray's Dr. A. P. J. Abdul Kalam HPC Award, 2020, by Hewlett Packard Enterprise

Prof. Sebastian C. Peter

- Received the CRSI Bronze Medal from the Chemical Research Society of India (CRSI)
- Received the Technology National Award 2021 from the Technology Development Board (TDB), the Department of Science and Technology (DST)

AWARDS AND ACHIEVEMENTS

Prof. Shobhana Narasimhan

- Received the Marshak Lectureship for 2021 by the American Physical Society

Prof. Rajesh Ganapathy (under the physical sciences category)

- Received the CSIR Shanti Swarup Bhatnagar Prize 2020

Prof. Subi J. George (under the chemical sciences category)

- Received the CSIR Shanti Swarup Bhatnagar Prize 2020

Prof. Sundaresan A.

- Received the C. N. R. Rao National Prize in Chemical Sciences from CRSI
- Received the Prof. C. N. R. Rao Oration Award Lecture 2020

Prof. T. Govindaraju

- Received the National Prize for research in peptide and nucleic acids, awarded by the C. N. R. Rao Education Foundation and JNCASR
- Winner of Health and Wellbeing, Commonwealth Chemistry Posters

FELLOWSHIPS

Prof. Anuranjan Anand

- Received the DST/ SERB J. C. Bose Fellowship 2020

Prof. Kaustuv Sanyal

- Received the DST/ SERB J. C. Bose Fellowship 2020

Dr. Bivas Saha

- Selected as a Young Associate of the Indian Academy of Sciences, 2020

Prof. Giridhar U. Kulkarni

- Received the Honorary Fellowship of the Karnataka Science and Technology Academy

Prof. Kanishka Biswas

- Invited to become the Fellow of Royal Society of Chemistry (FRSC) in the 'Leaders in the field' category
- Received the Sheikh Saqr Career Award Fellowship by the Sheikh Saqr Laboratory, JNCASR

Dr. Sarit S. Agasti

- Selected as a Young Associate of the Indian Academy of Sciences, Bengaluru, for 2020

AWARDS AND ACHIEVEMENTS

Prof. Shobhana Narasimhan

- Elected as a Fellow of the Indian Academy of Sciences

Prof. S. M. Shivaprasad

- Received the Honorary Fellowship of the Karnataka Science and Technology Academy

Prof. Subi J. George

- Invited to become the Fellow of the Royal Society of Chemistry (FRSC) in the 'Leaders in the field' category

Prof. T. Govindaraju

- Invited to become a Fellow of the Royal Society of Chemistry (FRSC)

Prof. Umesh V. Waghmare

- Elected as a Fellow of the Indian National Academy of Engineering
- Elected as a Fellow of the Maharashtra Academy of Sciences

Prof. Vidhyadhiraja N. S.

- Invited to become a Sheikh Saqr RAK-CAM Senior Fellow

MEMBERSHIPS

Prof. Giridhar U. Kulkarni

- Elected as Member, Academic Council, Indian Association for the Cultivation of Science (IACS), Kolkata
- Elected as Member, Vision Group on Nanotechnology, Department of IT, BT, S&T, Government of Karnataka
- Received Adjunct professorship at Centre for Nano and Soft Matter Sciences (CeNS)

Prof. Hemalatha Balaram

- Elected as Member, Selection Committee, G. N. Ramachandran Gold Medal, CSIR
- Elected as a Co-convenor for life sciences joint CSIR-UGC NET, 2021
- Elected as Member, Committee for the Selection of Projects under the POWER scheme of the Science and Engineering Research Board (SERB)
- Elected as Member, Committee for the Selection of Projects under the SUPRA scheme of the SERB
- Selected as a DST representative from the Autonomous Institutes for UNESCO-related work to assist INCCU, 2021
- Elected as Member, Research Council, Central Leather Research Institute (CLRI), Chennai
- Elected as Member, Governing Council, Institution of Eminence, University of Hyderabad

AWARDS AND ACHIEVEMENTS

Prof. Kanishka Biswas

- Elected as an Editorial Advisory Board Member, *iScience*, Cell Press
- Elected as an Editorial Advisory Board Member of *JACS Au*, from the American Chemical Society (ACS)
- Elected as an Advisory Board Member of *Material Horizons*, from the Royal Society of Chemistry (RSC)

Prof. Kavita Jain

- Elected as an Associate Editor of the *International Journal of Genetics* in 2020

Prof. K. S. Narayan

- Elected as a Member of the Research Council of the National Physics Laboratory, New Delhi
- Elected as a Member of the FIST Advisory Board, DST, Government of India

Prof. Maneesha S. Inamdar

- Elected as Member of the Gene Therapy Advisory and Evaluation Committee, Indian Council for Medical Research
- Elected as Member, Education, Engagement, and Empowerment (3E), working group to the WHO Expert Advisory Committee to develop global standards of governance and oversight of human genome editing
- Elected as the Member of the Statement Working Group on Regenerative Medicine of the Inter Academy Partnership
- Elected as Nominee of Secretary, DST, for the National Apex Committee on Stem Cell Research and Therapy
- Elected as Convenor of the Indian National Science Academy (INSA) Bengaluru Chapter (2021–24)

Prof. Ranjani Viswanatha

- Elected as a Member of the Editorial Advisory Board of *ChemPhotoChem*

Prof. Subi J. George

- Elected as an Associate Editor in the Editorial Board of the journal *Chemical Science* from the Royal Society of Chemistry (RSC)

Prof. T. N. C. Vidya

- Elected as a Member of the Editorial Board of the journal *Frontiers in Conservation Science*

STUDENT ACHIEVEMENTS

Mr. Abhishek Kumar Adak (Ph.D. student, Theoretical Science Unit (TSU); research supervisor: Prof. Shobhana Narasimhan)

- Received the best poster prize at the in-house symposium at JNCASR

AWARDS AND ACHIEVEMENTS

Ms. Anushka Chakravorty (Ph.D. student, Molecular Biology and Genetics Unit (MBGU); research supervisor: Prof. Ravi Manjithaya)

- Received the ALBA-FKNE-YIBRO diversity grant, funded by FENS Kavli, young IBRO and ALBA, to attend the FENS conference in 2020

Ms. Bhavana Kayyar (Int. Ph.D. student, MBGU; research supervisor: Prof. M. R. S. Rao)

- Received an EMBO training Fellowship

Ms. Divya Chalapathi (Senior Research Fellow, Chemistry and Physics Materials Unit (CPMU); research supervisor: Prof. Chandrabhas Narayana)

- Received the best oral presentation prize at the International Conference on Perspectives in Vibrational Spectroscopy (ICOPVS-2020)

Dr. K. N. Lakshmeesha (alumnus, MBGU; research supervisor: Prof. Hemalatha Balam)

- Received the INSA medal for young scientists, 2020

Mr. Pradeep K. R. (Ph.D. student, New Chemistry Unit (NCU); research supervisor: Prof. Ranjani Viswanatha)

- Received the prestigious Society for Research and Initiative for Sustainable Technologies and Institutions (SRISTI) GYTI (Gandhian Young Technological Innovation) Award 2020

Ms. Revathe T. (Ph.D. student, Evolutionary and Integrative Biology Unit (EIBU); research supervisor: Prof. T. N. C. Vidya)

- Received an abstract prize by the International Society of Behavioural Ecology

Dr. Ritu Gupta (alumnus, CPMU; research supervisor: Prof. G. U. Kulkarni)

- Received the SERB Women Excellence Award 2021

Dr. Sangeeta Dutta (Department of Biotechnology (DBT) Research Associate I, MBGU; research supervisor: Prof. M. R. S. Rao)

- Received the AWSAR award of the DST on 28 February on the occasion of National Science Day

Ms. Shrilaxmi Joshi (Ph.D. student, Neuroscience Unit (NSU); research supervisor: Prof. Anuranjan Anand)

- Received a scholarship to attend the Keystone Symposia on 'Neuropsychiatric and Neurodevelopmental Disorders: Harnessing Rare Variants' (February 2021)
- Received a conference Fellowship for the European Human Genetics Conference 2020 to present the research work entitled 'EFHC2 Variants in Juvenile Myoclonic Epilepsy' (June 2020)

AWARDS AND ACHIEVEMENTS

Ms. Sukanya Das (Int. Ph. D. student, CPMU; research supervisor: Prof. Narayan K. S.)

- Received the best poster prize for her work on conductivity measurements of confined PEDOT-PSS in nano-channels, at the Sunrise symposium held at the Indian Institute of Science (IISc) in February 2020

Ms. Vijaya Verma (Ph.D. student, NSU; research supervisor: Prof. James P. C. Chelliah)

- Received the Travel Award to attend the 44th Annual Meeting of the Japan Neuroscience Society held in July 2021

Mr. Yogendra Kumar (Ph.D. student, NCU; research supervisor: Prof. H. Ila)

- Received the poster presentation prize among NCU students during the JNCASR faculty meeting symposium in November 2020



MAJOR EVENTS AND CELEBRATIONS

WEBINARS



Earthquake and challenges: Balancing between nature and technology

The webinar lecture was given by Dr. C. P. Rajendran, Senior Associate, Geodynamics Unit, JNCASR, and organised by the Indian Academy of Sciences, Bengaluru, on 17 June 2020.



Controlling heat flow by manipulating phonons and their interactions: A bottom-up approach

The webinar conducted by Navaneetha Krishnan Ravichandran, Department of Mechanical Engineering, Indian Institute of Science (IISc), Bengaluru, was organized by Chemistry and Physics of Materials Unit, JNCASR, on 26 June 2020.

ENDOWMENT LECTURES



A. V. Rama Rao Foundation Lecture in Chemistry

The lecture was organised in JNCASR on 12 January 2021. The speaker of this lecture was Prof. Ruchi Anand from Indian Institute of Technology (IIT) Bombay, Mumbai. She gave a talk on 'Probing Mechanisms of Targeting and Allostery to Attain Specificity in Enzymatic Reactions'. In addition, the Prize Lecture, titled 'Swarm Intelligence Guided Global Minima Search on Complex Potential Energy Surfaces', was delivered by Dr. R. S. Swathi from the School of Chemistry, Indian Institute of Science Education and Research (IISER), Thiruvananthapuram.



Prof. V. Ramalingaswami Memorial Lecture in Biological Sciences

The lecture was organized at JNCASR on 26 February 2021. The speaker of this lecture was Prof. Gagandeep Kang, FRS, from the Wellcome Trust Research Laboratory, Division of Gastrointestinal Sciences, Christian Medical College, Vellore, Tamil Nadu, and the title of her talk was 'Virus, Vaccines, and Variants'. This online event was live streamed on the YouTube channel of JNCASR and was open for participation via WebEx.

MAJOR EVENTS AND CELEBRATIONS



Annual Faculty Meeting and In-house Symposium

The Annual Faculty Meeting and In-House Symposium (IHS-2020) was held during 26–27 November 2020. For the first time, the event was held via a hybrid model comprising talks, posters, and additional associated activities, participation for which could be either online or in person. Online poster sessions were hosted during the afternoons of 23–25 November 2020. The Annual Faculty Meeting took place on the forenoon of 26 November, followed by the In-House Symposium. Speakers were Profs. Hemalatha Balaram, H. Ila, and Srikanth Sastry from JNCASR, Milan K. Sanyal from the Department of Atomic Energy (DAE)—Saha Institute of Nuclear Physics, and Jyotirmayee Dash from the Indian Association for the Cultivation of Science, Kolkata. There was a total of 9 sessions comprising 33 scientific talks by faculty members and students of the Centre. The event was livestreamed on YouTube and was participated online over Microsoft Teams. Awards for best talk and poster were also announced in appreciation of the high quality of scientific presentations. The degree award ceremony was also held on 26 November 2020. Prof. G. U. Kulkarni, President, JNCASR, distributed the degree certificates to the graduating students.

OTHER FUNCTIONS



Book Release Function

A book release function was held online for a book authored by Prof. C. N. R. Rao and Dr. Indumati Rao titled *Founders of Modern Science in India*. The event was organised by the Indian Academy of Science (IASc), Bengaluru, on 31 March 2021. The book was released by Prof. Ashutosh Sharma, Secretary, DST, Government of India; Prof. C. N. R. Rao; Dr. Indumati Rao; Prof. Partha Majumdar, President, IASc; and Prof. Amitabh Joshi, Editor of the publications of the Academy; who also shared their views on the book during the event. This event was hosted on WebEx and streamed live by JNCASR on [YouTube](#).

CELEBRATIONS OF SIGNIFICANT DAYS



International Yoga Day

The 6th edition of International Yoga Day was observed on 21 June 2020 (Sunday) at JNCASR. Due to the constraints imposed by the COVID-19 pandemic, no major outdoor activities involving the students/staff of the Centre were planned. However, the members of the Centre were informed of the guidelines promulgated by the Ministry of AYUSH by displaying them prominently on notice boards and digital display screens. To mark the occasion, on-duty security guards hired through PSA practiced various asanas of yoga, while maintaining social distancing norms and adopting safety measures.

MAJOR EVENTS AND CELEBRATIONS



Vigilance Awareness Week

On the occasion of Vigilance Awareness Week 2020, an Online Integrity Pledge was organised on 27 October 2020 at JNCASR. The Pledge was administered by Prof. K. R. Sreenivas, Vigilance Officer, JNCASR. The program was attended by the faculty members, staff, and students.



Constitution Day

To mark the occasion of Constitution Day (Samvidhan Diwas), a series of programmes was organized in JNCASR, including a running event, quiz contest, essay contest, and webinar. In the webinar held on 24 November 2020, Dr. H. K. Nagaraja from the National Law School of India delivered a talk on 'Constitution of India – A Common Man's Perspective'.

On 26 November 2020, faculty members, staff, and students at JNCASR read the Pledge along with the Hon'ble President of India, Shri Ram Nath Kovind.



MAJOR EVENTS AND CELEBRATIONS

The live streaming of the address by the Hon'ble Prime Minister Shri Narendra Modi on the occasion of Samvidhan Diwas at the 80th All India Presiding Officers' Conference in Kevadia, Gujarat, on 26 November 2020 was viewed at JNCASR. The event was watched by the President of JNCASR along with other officers.



National Science Day

The Fellowships and Extension Programmes office in association with C. N. R. Rao Hall of Science and Education Technology Unit celebrated National Science Day on 28 February 2021. Prof. N. S. Vidhyadhiraja, Dean Fellowships and Extension (F&E), Dr. Bivas Saha, New Chemistry Unit (NCU), and Prof. Sebastian C. Peter, NCU, gave lectures on various scientific topics as a part of the celebration.



International Women's Day

The Fellowships and Extension Programmes office in association with the C. N. R. Rao Hall of Science and Education Technology Unit celebrated International Women's Day on 08 March 2021. Dr. Jahnvi Phalkey, Director of Science Gallery, Bengaluru, gave a lecture entitled 'Why History of Science?' as a part of the celebration.

MAJOR EVENTS AND CELEBRATIONS

EVENTS ORGANISED BY THE HINDI CELL

Talk on awareness on official correspondence



03 JUN
2020

In the online event, the message on the COVID-19 pandemic issued by the Hon'ble Home Secretary was read.

22 SEP
2020



Hindi Diwas programme in association with the Indian Institute of Science, Bengaluru

Talk on Hindi newspaper reading



04 DEC
2020

22 JAN
2021



Talk on the significance of Official Language

Easy methods to crack Hindi exams



17 FEB
2021

Mr. M. G. Savadhata, Assistant Director (Retd.), Hindi Training Programme, Bengaluru

Mr. Joydeep Deb, Incharge Hindi Officer, JNCASR

01 MAR
2021



Significance of National Language

Noting and drafting



05 MAR
2021

Mr. M. G. Savadhata, Assistant Director (Retd.), Hindi Training Programme, Bengaluru

MAJOR EVENTS AND CELEBRATIONS

OTHER MAJOR EVENTS

1. The JNCASR-FCBS Workshop for college chemistry students and teachers was conducted online from 15 to 17 December 2020. Talks were delivered by the faculty members of NCU along with speakers from IISER Trivandrum.
2. International Winter School 2020 on Frontiers in Materials Science (A Virtual Event), 07-11 December 2020, Convenors: Prof. M. Eswaramoorthy, Chemistry and Physics of Materials Unit (CPMU), and Prof. Umesh V Waghmare, Theoretical Sciences Unit (TSU), JNCASR.
3. The 10th Sheikh Saqr Materials Online Lecture on 'Developing and Applying New Tools to Understand How Materials for Li and "Beyond-Li" Battery Technologies Function' was given by Prof. Clare P. Grey, University of Cambridge, UK, on 8 December 2020.
4. The Curtain Raiser Programme of the 6th India International Science Festival 2020 and Public Outreach Lectures were jointly organised by JNCASR and the Centre for Nano and Soft Matter Sciences (CeNS), Bengaluru, on 11 December 2020.
5. The CPMU Silver Jubilee Conference and the first C. N. R. Rao Materials Lecture were held on 18 December 2020.
6. The lecture 'Brain Proposes, Spinal Cord Disposes – Spinal Cells and Circuits for Motor Control' was delivered by Dr. Anupama Sathyamurthy, Centre for Neurosciences, IISc, Bengaluru, on 23 December 2020.
7. The lecture 'Emergent Phenomena of Polar Topologies' was delivered by Dr. Sujit Das, Post Doc, Department of Physics, University of California, Berkeley, USA, and Department of Materials Science and Engineering on 25 January 2021.
8. Dr. Argel Aguilar-Valles, Assistant Professor, Department of Neuroscience Carleton University, Ottawa, Canada, delivered a lecture titled 'Antidepressant Actions of Ketamine Engage Cell-specific Translation via eIF4E', on 28 January 2021.
9. A lecture on 'Two-dimensional van der Waals Heterostructure-based Electronic and Optoelectronic Devices' was given by Dr. Bablu Mukherjee, Designated Assistant Professor (Lecturer), Center for Low-temperature Plasma Sciences, Nagoya University, Japan, on 01 February 2021.
10. Dr. M. S. Bootharaju, Post Doc, Chemical and Biological Engineering, Seoul National University, Seoul, South Korea, delivered a lecture titled 'Exciting Chemistry of Molecular Metal Nanostructures' on 05 February 2021.
11. The C. N. R. Rao Hall of Science and Education Technology Unit (ETU) organized an online science outreach programme on the 'Origin and Fate of Viral Pandemics' by Dr. Shashank Tripathi, Microbiology and Cell Biology Department, Center for Infectious Disease Research, IISc, Bengaluru, on 05 February 2021.

MAJOR EVENTS AND CELEBRATIONS

12. A lecture titled 'Dynamic Behaviour of Biomimetic Systems' was delivered by Dr. Subhadip Ghosh, Department of Biophysics, University of Michigan, on 08 February 2021.
13. Dr. Geet Awana, Post Doc, Loughborough University, gave a lecture on 'Structural and Magnetic Characterization of Magnetic Thin Films Used in Memory-based Devices' on 10 February 2021.
14. The Fluorescence Microscopy Webinar and Workshop was held on 17 February 2021. The online workshop consisted of various scientific talks by eminent speakers in the field.
15. The lecture 'Non-coding RNA-mediated Mechanisms and Perspectives in Chronic Pain' was given by Dr. Kiran Bali, Department of Experimental Pain Research, Mannheim Center for Translational Neuroscience (MCTN), Heidelberg University, on 19 February 2021.
16. DST-Nano Mission's Users Meeting of Synchrotron Projects was held from 4–5 March 2021.
17. Prof. G. U. Kulkarni, President, JNCASR, attended the meeting on Aazadi ka Amrut Mohotsav on 12 March 2021. The meeting was chaired by Prof. Ashutosh Sharma, Secretary, DST, Government of India, and attended by directors of all autonomous institutions of DST.

MAJOR INFRASTRUCTURAL DEVELOPMENT



Inauguration of the fire hydrant system at JNCASR

A campus-wide installation of the fire hydrant system was recently completed. On 20 January 2021, Prof. G. U. Kulkarni, President, JNCASR, inaugurated the system at a ceremony, followed by a demonstration of the system.



Prof. G. U. Kulkarni, President, JNCASR inaugurating the fire hydrant system at JNCASR



ACTIVITIES CHART

EDUCATION

Academic programmes

Ph.D. | M.S. (Engineering) | Int. Ph.D. | M.Sc. in Chemistry |
M.S.-Ph.D. | M.S. (Research) | P.G.D.M.S.

RESEARCH

Faculty members

Units and Laboratories

EXTENSION PROGRAMMES

Fellowships and extension programmes

- Summer Research Fellowship Programme (SRFP)
- Visiting Fellowship Programme
- Project Oriented Chemistry Education (POCE) and Biology Education (POBE) programmes
- Student Buddy Programme

Science education and education technology

DISCUSSIONS, MEETINGS, AND OUTREACH

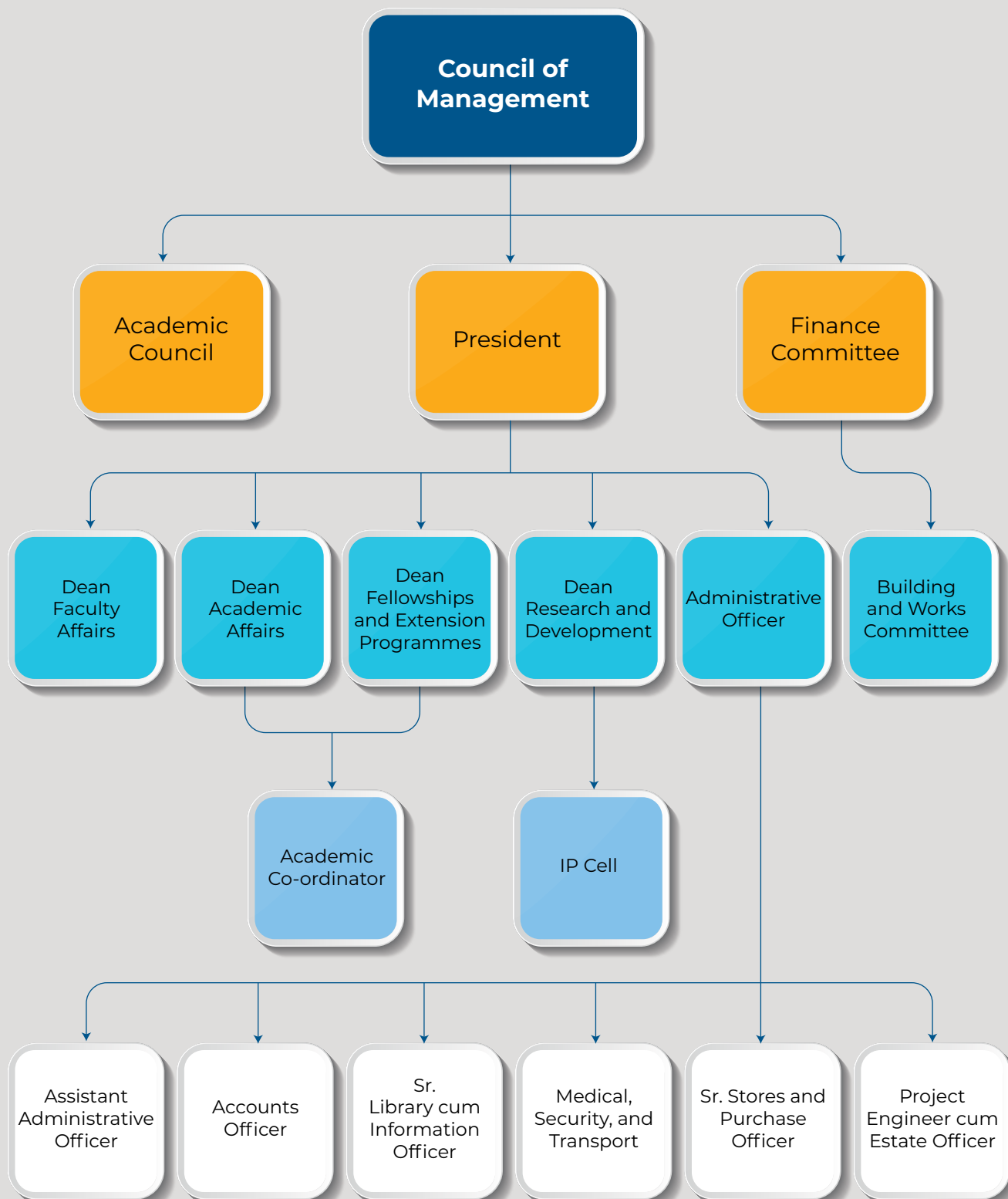
23 lectures and conferences held during 2020–21

10 outreach programmes organised by the Education Technology Unit during 2020–21

PUBLICATION OF MONOGRAPHS AND PROCEEDINGS



ORGANISATIONAL CHART



COUNCIL OF MANAGEMENT

Administration and management of the affairs and finances of the Centre are conducted by the Council of Management. The Council of Management of the Centre meets twice a year.

Council of Management:



Prof. Goverdhan Mehta
Chairperson
Former Director,
IISc, Bengaluru



Prof. Virander S. Chauhan
Member
Arturo Falaschi
Emeritus Scientist,
ICGEB, New Delhi



Prof. M. Jagadesh Kumar
Member
VC, JNU, New Delhi



Shri Vinod K. Singh
Member
Professor,
IIT Kanpur



Shri K. N. Vyas
Member Secretary,
DAE and Chairman, AEC



Govindan Rangarajan
Member
Director, IISc



Prof. Ashutosh Sharma
Member
Secretary, DST



Shri Vishvajit Sahay
Member
AS and FA, DST



Prof. G. U. Kulkarni
Member
President, JNCASR



Nominee of the Society



Prof. Sriram Ramaswamy
Member Physics
Department, IISc



Prof. Hemalatha Balaram
Member Dean,
Faculty Affairs, JNCASR



Prof. Umesh V. Waghmare
Member Dean,
Academic Affairs,
JNCASR



Prof. Anuranjan Anand
Member
Professor, MBGU,
JNCASR



Mr. Joydeep Deb
Non-Member
Secretary
Administrative Officer,
JNCASR

COMMITTEES

FINANCE COMMITTEE

The Finance Committee of the Centre scrutinises all financial proposals and makes recommendations to the Council of Management. During 2020–21, the Committee consisted of the following members:

NAME AND DESIGNATION	POSITION
Prof. G. U. Kulkarni, President, JNCASR	Chairperson (Ex-officio)
Prof. Vinod K. Singh, Professor, IIT Kanpur	Member
Prof. N. Balakrishnan, Professor, IISc	Member
Prof. Hemalatha Balaram, Dean, Faculty Affairs, JNCASR	Member
Shri Vishvajit Sahay, AS and FA, DST	Member
Mr. Sampad Patra, Accounts Officer, JNCASR	Member (Ex-officio)
Mr. Joydeep Deb, Administrative Officer, JNCASR	Non-Member Secretary (Ex-officio)

ACADEMIC COUNCIL (ERSTWHILE ACADEMIC ADVISORY COMMITTEE)

The functions of the Academic Council include planning, execution, and co-ordination of research and academic activities of the Centre. It regulates the courses of study, procedures for admission of students, examination, etc. It meets at least twice a year. This Council makes its recommendations on all academic matters to the Council of Management. During 2020–21, the following members formed this Council:

NAME AND DESIGNATION	POSITION
Prof. G. U. Kulkarni, President, JNCASR	Chairperson (Ex-officio)
Prof. Raghavan Varadarajan, Professor, MBU, IISc	Member
Prof. Devang V. Khakhar, Professor, IIT Bombay	Member (UGC nominee)
Prof. D. D. Sarma, Professor, SSCU, IISc	Member
Prof. U. Ramamurty, Professor, MAE, NTU, Singapore	Member
Prof. R. Murugavel, Professor, IIT Bombay	Member
Prof. Hemalatha Balaram, Dean, Faculty Affairs, JNCASR	Member (Ex-officio)
Prof. Umesh V. Waghmare, Dean, Academic Affairs, JNCASR	Member (Ex-officio)
Prof. K. R. Sreenivas, Dean, Research and Development, JNCASR	Member (Ex-officio)
Prof. Vidhyadhiraja N. S., Dean, Fellowships and Extension Programmes, JNCASR	Member (Ex-officio)
Mr. Joydeep Deb, Administrative Officer, JNCASR	Non-Member Secretary (Ex-officio)

ENDOWED CHAIRS

Linus Pauling Research Professor, Bharat Ratna Prof. C. N. R. Rao, F.R.S.

Hindustan Lever Research Professor, Prof. H. Ila, New Chemistry Unit

ADMINISTRATION

POSITION	NAME OF THE MEMBER
President	G. U. Kulkarni, Ph.D., F.A.Sc., F.N.A.Sc.
Dean, Faculty Affairs	Hemalatha Balaram, Ph.D., F.A.Sc., F.N.A.Sc.
Dean, Academic Affairs	Umesh V. Waghmare, Ph.D., F.A.Sc., F.N.A.Sc., F.N.A.
Dean, Fellowships and Extension Programmes	Vidhyadhiraja N. S., Ph.D.
Dean, Research and Development	G. U. Kulkarni, Ph.D., F.A.Sc., F.N.A.Sc.
Warden and Student Counsellor	Jayanta Haldar, Ph.D.
Associate Warden	Sheeba Vasu, Ph.D.
Administrative Officer and Public Information Officer	Joydeep Deb, M.Sc. (Electronics), M.Sc. (Telecommunication), M.B.A. (HRM)
Assistant Administrative Officer (SG)	C. S. Chitra, B.Com.
Co-ordinator (Academic, F & E and R & D)	Dr. Panneer K. Selvam, M.A., M.B.A., L.L.B., Ph.D.
Accounts Officer	Sampad Patra, B.Com, P.G.D.C.A., M.B.A. (Finance)
Sr. Stores and Purchase Officer	K. Bhaskara Rao, M.Sc.
Sr. Library cum Information Officer	Nabonita Guha, M.L.I.S.
Sr. Secretary to President	A. Srinivasan, B.A.
Jr. Accounts Officer	B. Venkatesulu, B.Sc.
Assistant Public Information Officer	Susheela G., B.Sc.
Project Engineer	Mahadevan N., B.E., M.I.E.
Project Engineer Gr. II	Nadiger Nagaraj, D.C.E.
Assistant Project Engineer (Elec.)	Sujeeth Kumar S., D.E.E.
Junior Project Engineer (Civil)	Veerasha N. R., D.C.E.
Chief Medical Officer	G. R. Naghabhushana, M.B.B.S., F.C.C.P., F.C.G.P., P.G., Dip. in M&CHL
Medical Officers	Kavitha Sridhar, M.B.B.S. Senthamarai S Manoharan, M.B.B.S., P.G.D.M.L.S., Diploma in Preventive and Promotive Health Care, Diploma in Counseling Skills, P.G.D.H.H.M., M.B.A. (HA)
Clinical Psychologist	Elizebath Daniel, M.A., M.Phil., Ph.D.
Physiotherapist	Y. Yogesh, B.P.T.
Honorary Medical Officer	C. Satish Rao, M.B.B.S. R. Nirmala, M.B.B.S.
Adviser Special Projects and Initiatives	A. N. Jayachandra, B.Com., P.G. Diploma
Co-ordinator (Security and Fire Fighting)	M. R. Chandrasekhar, B.Sc., L.L.B.

APPOINTMENTS

ADDITIONAL RESPONSIBILITIES

Prof. Subi J. George	Chairperson, NCU (02 November 2020)
Prof. Govindaraju T.	Chairperson, ETU (02 November 2020)
Mr. A. N. Jayachandra	Nodal Officer (COVID-19)
Mr. M. G. Narayana	Assistant Nodal Officer (COVID-19)
Mr. K. Bhaskara Rao	Records Officer
Mr. Sreenath V.	Co-ordinator (Health, Safety, and Conservation)
Prof. N. S. Vidhyadhiraja	Nodal Officer (for celebration of Constitution Day) Event Co-ordinator (for celebration of Golden Jubilee Year of DST at the Centre)
Prof. Kavita Jain	Nodal Officer - GATI (Gender Advancement for Transforming Institutions), Pilot Project of DST
Prof. Shobhana Narasimhan	Faculty In-charge, PAIRs office
Mrs. Chitra C. S.	Nodal Officer - Compassionate Grounds appointment

PROMOTIONS

PROFESSOR

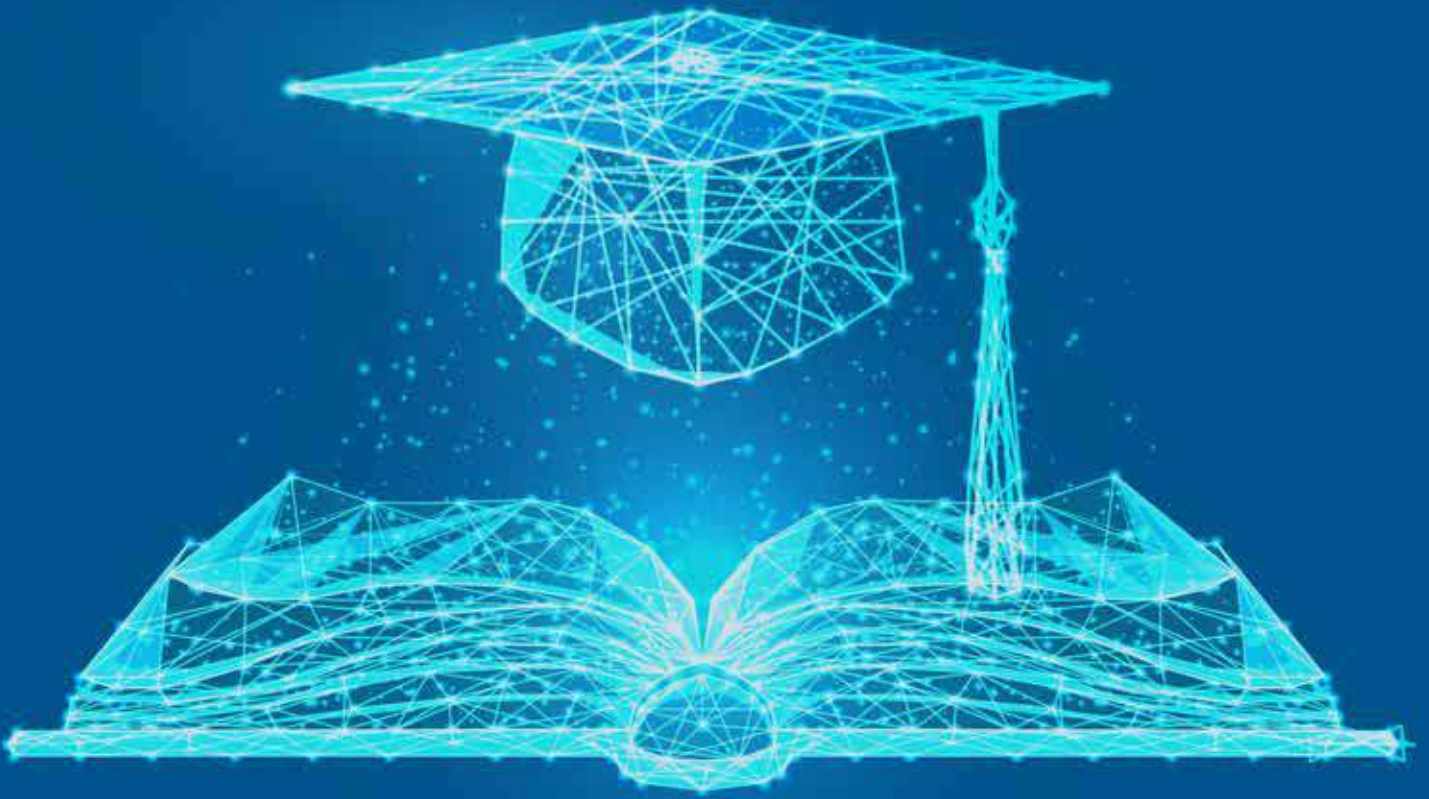
Prof. Subi J. George	Associate Professor, NCU (07 May 2020)
Prof. T. Govindaraju	Associate Professor, NCU (07 May 2020)
Prof. Kavita Jain	Associate Professor, TSU (26 September 2019)

ASSOCIATE PROFESSOR

Prof. James P. C. Chelliah	Faculty Fellow, NSU (17 July 2019)
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NEW JOININGS (ON CONTRACT)

Mr. Vinayak Pattar	Assistant Co-ordinator, ETU (w.e.f. 04 November 2020)
Mr. M. G. Narayan	Co-ordinator (PR) (w.e.f. 01 April 2020)



02

ACADEMICS

At JNCASR, a range of postgraduate courses can be studied while conducting cutting-edge research alongside curious and driven peers, adding to a 32-year legacy of scientific advancement that is evidenced by the numerous academic achievements. This section provides an overview of academic programmes and achievements in 2020–21.

ACADEMIC PROGRAMMES

JNCASR is a vibrant institution that has University status and offers Ph.D., Integrated (Int.) Ph.D., M.S. (Research), and M.S. (Engineering) degrees in Science and Engineering. The final selection of candidates is based on their academic record, performance in national level qualifying exams, recommendations from referees, and performance in an interview. Int. Ph.D. programmes are offered in the fields of Materials Science, the Chemical Sciences, and the Biological Sciences. The programme is offered only during the August session of admissions. Enrolled students are expected to take courses and actively participate in research. Research students receive a monthly fellowship as per the government or JNCASR's guidelines. On successful completion of their coursework and thesis, students are awarded the relevant degrees. They get ample opportunities to interact with renowned scientists and other fellow students via national and international conferences and workshops. Every department also conducts its own seminars where faculty and students can discuss their research. Students have access to world-class infrastructure and cutting-edge facilities.

Research admissions

In the academic year 2020–21, **69** students were enrolled in various degree programmes at JNCASR:

Ph.D.: 38
M.S. (Engineering): 08
M.S. of Int. PhD in Biological Sciences: 05
M.S. of Int. Ph.D. in Materials Science: 04
M.S. of Int. Ph.D. in Chemical Sciences: 07
M.Sc. Chemistry: 05
P.G.D.M.S.: 02

The current student strength at JNCASR is **320**.

Degrees awarded

In the past year, the following number of degrees were awarded:

Ph.D.: 50
M.S. (Engineering): 08
M.S. in Biological Sciences: 07
M.S. in Materials Science: 03
M.S. in Chemical Sciences: 02
M.Sc. Chemistry: 05
P.G.D.M.S.: 03

Total degrees awarded: **78**
(50 Ph.D.s, 20 M.S., 3 P.G.D.M.S.)

MEMBERS OF ACADEMIC SECTION

Dean, Academic Affairs: **Prof. Umesh V. Waghmare**

Academic Co-ordinator: **Dr. Princy Jaison Pereira** (On Lien w.e.f November 2019)

Co-ordinator (Academic, F & E and R & D) (On Contract): **Dr. Panneer Selvam K.**

Jr. Admin. Assistant: **Vinutha S.**

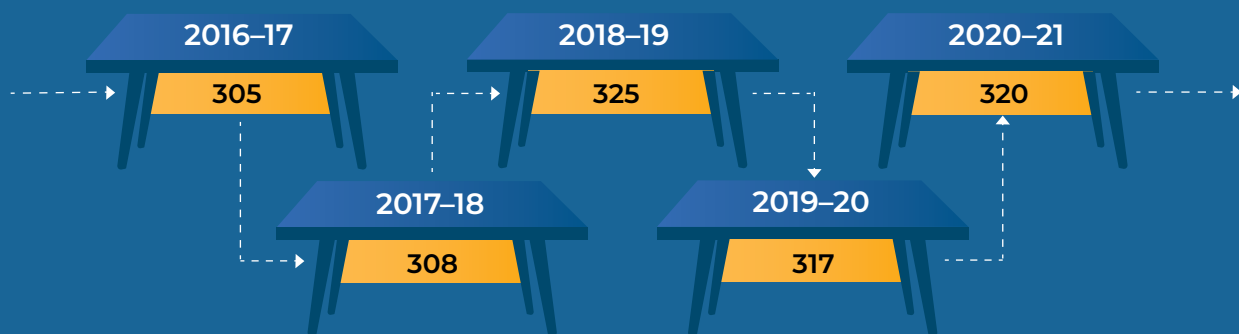
Jr. Admin. Assistant: **Bhagya Shree P.**

ACADEMIC PROGRAMMES

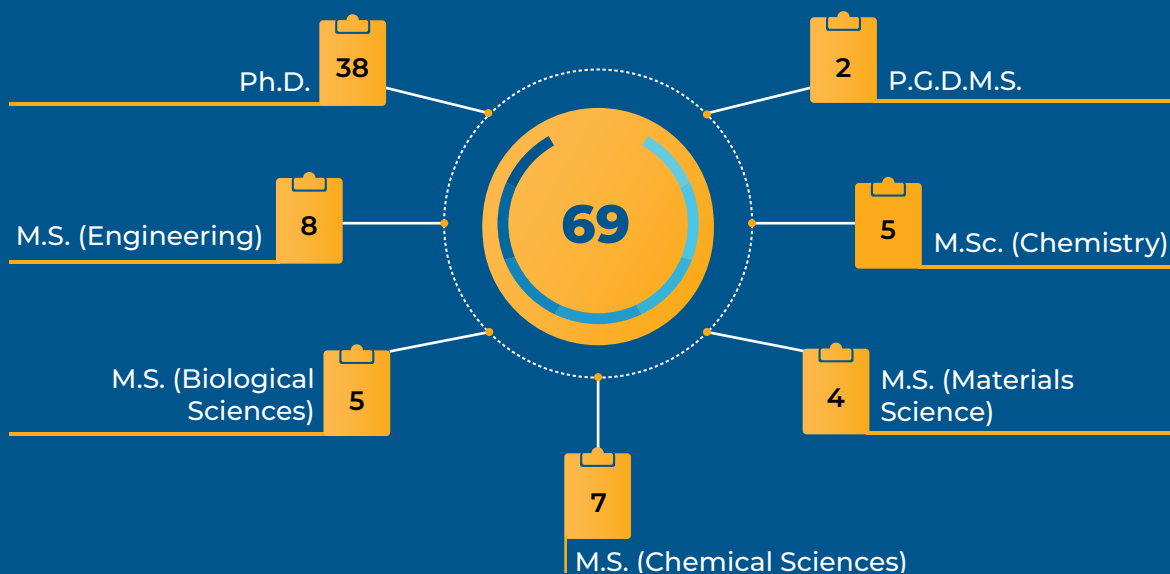
STUDENTS REGISTERED ACROSS ACADEMIC COURSES 2020-21



TOTAL STUDENT STRENGTH (PAST 5 YEARS)



TOTAL ADMISSIONS 2020-21



ACADEMIC PROGRAMMES



DEGREES AWARDED 2020-21

78 Total degrees



STUDENTS AND DEGREES BY UNIT 2020-21

Total students

Degrees awarded



83

CPMU



14

Ph.D.	72
M.S. (Engineering)	1
M.S. (Materials Science)	10

Ph.D.	11
M.S. of Int. Ph.D.	3



12

EIBU



2

Ph.D.	12
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Ph.D.	2
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23

EMU



10

Ph.D.	12
M.S. (Engineering)	11

Ph.D.	4
M.S. (Engineering)	6



2

ICMS

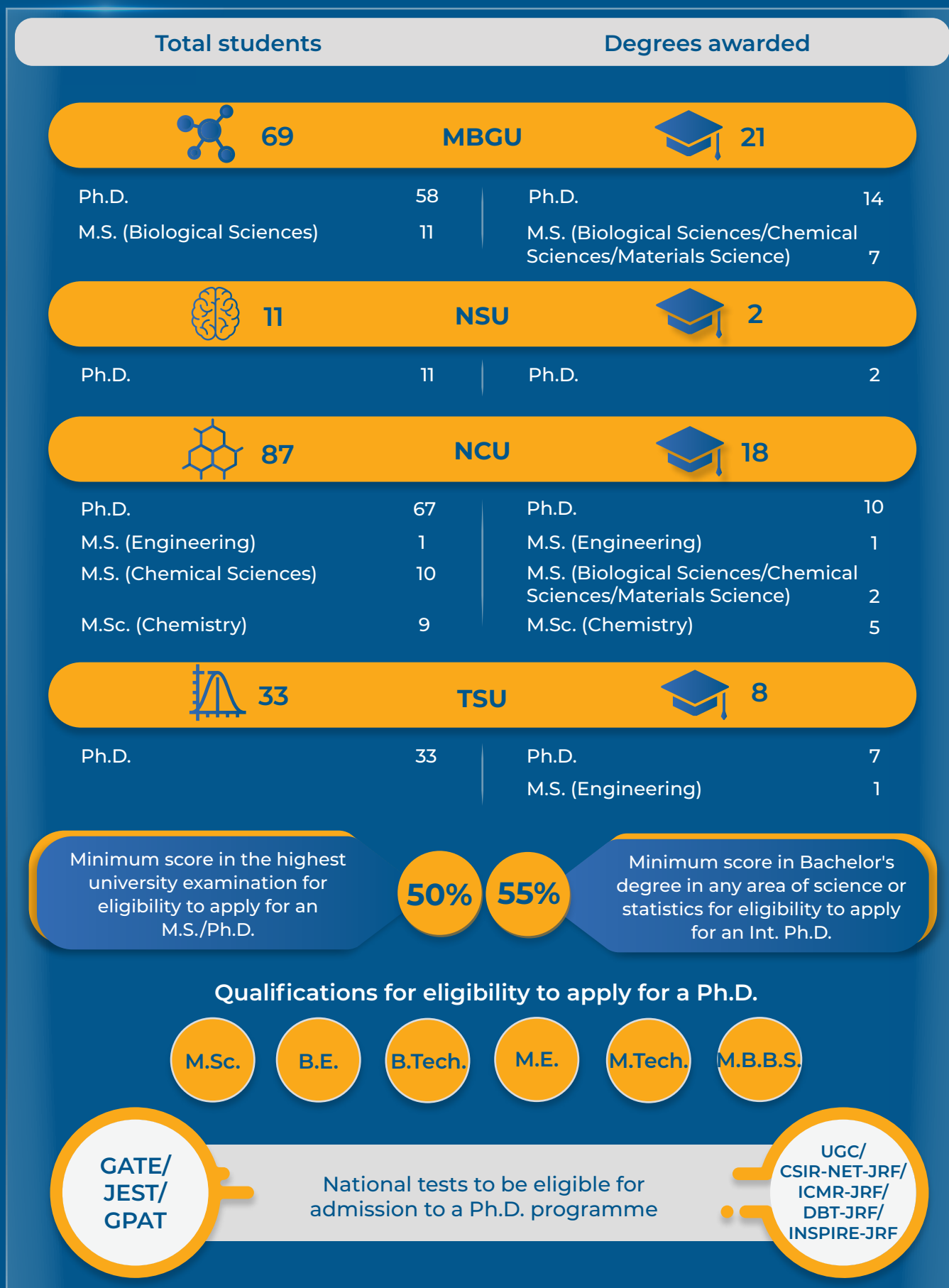


3

P.G.D.M.S.	2
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P.G.D.M.S.	3
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ACADEMIC PROGRAMMES



ACADEMIC PROGRAMMES

Stipend

Ph.D.	₹31,000–35,000
M.S.	₹31,000
Int. Ph.D.	₹19,000–35,000

Check www.jncasr.ac.in/admit for more details

When to apply

January session for Ph.D. and M.S. only	Admissions are advertised in October
August session for all programmes	Admissions are advertised in February

New students per unit 2020–21



CPMU

Ph.D.	6
Int. Ph.D. M.S.	4



EMU

Ph.D.	2
M.S. (Engineering)	5



MBGU

Ph.D.	4
Int. Ph.D. (Biological Sciences)	5



NSU

Ph.D.	2
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NCU

Ph.D.	13
Int. Ph.D. (Chemical Sciences)	7
M.S. (Chemistry)	5



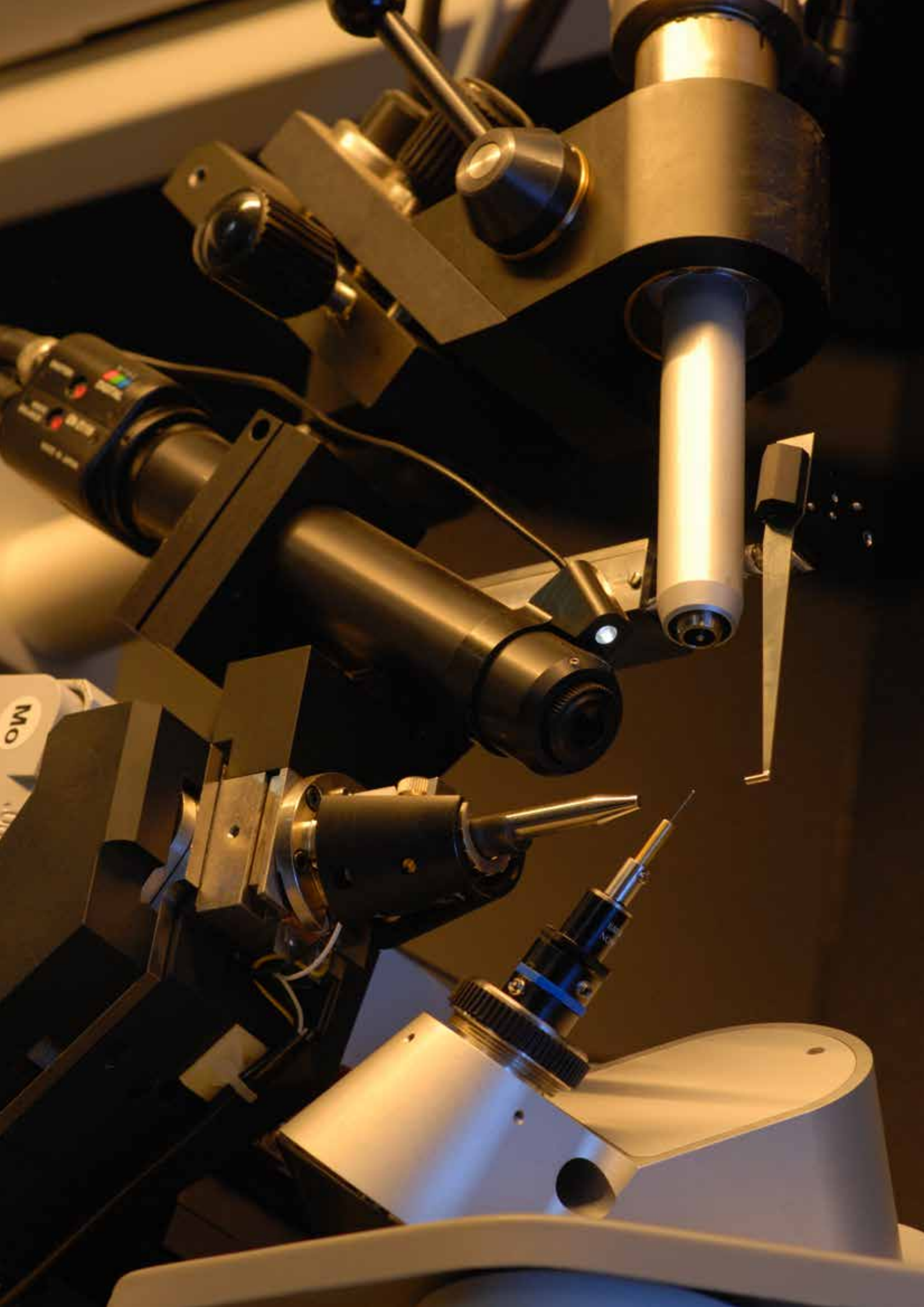
TSU

Ph.D.	6
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ICMS

P.G.D.M.S.	2
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03

RESEARCH AND DEVELOPMENT

Research and development in the frontier areas of science is at the core of activities at JNCASR, with a strong emphasis on interdisciplinary research, meeting the highest standards of quality and integrity. This continuous pursuit of excellence has led to academicians, past and present, making notable discoveries for which they have received numerous awards and patents. Over the years, a remarkable 107 patents were granted for our research. This has resulted in the Centre being recognised as a top scientific research institute at the national and international levels.

The following section describes how the 9 research units of JNCASR fared during 2020–21. They are the Chemistry and Physics of Materials Unit (CPMU), Evolutionary and Integrative Biology Unit (EIBU), Engineering Mechanics Unit (EMU), International Centre for Materials Science (ICMS), Molecular Biology and Genetics Unit (MBGU), New Chemistry Unit (NCU), Neuroscience Unit (NSU), Theoretical Sciences Unit (TSU), and Geodynamics Unit (GDU).

CHEMISTRY AND PHYSICS OF MATERIALS UNIT (CPMU)



CPMU was established at JNCASR as a seat for world-class research and higher education on materials science and technology. It was the first research unit to be established at JNCASR and has been up and running for over 25 years. Here, we strive to be a centre of the confluence of talents drawn from both the titular traditional disciplines. The Unit is equipped with state-of-the-art facilities.

Due to the interdisciplinary nature of materials research, we join forces with and welcome researchers from chemistry, physics and biology backgrounds. Since its inception, CPMU has come up with many groundbreaking discoveries and advances in the field of materials science and has collaborated with many national and international laboratories.

RESEARCH AREAS

- Nanomaterials fabrication and nanolithography
- Supramolecular self-assembly
- Functional processable 'soft' organic/hybrid gel materials
- Superconductivity
- Biological systems (proteins)
- Room temperature ionic liquids
- Semiconductors
- Molecular beam epitaxial growth of III-nitrides
- Brillouin spectroscopy of carbon nanotube and other novel systems
- Porous materials (metal organic frame works and organic porous polymers)
- High energy resolution electron energy loss spectroscopy
- Catalysis and solid-state chemistry
- Two-dimensional materials
- Aberration corrected high-resolution transmission electron microscopy
- Neuromorphic devices
- Quantum materials
- Magnetoelectrics and multiferroics
- Atomic layer deposition and pulsed laser deposition

RESEARCH HIGHLIGHTS

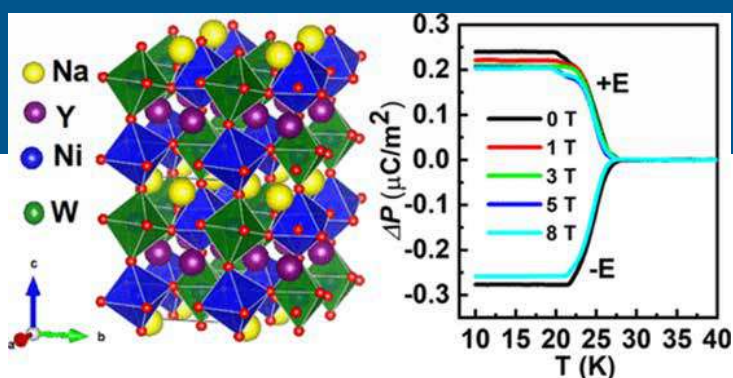
- The A-site and B-site cation ordering in NaLnNiWO_6 perovskites was investigated using neutron diffraction and X-ray diffraction analyses.
- The computational analysis of ion-hopping signatures in liquid high-concentration electrolytes was performed using lithium tetrafluoroborate-in-sulfolane mixtures as models.
- Layered nanocomposites of polymer-functionalised reduced graphene oxide and borocarbonitride with molybdenum diselenide (MoSe_2) and molybdenum disulfide (MoS_2) showed excellent activity for the hydrogen evolution reaction.
- The mechanisms by which change in the divalent cation switches the DNA cleavage property of the restriction enzyme KpnI endonuclease was demonstrated.
- Inorganic phosphides were used as electrocatalysts to improve the efficiency of water splitting.
- A biomimicking artificial syntactic network was fabricated that emulates the behaviour of bioneurons and neurotransmitters.
- Carrier diffusion was studied in the context of recombination and carrier trapping, allowing for the tailoring of the hybrid-perovskite single-crystal solar cell architecture for suitable optoelectronic applications.
- Theoretical modelling was performed and geometrical considerations were made for gallium nitride nanowall network morphologies to provide experimental evidence of intense light emission.
- An integrated catalytic system was designed by grafting both the molecular catalyst and photosensitiser inside a confined metal-organic framework pore to achieve the solar-driven reduction of CO_2 : artificial photosynthesis.
- A distinct approach was developed to selectively barcode cells by spatially controlling the positioning of fluorescent labels using light.
- The relationship between the substrate temperature and growth mode was established in scandium nitride semiconductor thin films.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

Prof. Sundaresan A. Ph.D., FASc.

Professor and Chair, CPMU

Our team has reported an unusual combination of the layered A-site cation ordering and B-site rock salt ordering in NaYNiWO_6 prepared under high-pressure and high-temperature conditions. ABO_3 perovskite materials are, in general, prone to octahedral distortion due to the ionic size mismatch between A and B cations, and this often leads to the formation of various kinds of crystal symmetry. Such distortions always result in centrosymmetric structures except for a covalent bond formation because of the second-order Jahn–Teller effect. This effect is predominant in the case of d^0 or lone-pair cations. But in our study, we discovered an unusual combination of the layered A- and B-site cation ordering in NaYNiWO_6 . We synthesised this material under high-pressure and high-temperature conditions, and this led to the formation of a polar ($P2_1$) structure, as revealed by neutron diffraction analysis. The NaYNiWO_6 perovskite crystals also exhibited multiferroic properties below the magnetic ordering of Ni^{2+} ions ($T_N = 21$ K). Our neutron diffraction data at 20 K revealed an incommensurate sinusoidal spin ordering with the propagation vector and a commensurate collinear spin structure below 18 K. We provided evidence for the presence of a polar structure in the D_y , H, and Y_b compounds with X-ray diffraction analysis. Our results also indicate that the four compounds exhibit a switchable change in electric polarisation (ΔP) at the magnetic ordering temperatures, demonstrating coupling between ferroelectricity and magnetism.



