ISSN.0973-9319

ANNUAL REPORT

2019-2020

JNCASR

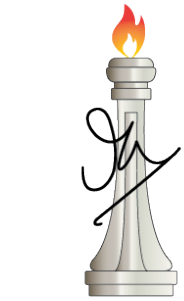
Jawaharlal Nehru Centre for Advanced Scientific Research

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Jakkur Post, Bengaluru - 560 064, Karnataka, India
Phone: +91 80 2208 2750
Email: admin@jncasr.ac.in
Website: www.jncasr.ac.in

This report is published in August 2020

Content writing and copyediting by
Dr. Neena Ratnakaran
E-mail: neenarp@gmail.com
✆ +91 9930247005

Design by
www.commworks.in ✆ +91 9886349794



JNCASR

Jawaharlal Nehru Centre for Advanced Scientific Research

ANNUAL REPORT

2019-2020

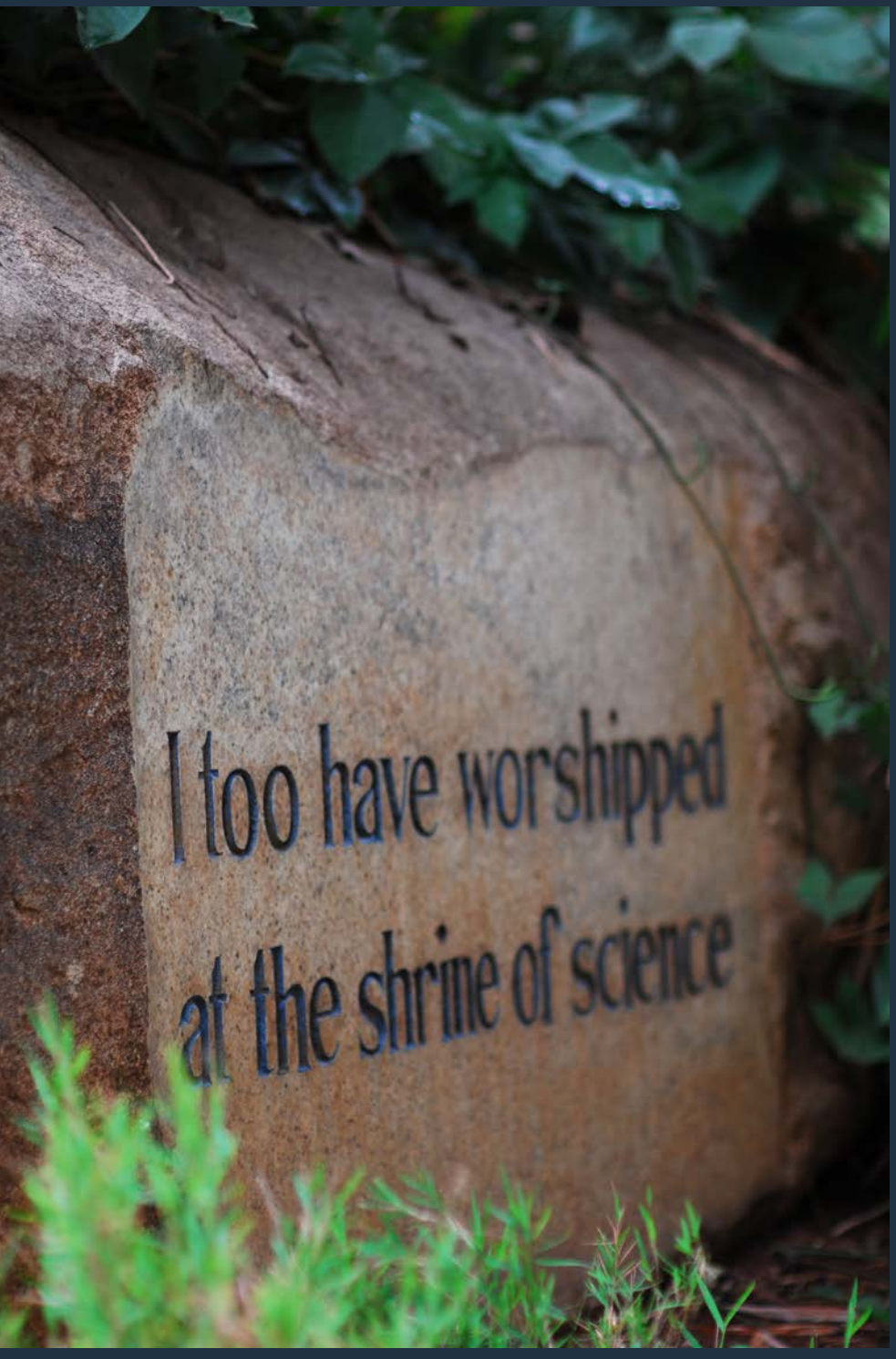
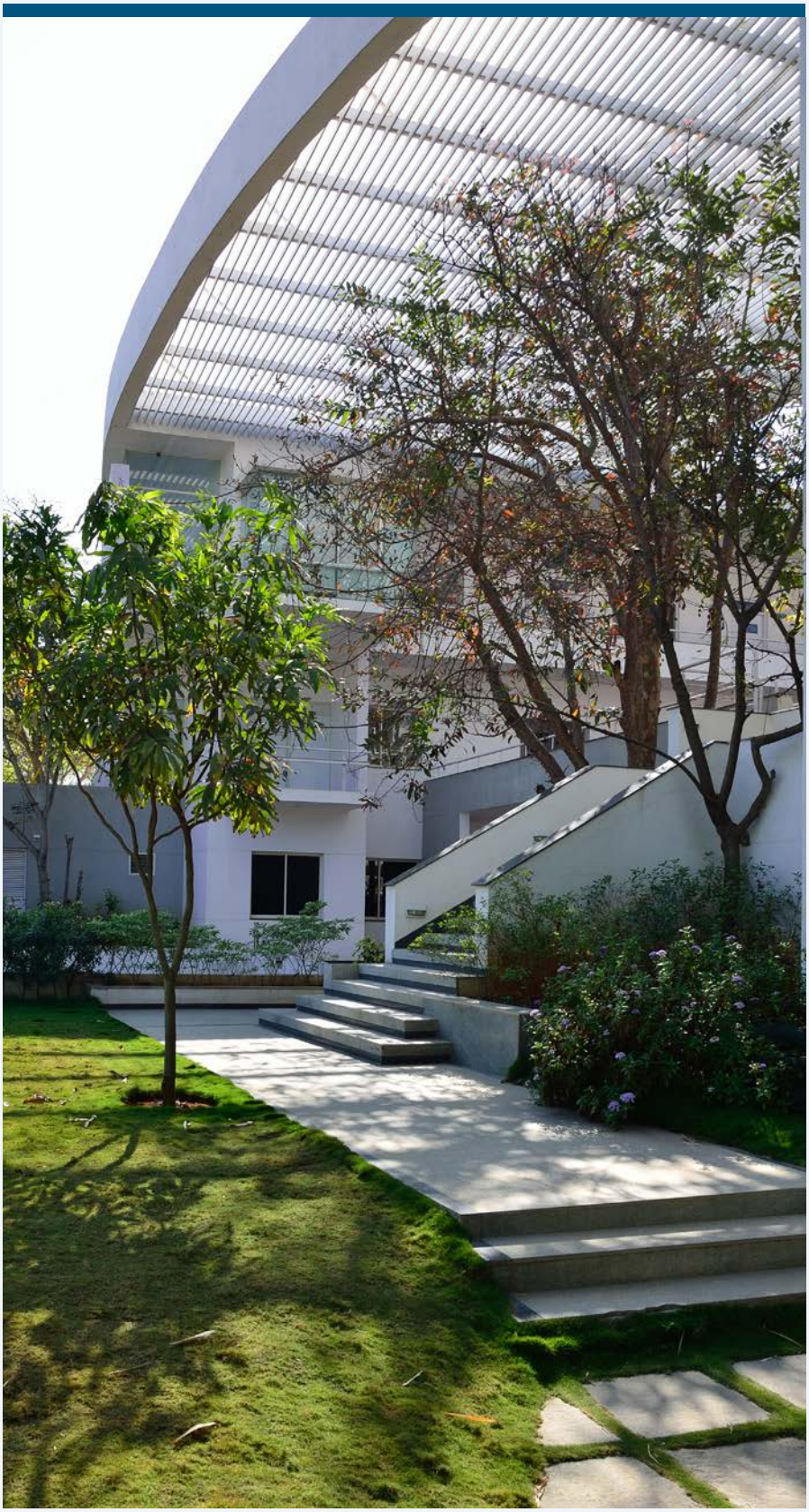

I too have worshipped
at the shrine of science

TABLE OF CONTENTS



FOREWORD

It is a matter of pride and honor, having taken charge as the President of JNCASR beginning of this year, to present the 31st Annual Report of the Centre for the financial year, 2019-20. I am delighted to note that JNCASR continues to make significant contributions in various fields of scientific research. The Centre has made an excellent impact on the international arena, which is evident from the 2019 Nature Index ranking that places the Centre, 40th among the top 175 young universities, and in Chemistry, 17th among the top 50 young universities. This is indeed an incredible feat.

We have seen progress and success on multiple fronts during the year with several of our faculty receiving numerous awards and honours. Foremost, I would like to congratulate Prof. C.N.R. Rao, Bharat Ratna, for receiving the First Sheikh Saud International Prize for Materials Science Research, 2019. He has also been quoted as the Highly Cited Researcher 2019 by Web of Science

Group. Also, he is the recipient of TV9 Lifetime Achievement award. I congratulate Prof. Roddam Narasimha for receiving the Lifetime Achievement Award at the 2019 Nature Mentoring Awards. Congratulations to Prof. K.B. Sinha as well for having received the Srinivasa Ramanujan Medal in Mathematics by the Indian National Science Academy, 2019. I also congratulate our other faculty colleagues, Prof. Tapas K. Maji having been selected for receiving the Shanti Swaroop Bhatnagar Prize (Chemical Sciences) 2019, Prof. Subi J. George for the Fellowship of Indian Academy of Sciences, Prof. Hemalatha Balaram and Prof. Maneesha S. Inamdar for receiving the SERB J.C. Bose Fellowships 2019; Prof. Ravi Manjithaya, selected as a joint recipient of the CDRI Award 2020 for Excellence in Drug Research; and Dr. Kushagra Bansal for receiving the Wellcome Trust/DBT India Alliance Intermediate Fellowship. I wholeheartedly congratulate other faculty colleagues for receiving various recognitions and awards for their outstanding research in the recent months. I take pride to quote here that our students too have done exceptionally well on various platforms, and many of them have won awards and recognitions. Notably, Mr. Tarandeep Singh and Mr. Brijesh of Team ZincAir won the Silver Award at KPIT Sparkle 2020 iInnovate contest.

JNCASR continues to publish quality research in high-impact journals, about 250 during 2019. The Technical Research Centre on the campus has made significant contributions to society through various technological innovations and start-ups. We were granted 13 patents during the year. Several MoUs were signed during this period, notably among them are with Sankhyasutra Labs Pvt. Ltd., Tata Steel and CDAC.

On the academic front, this deemed-to-be-university has admitted 55 new students during 2019-20, taking our student strength to 317. A total of 28 Ph.D., 21 M.S. (Int. Ph.D.) and 3 M.S. (Engg.) and 3 P.G.D.M.S. degrees were awarded.

Under Centre's Science Outreach Programme, several workshops and lectures were conducted for school and college students across the country. Prof. C.N.R. Rao delivered several lectures igniting scientific thoughts in young minds. On the 150th anniversary of the Periodic Table of Chemical Elements, a week-long exhibition ELEMENTS, was organized by JNCASR in association with the Science Gallery Bengaluru and the Royal Society of Chemistry.

The World at large is facing difficult times owing to the COVID-19 pandemic. Besides implementing necessary health measures on campus, we are also engaged in active research on many fronts pertaining to this disease.

The following pages provide a glimpse of our achievements pertaining to the year. I would like to thank every member of JNCASR for upholding the Centre's objectives and for making this yet another successful year. I take this opportunity to thank the Department of Science & Technology, GoI for the continued support.

I look forward to a safe, healthy and vibrant academic year ahead.