Perovskite structure and electric polarisation versus temperature graph for NaYNiWO_6 (*Chem. Mater.* 2020 (32): 5641–5649. doi: 10.1021/acs.chemmater.0c01149).

Reference:

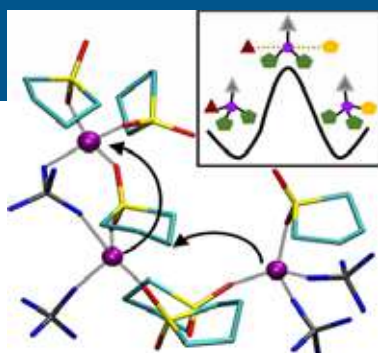
Chem. Mater. 32 (13): 5641–5649. doi: 10.1021/acs.chemmater.0c01149

Other research activity during 2020–21:

Phys. Rev. Res. 2 (2): 049002. doi: 10.1103/PhysRevResearch.2.023271

Prof. Balasubramanian Sundaram Ph.D., FASc.**Professor**

Ion-hopping is believed to be a significant mode of transport for small ions in liquid high concentration electrolytes (HCE). But bulk signatures of ion-hopping over sufficiently long time intervals have not been explored enough. In our study, we computationally established the long and short time imprints of hopping in HCEs using lithium tetrafluoroborate (LiBF₄)-in-sulfolane mixtures as models. We used a highly viscous LiBF₄ based electrolyte, which led to significant dynamic heterogeneity in Li-ion transport. Li-ions prefer to move to the previously occupied Li-ion-sites when bridged through anion or solvent molecules. Our computational experiments for determining the free energy barrier and transition state structure revealed that the hopping of ions in the liquid matrix was an activated process. We presented evidence for nanoscale compositional heterogeneity at high salt concentrations. The simulations we conducted also shed light on the composition, stiffness and lifetime of the solvation shell of Li-ions. The understanding of HCEs gleaned from this study will spearhead the choice, engineering and applicability of this class of electrolytes.



Computational model for ion hopping in LiBF₄-in-sulfolane (*J. Phys. Chem. Lett.* 11 (22): 9613–9620 . doi: 10.1021/acs.jpcllett.0c02995).

Reference:

J. Phys. Chem. Lett. 11 (22): 9613–9620. doi: 10.1021/acs.jpcllett.0c02995

Other research activities during 2020–21:

- *J. Phys. Chem. B.* 40: 8844–8856. doi: 10.1021/acs.jpccb.0c04939
- *J. Phys. Chem. Lett.* 11: 2977–2982. doi: 10.1021/acs.jpcllett.0c00470

Bharat Ratna Prof. C. N. R. Rao F.R.S.**Honorary President, Linus Pauling Research Professor**

Water splitting reactions by photo- and electro-chemical means is an important area of research related to renewable energy. In this context, we have studied nanocomposites of (i) MoS₂ nanotubes with single-walled carbon nanotubes and borocarbonitride (BCN) nanotubes, (ii) nanocomposites of phosphorene–MoS₂/MoSe₂, RGO or BCN with MoS₂ and MoSe₂ and (iii) exfoliated solid solutions of MoS_xSe_(2-x)/MoSe_xTe_(2-x). We have investigated new classes of 2D materials like PbFCl, BaFCl and metal phosphochalcogenides (MPX₃) for their supercapacitor and photocatalytic water splitting properties, respectively. We have also designed a chemical route to synthesise twisted graphene, graphene oxide and boron nitride. We have studied the variations in electronic and optical properties

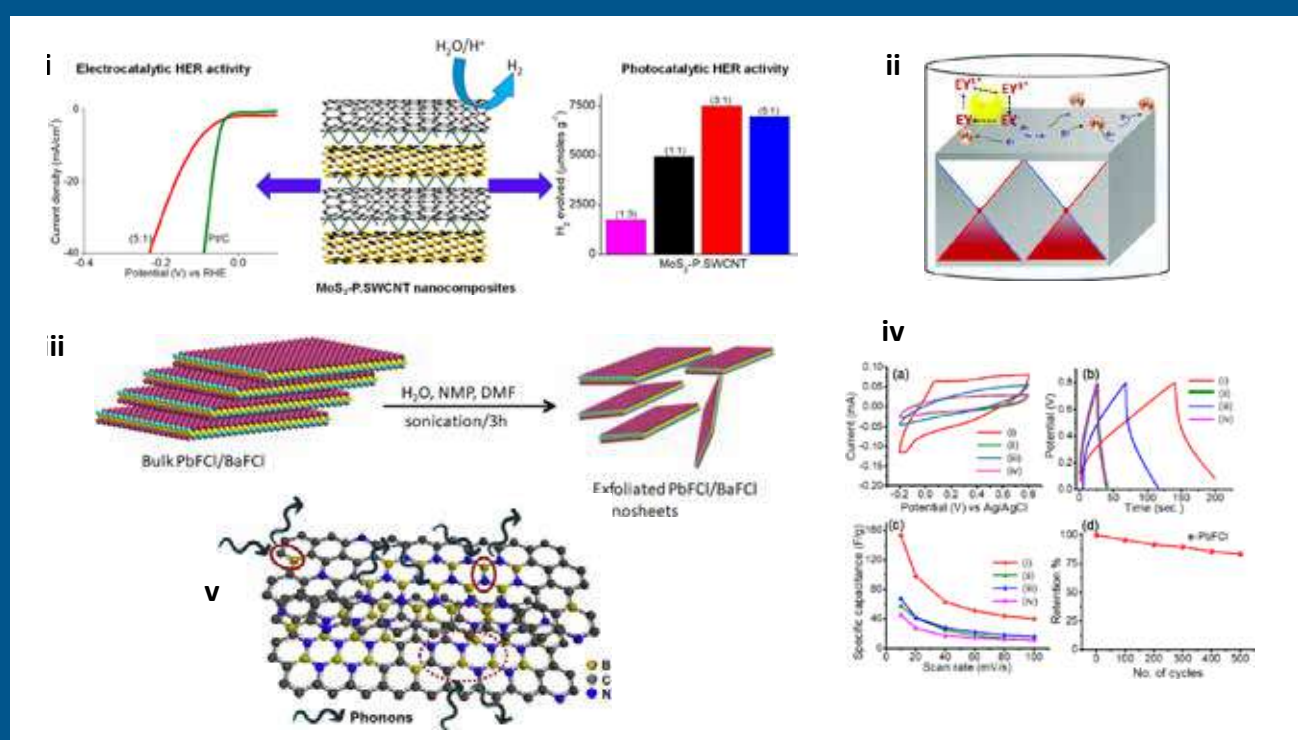
Contd. from pg. 45

Bharat Ratna Prof. C. N. R. Rao

of CdPS₃ and its superior photo(electro)chemical hydrogen evolution reaction (HER) activity. We have also investigated the selective fabrication of β-phase NiS and VO_x thin films and crystalline epitaxial ultrathin films of NiO via the atomic layer deposition (ALD) technique, performed their detailed characterisation and conducted an ALD parameter-dependent study.

Reference:

ACS Appl. Nano. Mater. 3 (2): 1792–1799. doi: 10.1021/acsnm.9b02482



(i) Nanocomposites of MoS₂ nanotubes with single-walled carbon nanotubes and borocarbonitride nanotubes; their photocatalytic and electrocatalytic HER activities. (ii) Enhancement of the HER catalytic activity of non-magnetic Weyl semimetals of the NbP family upon the application of a magnetic field. (iii) Schematic representation of the exfoliation of PbFCI and BaFCI with various molecules and (iv) their electrochemical supercapacitor studies. (v) Schematic representation of the low thermal conductivity of BCN nanosheets due to significant phonon scattering from the different length scale hierarchical nano/meso architectures (*ACS Appl. Nano. Mater.* 3 (2): 1792–1799. doi: 10.1021/acsnm.9b02482).

Prof. Chandrabhas Narayana Ph.D., F.A.Sc., F.N.A.Sc., F.R.S.C

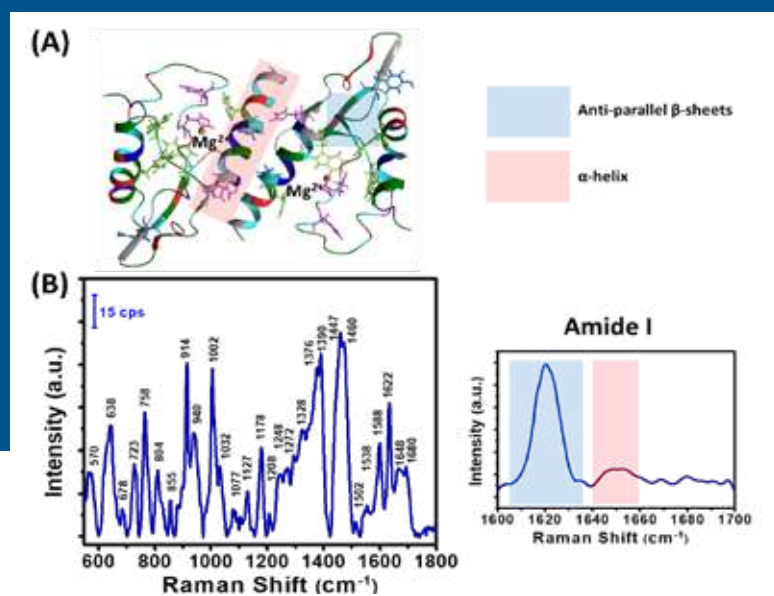
Professor (on lien)

Our group has been using Raman spectroscopy, surface enhanced Raman spectroscopy (SERS) and X-ray diffraction tools to understand the molecular origins of the physical properties shown by various materials. We have looked at materials from the perspectives of energy, condensed matter and biological phenomena. We have looked at metal-organic framework (MOF) materials,

demonstrating unusual gas or guest adsorption properties and their stabilities. We have also provided insight into high-performance asymmetric supercapacitors made of covalent graphene–MOF hybrids.

Another material we studied is the antimony telluride (Sb_2Te_3)/graphite nanocomposite to understand its thermal conductivity. In addition, we have been looking at the molecular origins of biological phenomena. We have successfully demonstrated the use of Raman spectroscopy as a tool to detect extracellular vesicles, which can be disease markers.

The effect of divalent ions on the DNA cleavage property of restriction enzymes has, additionally, been a very important research topic, because with a better understanding of their molecular origins, disease management can be improved. In this regard, we were able to use SERS to understand protein secondary structure changes, gaining insight into the effect of divalent ion-induced switching in DNA cleavage (Figure).



(A) Homology modelled structure of the R.KpnI homodimer of residues 97–190 containing the Zn^{2+} , and Mg^{2+} in HNH motif. Aromatic amino acids are highlighted in yellow-green (tryptophan), blue (tyrosine), and pink (histidine). Anti-parallel β -sheets (blue shaded region) and α -helices (red shaded region) constitute the $\beta\beta\alpha$ -metal finger of KpnI. SERS spectra of R.KpnI (B) within 600–1800 cm^{-1} , and (C) of the amide I region within 1600–1700 cm^{-1} were obtained with 532 nm excitation (*J. Phys. Chem. B.* 125 (9): 2241–2250. doi: 10.1021/acs.jpccb.0c10667).

Reference:

J. Phys. Chem. B. 125 (9): 2241–2250.
doi: 10.1021/acs.jpccb.0c10667

Other research activities during 2020–21:

- *J. Phys. Chem. C.* 125 (28): 15472–15478. doi: 10.1021/acs.jpcc.1c00937
- *J. Phys. Chem. B.* 124 (48): 10952–10960. doi: 10.1021/acs.jpccb.0c06910

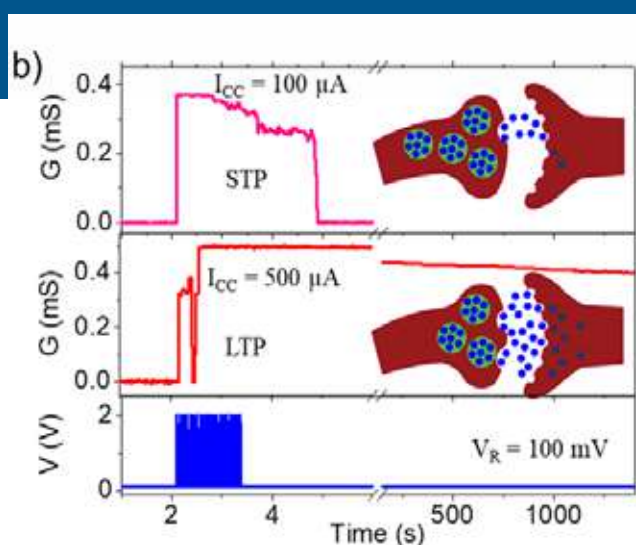
Major talks during 2020–21:

- 08 April 2021: Keynote speaker at International Conference on Hierarchical Structured Materials (ICHSM 2021, Department of Physics, SRM Institute of Science and Technology, Ramapuram Campus, Chennai, Tamil Nadu.
- 19 May 2021: Plenary Lecture International Conference on Light-Matter Interaction (IC-LMIN 2021) organized by Indira Gandhi Centre for Atomic Research, Kalpakkam.
- 22 May 2021: Invited speaker at Indian Society for Analytical Scientists (ISAS) Mumbai.
- 31 May 2021: Keynote speaker at Advanced Materials for Energy Applications for Department of Physics, Mangalore University, Mangalagangothri, Karnataka.

Prof. Giridhar U. Kulkarni Ph.D., F.N.A.Sc., F.A.Sc., F.A.P.A.M.

Professor and President, JNCASR

Technology has taken a big leap towards artificial intelligence recently. Software-based artificial neural networks (ANN) can be seen defeating humans in games or helping to handle the COVID-19 situation. However, the von Neumann architecture slows down ANN performance due to its huge power requirement, whereas the brain does the job parallelly with just 20 W. Since a synaptic device forms an essential component of hardware-based neuromorphic artificial intelligence, our team reported a novel approach for fabricating an artificial synaptic network (ASN) that emulates several human-like behaviour patterns in a synaptic device fabricated via self-forming. The metal islands and nanoparticles used in the ASN were constructed by mimicking bio-neurons and neurotransmitters. The fabricated biomimicking device emulated various behaviours from basic synaptic actions, such as STP, LTP, potentiation and depression, to complex learning activities, such as associative learning, interest-based learning, supervision and impression of supervision. We developed a prototype kit that emulated the famous Pavlov's dog behaviour and demonstrated the potential of our device to advance neuromorphic artificial intelligence. Our work could be key to opening doors to research where chemical methods are employed to realize a synaptic device!



Synaptic behavior emulated with a pulsed voltage signal (*Mater. Horiz.* 7: 2970. doi: 10.1039/D0MH01037E).

Reference:

Mater. Horiz. 7: 2970. doi: 10.1039/D0MH01037E

Other research activities during 2020–21:

- *Bull. Mater. Sci.* 43: 323. doi: 10.1007/s12034-020-02294-1
- *ACS Appl. Mater. Interfac.* 12: 54203–54211. doi: 10.1021/acsami.0c17018

Major talks during 2020–21:

- 13 October 2020: Talk on “Advanced Materials” at the Vaibhav Summit of the Government of India, organized by IISER Thiruvananthapuram, IIT Madras, CSIR NML Jamshedpur, and CMET Hyderabad.
- 7 December 2020: Talk on “A Brain-inspired Intelligent Device” at the Winter School, organized by JNCASR.

Prof. K. S. Narayan Ph.D., F.A.Sc., F.N.A.Sc., F.N.A.

Professor

Record high efficiencies of hybrid perovskites are attributed to long carrier diffusion length (L_d). In the literature, numerous L_d values have been reported, and its variation has been studied as a function of charge generation density. Previous studies largely used indirect estimates, i.e., independent determinations of lifetime and mobility. A study on the direct spatial estimation of L_d in a device configuration in single crystals was hence desirable. We directly estimated L_d by employing the scanning photocurrent microscopy technique. Measurements on high-quality single crystals of methylammonium lead tribromide (MAPbBr_3) eliminated contributions from recombination processes at grain boundaries. We studied the dependence of L_d on the carrier generation density by introducing a uniform light bias, and correlated the observed trends with independent lifetime measurements using transient photoluminescence experiments. Interestingly, we observed an increase in steady-state modulated photocurrents, as the background light bias, which was explained using a simple intuitive model of trap-filling. We analysed the results using drift-diffusion formalism. The key highlights of this work include:

- (i) Spatial estimation of L_d and its dependence on carrier density using scanning photocurrent microscopy.
- (ii) Superposition of a background-DC light uniformly on the crystal, increasing the modulated photocurrent and simultaneously decreasing L_d , presenting a direct demonstration of trap assisted recombination and trap-filling.
- (iii) Photoluminescence studies bringing out the effects of monomolecular and bimolecular recombination. The emission lifetime trends explained the L_d results.
- (iv) The defect tolerance capability of hybrid perovskite crystals along with the L_d and carrier lifetime studies should help in tailoring hybrid-perovskite single-crystal solar cells.

These findings are of fundamental scientific interest and of direct relevance to enhance the performance of hybrid perovskite-based solar cells. Understanding carrier diffusion in the context of recombination and carrier trapping allows for tailoring of the device architecture for suitable optoelectronic applications.

Major talks during 2020–21:

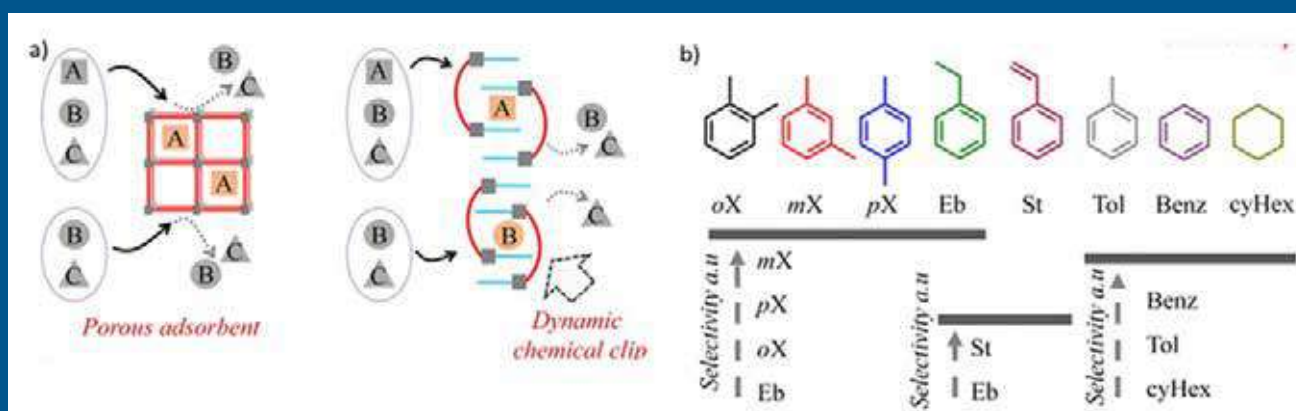
- 3–8 August 2020: Plenary talk at a conference on Frontiers in Materials for Technological Application, organized by CSIR-IMMT Bhubaneswar.
- 19 November 2020: Talk on “Metal-Semiconductor-Metal Lateral Device Structures Based on Hybrid Perovskites” at the online conference on Perovskites for Energy Harvesting: From Fundamentals to Devices.
- 16 December 2020: Panelist on the “Future of PV” in a seminar at the conference on Advances in Catalysis, Energy, and Environmental Research (CACEE-2020).
- 16 February 2021: Talk about “Organic Semiconductors for Bio-Electronics” at SCDT–FlexE Centre Webinar Series on Flexible Electronics, IIT Kanpur.

Prof. Tapas Kumar Maji Ph.D., F.R.S.C., F.A.Sc.

Professor

In another study, we explored adsorptive chemical separation, which is at the forefront of future technologies to be used in the chemical and petrochemical industries. In this process, a porous adsorbent selectively allows a single component from a mixture of three or more chemical components to be adsorbed or permeate. To separate the remaining unsorted chemical mixture, a different type of adsorbent is required. A unique adsorbent which can recognise and separate each chemical from a mixture of three or more components is necessary for next generation porous materials. Recently, we reported a “dynamic chemical clip” in a supramolecular metal-organic porous framework capable of thermodynamic and kinetics-based chemical separation. The dynamic space, featuring strong preference for aromatic guests through π - π and C-H \cdots π interactions and adaptability, can recognise the individual chemical isomers from mixtures (such as C₈ alkylaromatic isomers, benzene, toluene and styrene) and separate those based on thermodynamic and kinetic factors. The liquid-phase high selectivity and separation of the aromatic isomers are possible by the adaptability of the “chemical clip” which is supported by crystallographic and detailed computational studies (Figure).

Nature's design of carrying out the photosynthetic redox cycle involving carbon dioxide (CO₂) and water inspired us to design an integrated catalytic system that achieves artificial photosynthesis. We have reported a unique design to fabricate an integrated catalytic system by grafting both the molecular catalyst and photosensitiser inside a confined metal organic framework pore to achieve the solar-driven reduction of CO₂. The as-prepared catalyst exhibits excellent sunlight-driven CO₂ reduction to carbon monoxide (CO) (a component of syngas) with 99% selectivity in aqueous medium and without any sacrificial electron donor. Our presented results demonstrate an excellent approach to fabricate a novel photocatalyst, for tackling the energy crisis and imitating natural photosynthesis.



(a) A schematic illustration of the “dynamic chemical clip” for the separation of individual chemical isomers (A, B and C), compared with conventional porous adsorbents. (b) Chemical isomers sorted by dynamic chemical clipping process (a.u = arbitrary unit) (*Energy Environ. Sci.* 14: 2429–2440. doi: 10.1039/D0EE03643A).

Reference:

Energy Environ. Sci. 14: 2429–2440. doi: 10.1039/D0EE03643A

Major talks during 2020–21:

- 8–21 September 2020: Refresher Course in Emerging Trends in Science and Technology by the UGC Human Resource Development Centre, University of Burdwan.
- 24 November 2020 to 7 December 2020: Refresher Course in Natural and Biosciences by the UGC Human Resource Development Centre, University of Burdwan.
- 17 March 2021: Talk on “Porous Metal-Organic Hybrids for Energy and Environment Related Applications” at the Induction Training Programme (physical) at Higher Education Academy, Dharwad, for Assistant Professors of Physics, Chemistry, and Mathematics.
- 09–10 July 2021: Talk on “Metal-organic ‘Soft’ Hybrids for Photocatalytic CO₂ Reduction and H₂ Production” at the 15th National Frontiers of Engineering (NatFoE) Symposium, Organized by Indian Institute of Technology, Hyderabad and Indian National Academy of Engineering.
- 6 February 2021: Talk on “Functional Coordination Driven Metal-Organic ‘Soft’ Materials” at conference on Recent Trends in Chemical Science at IIT Bhilai.

Prof. Eswaramoorthy M. Ph.D.

Professor and Associate Director, ICMS

In our study, we used inorganic phosphides as electrocatalysts to improve the efficiency of water splitting. We synthesised a porous bi-metallic nickel-cobalt (Ni-Co) phosphide with large surface area having a high density of electrochemically active sites, which exhibits outstanding performance in catalysing the oxygen evolution reaction under alkaline conditions. It requires a very low overpotential of 230 mV to achieve an anodic current density of 10 mA cm² with a Tafel slope of 44 mVdec⁻¹. We also demonstrated its good performance in catalysing the hydrogen evolution reaction under both alkaline and acidic conditions. Through first-principles theoretical analysis, we showed that such high catalytic activities arise from the synergistic effect of Ni and Co on the energies of the *d* and *p* bands of the compound, which is further enhanced by the rapid mass transport possible due to the porous architecture of its three-dimensional network morphology.

Further, clay-MoS₂ composites were explored for electrochemical water splitting.

High surface area borocarbonitride materials were also used for the catalytic dehydrogenation of alkanes.

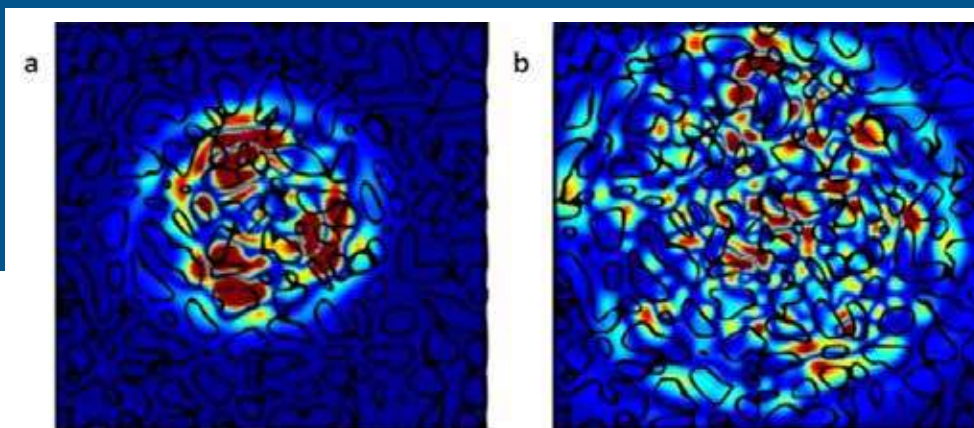
Major talks during 2020–21:

- Keynote lecture at 2nd Indo-Korea Virtual Conference on Development of Advanced Materials for Future Technologies (DAMFT-2021).
- Guest Speaker in the National Science Day celebration 2021 at Yogi Vemana University, Kadapa.

Prof. S. M. Shivaprasad Ph.D.

Professor (on lien; jointly with ICMS)

Scaling down the size of semiconductor cavity lasers and engineering their electromagnetic environment can bring about spectacular advances in nanodevice fabrication. Our team is working towards the development of highly directional nano-torches/nano-beams/nano-lighthouses with tunable frequencies. In one of our recent research works, we provided experimental evidence of intense photon emission from the nanocavities of the nanowall network (NwN) morphology of gallium nitride (w-GaN) upon highly localized excitation by a high energy electron beam. We presented numerical modelling results to support non-linear frequency conversion and the creation of whispering gallery modes (WGMs). Our results support the argument that the characteristic NwN morphology plays a very important role in sustaining WGMs and in providing an escape route through the nanocavities preferentially for near-infrared emissions. Our approach might be a precursor to obtaining highly intense laser sources of ultra-small dimensions packed with high density, where each source is addressable by appropriately deflecting the incident electron beam.



Pulse propagation in the NwN morphology, setting up whispering gallery type modes for a short duration
(*Sci. Rep.* 11 (1): 9368. doi: 10.1038/s41598-021-88660-3).

Reference:

Sci. Rep. 11 (1): 9368. doi: 10.1038/s41598-021-88660-3/10.1039/D0MH01037E

Other research activities during 2020–21:

- *Annu. Rev. Mat. Res.* (50): 179–206. doi: 10.1146/annurev-matsci-081919-014810
- *J. Vac. Sci. Tech. A: Vac. Surfac. Film.* 38 (6): 063205. doi: 10.1116/6.0000402
- *J. Mat. Sci. Mat. Elec.* 31 (10): 7871–7879. doi: 10.1016/j.apsusc.2020.148251
- *Solid State Sci.* 105: 106242. doi: 10.1016/j.apsusc.2020.148251
- *Ann. Rev. Mat. Res.* 50: 179–206. doi: 10.1016/j.apsusc.2020.148251
- *J. Mat. Sci. Mat. Elec.* 31 (16): 13756–13764. doi: 10.1016/j.apsusc.2020.148251
- *J. Vac. Sci. Tech. A: Vac. Surfac. Film.* 38 (6): 063205. doi: 10.1016/j.apsusc.2020.148251
- *J. Elec. Mat.* 50 (1): 52–58.
- *J. Microscop.* 282 (3): 250–257. doi: 10.1016/j.apsusc.2020.148251
- *Appl. Surfac. Sci.* 539: 148251. doi: 10.1016/j.apsusc.2020.148251
- *J. Appl. Phys.* 129 (5): 055305. doi: 10.1063/5.0038459

Major talks during 2020–21:

- 15 April 2020: Talk on “Curiosity, Imagination, and Knowledge” at the Indian Physics Teachers Association.
- 22 October 2020: Talk on “Morphology Induced Multi-functionality of Gallium Nitride Nanowall Network” at a webinar Endeavour in the USA.

Dr. Sarit S. Agasti Ph.D. Faculty Fellow (jointly with NCU)

In recent years, substantial attention is being directed towards learning about cells by looking at them singly, as this promises to provide key insights into many fundamental areas of biology, spanning from classical cell biology to developmental biology and heterogeneous disease biology. As a result, the ability to label and trace individual cells in an apparently homogeneous population and correlate their spatiotemporal dynamics with the corresponding functional outcome is becoming increasingly desirable in various domains of biological research. In our recent study, we created a distinct approach to selectively barcode cells by spatially controlling the positioning of fluorescent labels using light. In this design, we readily achieved the multiplexed barcoding of many cells in parallel by cycling the photoactivation and fluorophore anchoring steps at different cellular coordinates. For this, we utilised the exceptional molecular recognition property of CB[7] as it affords the key attributes of bio-orthogonal reactivity with extremely fast kinetics for selective association between host and guest moieties. The performance of this strategy was first demonstrated in fixed cells, where we utilised three spectrally distinct CB[7]-fluorescent labels and combined them with the spatial encoding approach to demonstrate a 10-colour barcoding of cells. Subsequently, to show the photochemical encoding of barcodes in living systems, we paired light-mediated recognition with a metabolically incorporated reporter tag to enable 7-colour barcoding in glycan labelled MCF7 cells.

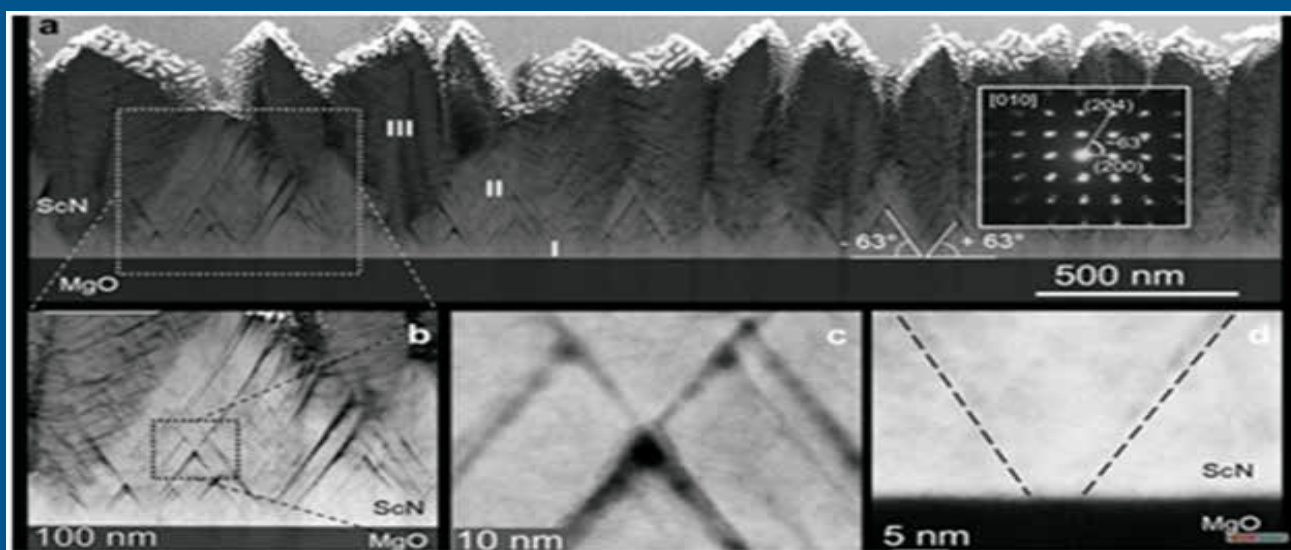
Major talks during 2020–21:

- 2020: Talk on “Host-guest Chemistry in Biological Imaging and Sensing” at Bangalore University.
- 2020: Talk on “DNA Origami Functionalization, Biological Interfacing and Imaging Through Engineered Molecular Interaction” at the virtual conference First India DNA Nanotechnology Meeting.
- 2020: Talk on “Imaging Life with Programmable Supramolecular Interaction” at the Annual Research Symposium of the Center for BioSystems Science and Engineering (BSSE) at IISc, Bengaluru.
- 2020: Talk on “Imaging Life with Programmable Supramolecular Interaction” at the Karnataka Science and Technology Academy (KSTA), Department of Science and Technology, Government of Karnataka

Dr. Bivas Saha Ph.D.

Faculty Fellow (jointly with ICMS)

Subjected to varied substrate temperatures, the thin film of semiconductor scandium nitride (ScN) exhibits different growth modes which affect its electronic properties significantly. In our study, we experimentally investigated the relationship between substrate temperature and growth mode. We found that the competing forces of temperature-dependent adatom mobility and Ehrlich–Schwoebel (ES) diffusion barrier determines the growth mode. We observed that at low substrate temperatures, adatoms had insufficient mobility to cross the ES diffusion barrier, which resulted in the semiconductor films having triangular grains with defects and voids running along the edges of the triangles. But when we raised the temperature of the substrate above a certain critical value, the adatoms acquired sufficient energy to cross the ES barrier, which resulted in planar and epitaxial film growth with minute defect concentrations. The results of our study provide a clearer understanding of the relationship between the substrate temperature and growth mode, which is necessary when it comes to designing defect-free single-crystalline ScN-based devices for practical use with precise control over the electronic properties.



Transmission electron microscopy image of ScN growth modes (*Appl. Phys. Lett.* 117: 212101. doi: 10.1063/5.0027091).

Reference:

Appl. Phys. Lett. 117: 212101. doi: 10.1063/5.0027091

UNIT MEMBERS

Faculty Members

Professor and Chair

Prof. Sundaresan A.

Linus Pauling Research Professor

Prof. C. N. R. Rao

Professors

Prof. Balasubramanian S., Prof. Chandrabhas Narayana (on lien), Prof. Eswaramoorthy M. (Associate Director, ICMS), Prof. G. U. Kulkarni (President, JNCASR), Prof. K. S. Narayan, Prof. S. M. Shivaprasad (on lien; jointly with ICMS); Prof. Tapas Kumar Maji

Faculty Fellows

Dr. Sarit S. Agasti (jointly with NCU),
Dr. Bivas Saha (jointly with ICMS)

Associate Faculty

Prof. Ranjan Datta (Professor, ICMS)

Prof. Rajesh Ganapathy (Associate Professor, ICMS)

Prof. Sridhar Rajaram (Associate Professor, ICMS)

Prof. Swapan K. Pati (Professor and Chair, TSU)

Prof. Shobhana Narasimhan (Professor, TSU)

Prof. Srikant Sastry (Professor, TSU)

Prof. Umesh V. Waghmare (Professor, TSU, and Dean, Academic Affairs)

Prof. Vidhyadhiraja N. S. (Professor, TSU, and Dean, Fellowships and Extension Programmes)

Research Students

Ph.D.

Abhijit Chatterjee, Priyanka Jain, Meenakshi Pahwa, C. S. Deepak, Ganesh N., Shivaram B. Kubakaddi, Rajendra Kumar, Divya C., Manodeep Mondal, Yanda Premakumar, Ravi Shankar P. N., Usha Manjunath Bhat, Sharona Thomas Horta, Nimish D., Soumita Chakraborty, Avula Venkata Siva Nikhil, Kompella V. K. Srinath, Momin Ahamed, Subhajit Laha, Abdul Azeez H., Parul Verma, Navneet Singh, Arunava Saha, Sanchita Karmakar, Divya, Surishi Vashishth, Swarnamayee Mishra, Sudarshan Behera, Purohit Sumukh Anil, Anjana Joseph, Krishna Chand Maurya, Mohit Chaudhary, Debendra Prasad Panda, Sourjyadeep Chakraborty, Soumen Pradhan, Faruk Ahamed Rahimi,

Oishika Jash, Sinay Simanta Behera, Bidesh Biswas, Rohan Jena , Anupam Dey, Rahul Kumar, Abhijith Krishnan, Suhas K. T., Prasanna Das, Souvik Banerjee, Simanta Kalita, Tejaswini S. Rao, Bhupesh Yadav, Megha

Int. Ph.D. (Materials Science)

Srimayee Mukherji, Anirudha Mirmira, Pavitra Nityanand Shanbhag, Anaranya Ghorai, Narendra Kumar, Lakshay Dheer, Niloyendu Roy, Janaky S., Sukanya Das, Shashank Chaturvedi, Pragya Arora, Raagya Arora, Nijita Mathew, Tarandeep Singh, Ashutosh Kumar Singh, Brijesh, Dheemahi, Anjali Gaur, Swaraj Servottam, Abhishek Kumar, Curshidali P., Gunjan Sharma, Manish Tiwari, Aashish Kumar, Sohini Chatterjee, Surabhi Menon, Uttam Tiwari, Dipanjana Patra, Sarbajit Dutta, Shubhanshi Mishra, Deeksha Sharma, Sneha Raj V. P.

Administrative Staff

Sr. Lab. Assistants

Anilkumar J., Vasudeva B. S.,
Alla Srinivasa Rao

Helper

Basavaraj T.

Temporary Staff

Consultant

Usha G. Tumkurkar

CPMU Office Secretary

Radha V.

Secretarial Assistant Trainee

Prema M. S.

Lab Helper

Victor Satish

Glass Blower

Nandha Kishore

Technical Staff

Sr. Technical Officers

Sreenath V., Srinivas S.

Mectronic Lab Support

Sunoj K. R.

Research Staff

SERB (TARE)	Dr. Shafeekh Kulathinte Meethal
SERB National Postdoctoral Fellows (NPDF)	Dr. Padipkanti Devi Lairenjam, Dr. Monoj Kumar Barman
Research Associates	Dr. Anzar Ali, Dr. Saraswathi C., Dr. Bharath B., Dr. Abhishek Sharma, Dr. Soumitra Barman, Dr. Anwesa Karmakar, Dr. Ishan Chhaganji Ghosekar, Dr. Vasudeva Rao Bakuru, Dr. Ashish Singh, Dr. Prashant Kumar, Dr. Swanand Vishnu Solanke, Dr. Chaitali Sow, Dr. Sudip Das
Research Associate 1	Dr. Anita Devi
Research Associate (Provisional)	Nikita Gupta
Senior Research Fellows	Divya Chalapathi, Priyanka Jain, Korlepara Divya Bharathi
Junior Research Fellows	Samyabrata Sen, Ganesh N., Deepak Kumar Patel
Project Assistants	Gaurav Vinayak Dhopeswarkar
Project Technical Assistant	Abhinandana Reddy B.
R&D Assistants	Anil Krishna Konduri, Manik Sharma

UNIT AT A GLANCE

Honours/Fellowships/Memberships Received



7

Faculty members

3

Senior research fellow, alumnus, and student

Faculty Members

Dr. Bivas Saha

- Received the Young Scientist Research Award from the Board of Research in Nuclear Sciences (BRNS) of DAE, India
- Selected as a Young Associate of the Indian Academy of Sciences, Bengaluru, 2020

Prof. C. N. R. Rao

- Received the National Youth Day Award 2021 from Bharat Seva Samvad, Surat, Gujarat
- Received a Honoris Causa Doctorate from the Assam Royal Global University, Guwahati
- Received the International Eni Award 2020 for research into renewable energy sources and energy storage

Prof. Giridhar U. Kulkarni

- Received the Honorary Fellowship of Karnataka Science & Technology Academy
- Elected as Member, Academic Council, IACS, Kolkata
- Elected as Member, Vision Group on Nanotechnology, Department of IT, BT, S&T, Government of Karnataka
- Received Adjunct professorship at CeNS

Prof. K. S. Narayan

- Elected as Member of the Research Council of the National Physics Laboratory New Delhi
- Elected as Member of the FIST Advisory Board, DST Government of India

Dr. Sarit S. Agasti

- Selected as a Young Associate of the Indian Academy of Sciences, Bengaluru for 2020

Prof. S. M. Shivaprasad

- Received the Honorary Fellowship of Karnataka Science and Technology Academy

Prof. Sundaresan A.

- Received the C. N. R. Rao National Prize in Chemical Sciences from the Chemical Research Society of India
- Received the Prof. C. N. R. Rao Oration Award Lecture 2020

Senior Research Fellow

Ms. Divya Chalpathi (research supervisor: Prof. Chandrabhas Narayana)

- Received the best oral presentation in the International Conference on Perspectives in Vibrational Spectroscopy (ICOPVS-2020)

Alumnus and Student

Dr. Ritu Gupta (alumnus; research supervisor: Prof. G. U. Kulkarni)

- Received the SERB Women Excellence Award 2021

Ms. Sukanya Das (Int. Ph. D. student; research supervisor Prof. Narayan K. S.)

- Received best poster prize for her work on conductivity measurements of confined PEDOT-PSS in nano-channels, in the Sunrise symposium held at IISc in February 2020

Total Publications



104

Peer reviewed articles indexed in Web of Science

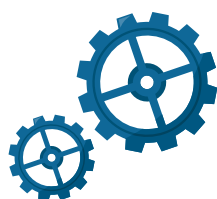
Sponsored Projects



New projects

9

₹ 2.12 cr.



Ongoing projects

26

₹ 7.90 cr.

Students Graduated During 2020–21



11

Ph.D.

- Sudip Das
- Korlepara Divya Bharathi
- Badri Vishal
- Abhijit Sen
- Sonu K. P.
- Raaghesh A. V.
- Bharath B.
- Chaitali Sow
- Shantanu Aggarwal
- Nikita Gupta
- Abhiroop Lahiri

3

M.S.

- Swaraj Servottam
- Anjali Gaur
- Dheemahi

Students Admitted During 2020–21



6

Ph.D.

- Prasanna Das
- Souvik Banerjee
- Simanta Kalita
- Tejaswini S. Rao
- Bhupesh Yadav
- Megha

4

Int. Ph.D. (M.S.)

- Sarbajit Dutta
- Shubhanshi Mishra
- Deeksha Sharma
- Sneha Raj V. P.

EVOLUTIONARY AND INTEGRATIVE BIOLOGY UNIT (EIBU)



Biological systems are organised hierarchically and can be studied at levels ranging from molecules to ecosystems. However, the principal level of structural complexity that is also a functionally integrated entity is the organism, which is also often the primary level at which selection acts. Therefore, at EIBU, we address questions regarding the biology of functioning organisms and attempt to synthesise information from different structural levels of complexity into a holistic understanding of how organisms function and evolve. EIBU is one of the principal centres in the country for research and training in evolutionary dynamics, population ecology and behavioural ecology. In our quest to understand functionality in living systems, we use tools from a wide range of disciplines including molecular and evolutionary genetics, biochemistry, physiology, behaviour, ecology, computation, physics, statistics and mathematics.

We do mostly empirical research, both in the laboratory and in the field, using a combination of experimental tools from evolutionary quantitative genetics, molecular genetics, developmental biology, animal behaviour and population biology. We also conduct theoretical research, largely through computer simulations of mathematical models of biological processes. Our unit is well equipped for field studies and studies using a range of experimental and computational tools, with labs for routine handling of large numbers of *Drosophila* populations, and experiments in physiology, biochemistry and molecular biology.

RESEARCH AREAS

- Asian elephant socioecology and behaviour
- Small population and metapopulation dynamics
- Evolution and ecology of life-histories and competitive ability in fruit flies

RESEARCH HIGHLIGHTS

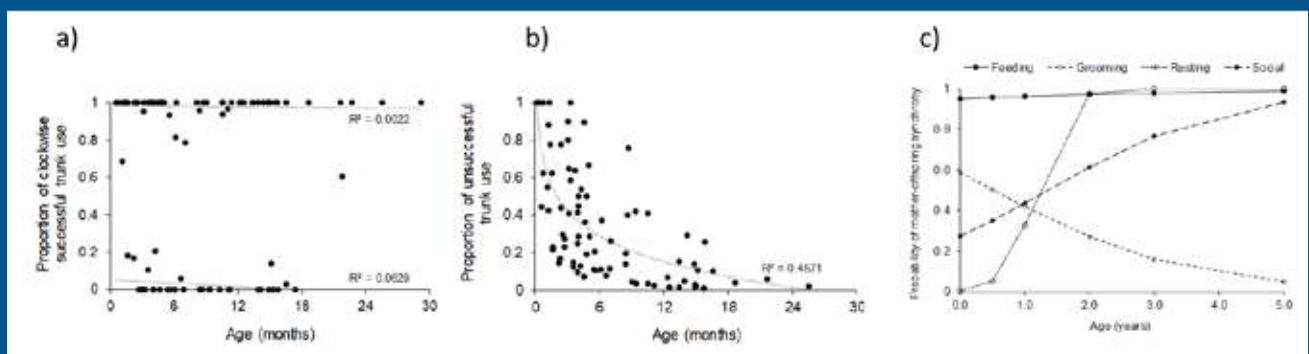
- The ontogeny of trunk lateralisation and behaviour in Asian elephants was revealed.
- The ecology and evolution of competitive ability were studied in laboratory populations of *Drosophila* (fruit flies).

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

Prof. T. N. C. Vidya Ph.D.

Associate Professor and Chair, EIBU

We studied the ontogeny (development) of trunk lateralisation, trunk motor skills, and behaviour in Asian elephant calves. Elephants are precocial and can, therefore, walk soon after birth. But they have an extended period of nutritional dependence on the mother. Using field data from individually identified elephants from Nagarahole-Bandipur, southern India, we discovered that trunk lateralisation or handedness, i.e., showing clockwise or anticlockwise preference, occurred in elephant calves as young as 3 months old, but trunk motor control developed more slowly, with fine control only after 6 months of age. Resting-related and certain grooming-related behaviours that did not require trunk usage were expressed in adult form early on, but feeding-related and other behaviours that required trunk usage developed gradually and showed adult-like expression only by around 1 year of age. While early expression of hand preference in humans has been linked to advanced language skills, the advantages of early trunk lateralisation remain to be studied.



Ontogeny (development) of a) trunk lateralisation, b) trunk adeptness, and c) behaviour in elephant calves. Trunk lateralisation (clockwise or anticlockwise trunk use) is fairly high early on and does not change much with age (a), whereas the proportion of unsuccessful trunk use decreases with age (b). The behavioural synchrony between calves and adults (the mother here) increases in resting and social behaviours with calf age, and decreases in grooming-related behaviours. c) Curves obtained using logistic regression equations (*Int. J. Dev. Biol.* 64 (4, 5, 6): 367–382. doi: 10.1387/ijdb.190274tv).

Reference:

Int. J. Dev. Biol. 64 (4, 5, 6): 367–382. doi: 10.1387/ijdb.190274tv

Other research activities during 2020–21:

- *J. Mammal.* 101: 259–270. doi: 10.1093/jmammal/gyz190
- *Trend. Ecol. Evol.* 36 (1): 17–19. doi: 10.1016/j.tree.2020.10.012
- *Trend. Ecol. Evol.* 35 (9): 834–847. doi: 10.1016/j.tree.2020.05.003
- *Resonance* 25 (8): 1069–1074. doi: 10.1007/s12045-020-1023-x

Major talks during 2020–21:

- 20 August 2020: Talk on “How is the Female Asian Elephant Society Organised?” in a webinar at the BioBlitz '20 webinar series Biocognizance, held at IISc, Bengaluru, India.
- 3 November 2020: Talk on “Social Organisation of Female Asian Elephants” in a webinar for the Refresher Course on Environmental Studies: Water, Earth and Environment (IDC), Centre for Professional Development in Higher Education (CPDHE), University of Delhi, India.
- 20 November 2020: Talk online on “Understanding an Asian Elephant Society”, at the G. N. Ramachandran Science Club, Mar Athanasios College for Advanced Studies (MACFAST), Tiruvalla (MACFAST), India.
- 6 March 2021: Talk (online) about “Socioecology of Asian Elephant Females” in the Jagannathan Vijaya Session on Biodiversity and Animal Behaviour at the “Her Story of Science: Celebrating Women in Research” conference, at Biologically Speaking (USA) and BiasWatchIndia, India.
- 31 March 2021: Invited along with Amitabh Joshi for an online discussion with Berty Ashley on “Organisms and Size—why Size Matters” at the Cosmic Zoom-ICTS-BaSH event as part of the virtual exhibition CosmicZoom, TIFR-International Centre for Theoretical Sciences and Bengaluru Science Habba, India.

Prof. Amitabh Joshi Ph.D.

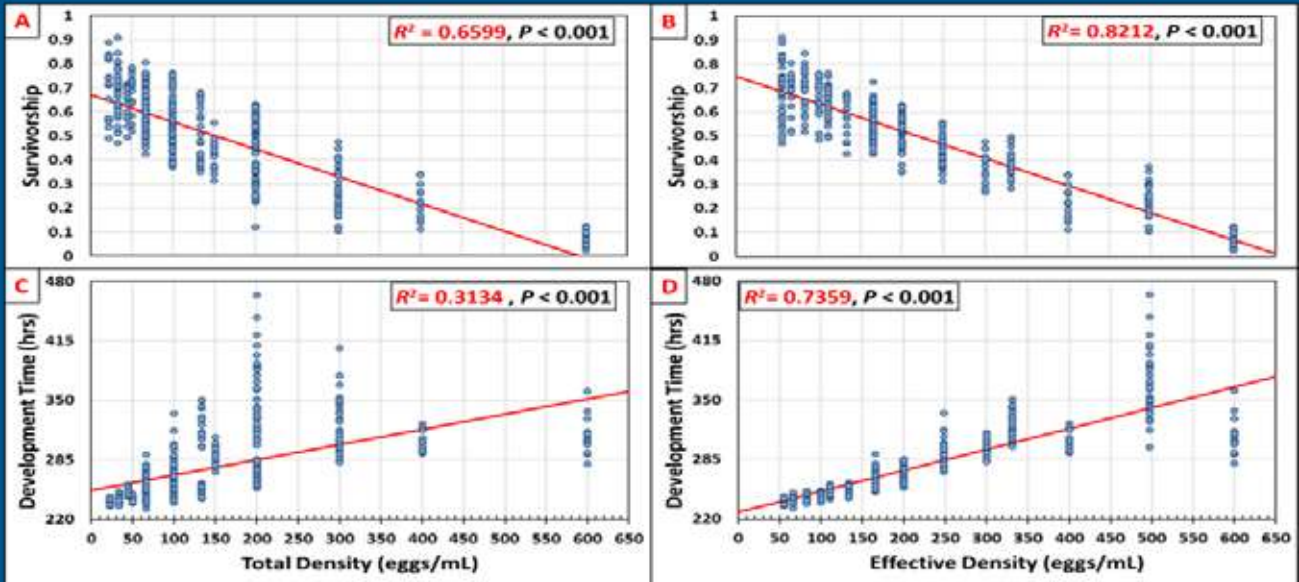
Professor

We conducted a large and paradigm-changing experimental study on the ecology of competitive ability in laboratory populations of *Drosophila* (fruit flies). It revealed an unappreciated complexity in the ecological context—how exactly larval crowding is experienced mediates alterations in fitness components like survivorship, body size and development time. We achieved vials with the same larval density (eggs per unit food volume) with different combinations of food surface area and food column height and showed that survivorship, development time and body size varied considerably. Effective larval density in the feeding band at the top of the food column explained the variation in survivorship and development time better than total larval density (larvae per unit volume of food medium). The results suggest that effective competition in the feeding band and diffusion of waste across the food column are more important in determining the precise nature of selection for increased competitive ability under larval crowding than the overall density.

Other research activities during 2020–21:

- *Resonance* 25 (4): 459–475. doi: 10.1007/s12045-020-0963-5
- *Resonance* 25 (4): 495–512. doi: 10.1007/s12045-020-0967-1
- *Current Sci.* 118: 1026–1034
- *Outlook.* 8 February 2021 issue; pg. 90
- *Current Sci.* 120: 1099–1100

Prof. Amitabh Joshi



Linear regressions of pre-adult survivorship and pre-adult development time versus either total density (eggs per unit volume of food medium) or effective density (eggs per unit volume of food medium in the feeding band within which larvae feed at the top of the food column in a vial). A. Pre-adult survivorship as predicted by total density. B. Pre-adult survivorship as predicted by effective density. C. Pre-adult development time as predicted by total density. D. Pre-adult development time as predicted by effective density (Srikant V. and A. Joshi; unpublished data).

Major talks during 2020–21:

- 7 June 2020: Hindi webinar on Evolutionary and Organismal Biology aimed at school and college students, organized by The Academy Trust and DST Rajasthan.
- 8 August 2020: Online Panel Discussion on The Importance of the Study of Evolution, organized by India March for Science, Karnataka Chapter.
- 10 November 2020: Talk on “Scientists’ Responsibility Towards Society” in an Online Panel Discussion on the occasion of Science Day, organized by INYAS and the DST, Government of Rajasthan.
- 27 November 2020: Online talk on “Mechanism in Biology: Holy Grail or Golden Deer?” at the In-House Symposium of JNCASR.
- 19 February 2021: Online talk on “Evolution of Plastic Versus Hard-wired Feeding Rates under Crowding in *Drosophila melanogaster* at the International Conference on Recent Advances in Genetics and Genomics organized by Department of Studies in Genetics and Genomics, University of Mysore.

UNIT MEMBERS

Faculty Members

Associate Professor and Chair

Prof. T. N. C. Vidya

Professor

Prof. Amitabh Joshi

Research Students

Ph.D.	Pavitra Prakash, Anuj Menon, Viveka Jagdish Singh, Neha Pandey, Revathe T., Satyabrata Nayak, Medha Rao, Athira T. K., Ankana Sanyal, Chinmay Krishna Yadav Temura, Srikant Venkitachalam
M.S.	Anvitha S.

Research Staff

Research Associates	Dr. Hansraj Gautam, Dr. P. Keerthipriya
Project Assistant	Tryambak Dasgupta
R&D Assistants	Ramesh M. K., Sajith V. S.

Administrative Staff

Driver	Pramod Kumar S.
Tracker	Shankar
Helper	Rajanna N.

UNIT AT A GLANCE

Honours/Memberships Received



2

Faculty members

1

Student

Faculty Members

Prof. Amitabh Joshi

- Received a Silver Jubilee Professorship donated by the C. N. R. Rao Education Foundation
- Research from Prof. Joshi's group, the only work from a non-western group, was included among 65 important breakthroughs in evolutionary ecology since Darwin to the present time (LD Mueller, 2020: Conceptual Breakthroughs in Evolutionary Ecology, Elsevier)
- A newly described ant species from Kerala was named *Ooceraea joshii* in the honour of Prof. Joshi in the year 2021

Prof. T. N. C. Vidya

- Elected as a Member of the Editorial Board of the journal *Frontiers in Conservation Science*
-

Student

Ms. Revathe T. (Ph.D. student; research supervisor: Prof. T. N. C. Vidya)

- Awarded an abstract prize by the International Society of Behavioural Ecology for abstract submitted to the ISBE 2020 conference

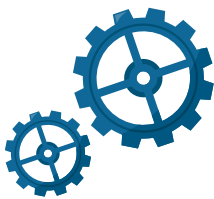
Total Publications



5

Peer reviewed articles indexed in Web of Science

Sponsored Projects



Ongoing projects

2

₹ 24.29 lac

Students Graduated During 2020–21



2

Ph.D.

- Avani Mital
- Hansraj Gautam

ENGINEERING MECHANICS UNIT (EMU)



EMU pursues research on a wide range of problems where momentum, heat, and mass transport processes play a critical role. At EMU, we delve into the science underlying the physical origin of events observed both in nature and in a laboratory. It is relevant to a host of technological applications as well. Our current research endeavours include the study of both complex micro-structured fluids (suspensions and emulsions, granular materials, polymer solutions, melts, active matter) and complex flows (linear and non-linear evolution of hydrodynamic instabilities, vortex dynamics, mechanisms of pattern formation, turbulence and dynamical systems theory), spanning an enormous range of length and time scales from the microscopic to the geological/astrophysical via a combination of observations, experiments, massively parallel computations and theoretical analyses.