Prof. G.U. KULKARNI
President, JNCASR

ABOUT JNCASR

Through initiatives taken by the Department of Science and Technology of the Government of India, the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) came into existence in 1989 to commemorate the birth centenary year of the first Prime Minister of India, Pandit Jawaharlal Nehru, who was an ardent advocate of scientific progress and development in independent India. The founder President of JNCASR is Prof. C.N.R. Rao, Bharat Ratna, who is also Honorary President of the Centre, in addition to being the Chair, New Chemistry Unit (NCU) and the Director, International Centre for Materials Science (ICMS). Prof. G.U. Kulkarni is the current President since January 29, 2020.

Since inception, JNCASR has slowly expanded its campus and now boasts of ten well established research units, namely, 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), Thematic Unit of Excellence in Computational Materials Science (TUE-CMS) and Theoretical Sciences Unit (TSU). JNCASR has always placed great emphasis on inter-disciplinary research, which has fostered numerous on-campus collaborations, allowing scientists from various backgrounds to come together to solve scientific challenges. Recently, with an aim to provide a more efficient Materials Science Programme at the Centre, the School of Advanced Materials was set up involving faculties from ICMS, NCU, and TSU. To enable faculties and students to carry out top-notch research, JNCASR ensures to provide them with state-of-the-art experimental, computational, and infrastructural facilities, always ensuring to upgrade resources and facilities based on scientific needs.

Estd. - 1989

As a fulfillment of one of the objectives of the Centre i.e., to provide world-class academic programmes to students in 2002, the Centre was recognised as a deemed to be university. The Centre offers Ph.D., Integrated Ph.D. as well as Masters Programmes in various disciplines. Currently, the Centre comprises of over 300 students, with most of them enrolled in Ph.D. Programmes. Since 1990, the Centre also offers two short-term Diploma Programmes to students.

For science to have its greatest impact, it is necessary to be able to connect with the society and communicate scientific ideas and findings with them. Therefore, an important objective of the Centre has been to engage in outreach activities through workshops, lectures, and extension programmes. Every year, under multiple science outreach programmes, school

teachers and students are invited to visit the Centre and attend talks and experimental demonstrations in an attempt to popularize science. The Centre also holds Student Buddy Programme, wherein school students make a day-long visit to the Centre and interact with researchers. The Centre has now completed 31 productive years. Over the time, it has achieved several scientific breakthroughs, successful innovations, numerous publications, and our students and faculty have been recognised by awards from national and international organisations. It has made noteworthy and remarkable contributions to the scientific community and the society at large and continues to pursue its missions.

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 rules and orders issued by the Government of India with necessary guidelines from the Council of Management from time to time.

During the year 2019-2020, there were no cases pertaining to the Centre that appeared before the CAT.

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;
- Capacity building through high-quality Ph.Ds in science and engineering;
- Increase awareness about science and research among school and college students through extensive science outreach, novel fellowship, and extension programmes;
- Take research from laboratory to society by making a conscious effort to connect with the society.

YEAR AT A GLANCE

Faculty awards	45
Student awards	57
Faculty fellowships	9
New admissions	55
Degrees awarded	55
Publications	250
Patent applications filed	12
Patents granted	13

AWARDS AND ACHIEVEMENTS

JNCASR was ranked the 40th among top the 100 Young Universities globally by Nature Index 2019.

JNCASR was ranked the 17th among the top 50 Young Universities in Chemistry by Nature Index 2019.

As part of an agreement between JNCASR and Bangalore International Airport Limited, a study team led by Prof. K.R. Sreenivas started a collaborative study from December 2019 on the atmospheric conditions in the vicinity of the Kempegowda International airport.

The first 200 kW roof-top solar power photovoltaic plant was successfully installed at the Centre. This installation has been estimated to generate over 3 lac units (kWh) annually and can save up to Rs.24 lakhs per annum, and Rs.6 crores in 25 years.

PROJECTS GRANTED TO JNCASR AS THE NODAL AGENCY

- Indian beamline for nano science and technology at Petra III at Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany (Phase II).

ONGOING PROJECTS

- Implementation of phase II of Indian Beamline at Photon Factory, Kek, Tskuba, Japan.
- Assured access to all the beam lines of ISIS Neutron Scattering Facility at Rutherford Appleton Laboratory (RAL), UK for carrying out research in nano science and technology.
- Setting up of Technical Research Centre at JNCASR, Bengaluru

For further details, see page 153

FACULTY ACHIEVEMENTS



Prof. C.N.R. Rao

- Named as the Highly Cited Researcher in 2019 award by Web of Science.
- Received the TV9 Lifetime Achievement Award.
- Conferred with the 80th Honorary Doctorate in Science by the University of Kerala, Thiruvananthapuram.
- Received the KAYAK SHREE Award (Gokak) (2019) from Shoonya Sampadana Math, Gokak.
- Received the COSINE Award from Chaldean Syrian Higher Secondary School, Trissur (2019).
- Received the Saud International Prize For Materials Research (2019) from RAK-CAM, UAE.
- Conferred with Honoris Causa Doctorate from Jadavpur University, Kolkata (2019).

Prof. Roddam Narasimha

- Awarded the Lifetime Achievement Award at the 2019 Nature Mentoring awards.
- Awarded the National Science Chair Professorship by SERB/DST.
- Establishment of the Roddam Narasimha Endowment Annual Lecture, by the Department of Aerospace Engineering, Indian Institute of Science.

Dr. Bivas Saha

- Received the SERB Start-Up Research Grant.

Prof. Chandrabhas Narayana

- Invited to be a member of the Editorial Advisory Board of *Journal of Applied Physics*.
- The paper authored by Sorb YA *et al*, which reports collaborative work from laboratories of Prof. Chandrabhas Narayana and Dr. Sebastian C. Peter (NCU), was one among the top 1% most-cited papers in Physics between 2016 and 2018, as published by Institute of Physics.
- Platinum Jubilee Lecture Award of Indian Science Congress 2020.

FACULTY ACHIEVEMENTS

Prof. G.U. Kulkarni

- Received MRSI-Distinguished Lecturership Award from Materials Research Society of India.
- SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences.
- Received Dr. Raja Ramanna State Award for Scientist for the year 2018 in the field of science education, awarded by Karnataka State Council for Science and Technology (KSCST).
- Honoured as Outstanding Achiever Past Student by Karnataka Education Board, Dharwad.
- The Prof. C.N.R. Rao National Prize for Chemical Research, 2020, by Chemical Research Society of India (CRSI).

Prof. H. Ila

- Awarded the Lifetime Achievement Award Gold Medal by the Chemical Research Society of India.

Prof. Hemalatha Balaram

- Received the SERB J.C. Bose Fellowship, 2019.

Prof. K.S. Narayan

- Chair, Working Group of Physics in Industry of IUPAP.

Prof. Kalyan B. Sinha

- Awarded the Srinivasa Ramanujan Medal in Mathematics by the Indian National Science Academy, 2019.

Prof. Kanishka Biswas

- Received the DST Swarnajayanti Fellowship.
- Among the top 10% of highly cited authors in Materials portfolio of Journals of Royal Society of Chemistry, 2018.
- Selected for MRSI-ICSC Materials Science Annual Prize, 2020.
- Invited to be an Editorial Advisory Board Member, *Journal of Materials Chemistry A*, RSC.
- Invited to be an Editorial Board Member, *Journal of Solid State Chemistry*, Elsevier.

Prof. Kaustuv Sanyal

- Received extension of Tata Innovation Fellowship supported by Dept. of Biotechnology, Government of India.
- Visiting Professor, Osaka University, Osaka, Japan (04/2020-03/2021).
- Received Travel Award for Chromopalooza, Vienna BioCenter, Vienna, Austria.
- Received Travel Award for EMBO, Barcelona, Spain.

Dr. Kushagra Bansal

- Awarded the Wellcome Trust/DBT India Alliance Intermediate Fellowship in basic biomedical research category.

Prof. Maneesha S. Inamdar

- Received the SERB J.C. Bose Fellowship, 2019.
- Was awarded the Prof. C.N.R. Rao Oration Award for the lecture “Swalpa adjust maadi: Tweaking longevity pathways in stem cells” delivered on August 13, 2019.

FACULTY ACHIEVEMENTS

Prof. Ranjani Viswanatha

- Featured in the article *"Women in the forefront of Energy Research"* by *ACS Energy Letters*, 2020.
- Awarded the CRSI Bronze Medal, 2020.
- Received the C. V. Raman Award for Young Scientist by Karnataka State, 2019.

Prof. Ravi Manjithaya

- Joint recipient of the CDRI Award 2020 for excellence in Drug Research in Life Science category.

Prof. Sarit Agasti

- Received the Sheikh Saqr Fellowship, International Centre for Materials Science (ICMS), JNCASR, 2020.
- Emerging Investigator by Chemical Communications, Royal Society of Chemistry, UK, 2020.

Prof. Sebastian C. Peter

- Received the DST Swarna Jayanti Fellowship.

Prof. Shobhana Narasimhan

- Elected as an International Honorary Member of the American Academy of Arts and Sciences.
- Awarded the Anna Boyksen Fellowship of the Technical University Munich.

Prof. Subi J. George

- Selected as a Fellow of Indian Academy of Sciences, Bangalore, 2019.

Prof. Subir K. Das

- Invited as a Professor at the École normale supérieure de Lyon, France, 2019.

Prof. Sundaresan A.

- Elected as the Fellow of Indian Academy of Sciences, Bengaluru.

Prof. Tapas K. Kundu

- Received the Shri Om Prakash Bhasin Award 2019 in the field of Health & Medical Sciences awarded by Shri Om Prakash Bhasin Foundation.

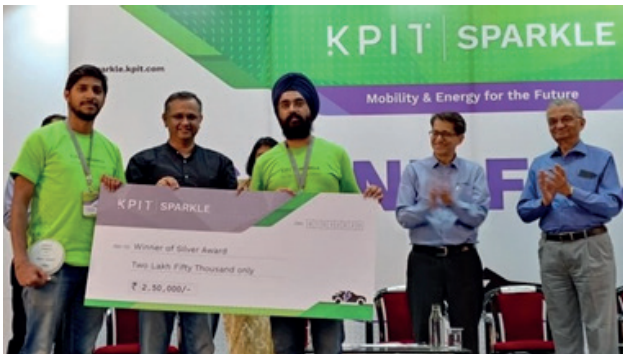
Prof. Tapas K. Maji

- Received the Shanti Swarup Bhatnagar Prize for the year 2019 in *Chemical Sciences*.
- Selected as Fellow of the Royal Society of Chemistry.
- Among top 10% of highly cited authors of RSC in 2018 in general chemistry portfolios of journals.
- Appointed as Associate Editor of the ACS journal: "*ACS Applied Materials & Interfaces*".

Prof. Umesh V. Waghmare

- Elected as Member and Secretary of the Council of the Indian Academy of Sciences, Bangalore.
- Elected as Member of the Council of the National Academy of Sciences, Allahabad.

STUDENTS ACHIEVEMENTS



Mr. Tarandeep Singh and Mr. Brijesh, members of Team ZincAir, won the Silver Award at KPIT Sparkle 2020 Innovate contest. Research supervisor: Prof. Tapas K. Maji.

Mr. Yanda Premakumar received the Best Poster Presentation Award at the 53rd Course of the International School of Crystallography held at Erice, Italy from May 31–June 9, 2019. Research supervisor: Prof. A. Sundaresan.

Ms. Chaitali Sow received the following awards under the research supervision of Prof. G.U. Kulkarni:

- Best Poster Award at 10th International Conference on Materials for Advanced Technologies (ICMAT), Singapore held at Marina Bay Sands, Singapore from June 23–28, 2019.
- Best Poster Award at 15th JNC Research Conference on Chemistry of Materials held at Trivandrum, India from September 30–October 2, 2019.
- Poster teaser award at JNCASR In-House Symposium, 2019 held at JNCASR, India from November 13–14, 2019.
- Best Poster Award at International Conference on Nano Science and Technology (ICONSAT) 2020, held at Biswa Bangla Convention Centre, New Town, Kolkata, India from March 5–7, 2020.

Mr. Sudarshan Behera received the CSIR-Shyama Prasad Mukherjee Fellowship. Research supervisor: Prof. S. Balasubramanian.

Mr. Abdul Azeez won the best poster prize at Sunrise Symposium, IISc, Bengaluru. Research supervisor: Prof. K.S. Narayan.

Mr. Soumen Pradhan received the CSIR-Shyama Prasad Mukherjee Fellowship. Research supervisor: Dr. Sarit Agasti.