RESEARCH AREAS

- Insect flight dynamics
- Hydrodynamic stability, transition, and turbulence
- Nonlinear dynamics and bifurcation phenomena
- Complex fluids and flows
- Active matter
- Momentum, heat, and mass transport phenomena in multiphase systems
- Acoustics
- Mechanics of granular suspensions: dilute to dense, rapid to Stokesian to Mohr-Coulombian rheology

RESEARCH HIGHLIGHTS

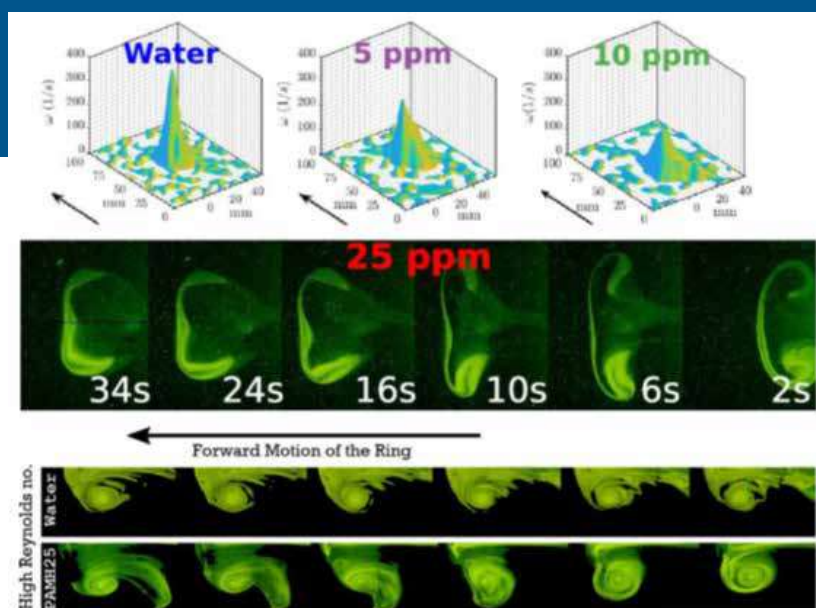
- Molecular dynamics simulations were applied to understand the bifurcation scenario and resulting patterns in compressible Taylor–Couette flow of dense gas.
- An experimental discovery of polymer vortex ring reversal was made.
- Purely elastic instability in rectilinear shearing flows, and thence, a continuous pathway between elastic and elastoinertial turbulence were revealed.
- A tool for medical inventory projection during COVID-19 was developed.
- Theoretical and experimental approaches were applied to understanding various convection wave regimes.
- An experimental discovery was made of interpenetrating spiral vortices and other non-axisymmetric states in suspension Taylor-Couette flow with stationary outer cylinder.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

Prof. K. R. Sreenivas Ph.D.

Professor and Dean, Research and Development

We experimentally studied the propagation of vortex rings in aqueous solutions of polyethylene oxide (PEO400) and hydrolysed polyacrylamide (PAMH25). We studied the canonical vortex ring as a caricature problem to the phenomenon of turbulent polymer drag reduction. PAMH25 has a similar infinite shear viscosity, ten times the zero shear viscosity and a thousand times the relaxation time of PEO400. We observed that PAMH25 drastically affects the propagation properties and structure of the vortex ring, while PEO400 shows a behaviour similar to water. We concluded that PAMH25 retards the roll-up process of the ring, due to both the large range of plateau viscosities and large relaxation time. We surmised that the behaviour of the vortex ring observed might be used to unravel the mechanism of polymer drag reduction. We found that while the circulation of PAMH solutions lie between the circulation curves of the two extreme Reynolds number-matched water experiments for an extended period of time, the enstrophy and peak vorticity do not. We attribute this behaviour to the modification of vorticity distribution within the core of vortex rings in PAMH solutions. We also studied the effect of polymer solutions on the formation number. We found that the formation number remains the same even in polymer solutions. We also demonstrated, using planar laser induced fluorescence, the phenomenon of ring reversal. Once the vortex ring stops, it begins to unwind and retract by translating and rotating in the opposite direction. We attribute this behaviour of ring reversal to the elastic properties of polymer solutions.



Distribution of vorticity and ring propagation in water and polymer rings (*Chem. Eng. Sci.* 115767 and 115961).

Reference:

Chem. Eng. Sci. 115767 and 115961

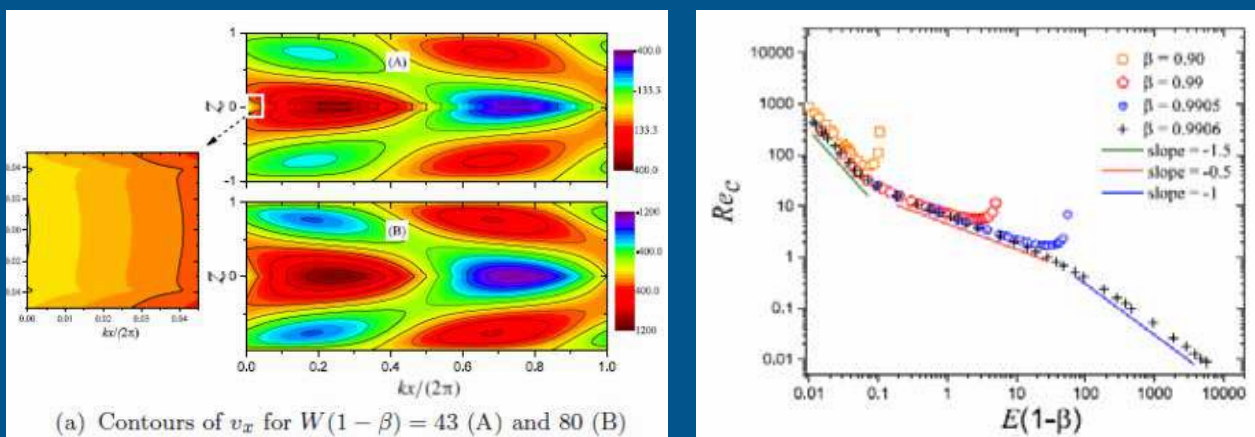
Prof. Ganesh Subramanian Ph.D.

Professor

Our group, in collaboration with Prof. Shankar's group at IIT Kanpur, have discovered purely elastic instability in rectilinear shearing flows, thereby debunking the long-held belief in the literature of the requirement of purely elastic instabilities being driven by a hoop-stress-based mechanism (See <https://arxiv.org/abs/2103.06794>). This novel instability establishes, for the first time, a continuous connection between two types of turbulence known in dilute polymer solutions (Figure).

Our group has also recently characterised the orientation distribution of sedimenting anisotropic particles in turbulence, showing them to be pronouncedly non-Gaussian. This is a problem of great importance to characterising cirrus cloud characteristics. Cirrus clouds are a crucial component of the earth-atmosphere radiation budget.

In addition, we have established the first phase diagram of the shear migration of active swimmers in pressure-driven flow that demarcates regimes of both high (near-centre depletion) and low shear trapping (near-centre excess).



(Left) Contour plots for the unstable eigenfunction underlying elastic instability. (Right) Critical Reynolds number for instability as a function of the elasticity number (<https://arxiv.org/abs/2103.06794>).

References:

- <https://arxiv.org/abs/2103.06794>
- *Phys. Rev. Lett.* 125 (3): 034501. doi:10.1103/PhysRevLett.125.034501
- *J. Fluid. Mech.* 890: A15. doi: 10.1017/jfm.2020.118

Major talk during 2020–21:

17 January 2020: IISER Pune Physics Seminar Series

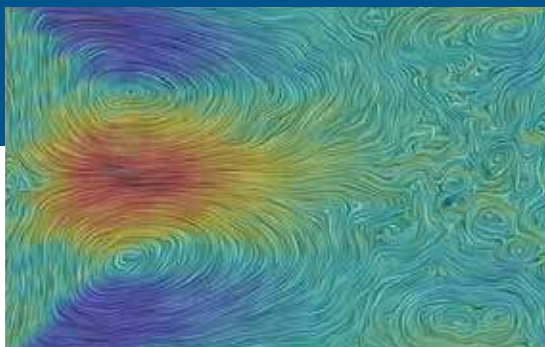
Prof. Meheboob Alam Ph.D.

Professor

In the past years, we developed a consistent second-order nonlinear theory for granular and gas-solid suspensions, which is likely to hold from dilute (gaseous) to dense (liquid) regimes. This theory incorporates normal stress differences and related anisotropies, which are signatures of non-Newtonian rheology, making our theory applicable for a much broader range of parameters where the standard Navier-Stokes-type models fail. This theory is embodied with a generalised heat-flux that goes beyond the standard Fourier-law by incorporating two new terms proportional to (i) density-gradient and (ii) stress-gradient. In each case, the respective conductivity tensor is anisotropic, which explains certain anomalous behaviour in flowing granular matter.

Our recent experiments on “suspension Taylor-Couette flow” uncovered an exotic state, wherein both stationary and travelling waves were found to co-exist. In addition, we also discovered interpenetrating spiral vortices when the outer cylinder is stationary.

We further conducted molecular dynamics simulations and direct numerical simulations to better understand the roles of compressibility and axial boundary conditions on “anomalous” Taylor vortices and the bifurcation structure in both dilute and dense (granular) gases (Figure) undergoing Taylor-Couette flow.



Streamline patterns of Taylor vortices in a wide gap (radius ratio = 2/3), small aspect-ratio (3/4) Taylor-Couette setup, with a stationary outer cylinder. The Reynolds number is 150 (*J. Fluid Mech.* 902: A18. doi: 10.1017/jfm.2020.534).

References:

- *J. Fluid Mech.* 902: A18. doi: 10.1017/jfm.2020.534
- *Phys. Rev. Fluids.* 5: 042301. doi: 10.1103/PhysRevFluids.5.042301
- *J. Fluid Mech.* 908: A24. doi: 10.1017/jfm.2020.897

Prof. Santosh Ansumali Ph.D.

Associate Professor (on lien)

During the recent COVID-19 crisis, we developed a tool that guides medical inventory projections for national needs, which helped in the prediction of herd immunity as well as growth pattern of the disease. We have created an India-specific model to take into account emerging situations. This initiative was facilitated by the office of the Principal Scientific Advisor, Government of India. This research work has resulted in several publications.

We have also been working on techniques to solve the Fokker-Planck equation using

deterministic methods. Now, in collaboration with researchers at Boston University, we have explored a new method to solve the Fokker-Planck equation for wealth distribution in a model economic system.

Our work on the Fokker-planck-equation was also extended to the kinetic theory of gases. A Fokker-Planck-based solver was developed for the gaseous mixture.

References:

- *Phil. Trans. Royal Soc. A.* 378 (2175): 20190401. doi: 10.1098/rsta.2019.0401
- *J. Fluid. Mech.* 899: A25. doi: 10.1017/jfm.2020.459
- *Curr. Sci.* 120 (11)
- *PLoS ONE.* 15 (12): e0242132. doi: 10.1371/journal.pone.0242132
- *Ann. Rev. Contr.* 50: 432–447. doi: 10.1016/j.arcontrol.2020.10.003
- *Phys. Rev E.* 102: 021301 (R). doi: 10.1103/PhysRevE.102.021301

Dr. Diwakar Seyyanur Venkatesan Ph.D.

Faculty Fellow

One of our major focus areas is to understand multi-layer convection phenomena like mantle convection and liquid encapsulated crystal growth. Our work, involving both theoretical and experimental approaches, has helped understand the regimes of different oscillatory modes of convection such as standing, travelling and modulated travelling waves.

In other work, in collaboration with Prof. Ranga Narayanan, University of Florida, USA, we have developed a novel instrument to measure interfacial tension. Correlating between the interfacial tension and volume of a pendant droplet before its breakup, the instrument yields accurate estimates without requiring cumbersome image processing and curve fitting.

With a renewed interest in explicit methods for solving non-linear partial differential equations, we have developed a new weighted scheme that considers an average of the convectional forward time centred space scheme and the asynchronous delayed difference scheme. The method relaxes the stability constraints of explicit approaches, and in conjunction with isotropic spatial difference operators, helps in overcoming the curse of dimensionality.

A novel immersed volume approach has been developed as a convenient way of handling finite size particles in a fixed grid formulation. A volume-fraction-based localised forcing was invoked to mimic the effects of solids in the fluid domain. Deriving from interface reconstruction procedures of the volume of fluid method, the present approach efficiently interpolates velocities and their derivatives closer to the interfacial cells, yielding second order accuracy.

Major talk during 2020–21:

December 2020: Complex Fluids 2020 Conference organised online by the IIT.

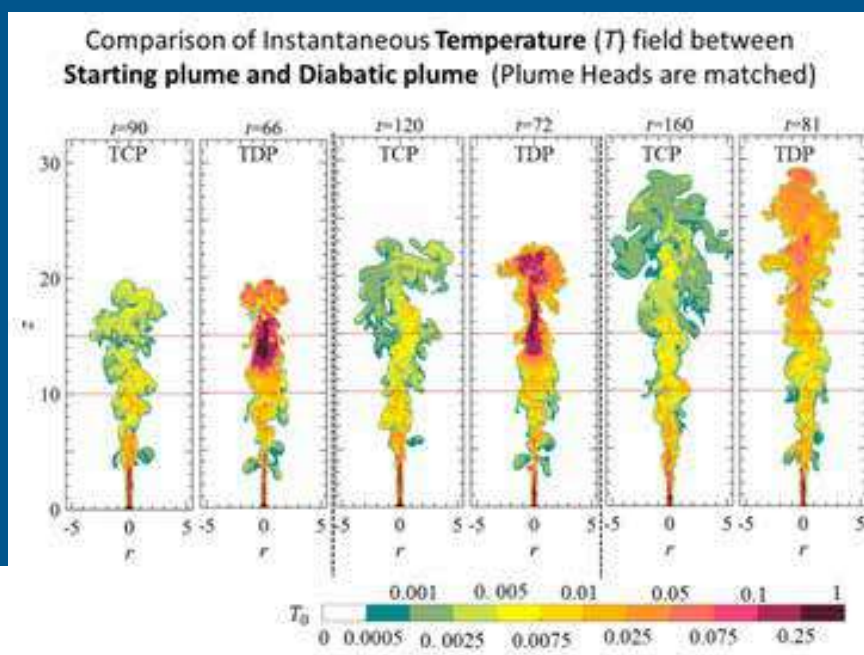
Prof. Roddam Narasimha Ph.D., F.A.Sc., F.N.A., F.T.W.A.S., F.R.S.

SERB National Science Chair (passed away on 14 December 2020)

We developed a new method of the otherwise time-consuming task of solving the pressure-Poisson equation, which in current codes may account for ~80% of the total computing time. The improvement was possible by the introduction of a new and more efficient code using a special function series for the representation of the pressure distribution. This was introduced into the MEGHA5 of our MEGHA series of cloud-flow codes. The new code will enable more realistic cloud flows at higher Reynolds numbers.

The earlier MEGHA4 code had been used for obtaining DNS solutions for laboratory experiments conducted at EMU (Figure).

Work on gas turbine blades using code ANUROOP has attracted attention, and we were invited to make a presentation at a Conference in San Jose, CA by INVIDIA, on our latest work on GPUs. Dr. N.H. Maruthi represented the JNC team at the Conference.



Cumulus clouds are familiar, but still far from being completely understood. Computations of idealized clouds can throw much light on the basic dynamics. Such an idealized cloud flow has been called a Transient Diabatic Plume (TDP), because of its finite life and higher temperature compared to a Transient Classical Plume (TCP). The images shown here are in three TCP-TDT pairs, the height (but not the time) being the same for both flows. Compared to the TCP, the TDP is hotter (due to phase change in real cloud), rises faster (because lighter), and spreads less (because accelerating).

Key publications:

- *Proc. Natl. Acad. Sci.* 2011. 108 (39): 16164–16169. doi: 10.1073/pnas.1112281108
- *Adv. Appl. Mech.* 1979. 19: 221–309. doi: 10.1016/S0065-2156(08)70311-9

UNIT MEMBERS

Faculty Members

Professor and Chair	Prof. Ganesh Subramanian
Professors	Prof. K. R. Sreenivas, Prof. Meheboob Alam
Associate Professor	Prof. Santosh Ansumali (on lien)
Faculty Fellow	Dr. Diwakar Seyyanur Venkatesan
SERB National Science Chair	Prof. Roddam Narasimha (passed away on 14 December 2020)

Research Students

Ph.D.	K. Siddharth, Vybhav G. R., Praveen Kumar K., Mohammad Raifuddin, Piyush Garg, Prateek Anand, Arun Kumar Varanasi, Shaurya Kaushal, Akshaysingh Bhawarsingh Shekhawat, Suryadev Pratap Singh, Raksha Mahalinkam, Subham Banerjee
M.S. (Engineering)	Mayank Toprani, Biswadeep Roy, Akshay Chandran, Sabarish V. N., Ritwik Das, Saumyakanta Mishra, Anomitra Saha, Shashank R., Sangamesh Gudda, Adharsh S., Akhilesh Srivastava

Research Staff

SERB National Postdoctoral Fellow (NPDF)	Dr. Manojit Ghosh
Research Associates	Dr. Harish N. Mirajkar, Dr. Subrat Kotoky, Dr. Lakshminarasimharao, Dr. Deepak Govind Madival
Research Associate 1	Dr. H. J. Shashank
Junior Research Fellows	Prateek Anand, Piyush Garg
R&D Assistants	Tejas N., Albin P. John, Shashank B. P., Tanumoy Dhar, Samarth Agrawal
Project Assistant	Mohammad Rafiuddin

Administrative Staff

Helper	K. Ravi Kumar
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UNIT AT A GLANCE

Honour Received by Faculty Member



1

Prof. Santosh Ansumali

Awarded the Cray's Dr. A. P. J. Abdul Kalam HPC Award, 2020, by Hewlett Packard Enterprise

Total Publications



21

Peer reviewed articles indexed in Web of Science

Sponsored Projects



New projects

7

₹ 1.25 cr.



Ongoing projects

11

₹ 1.41 cr.

Students Graduated During 2020–21



4

Ph.D.

- Sankalp Nambiar
- Shashank H. J.
- Mohammad Atif
- Mahan Raj Banerjee

6

M.S.
(Engineering)

- Prashanth Ramesh
- Pulkit Kumar Dubey
- Albin Prince John
- Tanumoy Dhar
- Nishant Soni
- Akanksha Bohra

Students Admitted During 2020–21



2

Ph.D.

- Raksha Mahalinkam
- Subham Banerjee

5

M.S.
(Engineering)

- Anomitra Saha
- Shashank R.
- Sangamesh Gudda
- Adharsh S.
- Akhilesh Srivatsava

GEODYNAMICS UNIT (GDU)



At GDU, our studies are focused on natural hazards evaluation. Our work involves the reconstruction of paleo-monsoon dynamics and behaviour of the Intertropical Convergence Zone concerning extreme climatic events over the Himalayas as a part of the Department of Science and Technology Women Scientist project. We carry out advanced modelling experiments with the help of reconstruction databases to explain the causal linkages between global and regional climate and the monsoon rainfall recorded in proxy data. We also continue to work on paleoseismology to identify surface ruptures caused by large earthquakes, using geological tools to investigate the earthquake mechanisms of the Himalayan arc and its contiguous regions. Our research interests involve unearthing evidence and facts to justify the plight of the Himalayan-born dried up River Saraswati, which was a victim of tectonically induced river piracy. At GDU, we are also dedicated to predicting tsunami hazards across the Indian coasts using multiple parameters related to sediment cores.

Along with the aforementioned, we also recently investigated several locations in the Himalayan regions that could contain apatite-bearing rocks. The research conducted by GDU can assist in the advancement of apatite property research and the development of biocompatible materials for dental/orthopaedic applications.

RESEARCH AREAS

- Himalayan climatic variation reconstruction
- Speleothem research
- Chronology
- Depositional environment
- Stable isotopes
- Geochemistry
- Computational modelling
- Relationship between global and regional climate
- Regional atmospheric circulation model
- Potential hazards in the Himalayan active mountain belt and Indian coastal regions
- Natural apatites

RESEARCH HIGHLIGHTS

- Traces of River Saraswati were discovered in the northwestern plains of India, proving how the river dried up around 2,600–2,500 years ago due to tectonic activity and drastic climate change.
- Anomalous weather events in the central Himalayas were identified using observation data and major past climatic events were documented based on proxy data collected via multiple analyses.
- The seismic gap of great earthquakes ($M_w > 8$) in the central Himalayas, which lasted for 600 years, was established.
- Long-term Indian Ocean tsunami records were established and alternating earthquake clusters punctuated by quiet interludes were revealed.
- The report for the BRNS project (2021) entitled “Evaluation of tsunami hazard for the Eastern Seaboard of India”, which is directly related to the “Sustainable Clean Energy Program”, was concluded.
- The combined effect of global warming, enhanced by anthropogenic influences on the Himalayan Province, was analysed.
- The historical and geological evidence of a tsunami impact zone was unearthed from a site in the Makran area of the Konkan coast in western India.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

Prof. K. S. Valdiya Ph.D., FASc., FNASc., FTWAS

Honorary Professor (passed away on 30 September 2020)

The central sector of the Himalayan province is witnessing unusual and frequent incidences of extreme weather, unending cycles of prolonged droughts and very short spells of excessive rainfall over geographically limited areas, the absence of ‘April Showers’ before the onset of the summer monsoon and the delayed arrival of the Indian summer monsoon. Are these occurrences related solely to the rise in global temperatures due to global warming, or are they caused by the presence of excess carbon generated by the rampant burning of agricultural residues and uncontrolled

Contd. from pg. 77

Prof. K. S. Valdiya

forest fires? One would also like to know whether the western disturbances and/or the mid-latitude interactions have a role in these distressing developments. The most simplistic answer is that all these anomalous happenings are “the combined effect of global warming enhanced by anthropogenic influences”.

Reference:

Curr. Sci. 119 (1): 19–25

Other research activity during 2020–21:

K. S. Valdiya. The Asiatic Society, Kolkata, pp. 1–28. ISBN: 978-81-946923-3-1

Dr. C. P. Rajendran Ph.D.

Senior Associate

The tsunami hazard for the west coast of India remains under-recognised in comparison to the east coast despite the impact in 1945 following an 8.1 magnitude (M_w) earthquake in the Makran subduction zone in the northern Arabian Sea. Our team presented historical and geological evidence of a tsunami impact zone at a site on the Indian Konkan coast: the village of Kelshi. The impact zone is preserved within a coastal dune complex that revealed its occupation layers. It is a laterally extending 30–40 cm thick zone that coincides with a habitation level. It displays scour-fill features inter-layered with shells at a height of ~3 m from the high-tide level, which we attributed to a tsunami flooding event synchronous with the transportation of shells in 1508–1681 CE. This event matches with the description of a sea disturbance in 1524 CE, reported by the Portuguese fleets from Dabhol, which is not far from Kelshi, and from the Gulf of Cambay. Our modelling results suggested that the source of the high impact in Kelshi could be an $M_w \geq 9$ earthquake in the Makran subduction zone. Thus, fresh efforts are needed to reconstruct the tsunami recurrence history along the Makran coast, in order to generate validating constraints on the 1524 event, if those events were indeed caused by a massive earthquake.

Reference:

Pure Appl. Geophys. 7: 1–20. doi:10.1007/s00024-020-02575-0

Other research activity during 2020–21:

Proc Indian Nat. Sci. Acad. 86 (1): 585–607. doi:10.16943/ptinsa/2020/49787.

Major talks during 2020–21:

- 17 June 2020: Webinar on Earthquake and Challenges: Balancing between Nature and Technology, organized by the Indian Academy of Science and Department of Science and Technology, Government of Rajasthan.

- October 2020: Talk on “Studies on Multi-hazard Vulnerability and Mitigation in the Coastal Area Towards Impact-based Multi-hazard Warning Systems” and “Risk Assessment of Coastal Multi-hazards Including Tsunamis, Storm Surges, Coastal Erosions, and Sea-level Rise due to Global Climate Change” at the virtual meeting organized by the Vaishvik Bharatiya Vaigyanik (Vaibhav) Summit, Ocean Sciences (Horizontal), Earth Sciences (Vertical), SessionV-13H259.

Dr. Jaishri Sanwal Bhatt Ph.D.

Woman Scientist

We analysed sediment cores from a site near Port Blair (South Andaman) and found out-of-sequence layers at various depths. We could differentiate these layers based on their sediment characteristics and microfossil constituents. The layers are between 596–6472 years old and are remarkably chronologically parallel to paleo-tsunami deposits identified from far field locations in the Indian Ocean. These findings are long-term tsunami records, which indicate that over time there have been temporally clustered sequences of causative earthquakes alternately interspersed with intervals of stand-alone events. This pattern is in agreement with theoretical models of active stress re-cycling processes in the subduction zones and transfer processes between the lower viscoelastic layer and upper seismogenic crust.

Reference:

Pure Appl. Geophys. 7: 1–20. doi: 10.1007/s00024-020-02575-0

Other research activity during 2020–21:

Reson 26: 301–316 doi: 10.1007/s12045-021-1133-0

Major talks during 2020–21:

- July 2020: Invited speaker for a talk on “Geological Archives of Late Quaternary Climate in the Central Himalaya: Interpretations and Inferences” at the virtual International Conference on Paleoclimate Changes (ICPC2020) organized by the Vellore Institute of Technology, Chennai.
- September 2020: Invited speaker for a talk on “20,000 Years Climatic Record from Central and Western Himalaya Using Lake Sediments and Cave Deposits” at INQUA SEQS2020 (virtual conference) on Quaternary Stratigraphy: palaeoenvironment, palaeofauna, and human migrations across Central Europe, organized by the Uniwersytet Wrocław, Poland.
- February 2021: Keynote speaker at the virtual meeting organized by: ||Haa᳚|| Haac Heritage on Calling: Postcards from the Magnificent Mountain Himalayas: Land, People, and Environment.
- February–March 2021: Invited lecture series on “Dynamics and Evolution of Earth: Plate Tectonics and Natural Disasters” at GKVK, Bengaluru.
- February 2021: Participated in an international workshop organized by the International Atomic Energy Agency (virtual meeting).

UNIT MEMBERS

Faculty Members

Honorary Professor and Chair	Prof. K. S. Valdiya
Senior Associate	Dr. C. P. Rajendran
Woman Scientist	Dr. Jaishri Sanwal Bhatt
Research Associates	M. Raja, Ananya Divyadarshini

UNIT AT A GLANCE

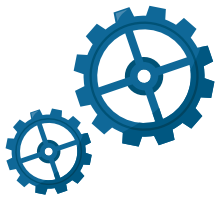
Total Publications



7

Peer reviewed articles indexed in Web of Science

Sponsored Projects



Ongoing projects

1

₹ 8.10 lac

INTERNATIONAL CENTRE FOR MATERIALS SCIENCE (ICMS)



ICMS is the first international Centre of its kind devoted to high impact, interdisciplinary scientific research, education and extension activity in materials science, established in the confines of a scientific cum educational institution. The Centre was envisaged by the Department of Science and Technology, Government of India. The plan to establish the Centre was crystallized in 2007, with JNCASR taking the lead and necessary steps to establish it. The Centre was inaugurated and dedicated to the nation on 3 December 2008 by the then Honourable Prime Minister of India, Dr. Manmohan Singh.

An important and unique activity of ICMS is to provide global research opportunities and to support international exchange programmes.

ICMS is a constituent of the School of Advanced Materials, JNCASR.

RESEARCH AREAS

- Solid state and structural chemistry
- Heteroepitaxial growth and formation of self-assembled nanostructures
- Semiconductor nanostructures
- Soft condensed matter physics
- Organic–inorganic hybrid materials
- Physics and chemistry of nanomaterials
- Plasmonic materials, metamaterials, and nanophotonics

RESEARCH HIGHLIGHTS

- Layered nanocomposites of polymer-functionalized reduced graphene oxide and borocarbonitride with MoS_2 and MoSe_2 showed excellent activity for the hydrogen evolution reaction.
- Inorganic phosphides were used as electrocatalysts to improve the efficiency of water splitting.
- Theoretical modelling was performed and geometrical considerations were made for gallium nitride nanowall network morphologies to provide experimental evidence of intense light emission.

- Direct phase retrieval was achieved in atomic resolution transmission electron microscopy from a single high-resolution transmission electron microscopy image by using a modified intensity equation.
- The mechanism behind glass devitrification was unravelled using soft colloidal glasses as a model system.
- A novel biodegradable polymer was developed with potential applications in the biomedical industry as a replacement for BPA-based plastics.
- Single-particle fluorescence spectroscopy and X-ray absorption spectroscopy were used to identify the oxidation state of copper dopants in semiconductor nanocrystals.
- High-performance NASICON- $\text{Na}_x\text{V}(\text{Mn}/\text{Mg}/\text{Al})(\text{PO}_4)_3$ cathodes were developed for sodium ion batteries.
- The relationship between the substrate temperature and growth mode was investigated in scandium nitride semiconductor thin films.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

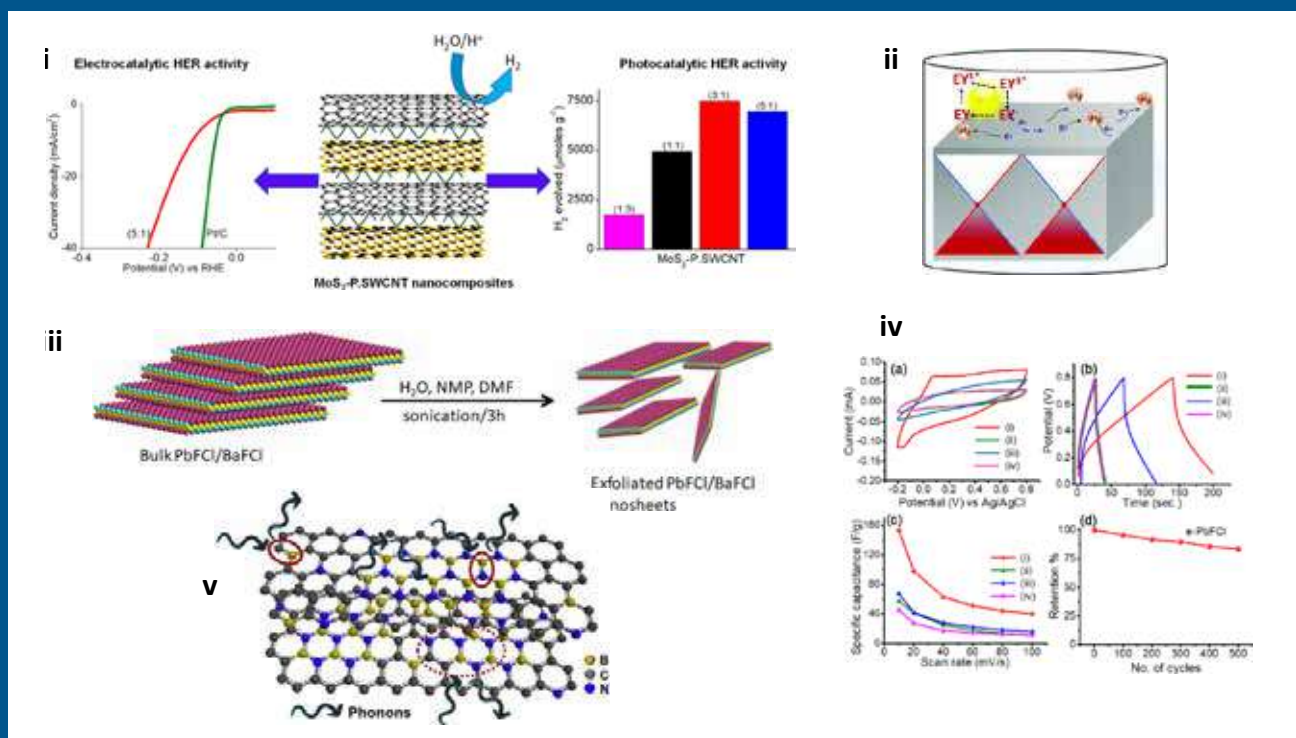
Bharat Ratna Prof. C. N. R. Rao F.R.S.

Honorary President, Linus Pauling Research Professor and Director, ICMS

Water splitting reactions by photo- and electro-chemical means is an important area of research related to renewable energy. In this context, we have studied nanocomposites of (i) MoS_2 nanotubes with single-walled carbon nanotubes and borocarbonitride (BCN) nanotubes, (ii) nanocomposites of phosphorene- $\text{MoS}_2/\text{MoSe}_2$, RGO or BCN with MoS_2 and MoSe_2 and (iii) exfoliated solid solutions of $\text{MoS}_x\text{Se}_{(2-x)}/\text{MoSe}_x\text{Te}_{(2-x)}$. We have investigated new classes of 2D materials like PbFCl , BaFCl and metal phosphochalcogenides (MPX_3) for their supercapacitor and photocatalytic water splitting properties, respectively. We have also designed a chemical route to synthesise twisted graphene, graphene oxide and boron nitride. We have studied the variations in electronic and optical properties of CdPS_3 and its superior photo(electro)chemical hydrogen evolution reaction (HER) activity. We have also investigated the selective fabrication of β -phase NiS and VO_x thin films and crystalline epitaxial ultrathin films of NiO via the atomic layer deposition (ALD) technique, performed their detailed characterisation and conducted an ALD parameter-dependent study.

Reference:

ACS Appl. Nano. Mater. 3 (2): 1792–1799. doi: 10.1021/acsnm.9b02482



(i) Nanocomposites of MoS₂ nanotubes with single-walled carbon nanotubes and borocarbonitride nanotubes; their photocatalytic and electrocatalytic HER activities. (ii) Enhancement of the HER catalytic activity of non-magnetic Weyl semimetals of the NbP family upon the application of a magnetic field. (iii) Schematic representation of the exfoliation of PbFCl and BaFCl with various molecules and (iv) their electrochemical supercapacitor studies. (v) Schematic representation of the low thermal conductivity of BCN nanosheets due to significant phonon scattering from the different length scale hierarchical nano/meso architectures (*ACS Appl. Nano. Mater.* 3 (2): 1792–1799. doi: 10.1021/acsnm.9b02482).

Prof. Ranjan Datta Ph.D.

Professor

We performed image simulations and reconstructions of a crystal with thickness and defocus. We also conducted image simulations through atomic resolution transmission electron microscopy by considering the atom as an electrostatic interferometer.

Further, we achieved direct phase retrieval in atomic resolution transmission electron microscopy from a single high-resolution transmission electron microscopy image by using a modified intensity equation.

Major talks during 2020–21:

- 3–7 February 2020: Talk on “Quantitative Counting of Zn and O Atoms by Atomic Resolution Off-axis and Inline Holography” at the 12th Asia Pacific Microscopy Conference and XL (40th) Annual Meeting of EMSI, Hyderabad.
- 26 November 2020: Talk on “Atom Counting in ZnO by Atomic Resolution In-line and Off-axis Electron Holography” at the in-house Symposium (IHS), JNCASR.

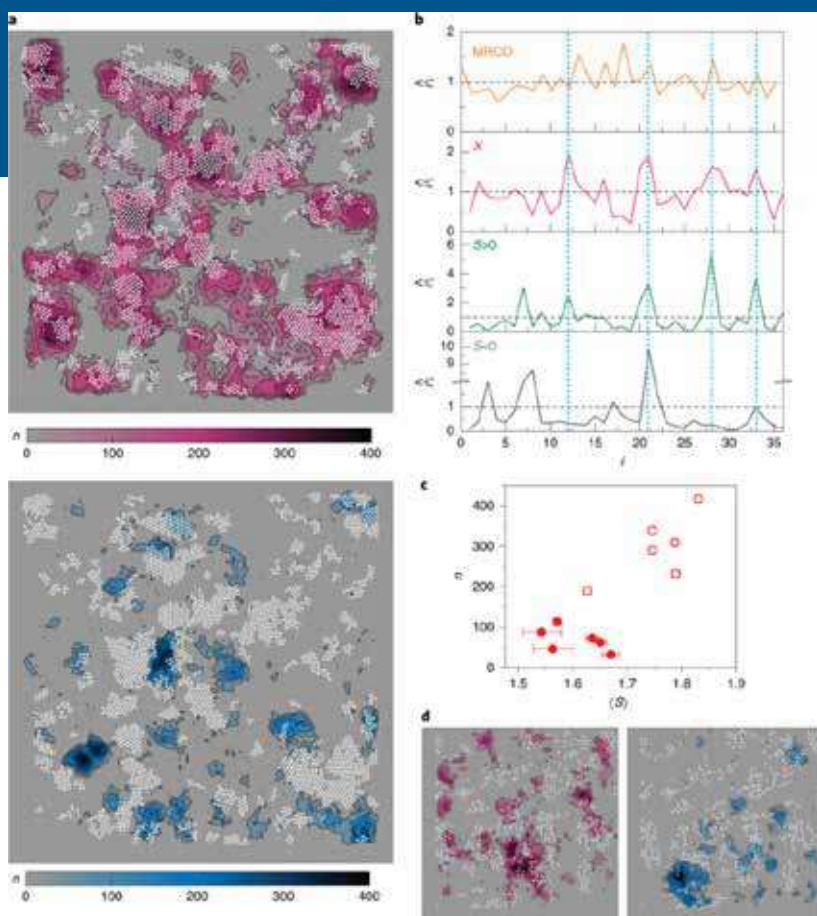
Prof. Rajesh Ganapathy Ph.D.

Associate Professor

A key research finding from our study was in unravelling how a glass devitrifies. Using colloidal glasses as a model system, we visualized this process by tracking dynamics at the single-particle level for days at a stretch. We uncovered two pathways through which a glass transforms into a crystal and then used machine learning methods to show that there are regions in glass that are already predisposed to crystallize. This finding has been published and highlighted in numerous media outlets both within the country and abroad (Figure).

Besides the abovementioned work, research activities in my group in the above period include:

- (1) Probing how curvature alters glass transition
- (2) Uncovering emergent stereoselective interactions in chiral active matter
- (3) Exploiting atomic heteroepitaxy concepts to steer colloidal self-assembly
- (4) Tuning the performance of a micron-sized Stirling engine
- (5) Uncovering the mechanisms of shear-thickening in colloidal rod suspensions



Softness, a structural parameter of colloidal glasses determined via machine learning, predicts where crystallization initiates in the glass (*Nat. Phys.* 17: 114–120. doi: 10.1038/s41567-020-1016-4).

References:

- *Nat. Phys.* 17: 114–120. doi: 10.1038/s41567-020-1016-4
- *Nat. Comm.* 11 (1): 4967. doi: 10.1038/s41467-020-18760-7
- *Sci. Adv.* 7 (9): eabd0331. doi: 10.1126/sciadv. abd0331
- *Sci. Adv.* 6 (10): eaay8418. doi: 10.1126/sciadv. aay8418
- *Phys Rev. E* 101: 040601(R). doi: 10.1103/PhysRevE.101.040601

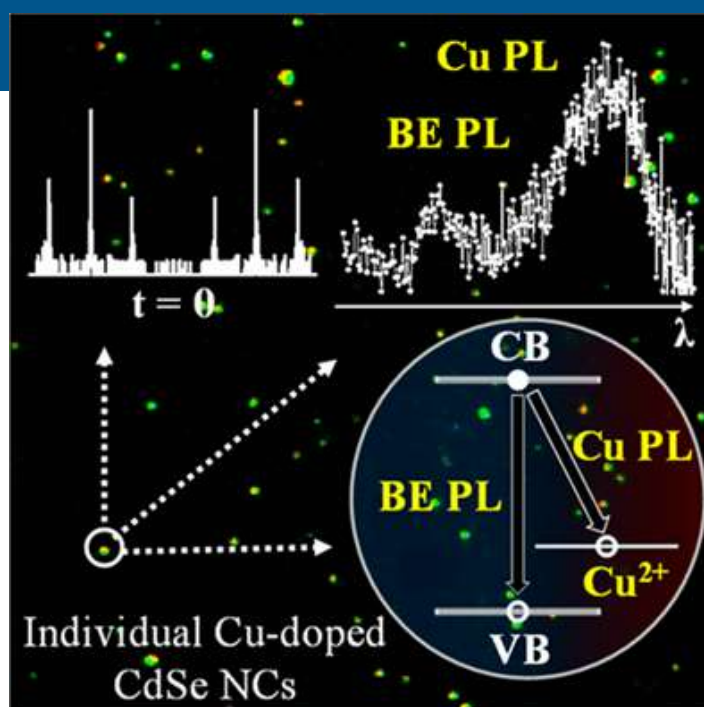
Major talks during 2020–21:

- 2020: SAMat Special Lecture by SSB Prize Awardees, JNCASR
- 2020: Institute Colloquium, Tata Institute of Fundamental Research, Mumbai
- 2020: Weekly seminar, Department of Chemical Engineering, IISc, Bengaluru
- 2020: Compflu-2020, IIT, Mumbai
- 2020: Monthly Colloquium, International Centre for Theoretical Studies, Bengaluru
- 2020: SS Bhatnagar Lecture Series, IIT Ropar, Punjab
- 2020: Webinar, Soft Matter Group, Department of Physics, University of Gothenburg, Sweden

Prof. Ranjani Viswanatha Ph.D.

Associate Professor

Identifying the oxidation state of copper ions (Cu) and the presence of the magnetically active Cu^{2+} ion or a magnetically inactive d^{10} Cu^+ ion in copper doped semiconductor nanocrystals (NCs) plays a very important role in material design due to their hugely differing consequences in optoelectronic applications. In our study, we used single-particle fluorescence spectroscopy along with X-ray absorption spectroscopy to probe the local environment of the dopant ions. We used this technique to avoid confusion arising due to spatial cluttering, which is usually associated with optical techniques of analysis. Using our technique, we studied Cu-doped II–VI semiconductor NCs to find conclusive evidence on the oxidation state of Cu dopants and hence the mechanism of their emission. We also conducted a detailed analysis of blinking properties to study the single-particle nature of the NCs.



Individual Cu-doped CdSe NCs (*J. Phys. Chem. Lett.* (11) 13: 5367–5372. doi:10.1021/acs.jpcllett.0c01570).

Reference:

J. Phys. Chem. Lett. 11 (13): 5367–5372.
doi:10.1021/acs.jpcllett.0c01570

Other research activities during 2020–21:

- *Nanoscale Adv.* 2 (11): 5305–5311.
doi:10.1039/D0NA00732C
- *J. Phys. Chem. Lett.* 11 (16): 6742–6748.
doi:10.1021/acs.jpcllett.0c01993

Prof. Sridhar Rajaram Ph.D.

Associate Professor

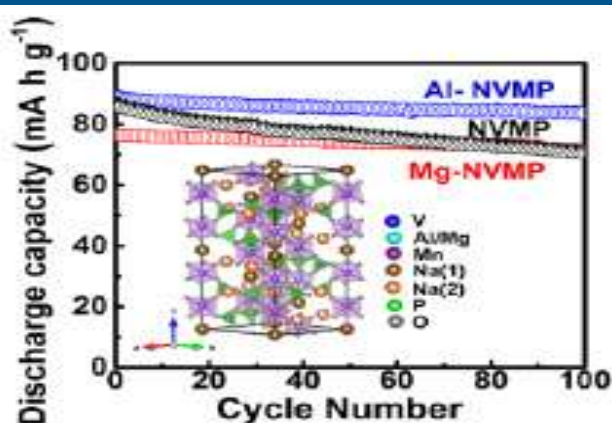
Aromatic polycarbonates are a part and parcel of daily life. Although their biodegradability is an advantage, two disadvantages exist: i) Aromatic polycarbonates do not mix well with other plastics during physical recycling and ii) their bio-degradation releases bis-phenol A, which is believed to be an endocrine disruptor. Aliphatic polycarbonates have been looked at as alternatives because of these issues. However, the poor mechanical properties of aliphatic polycarbonates have precluded their widespread application. We have developed a new aliphatic polycarbonate that combines the advantages of ring opening polymerisation and the mechanical properties of aromatic polycarbonates. This was done using a regio-regular ring opening polymerisation of α -aryl trimethylene carbonate. The glass transitions temperature of the polymers was shown to depend on the regio-regularity.

We have also looked into small molecule modulators of autophagy, which have a potential role in treating protein-aggregation-induced neurodegenerative disorders. Based on hits identified from high-throughput screens in Prof. Ravi Manjithaya's laboratory, we have developed lead molecules with better pharmacokinetics. The testing of these molecules has shown that all of them perform as well as or better than the initial hit. Further tests are currently in progress. Also, modifications to the core structure of the hit using organocatalysts developed in our laboratory is currently in progress.

Dr. Premkumar Senguttuvan Ph.D.

Faculty Fellow (jointly with NCU)

During this year, we explored high energy density NASICON cathodes ($>450 \text{ Wh kg}^{-1}$), established the structure–electrochemical property relationship in NASICON cathodes, and developed high capacity negative electrodes based on carbon, Bi, Sn, etc. Overall, this led to the development of high-performance NASICON- $\text{Na}_x\text{V}(\text{Mn}/\text{Mg}/\text{Al})(\text{PO}_4)_3$ cathodes for sodium ion batteries.



The crystal structure of the NASICON- $\text{Na}_x\text{V}(\text{Mn}/\text{Mg}/\text{Al})(\text{PO}_4)_3$ cathode for sodium ion batteries and its discharge capacity with use over time.

Major talk during 2020–21:

25 February 2021: Talk on “Exploration of High Voltage NASICON Cathodes for Sodium-ion Batteries” at the 11th Indo-German Frontiers of Engineering Symposium (Virtual).

Dr. Bivas Saha Ph.D.
Faculty Fellow (jointly with CPMU)

See pg. 54 for research activities

Prof. Eswaramoorthy M. Ph.D.
Professor and Associate Director, ICMS

See pg. 51 for research activities

Prof. S. M. Shivaprasad Ph.D.
Professor (on lien; jointly with CPMU)

See pg. 52 for research activities

UNIT MEMBERS

Faculty Members

Director	Prof. C. N. R. Rao
Professor and Associate Director	Prof. Eswaramoorthy M. (jointly with CPMU)
Professors	Prof. S. M. Shivaprasad (on lien; jointly with CPMU), Prof. Ranjan Datta
Associate Professor	Prof. Rajesh Ganapathy, Prof. Ranjani Viswanatha, Prof. Sridhar Rajaram
Faculty Fellows	Dr. Premkumar Senguttuvan (jointly with NCU), Dr. Bivas Saha (jointly with CPMU)

Associate Faculty

- Prof. G. U. Kulkarni** (President, JNCASR)
- Prof. Sundaresan A.** (Professor and Chair, CPMU)
- Prof. Balasubramanian S.** (Professor, CPMU)
- Prof. Chandrabhas Narayana** (Professor, CPMU; on lien)
- Prof. Tapas Kumar Maji** (Professor, CPMU)
- Prof. Kanishka Biswas** (Associate Professor, NCU)
- Prof. Swapan K. Pati** (Professor and Chair, TSU)
- Prof. Shobhana Narasimhan** (Professor, TSU)
- Prof. Srikant Sastry** (Professor, TSU)
- Prof. Umesh V. Waghmare** (Professor, TSU, and Dean, Academic Affairs)

PGDMS Students

Ph.D. Aiswarya R. P., Unnimaya K. C.

Technical Staff

Sr. Research Officer Sreenath V., Srinivas S.

Technical Assistant (Inst) Sunoj K. R.

Technical Assistant Trainee Deepak V.

Research Staff

Research Associate Dr. Pramoda K., Dr. Shashidhara,
Dr. Anand Kumar Roy, Dr. Badri Vishal,
Dr. Manjodh Kaur

Research Associate (P) Mahima Makkar

Project Assistant Krithika Upadhyaya, Pradeep K. R.

R&D Assistant M. S. Ramesh, Dheeraj Sangoji, Subhashri
Mannar, Amal Sanal Kumar

Research Scientist B Sanjit Kumar Parida

UNIT MEMBERS

Administrative Staff

Laboratory Asst.	Mune Gowda H.
Jr. Admin Assistant	Ramya C.

UNIT AT A GLANCE

Honours/Fellowships/Memberships Received



5

Faculty
members

Faculty Members

Prof. C. N. R. Rao

- Received the National Youth Day Award 2021 from Bharat Seva Samvad, Surat, Gujarat
- Received a Honoris Causa Doctorate from the Assam Royal Global University, Guwahati
- Received the International Eni Award 2020 for research into renewable energy sources and energy storage

Dr. Bivas Saha

- Received the Young Scientist Research Award from the Board of Research in Nuclear Sciences (BRNS) of DAE, India
- Selected as Young Associate of the Indian Academy of Sciences, Bengaluru, 2020

Prof. Rajesh Ganapathy

- Received the CSIR Shanti Swarup Bhatnagar Prize 2020 (under physical sciences category)

Prof. Ranjani Viswanatha

- Elected as a Member of the Editorial Advisory Board of *ChemPhotoChem*
- Featured in Womens' Perspectives in the Energy Materials Focus issue in *J. Phys.: Mater.* (2021)
- Guest edited a Festschrift along with Prof. Prashant Kamat and Prof. A. K. Cheetham in *J. Phys. Chem. C*

Prof. S. M. Shivaprasad

- Received an Honorary Fellowship from the Karnataka Science and Technology Academy

ICMS

Total Publications



43

Peer reviewed articles indexed in Web of Science

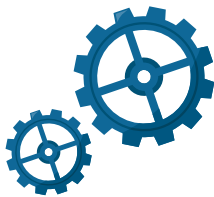
Sponsored Projects



New projects

3

₹ 39.09 lac



Ongoing projects

5

₹ 42.49 lac

Students Graduated During 2020-21

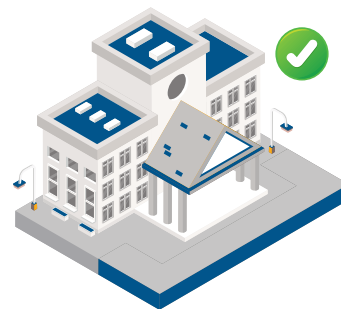


3

PGDMS

- Golla Prudhvi
- S. Sowmeya
- Pankaj Kumar Samal

Students Admitted During 2020-21



2

PGDMS

- Aishwarya R. P.
- Unnimaya K. C.

MOLECULAR BIOLOGY AND GENETICS UNIT (MBGU)



At MBGU, we use fundamental principles and advanced approaches to improve the understanding of concepts in biology and provide solutions for healthcare and medicine. Created in the field of infectious diseases, the Unit has expanded into several current areas of cell and molecular biology, developmental genetics, and biochemistry, incorporating inputs from physics, chemistry, materials science, and engineering. Given the unique array of research areas that JNCASR has expertise in, biologists can easily traverse disciplines and have a global network of collaborations.

Our research impacts the understanding and application of clinical and translational studies. Biological concepts and processes are unraveled by studying a wide range of organisms including, viruses, yeasts, protozoa, *Drosophila* and mouse as well as human clinical samples. Research questions include understanding biomolecules at one end of the spectrum to studying human development and disease at the other. Facilities, funding and training programs are designed to foster interdisciplinary interactions.

With decades of experience, the faculty hold key administrative and advisory positions at JNCASR, as well as nationally and internationally. The Unit has also seen a large number of awards and honors bestowed upon its members due to their contributions towards the development of science in the country. MGBU as a research unit has actively contributed to JNCASR's recent excellent ranking of 7th in Nature index normalized and 4th in the life sciences.

RESEARCH AREAS

- Cancer and autophagy inhibition
- Unconventional protein secretion
- Stem cells and development
- Cell cycle regulation
- Genome evolution and histone variants in fungal pathogens
- Crosstalk between nucleotide and energy metabolism in Plasmodium
- Regulation of immune cell differentiation and function
- Molecular mechanisms responsible for severity of malaria infection and drug resistance
- Xenophagy
- Chromatin dynamics and transcription regulation
- Molecular enzymology and protein structure–function analysis
- Cellular and molecular mechanism of neurological disorders
- Autophagy
- Long non-coding RNA biology
- Chromatin biology
- Molecular mechanism of T cell tolerance in the thymus
- Neurodegeneration and autophagy
- Mitophagy

RESEARCH HIGHLIGHTS

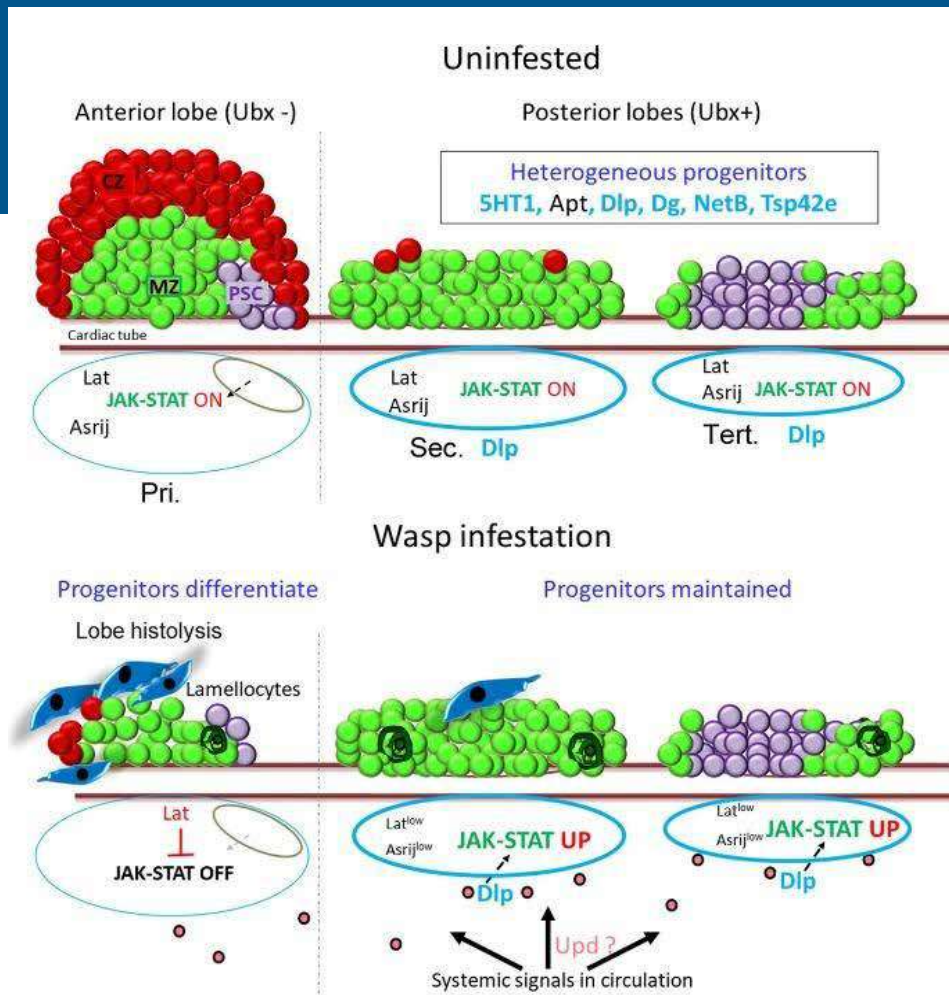
- Using *Drosophila* (fruit fly) as a model system, greater insight was gained into blood progenitor heterogeneity, conserved mitochondrial mechanisms regulating progenitor fate and lineage choice, and signalling mechanisms regulating the same.
- The structural basis for the hyperthermostability of an archaeal enzyme induced by succinimide formation was revealed.
- The rare variants of the *KANK4* and *CAP2* genes were found to be implicated in bipolar disorder.
- The Mrhl lncRNA was found to regulate the expression of the Sox 8 gene through a chromatin looping mechanism mediated by CTCF and YY1 in spermatogonial cells.
- The mechanism of centromere type transition was investigated, fragmented genome assembly was improved, and a chromosome-level genome assembly of the fungus, *C. tropicalis* was constructed.
- A small molecule xenophagy inducer, acacetin, was identified and investigated for its ability to capture and degrade intracellular bacteria; the involvement of the transcription factor, TFEB, in its mechanism of action was revealed.
- The TGF- β derived from T regulatory cells was found to be critical in controlling allergic and autoimmune responses.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

Prof. Maneesha S. Inamdar Ph.D., F.N.A.Sc.
Professor and Chair, MBGU

Blood and immune cells are derived from a diverse pool of stem cells and progenitor cells. Understanding progenitor heterogeneity is a major challenge. We are generating a series of CRISPR/Cas9 mediated gene targeting constructs to generate mutant and fluorescent reporter expressing human pluripotent stem cell models of hematopoiesis. Further, we are comparing mouse hematopoiesis and *Drosophila* (fruit fly) larval lymph gland hematopoiesis to understand

mechanisms by which organelles such as mitochondria and endosomes regulate blood cell homeostasis. We identified additional tools and reagents required to drive gene expression in specific subsets of progenitors across different model systems. Our work sets the stage for future studies to understand how systemic signals can control tissue-specific developmental events and haematopoietic homeostasis.



Model depicting lymph gland progenitor heterogeneity and response to immune challenge (*eLife* 10: e61409. doi: 10.7554/eLife.61409).