Mr. Hansraj Gautam won the Best Poster Award at the "ISEB1: Celebrating Ecology and Evolution in India" national conference held on October 24–25, 2019 at Bengaluru. Research supervisor: Prof. T.N.C. Vidya.

Ms. Medha Rao won the Best Poster Award at the "ISEB2: Indo-Swiss Meeting on Evolutionary Biology" international conference held from December 12–14, 2019 at Bengaluru. Research supervisor: Prof. T.N.C. Vidya.

Ms. Mahima Makkar was awarded the Best Popular Science Story award at the AWSAR event. Research supervisor: Prof. Ranjani Viswanatha.

Mr. Chitrang Dani won the third prize in AWSAR for his story entitled "Out of the Lab: a Clock Conversation". Research supervisor: Prof. Sheeba Vasu.

Mr. Rutvij Kulkarni won the best poster award in the Master's category at the Understanding Behaviour Conference held at IISER Kolkata from January 11–13, 2019. Research supervisor: Prof. Sheeba Vasu.

Mr. Arijit Ghosh won the Bhagwati Devi Memorial Award for best oral presentation in the International Symposium on Biological Rhythms held at Chaudhary Charan Singh University, India from March 11–13, 2019. Research supervisor: Prof. Sheeba Vasu.

Mr. Arijit Ghosh and Ms Aishwarya Iyengar received the Global Diversity Award for Young Investigators from the Society for Research on Biological Rhythms, 2020. Research supervisor: Prof. Sheeba Vasu.

Mr. Sumukh Purohit won the best poster prize at Sunrise Symposium, University of Oxford, UK. Research supervisor: Prof. K.S. Narayan.

STUDENTS ACHIEVEMENTS

Mr. Arindam Ray was awarded the CSIR travel grant to attend 60th Annual Drosophila Research Conference, Houston Texas, in March 2019. Research Supervisor: Prof. Maneesha Inamader.

Md. Hashim Reza was awarded DBT-RA-I fellowship. Research Supervisor: Prof. Kaustuv SanyaL

Ms. Shweta Panchal was awarded DST-WOS-A. Research Supervisor: Prof. Kaustuv Sanyal.

Mr. Vikas Yadav received the NASI Young Scientist award and the INSA Young Scientist award. Research Supervisor: Prof. Kaustuv Sanyal.

Ms. Neha Varshney was awarded Research Associate Fellowship from CSIR. Research Supervisor: Prof. Kaustuv Sanyal.

Md. Hashim Reza received financial support from SERB-NPDF to attend the "30th Fungal Genetics Conference" held during March 12–17, 2019 at Pacific Grove, California, USA. He also received the DBT-CTEP travel grant to attend the "8th International Rice Blast Conference" held at Chengdu, China from May 27–31, 2019. Research Supervisor: Prof. Kaustuv Sanyal.

Ms. Shreyas Sridhar received the EMBO travel grant to attend the "Chromosome segregation and Aneuploidy meeting" at Cascais, Portugal. Research Supervisor: Prof. Kaustuv Sanyal.

Ms. Disha Bhange's poster got selected for an oral presentation at the Combat HIV conference held at the School of Life Sciences, University of Hyderabad in January, 2019. Research Supervisor: Prof. Ranga Udayakumar.

Mr. Arun Panchapakesan won best poster award at the Combat HIV conference held at the School of Life Sciences, University of Hyderabad in January, 2019. Research Supervisor: Prof. Ranga Udayakumar.

Dr. Swetha Sikder won the Best Thesis Medal in Biological sciences (2018-2019) in JNCASR, Bangalore, India. Research Supervisor: Prof. Tapas Kumar Kundu.

Ms. Ruchika Kumari received the Best Poster Award at the XIth International Conference on Biology of Yeasts and Filamentous Fungi held at the University of Hyderabad, Hyderabad. Research Supervisor: Dr. Ravi Manjithaya.

Dr. Sreedevi P. received the Best Poster Award at the International Conference on Autophagy and Lysosomes held at the Indian Institute of Science, Bengaluru. Research Supervisor: Dr. Ravi Manjithaya.

Dr. Mukesh Kumar Chaurasia received DBT-Research Associate Fellowship on the project entitled 'Deciphering the molecular mechanism of immunological tolerance'. Research Supervisor: Dr. Kushagra Bansal.

Dr. Mouli Konar, a post-doctoral fellow, won the Best Oral Presentation award at the Student Indian Peptide Symposium 2020, held at Madurai Kamaraj University, Madurai, on February 20–21, 2020. Research Supervisor: Prof. Govindraju T.

Dr. Lakshmi P Datta, a post-doctoral fellow, won the Best Poster award at the 26th CRSI-National Symposium, held at VIT University, Vellore, on February 7–9, 2020. Research Supervisor: Prof. Govindraju T.

Ms. Geetika Dhanda received the Bapu Narayanswamy Award for the Best Master's thesis in Chemical and Materials Science. She also won the award for the Best Oral Presentation at the Chemical Frontiers conference held at Goa. Research Supervisor: Dr. Jayanta Haldar.

Md. Monis Ayyub received the Malhotra Weikfield Foundation Nano Science fellowship held at Bangalore India Nano, 2020. Research Supervisor: Prof. C.N.R. Rao.

Mr. Reetendra Singh received the Best Short Oral Presentation at Chemical Frontiers-2019, held in Goa from August 22–25, 2019. He also won the Best Oral Presentation at International Winter School, 2019 held in Bangalore, India from December 2–6, 2019. Research Supervisor: Prof. C.N.R. Rao.

STUDENTS ACHIEVEMENTS

Mr. Rohit Attri received the Best poster award at the 15th JNC Research Conference on Chemistry of Materials 2019, Kerala, India. Research Supervisor: Prof. C.N.R. Rao.

Mr. Swaraj Servottam received the Best poster award, Chemical Frontiers, held in Goa from August 22–25, 2019. Research Supervisor: Prof. C.N.R. Rao.

Mr. Subhajit Roychowdhury won the Best Thesis Award (2nd Prize) in the area of 'Energy & Mobility' by KPIT in IISER, held at Pune. He also won the Graduate Student Silver Award, 2019 from Materials Research Society, USA. Research Supervisor: Dr. Kanishka Biswas.

Mr. Paribesh Achyarya won the Best Poster Award at the International Conference on Nano Science and Technology, 2020, held at Kolkata. Research Supervisor: Dr. Kanishka Biswas.

Ms. Sushmita Chandra won the Best Poster Award at the International Conference on Nano Science and Technology, 2020, held at Kolkata. Research Supervisor: Dr. Kanishka Biswas.

Dr. Soumyabrata Roy bagged first prize in best poster category of KPIT Shodh Awards. Research Supervisor: Dr. Sebastian C. Peter.

Mr. Arjun Cherevotan won the Best Poster Award at the 26th CRSI-National Symposium, held at VIT University, Vellore, on February 7–9, 2020. He also won the Best Poster award at the Virtual Conference on "Materials for Energy Harvesting and Catalysis" held via Zoom on May 1–3, 2020. Research Supervisor: Dr. Sebastian C. Peter.

Dr. Saurav Ch. Sarma received the prestigious Marie-Curie postdoctoral fellowship, 2020. Research Supervisor: Dr. Sebastian C. Peter.

Mr. Angshuman Das was awarded the prestigious CSIR-Shyama Prasad Mukherjee Fellowship. Research Supervisor: Dr. Subi J. George.

Ms. Ananya Mishra won the BIRAC-SRISTI Gandhian Young Technological Innovation award. Research Supervisor: Dr. Subi J. George.

Ms. Anvitha S. was one of the winners of Speed Talks in "SPEEC-UP conference for Bangalore-based students and postdocs on behaviour, ecology, and evolution, held at the JNCASR, Bengaluru on August 30, 2019. Research Supervisor: Prof. T.N.C. Vidya.

Ms. Keerthipriya P. won a Speed Talk prize at the "Understanding Behaviour" conference held at IISER-Kolkata from January 11–13, 2019. Research Supervisor: Prof. T.N.C. Vidya.

Ms. Revathe T. won a Best Poster prize at the "Understanding Behaviour" conference held at IISER-Kolkata from January 11–13, 2019. Research Supervisor: Prof. T.N.C. Vidya.

Mr. Navneet Singh won the best oral presentation award at Compflu, 2019 held in IISER Bhopal. Research Supervisor: Dr. Rajesh Ganapathy.

Dr. Abhik Paul received CSIR travel grant to attend AWCBR neuroscience conference in New Zealand. Research Supervisor: Dr. James P.C. Chelliah.

Ms. Raagya Arora received the best poster presentation award in the JNCASR conference in October, 2019. Research Supervisor: Prof. Umesh V. Waghmare.

MAJOR VISITS AND EVENTS

Visit by Parliamentary Standing Committee

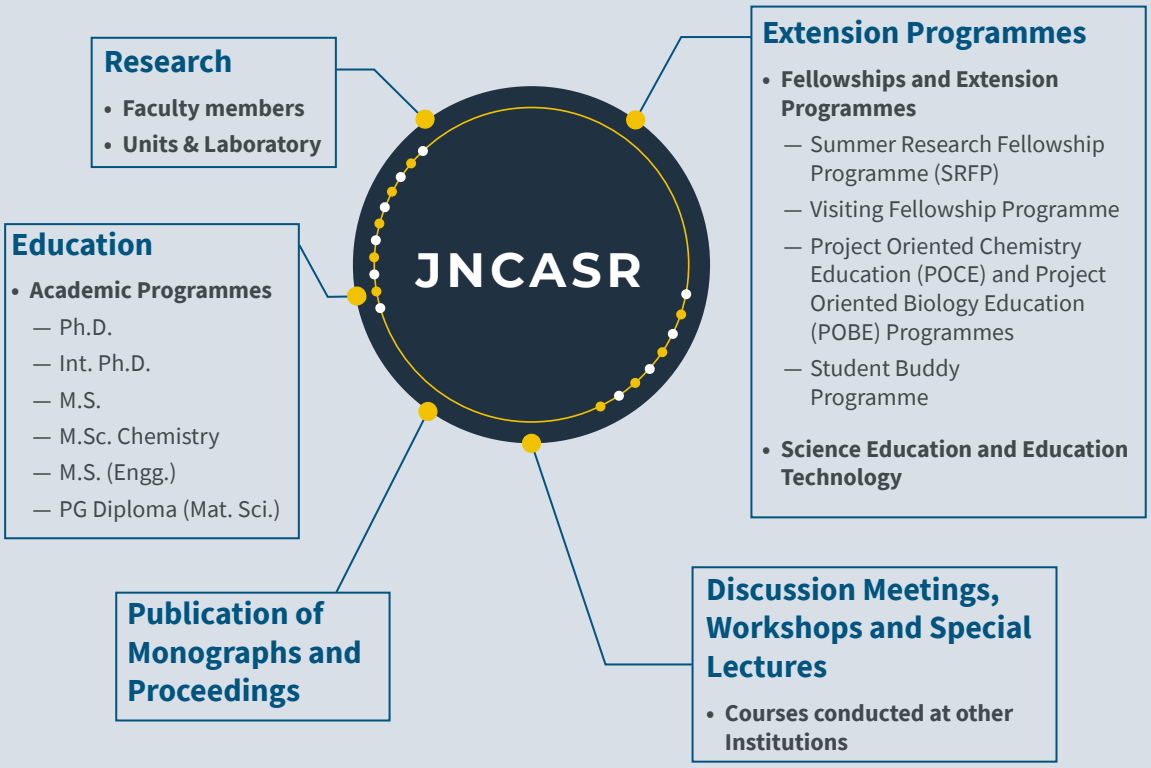
The Parliamentary Standing Committee visited JNCASR on December 29, 2019 under the Chairmanship of Dr. Jairam Ramesh, Hon'ble Member of Parliament, Rajya Sabha, along with a delegation of parliamentarians.