Reference:

eLife 10: e61409.
doi: 10.7554/eLife.61409

Other research activity during 2020–21:

Int. J. Dev. Biol. 64: 213–225. doi:10.1387/ijdb.190038mi

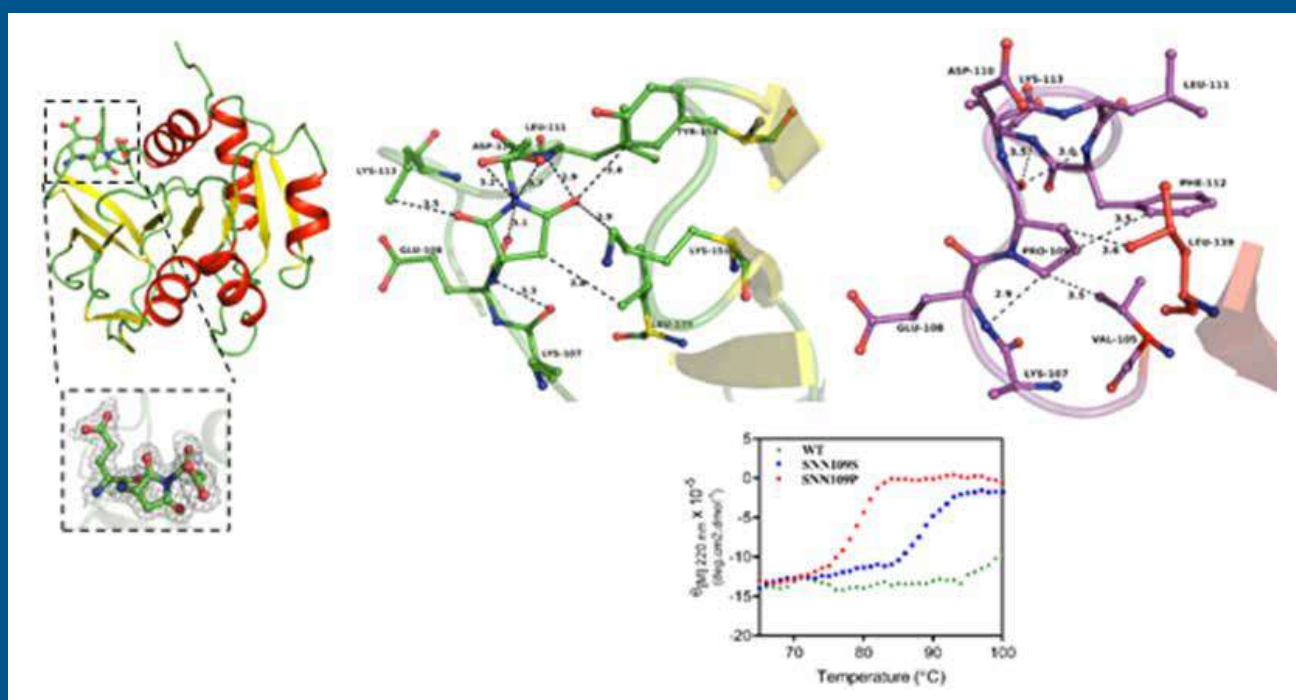
Prof. Hemalatha Balaram Ph.D., F.N.A.Sc., F.A.Sc
Professor and Dean, Faculty Affairs

We realised the stability of proteins from hyperthermophiles (organisms existing under boiling water conditions) enabled by a reduction of their conformational flexibility through various mechanisms. We have solved the crystal structure of *Methanocaldococcus jannaschii* glutamine amidotransferase (MjGATase), and using enhanced sampling molecular dynamics simulations, addressed the mechanism of its increased thermostability, up to 100°C which is imparted by an unexpectedly stable succinimidyl residue (SNN) at position 109. The conservation of the succinimide

Prof. Hemalatha Balaram

forming tripeptide sequence (E(N/D)(E/D)) in several archaeal GATases strongly suggests that an adaptation of this otherwise detrimental post-translational modification is a harbinger of thermostability.

The parasite *Plasmodium falciparum* (Pf) relies solely on the salvage pathway for its purine nucleotide requirements, making this pathway indispensable to it. Certain apicomplexan parasites, including Pf, have an inosine monophosphate (IMP)-specific-nucleotidase 1 (ISN1). Via comprehensive substrate screening, we have shown that PfISN1 catalyses the dephosphorylation of IMP and is allosterically activated by ATP. Crystal structures of tetrameric PfISN1 reveal complex rearrangements of domain organization tightly associated with catalysis. Immunofluorescence microscopy and expression of GFP-fused protein indicate the cytosolic localisation of PfISN1 and expression in the asexual and gametocyte stages of the parasite. With earlier evidence of ISN1 upregulation in female gametocytes, the structures reported in this study may contribute to initiating the design for possible transmission-blocking agents (Figure).



Interaction of the SNN109 in MjGATase and impact of its replacement with a prolyl residue on the thermostability (*Nat Commun.* 11: 3228. doi: 10.1038/s41467-020-17013-x).

References:

- *Biophys J.* In press. doi: 10.1101/2021.03.02.433506
- *Nat Commun.* 11: 3228. doi: 10.1038/s41467-020-17013-x

Other research activities during 2020–21:

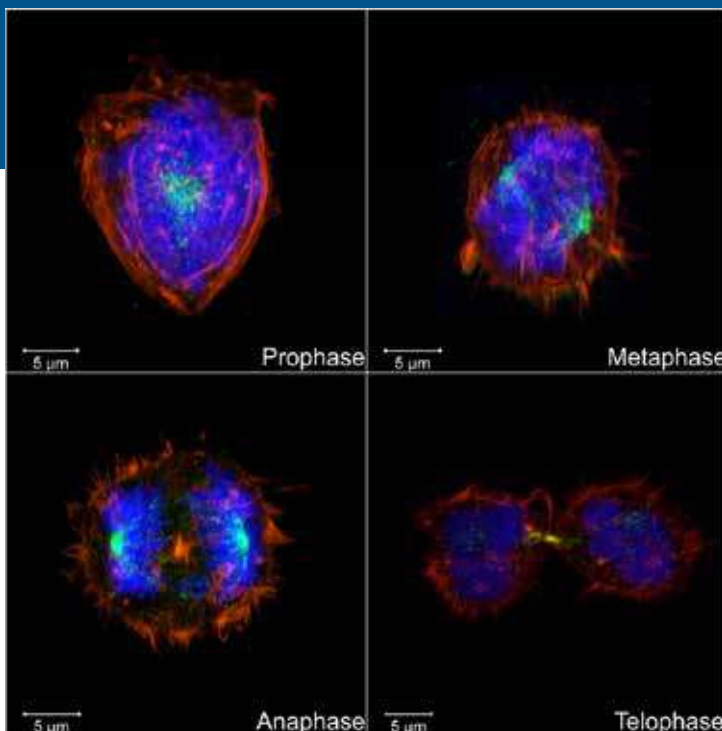
- *ACS Omega*. 5: 29667–29677. doi: 10.1021/acsomega.0c02402
- *Chembiochem*. 21: 2805–2817. doi: 10.1002/cbic.202000158

Major talk during 2020–21:

15 February 2021: National Level Lecture Workshop on frontiers in science and engineering by Women in Science.

Prof. Anuranjan Anand Ph.D., F.A.Sc., F.N.A, F.N.A.Sc., J. C. Bose National Fellow
Professor and Chair, NSU

Bipolar disorder (BPD) is a neuropsychiatric disorder with a complex pattern of inheritance. Although many genetic studies have been conducted on BPD, its genetic correlates remain uncertain. We have been focusing on identifying potential genetic causes of the disorder in an Indian family, who have been comprehensively evaluated clinically and have been under follow-up for over 12 years. We have analysed this four-generation family with several of its members diagnosed with BPD, employing a combination of genetic-linkage first and exome analysis later approach. Our findings suggest the involvement of rare variants of *KANK4* and/or *CAP2* in BPD in the family. Also, our ongoing work examining the *KANK4* protein expression at mitotic stages in cultured mammalian cells indicates that the protein localises to spindle poles and at the mid-body.



KANK4 protein localises to spindle and the midbody and exhibits punctate immunostaining along spindle fibres (*Bipolar Disord.* 22 (1): 70–78; doi: 10.1111/bdi.12815).

Reference:

Bipolar Disord. 22 (1): 70–78; doi: 10.1111/bdi.12815

Major talks during 2020–21:

December 2020: Talk and panel discussion “On Genetic Aspects of Hereditary Hearing Loss” at the Indian Speech and Hearing Association webinar meeting.

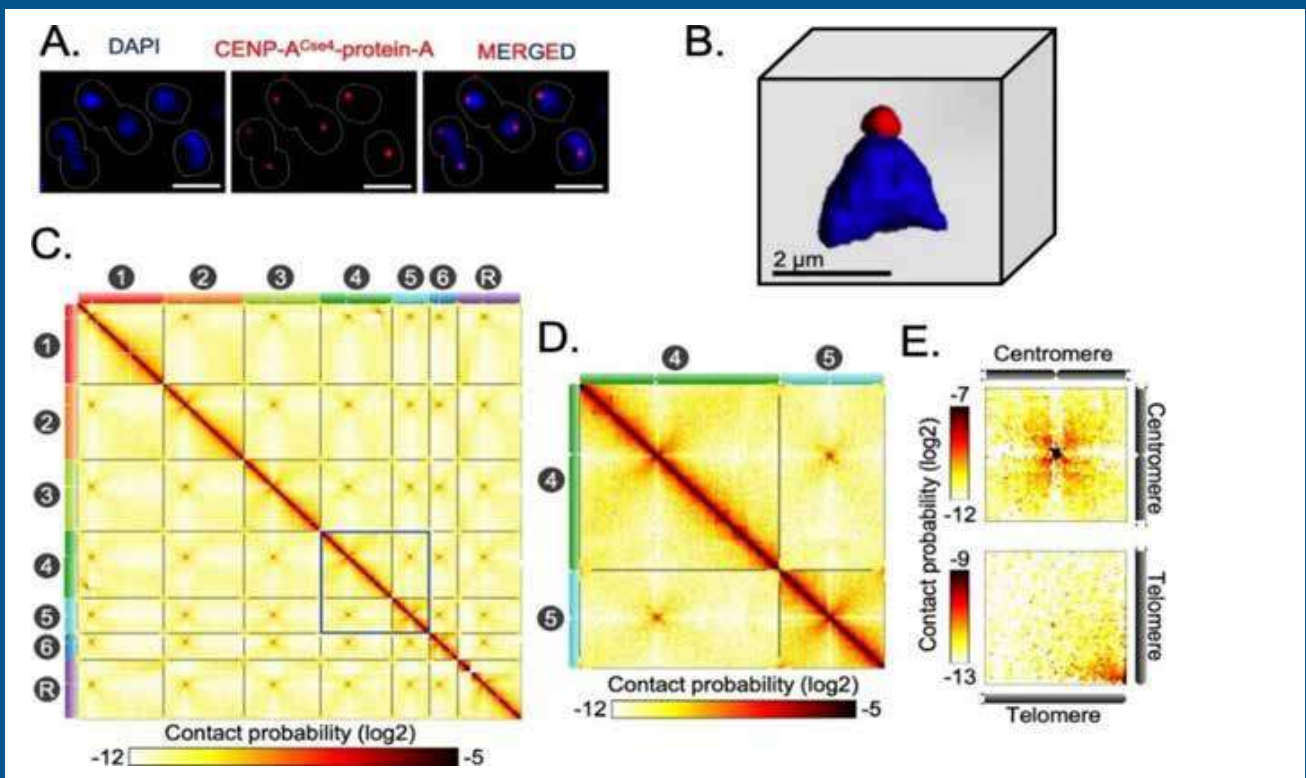
Prof. M. R. S. Rao Ph.D., F.A.Sc., F.N.A., F.N.A.Sc., F.A.M.S., F.T.W.A.S.
SERB YOS-Chair Professor

It has been well-established that long non-coding RNAs (lncRNAs) act as regulators and mediators of development and cell fate specification programs. In our study, we addressed the role of Mrhl in development and differentiation using mouse embryonic stem cells (mESCs) as our model. Mrhl is a nuclear-localised, chromatin-bound lncRNA with moderately stable expression in mESCs. Transcriptome analyses and loss-of-function phenotype studies revealed dysregulation of developmental processes, lineage-specific transcription factors, and key networks along with aberrance in the specification of early lineages during differentiation of mESCs.

Genome-wide chromatin occupancy studies suggest the regulation of chromatin architecture at key target loci through triplex formation. Recently, its human homolog, human mrhl (Hmrhl) was uncovered and studies revealed its differential expression in several types of cancers, notably in leukaemia. In this study, we further characterised the molecular features of lncRNA Hmrhl to gain insight into its functional role in leukaemia through gene silencing and transcriptome-based explorations. Results indicate its high expression in chronic myeloid leukaemia patient samples as well as in the K562 cell line. Silencing experiments suggested the role of Hmrhl in cell proliferation, migration and invasion in K562 cells. RNA-seq and ChiRP-seq data analyses further revealed its association with important biological processes, including the perturbed expression of crucial transcription factors and cancer-related genes. Among them, we identified *ZIC1*, *PDGFRβ*, and *TP53* as regulatory targets, with a high possibility of triplex formation by Hmrhl at their promoter site. In addition, we also found *TAL-1* to be a potential regulator of Hmrhl expression in K562 cells.

Prof. Kaustuv Sanyal Ph.D., J. C. Bose National Fellow, F.A.A.M, F.N.A., F.A.Sc., F.N.A.Sc.
Professor

Genomic rearrangements are often associated with the development of multiple diseases, including cancer. In our study, we investigated the mechanism of centromere type transition, improved the fragmented genome assembly and constructed a chromosome-level genome assembly of the fungus, *C. tropicalis*. We further analysed 3D genome organisation, which revealed spatial proximity among the centromeres as well as telomeres of seven chromosomes in *C. tropicalis*. We also provided the evidence of inter-centromeric translocations in the common ancestor of *C. albicans* and *C. tropicalis*. We observed the loss of ancestral histone regulator associated centromeres and the establishment of evolutionary new centromeres in *C. albicans* by identifying putative centromeres in other closely related fungi. We proposed that spatial proximity of the homologous centromere DNA sequences facilitates karyotype rearrangements and centromere type transitions in human pathogenic yeasts of the CUG-Ser1 clade.



Spatial genome organisation reveals centromere-centromere and telomere-telomere contacts in *C. tropicalis* (eLife. 9: e58556. doi: 10.7554/eLife.58556).

Reference:

eLife. 9: e58556. doi: 10.7554/eLife.58556

Other research activity during 2020–21:

<https://elifesciences.org/digests/53944/the-yeast-that-re-organized-its-chromosomes>

Prof. Ravi Manjithaya Ph.D.

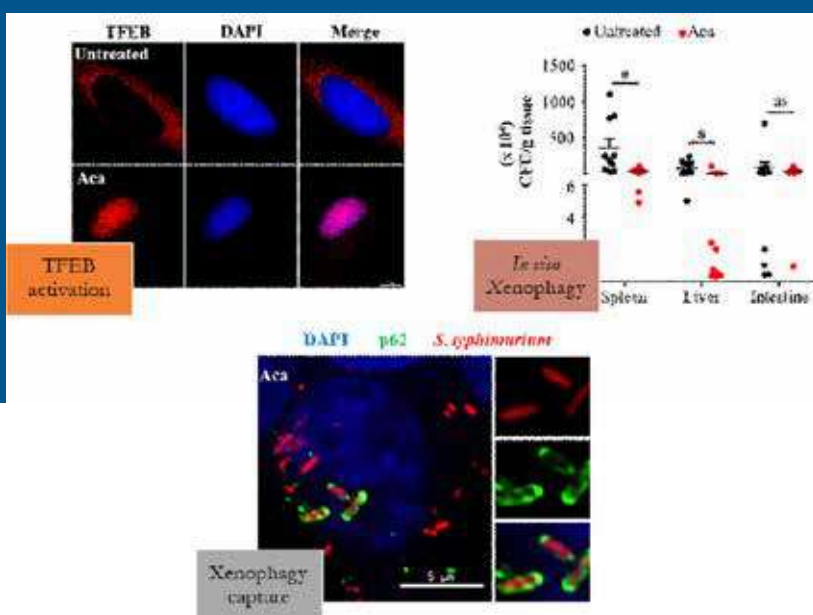
Associate Professor

Xenophagy (the autophagy of pathogens) is considered a host innate immune responses to intracellular pathogen invasion. Modulating xenophagy has proven beneficial to prevent pathogen replication and thereby ameliorate disease phenotype. However, pathogens have evolved ways to subvert xenophagy to facilitate their survival. Hence, restoration of the xenophagy block imposed by pathogens through genetic or pharmacological methods would enhance the clearance of intracellular pathogens and provide insights into host–pathogen mediated molecular events that control xenophagy.

Yeast-based high throughput screening performed previously in our laboratory has led to the identification of a number of autophagy inducers and inhibitors (Mishra *et al.*, Autophagy, 2017; Mishra *et al.*, Biochem Biophys Rep. 2017). We further screened the autophagy inducers to check

Prof. Ravi Manjithaya

for their ability to clear intracellular *Salmonella typhimurium*. Screening yielded a compound that showed more than a two-fold decrease in the intracellular pathogen burden. The identified compound has the following characteristics: i) it induces the host xenophagy process and does not directly affect the pathogen growth; ii) through post-transcriptional mechanisms, it enhances the recruitment of xenophagy mediators to efficiently capture the pathogen; iii) it acts through an autophagy and lysosomal biogenesis transcriptional master regulator, TFEB; iv) the activation of TFEB increases the active lysosomes in cells leading to enhanced fusion with Salmonella-containing vacuoles, thereby restricting its replication; and v) it is effective in an *in vivo* mouse model of bacterial infection. Additionally, we probed the interplay between xenophagy and other innate immunity pathways using microarray analysis. We then assessed the putative regulators revealed from the microarray analysis for their roles in modulating TFEB nuclear translocation and xenophagy mediated clearance. Based on this research, we have a patent pending for the use of acacetin in xenophagy-related therapeutic applications (Figure).



Xenophagy activation by autophagy inducer, acacetin. A. Microscopic analysis of the activation of transcription factor TFEB after acacetin treatment. B. Quantitative analysis of colony-forming units per gram of tissue in an *in vivo* mouse model of bacterial infection. C. Microscopic analysis of *S. typhimurium* capture by autophagy adaptor p62 after acacetin treatment (*Autophagy*. 16(9): 1584–1597. doi: 10.1080/15548627.2019.1689770).

Reference:

Autophagy. 16 (9): 1584–1597. doi: 10.1080/15548627.2019.1689770

Other research activities during 2020–21:

- *Semin Cancer Biol.* 66: 163–170. doi: 10.1016/j.semcancer.2020.02.015
- *J Cell Sci.* 134 (5): jcs240622. doi: 10.1242/jcs.240622
- *ACS Chem Biol.* 15 (4): 884–889. doi: 10.1021/acscchembio.0c00091

Media recognition:

“JNCASR scientists find a way to boost innate immunity against intracellular infection.” DST Vigyan Samachar, 30 January 2020. <https://vigyanprasar.gov.in/wp-content/uploads/JNCASR-scientists-find-a-way-to-boost-innate-immunity-against-intracellular-infection30Jan2020.pdf>

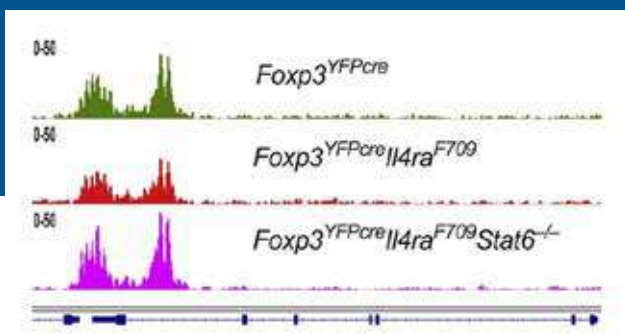
Dr. Kushagra Bansal Ph.D.

Faculty Fellow

Many immune cell types are known to produce TGF- β . However, the role of T regulatory (Treg) cell-intrinsic TGF- β is not clear. The results from a collaborative project with Prof. Talal Chatila's laboratory at the Children's hospital in Boston demonstrate that TGF- β is important for maintaining immunological tolerance.

In a mouse model of food allergy that has a gain-of-function mutation in the interleukin-4Ra chain gene (*Ii4ra*^{F709}), Treg cells have decreased access at the *Tgfb1* locus, which was reversed by the deletion of *Stat6*. These results are indicative of a decreased expression of TGF- β in Treg cells in food allergy. Furthermore, additional experiments demonstrated a dose-dependent role of Treg cell-derived TGF- β in regulating allergy and autoimmunity.

The research in our lab is also focused on understanding the molecular mechanisms of autoimmune regulator (Aire), a transcriptional regulator that controls the negative selection of self-reactive T cells in the thymus. Aire achieves this goal by inducing the expression of self-antigens in the thymus. Incidentally, Aire forms large aggregate-like assemblies visualized as speckles in nucleus. However, the significance of these structures of Aire is unknown. Our research, in collaboration with Prof. Sun Hur at Harvard Medical School, Boston, demonstrated that the CARD domain of Aire helps it in forming filamentous homo-multimers in vitro and this assembly is critical for Aire's transcriptional activity. However, this assembly also makes Aire susceptible to interaction with promyelocytic leukaemia (PML) bodies, the sites of protein quality control inside the nucleus. This study unraveled a new regulatory role of PML bodies in Aire function.



Genome browser view showing the ATAC-seq profile of the *Tgfb1* locus in Treg cells from the respective mouse strains (*Immunity*. 53 (6): 1202–1214.e6. doi: 10.1016/j.immuni.2020.10.002).

Reference:

Immunity. 53 (6): 1202–1214.e6. doi: 10.1016/j.immuni.2020.10.002

Other research activity during 2020–21:

Nat. Comm. 11: 1625. doi: 10.1038/s41467-020-15448-w

Major talk during 2020–21:

28 May 2021: Talk on “Molecular Mechanisms in the Immune System” at the Clevergene talk series, organized by Clevergene Biocorp Pvt. Ltd.

UNIT MEMBERS

Faculty Members

Professor and Chair	Prof. Maneesha S. Inamdar
Linus Pauling Research Professor	Prof. Hemalatha Balaram
Professors	Prof. Anuranjan Anand (Chair, NSU), Prof. Ranga Udaykumar, Prof. Tapas Kumar Kundu (on lien), Prof. Kaustuv Sanyal
Associate Professor	Prof. Ravi Manjithaya
Faculty Fellow	Dr. Kushagra Bansal
Honorary Professor and SERB-YOS Chair Professor	Prof. M. R. S. Rao
Distinguished Biotechnology Research Professor	Prof. Namita Surolia

Research Students

Ph.D.	Wulligundam Praveen, Arun Panchapakesan, Arindam Ray, Shrilaxmi V. Joshi, Asutosh B., Aditya Bhattacharya, Bhange Disha Ramesh, Ananya Ray, Sambhavi Puri, Moumita Basu, Nivedita Pandey, Priya Brahma, Preeti Jindal, Rajarshi Batabyal, Sreshtha Pal, Smitha A. S., Resmi Ravi, Anushka Chakravorty, Cuckoo Teresa Jetto, Kamat Kajal Murli, Anusha Chandrashekarmath, Kumari Ruchika Ranjan, Alice Sinha, Aarti Pant, Prerana M., Swarnima Mishra, Amit Kumar, Nazia, Ankita Chattopadhyay, Debapriya Ghosh, Priyamvada Rathaur, Buch Hrimakar Bhargav, Shobith Suresh
Int. Ph.D. (Biological Sciences)	Shveta Jaishankar, Pooja Barak, Arpitha A. Suryavanshi, Siddharth Singh, Pallabi Mustafi, Priya Jaitly, Bhavana Kayyar, Akash Kumar Singh, Polisetty V. S. Satya Dev, Chhavi Saini, Irine Maria Abraham, Rashi Aggarwal, Kuladeep Das, Ankit Sharma, Sharma Pragya Niraj, Dongre Prathamesh Rajesh, Jyotsna Karan, Akshaya C. Nambiar,

Karandeep Singh, Rohit Goyal, Harshdeep Kaur, Bhat Mallika Dattatray, Pallawi Choubey, Aishwarya Prakash, Srijana Dutta, Yashashwinee Rai, Harshit Arya, Vanshika Sood, Jayendra Singh, Amrutha A. S., Arghakusum Das, Deepam Bhattacharya, Vishal Rajesh Lolam, Ritoprova Sen, Souradip Mukherjee, Aman Sharma

Technical Staff

Technical Officer Gr II	Suma B. S.
Technical Assistant (Inst)	Mohan V.

Research Staff

SERB (TARE)	Dr. H. Dhanalakshmi
Women Scientist Scheme A	Dr. Shweta Panchal
DBT Research Associate	Dr. Keerti
DBT Research Associate I	Dr. Md. Hashim Reza, Dr. Sangeeta Dutta, Dr. Mukesh Kumar Chaurasia, Dr. Sreedevi P.
DBT Research Associate III	Dr. V. Shalini
Research Associates	Dr. Sundar Ram S., Dr. Gokulanth M., Dr. Ligy Thomas, Dr. Jayprakash Rao, Dr. Santosh Shivakumaraswamy, Dr. Rima Singha, Dr. Krishnendu Guin, Dr. Saloni Sinha
Research Associate I	Dr. Suchismita Dey
Research Associate II	Dr. Narendra Nala
Scientist B	Dr. Aswathy Narayanan
Senior Research Fellows	Kavita Mehta, Tejal R. Gujarathi, Asutosh B. R., Arpitha Suryavanshi, Diana Rodrigues, Dongre Aparna Vilas, Aksah Sam, Deepesh Panwar
Junior Research Fellows	Miti Mathur, Swati Singh, Tanya Pareek, Debadeep Chaudhury, Patel Tejas Mahendra, Ila Joshi, Wulligundam Praveen, Sajjan C. Achi, Tharun Selvam Mahendran, Haider Ali

R&D Assistants

Sameesh Ravindra Kher, Afzal Amanullah, Yuvrajsinh Gohil, Anish D'Silva, Anjhana C. R., Aishvaryaa Prabhu, Harshit Kumar Prajapati, T. Gokul Sriman, Kaushik V. Iyer, Girija J. Subodhi, Ashlesha Anand Gogate, Archit Singh, Vijeta Jaiswal

Project Assistants

Sukanya Majumdar, Vishnu V. Ashok, Dharaneeswar Reddy M.

Administrative Staff

For Animal Facility

Sr. Technical Officer (Animal Facility)

Prakash R. G.

Helpers (Animal Facility)

Ambarisha G., Muniraju M.

Helpers

Mune Gowda N., Chandrashekara H. C., Lakkappa G., Raju B. N.

Temporary Staff

Lab In-Charge

Ramesh G. R.

Lab Manager

Swathi L. R.

Trainee

Sahana Ravi

UNIT AT A GLANCE

Honours/Fellowships/Memberships Received



4

Faculty members

4

Student, alumnus, and research associate

Faculty Members

Prof. Anuranjan Anand and Prof. Kaustuv Sanyal

- Received the DST/ SERB J. C. Bose Fellowship 2020

Prof. Hemalatha Balaram

- Elected as Member, Selection Committee, G. N. Ramachandran Gold Medal, CSIR
- Elected as Co-convenor for life sciences joint CSIR-UGC NET, 2021
- Elected as Member, Committee for the Selection of Projects under the POWER scheme of SERB
- Elected as Member, Committee for the Selection of Projects under the SUPRA scheme of SERB
- Elected as a DST representative from the Autonomous Institutes for UNESCO related work to assist INCCU, 2021
- Elected as Member, Research Council, Central Leather Research Institute (CLRI), Chennai
- Elected as Member, Governing Council, Institution of Eminence, University of Hyderabad

Prof. Maneesha S. Inamdar

- Elected as a member of the Gene Therapy Advisory and Evaluation Committee, Indian Council for Medical Research
- Elected as Member Education, Engagement, and Empowerment (3E), working group to the WHO Expert Advisory Committee to develop global standards of governance and oversight of human genome editing
- Elected as a member of the Statement Working Group on Regenerative Medicine of the Inter-Academy Partnership
- Elected as Nominee of Secretary, DST, for the National Apex Committee on Stem Cell Research and Therapy
- Elected as Convenor of INSA-Bengaluru Chapter (2021–2024)

Prof. Ravi Manjithaya

- Received the S. Ramachandran National Bioscience Award for Career Development, 2020–21

Student, Alumnus, and Research Associate

Ms. Anushka Chakravorty (Ph.D. student; research supervisor: Prof. Ravi Manjithaya)

- Received the ALBA-FKNE-YIBRO diversity grant, funded by FENS Kavli, young IBRO and ALBA, to attend the FENS conference in 2020

Ms. Bhavana Kayyar (Int. Ph.D. student; research supervisor: Prof. M. R. S. Rao)

- Received an EMBO training Fellowship

Dr. K. N. Lakshmeesha (alumnus; research supervisor: Prof. Hemalatha Balaram)

- Received the INSA medal for young scientists, 2020

Dr. Sangeeta Dutta (DBT-Research Associate I; research Supervisor: Prof. M. R. S. Rao)

- Received the AWSAR award of DST on 28 February on the occasion of National Science Day

Total Publications



29

Peer reviewed articles indexed in Web of Science

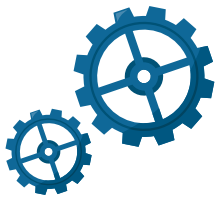
Sponsored Projects



New projects

4

₹ 1.52 cr.



Ongoing projects

34

₹ 5.24 cr.

Students Graduated During 2020–21



14

Ph.D.

- Barve Gaurav Ramanand
- Iyer Aditya Mahadevan
- Palak Agrawal
- Suchismita Dey
- Krishnendu Guin
- Sunaina Singh Rajput
- Lakshmeesha K. N.
- Saloni Sinha
- Shreyas Sridhar
- Somya Vats
- S. Sundar Ram
- T. Lakshmi Prasoon
- Rima Singha
- Veena A.

7

M.S.

- Ranabir Chakraborty
- Sharma Pragya Niraj
- Dongre Prathamesh Rajesh
- Jyotsna Karan
- Padmalaya
- Rahul Madaan
- Akshaya C. Nambiar

Students Admitted During 2020–21



4

Ph.D.

- Debapriya Ghosh
- Priyamvada Rathaur
- Buch Hrimkar Bhargav
- Shobith Suresh

5

Int. Ph.D.
(Biological
Sciences)

- Deepam Bhattacharya
- Vishal Rajesh Lolam
- Ritoprova Sen
- Souradip Mukherjee
- Aman Sharma

NEW CHEMISTRY UNIT (NCU)



NCU has been created by JNCASR as part of the 11th Five Year Plan. At the Unit, we work on interdisciplinary aspects of chemical science. The actively pursued areas are chemical biology, chemical science and materials science, especially the chemistry of carbon nanostructures. Our projects usually involve the development of new strategies for the synthesis of solid-state materials that address contemporary energy and environmental concerns. At NCU, we synthesise a host of organic and inorganic multi-dimensional nanomaterials with an aim to understand their electronic structure for their application in magnetic, optical and electrical devices.

Renewable energy research, development of materials for thermoelectrics, photovoltaics, lasers and organic synthesis of polymers, hybrid materials, supramolecules and multi-functional metal-organic frames are some of the major research activities carried out at NCU. We also look into the synthesis of peptide/protein-based materials and programmable DNA based materials for biomaterial and therapeutic applications. For complete characterisation and analysis of the materials pursued in the laboratories, we have curated a wide range of advanced equipment. At NCU, we often collaborate with various national and international research centres for the exchange of resources and knowledge.

Further, the microscopic understanding of exotic phenomena is an area of interest for the theoretical group. At NCU, this group of researchers has developed novel methods to study concepts such as quantum magnetism, charge transfer and electrical transport phenomena, new carbon systems and cold atom phenomena. The Unit also houses excellent facilities for computational and theoretical studies to complement the experimental research.

RESEARCH AREAS

- Thermoelectric and nanoplasmonic materials
- Catalysis and fuel cells
- Carbon dioxide reduction
- Solid state chemistry
- Study of electronic and optical properties
- Energy materials
- Supramolecular chemistry and organic materials
- Atomic and pulsed laser deposition
- Circularly polarised luminescent materials
- Molecular architectonics
- Functional and disease amyloids
- Neurodegenerative disorders
- Diagnostic therapy (theranostics)
- Silk-inspired and cyclic dipeptide based biomimetics and biomaterials
- Bioorganic chemistry
- Understanding conformational properties and $n \rightarrow \pi^*$ interactions

RESEARCH HIGHLIGHTS

- Molecular dynamics simulations were used to realise kinetic and thermodynamically controlled approaches for designing axial organic heterostructures via the supramolecular block co-polymerisation of opto-electronically active organic semiconducting monomers.
- Layered nanocomposites of polymer-functionalised reduced graphene oxide and borocarbonitride with MoS₂ and MoSe₂ showed excellent activity for the hydrogen evolution reaction.
- A novel drug candidate (TGR63; now being considered for clinical studies) for the treatment of Alzheimer's disease via the significant reduction of amyloid burden and reversal of cognitive decline (mouse model) was discovered.
- Various heterocyclic motifs were constructed based on transition metal-free electron catalyzed C-heteroatom bond formation reactions.
- One-step curable covalent coatings were developed with antimicrobial activity against bacteria, fungi, and the influenza virus.
- First-principles density functional theory analysis was used to understand the thermoelectric properties and thermal conductivity of crystalline solids.
- Integrated technologies were developed to capture and convert anthropogenic CO₂ into industrially relevant value-added chemicals and fuels.
- A new way of harvesting delayed fluorescence in perovskite nanocrystals using spin forbidden manganese *d* states was discovered.
- A novel biodegradable polymer was developed with potential applications in the biomedical industry as a replacement for BPA-based plastics.
- A combination of experimental and theoretical methods revealed that $nN \rightarrow \pi^*Ar$ interactions play important roles in stabilizing the most stable conformers of N-acyl- and N,N'-diacylhydrazines.
- High-performance NASICON-Na_xV(Mn/Mg/Al)(PO₄)₃ cathodes were developed for sodium ion batteries.
- A distinct approach was developed to selectively barcode cells by spatially controlling the positioning of fluorescent labels using light.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

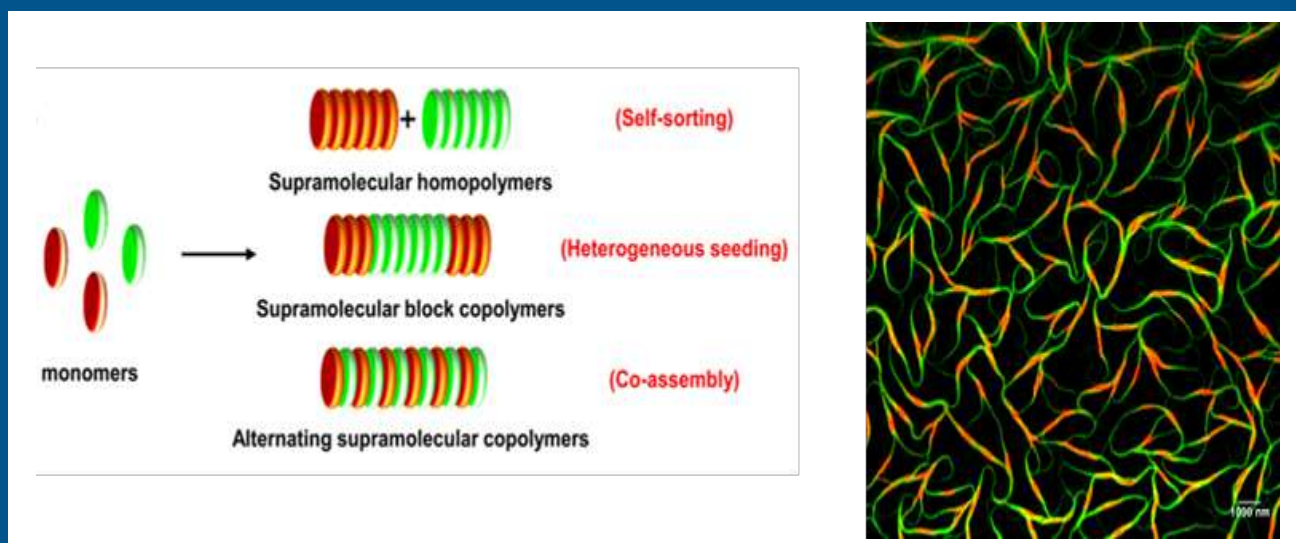
Prof. Subi Jacob George Ph.D., F.A.Sc., F.R.S.C.

Professor and Chair, NCU

Multicomponent supramolecular copolymerisation gives rise to complex nanostructures with emergent properties. Predicting the structures of copolymers even with two monomeric components is a highly challenging task due to the possibility of various outcomes that are determined by the intermolecular interactions and monomer exchange dynamics. In our study, we targeted this challenge and demonstrated unprecedented two-component sequence-controlled supramolecular copolymerisation. This was achieved by manipulating the thermodynamic and kinetic routes in the pathways of monomer self-assembly. We used molecular dynamics simulations as a tool to analyse the mechanistic properties of monomer exchange rates and the free energy of interactions between the monomers that dictate the self-assembly pathway and sequence. We utilised the fluorescent nature of core-substituted naphthalene di-imide monomers to characterise the sequences via structured illumination microscopy.

Reference:

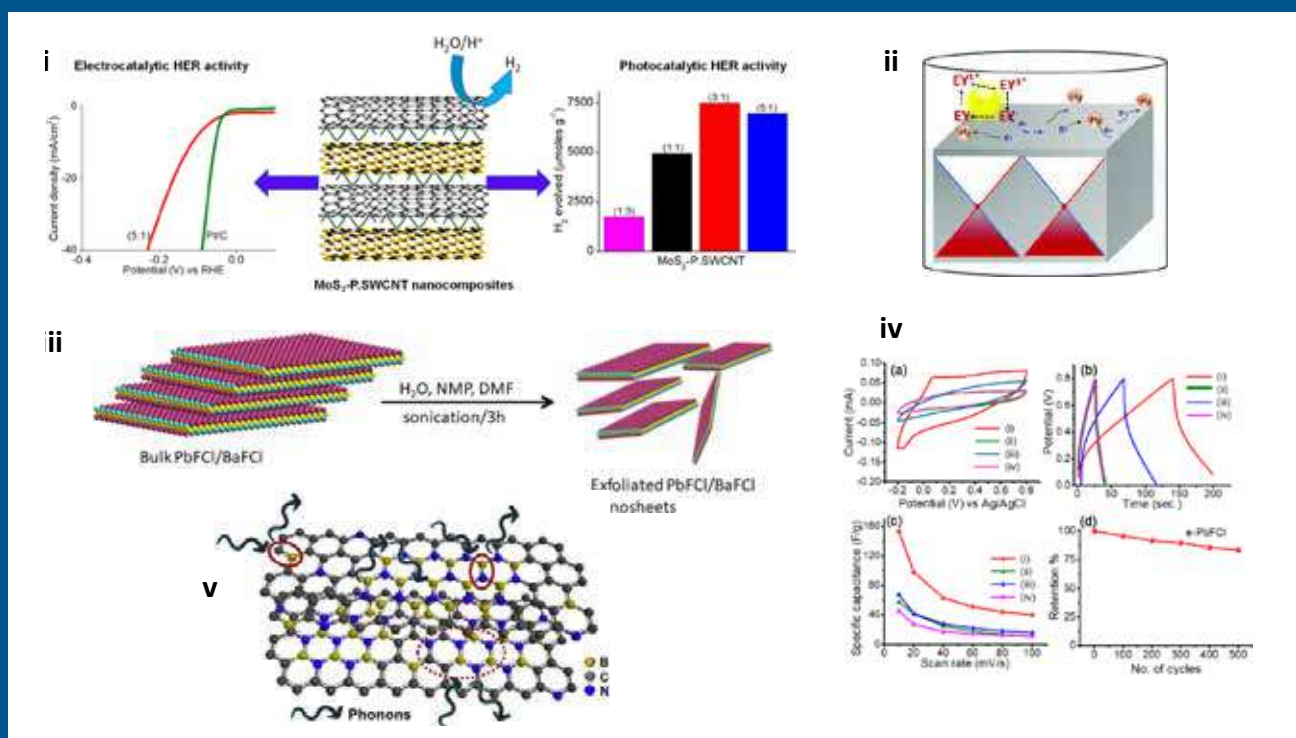
J. Am. Chem. Soc. 142: 7606–7617. doi: 10.1021/jacs.0c01822



Kinetic and thermodynamically controlled approaches for the design of axial organic heterostructures, via the supramolecular block co-polymerisation of opto-electronically active organic semiconducting monomers (*J. Am. Chem. Soc.* 142: 7606–7617. doi: 10.1021/jacs.0c01822).

Bharat Ratna Prof. C.N.R. Rao F.R.S.
Honorary President, Linus Pauling Research Professor

Water splitting reactions by photo- and electro-chemical means is an important area of research related to renewable energy. In this context, we have studied nanocomposites of (i) MoS₂ nanotubes with single-walled carbon nanotubes and borocarbonitride (BCN) nanotubes, (ii) nanocomposites of phosphorene–MoS₂/MoSe₂, RGO or BCN with MoS₂ and MoSe₂ and (iii) exfoliated solid solutions of MoS_xSe_{2(2-x)}/MoSe_xTe_{2(2-x)}. We have investigated new classes of 2D materials like PbFCl, BaFCl and metal phosphochalcogenides (MPX₃) for their supercapacitor and photocatalytic water splitting properties, respectively. We have also designed a chemical route to synthesise twisted graphene, graphene oxide and boron nitride. We have studied the variations in electronic and optical properties of CdPS₃ and its superior photo(electro)chemical hydrogen evolution reaction (HER) activity. We have also investigated the selective fabrication of β-phase NiS and VO_x thin films and crystalline epitaxial ultrathin films of NiO via the atomic layer deposition (ALD) technique, performed their detailed characterisation and conducted an ALD parameter-dependent study.



(i) Nanocomposites of MoS₂ nanotubes with single-walled carbon nanotubes and borocarbonitride nanotubes; their photocatalytic and electrocatalytic HER activities. (ii) Enhancement of the HER catalytic activity of non-magnetic Weyl semimetals of the NbP family upon the application of a magnetic field. (iii) Schematic representation of the exfoliation of PbFCl and BaFCl with various molecules and (iv) their electrochemical supercapacitor studies. (v) Schematic representation of the low thermal conductivity of BCN nanosheets due to significant phonon scattering from the different length scale hierarchical nano/meso architectures (*ACS Appl. Nano. Mater.* 3 (2): 1792–1799. doi: 10.1021/acsnm.9b02482).

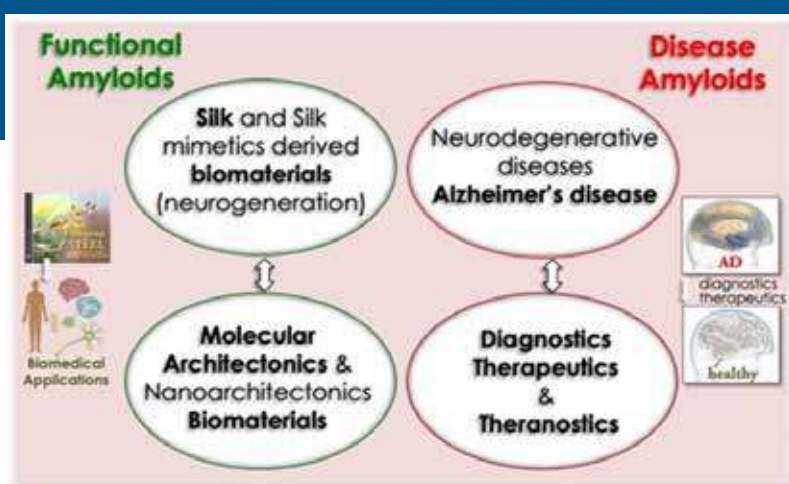
Reference:

ACS Appl. Nano. Mater. 3 (2): 1792–1799. doi: 10.1021/acsnm.9b02482

Prof. Govindaraju T. Ph.D.

Professor and Chair, Education Technology Unit

Our research interests are at the interface of chemistry, biology and biomaterials science focused on the chemical biology of 'functional and disease amyloids'. Our group is effectively using tools from organic synthesis, biophysics, chemistry and chemical biology to tackle two classes of challenging problems currently relevant to human health and society: i) disease amyloids, where our work has led to development of novel diagnostics for Alzheimer's disease (AD) and a novel drug candidate molecule (TGR63; now been taken up for clinical studies by a pharmaceutical company), which can significantly reduce the amyloid burden in the AD brain and reverse cognitive decline in animal models; ii) functional amyloids, where our work has led to development of silk-derived formulations for sustained in vivo insulin delivery, diabetic wound healing, and skeletal muscles and neuronal tissue engineering, a value addition to the sericulture industry and farmers. This work further inspired the concept of molecular architectonics, which integrates the realms of molecules and derived nanoscale molecular architectures into functional biomaterials.



Flowchart depicting the uses of research on amyloids (*Adv. Therap.* 4 (4): 2000225. doi: 10.1002/adtp.202000225).

Reference:

Adv. Therap. 4 (4): 2000225. doi: 10.1002/adtp.202000225

Major talks during 2020–21:

- 25 May 2020: Talk on "Alzheimer's is a Multifactorial Disease" at ChemBiosis2020, organized by IISER Tirupati.
- 24 July 2020: Talk on "Why Alzheimer's is a Tough Disease to Crack?" at the ACS Science Talks: Virtual Lecture Series.
- 4–5 September 2020: Talk on "Functional Molecule Templated DNA Molecular Architectonics" at the First DNA Nanotechnology India Virtual Symposium, organized by IIT Gandhinagar.
- 18 September 2020: Talk on "Alzheimer's is a Multifactorial Disease" at IIT Gandhinagar.
- October 2020: Panelist and speaker at a Webinar Session on Drug Discovery, Repurposing, and Drug Delivery at the Vaibhav Summit, Government of India, under the Aatma Nirbhar Bharat initiative.
- 24–26 March 2021: Talk on "Peptidomimetic Inhibitors of Multifaceted Toxicity in Alzheimer's Disease" at the 8th Indian Peptide Symposium, IISc, Bengaluru.

- 18–20 May 2021: Talk on “Small Molecule Ameliorates Amyloid Burden and Cognitive Decline in AD Mouse Model” at the First Commonwealth Chemistry Conference 2021, (London, Virtual), organized by Commonwealth Chemistry, Federation of Chemical Sciences Societies.

Prof. H. Ila Ph.D., F.N.A., F.A.Sc.

Hindustan Lever Research Professor

Our research activities presently focus on using readily accessible precursors, particularly sulfur-containing building blocks, to design and develop novel and innovative methods for synthesising biologically important substituted and condensed five- and six-membered heterocycles. We aim to develop greener methods, a pot economy, shorter routes involving domino reactions and multicomponent techniques for the synthesis of these target heterocyclic compounds. Previously, we focused on the transition metal catalysed coupling reaction (using Pd and Cu) and $-CH$ activation for the construction of C-heteroatom bonds. Recently, we have developed transition-metal-free coupling reactions, proceeding through electron catalysed reactions via single electron transfer mechanisms.

Major talks during 2020–21:

- 5 November 2020: Plenary lecture in symposium Women Scientists in Chemical Sciences, at the CRSI local meeting at North Bengal University, North Bengal.
- 26 November 2020: Invited lecture at the Annual faculty Meeting, JNCASR, Bengaluru.
- 10 November 2020: Invited lecture at the Women in STEM: Academia to Industry symposium, University Faculty Association, Institute of Chemical Technology, Mumbai.
- 28 December 2020: Invited Plenary lecture at the symposium Recent trends in Chemical Sciences (RTCS), Chemists Convention at IISER Kolkata, Kolkata.

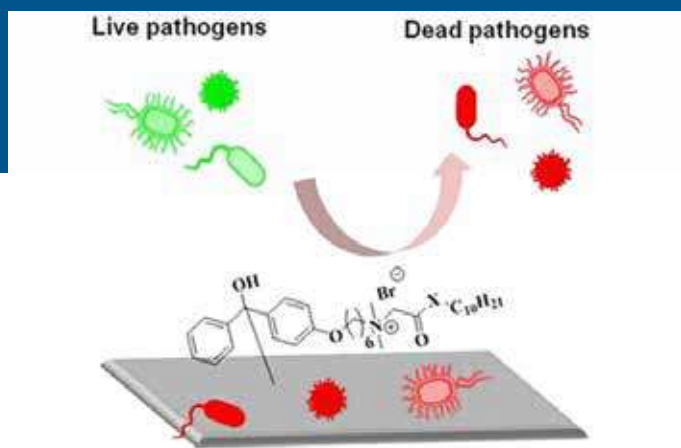
Prof. Jayanta Haldar Ph.D.

Associate Professor

Global health is plagued by the emergence of difficult to treat infections, and antimicrobial resistance (AMR) is adding to the problem. AMR claims around 0.7 million lives annually, and if no intervention is found, this number might rise to 10 million by 2050. Our lab works towards understanding antimicrobial resistance and countering it via the development of new therapeutic options, strategies, and biomaterials. We have contributed to the field of novel antibacterial agents through the development of new amphiphilic, membrane-targeting agents which destabilise the bacterial membrane, interact with the bacterial cell wall and selectively kill bacteria. In light of the recent COVID-19 pandemic, a part of our research was dedicated to the development of extremely effective antimicrobial surface coatings that can be applied to a variety of surfaces such as cotton, plastic, etc. to render them antimicrobial, antifungal as well as antiviral. Another major aspect of our work involves restoring the activity of certain blockbuster drugs against resistant superbugs. Our designs and technologies have taken shape in the form of several national and international patents.

Contd. from pg. 111

Prof. Jayanta Haldar



Antimicrobial surface. Its properties are: easy synthesis; covalently coated from water and organo-solution; and complete killing of bacteria, fungi, and viruses (*J. ACS Appl. Mater. Interfaces* 12 (25): 27853–27865. doi: 10.1021/acsami.9b22610).

Reference:

J. ACS Appl. Mater. Interfaces 12 (25): 27853–27865. doi: 10.1021/acsami.9b22610

Other research activity during 2020–21:

J. ACS Chem. Biol. 15 (4) 884–889. doi: 10.1021/acscchembio.0c00091

Prof. Kanishka Biswas Ph.D., F.R.S.C.

Associate Professor

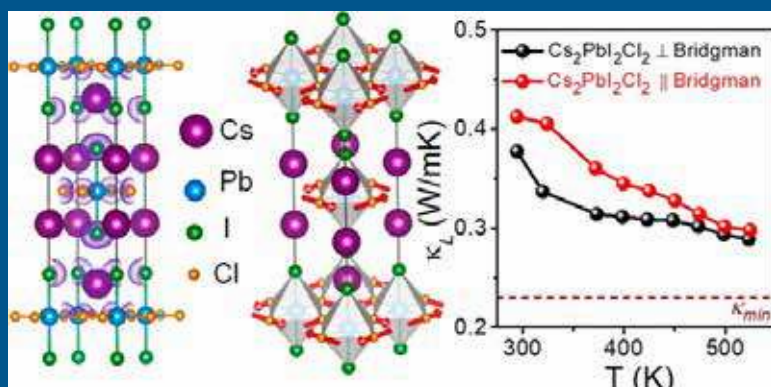
Our research aims to understand the correlation between chemical bonding and lattice dynamics in intrinsically low thermal conductive crystalline solids, which can be used in thermoelectrics, thermal barrier coating and photovoltaics. We discovered that a single crystal of the all-inorganic layered Ruddlesden–Popper (RP) perovskite $\text{Cs}_2\text{PbI}_2\text{Cl}_2$, synthesised using the Bridgman method, exhibited intrinsically ultralow lattice thermal conductivity. To uncover the presence of soft optical phonon modes, we conducted the first-principles density functional theory analysis of the phonon spectrum. The study also provided experimental evidence for low-energy optical phonon modes with low-temperature heat capacity and temperature-dependent Raman spectroscopic measurements. All our measurements and analyses led to the conclusion that the intrinsically ultralow lattice thermal conductivity in a single crystal of the all-inorganic layered RP perovskite $\text{Cs}_2\text{PbI}_2\text{Cl}_2$ is due to the combined effect of a soft elastic layered structure, an abundance of low energy optical phonons and a strong acoustic–optical phonon coupling.

Reference:

J. Am. Chem. Soc. 142: 36. 15595–15603. doi : 10.1021/jacs.0c08044

Other research activity during 2020–21:

J. Am. Chem. Soc. 142: 28. 12237–12244. doi: 10.1021/jacs.0c03696



The intrinsically ultralow lattice thermal conductivity in a single crystal of the all-inorganic layered Ruddlesden–Popper (RP) perovskite $\text{Cs}_2\text{PbI}_2\text{Cl}_2$ is due to the combined effect of a soft elastic layered structure, an abundance of low energy optical phonons, and a strong acoustic–optical phonon coupling (*J. Am. Chem. Soc.* 142: 36. 15595–15603. doi : 10.1021/jacs.0c08044).

Major talks during 2020–21:

- June 2020: Talk on “Ultra-Low Thermal Conductive Metal Chalcogenides for High Performance Thermoelectric Energy Conversion” at the ACS Science Talk organized by the American Chemical Society
- September 2020: Talk on “Special Lecture: Crystalline Solids with Intrinsically Low Lattice Thermal Conductivity for Thermoelectric Energy Conversion” at the TIFR Colloquium organized by the Tata Institute of Fundamental Research, Mumbai, India.
- October 2020: Talk on “Advanced Energy Materials Based on Solid State Metal Chalcogenides and Halides” at the Vaibhav Summit.
- October 2020: Talk on “Crystalline Solids with Intrinsically Low Thermal Conductivity for Thermoelectric Energy Conversion”, organized by NIT Manipur, India.
- October 2020: Talk on “Ultra-Low Thermal Conductivity in Crystalline Solids for Thermoelectric Energy Conversion” at the Asian Chemical Editorial Society (ACES) and the Chemical Research Society of India (CRSI) Virtual Symposium, organized by ACES and CSRI.

Events organised during 2020–21:

20 July 2021: Virtual Conference on Thermoelectrics (VCT2021), organized by the International Thermoelectric Society.

Prof. Sebastian Chirambatte Peter Ph.D.

Associate Professor

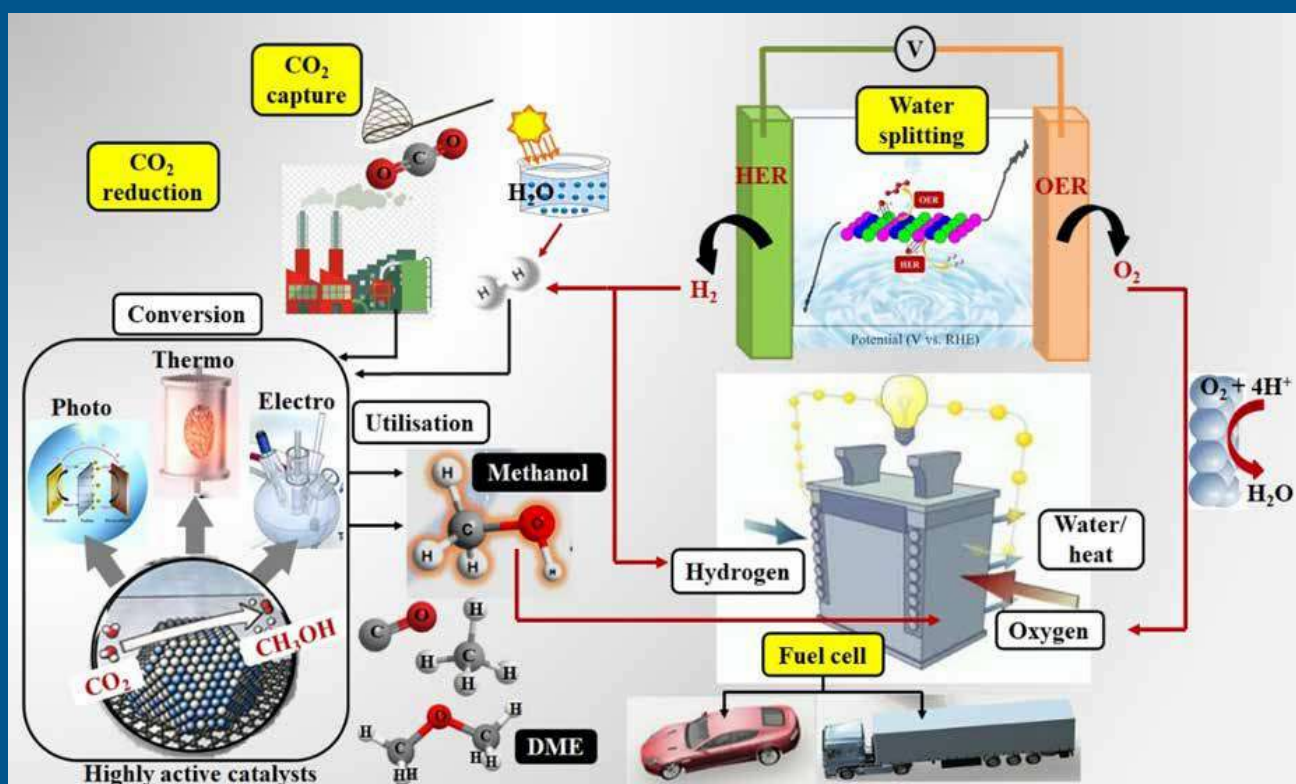
We have strategically designed materials in various forms (metals, bimetallics, alloys, intermetallics, core shell, etc.) and studied their efficiency for the photochemical, electrochemical and heterogeneous conversion of CO_2 into fuel and other chemicals. Through detailed electronic structure calculations, we have understood the reaction mechanisms and kinetics. Our materials and methods are expected to have the potential to convert waste CO_2 into gasoline, diesel fuel, jet fuel, and industrial chemicals. During the course of our research, we have scaled up technology for the conversion of CO_2 into methanol to a capacity of 300 kg CO_2 /day, which is a first in India. Various national and international teams (Shell, BPCL, 350 Solutions, and Southern Research) have

Prof. Sebastian Chirambatte Peter

evaluated the technology, and the University of Calgary has conducted the life cycle analysis, going on to endorse it as carbon negative technology.