Annual Faculty Meeting and In-House Symposium

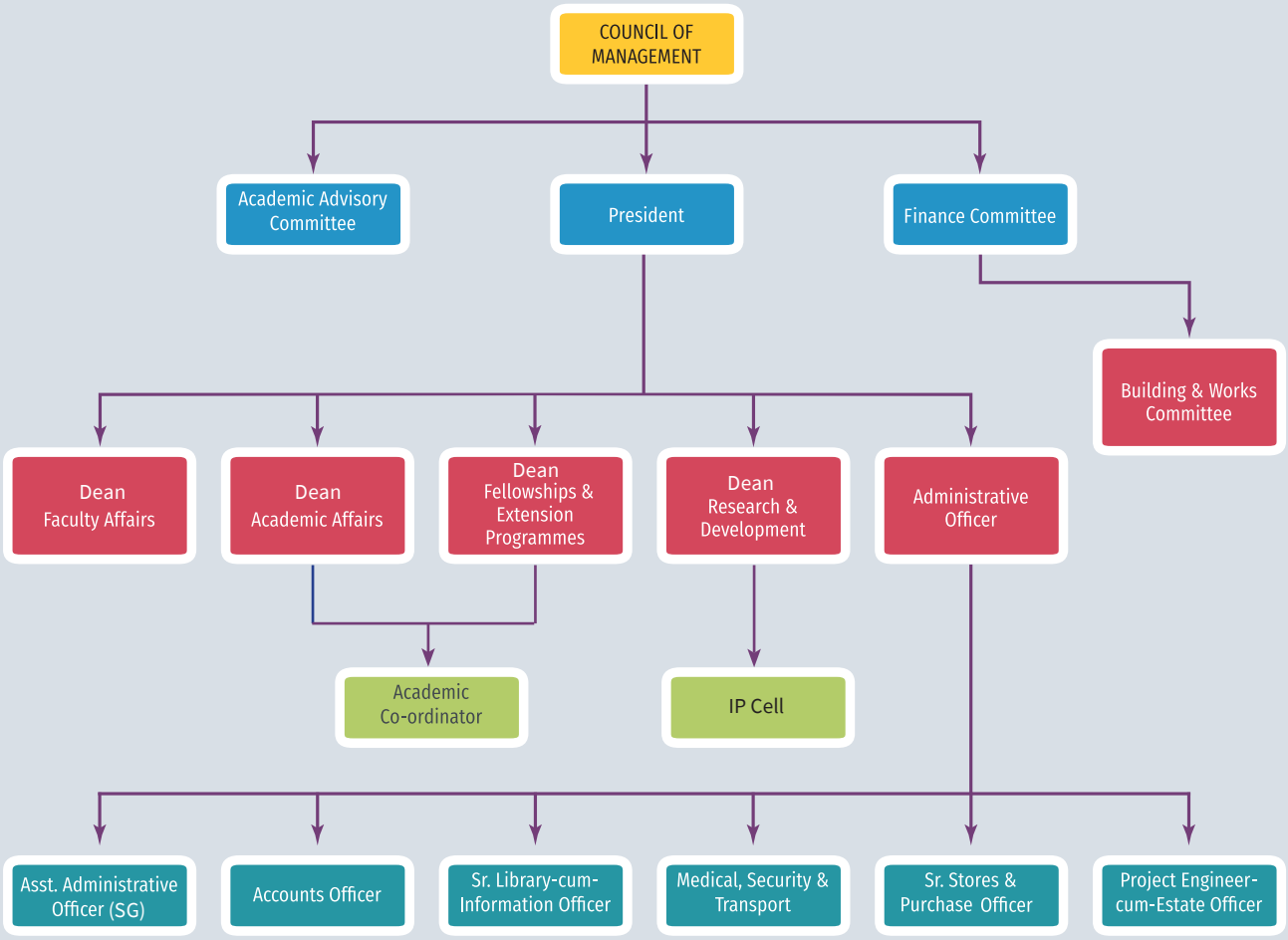
The Annual Faculty Meeting and In-House Symposium were held during November 13–14, 2019. Several eminent scientists from the Centre, InStem, and TIFR delivered talks on their latest research. The two-day programme spanning across 9 sessions, included faculty and student talks, poster teasers, and poster presentations. On the second day of the event, degree certificates were distributed by Prof. K.S. Narayan, President In-charge, JNCASR to the students who graduated this year.

As part of this event, a theatrical performance (drama) was presented on November 13, 2019 at the New Auditorium, JNCASR, Jakkur Campus. The play, "Bharat Bhagya Vidhata", was based on the life of Mahatma Gandhi and was performed by members of Shrimad Rajchandra Mission, Dharampur.

ACTIVITIES CHART

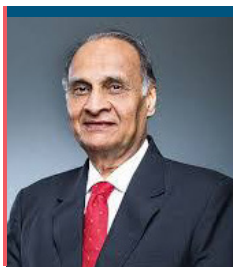


ORGANIZATIONAL CHART



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.
The constitution of the Council of Management is as follows:



Prof. Goverdhan Mehta
Chair (DST Nominee) Former
Director, IISc, Bengaluru

Prof. M. Jagadesh Kumar
Member (DST Nominee)
VC, JNU, New Delhi

Prof. Vinod K. Singh
Member (DST Nominee)
Professor, IIT-Kanpur

Shri K.N. Vyas
Member (DST Nominee)
Secretary, DAE & Chairman, AEC

Prof. Virander S. Chauhan
Member (UGC Nominee)
Arturo Falaschi Emeritus Scientist
ICGEB, New Delhi

Prof. Ashutosh Sharma
Member (Ex-officio)
Secretary, DST

Shri B. Anand
Member (Ex-officio)
AS & FA, DST

Prof. Anurag Kumar
Member (Ex-officio)
Director, IISc, Bengaluru

Prof. Sriram Ramaswamy
Member (IISc Nominee)
Physics Dept., IISc

Prof. G.U. Kulkarni
Member (Ex-officio)
President, JNCASR

Prof. Hemalatha Balaram
Member
Dean, Faculty Affairs, JNCASR

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

Prof. Anuranjan Anand
Member
Professor, MBGU & Chair, NSU
JNCASR

Prof. Roddam Narasimha
Member
Hon. Professor, JNCASR

Mr. Joydeep Deb
Non Member Secretary
Administrative Officer, JNCASR

FINANCE COMMITTEE

The Finance Committee of the Centre scrutinizes all financial proposals, and makes recommendations to the Council of Management.

NAME AND DESIGNATION	POSITION
Prof. G.U. Kulkarni, President, JNCASR	Chair (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 B. Anand, AS & FA, DST	Member (Ex-officio)
Mr. Sampad Patra, Accounts Officer, JNCASR	Member (Ex-officio)
Mr. Joydeep Deb, Administrative Officer, JNCASR	Non Member Secretary (Ex-officio)

ACADEMIC ADVISORY COMMITTEE

The functions of the AAC include planning, execution and coordination 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. The Committee makes its recommendations on all academic matters to the Council of Management.