We have also made some strides in water splitting technology. We can generate hydrogen in a water electrolyzer consisting of a hydrogen evolution reaction (HER) cathode and an oxygen evolution reaction (OER) anode. The current benchmark electrolyzer utilizes platinum (Pt)-based cathode and RuO₂/IrO₂ anodes to expedite HER and OER respectively. Using various synthetic strategies and concepts including alloying, inverse strain effect, dealloying, multiphase tuning, etc., our group developed a series of efficient catalysts for water splitting and hydrogen generation.

Our group has also developed non-Pt based materials as anode and cathode materials for proton exchange membrane fuel cell applications. Tuning lattice strain, single atom design, alloying and ordering are a few concepts proposed, and a couple of promised materials have been tested for full cell operation.



Schematic of overall research activities.

References:

- *ACS Appl. Energy Mater.* 3 (2): 1271–1278. doi: 10.1021/acsaem.9b02097
- *ACS Appl. Energy Mater.* 3 (4): 4051–4056. doi: 10.1021/acsaem.0c00512
- *ChemSusChem*. Early View. doi: 10.1002/cssc.202100967
- *ACS Catal.* 11 (2): 800–808. doi: 10.1021/acscatal.0c03415
- *J. Mater. Chem. A.* 9: 5164–5196. doi: 10.1039/D0TA12063D
- *Chem Commun.* 57: 1951–1954. doi: 10.1039/D0CC08225B

Major talks during 2020–21:

- August 2020: Plenary talk on “The Boon of CO₂ Carbon Negative Approach” at a Webinar on Catalysis from Life to Livelihood, organised by the Ramanujan Institute for Basic Sciences, Kerala State Council for Science, Technology and Environment, Government of Kerala.
- October 2020: Talk on “Catalysis in Energy and Environment Fuel Cell, Water Splitting and CO₂ Capture and Utilization” at the Vaibhav Summit organised by the Department of Science and Technology.
- February 2021: Talk on “Journey of Breathe in translating Economical de-Carbonization from Science to Technology” at the National Science Day programme organised by JNCASR and the Department of Science and Technology.
- March 2021: Talk on “Operando Generated Materials as an Efficient Catalyst for the Selective Conversion of CO₂ to Methanol” on the Material Chemistry Annual Day organised by the Indian Association for the Cultivation of Science, Kolkata.

Event organized during 2020–21:

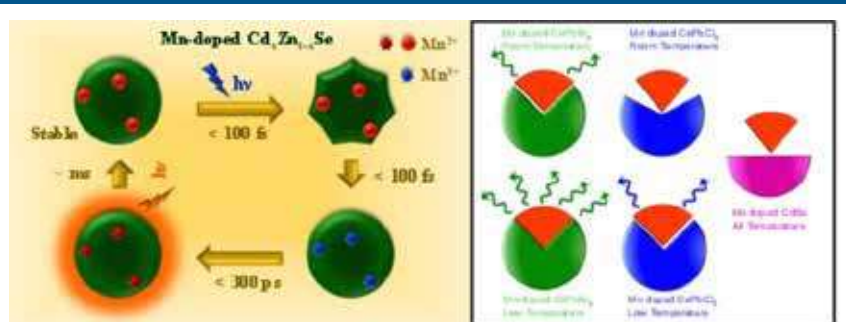
February 2021: Organiser and session chair of the Indo German Frontiers of Engineering Meeting (INDOGFOE 2020) in association with the Humboldt Foundation.

Prof. Ranjani Viswanatha Ph.D.

Associate Professor, ICMS

The introduction of dopants into nanomaterials still surprises researchers with new functionalities based on their interaction with the host materials. In our studies, we found several new properties, namely vibrationally assisted delayed fluorescence, the magneto-optical Stark effect, magnetically driven cooperative behaviour in doubly doped nanocrystals with a non-magnetic host, and several others. We also addressed some unsolved debates on the mechanism of emission in doped nanocrystals. These new interactions open up new avenues to address challenges in nanomaterial applications.

Prof. Ranjani Viswanatha



Mechanism of Mn emission

Spin Orbit Coupling in Nanocrystals

(Left) Delayed fluorescence in Mn-doped nanocrystals. (Right) Spin orbit coupling in Mn-based doubly-doped nanocrystals.

Major talks during 2020–21:

- ECS Webinar Series
- Chair at the Indian delegation for BRICS Photonics working group meeting

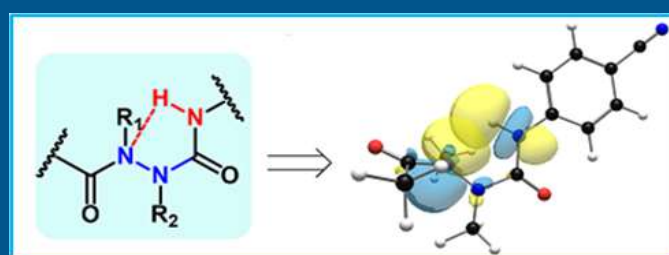
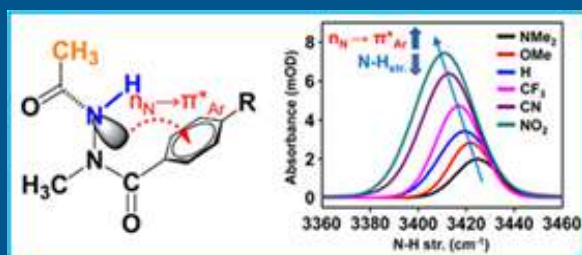
Dr. Bani Kanta Sarma Ph.D.

Faculty Fellow

We studied the conformational properties of mono- and diacylhydrazines as well as structurally related azapeptides. We discovered that noncovalent carbon bonding interactions can affect the conformational properties of N-methyl-N,N'-diacylhydrazines. We also discovered unusual nN(amide) \rightarrow π^* Ar interactions that can affect the conformational properties of N,N'-diacylhydrazines. Subsequently, we discovered that nN \rightarrow π^* Ar interactions play a crucial role in stabilizing the E-ac (cis) amide bond conformation of arylhydrazides. Interestingly, when a leaving group (F) was present in the ortho-position of the carbonyl group of acylhydrazides, the n-N \rightarrow π^* Ar interaction facilitated an SNAr reaction to produce indazolone, an important heterocycle with numerous biological activities. Finally, we also discovered a previously unexplored unusual N(amide)...HN(amide) hydrogen bond that stabilizes azapeptide molecules.

References:

- *Org. Lett.* 23 (13): 4949–4954. doi: 10.1021/acs.orglett.1c01111
- *Org. Lett.* 10.1021/acs.orglett.1c00834
- *Phys. Chem. Chem. Phys.* 22: 26669–26681. doi: 10.1039/DOCP03557B
- *Chem. Commun.* 56: 4874–4877. doi: 10.1039/DOCC00943A
- *J. Org. Chem.* 85: 2927–2937. doi: 10.1021/acs.joc.9b02083



(Left) $n_{\text{N}}(\text{amide}) \rightarrow \pi^*_{\text{Ar}}$ interactions in N,N'-diacylhydrazines.

(Right) N(amide)...N(amide) hydrogen bond in azapeptides (*Org. Lett.* 23 (13): 4949–4954. doi:10.1021/acs.orglett.1c01111 and *Org. Lett.* 10.1021/acs.orglett.1c00834)

Major talks during 2020–21:

- 9 January 2020: Talk on “Carbonyl-carbonyl $n\text{N} \rightarrow \pi^*$ and $n\text{N}(\text{amide}) \rightarrow \pi^*/\sigma^*$ Interactions in Small Molecules, Peptides and Peptidomimetics” in the Workshop on Hydrogen Bonding (One Hundred Years of Hydrogen Bonding) at IISc Bengaluru.
- 27 November 2020: Talk on “Understanding the Conformational Properties of Aza-peptidomimetics” at the Annual Faculty Meeting and In-House Symposium JNCASR 2020 held at JNCASR.
- 25 March 2021: Talk on “Understanding the Conformational Properties of Aza-peptidomimetics” in the 8th Indian Peptide Symposium, 2021 (IPS-2021) organized by IISc.

Dr. Premkumar Senguttuvan Ph.D.

Faculty Fellow (jointly with ICMS)

See pg. 86 for research activities

Dr. Sarit S. Agasti Ph.D.

Faculty Fellow (jointly with CPMU)

See pg. 53 for research activities

UNIT MEMBERS

Faculty Members

Professor and Chair	Prof. Subi Jacob George
Linus Pauling Research Professor	Prof. C. N. R. Rao
Hindustan Lever Research Professor	Prof. H. Ila
Professor	Prof. Govindaraju T.
Associate Professors	Prof. Jayanta Haldar, Prof. Sebastian Chirambatte Peter, Prof. Kanishka Biswas
Faculty Fellows	Dr. Bani Kanta Sarma, Dr. Sarit S. Agasti (jointly with CPMU), Dr. Premkumar Senguttuvan (jointly with ICMS)

Associate Faculty

- Prof. Sundaresan A.** (Professor and Chair, CPMU)
- Prof. Tapas Kumar Maji** (Professor, CPMU)
- Prof. Sridhar Rajaram** (Associate Professor, ICMS)
- Prof. Ranjani Viswanatha** (Associate Professor, ICMS)
- Prof. Swapan K. Pati** (Professor and Chair, TSU)

Research Students

Ph.D.	Ramesh M. S., Swagatam Barman, Ranjan Sasmal, Anusha S. Avadhani, Debasis Ghosh, Brinta Bhattacharjee, Arjun C. H., Arka Som, Sumon Pratihar, Biswanath Maity, Mohd Monis Ayyub, Yogendra Kumar, Subham Ghosh, Payel Mondal, Moinak Dutta, Swadhin Garain, Rajib Dey, Souvik Sarkar, Saptarshi Chakraborty, Risov Das, Ahuja Vinita Ashok Kumar, Madhu R., Mary Antony P., Robi Sankar Patra, Debabrata Bagchi, Paribesh Acharyya, Bitan Ray, Debattam Sarkar, Angshuman Das, Prasenjit Mandal, Ashish Kumar, Devender Goud G., Animesh Bhui, Dikshaa Padhi , Hariharan M., Soumi Mondal,
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Satyajit Patra, Arindam Ghosh, Devesh Chandra Binwal, Sabyasachi Mandal, Acharya Yash Sanjay, Anustoop Das, Anju A. K., Saikat Ghosh, Subhajit Chakraborty, Gauttam Dash, Bhaskar Kakoty, Debajit Kalita, Paramesh Das, Biplab Patra, Rohit, Subham Das

Int. Ph.D. (Chemical Sciences)

Paramita Sarkar, Mahima Makkar, Suchi Smita Biswas, Ekashmi Rathore, Madhulika Mazumder, Sreyan Ghosh, Manaswee Barua, Sushmita Chandra, Geetika Dhanda, Sudip Mukherjee, Reetendra Singh, Adrija Ghosh, Aditi Saraswat, Akshay Saroha, Darshana Deb, Riddhimoy Pathak, Mohd Arif, Tarak Nath Das, Animesh Das, Ivy Maria, Prabhat Thapliyal, Sayan Chakravarty, Surya Pravo Mookerjee, Ritika Raghuvanshi, Arghya Ghosh, Vandana Kushwaha

M.Sc. (Chemistry)

Anustup Mukherjee, Aditya Bhardwaj, Amit Choshal, Naral Vinay Srinivas, Daizy Kalita, Anupama Ghata, Dharshini Raghavan, Chahat, Kulkarni Saurav Ajit

Technical Staff

Technical Assistant (Inst)

Shivakumar K. M.

Technician

Athira M. P.

Technical Support

Meenakshi Baburao Tayade

Research Staff

Junior Research Fellow

Subhankar Maity, Ranjana Burman, Anish Yadav, Jithu Raj, Manu C. S., Subham Sarkar, Chinthu Prasad S. D., Subhankar Choudhury, Punith S., Subrata Mandal

Research Associates (Provisional)

Kousik Das, Shagufi Naz Ansari, Suman Kuila, Shikha Dhiman, Aritra Sarkar

Research Associates

Dr. Raju Laishram, Dr. Tanmay Mondal, Y. V. Suseela, Dr. Chenikkayala Balachandra,

Dr. Debajyoti Basak, Dr. Prabir Dutta,
 Dr. Shreya Sarkar, Dr. B. Senthilkumar,
 Dr. Biswajit Sahariah, Dr. Supriya Ghanty,
 Dr. Suvankar Bera, Dr. Mouli Konar,
 Dr. Pardhasaradhi Satha , Dr. Rimzhim Gupta,
 Dr. Jerrin Thomas George, Dr. Suman Das,
 Dr. Sourav Pradhan, Dr. Iniyavan P.,
 Dr. Saurav Chandra Sarma, Dr. Sourav
 Samanta, Dr. Manikandan, Dr. Jayita Pradhan,
 Archana K. Munirathnappa, Dr. Sathyapal
 Churipard R., Dr. Nilanjana Das Saha,
 Dr. Manisha Samanta, Dr. Lakshmi Priya Datta

Research Associate I	Dr. Radha Krishna Gopal
Research Associate II	Dr. Tanmoy Ghosh
DBT Research Associate	Dr. Riya Mukherjee
DBT Research Associate I	Dr. Sohini Basu Roy
SERB National Postdoctoral Fellows	Dr. Mukkabla Radha, Dr. Pratibha Kumari, Dr. Gautam Achar N. B., Dr. Kaushik Kundu
SERB (TARE)	Dr. Ashly P. C.
Teacher's Research Associates	Dr. B. N. Ramesh, Dr. Manjunatha S. O.
Technician	Shilpa
R&D Assistants	Subhajit Das, Pradhresh N. Andhare, Logia Jolly, Kavana H. S., Nirmal Jose, Monica Swetha Bosco, Kathakali De, Rishikesh V., Krishnendu Maji
Project Assistants	Sneha Rajendra Basa, Saigoutham Paturu

UNIT AT A GLANCE

Honours/Fellowships/Memberships Received



7

Faculty
members

2

Students

Faculty Members

Prof. C. N. R. Rao

- Received the National Youth Day Award 2021 from Bharat Seva Samvad, Surat, Gujarat
- Received a Honoris Causa Doctorate from the Assam Royal Global University, Guwahati
- Received the International Eni Award 2020 for research into renewable energy sources and energy storage

Prof. Jayanta Haldar

- Received the Indo-US Virtual Networks for COVID-19 by IUSSTF

Prof. Kanishka Biswas

- Received the Sheikh Saqr Career Award Fellowship by the Sheikh Saqr Laboratory, JNCASR
- Invited to become a Fellow of the Royal Society of Chemistry (FRSC) in the 'Leaders in the field' category
- Elected as an Editorial Advisory Board Member, *iScience*, Cell Press
- Elected as an Editorial Advisory Board Member of *JACS Au*, ACS
- Elected as an Advisory Board Member of *Material Horizons*, RSC

Dr. Sarit S. Agasti

- Selected as a Young Associate of the Indian Academy of Sciences, Bengaluru, for 2020

Prof. Sebastian C. Peter

- Received the CRSI Bronze Medal from the Chemical Research Society of India
- Received the Technology National Award 2021 from the Technology Development Board (TDB) at the Department of Science and Technology (DST), Government of India

Prof. Subi J. George

- Received the CSIR Shanti Swarup Bhatnagar Prize 2020 (under chemical sciences category)
- Invited to become a Fellow of the Royal Society of Chemistry (FRSC) in the 'Leaders in the field' category
- Elected as an Associate Editor in the editorial board of the journal *Chemical Science* of the Royal Society of Chemistry

Prof. T. Govindaraju

- Received the National Prize for Research in Peptide and Nucleic Acids, awarded by the C. N. R. Rao Education Foundation and JNCASR
- Winner of Health and Wellbeing, Commonwealth Chemistry Posters
- Invited to become a Fellow of the Royal Society of Chemistry (FRSC)

Students

Mr. Pradeep K. R. (Ph.D. student; research supervisor: Prof. Ranjani Viswanath)

- Received the prestigious SRISTI GYTI (Gandhian Young Technological Innovation) Award 2020

Mr. Yogendra Kumar (Ph.D. student; research supervisor: Prof. H. Ila)

- Received poster presentation prize among NCU students during JNCASR faculty meeting symposium in November 2020

Total Publications



99

Peer reviewed articles indexed in Web of Science

Sponsored Projects



New projects

12

₹ 1.70 cr.



Ongoing projects

38

₹ 7.21 cr.

Students Graduated During 2020–21



10 Ph.D.

- Manisha Samanta
- Krishnendu Jalani
- Ananya Mishra
- Saurav Chandra Sarma
- Shikha Dhiman
- Suman Kuila
- Aritra Sarkar
- Sourav Samanta
- Shreya Sarkar
- Pradeep K. R.

2 M.S.

- Reetendra Singh
- Sudip Mukherjee

1 M.S.
(Engineering)

- Rohit

5 M.Sc.
(Chemistry)

- Acharya Yash Sanjay
- Subhajit Das
- Arnab Sinhababu
- Abhishek Rawat
- Subham Singh

Students Admitted During 2020–21



5 M.Sc.
(Chemistry)

- Daizy Kalita
- Anupama Ghata
- Dharshini Raghavan
- Chahat
- Kulkarni Saurav Ajit

13 Ph.D.

- Sabyasachi Mandal
- Acharya Yash Sanjay
- Anustoop Das
- Anju A. K.
- Saikat Ghosh
- Subhajit Chakraborty
- Gauttam Dash
- Bhaskar Kakoty
- Debajit Kalita
- Paramesh Das
- Biplab Patra
- Rohit
- Subham Das

7 Int. Ph.D.
(Chemical Sciences)

- Ivy Maria
- Prabhat Thapliyal
- Sayan Chakravarty
- Surya Pravo Mookerjee
- Ritika Raghuvanshi
- Arghya Ghosh
- Vandana Kushwaha

NEUROSCIENCE UNIT (NSU)



NSU pursues an understanding of the nervous system and its role in modulating behaviours and physiological processes associated with health and disease. NSU research areas encompass studies on the unique molecular and biophysical properties of neuronal cells and their partners to emergent properties of neuronal networks.

Our current research interests include the study of synaptic function and its relationship with intellectual disability, the chronobiology and neurogenetics in *Drosophila*, molecular and cellular mechanisms of human brain disorders, biomaterials for interfacing sensory organs with soft analogue devices and molecular neuro-oncology. The diversity in individual research themes of the faculty reflects the interdisciplinary approaches and methodologies employed to understand how the nervous system functions and defines behaviour in organisms, including humans.

In the years to come, the Unit intends to expand its activities into the field of computational neuroscience, cellular neuroscience and mammalian developmental neurobiology. The Unit is also looking towards building advanced imaging technologies to investigate synaptic function and morphology and neuronal circuit functions, which will have biomedical implications.

RESEARCH AREAS

- Neuronal circuitry underlying locomotor activity rhythms
- Chronotype evolution or the evolution of 'owl' and 'lark' phenotypes
- Understanding autism spectrum disorder using *Syngap1* mutant mice as a model
- Sleep circuits of fruit flies
- Dysregulated autophagy in neuro-degenerative diseases
- Plasticity of circadian waveforms
- Clock evolution under semi-natural conditions
- The circadian neuronal circuit as a model to understand cellular players in neurodegeneration

RESEARCH HIGHLIGHTS

- The rare variants of the *KANK4* and *CAP2* genes were found to be implicated in bipolar disorder.
- The fact that the temperature sensitivity of circadian clocks can co-evolve with selection for extreme chronotypes was demonstrated.
- Tasigna®, a common drug for Parkinson's disease, was found to be ineffective for Huntington's disease.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

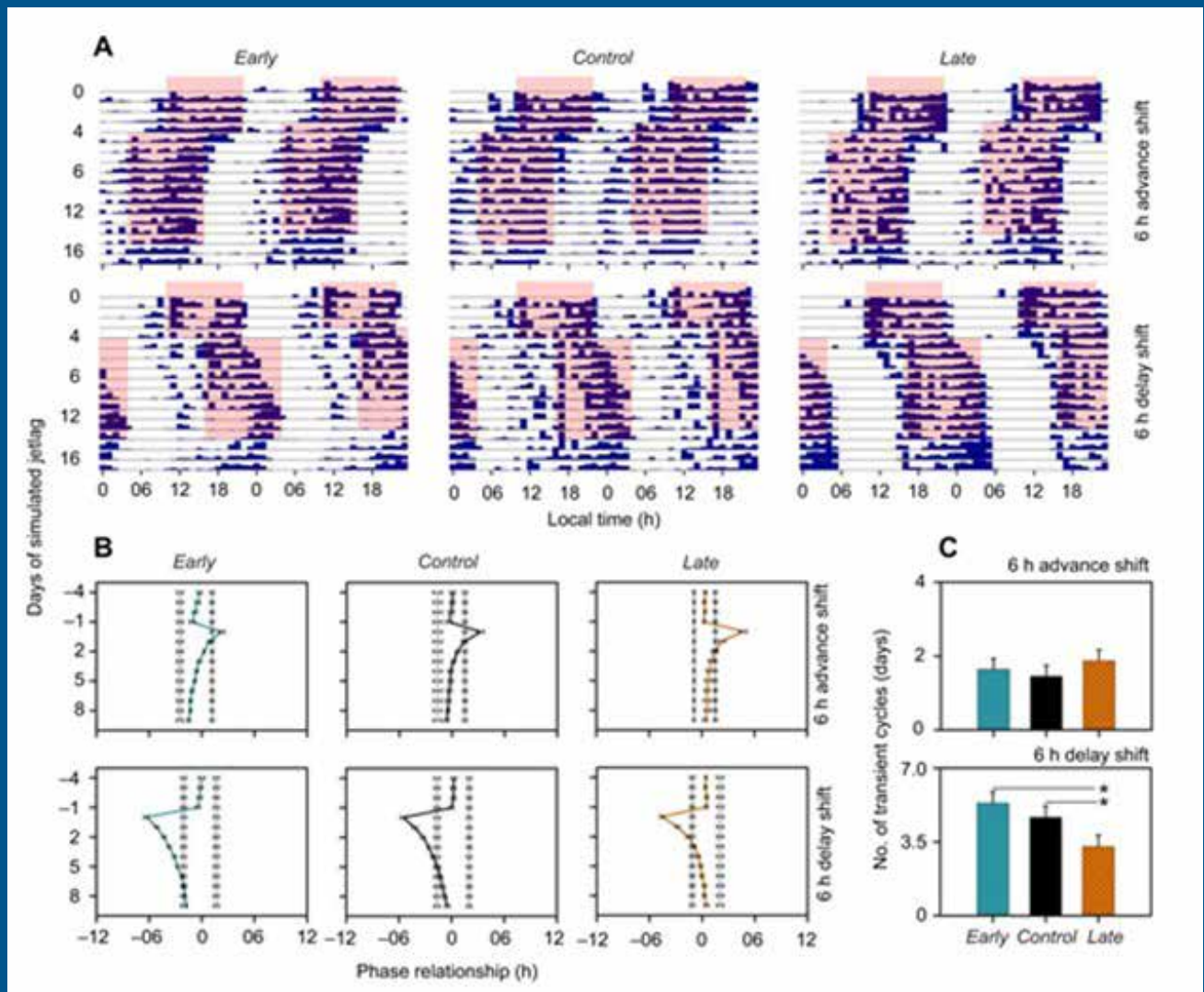
Prof. Anuranjan Anand Ph.D., F.A.Sc., F.N.A., F.N.A.Sc., J. C. Bose National Fellow
Professor and Chair, NSU

See pg. 95 for research activities

Prof. Sheeba Vasu Ph.D.
Associate Professor

The rhythms in adult emergence and locomotor activity are two different phenomena that occur at distinct stages of the fly (*Drosophila melanogaster*) life cycle. However, studies have hinted at similarities between the organisations of the circadian clock driving these two rhythms. Our study was an attempt to understand the extent of similarity in the circadian organisation underlying the two rhythms. We investigated whether temperature sensitivity of the locomotor activity rhythm evolved separately from the adult emergence rhythm. We found that in response to simulated jetlag with temperature cycles, late chronotypes (flies that emerge during dusk) synchronised their internal rhythms to six hour phase delays faster than early chronotypes (flies that emerge during dawn). This indicates an enhanced sensitivity of the activity/rest clock to temperature cues in these flies. In addition, late chronotypes showed a higher plasticity of phases across regimes, higher day-to-day stability in phases and a greater range of internal rhythm synchronisation, all of which are indicative of enhanced temperature sensitivity to activity/rest rhythms. Correlations between activity rhythm properties and emergence chronotypes highlight the remarkably similar organisational principles of circadian clocks regulating emergence and activity/rest rhythms.

Prof. Sheeba Vasu



Synchronising to six-hour phase-shifted thermophase–cryophase (TC) cycles after jetlag simulation (*J. Exp. Biol.* 223 (11). doi: 10.1242/jeb.222414).

Reference:

J. Exp. Biol. 223 (11). doi: 10.1242/jeb.222414

Major talks during 2020–21:

- April 2020: Talk on “The Genetic Basis of Behavior” at a webinar organized by Amity University.
- May 2020: Talk on “Keeping Time in the Biological World” at a webinar organized by PT Science College, Surat.
- March 2021: Talk on “A Role for Electrical Synapses in Regulating the Circadian Pacemaker Circuit” at the International Colloquium on Regulatory Mechanisms Underlying Behavior, Physiology and Development, organized by the Department of Zoology, Delhi University.

- March 2021: Talk on “Time Flies: an Extraordinary Tale of Clocks and Fruit Flies” at the Science Week celebrations, organized by the Microzome Association, Mount Carmel College, Bengaluru.

Prof. James Premdoss Clement Chelliah Ph.D.

Associate Professor

Our recent work published in *Scientific Reports* shows how Tasigna®, a common drug, used to treat Parkinson’s disease, is ineffective for Huntington’s disease.

Further, we are in the process of publishing a novel compound to treat autism spectrum disorder. Our study is the first to demonstrate that this compound can correct the deficits observed in a mouse model of autism, *syngap1*^{+/−}, bringing them to wild type levels.

Major talks during 2020–21:

- 2020: Neuroscience Workshop, RCB, Delhi, India
- November 2020: Bridge the GAP International SYNGAP1 Conference
- December 2020: *Syngap1* Research Fund Seminar
- March 2021: BSBE colloquium, IIT Kanpur
- March 2021: European *Syngap1* Symposium

UNIT MEMBERS

Faculty Members

Professor and Chair

Prof. Anuranjan Anand

Associate Professors

Prof. Sheeba Vasu, Prof. James Premdoss
Clement Chelliah

Associate Faculty

Prof. K. S. Narayan (Professor, CPMU)

Prof. Ranga Udaykumar (Professor, MBGU)

Prof. Tapas Kumar Kundu (Professor, MBGU; on lien)

Prof. Ravi Manjithaya (Associate Professor, MBGU)

Research Students

Ph.D.	Iyengar Aishwariya Prasan, Kulkarni Rutvij Kaustubh, Vijaya Verma, Iyer Aishwarya Ramakrishnan, Arijit Ghosh, Dani Chitrang Kamal, Vijay Kumar M. J., Manjushree Sarda, Yashwini Dewan, Joshi Pooja Amrishkumar, Deena Rose Joseph
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Research Staff

Research Associate	Dr. Roshan Fatima Begum
R&D Assistants	Sushmitha S. P., Sushma S. Rao, Pratishtha P. Wadnerkar, Zahid Mushtaq Dar
Project Assistants	Niveditha Sankar, Neeharika Reddy M. N.

Administrative Staff

Sr. Helper	Samuel S.
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UNIT AT A GLANCE

Honours/Fellowships Received



1

Faculty member

2

Students

Faculty Member

Prof. Anuranjan Anand

- Received the DST/SERB J. C. Bose National Fellowship 2020

Students

Ms. Shrilaxmi Joshi (Ph.D. student; research supervisor: Prof. Anuranjan Anand)

- Received a scholarship to attend the Keystone Symposia on "Neuropsychiatric and Neurodevelopmental Disorders: Harnessing Rare Variants" (February 2021)
- Received a conference Fellowship for the European Human Genetics Conference 2020 to the present research work entitled "EFHC2 variants in juvenile myoclonic epilepsy" (June 2020)

Ms. Vijaya Verma (Ph.D. student; research supervisor: Dr. James P. C. Chelliah)

- Received the Travel Award to attend the 44th Annual Meeting of the Japan Neuroscience Society to be held in July 2021

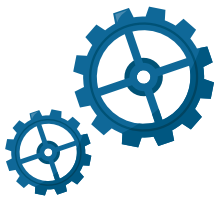
Total Publications



7

Peer reviewed articles indexed in Web of Science

Sponsored Projects



Ongoing projects

3

₹ 27,943

Students Graduated During 2020–21



2

Ph.D.

- Abhik Paul
- Abhilash Lakshman

Students Admitted During 2020–21



2

Ph.D.

- Joshi Pooja Amrishkumar
- Deena Rose Joseph

THEORETICAL SCIENCES UNIT (TSU)



The research at TSU is inspired by two complementary approaches to the study of matter and life: the search for universality and the exploration and explanation of diversity. At TSU, we aim to address, explain, understand and predict new physical phenomena, and design new materials. We unravel the perplexing and fascinating range of behaviours shown by materials by looking into their structures and properties at a very fundamental level using various analytical and computational techniques. The concept of “emergence”, where the underlying natural laws are simple in form but manifest as a complex behaviour as the system sizes increase, is of specific interest to the researchers at the Unit.

The faculty members from this Unit have expertise in many body physics, computational chemistry, quantum mechanical density functional theory, statistical mechanics and mathematical physics, and often collaborate with researchers within and outside JNCASR. Since the nature of research conducted at TSU is quite interdisciplinary (foraying into theoretical physics, chemistry, mathematics, and evolutionary biology), students and researchers from a variety of academic disciplines, such as chemistry, physics, engineering and computer science, are welcome to join.

RESEARCH AREAS

- Self-organisation and transition of soft materials
- Measuring information density for off-lattice systems
- Molecular dynamics simulations
- Computational nanoscience
- Quantum many body systems
- Statistical physics of disordered systems
- Statistical physics of living and non-living matter

RESEARCH HIGHLIGHTS

- Computational studies were used to understand how particle assemblies respond to cyclic deformation and what the relevance of this phenomenon is to a wide range of problems related to amorphous particle assemblies.
- Molecular dynamics were used to study the kinetics of domain growth, vapour–solid phase transition and pattern formation in a two-dimensional active matter system.
- The solid solution of two oxides was theoretically demonstrated to have high temperature thermoelectric efficiency due to phonon localisation along the stacking direction, opening doors to the discovery of the solid solutions of innumerable more oxides.
- Polar discontinuities were leveraged to tune the binding of methanol on graphene-BN lateral heterostructures.
- Scale-free ferroelectricity was discovered in orthorhombic hafnium oxide, a material that can be readily integrated into silicon technology.
- A typical medium dynamical cluster framework was developed that captures Anderson localization effects non-perturbatively in disordered electron and phonon systems.
- Analytical and numerical techniques were used to test a recent proposal that coarsening dynamics play a role in slow quench dynamics, and the parameter space where the aforementioned proposal does not hold was delineated.
- The effect of individual policy measures on the R_0 of COVID-19 was predicted.
- The Lyapunov property was defined for C_0 -semigroups on non-commutative L_p spaces.

RESEARCH ACTIVITIES AND ACHIEVEMENTS DURING 2020–21

Prof. Swapan K. Pati Ph.D., FNA, FASc., FNASc., FTWAS
Professor and Chair, TSU

We studied four distinct maricite (NaCoPO_4) phases (α , β , ABW, and γ) in detail and published the first report of a high temperature γ phase for NaCoPO_4 , which has a different coordination geometry than the other phases but can be reversibly transformed into lower temperature α/β

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Prof. Swapan K. Pati

phases via controlled cooling. We probed the formation mechanisms of these systems through density functional theory modelling, simulated the phase transitions of the γ phase by *ab initio* molecular dynamics and observed the topological variations at local sites. We also noted how a first order phase transition from a disordered γ phase to a more ordered β phase is entropically driven. Further, we discovered that although these maricite systems are known to be poor candidates for cathodes as they lack ionic diffusion channels and deliver poor voltages, the γ phase seems to be promising as it has low kinetic barriers for Na diffusion.

In other research work, we performed density functional theory calculations and investigated a family of intramolecular stannylum/nitrogen frustrated Lewis pairs (FLPs) (1-R-X) for their ability to activate dihydrogen and subsequently facilitate the catalytic hydrogenation of organic compounds with their unsaturated functional groups. We designed these FLPs by embedding stannylum motifs into a cyclic guanidinate backbone, which provides a complementary Lewis basic nitrogen site.

We also explored a b-TeO₂ system, in which with strain we achieved very high charge carrier mobility values. We found that upon the application of a small uniaxial strain, the electron mobility increases many fold along one direction and hole mobility increases to a very high value in the other direction. Such anisotropic carrier mobility can be created using small uniaxial strain in a stable layered TeO₂ semiconductor.

Major talk during 2020–21:

MRS Fall 2020 Symposium F. NM03 on nanotubes, graphene, and related nanostructures.

Prof. Shobhana Narasimhan Ph.D., F.N.A.Sc., F.A.Sc.

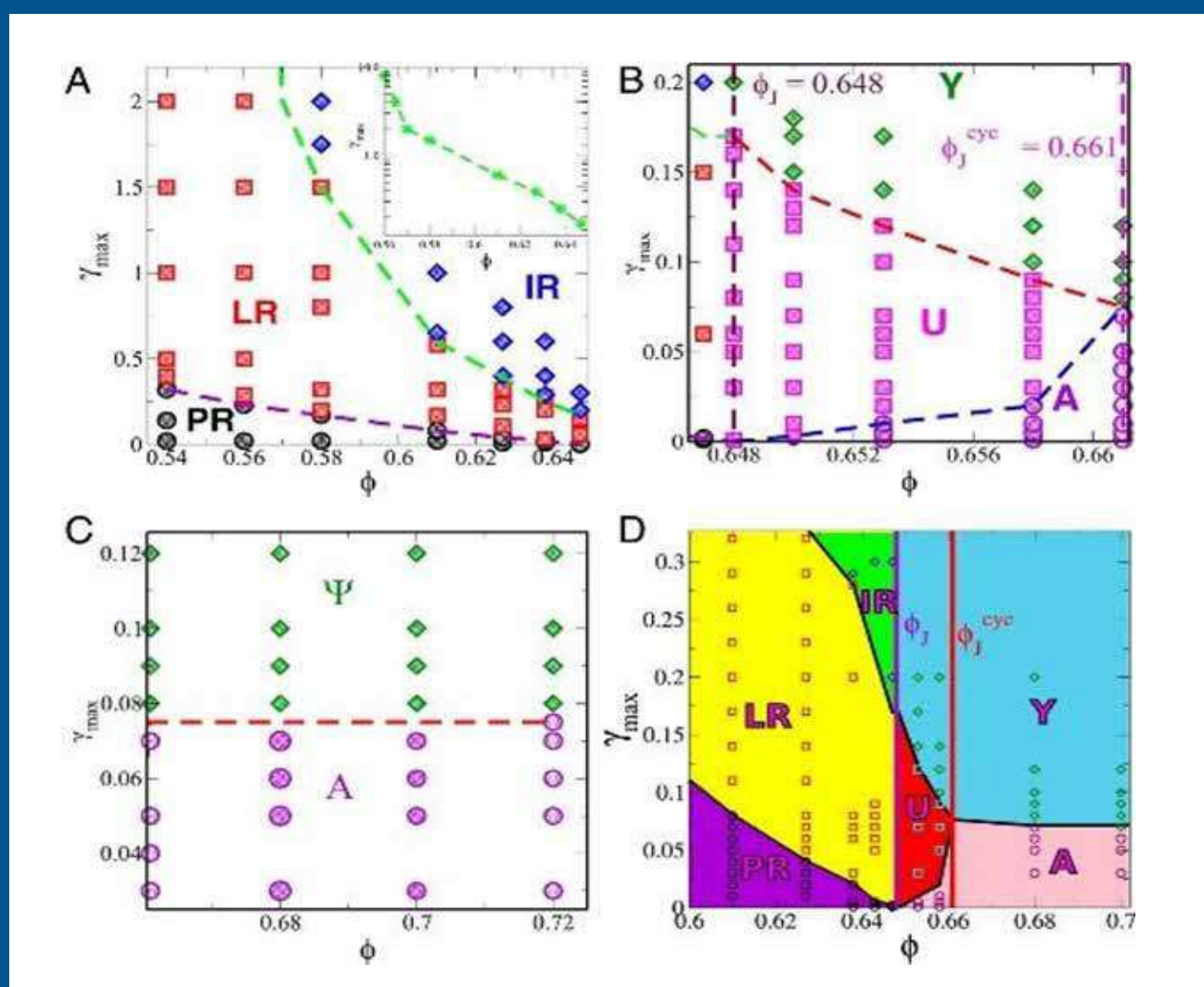
Professor

We studied the activation of methane on single metal atoms supported on graphene. We also studied the binding of methanol on graphene-boronitride lateral heterostructures. In other work, we explored the water-gas shift reaction on supported metal nanocatalysts. In addition, we investigated the growth of blue and black phosphorene on metal substrates. Further, we studied molecular rotors and obtained a rotational energy landscape using density functional theory. We also studied the electronic structure of halide perovskites.

Major talks during 2020–21:

- Talk at MACB 2020
- Talk at QMAT3
- Plenary Guest Lecture on “Solid State Physics in Quarantine” at ICTP Trieste Italy
- Talk at ICTS Bangaluru

Our research focused on obtaining a unified view of soft-matter behaviours and transitions in different regimes. The self-organisation and transition of soft matter under external stress or deformation have been studied for a wide range of materials, but the relation between these phenomena have not been looked into. With the help of computational techniques, we have, thus, investigated the response of soft-sphere assemblies to thermal cyclic-shear deformations over a wide range of densities and amplitudes. We analysed the reversible–irreversible transitions of soft-matter below and close to the jamming density. We also investigated the role of friction in shear jamming, the findings of which could be used to obtain a unified understanding of frictionless and frictional shear jamming. Our unified phase diagram exhibits a rich diversity of behaviours and transitions such as yielding, jamming, unjamming and shear jamming.



(A to C) Phase diagrams showing transitions for different ranges of packing fractions. (D) Complete phase diagram showing different phases and transitions across the isotropic jamming density. Here, A: absorbing phase; U: unjammed phase; Y: yielded phase (*PNAS* 117 (19): 10203–10209. doi: 10.1073/pnas.1912482117).

Contd. from pg. 133

Prof. Srikanth Sastry

Reference:

PNAS 117 (19): 10203–10209. doi: 10.1073/pnas.1912482117

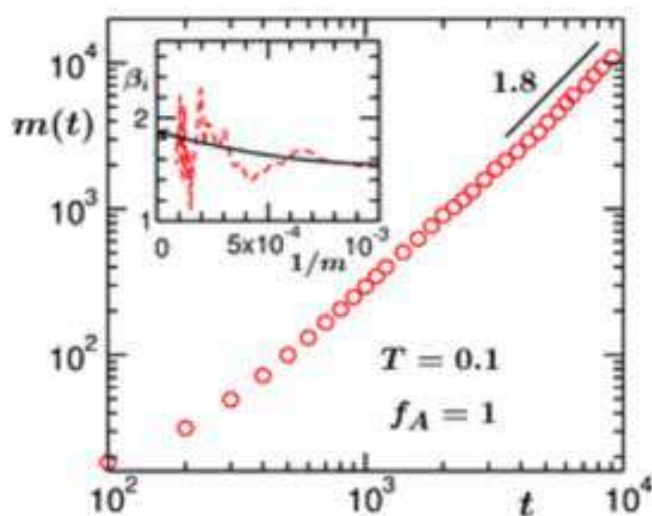
Other research activity during 2020–21:

Theory Exp. 2: 023204. doi: 10.1088/1742–5468/ab684b.pnas.1912482117

Prof. Subir K. Das Ph.D.

Professor and Head, CompLab

Our team studied the kinetics of vapour via molecular dynamics simulations. We used the Vicsek rule to introduce self-propulsion in an active matter model of solid phase transition. We then chose the overall density of the particles in such a way that the evolution morphology consisting of disconnected clusters was defined as regions of high density of particles. Our goal was to understand the influence of self-propulsion on the structure and growth of these clusters. Comparing the results of our simulations with those for the passive limit of the model that also exhibited vapour–solid transition, we found that the chosen Vicsek activity led to very rapid growth, via a process that was practically equivalent to the ballistic aggregation mechanism. The emerging growth law was accurately estimated and explained by inputting information on velocity and the structural aspects of the clusters into a relevant theory. Some of the results were also discussed with reference to a model for active Brownian particles.



The molecular dynamics of vapour with time (*Soft Matter* 17 (3): 645–654. doi: 10.1039/d0sm01762k).

Reference:

Soft Matter 17 (3): 645–654. doi: 10.1039/d0sm01762k

Other research activities during 2020–21:

- *J. Chem. Phys.* 153 (4): 044905. doi: 10.1063/5.0010043
- *Bull. Mat. Sci.* 43 (1). doi: 10.1007/s12034-020-02199-z
- *Phys. Rev. E* 102 (6). doi: 10.1103/physreve.102.062119

Prof. Umesh V. Waghmare Ph.D., F.A.Sc., F.N.A.Sc., F.N.A.

Professor and Dean, Academic Affairs

We developed a simple method to estimate exciton–phonon coupling from first principles and used it to understand the pressure dependent stabilities of excitonic insulator phases.

We uncovered how the crystalline architecture of orthorhombic hafnium oxide (HfO₂) supports scale-free ferroelectricity, which can ultimately enable high-density computer memories.

We provided a mechanism of tunable ferroelectric instability to achieve high thermoelectric performance in group IV chalcogenides.

We developed a machine learning based model to estimate electronic hopping between the base pairs of DNA molecules and therefore determine its transport properties. This technique combines quantum mechanical methods, molecular dynamics simulation and machine learning techniques.

We explained the record high thermoelectric performance that can be achieved by controlling chemical ordering at the atomic scale and the consequent electron localisation.

Finally, we developed a simple model for the interaction of water molecules with hybrid perovskites to understand how humidity may affect their properties.

Major talks during 2020–21:

- 15 December 2020: Talk at the joint event by the Maharashtra Academy of Sciences and MRSI, in Pune.
- 24 December 2020: Talk at the Platinum Jubilee Seminar, Materials Engineering Department of IISc, Bengaluru.
- 18 January 2021: Talk at the Annual Meeting of INAE.
- 8 March 2021: Talk at the SSB Symposium, DD University, Delhi.
- 25 March 2021: Talk at Colloquium, Department of Physics, University of UAE.

Prof. Vidhyadhiraja N. S. Ph.D.

Professor and Dean, Fellowships and Extension Programmes

Our work in this academic year included studies on quantum criticality, non-hermitian quantum many body systems, disordered electron and phonon systems, strongly correlated electronic systems out of equilibrium and the integration of the density functional theory-based *ab initio* approaches with a quantum many body approach.

This work led us to develop a typical medium dynamical cluster framework that captures Anderson localization effects non-perturbatively in disordered electron and phonon systems.

Prof. Kavita Jain Ph.D.**Professor**

Although coarsening dynamics following a rapid quench from the disordered to ordered states are quite well studied, slow quench dynamics are still not fully understood. Using analytical and numerical techniques, we tested a recent proposal that coarsening dynamics play a role in slow quench dynamics and delineated the parameter space where the aforementioned proposal does not hold.

We also studied slow quench dynamics in classical systems, investigated the dynamics of a paradigmatic model in evolutionary biology via an eigenfunction expansion, and conducted a detailed study of the stochastic dynamics of a population evolving in a changing environment.

Major talks during 2020–21:

- November 2020: Computational biology webinar at IMSc, Chennai.
- December 2020: Statistical Biological Physics: From Single Molecule to Cell, ICTS.
- February 2021: Talk at the Statphys Journal Club, ICTS.
- May 2021: Outreach talk in the Manav Data Science Webinar series.

Dr. Meher K. Prakash Ph.D.**Faculty Fellow**

Our research was heavily focused on the epidemiology of COVID-19: the predictions for the factors contributing to R_0 , understanding the household spread of COVID-19 in India, the strategies for the distribution of vaccines in a country with a relatively young population demographic, etc.

Based on our research, our team provided COVID-19 modelling inputs to the Department of Science and Technology committee during May to September 2020.

Further, our modelling results on the Swiss COVID-19 data were included in the Swiss COVID-19 taskforce's recommendations to their government.

In addition, we also modelled gut bacteria, attempted to understand their interactions among themselves and with drugs, and explored the function of enzymes using machine learning.

Major talks during 2020–21:

Two talks on our COVID-19 research at the Swiss Tropical and Public Health Institute and the Università del Piemonte Orientale, Novara.

Dr. Kalyan B. Sinha Ph.D., F.N.A., F.A.Sc., F.T.W.A.S.

INSA Senior Scientist

We studied the Lyapunov property for C_0 -semigroups defined on non-commutative L_p spaces and also focused on (i) the properties of quantum dynamical semigroups, a tool to mathematically implement the description of unstable (or decaying) quantum systems, and (ii) trace formulae for operators to connect with a form of non-commutative geometry.

UNIT MEMBERS

Faculty Members

Professor and Chair	Prof. Swapan K. Pati
Professors	Prof. Kavita Jain, Prof. Shobhana Narasimhan, Prof. Srikanth Sastry, Prof. Subir Kumar Das Prof. Umesh V. Waghmare, Prof. Vidhyadhiraja N. S.
Faculty Fellow	Dr. Meher K. Prakash
INSA Senior Scientist	Dr. Kalyan B. Sinha

Research Students

Ph.D.	Alok Kumar Dixit, Monoj Adhikari, Malay Ranjan Biswal, Pallabi Das, Yagyik Goswami, Nalina V., Koyel Das, Varghese Babu, Arabinda Bera, Archana Devi, Raju Kumar Biswas, Pallavi Sarkar, Abhishek Kumar Adak, Ankit Kumar, Sachin Kaushik, Koyendrila Debnath, Himanshu Joshi, Vinayak M. Kulkarni, Bidhan Chandra Garain, Supriti Dutta, Soumik Ghosh, Arpan Das, Khandare Pushkar Gopalrao, Arijit Sinha, Anita Gemmy Francis, Disha Brahma, Ritam Chakraborty, Sujan K. K., Krishna Kanhaiya Tiwari, Purnendu Pathak, Bhuvanewari R.
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Research Staff

Research Associates	Dr. Meghna Manae A., Dr. Matukumilli V. D. Prasad, Dr. Himangsu Bhaumik, Dr. Rajneesh Kumar, Dr. Paramita Banerjee, Dr. Sourav Mondal, Dr. Prashant Vijay Gaikwad, Dr. Sanat Kumar Singha, Dr. S. Siva Nasarayya Chari, Dr. Arpita Paul, Dr. Arunkumar Bupathy, Dr. K. Navamani, Dr. Pawan Kumar
Research Associates (Provisional)	Neha Bothra, Arpita Sen, Abhiroop Lahiri, Tanay Paul
Research Associate II	Dr. I. Iyyappan
Research Associate III	Dr. Shazia Janwari
Research Scientist B	Anoop S., Suresh J.
Senior Research Fellow (R & D Assistant)	Meha Bhogra
SERB National Postdoctoral Fellow (NPDF)	Dr. Devina Sharma
R&D Assistants	Syam Sadan, Sujan K. K., Palaparthi Neehar, Monoj Adhikari, Vybhav G. R., Krishna Kanhaiya Tiwari

UNIT AT A GLANCE

Honours/Fellowships/Memberships Received



4

Faculty members

1

Student

Faculty Members

Prof. Kavita Jain

- Elected as an Associate Editor of the *International Journal of Genetics* in 2020

Prof. Shobhana Narasimhan

- Received the Marshak Lectureship for 2021 by the American Physical Society
- Elected as a Fellow of Indian Academy of Sciences

Prof. Umesh V. Waghmare

- Elected as a Fellow of Indian National Academy of Engineering
- Elected as a Fellow of the Maharashtra Academy of Sciences

Prof. Vidhyadhiraja N. S.

- Invited to become the Sheikh Saqr RAK-CAM Senior Fellow

Student

Mr. Abhishek Kumar Adak (Ph.D. student; research supervisor: Dr. Shobhana Narasimhan)

- Received the best poster prize at the in-house symposium at JNCASR

Total Publications



53

Peer reviewed articles indexed in Web of Science

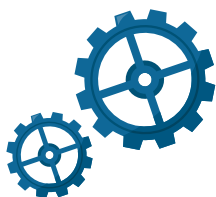
Sponsored Projects



New projects

3

₹ 78.39 lac



Ongoing projects

20

₹ 1.87 cr.

Students Graduated During 2020–21



7

Ph.D.

- Kaushlendra Kumar
- Rajdeep Banerjee
- Wasim Raja Mondal
- Debdipto Acharya
- Pawan Kumar
- Sruthi C. K.
- Sourav Mondal

1

M.S.
(Engineering)

Dheeraj Kumar

Students Admitted During 2020–21



6

Ph.D.

- Disha Brahma
- Ritam Chakraborty
- Sujan K. K.
- Krishna Kanhaiya Tiwari
- Purnendu Pathak
- Bhuvaneshwari R.

SCHOOL OF ADVANCED MATERIALS (SAMat)

Over the last 30 years, JNCASR has emerged as one of the leading research institutes in frontier areas of materials research in the country and worldwide. In view of the number of faculty members involved in a broad spectrum of materials research, encompassing nanomaterials, energy materials, soft materials, biomaterials and theory, it was felt advisable to have an umbrella structure under which to bring all the materials research activity together at the Centre. This idea was realised with the creation of the School of Advanced Materials (SAMat) in 2018. It comprises of 28 faculty members from the International Centre for Materials Science (ICMS), Chemistry and Physics of Materials Unit (CPMU), New Chemistry Unit (NCU), and the Theoretical Sciences Unit (TSU), with Prof. C.N.R Rao as the Chairperson.

In 2019, the faculty members of SAMat brought out a book called “Advances in the Chemistry and Physics of Materials: Overview of Selected Topics”, published by the World Scientific Publishing. It touches upon topics spanning nanomaterials and various other classes of energy materials for harvesting, storage and conversion. In the book, a relatively new and exciting range of materials, such as supramolecular, soft and biomaterials, have been introduced and elucidated. Special emphasis has been laid on the synthesis, phenomena and characterization of these kinds of materials. Theoretical and computational chemistry has played an important role in the growth of materials science as a discipline, and the book covers a special topical session on the theoretical efforts in materials research.

FACULTY PUBLICATIONS

TOTAL NUMBER OF FACULTY PUBLICATIONS IN 2020



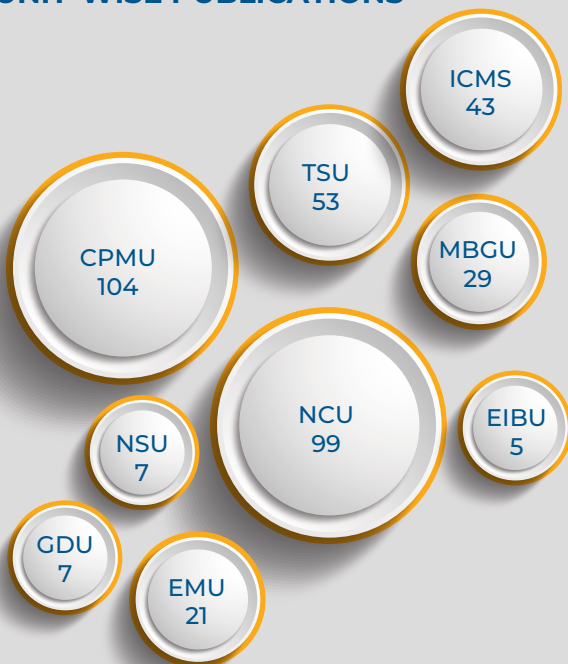
TOTAL PUBLICATIONS IN IMPACT FACTOR JOURNALS

279

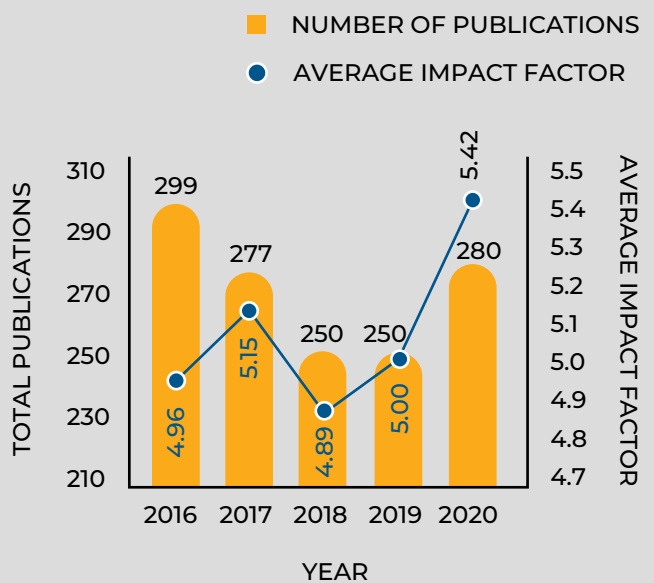
AVERAGE IMPACT FACTOR

5.42

UNIT-WISE PUBLICATIONS



KEY INFORMATION YEAR-WISE



INTELLECTUAL PROPERTY

Intellectual property assets (IPAs) are collections of intellectual properties (IPs)—patents, trademarks, copyrighted works, industrial designs, geographical indications, trade secrets, etc. IPAs have tremendous economic significance because of their ability to enhance the value and financial returns from technologies, products, and services.

The Centre has been one of the foremost research institutes in the country to realise the importance of IPAs created by its researchers. The Centre encourages and facilitates the creation, development, protection, and management of commercially exploitable IPs and their enforcement in addition to fostering the academia–industry partnership.

TOTAL IPAs OVER THE YEARS UNTIL MARCH 2021



PATENTS 2020–21

PATENT APPLICATIONS FILED

INDIAN PATENT APPLICATIONS

INVENTORS	UNIT	TERRITORY	APPLICATION NO.	DATE OF FILING
Jayanta Halder, Sreyan Ghosh, Riya Mukherjee	NCU	India (Prov)	202041014961	03 Apr 2020
Govindaraju Thimmaiah, Biswanath Maity, Sourav Samanta	NCU	India (Prov)	202041015174	06 Apr 2020
Sridhar Rajaram, Mokshan Sridhar Ramesh	ICMS	India (Prov)	202041023006	01 Jun 2020
Govindaraju Thimmaiah, Rajasekhar Kolla, Sourav Samanta	NCU	India (Prov)	202041031875	24 Jul 2020
Tapas Kumar Maji, Subhajit Laha	CPMU	India (Prov)	202041055639	21 Dec 2020
Sridhar Rajaram, Mokshan Sridhar Ramesh	ICMS	India (Prov)	202141007142	19 Feb 2021

INTELLECTUAL PROPERTY

INTERNATIONAL PHASE PATENT APPLICATIONS FILED UNDER PCT

TITLE OF THE INVENTION	INVENTORS	UNIT	TERRITORY	APPLICATION NO.	DATE OF FILING
Small-Molecular Adjuvants and Implementations Thereof	Jayanta Haldar, Geetika Dhanda	NCU	PCT	PCT/IN2020/050358	15 Apr 2020
A p-Type Material, and Implementations Thereof	Kanishka Biswas, Subhajit Roychowdhury, Tanmoy Ghosh	NCU	PCT	PCT/IN2020/050595	08 Jul 2020
Process for Purification of Hydrocarbons	Tapas Kumar Maji, Subhajit Laha, Ritesh Haldar	CPMU and NCU	PCT	PCT/IN2021/050040	15 Jan 2021
Phenanthroline, Carbazole, and Flavylium-based Cyanines and Compositions and Methods of Making and Using the Same	Govindaraju Thimmaiah, Yelisetty Venkata Suseela, Pardhasaradhi Satha	NCU	PCT	PCT/IB2021/051887	06 Mar 2021

NATIONAL PHASE PATENT APPLICATIONS FILED UNDER PCT

TITLE OF THE INVENTION	INVENTORS	UNIT	TERRITORY	APPLICATION NO.	DATE OF FILING
Enhancing Photocatalytic Water Splitting Efficiency of Weyl Semimetals by a Magnetic Field	Chintamani Nagesa Ramachandra Rao, Claudia Felser, Catherine Ranjitha Rajamathi, Nitesh Kumar, Uttam Gupta	NCU and CPMU	Japan	2020-543328	13 Aug 2020
			USA	16/969,841	13 Aug 2020
			Europe	19706243.3	26 Aug 2020
			China	201980016975.4	03 Sep 2020
			Korea	10-2020-7026259	11 Sep 2020

PATENTS GRANTED

TITLE OF THE INVENTION	INVENTORS	UNIT	TERRITORY	APPLICATION NO.	GRANTED ON
A Template Free Metal, Polymer-Free Metal Nanosponge and a Process Thereof	Eswaramoorthy Muthusamy, Saikrishna Katla	CPMU	Europe (validated in UK, Germany, and France)	2276691	15 Apr 2020

INTELLECTUAL PROPERTY

PATENTS GRANTED

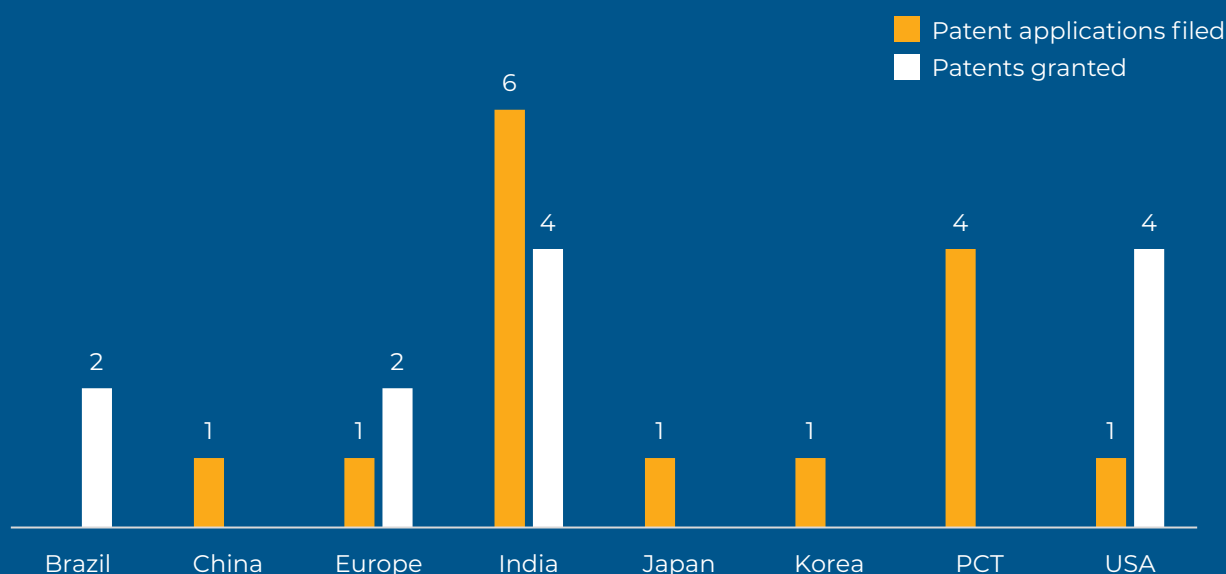
TITLE OF THE INVENTION	INVENTORS	UNIT	TERRITORY	APPLICATION NO.	GRANTED ON
Composition, Substrates and Methods Thereof	Giridhar Udapi Rao Kulkarni, Kunala Durga Mallikarjuna Rao, Ritu Gupta, Boya Radha, Shanmugam Kiruthika	CPMU	USA	10,626,279	21 Apr 2020
Glycopeptides Conjugates and Uses Thereof	Jayanta Haldar, Yarlagadda Venkateswarlu	NCU	USA	10,626,148	21 Apr 2020
Compounds as DNA Probes, Methods and Applications Thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy	NCU	USA	10,683,273	16 Jun 2020
Antimicrobial Compounds, Their Synthesis, and Applications Thereof	Jayanta Haldar, Chandradhish Ghosh, Gautham Belagula Manjunath, Padma Akkapeddi	NCU	Europe (Validated in Germany, and Great Britain)	2934563	08 Jul 2020
A Method for Inspecting the Quality of Solar Cells and Configuration Thereof	Giridhar Udapi Rao Kulkarni, Ritu Gupta, Shanmugam Kiruthika, Kunala Durga Mallikarjuna Rao, Mikkel Jorgensen, Frederik Christian Kerbs	CPMU	India	341132	10 Jul 2020
Wing and Propeller System, Method of Optimizing Wing and Propeller/Rotor System, and Method of Reducing Induced Drag	Roddam Narasimha, Suresh Madhusudan Deshpande, Praveen Chandrashekarap- pa, Rakshith Belur Raghavan	EMU	Brazil	PI 1016070-1	21 Jul 2020
Small Molecular Probes, Processes and Use Thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy, Kolla Rajasekhar	NCU	USA	10,745,393	18 Aug 2020

INTELLECTUAL PROPERTY

PATENTS GRANTED

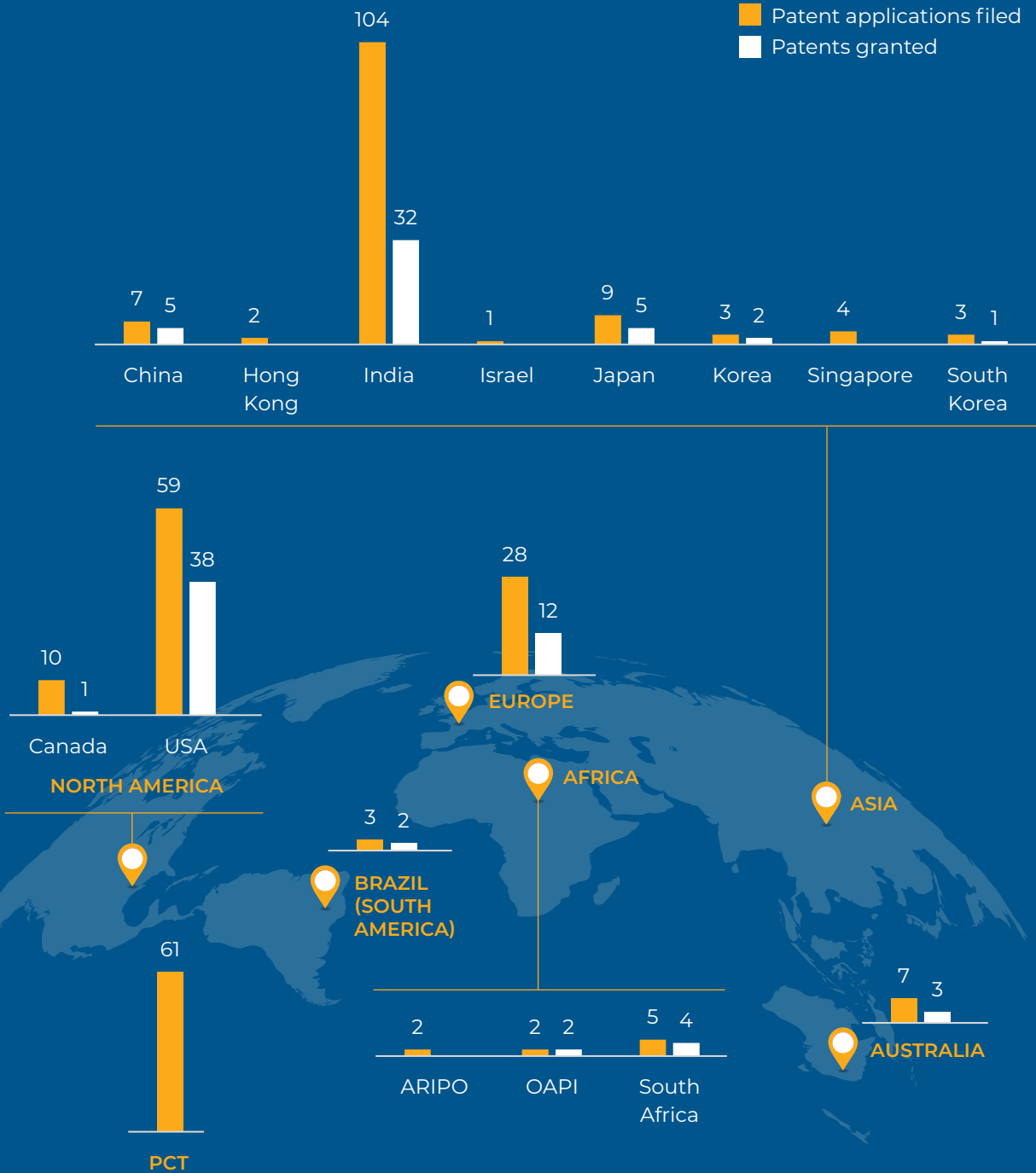
TITLE OF THE INVENTION	INVENTORS	UNIT	TERRITORY	APPLICATION NO.	GRANTED ON
Conjugated Microporous Polymer	Tapas Kumar Maji, Syamantak Roy	CPMU	India	345577	29 Aug 2020
Antimicrobial Compounds, Their Synthesis, and Applications Thereof	Jayanta Halder, Chandradhish Ghosh, Gautham Belagula Manjunath, Padma Akkapeddi	NCU	Brazil	BR112015014391-1	03 Nov 2020
A Composition and Methods Thereof	Eswaramoorthy Muthusamy, Kesavan Subaharan, Bosukonda Veera Venkata Surya Pavan Kumar	CPMU	India	354729	29 Dec 2020
Hybrid Cyclic Peptoids, Synthesis, and Applications Thereof	Govindaraju Thimmaiah, Kolla Rajashekhar, Ravi Manjithaya, Piyush Mishra, Santhi Natesan Suresh, Nagarjun Narayanaswamy	NCU and MBGU	India	359950	01 Mar 2021

OVERVIEW OF INTELLECTUAL PROPERTY (2020-21)



INTELLECTUAL PROPERTY

TERRITORY-WISE DISTRIBUTION OF IP (FROM INCEPTION TILL 31 MARCH 2021)



UNIT MEMBERS

DEAN, RESEARCH AND DEVELOPMENT

Chandrabhas Narayan
Ph.D., F.N.A.Sc, F.A.Sc.
(April to November 2020)

TECHNICAL OFFICER GR.-I

A. V. Nagarathamma

OFFICE EXECUTIVE

H. C. Kavyashree

AGREEMENTS SIGNED

Four new agreements were signed between **JNCASR** and **M/s. Breathe Applied Science Private Ltd.**, Bengaluru (a startup company from JNCASR). The Founder Directors of the start-up company **Prof. Sebastian Peter** and **Prof. Umesh Waghmare** signed the agreements, which include:

1. A **terms and conditions** for *establishing the start-up* (signed on 4 June 2020 at JNCASR);
2. A **lease deed agreement**, which is valid for as long as the intellectual property license and incubation agreement is valid (signed on 31 August 2020);
3. An **intellectual property license and incubation agreement** that holds true for the next 10 years (signed on 4 June 2020); and
4. A **share subscription agreement** (signed on 4 June 2020).

Prof. Sridhar Rajaram of JNCASR signed 2 new agreements in 2020:

1. A 12-month **consulting service agreement** with **GE India Technology Pvt. Ltd.** (signed on 21 August 2020). The project is funded by GE India Technology Pvt. Ltd.
2. A 3-month **grant agreement** with **Mr. Venkata Sudhakar Namala**, Director of Finance, **United Way of Bengaluru**, to *support grantees mission in combating COVID-19* (signed on 7 June 2020). The Project was funded by United Way of Bengaluru.

To oversee the mental and physical health of the students and staff at JNCASR, 2 new **service agreements** were signed:

1. **Prof. Umesh Waghmare** signed a 1-year agreement with **M/s. YourDost Health Solution Pvt. Ltd** for *online counselling services* (signed on 20 November 2020)
2. **Mr. Joydeep Deb**, Administrative Officer, JNCASR, signed an agreement with **Manipal Northside Hospital** for *providing medical facility to the JNCASR Community* (signed on 15 December 2020).

Prof. Jayanta Haldar, JNCASR and **Prof. Burkhard Bechinger**, **University of Strasbourg**, joined forces with a 4-year **collaborative research agreement** for '*Development and Biophysical Investigations of Small Antimicrobial Peptide Mimetics*' (signed on 1 September 2020). This project is funded by the University of Strasbourg, France.

An existing collaboration between **M/s. Clevergene Bicorp Pvt Ltd**, Bengaluru, and **JNCASR** for *managing the Next Generation Sequencing Facility at JNCASR*, which is funded by the former, was renewed with a 3-year **memorandum of understanding (MoU)**, signed by **Dr. Kushagra Bansal**, of JNCASR, and **Mr. Tony Rose**, CEO, **M/s. Clevergene Bicorp Pvt. Ltd.**, Bengaluru (signed on 10 November 2020).

AGREEMENTS SIGNED

Prof. G. U. Kulkarni, JNCASR, signed for a 6-month **consultancy project** with **Dr. Shyam**, Head Graphene Technologies and Applications, **Tata Steel Ltd.** Jamshedpur, titled the '*Market Sensitization of Graphene Products Developed In-house*' (signed on 14 September 2020). The project was funded by Tata Steel Ltd., Jamshedpur.

The following memorandums of agreement (MoAs), non-disclosure agreements (NDAs), and material transfer agreements (MTAs) were signed as well:

TWO NDAs



- 1 Between **Prof. Jayanta Haldar**, of JNCASR, and **M/s. Boyce Biosynthesis** (for 3 years; signed on 16 December 2020)
- 2 Between **Prof. T. Govindaraju**, **New Chemistry Unit**, JNCASR, and **Dr. Nitin K. Damle**, Sr. Vice President and Chief Innovation Officer, **M/s. Sun Pharma Advanced Research Company. Ltd. (SPARC)** for a mutual confidential non-disclosure (for 3 years; signed on 15 March 2021)

TWO MTAs



- 1 Between **Prof. Ranga Udaykumar**, JNCASR, and **Mr. Brian Smith**, Associate Director, **Griffith University, Australia** (for 7 years; signed on 17 November 2020)
Project: Academic Research related to COVID-19/SARS-CoV-2
- 2 Between **Prof. Maneesha Inamdar**, JNCASR, and **Dr. Suresh Subramani**, Global Director, **Tata Institute for Genetics and Society, Bengaluru** (for 3 years; signed on 14 April 2021)
Project: Human Stem Cell Lines- BJNhem19 and BJNhem20

AGREEMENTS SIGNED

FIVE DBT FUNDED GRANT AGREEMENT-RELATED MOAs

Project:

Small Molecular Mimics of Antimicrobial Peptide to Tackle Eye Infections

Between
Prof. Jayanta Haldar,
JNCASR
and
Dr. Prasahanth Garg of L.V. Prasad Eye Institute,
Hyderabad

(for 3 years; signed on
8 Sep 2020)

Project:

Investigating the Role of Peroxisomes in Parkinson's Disease

Between
Prof. Ravi Manjithaya,
Co-PI, JNCASR
and
Dr. Shirisha Nagotu, Project
Co-ordinator, IIT Guwahati,
Assam

(for 3 years; signed on
29 Sep 2020)

Project:

Characterization of the Genome-wide Alterations Associated with Drug Resistance in *Candida Tropicalis*

Between
Prof. Kaustuv Sanyal,
JNCASR
and
Dr. Arunaloke Chakrabarti,
Post Graduate Institute of
Medical Education and
Research

(for 3 years; signed on
29 Sep 2020)

Project:

Next Generation Advanced Therapies for Fight β -hemoglobinopathies via Rational Intervention in γ -globin Regulatory Network

Between
Prof. Tapas Kumar Kundu, PI, and
Prof. T. Govindraju,
Co-PI, JNCASR
and
Prof. Siddhartha Roy (PI), and
Prof. Gautam Basu (Co-PI), Bose
Institute, Kolkata, and **Prof. Yakov**
(Kobi) Benenson, Swiss
Investigator, **Swiss Federal**
Institute of Technology,
Switzerland

(for 4 years;
signed on 01 Oct 2020)

Project:

Exploration of Novel Molecular Entities and Pathways in Neuronal Excitation Intrinsic to Neuropathic Pain to Identify and Design Inhibitors for its Treatment

Between
Prof. James P. C. Chelliah,
JNCASR
and
IISc, Bengaluru

(for 3 years; signed on
16 Mar 2021)

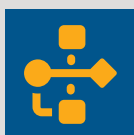
TECHNICAL RESEARCH CENTRE



The inception

The Technical Research Centre (TRC) Programme was launched in 2016 with support from the Department of Science and Technology (DST), Government of India. The TRC is a multi-faceted platform with a mission to support scientists and researchers in fostering the translation of scientific capabilities and intellectual properties into products and processes of national, social, and industrial importance by:

- supporting application-oriented projects that build upon background intellectual property (IP) developed under JNCASR and create new IP;
- bolstering JNCASR industry partnerships to escalate commercialisation of the IP developed by JNCASR via out-licensing of IP/know-how, industry-funded research and development (R&D) projects, industrial consulting, and collaborative R&D projects;
- creating a conducive ecosystem to spin-off technologies/IPs developed by JNCASR; and
- developing the infrastructure required to perform translational R&D.



The framework

The TRC supports the scientific community in translating scientific discoveries and inventions into technologies, products, and services of social and industrial relevance. Accordingly, it has been instrumental in building a translation ecosystem for R&D at JNCASR by supporting advances in the technology readiness levels of background skills in R&D and IP rights; optimising the involvement of multiple stakeholders, including industry – academic partnerships; technology out-licensing; setting up platforms for start-ups; and strengthening and sharing state-of-the-art R&D infrastructure.

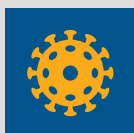


The journey

JNCASR structured the TRC programme in a way that significantly promoted translational research by striking the right balance between basic research, directed development, and deployment. Mandated to support technologies with high growth potential, TRC-supported translation projects aimed to address challenges in the areas of health, energy, transportation, solar energy, raw materials supply, resource efficiency, climate change mitigation, secure societies, and so on. In a nutshell, the TRC at JNCASR strengthened the translational capabilities of the scientific community to generate new knowledge that has tremendous application potential in addressing some of today's pressing challenges. In addition, the TRC has not only provided the resources needed to conduct applied research on the ground but has also encouraged the culture of translating such inventions into useful products and processes through industrial participation, commercialisation, and spin-off creation.

TECHNICAL RESEARCH CENTRE

This is reflected in the fact that the TRC has supported around 18 translational R&D projects at JNCASR in the last 5 years and around 6 application-oriented R&D projects, with success in translation through industry participation, out-licensing, and start-up creation. Accordingly, the TRC facilitated the industrial licensing of 17 technologies/IPs at JNCASR; built a rich pipeline of technologies/IPs, established 4 start-ups, including an exit from the first start-up; supported approximately 83 patents; published 38 peer-reviewed research papers; trained 56 researchers; structured collaboration with more than 15 industrial partners; established a state-of-the-art centralised R&D infrastructure accessible to a broader R&D community of academic and industrial stakeholders; and built a broader network of R&D stakeholders in a conducive innovation ecosystem.



SARS-CoV-2

In times of the COVID-19 pandemic, the TRC initiated several R&D projects with the translational potential to strengthen the nation's ability to meet health needs. To find an applicable solution to combat SARS-CoV-2, the TRC supported an R&D project to develop a 'high throughput assay to target the evolutionarily conserved proteases of coronaviruses'. This project has the potential to identify existing drugs that are also effective against SARS-CoV-2.

Scientists at JNCASR have developed an antimicrobial coating that can prevent the surface-mediated spread of infections. They have claimed that it is effective against various drug-resistant bacteria, fungi, and viruses, including the influenza viruses, and could therefore also be effective against SARS-CoV-2. While the novel compounds are being tested against SARS-CoV-2, the TRC is in discussions with several companies to deploy products based on this technology.



Translational activities in 2020–21

With the support of the TRC, JNCASR spun-off Breathe Applied Sciences Pvt. Ltd., the only Asian start-up among the 5 finalists for the \$20 million NRG COSIA Carbon XPRIZE—a global competition to develop breakthrough technologies to convert CO₂ emissions from power plants and industrial plants into valuable products such as alternative fuels. Breathe has also been recognised as a top-100 start-up by the Government of Karnataka under its prestigious Elevate programme.

As part of its technology commercialisation activities, the TRC has entered into a licensing agreement with an industry partner to develop a cardiovascular prognosis and diagnosis method based on computer imaging-assisted tools and the prediction of the fractional flow reserve (CT-FFR) using fluid dynamics.

TECHNICAL RESEARCH CENTRE

To enhance its interaction with industry stakeholders, the TRC facilitated an industrial partnership to analyse the coke deposit samples of aviation fuel produced under various process conditions. This study might help in the development of a viable strategy for limiting coke deposition to improve jet-engine performance.

To overcome challenges in health, energy, transport, solar energy, supply of raw materials, resource efficiency, climate change, etc., the TRC at JNCASR has initiated translational R&D projects viz. 'Hypothesis-free clinical diagnosis via macrocyclic "chemical-nose" sensor' for early detection of pre-eclampsia, which is a leading cause of maternal and perinatal mortality and morbidity in India; and 'Development of next-generation materials for water purification, storage, and harvesting'.

The TRC has established a collaborative research centre with an industry partner for the 'Study of convection with phase change and radiation'. Convection involving phase change has many engineering applications, such as solidification, chemical vapor deposition (CVD) processes, clouds, and fog in the atmosphere.

Scientists from JNCASR ICAR-NBAIR have jointly developed a technology: 'Mesoporous Silica Loaded with the Pheromone of Rhinoceros Beetle Red Palm Weevil, *Tuta absoluta*, and Fall Armyworm'. The technology is licensed to a Tamil Nadu-based large corporation for productisation and commercialisation in India and abroad. The product could be an answer to the farming community's quest for an economic and effective solution against the said crop-damaging insects.

In another significant development, the TRC supported a team of scientists from JNCASR and ICAR-NBAIR who successfully concluded an R&D project titled 'Controlled Release Dispenser for Delivery of Rice Stem Borer, *Scirpophaga incertulas*, Citrus Leaf Miner, *Phyllocnistis citrella*, Diamond Back Moth, *Plutella xylostella*, Fall Armyworm, *Spodoptera frugiperda*, and Tomato Pinworm, *Tuta absoluta pheromone*'. It was accomplished in partnership with ATGC Biotech Pvt. Ltd., a Hyderabad-based industrial partner, on account of its strength and experience in insect pheromones, integrated pest control solutions, large volume semiochemical synthesis, and pheromone intermediates, and its ability to contract research and manufacture specialty chemicals for agricultural use.

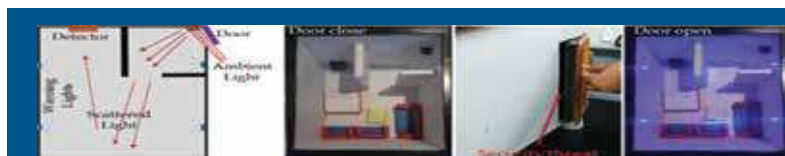
The project was originally embarked upon to develop nanomaterial for 2 insects, the rice stem borer and citrus leaf miner. However, over time, the project team felt the need to include other insects such as the tomato needle worm, American fall armyworm, cabbage diamond moth, brinjal shoot, and fruit borer. The team has developed nanoporous carbon spheres and tablets that can be used to deliver pheromones to these insects. The project progressed well with extensive field trials and encouraging results, reaching a stage where the technology will be produced and marketed by an industry partner to reach farmers at an affordable price, significantly reducing the use of pesticides and insecticides. The technology has already been scaled up at the production level and processed into bi-layer and monolayer pellets that can be used for different applications and that have been extensively evaluated in the field. The pheromone dispensers currently available in the market last only 14–20 days, whereas the dispenser developed in this project lasted for up to 90 days during field trials.

MEDIA REPORTS

The Centre has been in the news for various achievements during the year 2020–21. These are the following:

Energy-efficient and economical system for security applications

Prof. G. U. Kulkarni and his research team at JNCASR fabricated a gold-silicon interface that shows high sensitivity towards light, allowing it to detect weak scattered light as an indication of intrusions or unwanted activity.



Prototype of the energy and cost efficient photodetector
(Image from <https://dst.gov.in/jncasr-scientists-fabricate-energy-efficient-photodetector-security-application>)

Furthermore, the wafer-scale photodetector is economical, and energy-efficient, and shows a rapid response, making it suitable for security applications. Moreover, it could also have use as a prototype imaging system and lux and power meter.

🔗 'JNCASR Scientists Fabricate Energy-Efficient Photodetector for Security Application'.
Department of Science and Technology. 06 May 2020. <https://bit.ly/3nZmH7P>

Injectable hydrogel for sustained insulin delivery in diabetic patients

Prof. T. Govindaraju and his research team at JNCASR developed a silk fibroin (SF) formulation using biocompatible additives and prepared an injectable SF hydrogel (iSFH) that, once injected under the skin, can slowly release insulin-making delivery in diabetic patients.

🔗 Tweet by @AIRVijayawada, 16 May 2020. <https://bit.ly/3dCDMj7>

🔗 Tweet by @PBNS_India, 16 May 2020. <https://bit.ly/2Hflati>

🔗 'JNCASR Scientists Develop Injectable Hydrogel For Sustained Insulin Delivery In Diabetic Patients.' *EHealth*. 14 May 2020. <https://bit.ly/2FHdgsn>

Leading India's COVID prediction model

The Department of Science and Technology (DST) has started 'COVID-19 Indian National Supermodel' for prediction and monitoring of infection patterns. The project will aid decisions on health and mitigation measures. Two top institutes in Bengaluru—JNCASR and Indian Institute of Science (IISc)—will play a crucial role in the programme. 'It will aggregate successful evidence-based mathematical and statistical forecasting models and include the best predictive analytics for robust forecasting of infectious disease spread', the department said.

🔗 'Two Institutes in Bengaluru to Lead India's Covid Prediction Model.' *The Times of India*.
31 May 2020. <https://bit.ly/34bIMcA>

MEDIA REPORTS

JNCASR signs a memorandum of understanding (MoU) with Breathe Applied Sciences Pvt. Ltd.



In the photograph: (left to right) After the signing of the MoU between JNCASR and Breathe Applied Sciences Pvt. Ltd.—Prof. Umesh V. Waghmare, Professor, JNCASR; Prof. Sebastian C. Peter, Associate Professor, JNCASR—Founder Directors, Breathe Applied Sciences Pvt. Ltd. with Bharat Ratna Prof. C. N. R. Rao (centre), Linus Pauling Research Professor, JNCASR; Mr. Joydeep Deb, Administrative Officer, JNCASR; Prof. Chandrabhas Narayan, Dean, Research and Development, JNCASR; and Prof. G. U. Kulkarni, President, JNCASR

(Image from <https://dst.gov.in/jncasr-signs-mou-incubated-company-scaling-technology-reducing-co2-methanol-other-useful-chemicals>)

An agreement was signed between JNCASR and Breathe Applied Sciences Pvt. Ltd., a start-up company incubated at JNCASR for transfer of technology based on lab-scale research on reducing CO₂ to methanol and other useful chemicals and fuels. The laboratory research was carried out by Prof. Sebastian C. Peter and his group from the New Chemistry Unit (NCU) at JNCASR. The startup company was generously funded by the DST Nano Mission Project, with a focus on scaling up the technology to the pilot level and then commercialisation.

The MoU will help in the smooth translation of the research from the laboratory scale to pilot scale economically and in the development of an indigenous technology in line with government policy. The outcome is expected to solve the problems associated with renewable energy and environmental pollution.

- [🔗](https://bit.ly/37vCyoR) 'JNCASR Signs MoU with Incubated Company for Scaling up Technology for Reducing CO₂ to Methanol & Other Useful Chemicals.' *Department of Science and Technology*. 09 June 2020. <https://bit.ly/37vCyoR>
- [🔗](https://bit.ly/3mhJXMK) 'Bangalore-Based JNCASR Signs MoU With Breathe for Scaling Up Technology.' *Economics Times*. 10 June 2020. <https://bit.ly/3mhJXMK>
- [🔗](https://bit.ly/37y4ZIT) 'JNCASR Signs MoU With Incubated Company for Scaling Up Technology for Reducing CO₂ To Methanol & Other Useful Chemicals'. *Press Information Bureau*. 09 June 2020. <https://bit.ly/37y4ZIT>
- [🔗](https://bit.ly/3mc7Jti) 'Coal India, Steel Giant in Talks With JNCASR for CO₂ Reduction'. *The Times of India*. 10 June 2020. <https://bit.ly/3mc7Jti>
- [🔗](https://bit.ly/3jjuae9) Tweet by @VigyanPrasar. 10 June 2020. <https://bit.ly/3jjuae9>

MEDIA REPORTS

COVID Diagnostic Training Centre at JNCASR kicks off crash course in molecular diagnosis of infectious diseases focusing on COVID-19



Trainees at COVID Diagnostic Training Centre at JNCASR (Image from <https://dst.gov.in/covid-diagnostic-training-centre-jncasr-kicks-crash-course-molecular-diagnosis-infectious-diseases>)

JNCASR has established a state-of-the-art COVID Diagnostic Training Centre at its Jakkur campus to help build capacity for COVID-19 testing, which continues to be a nationwide challenge, as there is a lack of skilled personnel for real-time polymerase chain reaction (PCR)-based clinical diagnostics in India. Appreciating the importance of this, JNCASR has embarked upon a campaign to train personnel in real-time PCR for COVID-19 diagnostic testing. The primary objective of the programme is to train multiple batches of trainees, 6–10 trainees per batch, in real-time PCR. The first batch has undergone training from 16 to 22 June 2020, at the COVID Training Facility, JNCASR. Three batches have completed training so far.

🔗 'COVID Diagnostic Training Centre at JNCASR Kicks Off Crash Course in Molecular Diagnosis of Infectious Diseases Focusing on COVID-19.' *Department of Science and Technology*. 24 June 2020. <https://bit.ly/2TkZRJu>

🔗 'JNCASR Kicks Off Crash Course in Molecular Diagnosis of Infectious Diseases Focusing on COVID 19'. *Press Information Bureau*. 24 June 2020. <https://bit.ly/3mdataqm>

🔗 'Bangalore Corona Update: A First, Course on Covid Diagnosis Kicks Off.' *The Times of India*. 24 June 2020. <https://bit.ly/35oT9bb>

JNCASR spinoff launches molecular probes for use in COVID-19 test kits

VNIR Biotechnologies Private Ltd., a spin-off by JNCASR, launched indigenous fluorescent molecular probes and PCR mix as part of COVID-19 test kits for carrying out reverse transcription-PCR (RT-PCR)-based detection assays. The company is incubated at the Bangalore Bio-innovation Centre of the Government of Karnataka.

MEDIA REPORTS

Prof. T. Govindaraju and Dr. Meher Prakash, co-founders of VNIR, developed the fluorescence probes and PCR mix for the RT-PCR COVID-19 test kits. A typical PCR-based test kit has 3 critical components (oligos, enzymes, and molecular probes), of which the molecular probes used in COVID-19 tests have to be imported. Thus, with this new launch, the test kits will not have to rely on import of the molecular probes. Furthermore, apart from the immediate application for COVID-19 testing, these molecular probes will be useful for research as well as other molecular diagnostic assays.

🔗 'JNCASR Spinoff Launched Molecular Probes Used in COVID-19 Test Kits.'

Press Information Bureau. 12 July 2020. <https://bit.ly/31C5qYD>

🔗 'JNCASR Spinoff Launches Molecular Probes for Use in COVID-19 Test Kits.' *Biovoicenews.*

13 July 2020. <https://bit.ly/31zGoJw>

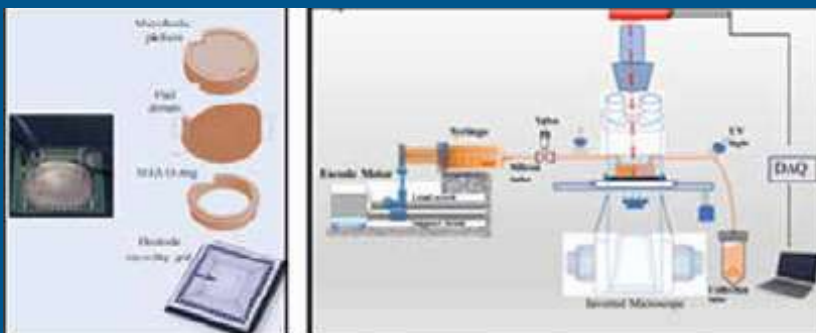
🔗 'Govt Launches Made in India Components of Virus Test Kit.' *Mint.* 12 July 2020.

<https://bit.ly/2Tjs5o6>

🔗 'DST Start-Up Launches Indigenous Fluorescence Probes Used in RT-PCR Tests'.

Deccan Herald. 12 July 2020. <https://bit.ly/2FYvO7C>

JNCASR scientists develop a device for long-term monitoring of cells and tissues and study drug delivery effects, tissue repair, and regeneration



Schematic of the device for the long-term monitoring of cells and tissues. (Image from <https://dst.gov.in/jncasr-scientist-s-develop-device-long-term-monitoring-cells-tissues-and-study-drug-delivery-effects>)

The need for monitoring of growth patterns of cells over long hours on desired substrates and the functionality of an explant-tissue in a non-vivo environment at a laboratory set-up triggered the research team led by Prof. K. S. Narayan from JNCASR to come up with a suitable device.

The team implemented a 3D-fluidic device (3D-FD), which has an auto bubble guidance geometry that allows controlled medium exchange to maintain the metabolites without a trace of fluid leakage and bubble formation. The auto bubble guidance geometry (helical pathway) and controlled delivery of the medium make it efficient as a drug screening platform and unique in the current scenario of neuro-technology.

MEDIA REPORTS

- 🔗 'JNCASR Scientists Develop a Device for Long-Term Monitoring of Cells & Tissues and Study Drug Delivery Effects, Tissue Repair and Regeneration.' *Department of Science and Technology*. 20 July 2020. <https://bit.ly/2IJUvFP>
- 🔗 'Long-term Monitoring of Cells & Tissues, JNCASR Scientists Develop a Device.' *APAC Digital News Network*. 21 July 2020. <https://bit.ly/3jd7dt2>

Elephants pick right or left side trunk preference at early age

The trunk is to an elephant what hands are to humans. Prof. T. N. C. Vidya and her research team studying elephant behaviour in Karnataka have come up with an interesting observation—elephant calves pick up their right or left-sided preference for trunk usage so early in life that this trait could be innate in them. This is analogous to humans showing distinct dextral or sinistral behaviour soon after birth. The team observed 30 'unique' calves from 11 distinct clans in the Kabini Project in Nagarhole and the Bandipur National Park in a span of 2 years.



- 🔗 Tweeted by Dr. Harsh Vardhan, Hon'ble Union Minister for Health and Family Welfare, Department of Science and Technology, Earth Sciences, Government of India on 24 July 2020.
- 🔗 'Elephants Pick Right or Left Side Trunk Preference at Early Age: Researchers'. *The Week*. 21 July 2020. <https://bit.ly/31nBoaX>
- 🔗 'How Young Asian Elephants Learn to Bend Their Trunks Left or Right'. *The Hindu*. 25 July 2020. <https://bit.ly/31ldpJk>
- 🔗 'Left or Right? Jumbo Calves Make Trunk Choice Early'. *Deccan Herald*. 23 July 2020. <https://bit.ly/31mtheH>
- 🔗 'Right or Left: Elephant Calves Pick Their "Trunk Handedness" Early on in Life'. *Research Matters*. 20 Jul 2020. <https://bit.ly/3dIMw7d>

MEDIA REPORTS

A unique way devised to observe the process of devitrification under a microscope, in real time

In a new study, Prof. Rajesh Ganapathy (Associate Professor, JNCASR) and researchers from IISc, Bengaluru, have devised a unique way to observe the process of devitrification under a



Image Credit: Rajesh Ganapathy

microscope, in real-time. Funded by the DST, Government of India, their study was published in the journal *Nat. Phys.* 17: 114–120. doi: 10.1038/s41567-020-1016-4

It is impossible to watch the dynamics of this transformation at a molecular level, as the constituent particles are very small. Hence, the physicists carefully chose to work with a glass made of polymer particles suspended in water.

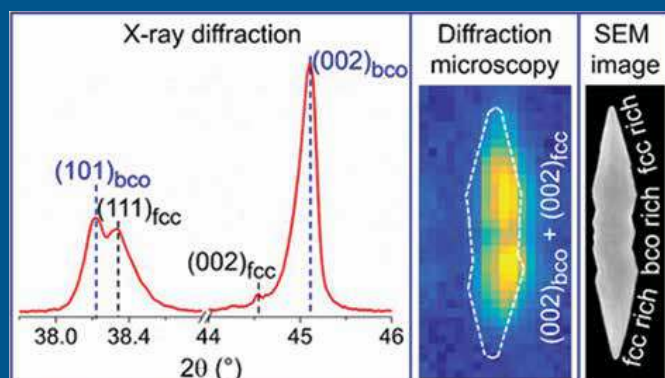
- [🔗](https://bit.ly/3kkdGDR) All India Radio News Services Division. 07 September 2020. <https://bit.ly/3kkdGDR>
- [🔗](https://bit.ly/3dNcpmh) 'Cracked: Scientists Show How Glass Crystallises in Real-Time.' *Research Matters*. 07 September 2020. <https://bit.ly/3dNcpmh>
- [🔗](https://bit.ly/2HITl2v) 'Indian Researchers Demystify Process of Transformation of Glass into Crystal.' *Deccan Herald*. 08 September 2020. <https://bit.ly/2HITl2v>
- [🔗](https://bit.ly/3kihblI) 'Indian Researchers Demystify Process of Transformation of Glass into Crystal.' *The Week*. 08 September 2020. <https://bit.ly/3kihblI>
- [🔗](https://bit.ly/37s2Log) 'Shanti Swarup Bhatnagar Awardee's Demystification of Transformation of Glass to Crystal Can Help Dispose Liquid Nuclear Waste Safely.' *Press Information Bureau*. 17 October 2020. <https://bit.ly/37s2Log>

New catalytic properties in gold discovered

Prof. G. U. Kulkarni (Professor, JNCASR) and other researchers from JNCASR, SINP, Kolkata, and DESY, Germany introduced new catalytic properties in gold by altering the most stable face-centred cubic (fcc) lattice, converting it into a new avatar that can trigger gold-based catalysis for industry.

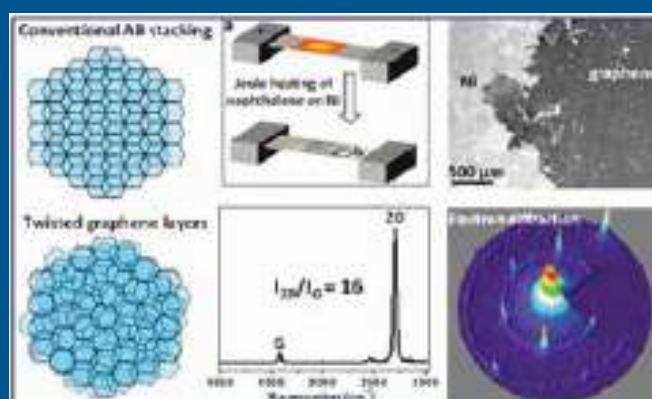
- [🔗](https://dst.gov.in/striking-gold-efficient-catalysts-industry) 'Striking Gold as Efficient Catalysts For The Industry.' *Department of Science and Technology*. 18 September 2020. <https://dst.gov.in/striking-gold-efficient-catalysts-industry>

MEDIA REPORTS



Correlation between X-ray diffraction, diffraction microscopy and the corresponding multi-phased diffracting volumes in the crystallite
(Image from <https://dst.gov.in/striking-gold-efficient-catalysts-industry>)

Scientists of JNCASR of DST develop a new low-cost method of upscaling the most conductive material 'graphene' while preserving its single-layered properties



Schematic of method and validation of method to upscale single-layer graphene production (Image from <https://dst.gov.in/new-low-cost-method-upscases-produces-twisted-multilayer-highly-conducting-graphene>)

A new low-cost method of upscaling production of graphene while preserving its single-layered properties, developed by Prof. G. U. Kulkarni (Professor, JNCASR) and his research group, may reduce the cost of producing this thinnest, strongest, and most conductive material in the world. Through their recent research work, the researchers have upscaled graphene production while retaining its thin-layered properties. This was made possible by a simple, affordable method wherein naphthalene-coated nickel foil was heated for a few minutes in an ordinary vacuum by joule heating and was cooled to get twisted layers of graphene. The study was published in *J. Phys. Chem. Lett.* 11 (8): 2797–2803. doi: 10.1021/acs.jpcclett.0c00582.

🔗 'New Low-Cost Method Upscales & Produces Twisted Multilayer Highly Conducting Graphene.' *Department of Science and Technology*. 19 July 2021. <https://bit.ly/2U9nmcc>

🔗 'Scientists of JNCASR of DST develop a new low cost method of upscaling most conductive material 'graphene' while preserving its single layered properties.' *Press Information Bureau*, 25 September 2020. <https://bit.ly/2HlwZOD>

MEDIA REPORTS

🔗 'New Low-Cost Method Upscales and Produces Twisted Multilayer Highly Conducting Graphene.' *The Graphene Council*, 17 September 2020. <https://bit.ly/37xq6VH>

🔗 Tweet by @IndiaDST. <https://bit.ly/3jlTP62>

🔗 'Low-Cost Approach Upscales and Produces Highly Conducting Graphene.' *EE Times India*. 28 September 2020. <https://bit.ly/35yErP5>

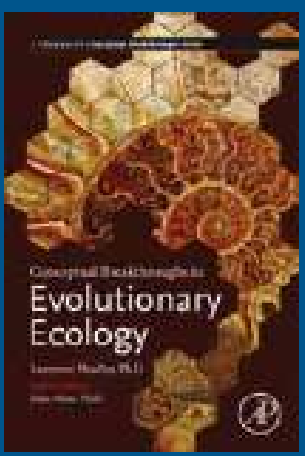
🔗 'New Low-Cost Method Upscales and Produces Twisted Multilayer Highly Conducting Graphene.' *DD News*. 2021. <https://bit.ly/2TcXlj9>

JNCASR evolutionary biology research one among 65 breakthroughs

The research work on 'the evolution of population stability as a by-product of life-history evolution' by the research team led by Prof. Amitabh Joshi of the Evolutionary and Integrative Biology Unit (EIBU), JNCASR, has been featured as one of the 65 breakthroughs in evolutionary ecology (from Darwin, 1859 onwards) in the recently published book: *Conceptual Breakthroughs in Evolutionary Ecology*, authored by Laurence Mueller, <https://bit.ly/2TegR4g>.

It is the only research work from a non-western country to be included in the 65 major breakthroughs selected in this book.

The study was published in the journal *Proc. R. Soc. Lond. B*. 270: S84–S86 doi: 10.1098/rsbl.2003.0020.



🔗 Tweet by @jncasr, 21 September 2020. <https://bit.ly/2IS3ZyT>

🔗 Tweet from @IndiaDST, 24 September 2020. <https://bit.ly/34eMroG>

🔗 'An Indian study conducted by the JNCASR of the Department of Science and Technology has found a place among the important discoveries in the field of ecology and evolution starting with the 'origin of species'.' *Press Information Bureau*, 23 September 2020. <https://t.co/5qUsy4XN4G?amp=1>

🔗 'Study by Indian Researchers Part of Book On Evolution.' 23 September 2020. <https://bit.ly/2Hk3xJd>

🔗 'An Indian Study by JNCASR of Department of Science and Technology Finds Place among Major Breakthroughs in Ecology and Evolution Counted from "Origin of Species".' *India Education Diary Bureau*. 23 September 2020. <https://bit.ly/2HigAul>

MEDIA REPORTS

Liquids behave differently on curved surfaces than flat ones

Prof. Rajesh Ganapathy and his team of physicists from JNCASR and IISc, Bengaluru, demonstrated novel experiments in the laboratory to study the behaviour of liquids and glasses on spherical surfaces. The study was published in the journal *Nat. Commun.* 11: 4967. doi: 10.1038/s41467-020-18760-7.

🔗 'Liquids Behave Differently on Curved Surfaces Than Flat Ones'. *Research Matters*. 02 October 2020. <http://bit.ly/34bKfNq>

Leading the Indian delegation at the virtual 2nd Meeting of BRICS Working Group on Photonics

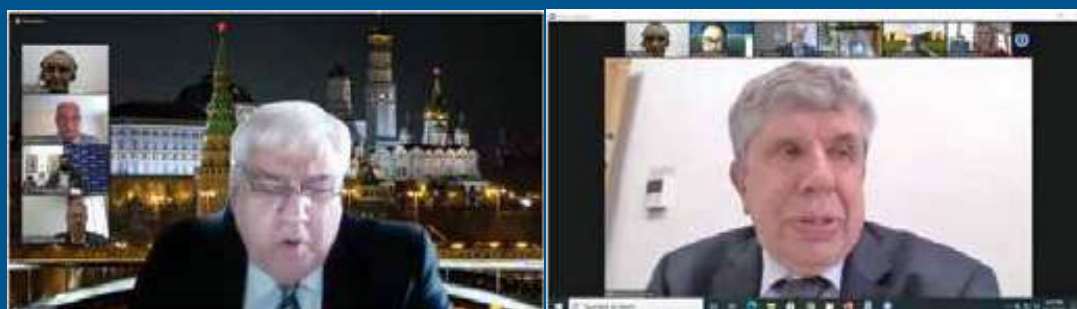


Image Credit:
@IndiaDST
on Twitter

Prof. Ranjani Viswanatha, Associate Professor, JNCASR, led the BRICS Working Group on Photonics during its 2nd meeting organised as a virtual event by Russia on 13 October 2020.

🔗 '2nd meeting of BRICS Working Group on Photonics'. *Department of Science and Technology*. 14 October 2020. <https://bit.ly/3meYUil>

Research by scientists of JNCASR opens up prospects of bio-inspired materials for energy and biotechnology sector

In their recently published work in *Nature Communications* (<https://rb.gy/u5b17b>), Prof. Subi George, a Bhatnagar awardee of 2020, and his group have shown that such bio-inspired structures are formed by assembling transient dormant monomeric molecules (basic units of polymers) by coupling them to a reduction-oxidation reaction network. They form a chemical entity called supramolecular polymers with strikingly dynamic properties. The properties arise because they are connected by non-covalent bonds, which are reversible bonds that hold their chains together. These dynamic properties open up prospects of many new applications of these materials.

The research by the team, which also included Krishnendu Jalani, Anjali Devi Das, and Ranjan Sasmal, is a major step towards the goal of chemists to harness blueprints of life to design innovative materials and provide future energy or biotechnology-related solutions.

MEDIA REPORTS

- 🔗 'Research by Scientists Of JNCASR Opens up Prospects of Bio-Inspired Materials for Energy and Biotechnology Sector'. *Ministry of Science and Technology*. 17 October 2020. <https://rb.gy/jraybl>
- 🔗 'Research by Scientists of JNCASR Opens up Prospects of Bio-Inspired Materials for Energy and Biotechnology Sector.' *India Education*. 17 October 2020. <https://rb.gy/9apjkw>
- 🔗 "Indian Scientists Develop Synthetic Material That Opens Up Prospects of Smart Materials for Energy And Biotech Sector'. *Swarajyamag*. 17 October 2020 <https://rb.gy/krdqta>
- 🔗 'Scientists of JNCASR Opens up Prospects of Bio-Inspired Materials for Energy and Biotechnology Sector.' *MrSocial News*, 19 October 2020. <https://rb.gy/uvhse4>

On the path to developing technically superior molecular probes

Professor T. Govindaraju and Dr. Meher Prakash, Co-founders, VNIR Biotechnologies Pvt. Ltd. mention the importance of developing 'molecular probes' locally and using them to make COVID-19 test kits and their components.

- 🔗 'On the Path to Developing Technically Superior Molecular Probes'. *World of Chemicals*. 4 January 2021. <https://rb.gy/6omhhv.ts>

Prof. T. Govindaraju (left) and Dr. Meher Prakash (right), co-founders, VNIR Biotechnologies Pvt. Ltd., mention the importance of



developing molecular probes used in manufacturing COVID-19 test kits for the Indian market. (Image from <https://www.worldofchemicals.com/media/on-the-path-to-developing-technically-superior-molecular-probes/5348.html>)

Recently discovered new ant species from Kerala is named in honour of JNCASR researcher, Prof. Amitabh Joshi from EIBU

In a paper published recently in the zoology journal *ZooKeys* (<https://zookeys.pensoft.net/article/58436/element/2/13//>), a team led by Prof. Himender Bharti of Punjabi University, Patiala, has described and named 2 new species of the rare ant genus *Ooceraea*. One of the new species, found in the Periyar Tiger Reserve of Kerala, has been named *Ooceraea joshii*, in honour of Prof. Amitabh Joshi. New species are typically named after some distinguishing attribute or location, but are often named after scientists as a means of honouring their research contributions to biology, especially in the fields of evolutionary and organismal biology, ecology, or systematics. The paper in *ZooKeys* states, under 'Etymology' for the new species name: 'The species has been named in honor of Professor Amitabh Joshi, a distinguished evolutionary biologist based at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru, India'.

MEDIA REPORTS



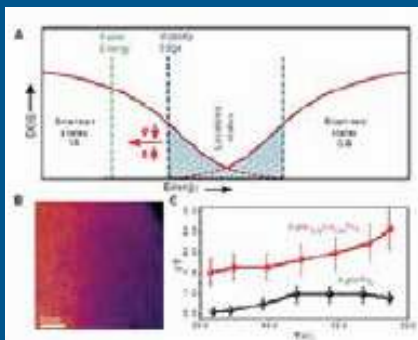
Image of an ant from the newly discovered species.

(Image from <https://zookeys.pensoft.net/article/58436/element/2/13/>)

- 'New Ant Species Discovered from Kerala Named After JNCASR Researcher, Evolutionary Biologist Prof. Amitabh Joshi.' Ministry of Science and Technology. 23 January 2021. <https://rb.gy/dnlvha>
- 'Scientists Find Two New Species of Rare Ant in Kerala, Tamil Nadu.' *Outlook India*. 23 January 2021. <https://rb.gy/g6x1wh>
- 'Two New Species of Ants Discovered from Kerala and Tamil Nadu.' *The Hindu*. 23 January 2021. <https://rb.gy/ulekfe>
- 'Two New Species of Rare Ant Found in Kerala, Tamil Nadu.' *Deccan Herald*. 23 January 2021. <https://rb.gy/jzuqdb>

New material found can efficiently convert waste heat to electricity to power small home equipment and vehicles

Dr. Kanishka Biswas and his team, from JNCASR have developed a material to tap waste heat generated by appliances and reuse it: The heat from the laptop, for example, can be used to charge a mobile phone. Or, that from the phone can be used to charge a small watch. Industrial processes and power plants produce ample amount of waste heat that can be utilised to do significant amounts of work. The key is to find an energy conversion process that can convert heat into the more convenient electrical energy, which can then be deployed to drive other machines or processes. The researchers now claim to have found a new material, Silver Antimony Telluride, that can facilitate this energy conversion. Their latest finding, which improves upon their own earlier work in this field, has been reported in the journal *Science*.



- A. Schematic of the atomic ordering optimisation strategy and its impact on thermoelectric parameters; electrical conductivity and Seebeck coefficient (S)
- B. Electron microscopic image exhibits the formation of cation ordering in 6 mol% Cd doped AgSbTe_2
- C. Temperature-dependent thermoelectric figure of merit, zT of pristine AgSbTe_2 , and 6 mol % Cd doped AgSbTe_2

(Image from <https://dst.gov.in/new-material-found-can-efficiently-convert-waste-heat-electricity-power-small-home-equipment>)

MEDIA REPORTS

- 🔗 'Power from Wasted Heat Could Help Run Gadgets.' *The Times of India*. 19 February 2021. <https://rb.gy/brifvl>
- 🔗 'Bengaluru-Based Scientists Develop Material to Tap Waste Heat Generated by Appliances and Reuse it.' *The Indian Express*. 20 February 2021 <https://rb.gy/wfhfii>
- 🔗 'Kudos! Bengaluru Scientists Develop Material For Efficient Conversion of Waste Heat into Electricity.' *The Financial Express*. 20 February 2021. <https://rb.gy/kirnpv>
- 🔗 'New Material Found can Efficiently Convert Waste Heat to Electricity to Power Small Home Equipment and Vehicles.' *Department of Science and Technology*. 18 February 2021. <https://rb.gy/29jiyh>
- 🔗 'Scientists Develop Lead-Free Material for Converting Heat into Electricity.' *Business Line*. 23 February 2021. <https://rb.gy/2uwozy>

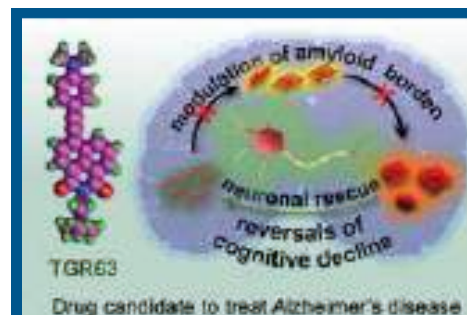
New molecule developed could be potential drug candidate for the treatment of Alzheimer's

A team of scientists led by Prof. T. Govindaraju from JNCASR have developed a small molecule (TGR63) that disrupts the mechanism through which neurons become dysfunctional in Alzheimer's disease (AD). The molecule could be a potential drug candidate to halt or cure the leading cause of dementia (70–80%) worldwide.

The scientists have designed and synthesized a set of novel small molecules and identified a lead candidate which they found could reduce the toxicity of Amyloid Beta ($A\beta$) toxicity.

The mice brain affected with AD when treated with TGR63 showed significant reduction of amyloid deposits validating its therapeutic efficacy. The mice also showed reduction of learning deficiency, memory impairment, and cognitive decline as revealed by distinct behavioural tests. These key attributes have validated the potential of TGR63 as a promising drug candidate for the treatment of AD.

- 🔗 'JNCASR Develops Molecule That May Help Treat Alzheimer's.' *The New Indian Express*. 25 February 2021. <https://rb.gy/eseayq>



Schematic of the mechanism of action of the new drug candidate for Alzheimer's.

Image Credit: Prof. T. Govindaraju

MEDIA REPORTS

- 🔗 'JNCASR Scientists Develop Molecule to Halt Dementia'. *The Pioneer*. 26 February 2021. <https://rb.gy/yajqgb>
- 🔗 'New Molecule Could be Potential Drug Candidate for Alzheimer's.' *The Times of India*. 26 February 2021. <https://rb.gy/hgkkg5>
- 🔗 'Scientists Develop New Molecule That Could Halt, Cure Alzheimer's.' *The Federal*. 25 February 2021. <https://rb.gy/pbssrc>

Prof. Tapas Maji and team mimic photosynthesis, convert CO₂ into solar fuel



CO₂ capture and conversion in aqueous medium under direct sunlight (artificial photosynthesis)

(Image from

<https://dst.gov.in/artificial-photosynthesis-provide-solutions-carbon-capture-and-conversion>)

Scientists have found a method to mimic nature's own process of reducing carbon dioxide (CO₂) in the atmosphere, namely, photosynthesis, to capture excess CO₂ in the atmosphere. This artificial photosynthesis (AP) harnesses solar energy and converts the captured CO₂ to carbon monoxide (CO), which can be used as a fuel for internal combustion engines.

In AP, scientists are essentially conducting the same fundamental process in natural photosynthesis but with simpler nanostructures. However, there are plenty of hurdles to overcome as a successful catalyst to carry out AP.

A team of scientists from JNCASR, an autonomous institute of the DST, Government of India, designed and fabricated an integrated catalytic system based on a metal-organic framework (MOF-808) comprising a photosensitiser (molecules which absorb light and transfer the electron from the incident light into another nearby molecule) that can harness solar power and a catalytic centre that can eventually reduce CO₂. The work described above has been accepted for publication in the journal '*Energy & Environmental Science*' of the Royal Society of Chemistry, UK.

- 🔗 'Artificial Photosynthesis to Provide Solutions for Carbon Capture and Conversion.' *Department of Science and Technology*. 17 March 2021. <https://rb.gy/yazx7q>
- 🔗 'Artificial Photosynthesis to Provide Solutions for Carbon Capture and Conversion.' *Press Information Bureau*. 18 March 2021. <https://rb.gy/bexwxl>

MEDIA REPORTS

🔗 'Researchers Mimic Photosynthesis, Convert CO₂ into Solar Fuel.' *The Times of India*. 18 Mar 2021. <https://rb.gy/o0l9g9>

New clue about how particles self-assemble can pave the way for understanding dynamics in living cells

Scientists from JNCASR, Bengaluru and IISc, Bengaluru, tuned the nature of the chiral activity of millimetre-sized rice-shaped grains with the help of 3D printing.

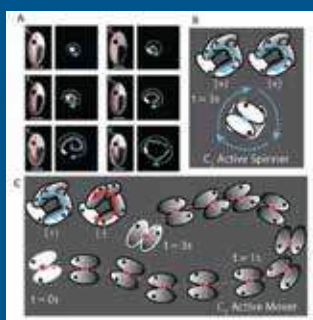
This is the first experimental study to uncover that even when objects are not chiral in shape, chirality inactivity alone can bring about selectivity and recognition between the interacting particles. This work published in the journal *Science Advances* (Sci. Adv. 7 (9): eabd0331. doi: 10.1126/sciadv.abd0331) recently opens new pathways to self-assemble matter by imparting the constituents with chiral activity.

The scientists said that by exploiting 3D printing to design chiral active matter, they can systematically encode different extents of chiral activity and explore its consequences on the emergent dynamical behaviour. Chirality-mediated selective interactions are of utmost importance in asymmetric catalysis, supramolecular polymerisation, medicinal drug designing, and separation where self-recognition, sorting, and discrimination of molecules are required.

🔗 'New Clue About How Particles Self-Assemble Can Pave the Way for Understanding Dynamics in Living Cells.' *Department of Science and Technology*. 05 April 2021. <https://bit.ly/2SOU1Aa>

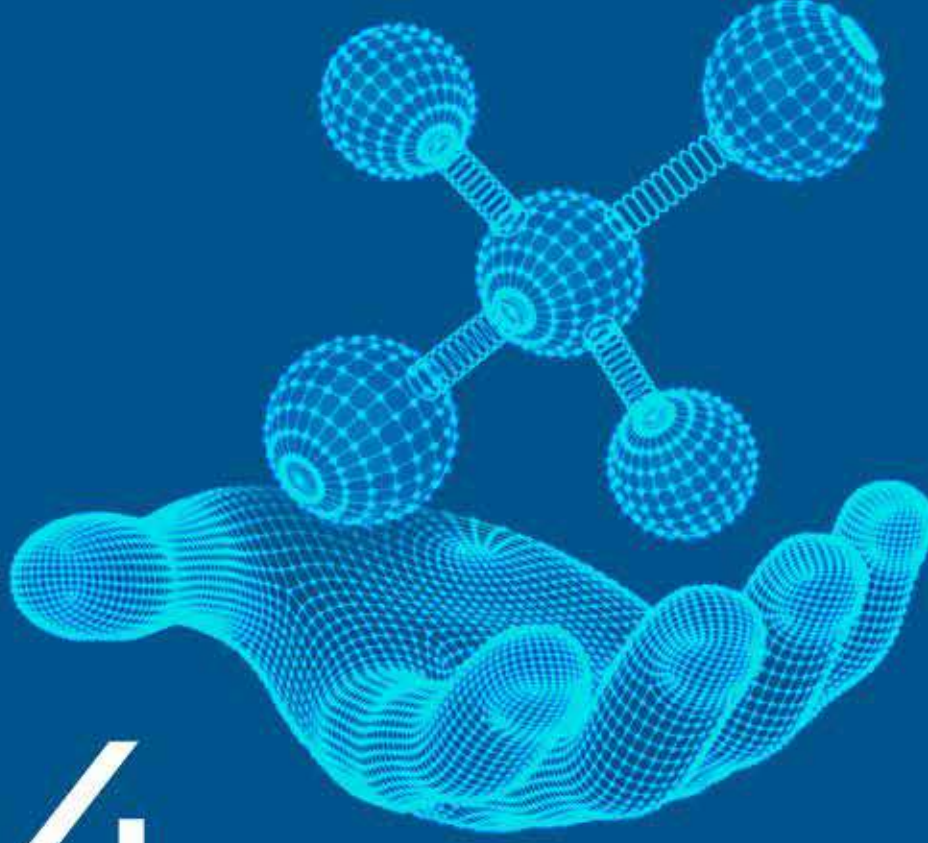
🔗 'New Clue About How Particles Self-Assemble Can Pave the Way for Understanding Dynamics in Living Cells.' *DD news*. 01 April 2021. <https://bit.ly/3d1NrkJ>

🔗 'New Clue About How Particles Self-Assemble Can Pave the Way for Understanding Dynamics in Living Cells.' *Press Information Bureau*. 31 March 2021. <https://bit.ly/3vISOMs>



(Left) Snapshots of 3D-printed chiral active ellipsoids for six different left-right mass asymmetries. The red dashed lines show the hollowed-out portion of the particle. (Right) Superimposed snapshots showing a nearly circular path traced by the ellipsoids under vertical agitation. The snapshot of the ellipsoid at $t = 0$ is shown in white. The blue arrows indicate the handedness of the orbit. (B and C) Superimposed snapshots of a representative active spinner and movers, respectively. The spinner is made of two clockwise (+) monomers while the mover is composed of a clockwise (+) and anticlockwise (-) monomer [top left in C], while the spinner is made of two (+) monomers [B]. Note that the spinner has a net clockwise (+) motion (blue dashed arrow), same as that of its components, and is localized in space.

(Image from <https://dst.gov.in/new-clue-about-how-particles-self-assemble-can-pave-way-understanding-dynamics-living-cells>)



04

FELLOWSHIPS AND OUTREACH ACTIVITIES

JNCASR recognises that science is for everybody. To disseminate scientific knowledge and make science more accessible, the Centre has sought to communicate its research with the public. The outreach programmes and events organised by the Centre were efforts toward this mission.

The Centre has also aimed to foster research excellence and inspire people to contribute to the wonders of scientific discovery. Through outreach events, and fellowship activities for students at the school and college level across the country, the Centre has pursued this objective.

The Education Technology Unit (ETU) and the Fellowships and Extension Programmes office work together to host these activities. The following section outlines their achievements.

FELLOWSHIPS AND EXTENSION PROGRAMMES

JNCASR offers a range of fellowship programmes for students of class 11 to undergraduate students, to give them an experience of research in their early phase of education in science. There are programmes for scientists working in research and development (R&D) institutions to give them an opportunity of working in state-of-the-art research facilities at JNCASR.



Student Buddy Programme for class 11 and 12 students

The aim of this programme is to share the latest advances in science and engineering with school-going and junior college students from class 11 and 12. This gives them a window into scientific research and also provides research scholars at the Ph.D. and postdoctoral level the opportunity to participate in educational programmes. Each school student spends a full day interacting with a research scholar, and has the opportunity to observe and/or participate in the research and discussion. Since its inception in 2015, the programme has catered to 434 students and 33 teachers. The 2020–21 edition was suspended because of the COVID-19 pandemic.



Summer Research Fellowship Programme (SRFP) for undergraduate and postgraduate students

Established in 1991, the SRFP is a flagship programme of JNCASR. Science and engineering students at the bachelors and masters level are placed at reputed institutions all over the country for two months to train in areas of their interest, which include the life sciences, chemical sciences, physical sciences, mathematics, and engineering. Selection is based on merit on an all-India basis. Around 150 fellowships are offered each year and the admitted students are given a fellowship of Rs. 10,000 per month. Students have praised this programme as enabling them to pursue scientific research during the early stages of their education. Several SRFP fellows have gone on to pursue a career in science, mathematics, and engineering, and hold responsible positions in India and abroad. So far 2,430 students have benefited but the 2020–21 edition was suspended because of the COVID-19 pandemic.



Project Oriented Chemistry Education (POCE)

This is a 3-year diploma programme which commenced in 2004 to foster an interest in science education and research in undergraduate students. Ten meritorious students who are pursuing a Bachelor's degree in Chemistry are selected from across the country each year. After their first year of studying a Bachelor of Science, students visit the Centre during semester breaks. They attend structured lecture programmes taught by highly accomplished scientists from JNCASR and other institutes in Bengaluru. After successfully completing the programme, they are

FELLOWSHIPS AND EXTENSION PROGRAMMES

awarded a Diploma in Chemistry. Most participants have gone on to study science and do research in renowned institutions nationally and overseas. Till date, around 122 students from different colleges across the country have passed through the programme. The 2020–21 edition was suspended because of the COVID-19 pandemic.



Project Oriented Biology Education (POBE)

This programme is similar to the POCE programme with 10 meritorious students who are in the first year of their Bachelor of Science degree in the life sciences being selected from across the country each year. Upon successfully completing the programme they are awarded a Diploma in Biology. Since its inception in 2006, 96 students from different colleges across the country have participated in the programme. The 2020–21 edition was suspended because of the COVID-19 pandemic.



Visiting Fellowships Programme

Scope: To foster collaborations with the Centre's faculty members and to provide research opportunities, JNCASR offers visiting fellowships to faculty/scientists working in state or central universities and R&D laboratories in India. Visiting fellows are associated with the faculty of JNCASR, and research work is carried out on campus.

Research areas

- Life sciences (including molecular and developmental biology, chronobiology, genetics, ecology, behaviour, neurobiology)
- Materials sciences (including nanoscience)
- Chemical sciences (including chemical biology; interfaces of chemical science with materials; solid-state chemistry; theoretical/computational chemistry; inorganic; physical; and organic chemistry)
- Physical sciences (including experimental and theoretical condensed-matter and materials physics, statistical physics, organic electronics; experimental nanobiotechnology)
- Engineering sciences (including fluid dynamics, nonlinear dynamics, thermal and chemical engineering); and
- Atmospheric sciences.

The Centre also offers visiting scientist fellowships to research scientists in educational institutions and R&D laboratories to work with the faculty of JNCASR. This programme has been welcomed by many young researchers who are able to hone their skills and work at research laboratories in their parent establishment after undergoing research training at the Centre. Since its inception in 2006, 111 research scientists/faculty members have benefited from the programme. The deadline for completing the programme has been extended to December 2021 owing to the COVID-19 pandemic.

FELLOWSHIPS AND EXTENSION PROGRAMMES



Institutional visits

With a view to popularise science and encourage motivated students to pursue science education and research, the Centre encourages students and teachers from schools, colleges, and universities to visit the campus. The 2020–21 edition was suspended because of the COVID-19 pandemic.



Graduate Research Internship Programme (GRIP)

This programme was initiated in 2021 to attract bright final year B.E./B.Tech./Masters in Science and Engineering/M.B.B.S. students to carry out quality research project work at JNCASR. The project work forms part of the degree requirement and the duration is for a semester. However, the duration can be extended for up to a year depending upon the requirement of the degree. The 2021 edition was suspended because of the COVID-19 pandemic.

MAJOR EVENTS ORGANISED BY FELLOWSHIPS AND EXTENSION OFFICE



National Science Day

The Fellowships and Extension office in association with the C. N. R. Rao Hall of Science and ETU celebrated National Science Day on 28 February 2021. Professor N. S. Vidhyadhiraja, the Dean of Fellowships and Extension, Dr. Bivas Saha, and Prof. Sebastian C. Peter, both from the New Chemistry Unit (NCU), gave lectures on various scientific topics as part of the celebration.



International Women's Day (IWD)

The Fellowships and Extension office in association with the C. N. R. Rao Hall of Science and ETU celebrated International Women's Day on 08 March 2021. Dr. Jahnavi Phalkey, director of the Science Gallery, Bengaluru gave a lecture titled Why History of Science? as part of the celebration.

MEMBERS OF FELLOWSHIPS AND EXTENSION OFFICE

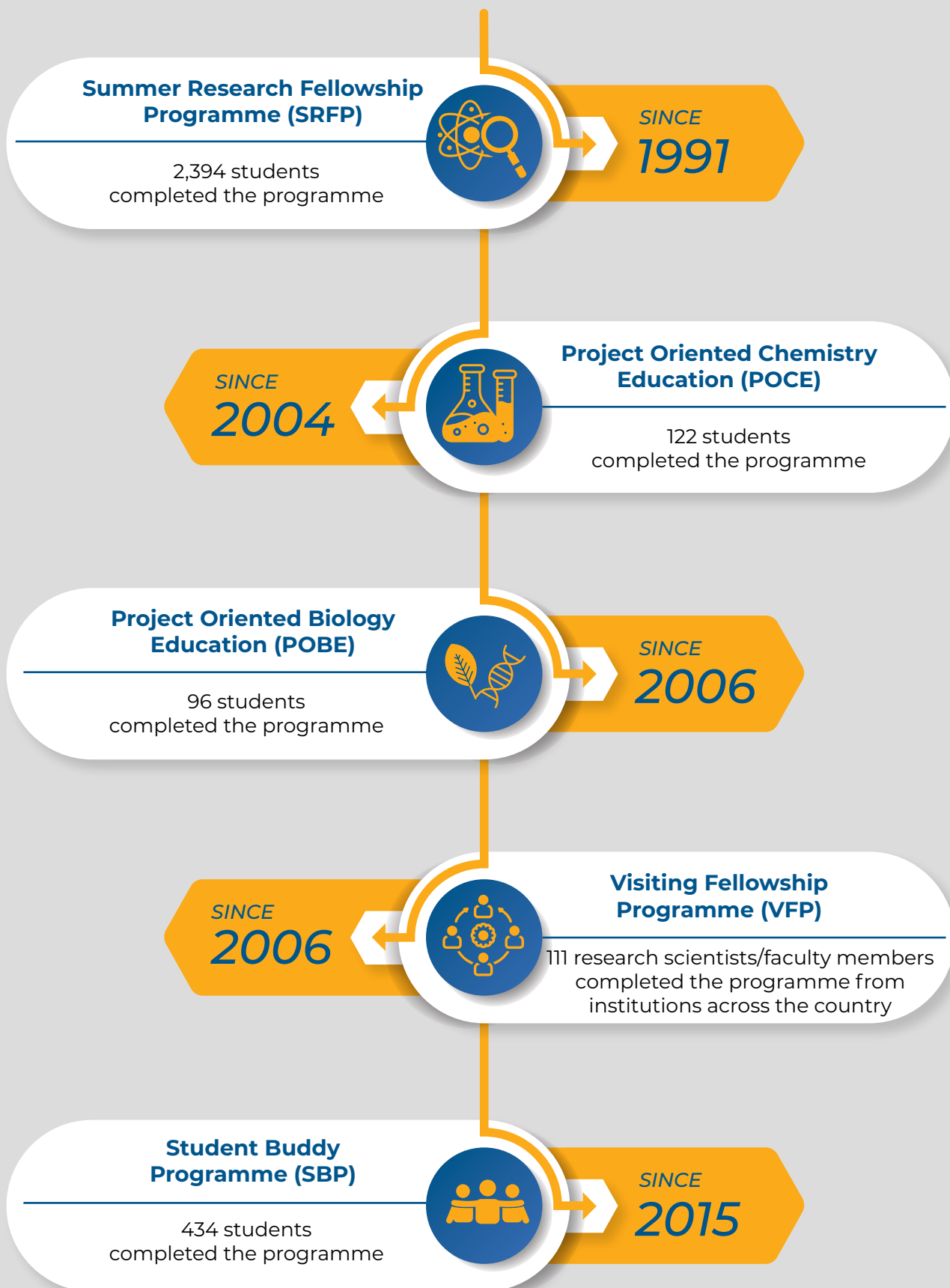
Dean, Fellowships and Extension Programmes: **Prof. N. S. Vidhyadhiraja**

Academic Co-ordinator: **Dr. Princy Jaison Pereira** (On Lien w.e.f November 2019)

Co-ordinator (Academic, Fellowships and Extensions and R & D): **Dr. Panneer Selvam K.**

Sr. Admin. Assistant Grade I: **Bannaiah R.**

FELLOWSHIPS AND EXTENSION PROGRAMMES



ETU

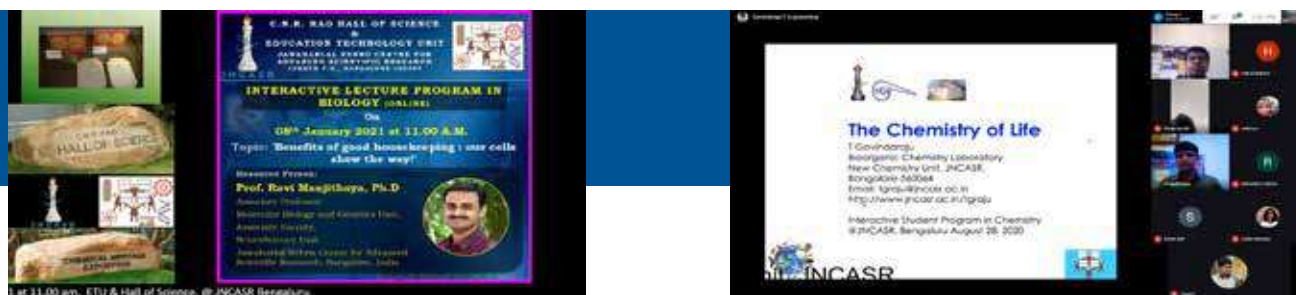


EDUCATION TECHNOLOGY UNIT

Our Education Technology Unit (ETU), in conjunction with C. N. R. Rao Hall of Science, organised several science outreach programmes in 2020–21. These were all short programmes for durations of 1 to 3 hours for high school teachers and students in various schools across the country. All of these programmes had to go virtual due to the pandemic and were conducted on Google Meet and YouTube Live. The following are the programmes:

Interactive lecture programme in chemistry

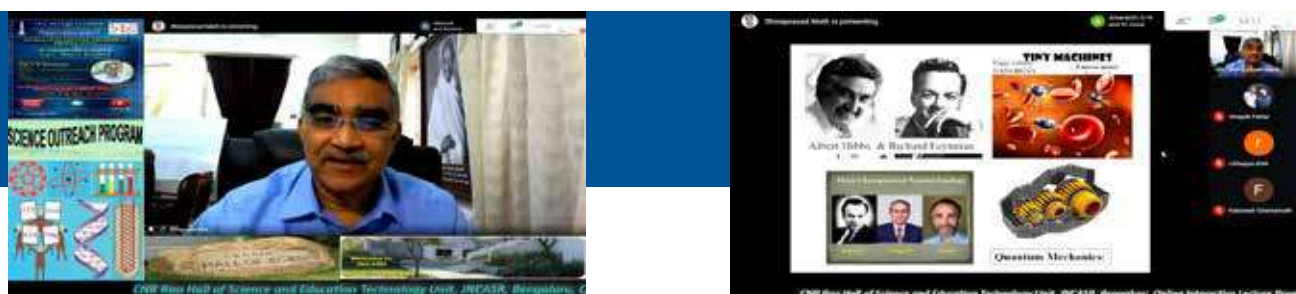
This was a session on 28 August 2020, featuring lectures by Prof. T. Govindaraju and Prof. Sridhar Rajaram from JNCASR. Thirty teachers and 370 students from classes 10 to 12 attended, from various schools in Karnataka (Shimoga, Nelamangala, Gadag, Vijayapura, Raichur, Hassan, Bangalore Urban and Rural).



Interactive lecture programme in Physics

On 15 September 2020, Prof. S. M. Shivaprasad from JNCASR delivered a lecture to 98 teachers and 650 students from classes 10 to 12 from various schools across Karnataka (Hubli, Hassan, Mysore, Belagavi, Vijayapur, Tumkur, Bangalore Urban and Rural, Gadag).

On 25th September 2020, Prof. N. S. Vidhyadhiraja from JNCASR delivered a lecture to 26 teachers and 320 students from classes 9 to 12 in schools across Karnataka (Bangalore Urban and Rural, Yadagir, Udupi, Gadag).



EDUCATION TECHNOLOGY UNIT

Interactive lecture programme in mathematics

This was a lecture given on 20 November 2020 by Smt. Seethalakshmi M. R. from Shimoga. Twenty four teachers and 300 students from classes 9 to 12 across Karnataka (Bagalakot, Vijayapura, Shimoga, Bangalore Urban and Rural, Gadag) attended.



Science outreach programme for teachers

This was conducted on 10 December 2020 by Prof. S. M. Shivaprasad of KHEA and JNCASR in classes 9 to 12 of schools in various parts of Karnataka (Bidar, Raichur, Mandya, Davanagere, Haveri, Tumkur, Vijayapur, Gadag, Hassan, Bangalore Urban and Rural). It was attended by 149 teachers and 135 students.



Learning chemistry through experiments

This was conducted on 29 December 2020, by Dr. K. Pramoda from JNCASR to 22 teachers and 298 students from classes 9 to 12 in schools across Karnataka (Mangalore, Kalaburagi Ramanagara, Mysore, Yadgir, Bangalore Urban and Rural, Gadag).



EDUCATION TECHNOLOGY UNIT

Interactive lecture programme in biology

On 8 January 2021, Prof. Ravi Manjithaya from JNCASR delivered a lecture to 16 teachers and 170 students from classes 9 to 12 in schools across Karnataka (Dharwad, Kalaburagi, Haveri, Bangalore Urban and Rural, Gadag).

On 5 February 2021, Dr. Shashank Tripathi from the Indian Institute of Science, delivered a lecture to 49 teachers and 320 students from classes 9 to 12 in schools across Kerala (Pathanamthitta and Ranni), Karnataka (Udupi, Mysore, Bangalore Urban and Rural), and Andaman and Nicobar Islands.



Learning physics through experiments

This was conducted on 22 January 2021 by Prof. N. S. Vidhyadhiraja from JNCASR and attended by 15 teachers and 385 students from classes 9 to 12 in schools across Karnataka (Uttara Kannada, Udupi, Davanagere, Belgavi, Vijayapura, Bangalore Urban and Rural).



National Science Day

This was held both virtually and in person at the AMRL conference hall on 28 February 2021. Dr. Bivas Saha, Dr. Sebastian C. Peter, and Dr. N. S. Vidhyadhiraja, all from JNCASR, presented the seminars, attended by 180 students and 31 teachers from all over India (Delhi, Lucknow, Noida, Pune, Haveri, Ramanagar, Bagalakot, Davanagere, Tumkur, Belagavi, Kalaburagi, etc.).



EDUCATION TECHNOLOGY UNIT

PROGRAMMES



10

NUMBER OF PARTICIPANTS



3128

Students



460

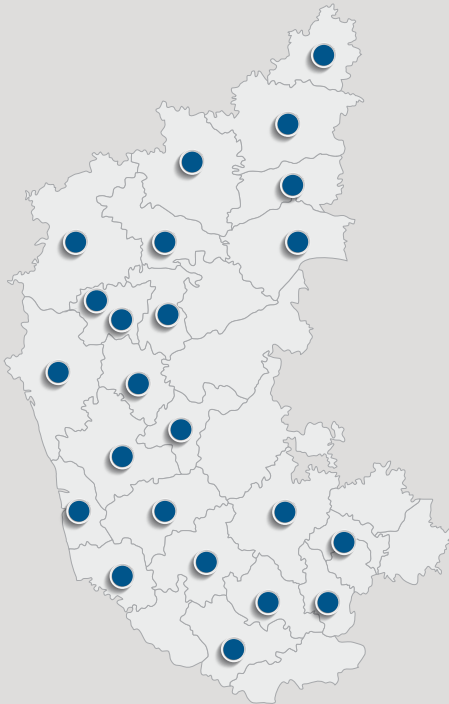
Teachers



3588

Total

OUR OUTREACH



Karnataka:

Bagalakot	Mangalore
Bangalore Urban and Rural	Mysore
Belagavi	Nelamangala
Bidar	Raichur
Davanagere	Ramanagara
Dharwad	Shimogga
Gadag	Tumkur
Hassan	Udupi
Haveri	Uttara Kannada
Hubli	Vijayapura
Kalaburagi	Yadagir
Mandya	

WE HAVE ALSO BEEN EXPANDING TO THE REST OF INDIA

Delhi

Noida

Kerala (Pathanamthitta and Ranni)

Lucknow

Pune

Andaman and Nicobar Islands





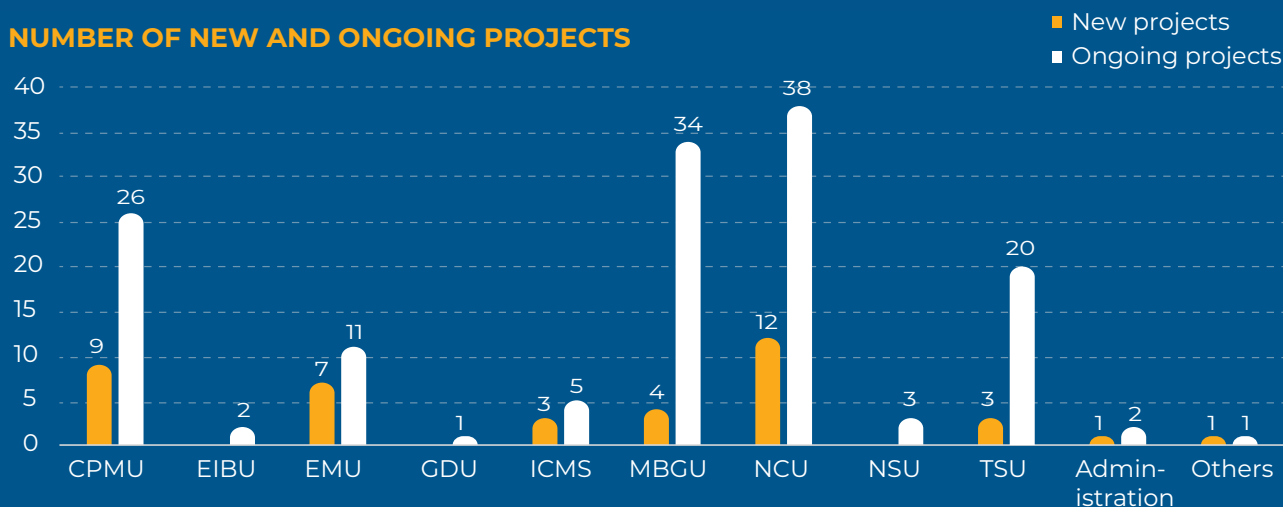
05

FUNDING AND FACILITIES

To pursue ground-breaking research and make discoveries, it helps to have state-of-the-art facilities and infrastructure. JNCASR is home to not only talented scientists but also specialised equipment and top-grade infrastructure. The Centre consistently improves its facilities as research needs change so that scientists have the best resources at their disposal. The following section describes the various facilities on offer, including new acquisitions and sponsored projects for this financial year.

SPONSORED PROJECTS

NUMBER OF NEW AND ONGOING PROJECTS



GRANT RECEIVED BY UNITS

New projects 2020-21



40

New sponsored projects



₹ 7.99 cr.

Total grant received for new projects



Ongoing projects 2020-21



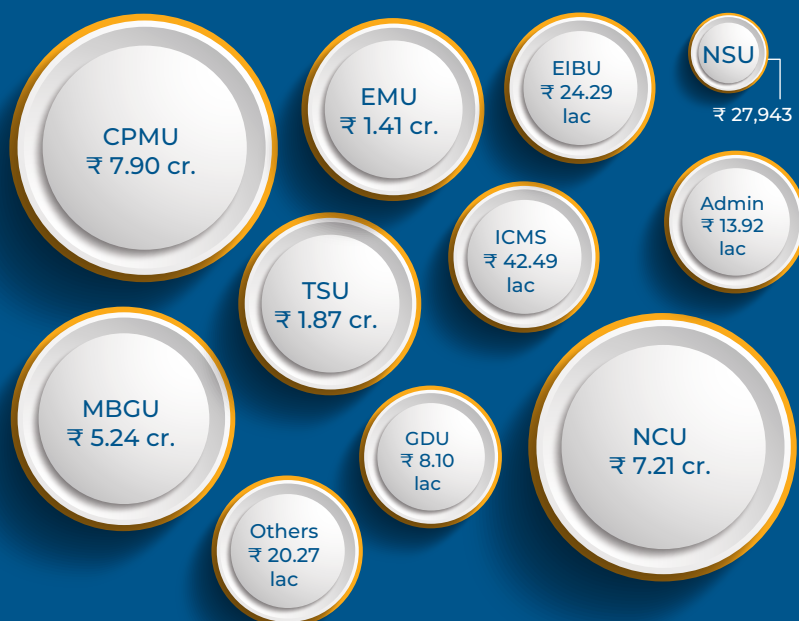
141

Ongoing sponsored projects



₹ 24.58 cr.

Total grant received for ongoing projects



SPONSORED PROJECTS

NUMBER OF ONGOING PROJECTS PER FUNDING PARTNER

39

Science and Engineering Research Board (SERB)

24

Department of Science and Technology (DST)

17

Department of Biotechnology (DBT)

8

SERB—J. C. Bose Fellowship

5

SERB—TARE

4

Indo-French Centre for the Promotion of Advanced Research

DST—Swarnajayanti Fellowship

Indian Institute of Science

3

Shell India Markets Pvt. Ltd.

Department of Atomic Energy—Board of Research in Nuclear Sciences

2

Asian Office of Aerospace Research and Development

Tata Steel Ltd.

Society for Research and Initiative for Sustainable Technologies and Institutions

DST—BRICS

Indo-Korea Science and Technology Center

Wellcome Trust/DBT India Alliance

The World Academy of Sciences

Bangalore International Airport Limited

Sunrise

Indo-US Science and Technology Forum

United Way of Bengaluru

Loreal India Pvt. Ltd.

Sheikh Saqr Laboratory

NIH—UNMC

Indian Institute of Technology—Roorkee

1

Renalyx Health Systems Pvt. Ltd.

Indian National Science Academy

Sankhyasutra Labs Pvt. Ltd.

TIGS

DBT—TIFA

University of Reading

Human Spaceflight Centre—ISRO

Biotechnology Industry Research Assistance Council

Indian Council of Medical Research

SPONSORED PROJECTS

NUMBER OF NEW PROJECTS PER FUNDING PARTNER

15

Science and Engineering
Research Board
(SERB)

4

SERB—J. C. Bose Fellowship
Indian Institute of Science

2

SERB—TARE

Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)
Department of Atomic Energy—Board of Research in Nuclear Sciences

1

The World Academy of Sciences
Indo-US Science and Technology Forum
University of Reading
Human Spaceflight Centre—ISRO
Tata Steel Ltd.
Department of Science and Technology
United Way of Bengaluru
GE India Technology Pvt. Ltd.
Wellcome Trust/DBT India Alliance
Indo-French Centre for the Promotion of Advanced Research
Society for Research and Initiative for Sustainable Technologies and Institutions



06

CENTRAL FACILITIES

Every discipline has its own research lab that comes equipped with resources and infrastructure unique to their needs. In addition, there is a wide range of common facilities, including knowledge resources, healthcare, and research equipment. In the following section, you will read about JNCASR's well-stocked library, which contains more than 9,500 books and provides access to over 4,000 scientific journals; the Dhanvantari health centre, where employees and students can take care of their medical needs; and the latest equipment that the Centre purchased in the last year.



LIBRARY

The JNCASR library is well-provisioned, with 9,720 books in its collection and access to over 4,000 scientific journals. The library continues to acquire, organise, and disseminate informational resources to render need-based information services to the faculty, students, and researchers. The library also offers services such as document delivery, interlibrary loan, current awareness, and bibliometric studies.

In the year 2020–21, 50 books were newly added. Additionally, 63 new patrons became part of the library, increasing the total to 695 current patrons.

In the current year, the expenditure for books was ₹ 25,612, while that for scientific journals was ₹ 59,07,398.

List of user orientation programmes organised:

1. Webinar on 'Using Orbit Intelligence, How to Perform Patentability' conducted by Orbit Intelligence on 13 May 2020.
2. Webinar on 'Selecting the Right Journal for Publication Using Web of Science'. Conducted by Clarivate Analytics on 8 June 2020.
3. Webinar on 'Supporting COVID-19 research Efforts: How to Make Your Search Strategies More Effective and Efficient' conducted by Clarivate Analytics on 25 June 2020.
4. Webinar on 'Peer Review and Publishing Ethics' conducted by the American Chemical Society on 10 August 2020.
5. Online training session on iThenticate plagiarism detection tool conducted by Turnitin on 27 August 2020.
6. Webinar on a topic based on Web of Science, i.e., 'The Importance of Older Research for Generating Novel Hypotheses' conducted by Clarivate Analytics on 7 September 2020.
7. Webinar on 'Accelerate Your Research and Patent Decisions Using SciFinder-n' conducted by CAS Scifinder on 21 December 2020.
8. Webinar on 'Advance Your Research Using SciFinder-n' conducted by CAS Scifinder on 18 January 2021.
9. Webinar on 'Introduction to Patent search platform—Orbit Intelligence—Understanding' conducted by Orbit Intelligence on 2 February 2021.
10. Webinar on 'Basic of Searching Patent in Your Technology Area' conducted by Orbit Intelligence on 9 February 2021.
11. Webinar on 'Advanced Searching Techniques for Patent Documents' conducted by Orbit Intelligence on 16 February 2021.
12. Webinar on 'Analysis Techniques for Your Result Set' conducted by Orbit Intelligence on 23 February 2021.
13. Webinar on 'Decoding the Predatory Journal Menace' conducted by Elsevier Science on 18 February 2021.
14. 4-day online training session of SciFinder/Taylor & Francis/Web of Science/InCites/Derwent Innovation from 23 to 26 March 2021 conducted by National Knowledge Resource Consortium (NKRC).

LIBRARY

STAFF MEMBERS OF THE LIBRARY

Senior Library cum Information Officer: **Nabonita Guha**

Senior Library cum Information Assistant Grade I: **Nandakumari E., Nagesh Hadimani**

Senior Helper: **Rajeeva J.**

Library Trainee: **Shruti Kude**

New books added:

50

Total books in collection:

9,720



Number of journal subscriptions:

142

Number of resources supported by the NKRC:

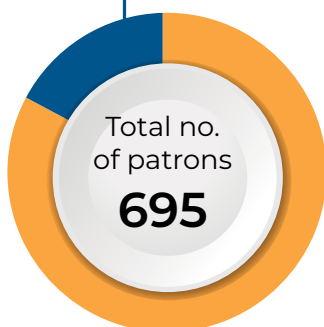
4,000+

Total books circulated



New patrons

63



Article requests fulfilled

69

User orientation programmes organised

14

COMPUTER LABORATORY (COMPLAB)



Network

JNCASR has a high-speed Local area network (LAN) which can support up to 10 Gbps of intranet connectivity. In the year 2020–21, efforts were made to ensure the steady availability of an integrated internet bandwidth of 600 Mbps, while further executing infrastructural upgrades to increase the internet bandwidth to 1 GBPs. This increased bandwidth is expected to ensure an average bandwidth of 100 Mbps per person on the campus.



Email

A number of new policies have been implemented to ensure the proper functioning of the email facility.



Secure and enhanced Wi-Fi

A high-speed wireless network of 802.11 b/g/n/ac has been successfully installed on campus. The entire campus has been covered with 210 Instant Access Points. Each Access Point can provide 350 Mbps to 500 Mbps of network connectivity at 802.11 b/g/n/ac. The campus Wi-Fi is fully configured with security modules. Wi-Fi users are authenticated via our centralised LDAP and CPPM servers. Permanent staff have available MAC-based authentication options and guests can authenticate their Wi-Fi connection via email and host verification. The Centre also has a signed subscription for the Eduroam Wi-Fi facility on campus.



Enhanced network management system

The network management system has been set up to ensure the security and redundancy of servers and other interconnecting devices such as the core switch, and firewall. All critical network components have been put on the active-active redundancy mode to increase network performance and provide continuous network connectivity across the campus.



Free software license for faculty and students

There is a free campus license policy where all faculty and students are given licenses to Mathematica, MATLAB, Intel Parallel Studio, and Microsoft Office 365, which support up to 5 device installations and include 5 TB Cloud storage.

COMPUTER LABORATORY (COMPLAB)



SMS notification

The Centre has signed an agreement with CDAC for push SMS notifications for campus users.

MEMBERS OF COMPLAB

Head, CompLab: **Prof. Subir K. Das**

Web Developer: **Chandan N.**

Technical Support: **Sathish Kumar P.**

Network cum System Administrator: **Santosh A. S.**

Onsite Engineers: **Rajeev Ranjan, Abhishek Kumar**



DHANVANTARI (JNCASR HEALTH CENTRE)

Activities and initiatives: The usual activities at Dhanvantari mainly involved running the outpatient department (OPD) from Monday to Sunday, which catered to all the permanent staff, students, and other temporary staff. Apart from the OPD, Dhanvantari also has a physiotherapy unit, which attended to the treatment of sports injuries and other common ailments. The clinical laboratory ran routine blood tests and urine tests. The biochemical tests were outsourced to RV Lab Metropolis, which is located in the city. The counselling centre functioned online. Finally, Dhanvantari regularly scrutinised the reimbursement of bills and kept the administration updated on various health fronts.

In light of the ongoing pandemic, a pre-employment exam was conducted for regular and temporary staff members, and their fitness was declared before they joined their duties. Dhanvantari also carried out medical examinations of food handlers, who worked periodically in the canteen. Like every year, an orientation program was held at Dhanvantari for new students.

In 2020–21, new initiatives were launched to handle the COVID-19 pandemic for the JNCASR Community. The main steps taken were tracing cases by identifying symptoms and signs, and then tracking those cases and regularly testing them on campus using RT-PCR via BBMP. Those found positive for the virus were isolated if their condition was mild and O₂ saturation was normal. Patients in isolation were provided a pulse oximeter and thermometer and advised treatment via teleconsultation. The total duration of the isolation was 14 days. Isolation was either in a transit facility or at home. All JNCASR COVID-19 patients were treated by Dhanvantari doctors. After the isolation period was completed, each patient underwent a fitness test at Dhanvantari. Whenever mild cases turned into moderate or severe cases during the monitoring period, patients were referred to designated COVID-19 hospitals for admission and followed up thereafter. This process was followed for all students and employees.

In early 2021, vaccines began to be given to JNCASR community members older than 18 years, including students.



DAY CARE

JNCASR Day Care

There have been no activities at the Day Care Facility, given that the pandemic has not abated, and we expect to re-open the Centre when we receive permission from municipal bodies. However, we have been using the time to finish repairs and construction work pertaining to the expansion of this facility.

Infrastructure



NEW RESEARCH FACILITIES

For cutting-edge research, one needs cutting-edge facilities. JNCASR has always provided its faculty and research students with top-notch facilities, the latest technologies, and the best available equipment. Some of those procured last year are listed below.



Chemistry and Physics of Materials Unit (CPMU)

Molecular compact rheometer MCR92, microwave analyser, Laben projection lithography basic system with accessories, upgradation of thermal evaporation system, optical beam shutter, ferroelectric test system, upgradation of LCMS system, real-time oscilloscope, time-correlated single photon counting (TCSPC) spectrometer system, micro Raman spectrometer Xplo RA plus, Renishaw inVia basis micro-Raman spectroscopy system



International Centre for Materials Science (ICMS)

Upgradation of imaging unit of FESEM, ICP spectrometer, super micro super server, electro-chemical workstation Bi-potentiostat.



Molecular Biology and Genetics Unit (MBGU)

CFX96 touch real-time polymerase chain reaction (PCR) system (COVID-19 lab), protein and nucleic acid, computer bundle and PM kit, superspeed centrifuges, centrifuge 5910 R refrigerated, gel documentation system, bioruptor pico sonication device, ion-chromatography mass spectrometer, ultra microtomy clamping system, phosphorImager systems—amersham typhoon, Innova stackable shaker Innove S44i Orbit, axiovert AL FL, iBright FLS00 imaging system.



New Chemistry Unit (NCU)

Tecan spark multimode, upgradation of LCMS system, CO₂ incubator bundle, HPPR/2 1 H2H NMR spectrometer spares, PH 0703 BB VMA SSB SMR spectrometer spares, dynamic heat flow differential scanning calorimeter, LFA micro flash laser flash apparatus, catalyst characterization system, MFC HEL model reactor test facility, multimode-8E system package with application module, freezer dryer, auto sample changer 24, Dynacool-9T cryogen-free PPMS base system, 450 Watt XE source, nitrogen generator, differential scanning calorimeter DSC-3, field emission scanning electron microscope (FESEM) with energy dispersive spectroscopy (EDS), Eppendorf cell culture centrifuge bundle.

NEW RESEARCH FACILITIES



Theoretical Sciences Unit (TSU)

Supply, installation, testing, and commissioning of IOKW DX based cooling system; Boston NAS storage server.



Neuroscience Unit (NSU)

Axiovert AL FL



07

FINANCIAL STATEMENTS

JNCASR prides itself on being accountable and transparent in all its operations. This extends to the financial side of running a top-class institution. The following section will show you an independent auditor's report on the Centre's income, expenditure, assets, and liabilities for this financial year.



INDEPENDENT AUDITOR'S REPORT

To
Members of Jawaharlal Nehru Centre for Advanced Scientific Research

Qualified Opinion

We have audited the accompanying financial statements of **M/s Jawaharlal Nehru Centre For Advanced Scientific Research, ("Institute")**, Jakkur, Bengaluru 560064, which comprises of the balance sheet as at March 31st 2021, the Income & Expenditure Account for the year then ended, the Receipts and Payment Account for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

In our opinion and to the best of our information and according to the explanations given to us, except for the effects of the matter described in the Basis for Qualified Opinion section of our report, the accompanying financial statements give a true and fair view of the financial position of the Institute as at March 31, 2021, and of its financial performance and its receipts and payments for the year then ended in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India (ICAI).

Basis for Qualified Opinion

Balances in certain accounts having **debit balance of Rs. 48,55,071/- and credit balance of Rs. 1,54,23,839/-** (net amount included) under **SCHEDULE 7- Current liabilities and provisions** relate to financial year 2015-16 or earlier and are subject to confirmation and reconciliation. In the absence of balance confirmation and reconciliation, the impact of these unreconciled balances on the profits/liabilities of the company is not ascertainable.

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Institute in accordance with the Code of Ethics issued by ICAI and we have fulfilled our other ethical responsibilities in accordance with the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our qualified opinion.

Emphasis of Matter

We draw attention to Note No. 2 of B. NOTES TO ACCOUNTS of Schedule 25 to the financial statements, which states that the balances of Loans and Advances & Current Liabilities are subject to confirmation by the parties and reconciliation. Our opinion is not modified in respect of this matter.

Responsibilities of Management and Those Charged with Governance for the Financial Statements.

Institute's Management is responsible for the preparation of these financial statements that give a true and fair view of the state of affairs, results of operations and receipts and payments of the Institute in accordance with the accounting principles generally accepted in India. This responsibility includes the design, implementation, and maintenance of internal control relevant to the preparation and





presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, the Institute's management is responsible for assessing its ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the Institute or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the Institute's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

As part of an audit in accordance with SAs, we exercise professional judgment and maintain professional skepticism throughout the audit. We also:

- Identify and assess the risks of material misstatement of the financial statements, whether due to fraud or error, design and perform audit procedures responsive to those risks, and obtain audit evidence that is sufficient and appropriate to provide a basis for our opinion. The risk of not detecting a material misstatement resulting from fraud is higher than for one resulting from error, as fraud may involve collusion, forgery, intentional omissions, misrepresentations, or the override of internal control.
- Obtain an understanding of internal control relevant to the audit in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the Institute's internal control.
- Evaluate the appropriateness of accounting policies used and the reasonableness of accounting estimates and related disclosures made by management.
- Conclude on the appropriateness of management's use of the going concern basis of accounting and, based on the audit evidence obtained, whether a material uncertainty exists related to events or conditions that may cast significant doubt on the Institute's ability to continue as a going concern. If we conclude that a material uncertainty exists, we are required to draw attention in our auditor's report to the related disclosures in the financial statements or, if such disclosures are inadequate, to modify our opinion. Our conclusions are based on the audit evidence obtained up to the date of our auditor's report. However, future events or conditions may cause the Institute to cease to continue as a going concern.


We communicate with those charged with governance regarding, among other matters, the planned scope and timing of the audit and significant audit findings, including any significant deficiencies in internal control that we identify during our audit.





We also provide those charged with governance with a statement that we have complied with relevant ethical requirements regarding independence, and to communicate with them all relationships and other matters that may reasonably be thought to bear on our independence, and where applicable, related safeguards.

For GRSM & ASSOCIATES
Chartered Accountants
FRN: 000863S


RAJGOPAL A
M.No.205296
Partner
UDIN: 21205296AAAACP4060



Place: Bengaluru
Date: 28th July 2021

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
BALANCE SHEET AS AT 31ST MARCH 2021**

Amount in Rs.

Description	Schedule No.	Current year 2020-21	Previous year 2019-20
Liabilities			
Capital/Centre's Development Fund	1	70,21,71,319	58,25,83,909
Reserves & surplus	2	2,16,05,50,118	1,98,73,86,731
Earmarked and endowment funds	3	96,15,48,728	1,00,68,80,776
Secured loans and borrowings	4	0	0
Unsecured loans and borrowings	5	0	0
Deferred credit liabilities	6	0	0
Current liabilities and provisions	7	7,65,65,959	14,98,72,992
Total		3,90,08,36,124	3,72,67,24,407
Assets			
Fixed assets	8	2,16,05,50,118	1,98,73,86,731
Investments-From earmarked/endowment funds	9	46,95,31,760	36,65,92,000
Investment - Others	10	28,30,20,013	29,25,08,890
Current assets, loans, advances etc.	11	98,77,34,233	1,08,02,36,787
Total		3,90,08,36,124	3,72,67,24,407
Significant accounting policies	24		
Contingent liabilities & notes on accounts	25		

Schedules 1 to 25 are integral part of accounts

**For Jawaharlal Nehru Centre for
Advanced Scientific Research**

As per our report of even date,
For GRSM & Associates
Chartered Accountants
FRN : 000863S



Rajgopal A
Partner

Membership No.: 205296
Place : Bengaluru, Date : 28/07/2021




Sampad Patra
Accounts Officer


Prof. G.U. Kulkarni
President


Joydeep Deb
Administrative Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2021

Amount in Rs.

Description	Schedule No.	Current year 2020-21	Previous year 2019-20
Income			
Income from sales/services	12	0	0
Grants/subsidies	13	71,67,00,000	68,14,70,000
Fees/subscriptions	14	53,00,708	61,68,379
Income from investments	15	0	0
Income from royalty, publication, licence fee etc.	16	3,01,954	3,73,941
Interest earned	17	13,67,228	51,32,407
Other income	18	95,38,080	89,25,605
Increase/decrease in stocks	19	0	0
Total (A)		73,32,07,970	70,20,70,331
Expenditure			
Establishment expenses	20	47,16,69,598	43,35,10,375
Other administrative expenses etc.	21	18,54,69,066	23,60,75,933
Expenditure on grants, subsidies etc.	22	0	0
Interest & bank charges	23	8,477	16,080
Depreciation		13,45,00,697	12,05,59,079
Less: Transferred from Capital Reserve		13,45,00,697	12,05,59,079
Total (B)		65,71,47,141	66,96,02,388
Balance being excess of income over expenditure (A-B)		7,60,60,829	3,24,67,944
Less: Prior period expenses		0	55,58,544
Balance being surplus/deficit carried to Capital Fund		7,60,60,829	2,69,09,400
Significant accounting policies	24		
Contingent liabilities & notes on accounts	25		

Schedules 1 to 25 are integral part of accounts

**For Jawaharlal Nehru Centre for
Advanced Scientific Research**

As per our report of even date,
For GRSM & Associates
Chartered Accountants
FRN : 000863S



Rajgopal A
Partner

Membership No.: 205296

Place : Bengaluru, Date : 28/07/2021




Sampad Patra
Accounts Officer



Prof. G.U. Kulkarni
President


Joydeep Deb
Administrative Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2021

Description	2020-21 Amount in Rs.	2019-20 Amount in Rs.
SCHEDULE 1- Capital Fund :		
A: Capital fund		
Opening balance	19,83,19,146	17,14,09,746
Add : Surplus/deficit in income and expenditure account	7,60,60,829	2,69,09,400
Total (A)	27,43,79,975	19,83,19,146
B: Centre's Development Fund		
Opening balance	31,54,87,424	29,21,21,295
Additions during the year	1,76,08,195	86,07,134
Income from investments out of Centre's Development Fund	2,39,99,439	2,34,85,117
Sub total	35,70,95,058	32,42,13,546
Less : Funds-utilisation/expenditure incurred	16,45,774	87,26,122
Total (B)	35,54,49,284	31,54,87,424
C: Grants for creation of Capital Assets		
Opening balance	6,87,77,339	-11,43,93,267
Add : Grants received during the year	31,00,00,000	41,13,46,000
Sub total	37,87,77,339	29,69,52,733
Less: Transferred to Capital Reserve upon acquisition of fixed assets	30,64,35,279	22,81,75,394
Total (C)	7,23,42,060	6,87,77,339
Total (A+B+C)	70,21,71,319	58,25,83,909
SCHEDULE 2- Reserves and surpluses :		
A: Capital Reserve		
Balance as at the beginning of the year	1,98,73,86,731	1,86,24,95,101
Add : Fixed assets addition during the Year out of Core grant	30,63,42,033	22,81,75,394
Add : Fixed assets addition during the Year out of Earmarked and endowment funds	13,22,051	1,72,75,314
Sub total	2,29,50,50,815	2,10,79,45,809
Less : Depreciation for the current year transferred to Income and Expenditure account	13,45,00,697	12,05,59,079
TOTAL	2,16,05,50,118	1,98,73,86,731



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2021

	FUND - WISE BREAK UP						TOTAL	
	Scheme Funds	Kiran Mazumdar Shaw - MBSRL	Chemical Heritage Exposition	Endowment Others	Student Residence, VSH& Dinning Hall	2020-21	2019-20	
A) Opening balance of the funds	85,58,06,167	-88,46,023	0	15,72,91,827	26,28,805	1,00,68,80,776	1,17,90,53,505	
B) Additions to the funds:								
i. Donations/grants	26,29,31,488	0	13,22,051	0	0	26,42,53,539	70,73,43,582	
ii. Income from investment made on account of funds	3,22,93,152	0	0	1,12,73,418	0	4,35,66,570	4,82,41,777	
iii. Others	0	0	0	0	1,03,80,628	1,03,80,628	1,82,23,991	
Total (A+B)	1,15,10,30,808	-88,46,023	13,22,051	16,85,65,245	1,30,09,433	1,32,50,81,513	1,95,28,62,854	
C) Utilisation/expenditure towards objectives of funds								
i. Capital expenditure								
- Fixed assets	13,45,56,619	0	13,22,051	0	0	13,58,78,670	33,98,08,678	
- Others	2,40,20,469	0	0	26,51,963	0	2,66,72,432	13,44,50,707	
Total	15,85,77,088	0	13,22,051	26,51,963	0	16,25,51,102	47,42,59,385	
i. Revenue expenditure								
- Salaries, wages & allowances etc	7,32,25,476	0	0	0	0	7,32,25,476	6,16,72,907	
- Other administrative expenses	11,74,07,219	0	0	0	1,03,48,989	12,77,56,207	41,00,49,786	
Total	19,06,32,695	0	0	0	1,03,48,989	20,09,81,683	47,17,22,693	
Total (C)	34,92,09,783	0	13,22,051	26,51,963	1,03,48,989	36,35,32,785	94,59,82,078	
Net balance as at the year end (A + B - C)	80,18,21,025	-88,46,023	0	16,59,13,282	26,60,444	96,15,48,728	1,00,68,80,776	



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2021

Description		2020-21 Amount in Rs.	2019-20 Amount in Rs.
<u>SCHEDULE 4- Secured loans and borrowings:</u>		0	0
<u>SCHEDULE 5- Unsecured loans and borrowings:</u>		0	0
<u>SCHEDULE 6- Deferred credit liabilities:</u>		0	0
Total		0	0
<u>SCHEDULE 7- Current liabilities and provisions</u>			
<u>A. Current liabilities</u>			
1. Sundry creditors :			
a. For goods	2,11,63,477		
b. Others - EMD/security deposit	1,13,61,711	3,25,25,188	9,29,38,937
2. Advances received :		3,11,698	9,29,328
3. Statutory liabilities :		28,70,167	8,19,499
4. Other current liabilities:		3,15,05,368	4,55,40,746
Total (A)		6,72,12,421	14,02,28,510
<u>B. Provisions</u>			
Stipend/salary payable		31,83,664	35,32,131
Expenses Payable		61,69,874	61,12,351
Total (B)		93,53,538	96,44,482
Total (A+B)		7,65,65,959	14,98,72,992



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH, JAKKUR POST, JAKKUR, BANGALORE 560 064
Schedules forming part of the accounts for the year ended 31st march 2021

SCHEDULE 8 - FIXED ASSETS

DESCRIPTION	GROSS BLOCK			DEPRECIATION			NET BLOCK			
	Rate	Cost/Value as at beginning of the year 2020-21	Additions during the year 2020-21	Dedn. during the year 2020-21	Cost/Value at the end of the year 2020-21	Depre. as at the beginning of the year 2019-20	Depre. On Dedn. during the year 2020-21	Total upto the year end 2020-21	as at the Current year - end 2020-21	Previous year - end 2019-20
Land - Free hold land	0.00	1,77,15,351	0	0	1,77,15,351	0	0	0	1,77,15,351	1,77,15,351
Buildings -										
Buildings	1.63	8,78,33,491	6,20,016	0	8,84,53,507	3,58,50,822	14,37,684	3,72,97,506	5,11,56,001	5,19,73,669
Hostel building	1.63	1,56,60,055	0	0	1,56,60,055	65,96,886	2,55,259	68,12,145	88,47,910	91,03,169
Advanced material research lab	1.63	2,59,30,339	0	0	2,59,30,339	71,60,697	4,22,665	75,92,272	1,83,38,067	1,87,60,732
Animal house	1.63	67,88,701	0	0	67,88,701	28,01,590	1,10,656	29,12,235	38,76,466	39,87,121
Staff housing	1.63	43,19,353	0	0	43,19,353	14,44,450	70,405	15,14,855	28,04,498	28,74,903
ETU building	1.63	30,81,348	0	0	30,81,348	8,11,695	50,389	8,62,074	22,29,274	22,70,663
Other buildings like extn. of hostel, college etc	1.63	1,18,83,626	0	0	1,18,83,626	29,55,920	1,93,703	31,49,623	87,34,003	89,27,706
Nano science lab	1.63	65,95,209	0	0	65,95,209	14,77,796	1,07,502	15,85,298	50,09,911	51,17,413
Engineering & mechanical lab	1.63	74,26,272	0	0	74,26,272	15,70,503	1,21,048	16,91,551	57,34,721	58,95,709
Dining hall & kitchen block	1.63	1,39,07,393	4,36,569	0	1,43,43,962	25,97,869	2,30,249	28,27,817	1,15,16,345	1,13,10,024
Hostel phase II	1.63	1,95,62,377	0	0	1,95,62,377	41,43,150	3,16,704	44,61,853	1,50,90,524	1,54,09,227
Lecture hall & academic block	1.63	96,36,712	0	0	96,36,712	20,24,414	1,57,078	21,81,493	74,55,219	76,12,298
Intl. centre for material sciences	1.63	5,01,48,316	0	0	5,01,48,316	96,31,876	8,17,418	1,06,49,293	3,94,99,023	4,03,16,440
International house	1.63	2,31,42,418	0	0	2,31,42,418	46,17,290	3,77,221	49,94,542	1,81,47,906	1,85,25,128
Hostel phase III	1.63	2,75,01,103	0	0	2,75,01,103	53,15,964	4,48,268	57,64,232	2,17,36,871	2,21,85,139
Prof. CNR Rao hall of science	1.63	1,03,33,669	0	0	1,03,33,669	20,00,648	1,68,439	21,69,087	81,64,682	83,33,021
Extension to HIV lab	1.63	10,16,085	0	0	10,16,085	1,98,745	16,562	2,15,307	8,00,778	8,17,340
Security office building	1.63	21,01,625	0	0	21,01,625	1,39,794	34,256	1,74,051	19,27,574	19,61,830
Radio activity - lab II	1.63	30,35,391	0	0	30,35,391	2,96,691	49,477	3,46,168	26,89,223	27,36,709
Sewage treatment building (STP)	1.63	2,91,699	0	0	2,91,699	61,812	4,755	66,566	2,25,133	2,29,887
Residential quarters - Adm. Officer	1.63	36,59,034	0	0	36,59,034	6,04,889	59,642	6,64,532	29,94,502	30,54,145
Child care centre	1.63	8,96,090	56,609	0	9,52,699	1,25,634	14,807	1,40,441	7,96,258	7,54,456
Extension to biology lab -2009	1.63	1,94,24,005	0	0	1,94,24,005	27,36,325	3,16,611	30,52,937	1,63,71,058	1,66,87,680
Animal house - Additional block	1.63	82,92,632	0	0	82,92,632	15,83,822	1,35,170	17,19,992	65,73,640	67,08,810
Hostel phase IV (62 rooms)	1.63	2,59,34,842	0	0	2,59,34,842	38,97,596	4,22,738	43,20,334	2,16,14,508	2,20,37,240
Extension to paulling building - Bio block	1.63	47,66,109	0	0	47,66,109	22,02,315	77,688	22,80,002	24,86,107	25,63,794
SCADA-DG room	1.63	2,40,660	0	0	2,40,660	31,383	3,923	35,306	2,05,354	2,09,277
Visiting students hostel	1.63	77,86,054	0	0	77,86,054	10,04,035	1,26,945	11,30,981	66,57,073	67,84,019
President's residence	1.63	3,39,82,070	0	0	3,39,82,070	44,01,200	5,53,908	49,55,107	2,90,26,963	2,95,80,870
Health centre	1.63	32,43,422	0	0	32,43,422	4,22,943	52,868	4,75,811	27,67,611	28,20,479
Nano institute-Shivanapura	1.63	37,09,242	0	0	37,09,242	4,83,687	60,461	5,44,147	31,65,095	32,25,555
Matr. science block - CCMS	1.63	5,54,31,961	0	0	5,54,31,961	67,50,383	9,03,041	76,53,924	4,77,78,037	4,86,81,578
Post doc housing- Srirampura	1.63	1,54,86,086	0	0	1,54,86,086	14,46,394	2,52,423	16,98,817	1,37,87,269	1,40,39,692
New auditorium	1.63	2,20,24,759	0	0	2,20,24,759	20,99,108	3,59,004	24,29,111	1,95,96,648	1,99,55,651
New auditorium phase II	1.63	4,99,08,687	0	0	4,99,08,687	24,22,538	8,13,512	32,36,050	4,66,72,637	4,74,86,149
EOBU lab block	1.63	2,09,11,646	0	0	2,09,11,646	24,98,368	3,40,860	28,39,228	1,80,72,418	1,84,13,278
Modern Biomedical Science Research Laboratory	1.63	6,91,86,143	0	0	6,91,86,143	10,95,769	11,27,767	22,23,536	6,69,64,607	6,80,92,373
Chemical Heritage Exposition	1.63	1,91,54,825	13,22,051	0	2,04,76,876	3,00,169	3,33,773	6,33,942	1,96,42,933	1,88,54,655
Extension to Engineering & Mechanical Unit (EMU)	1.63	1,24,86,836	21,29,876	0	1,46,16,712	1,43,744	2,38,252	3,81,996	1,42,34,716	1,23,43,082
Extension to Hall of Science	1.63	9,64,309	0	0	9,64,309	15,718	15,718	31,436	9,32,873	9,48,591
Infrastructure facility- Road, street lights, partitions etc	1.63	12,35,80,369	49,16,095	0	12,85,96,464	2,07,82,295	20,56,056	2,28,15,352	10,57,78,112	10,29,19,073



JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH, JAKKUR POST, JAKKUR, BANGALORE 560 004
Schedules forming part of the accounts for the year ended 31st march 2021 (SCHEDULE 8 - FIXED ASSETS - Contd....)

Plant/machinery/scientific equipments	4.75	1,17,22,86,916	20,28,16,914	93,245	1,37,50,10,585	50,14,03,798	6,31,86,322	0	56,45,38,121	81,04,12,465	67,08,77,118	1
Equipment carbon & nano materials	4.75	3,42,21,009	0	0	3,42,21,009	3,42,21,008	0	0	3,42,21,008	0	0	1
Equipment physics & chemistry of materi.	4.75	98,78,095	0	0	98,78,095	98,78,094	0	0	98,78,094	0	0	1
Equipment cluster studies	4.75	26,87,514	0	0	26,87,514	26,87,513	0	0	26,87,513	0	0	1
Equipment advance technology lab	4.75	2,02,02,562	0	0	2,02,02,562	2,02,02,561	0	0	2,02,02,561	0	0	1
Equipment magnet	4.75	70,90,855	0	0	70,90,855	70,90,854	0	0	70,90,854	0	0	1
ICMS-lab equipment/ lab facilities	4.75	39,93,37,774	0	0	39,93,37,774	12,38,77,695	1,89,68,544	0	14,28,46,239	25,64,91,534	27,54,60,079	1
Vehicles	9.50	61,63,340	0	0	61,63,340	50,98,922	5,85,517	0	56,84,439	4,78,901	10,64,418	1
Furniture and fixtures	6.33	10,19,07,457	1,53,81,282	0	11,72,88,739	9,08,10,009	69,33,911	0	9,78,03,920	1,94,84,819	1,10,97,448	1
Office equipments	4.75	2,49,92,222	21,67,718	0	2,71,59,940	1,55,75,991	12,78,506	0	1,68,54,007	1,03,05,933	94,16,721	1
Computer/peripherals	16.21	9,61,55,775	43,56,987	0	10,05,12,762	8,74,50,239	91,34,661	0	9,65,84,899	39,27,863	87,05,536	1
Electrical installations	1.63	12,82,54,261	10,85,433	0	12,93,39,694	2,13,82,301	26,99,391	0	2,34,81,692	10,58,58,002	10,68,71,960	1
Electrical installations - 2000 KVA DG SET	1.63	2,19,49,123	14,07,713	0	2,33,56,842	3,57,771	3,80,534	0	7,38,305	2,26,18,537	2,15,91,352	1
Library books	4.75	2,95,22,036	2,33,210	0	2,95,55,246	1,98,41,036	14,03,874	0	2,12,44,910	83,10,336	94,81,000	1
Library Journals	4.75	21,50,64,960	59,19,716	0	22,09,84,696	9,92,25,528	1,03,56,190	0	10,95,81,708	11,14,02,888	11,58,39,452	1
Tubewells & water supply	1.63	2,73,567	0	0	2,73,567	67,806	4,459	0	72,265	2,01,322	2,05,781	1
Other fixed assets												
Intangible assets-Softwares	40.00	4,01,78,132	92,35,361	0	4,94,13,493	3,59,94,812	64,49,393	0	4,24,44,205	69,69,288	41,83,321	1
Capital work in progress												
Basic infrastructure facilities - New campus - Chokkanalli	0.00	2,08,44,660	82,51,150	0	2,90,95,810	0	0	0	0	2,90,95,810	2,08,44,660	1
Hostel Phase - V	0.00	2,95,27,913	4,54,54,350	0	7,49,82,263	0	0	0	0	7,49,82,263	2,95,27,913	1
Sports Complex	0.00	25,960	0	0	25,960	0	0	0	0	25,960	25,960	1
Child Care Centre - Additional Room	0.00	0	8,39,868	0	8,39,868	0	0	0	0	8,39,868	8,39,868	1
Computer Lab - Pre Fab Structure	0.00	0	4,98,715	0	4,98,715	0	0	0	0	4,98,715	4,98,715	1
Estate Office	0.00	0	2,85,526	0	2,85,526	0	0	0	0	2,85,526	2,85,526	1
Library Renovation - Pre Fab Construction	0.00	0	3,42,164	0	3,42,164	0	0	0	0	3,42,164	3,42,164	1
Total		3,20,94,32,483	30,77,57,330	93,245	3,51,70,96,578	1,22,20,45,763	13,45,00,697	0	1,35,65,46,460	2,16,05,50,118	1,38,73,66,731	0
Previous year		2,96,39,81,785	24,87,47,093	2,96,385	3,20,94,32,493	1,10,14,86,684	12,05,59,079	0	1,22,20,45,763	1,98,73,86,731	1,86,24,95,101	0



Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2021

Description	2020-21 Amount in Rs.	2019-20 Amount in Rs.
SCHEDULE 9- Investments - Earmarked/endowment funds		
(Long term)		
Fixed deposits - Housing development finance corporation limited	8,10,90,265	6,50,25,000
Fixed deposits - PNB housing finance limited	32,54,41,495	23,85,67,000
Fixed deposits - Stock holding corporation of india	6,30,00,000	6,30,00,000
Total	46,95,31,760	36,65,92,000
SCHEDULE 10- Investments - Others		
(Current)		
Short term deposits	28,30,11,123	29,25,00,000
Others	8,890	8,890
Total	28,30,20,013	29,25,08,890
Schedule 11- Current assets, loans, advances etc.,		
Cash & bank balances (Schemes)		
Cash in hand	0	0
Cash at bank - Canara bank	12,33,34,649	9,25,78,835
Fixed deposits - Canara bank	17,45,79,761	15,47,76,135
Fixed deposits - Housing development finance corporation limited	20,98,60,000	24,12,40,000
Fixed deposits - PNB housing finance limited	22,20,00,000	26,15,00,000
Sub total	72,97,74,410	75,00,94,970
Loans and advances (Schemes)		
Interest accrued on fixed deposits	85,13,753	2,40,88,966
TDS receivable	70,58,630	66,97,847
Receivables from centre	0	1,43,83,329
Receivables from various funding agencies	5,64,74,232	6,05,41,056
Sub total	7,20,46,614	10,57,11,198
Total of Schemes	80,18,21,025	85,58,06,167
Cash & bank balances		
Cash in hand - Student Residence & VSH	10,674	22,010
Cash in hand - Dinning Hall	34,227	27,213
Cash in hand - Grant account	29,040	0
Cash at bank - Canara Bank - Grants account	5,47,58,948	2,03,09,314
Cash at bank - Canara Bank - FCRA account	1,19,140	11,31,185
Cash at bank - Canara Bank - Endowments account	4,53,10,513	2,41,90,411
Cash at bank - SBI	1,84,445	2,14,63,667
Cash at bank - HDFC	1,37,45,650	1,12,05,263
Cash at bank - Student Residence & VSH	9,55,458	20,07,225
Cash at bank - Dinning Hall	8,66,749	3,83,781
Sub total	11,60,14,845	8,07,40,070
Loans and advances		
Advances to staff	30,781	7,73,990
Deposits	39,98,967	27,02,467
Deposits - Dinning Hall	0	37,206
Interest accrued on earmarked/endowment funds	1,87,558	1,54,18,711
Other advances & receivables	1,71,33,309	3,22,58,970
Receivables- CSIR, UGC, DBT, DST	3,31,40,232	1,89,26,303
Endowment account - Receivables	46,62,000	6,31,51,778
TDS receivable - Grant account	40,83,785	40,99,012
TDS receivable - Endowment account	16,70,735	21,03,718
Imprest balance	20,000	75,000
Student Residence & VSH - Receivables	30,10,794	17,44,024
Dinning Hall -Receivables	8,97,042	12,52,006
Prepaid Expenses	10,63,160	11,47,364
Sub total	6,98,98,363	14,36,90,549
Total of other than Schemes	18,59,13,208	22,44,30,619
Total	98,77,34,233	1,08,02,36,787



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JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2021

Description	2020-21 Amount in Rs.	2019-20 Amount in Rs.
SCHEDULE 12- Income from sales/services	0	0
SCHEDULE 13- Grants/subsidies :		
Grants - DST	71,67,00,000	68,14,70,000
Grants - From government agencies/travel grants etc.	0	0
Grants - From other institutes	0	0
Grants - Other international agencies	0	0
Total	71,67,00,000	68,14,70,000
SCHEDULE 14- Income from fee/subscriptions etc :		
Income from fee, subscriptions, medical contribution etc.	53,00,708	61,68,379
Total	53,00,708	61,68,379
SCHEDULE 15- Income from investments;	0	0
SCHEDULE 16- Royalty income, publication, licence fee etc:		
From royalty	3,230	0
Licence fee	2,98,724	3,73,941
Total	3,01,954	3,73,941
SCHEDULE 17- Interest earned:		
From term deposits	7,75,974	44,79,725
Interest earned - Others	5,91,254	6,52,682
Total	13,67,228	51,32,407
SCHEDULE 18- Other income:		
From visitors house, guest rooms, students residence etc.	14,92,028	40,22,053
Prior year receipts	64,93,015	3,39,011
Miscellaneous income	15,40,712	45,04,249
From others (tender fee & other fee collected)	12,325	60,292
Total	95,38,080	89,25,605
SCHEDULE 19- Increase/decrease in stock:	0	0



Sampad Patra
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Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2021

Description	2020-21 Amount in Rs.	2019-20 Amount in Rs.
SCHEDULE 20- Establishment expenses:		
Salaries & scholarship to students	27,93,37,858	27,44,06,322
Wages	11,91,35,718	12,21,78,744
Allowances (Medical reimbursements etc.,)	88,21,841	1,04,09,396
Contribution to CPF	23,11,006	22,09,892
Contribution to new pension scheme	1,37,00,098	1,79,24,796
Contribution to group gratuity scheme	4,43,20,269	2,27,076
Leave encashment benefits	20,87,614	37,02,608
Retirement & Terminal Benefits- Pension	0	12,38,731
LTC	19,55,194	12,12,810
Total	47,16,69,598	43,35,10,375
SCHEDULE 21- Other Administrative expenses		
Electricity & power	5,88,79,083	6,39,38,624
Water charges	30,83,003	56,39,118
Insurance	10,36,637	3,64,265
Repairs & maintenance	5,78,81,630	7,00,34,242
Rents, rates & taxes	1,56,855	3,48,556
Vehicles running & maintenance	7,90,997	22,21,473
Postage, telephone & communication	30,61,026	24,18,255
Printing, stationery, books	42,73,522	50,70,483
Travelling and conveyance	11,86,304	22,42,544
Expenses on seminars/workshops/discussion meetings	53,69,457	50,06,086
Membership & subscriptions	12,83,525	14,43,564
Professional / Legal charges	1,72,140	2,46,845
Laboratory consumables	4,52,82,687	4,47,33,292
Advertisement & publicity	19,89,643	16,05,403
Student residence, guest house, I house, etc	8,07,262	28,91,728
Statutory audit fee	1,29,800	1,18,000
POBE & POCE programme	0	14,45,713
Summer research fellowship & student programme	80,000	30,77,106
ICMS - Workshops, Schools etc.,	0	34,82,043
ICMS - Visitor programmes (National & international)	0	15,027
ICMS - Recurring expenses	0	1,95,82,643
Loss on Asset Disposal	0	1,50,924
Foreign Exchange - Loss	5,496	0
Total	18,54,69,066	23,60,75,933
SCHEDULE 22- Expenditure on grants, subsidies etc;	0	0
SCHEDULE 23- Interest and bank charges:	8,477	16,080



Sampad Patra
Sampad Patra
Accounts Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH
2021**

SCHEDULE 24: SIGNIFICANT ACCOUNTING POLICIES

OVERVIEW:

Jawaharlal Nehru Centre for Advanced Scientific Research is a society registered under the Karnataka Societies Registration Act, 1960. It is also registered under section 35(1)(ii) of the Income Tax Act, 1961. It is an autonomous institution recognised and substantially funded by the Department of Science and Technology, Government of India.

The main objects of the Centre are to establish and conduct world-class research in science & engineering, foster interdisciplinary & collaborative research, establish state-of-the-art laboratories, computational & infrastructural facilities for conduct of scientific research, generate human capital through high-quality PhDs in science & engineering, increase awareness about science & research among school & college students through science outreach & extension activities and take research from laboratory to society.

SIGNIFICANT ACCOUNTING POLICIES:

1. Basis of Preparation

- a. **Accounting Conventions:** The financial statements are prepared in accordance with historical cost convention and on accrual basis of accounting unless otherwise stated.
- b. The financial statements are prepared as per the uniform form of financial statements for the central autonomous bodies issued by the Ministry of Finance, Government of India. These financial statements have been prepared to comply with the Accounting Standards issued by the Institute of Chartered Accountants of India.

2. Investments:

- a. Investments classified as long-term investments are carried in the financial statements at cost. However, provision for diminution, if any, are made to recognise a decline, other than temporary, in the value of the investments on an individual basis.
- b. Investments classified as current investments are carried in the financial statements at the lower of cost and fair value determined on an individual investment basis.

3. Fixed Assets:

- a. Fixed assets are stated at cost of acquisition, inclusive of inward freight, duties, taxes, and incidental expenses related to acquisition.
- b. Fixed assets received by way of non-monetary grants, are capitalised at values stated, by corresponding credit to Capital Reserve



- c. Depreciation on Fixed assets are provided on straight-line method at the below mentioned rates.

<i>Description of Asset</i>	<i>Depreciation Rate</i>
Building, Electrical Installations, Tube wells & Water Supply	1.63%
Plant, Machinery, Scientific, Electric & Office Equipment and Library Books & Journals	4.75%
Vehicles	9.50%
Furniture & Fixtures	6.33%
Computers & Peripherals	16.21%
Intangible assets – Computer Software	40.00%

Depreciation is charged at 50% of the above rates for assets used for less than 180 days during the year.

4. Government Grants / Other Grants:

- a. Grants are recognized in the accounts on realisation basis.
- b. Grants towards acquisition of capital assets are treated as Capital Reserve upon utilisation of such grants. Amount equivalent to the depreciation for the year on fixed assets acquired out of such capital grants are recognised as income and credited to the Income and Expenditure Account.
- c. Revenue Grants are directly recognised in the Income and Expenditure Account upon receipt.

5. Retirement Benefits:

- a. The centre has obtained group gratuity policy from the Life Insurance Corporation of India in respect of gratuity liability for its employees and accordingly, expenditure is recognised to the extent of premium paid annually.
- b. Expenditure on Leave Encashment are recognised upon actual payment i.e., the same is accounted on cash basis as and when the liability is discharged.

6. Allocation / Transfer to Schemes :

Interest earned on Bank Deposits (Investments) are allocated to various schemes based on the investment amount attributable to the Scheme.

7. Revenue/ Income Recognition

- a. Income from fee, subscriptions, medical contribution etc. are recognised on accrual basis on billing
- b. Royalty/ Licence fee is recognised on time proportion basis, based on the terms of agreement.
- c. Rental income from visitors' house, guest rooms, students' residences etc. are recognised based on occupancy for the month.



8. Foreign Currency and its Fluctuations :

The Foreign currency transactions are translated at the rates prevailing on the date of payment. Outstanding party balances as at the year end, denominated in foreign currency are re-stated at the closing rate and the consequent exchange difference is charged to the Income and Expenditure Account, except where it relates to procurement of fixed assets, in which case such exchange differences are capitalized with the respective fixed assets.

9. Prior Period Items :

Prior period items, being any income or expense, which has arisen in the current period as a result of errors or omissions in the preparation of the financial statements of one or more prior periods, are recognized as and when they are noticed and are shown separately.

SCHEDULE 25: CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

A. CONTINGENT LIABILITIES:

Contingent liability	2020-21 (Amount)	2019-20 (Amount)
1. Claims against the entity not acknowledged as debts	Nil	Nil
2. Letter of Credit outstanding	Nil	Nil

B. NOTES ON ACCOUNTS:

1. Income Tax: The Centre is registered under Section 35(1)(ii) of the Income Tax Act, 1961 and is eligible for exemption from tax and hence no provision has been made towards Income Tax.
2. Balances carried under Loans and Advances & Current Liabilities are subject to reconciliation and confirmation by the parties. The management is in the process of reconciliation of balances including the ones which are long outstanding.
3. Figures have been rounded off to the nearest rupee.
4. Figures of previous year have been regrouped and reclassified to conform to current year's presentation.



5. Schedules 1 to 25 are annexed to and form an integral part of the Balance Sheet as at 31st March 2021 and the Income and Expenditure Account for the year ended on that date.



Prof. G.U. Kulkarni
President



Joydeep Deb
Administrative Officer



Sampad Patra
Accounts Officer

Date : 28/07/2021
Place : Bengaluru

For M/s GRSM & ASSOCIATES
Chartered Accountants
FRN: 000863S



RAJGOPAL A
Partner
M. No.: 205296

**JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2021**

OPENING BALANCES & RECEIPTS	2020-21	2019-20	PAYMENTS & CLOSING BALANCES	2020-21	2019-20
I. Opening Balances:			I. Expenses:		
- Cash in hand & imprest at Centre	75,000	40,000	- Establishment Expenses	48,98,53,485	45,83,72,436
Bank balances:			- Administrative Expenses	19,82,72,944	24,07,68,254
<i>In savings bank Accounts:</i>			- Expenditure out of Endowments	2,52,769	0
- Canara Bank - Grant A/c	2,03,09,314	7,15,69,598	Sub Total:	68,83,79,198	70,01,40,690
- Canara Bank (Grant A/c) FCRA	11,31,185	98,557			
- Canara Bank - Endowment A/c	2,41,90,411	2,30,66,959			
- State Bank Of India	2,14,63,667	3,21,29,131			
- HDFC BANK	1,12,05,263	60,10,180	II. Expenditure on Fixed assets and Capital Work-in-progress:		
			- Purchase of fixed assets	33,24,14,466	21,28,56,429
II. Deposit accounts:					
- At HDFC Trust	6,50,25,000	9,77,05,500	III. Refund of surplus money/loans	0	0
- At PNB	23,85,67,000	10,35,00,000	IV. Finance charges(Bank charges)	21,066	29,574
- At SHC of India	6,30,00,000	6,30,00,000			
- At Canara Bank (Grant A/c)	29,25,00,000	8,94,32,125	V. Other payments:		
Sub Total:	73,74,66,841	48,55,52,051	- Earnest money deposit returned	33,01,755	0
III. Grants Received:			- Staff advances (festival adv. etc.)	5,09,986	0
- From DST-Grant in aid	1,02,67,00,000	1,09,28,16,000	- Other advances	17,75,61,162	66,63,77,353
- On behalf of endowments/Centre's Development Fund, others	4,43,35,456	4,43,35,456	- Security deposit returned	11,84,084	15,87,636
	1,02,67,00,000	1,13,71,51,456	- TDS payments	4,58,84,158	4,84,95,289
III. Income on Investments:			- Professional tax	6,86,800	7,70,000
Interest on FD's:			- Provident fund	3,82,96,924	4,66,58,923
- From earmarked/lendowment funds	4,55,04,010	28,91,646	- Advances to faculty	19,35,992	6,22,260
- From own funds	7,41,375	39,66,881	- Advances to CPF Account	51,63,114	0
Sub Total:	4,62,45,385	68,58,527	Sub Total:	27,45,23,975	77,06,10,909
IV. Interest received on SB accounts:			VI. Closing Balances:		
- From grant in aid	1,28,37,548	63,66,511	- Cash in hand & imprest at centre	49,040	75,000
Sub Total:	1,28,37,548	63,66,511	- Bank balances:		
			<i>In savings bank accounts, af.:</i>		
V. Other Income:			- Canara Bank - Grant A/c	5,47,58,948	2,03,09,314
- Collections from visitors, guest room etc	9,60,782	46,05,284	- At Canara Bank (Grant A/c) FCRA	1,19,140	11,31,185
- From fee, subscription etc	18,34,720	18,41,615	- Canara Bank - Endowment A/c	4,53,10,513	2,41,90,411
- CSIR fellowships,UGC, DBT, SRFP	3,68,23,945	3,90,86,017	- State Bank Of India	1,84,445	2,14,63,667
	3,96,19,447	4,55,32,916	- HDFC BANK	1,37,45,650	1,12,05,263
Sub total:	1,86,28,69,221	1,68,14,61,460	Sub Total:	11,41,67,736	7,83,74,841
Balance carried forward			Balance carried forward	1,40,95,05,441	1,76,20,12,443



**JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2021 (Contd...)**

	2020-21	2019-20	PAYMENTS & CLOSING BALANCES	2020-21	Amount in Rs. 2019-20
OPENING BALANCES & RECEIPTS					
Balance Brought Forward	1,86,28,69,221	1,68,14,61,460	Balance Brought Forward	1,40,95,06,441	1,76,20,12,443
VI. Other receipts :			<i>In deposit accounts at:</i>		
- Income tax refunds	10,39,768	6,56,674	- At HDFC Trust	8,10,90,265	6,50,25,000
- From Sundry Creditors	0	21,578	- At PNB	32,54,41,495	23,85,67,000
- Staff advances recovered	0	0	- At SHC of India	6,30,00,000	6,30,00,000
- Settlement of advance to faculty	2,64,757	3,15,747	- At Canara Bank (Grant A/c)	28,30,11,123	29,25,00,000
- Earnest money received	7,29,000	5,79,400			
- Project funding received	9,00,04,299	46,97,01,278			
- Project receipt	24,35,523	30,76,260			
- GSLI receipt	96,21,985	1,04,33,257			
- Support to meetings	19,50,84,771	25,48,59,789			
- Other	29,91,80,103	73,96,42,983			
Sub Total :			Sub Total :	75,25,42,383	65,90,92,000
TOTAL	2,16,20,49,324	2,42,11,04,443	TOTAL	2,16,20,49,324	2,42,11,04,443

For Jawaharlal Nehru Centre for Advanced Scientific Research

As per our report of even date,
For GRSM & Associates
Chartered Accountants
FRN : 000863S



Rajgopal A
Rajgopal A
Partner

Membership No.: 205296
Place : Bengaluru, Date : 28/07/2021

Prof. G.U. Kulkarni
Prof. G.U. Kulkarni
President

Joydeep Deb
Joydeep Deb
Administrative Officer

Sampad Palra
Sampad Palra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
STATEMENT OF ENDOWMENT, CENTRE'S DEVELOPMENT FUND & OTHER FUNDS BALANCES AS ON 31/03/2021
(2020- 21)

Rs. in Lakhs

PARTICULARS	Principal	Opening	Additions	Interest	Interest	Total	Expen-	Closing
	Endow.	balance	during	Received	Accrued		diture	balance
	Fund	2020-21	2020-21	2020-21	2020-21		2020-21	2020-21
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
ENDOWMENT CHAIRS								
Hindustan Lever Ltd. & Gharda Chemicals Chair	32.00	43.32	0.00	2.42	0.00	45.74	3.60	42.14
Astra Zeneca & IBM Chair	20.00	55.13	0.00	1.51	0.00	56.64	0.00	56.64
DAE - Dr.Vikram Sarabhai Chair	22.00	35.86	0.00	1.76	0.00	37.62	0.00	37.62
DRDO & CSIR Chair	30.00	69.31	0.00	2.26	0.00	71.57	0.00	71.57
Silver Jubilee Professorship -Prof. C.N.R. Rao	25.00	30.57	0.00	2.11	0.00	32.68	1.09	31.59
TOTAL- ENDOWMENT CHAIRS	129.00	234.19	0.00	10.06	0.00	244.25	4.69	239.56
RELIANCE INDUSTRIES								
Prof.Linus Pauling Professorship	84.34	71.10	0.00	6.93	0.00	78.03	14.91	63.12
OTHER ENDOWMENT FUNDS								
Contribution from Prof.CNR Rao	4.25	14.45	0.00	0.34	0.00	14.79	0.00	14.79
Shantha Seetharamaiah Award	1.00	3.61	0.00	0.08	0.00	3.69	0.11	3.58
Bapu Narayanaswamy Prize	1.00	3.10	0.00	0.08	0.00	3.18	0.06	3.12
Prof. Roddam Narasimha Prize	2.00	3.17	0.00	0.17	0.00	3.34	0.10	3.24
Prof. M.K.Chandrashekarana Fund	5.43	5.09	0.00	0.33	0.00	5.42	0.00	5.42
Sanjay S R Rao	25.00	26.50	0.00	1.72	0.00	28.22	1.20	27.02
Indumathi Rao	25.00	27.81	0.00	9.72	0.00	37.53	0.59	36.94
Reliance Fund - Sankhyasutra	431.37	441.43	0.00	35.32	0.00	476.75	0.00	476.75
TOTAL - OTHER ENDOWMENT FUNDS	495.05	525.16	0.00	47.76	0.00	572.92	2.06	570.86
LECTURE SERIES								
Dr. A.V.Rama Rao Fund	31.00	32.54	0.00	2.62	0.00	35.16	1.50	33.66
ISRO-Dr. Satish Dhawan	14.00	23.06	0.00	1.04	0.00	24.10	0.00	24.10
DAE-Dr. Raja Ramanna	15.00	16.83	0.00	1.27	0.00	18.10	0.00	18.10
DBT-Prof. V Ramalingaswamy	7.00	12.21	0.00	0.52	0.00	12.73	0.30	12.43
TOTAL - LECTURE SERIES	67.00	84.64	0.00	5.45	0.00	90.09	1.80	88.29
C.N.R. RAO HALL OF SCIENCE FUND	170.00	217.53	0.00	14.26	0.00	231.79	3.06	228.73
MATERIALS RESEARCH FUND	341.45	440.30	0.00	28.28	0.00	468.58	0.00	468.58
CENTRE'S DEVELOPMENT FUND	1,682.07	3154.87	176.08	239.07	0.93	3,570.95	16.46	3,554.49
GRAND TOTAL	2,968.91	4,727.79	176.08	351.80	0.93	5,256.60	42.98	5,213.62



Sampad Patra
Sampad Patra
Accounts Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
CPF FUND STATEMENT OF AFFAIRS FOR THE YEAR ENDED 31ST MARCH 2021**

Particulars	Amount in Rs.	Amount in Rs.	Particulars	Amount in Rs.	Amount in Rs.
Contributory provident fund			Investment of funds:		
Subscription:			Government of India 8 % Bonds (SHCIL)		4,95,00,000
Opening balance	4,28,80,027		Fixed Deposits at PNB housing finance		2,10,00,000
Add : Subscriptions received during the year	54,91,577				
Advances repayments	6,72,304				
Interest on subscriptions	31,71,836				
Sub total	52,21,5,744		Cash at Bank:		
Less : Advances granted	6,99,273		Canara Bank, SB A/C No. 06683101017513	42,85,110	42,85,110
Less : Part finals / Finals settlement	47,59,415				
Sub total	54,58,688		TDS receivable:		
Closing balance		4,67,57,056	Gol Bonds (2012-13) receivable	1,48,000	
			Gol Bonds (2014-15) receivable	1,48,000	
Contribution:			Gol Bonds (2015-16) receivable	1,49,400	
Opening balance	3,19,39,871		Canara Bank (2018-19) receivable	1,40,020	
Add : Contribution during the year	23,20,988		Canara Bank (2019-20) receivable	1,49,754	
Interest on total contributions	22,14,368		Canara Bank (2020-21) receivable	50,906	7,86,080
Sub total	3,64,75,227				
Less : Final settlement	31,01,057		Accrued interest:		
Closing balance		3,33,74,170	Accrued interest on deposits in Gol 8 % Bonds (SHCIL)	1,81,07,699	
			Accrued interest on Deposits in PNB housing finance	8,21,589	1,89,29,288
Payable to Endowment		46,62,000			
Payable to Centre		51,63,114			
Balance surplus/deficit (-)		45,44,138			
Total		9,45,00,478	Total		9,45,00,478

For GRSM & Associates
Chartered Accountants
FRN : 000863S



Rajgopal A
Rajgopal A
Partner

Membership No.: 205296
Place : Bengaluru, Date : 28/07/2021

Prof. G.U. Kulkarni
Prof. G.U. Kulkarni
President

Joydeep Deb
Joydeep Deb
Administrative Officer

Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH							
Details of Scheme funds for the financial year 2020-21							
Sl. No.	Code	Opening Balance		Additions to the Funds	Utilisation / Expenditure	Closing Balance	
		Debit	Credit			Debit	Credit
1	4037	1,63,516	0	0	0	1,63,516	0
2	4041	0	1,39,376	0	0	0	1,39,376
3	4044	0	2,20,968	0	0	0	2,20,968
4	4048	58,378	0	0	0	58,378	0
5	4051	0	4,000	0	0	0	4,000
6	4052	1,30,972	0	0	0	1,30,972	0
7	4053	3,55,267	0	0	0	3,55,267	0
8	4058	0	5,000	0	0	0	5,000
9	4059	30,526	0	0	0	30,526	0
10	4062	22,445	0	0	0	22,445	0
11	4063	0	7,87,513	0	0	0	7,87,513
12	4064	0	2,61,088	0	0	0	2,61,088
13	4066	3,28,461	0	0	0	3,28,461	0
14	4070	15,075	0	0	0	15,075	0
15	4071	0	3,54,148	0	0	0	3,54,148
16	4072	0	20,33,705	38,120	0	0	20,71,825
17	4073	0	2,450	0	0	0	2,450
18	4074	0	1,27,700	0	0	0	1,27,700
19	4075	0	10,961	0	0	0	10,961
20	4076	4,615	0	0	0	4,615	0
21	4077	0	335	0	0	0	335
22	4078	5,011	0	0	0	5,011	0
23	4079	36,982	0	0	0	36,982	0
24	4082	0	887	0	0	0	887
25	4083	10,856	0	0	0	10,856	0
26	4084	0	79,865	0	0	0	79,865
27	4085	0	65,891	0	0	0	65,891
28	4086	18,500	0	18,500	0	0	0
29	4087	4,50,000	0	0	0	4,50,000	0
30	4089	0	6,99,975	0	0	0	6,99,975
31	4093	2,250	0	0	0	2,250	0
32	4095	0	12,129	0	0	0	12,129
33	4096	0	1,500	0	0	0	1,500
34	4097	0	3,00,492	0	0	0	3,00,492
35	4098	2,75,295	0	0	0	2,75,295	0
36	4099	97,970	0	0	0	97,970	0
37	4100	2,527	0	0	0	2,527	0
38	4102	0	67,035	0	0	0	67,035
39	4104	1,05,343	0	0	0	1,05,343	0
40	4105	301	0	0	0	301	0
41	4106	10,312	0	0	0	10,312	0
42	4107	1,19,464	0	0	0	1,19,464	0
43	4109	5,836	0	0	0	5,836	0
44	4111	0	9,655	0	0	0	9,655
45	4113	0	2,29,542	0	0	0	2,29,542



46	4114	0	5,69,013	0	0	0	5,69,013
47	4115	237	0	0	0	237	0
48	4116	18,548	0	10,000	0	8,548	0
49	4117	326	0	316	0	10	0
50	4119	17,17,113	0	0	0	17,17,113	0
51	4121	0	72,153	0	0	0	72,153
52	4122	32,794	0	0	0	32,794	0
53	4124	22,425	0	36,000	0	0	13,575
54	4126	0	1,62,570	0	0	0	1,62,570
55	4127	0	1,41,885	0	0	0	1,41,885
56	4128	0	36,85,150	5,00,000	42,59,970	74,820	0
57	4130	0	2,41,551	0	0	0	2,41,551
58	4131	81,231	0	0	0	81,231	0
59	4132	10,338	0	0	0	10,338	0
60	4133	1,64,849	0	0	0	1,64,849	0
61	4134	15,141	0	0	0	15,141	0
62	4136	18,509	0	0	0	18,509	0
63	4137	1,63,923	0	0	0	1,63,923	0
64	4138	65,453	0	0	0	65,453	0
65	4139	38,614	0	0	0	38,614	0
66	4140	0	34,52,216	0	0	0	34,52,216
67	4141	84,400	0	0	0	84,400	0
68	4142	0	3,56,244	0	0	0	3,56,244
69	4143	21,028	0	0	0	21,028	0
70	4144	1,18,646	0	0	0	1,18,646	0
71	4145	1,02,879	0	0	0	1,02,879	0
72	4146	0	6,89,158	0	0	0	6,89,158
73	4147	0	1,82,576	0	0	0	1,82,576
74	4148	0	4,29,860	0	0	0	4,29,860
75	4150	1,94,103	0	0	0	1,94,103	0
76	4152	2,47,382	0	5,000	0	2,42,382	0
77	4153	0	1,53,454	0	0	0	1,53,454
78	4154	1,64,301	0	0	0	1,64,301	0
79	4155	0	14,253	9,810	0	0	24,063
80	4157	7,483	0	0	0	7,483	0
81	4158	0	4,26,528	0	0	0	4,26,528
82	4159	0	2,15,630	0	0	0	2,15,630
83	4161	1,05,786	0	0	0	1,05,786	0
84	4163	355	0	0	0	355	0
85	4164	25,813	0	0	0	25,813	0
86	4165	20,000	0	20,000	0	0	0
87	4166	42,600	0	0	0	42,600	0
88	4168	18,329	0	0	0	18,329	0
89	4169	3,260	0	0	0	3,260	0
90	4171	0	2,34,213	0	0	0	2,34,213
91	4175	21,016	0	0	0	21,016	0
92	4176	0	1,91,625	0	0	0	1,91,625
93	4178	0	3,35,703	0	0	0	3,35,703
94	4179	0	98,108	0	0	0	98,108
95	4180	0	6,37,635	0	0	0	6,37,635
96	4181	0	52,507	0	0	0	52,507
97	4182	1,483	0	0	0	1,483	0



98	4185	0	74,616	0	0	0	74,616
99	4187	0	5,80,015	0	0	0	5,80,015
100	4189	12,32,132	0	0	0	12,32,132	0
101	4190	0	12,713	0	0	0	12,713
102	4191	12,318	0	0	0	12,318	0
103	4193	0	1,766	0	0	0	1,766
104	4195	94,586	0	0	0	94,586	0
105	4196	0	32,000	0	0	0	32,000
106	4197	0	82,042	0	0	0	82,042
107	4198	37,731	0	0	0	37,731	0
108	4199	50,309	0	0	0	50,309	0
109	4200	0	97,682	0	0	0	97,682
110	4201	0	24,769	0	0	0	24,769
111	4203	13,32,342	0	0	0	13,32,342	0
112	4206	14,82,764	0	14,82,764	0	0	0
113	4208	3,62,295	0	0	0	3,62,295	0
114	4209	0	4,01,722	0	0	0	4,01,722
115	4210	0	2,48,986	0	0	0	2,48,986
116	4212	39,059	0	0	0	39,059	0
117	4213	36,30,285	0	0	0	36,30,285	0
118	4215	0	10,000	0	0	0	10,000
119	4216	362	0	0	0	362	0
120	4218	19,189	0	15,000	0	4,189	0
121	4219	48,928	0	0	0	48,928	0
122	4220	9,16,740	0	0	0	9,16,740	0
123	4222	2,51,521	0	0	0	2,51,521	0
124	4223	0	1,22,567	0	0	0	1,22,567
125	4225	2,17,136	0	0	0	2,17,136	0
126	4227	0	7,936	0	0	0	7,936
127	4228	1,57,085	0	0	0	1,57,085	0
128	4229	0	40,831	0	0	0	40,831
129	4230	0	0	0	0	0	0
130	4231	46,243	0	0	0	46,243	0
131	4232	1,52,544	0	0	0	1,52,544	0
132	4233	2,06,789	0	0	0	2,06,789	0
133	4234	0	6,145	0	0	0	6,145
134	4235	0	62,793	0	0	0	62,793
135	4237	43,427	0	10,000	0	33,427	0
136	4238	0	16,42,830	0	0	0	16,42,830
137	4239	2,49,927	0	0	0	2,49,927	0
138	4240	7,52,659	0	0	0	7,52,659	0
139	4241	36,500	0	0	0	36,500	0
140	4242	6,09,511	0	0	0	6,09,511	0
141	4243	0	4,52,016	0	0	0	4,52,016
142	4247	0	5,47,873	0	0	0	5,47,873
143	4248	6,67,842	0	0	0	6,67,842	0
144	4252	0	5,85,512	0	5,85,512	0	0
145	4253	1,15,419	0	40,419	0	75,000	0
146	4254	3,12,285	0	0	0	3,12,285	0
147	4257	0	5,20,000	0	0	0	5,20,000
148	4258	9,09,065	0	0	0	9,09,065	0
149	4259	1,56,934	0	0	0	1,56,934	0



150	4262	3,60,110	0	0	0	3,60,110	0
151	4263	16,674	0	0	0	16,674	0
152	4266	74,971	0	35,000	0	39,971	0
153	4267	0	1,62,265	0	0	0	1,62,265
154	4268	0	5,594	0	0	0	5,594
155	4270	0	20,000	0	0	0	20,000
156	4272	3,219	0	0	0	3,219	0
157	4274	5,83,343	0	0	0	5,83,343	0
158	4275	0	8,977	0	0	0	8,977
159	4276	12,352	0	0	0	12,352	0
160	4277	0	6,99,092	0	94,005	0	6,05,087
161	4279	166	0	0	0	166	0
162	4280	3,08,285	0	0	0	3,08,285	0
163	4281	4,19,901	0	0	0	4,19,901	0
164	4282	0	3,14,167	0	0	0	3,14,167
165	4283	0	45,533	0	0	0	45,533
166	4284	0	30,162	0	0	0	30,162
167	4285	25,970	0	0	0	25,970	0
168	4286	33,549	0	0	0	33,549	0
169	4287	0	9,712	0	0	0	9,712
170	4288	6,16,803	0	0	0	6,16,803	0
171	4289	1,80,424	0	0	0	1,80,424	0
172	4290	0	79,002	0	0	0	79,002
173	4291	0	0	0	0	0	0
174	4292	0	4,75,527	14,16,093	12,42,389	0	6,49,231
175	4293	0	0	0	0	0	0
176	4294	0	44,18,166	0	62,54,629	18,36,463	0
177	4295	0	19,092	0	0	0	19,092
178	4297	99,865	0	0	0	99,865	0
179	4298	7,37,221	0	0	0	7,37,221	0
180	4300	19,02,409	0	0	0	19,02,409	0
181	4301	1,89,347	0	0	0	1,89,347	0
182	4302	1,07,814	0	0	0	1,07,814	0
183	4307	4,22,510	0	4,22,510	0	0	0
184	4308	0	2,39,309	0	0	0	2,39,309
185	4312	1,52,000	0	0	0	1,52,000	0
186	4313	0	2,01,186	0	0	0	2,01,186
187	4314	3,77,469	0	0	0	3,77,469	0
188	4318	1,212	0	0	0	1,212	0
189	4319	15,985	0	0	0	15,985	0
190	4320	62,558	0	0	0	62,558	0
191	4324	0	24,85,488	2,23,934	0	0	27,09,422
192	4325	0	24,994	0	0	0	24,994
193	4326	2,05,197	0	2,05,197	0	0	0
194	4327	47,323	0	0	0	47,323	0
195	4330	0	20,000	0	20,000	0	0
196	4333	4,83,351	0	0	0	4,83,351	0
197	4334	5,41,134	0	0	0	5,41,134	0
198	4335	0	1,218	0	0	0	1,218
199	4336	0	9,20,229	0	2,63,318	0	6,56,911
200	4337	2,58,870	0	0	43,966	3,02,836	0
201	4339	0	26,693	0	0	0	26,693



202	4340	5,233	0	0	0	5,233	0
203	4342	0	9,84,995	0	55,490	0	9,29,505
204	4343	0	10,000	0	0	0	10,000
205	4344	1,09,450	0	0	0	1,09,450	0
206	4346	0	11,64,476	0	1,46,332	0	10,18,144
207	4351	59,277	0	0	1,00,000	1,59,277	0
208	4352	6,92,505	0	4,91,791	0	2,00,714	0
209	4353	0	30,30,080	0	0	0	30,30,080
210	4354	0	1,46,497	0	0	0	1,46,497
211	4355	63,842	0	0	0	63,842	0
212	4357	0	3,85,715	141	0	0	3,85,856
213	4358	0	28,88,238	0	28,88,238	0	0
214	4359	0	8,95,848	0	8,95,848	0	0
215	4360	99,682	0	0	0	99,682	0
216	4361	4,40,071	0	0	1,87,467	6,27,538	0
217	4362	0	96,011	0	0	0	96,011
218	4365	41,564	0	0	0	41,564	0
219	4366	0	9,31,396	0	9,44,729	13,333	0
220	4371	40,485	0	0	2,23,139	2,63,624	0
221	4372	0	4,000	0	0	0	4,000
222	4374	0	2,44,639	0	2,44,639	0	0
223	4375	2,66,161	0	0	0	2,66,161	0
224	4376	0	14,15,33,604	0	5,59,84,718	0	8,55,48,886
225	4377	0	7,76,521	0	43,069	0	7,33,452
226	4378	3,42,097	0	0	0	3,42,097	0
227	4379	57,152	0	57,152	0	0	0
228	4382	0	1,05,402	0	0	0	1,05,402
229	4384	0	4,19,552	24,19,317	8,05,273	0	20,33,596
230	4385	0	55,12,755	22,61,844	77,74,599	0	0
231	4386	0	3,67,52,648	1,30,00,000	47,30,435	0	4,50,22,213
232	4387	0	2,71,01,034	1,01,00,000	2,09,21,258	0	1,62,79,776
233	4388	13,13,929	0	0	1,14,496	14,28,425	0
234	4391	1,55,932	0	0	1,46,329	3,02,261	0
235	4393	38,924	0	0	0	38,924	0
236	4394	0	1,00,129	0	0	0	1,00,129
237	4400	90,586	0	0	0	90,586	0
238	4401	2,57,351	0	2,57,351	0	0	0
239	4402	9,71,693	0	0	0	9,71,693	0
240	4404	2,48,492	0	0	0	2,48,492	0
241	4405	15,401	0	0	0	15,401	0
242	4406	10,31,359	0	0	0	10,31,359	0
243	4407	0	18,05,229	0	14,53,918	0	3,51,311
244	4409	40,413	0	0	0	40,413	0
245	4411	4,29,857	0	0	4,05,880	8,35,737	0
246	4412	18,47,830	0	0	77,626	19,25,456	0
247	4413	0	1,73,750	0	1,73,750	0	0
248	4414	9,35,645	0	0	0	9,35,645	0
249	4418	6,22,997	0	16,12,861	9,89,864	0	0
250	4419	0	2,455	0	0	0	2,455
251	4420	6,43,212	0	0	61,079	7,04,291	0
252	4422	0	6,78,083	15,40,348	6,16,749	0	16,01,682
253	4423	0	7,53,674	0	3,55,057	0	3,98,617



254	4424	2,48,936	0	0	0	2,48,936	0
255	4425	22,96,285	0	20,11,906	12,61,145	15,45,524	0
256	4427	21,02,610	0	51,85,810	15,63,192	0	15,20,008
257	4428	28,23,647	0	0	0	28,23,647	0
258	4430	1,72,426	0	0	0	1,72,426	0
259	4431	0	6,46,061	0	6,46,061	0	0
260	4432	0	2,42,902	0	1,28,203	0	1,14,699
261	4433	40,938	0	8,00,000	6,65,001	0	94,061
262	4436	0	2,67,823	0	0	0	2,67,823
263	4438	1,28,138	0	9,53,090	8,58,015	33,063	0
264	4439	1,85,213	0	0	0	1,85,213	0
265	4442	1,22,569	0	0	0	1,22,569	0
266	4444	8,58,625	0	0	0	8,58,625	0
267	4445	0	9,18,215	5,00,000	14,20,122	1,907	0
268	4446	0	2,01,299	0	1,46,036	0	55,263
269	4447	0	1,02,044	6,50,770	8,24,603	71,789	0
270	4448	3,07,415	0	2,50,000	4,603	62,018	0
271	4450	1,69,039	0	0	0	1,69,039	0
272	4452	42,026	0	42,026	0	0	0
273	4455	0	1,71,502	0	0	0	1,71,502
274	4456	0	55,930	24,650	80,580	0	0
275	4457	1,99,076	0	0	58,312	2,57,388	0
276	4458	49,140	0	0	558	49,698	0
277	4459	51,545	0	51,545	0	0	0
278	4460	0	16,511	0	16,511	0	0
279	4462	33,041	0	0	0	33,041	0
280	4463	8,553	0	13,90,214	13,81,661	0	0
281	4464	0	26,923	98,806	0	0	1,25,729
282	4467	1,54,572	0	1,89,000	39,032	4,604	0
283	4469	0	5,55,974	7,21,626	4,34,715	0	8,42,885
284	4471	16,909	0	0	0	16,909	0
285	4472	61,878	0	0	0	61,878	0
286	4473	1,21,812	0	2,46,479	0	0	1,24,667
287	4474	0	1,14,980	2,59,727	3,74,707	0	0
288	4475	0	3,42,984	14,031	1,02,578	0	2,54,437
289	4476	0	3,46,452	0	16,62,208	13,15,756	0
290	4477	0	3,91,357	0	4,29,600	38,243	0
291	4478	12,530	0	0	0	12,530	0
292	4479	12,318	0	12,318	0	0	0
293	4483	0	87,968	0	2,10,899	1,22,931	0
294	4484	1,92,000	0	4,64,537	2,72,537	0	0
295	4487	1,11,522	0	0	0	1,11,522	0
296	4488	2,852	0	0	0	2,852	0
297	4489	0	1,96,014	0	0	0	1,96,014
298	4490	0	441	0	441	0	0
299	4491	0	9,59,018	0	4,24,300	0	5,34,718
300	4492	0	11,51,983	11,49,633	10,79,484	0	12,22,132
301	4493	92,197	0	15,25,512	13,94,816	0	38,499
302	4494	0	3,63,571	0	0	0	3,63,571
303	4495	0	27,942	0	27,942	0	0
304	4496	0	5,56,945	0	0	0	5,56,945
305	4497	0	8,59,188	2,88,326	12,70,414	1,22,900	0



306	4498	0	3,59,951	5,76,849	7,01,042	0	2,35,758
307	4499	0	1,97,813	0	1,97,813	0	0
308	4500	0	17,67,238	46,43,840	31,21,270	0	32,89,808
309	4501	3,09,088	0	41,74,390	6,52,903	0	32,12,399
310	4502	0	1,94,140	0	95,940	0	98,200
311	4503	7,56,456	0	0	5,72,060	13,28,516	0
312	4504	4,95,241	0	19,70,041	3,92,525	0	10,82,275
313	4505	0	12,25,605	17,03,021	25,11,361	0	4,17,265
314	4506	0	11,89,288	21,80,542	9,16,753	0	24,53,077
315	4507	0	3,04,426	0	3,04,426	0	0
316	4508	5,98,440	0	0	0	5,98,440	0
317	4510	0	28,064	0	28,064	0	0
318	4511	0	4,94,900	1,61,184	0	0	6,56,084
319	4514	0	4,35,171	18,00,000	14,80,908	0	7,54,263
320	4515	0	7,48,49,110	0	3,76,50,193	0	3,71,98,917
321	4516	0	5,22,529	9,48,213	17,03,787	2,33,045	0
322	4518	0	6,49,303	9,862	5,58,650	0	1,00,515
323	4519	1,53,739	0	9,21,478	2,21,881	0	5,45,858
324	4549	0	3,07,693	5,59,149	5,21,740	0	3,45,102
325	4551	0	1,085	0	0	0	1,085
326	4552	0	4,01,839	10,13,249	11,82,422	0	2,32,666
327	4553	0	37,94,655	0	24,17,248	0	13,77,407
328	4554	0	1,71,281	17,17,590	17,13,909	0	1,74,962
329	4555	0	1,43,106	0	1,43,106	0	0
330	4556	0	10,857	0	0	0	10,857
331	4558	0	2,48,029	4,537	2,72,667	20,101	0
332	4559	0	49,592	3,30,136	1,68,296	0	2,11,433
333	4560	10,13,820	0	10,28,453	14,633	0	0
334	4562	0	72,401	10,58,687	8,90,608	0	2,40,480
335	4563	0	1,48,954	2,89,828	4,38,782	0	0
336	4564	0	5,595	3,35,615	25,000	0	3,16,210
337	4565	88,654	0	10,45,000	11,65,165	2,08,819	0
338	4566	0	3,18,652	38,47,943	41,80,683	14,088	0
339	4567	0	6,60,562	5,80,747	4,47,269	0	7,94,040
340	4568	0	1,77,368	25,65,200	8,09,946	0	19,32,622
341	4569	0	3,40,140	19,08,593	7,04,633	0	15,44,100
342	4570	0	6,80,539	0	7,99,972	1,19,433	0
343	4571	0	6,20,631	7,22,438	6,13,452	0	7,29,617
344	4572	0	1,77,725	0	54,490	0	1,23,235
345	4573	0	17,013	0	17,013	0	0
346	4574	0	1,00,182	10,46,346	6,57,650	0	4,88,878
347	4575	0	54,07,368	0	11,50,248	0	42,57,120
348	4576	9,85,911	0	28,03,968	10,04,135	0	8,13,922
349	4577	0	2,60,474	1,43,291	3,02,306	0	1,01,459
350	4578	0	54,57,271	0	43,22,901	0	11,34,370
351	4579	0	21,24,027	0	18,14,128	0	3,09,899
352	4580	0	3,25,792	8,18,479	7,65,521	0	3,78,750
353	4581	0	52,53,254	0	50,69,475	0	1,83,779
354	4582	0	1,82,68,953	0	66,17,002	0	1,16,51,951
355	4583	0	8,78,754	9,82,434	15,68,011	0	2,93,177
356	4584	0	4,51,466	9,83,454	10,40,898	0	3,94,022
357	4585	0	68,129	10,47,000	33,160	0	10,81,969



358	4586	0	3,63,34,441	2,60,00,000	97,551	0	6,22,36,890
359	4587	0	48,32,201	39,18,089	54,54,256	0	32,96,034
360	4588	0	4,64,866	8,00,000	10,44,832	0	2,20,034
361	4589	0	4,00,054	0	5,65,556	1,65,502	0
362	4590	0	2,63,08,143	16,93,176	64,88,905	0	2,15,12,414
363	4591	0	15,77,177	4,50,000	14,86,010	0	5,41,167
364	4592	0	64,04,595	0	6,71,208	0	57,33,387
365	4593	0	7,28,536	0	4,56,835	0	2,71,701
366	4594	0	180	6,76,414	4,27,285	0	2,49,309
367	4595	0	16,84,652	8,61,000	27,86,207	2,40,555	0
368	4596	0	7,82,839	10,63,986	10,12,263	0	8,34,562
369	4597	0	57,03,232	8,00,000	36,51,688	0	28,51,544
370	4598	0	7,19,958	8,012	7,54,285	26,315	0
371	4599	0	22,47,500	29,967	22,02,726	0	74,741
372	4600	0	8,96,989	14,210	8,93,400	0	17,799
373	4601	0	16,93,795	2,29,533	15,97,700	0	3,25,628
374	4602	0	23,54,000	0	5,58,300	0	17,95,700
375	4603	0	52,92,272	11,34,223	47,28,951	0	16,97,544
376	4604	0	23,98,414	12,59,141	24,08,215	0	12,49,340
377	4605	0	2,56,798	5,00,000	4,07,900	0	3,48,898
378	4606	0	13,05,164	27,943	9,42,591	0	3,90,516
379	4607	0	22,05,431	52,021	18,65,714	0	3,91,738
380	4608	0	2,18,524	4,031	2,07,138	0	15,417
381	4609	0	28,46,573	65,349	13,39,216	0	15,72,706
382	4610	0	4,82,159	14,22,362	11,33,375	0	7,71,146
383	4611	0	39,17,328	0	9,19,403	0	29,97,925
384	4614	0	16,91,487	8,36,527	14,95,022	0	10,32,992
385	4615	0	21,24,087	49,727	10,68,499	0	11,05,315
386	4616	0	3,44,05,076	9,81,942	13,17,062	0	3,40,69,956
387	4617	0	28,52,130	43,084	21,73,872	0	7,21,342
388	4618	0	26,26,608	2,50,462	23,05,167	0	5,71,903
389	4619	0	0	17,68,878	2,56,016	0	15,12,862
390	4620	0	0	19,70,522	10,19,572	0	9,50,950
391	4621	2,621	0	15,00,000	7,55,390	0	7,41,989
392	4622	0	0	20,26,598	15,89,281	0	4,37,317
393	4623	0	0	1,09,73,285	40,41,747	0	69,31,538
394	4624	0	0	19,20,000	4,69,200	0	14,50,800
395	4625	0	0	24,29,377	13,67,742	0	10,61,635
396	4627	0	0	19,24,844	5,53,932	0	13,70,912
397	4628	0	0	4,97,979	4,97,979	0	0
398	4629	0	0	1,97,077	1,18,124	0	78,953
399	4630	0	0	32,12,199	1,31,139	0	30,81,060
400	4631	0	0	5,87,044	3,50,364	0	2,36,680
401	4632	0	0	19,92,122	95,580	0	18,96,542
402	4633	0	0	5,16,783	0	0	5,16,783
403	4634	0	0	20,21,775	2,10,339	0	18,11,436
404	4635	0	0	29,62,922	17,81,063	0	11,81,859
405	4636	0	0	16,03,111	8,47,882	0	7,55,229
406	4637	0	0	14,16,641	3,57,622	0	10,59,019
407	4638	0	0	19,08,158	3,75,630	0	15,32,528
408	4640	0	0	11,89,000	0	0	11,89,000
409	4642	0	0	12,10,596	1,30,915	0	10,79,681



410	4643	0	0	17,10,327	1,28,514	0	15,81,813
411	4644	0	0	5,00,000	40,543	0	4,59,457
412	4645	0	0	24,90,801	36,036	0	24,54,765
413	4646	0	0	11,26,399	2,29,600	0	8,96,799
414	4647	0	0	9,67,149	1,39,463	0	8,27,686
415	4648	0	0	11,26,535	1,93,871	0	9,32,664
416	4649	0	0	11,26,251	2,87,873	0	8,38,378
417	4650	0	0	15,32,353	2,05,200	0	13,27,153
418	4651	0	0	2,21,598	5,000	0	2,16,598
419	4652	0	0	2,86,668	1,22,911	0	1,63,757
420	4653	0	0	3,37,423	8,333	0	3,29,090
421	4654	0	0	3,37,004	17,184	0	3,19,820
422	4655	0	0	50,34,670	85,893	0	49,48,777
423	4656	0	0	13,74,237	25,000	0	13,49,237
424	4657	0	0	19,09,287	61,533	0	18,47,754
425	4658	0	0	22,24,990	22,678	0	22,02,312
426	4659	0	0	11,22,991	76,533	0	10,46,458
427	4662	0	0	37,96,000	0	0	37,96,000
428	4663	0	0	41,99,920	0	0	41,99,920
429	4664	0	0	70,32,800	0	0	70,32,800
430	4674	0	0	17,30,000	0	0	17,30,000
431	5100	4,10,730	0	0	0	4,10,730	0
432	5101	5,73,994	0	0	0	5,73,994	0
433	5102	8,000	0	8,000	0	0	0
434	5103	1,64,650	0	40	0	1,64,610	0
435	5104	29,10,103	0	5,000	0	29,05,103	0
436	5105	24,28,431	0	0	0	24,28,431	0
437	6001	0	83,33,912	0	26,58,047	0	56,75,865
438	6003	0	33,00,847	0	0	0	33,00,847
439	6004	0	5,10,40,651	3,66,40,717	2,16,98,440	0	6,59,82,928
440	6005	0	9,43,778	5,13,459	37,687	0	14,19,550
441	P.D.F.	0	33,89,486	15,95,728	7,50,445	0	42,34,769
442	O.C.B.	0	23,52,63,134	1,18,31,357	85,21,639	0	23,85,72,852
		6,05,41,056	85,58,06,167	27,47,62,845	32,46,81,164	5,64,74,232	80,18,21,025



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