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

ADMINISTRATION

POSITION	NAME OF MEMBER
President	Prof. G.U. Kulkarni, Ph.D., FASc, FNASc
Dean, Faculty Affairs	Prof. Hemalatha Balaram, Ph.D., FASc, FNASc
Dean, Academic Affairs	Prof. Umesh V. Waghmare, Ph.D., FASc, FNASc, FNA
Dean, Fellowships and Extension Programmes	Prof. Vidhyadhiraja N.S., Ph.D.
Dean, Research and Development	Prof. Chandrabhas Narayan, Ph.D., FNASc, FRSc
Warden & Student Counsellor	Dr. Jayanta Haldar, Ph.D.
Associate Warden	Dr. Sheeba Vasu, Ph.D.
Administrative Officer & Public Information Officer	Mr. Joydeep Deb, M.Sc. (Electronics), M.Sc. (Telecommunication)
Asst. Administrative Officer (SG)	Mrs. C.S. Chitra, B.Com.
Co-ordinator (Academic, F&E and R&D)	Dr. Panneer K. Selvam, MA, MBA, LLB, Ph.D
Accounts Officer	Mr. Sampad Patra, B.Com, PGDCA, MBA (Finance)
Sr. Stores & Purchase Officer	Mr. K. Bhaskara Rao, M.Sc.
Sr. Library-cum-Information Officer & Media Co-ordinator	Ms. Nabonita Guha, MLIS
Sr. Secretary to President	Mr. A. Srinivasan, B.A.
Jr. Accounts Officer	Mr. B. Venkatesulu, B.Sc.
Asst. Public Information Officer	Mrs. Susheela G., B.Sc.
Project Engineer	Mr. Mahadevan N., B.E., MIE
Project Engineer Gr. II	Mr. Nadiger Nagaraj, DCE
Asst. Project Engineer (Elec.)	Mr. Sujeeth Kumar S., DEE
Jr. Project Engineer (Civil)	Mr. Veeresha N.R., DCE
Consulting Medical Officer	Dr. G.R. Naghabhushana, MBBS, FCCP, FCGP, P.G. Dip. in M&CHL
Consulting Lady Medical Officers	Dr. Kavitha Sridhar, MBBS Dr. Archana. M.L.V., MBBS Dr. H.V. Chandralekha, MBBS
Clinical Psychologist	Dr. Elizebath Daniel, M.A., M. Phil., Ph.D.
Physiotherapist	Mr. Y. Yogesh, BPT
Honorary Medical Officer	Dr. C. Satish Rao, MBBS Dr. R. Nirmala, MBBS
Advisor- Special Projects and Initiatives	Mr. A.N. Jayachandra, B.Com, P.G. Diploma (Finance)
Co-ordinator (Security And Fire Fighting)	Mr. M.R. Chandrasekhar, B.Sc., LLB

New Appointments

Prof. G.U. Kulkarni taking over as President, JNCASR from Prof. K.S. Narayan (President In-charge) on January 29, 2020 at the President's Office in JNCASR.

Dr. Bani Kanta Sarma joined as Faculty Fellow at New Chemistry Unit, JNCASR

APPOINTMENTS	Prof. G.U. Kulkarni (President, JNCASR)
	Dr. Bani Kanta Sarma (Faculty Fellow, NCU)
DEANS	Prof. Chandrabhas Narayana (Dean, R&D)
	Prof. N.S. Vidhyadhiraja (Dean, F&E)
CHAIRS	Prof. Maneesha S. Inamdar (MBGU)
	Prof. A. Sundaresan (CPMU)
ADDITIONAL RESPONSIBILITIES	Prof. M. Eswaramoorthy (Associate Director, ICMS)
	Prof. Subi J. George (Associate Chairperson, NCU)
	Prof. Govindaraju T. (Faculty In-charge, ETU)
	Prof. Jayanta Haldar (Warden)
	Prof. Sheeba Vasu (Associate Warden)
	Prof. Ranjani Viswanatha (DCF Chairperson)
	Mrs. Nabonita Guha (Media Co-ordinator to DST Vigyan Samachar)
	Dr. R.G. Prakash (Liaison Officer, OBC)
	Mr. B. Venkatesulu (Liaison Officer, SC/ST)
	Dr. Panneer Selvam K. (Co-ordinator, R & D)
	Mr. Sreenath V. (Co-ordinator, Health, Safety and Conservation)
PROMOTION	Mrs. Chitra C.S. (Assistant Administrative Officer)
TEMPORARY APPOINTMENTS	Prof. Jaywant H. Arakeri (Visiting Professor)
	Mr. M.G. Narayan (Co-ordinator, PR)
	Mr. Vinayak Pattar (Technical Support)
	Mr. Lenen John Thomas (Nurse)
	Mr. Godson Anburaj (Nurse)

ACADEMICS

JNCASR is a deemed-to-be-university and awards Ph.D. and Master's degrees in various fields to its students. This section provides a brief overview of the different degree programmes and showcases the academic achievements of the year 2019–20.

Academic Activities

The Centre offers various academic programmes, such as Ph.D., Integrated (Int.) Ph.D., M.S.(Research) and M.S.(Engg.), Masters in Chemistry and PGDMS degree programmes in Sciences and Engineering. Candidates with an B.E./B.Tech., M.E./M.Tech./MBBS/M.Sc./B.Sc. degree are eligible to apply for these programmes as per requirements of each programme. In addition, the candidate for Ph.D. programmes should have at least 50% in their highest University examination, and be qualified in the nationalized tests like GATE JEST/GPAT/UGC/CSIR-NET-JRF/ICMR-JRF/DBT-JRF/INSPIRE-JRF. 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. The Int. Ph.D. programmes are offered in the areas of Materials Sciences, Chemical Sciences, and Biological Sciences, and are offered only during the August admission session.

Enrolled students are expected to take courses and actively participate in research. The research students receive monthly fellowship as per the Govt./Centre's norms. Students are awarded the relevant degrees on successful completion of coursework and thesis. The students get several opportunities to interact with renowned scientists and other fellow students via national and international conferences and workshops. They also get multiple chances to discuss their own research through departmental seminars. Students have access to world-class research infrastructure and cutting-edge facilities.

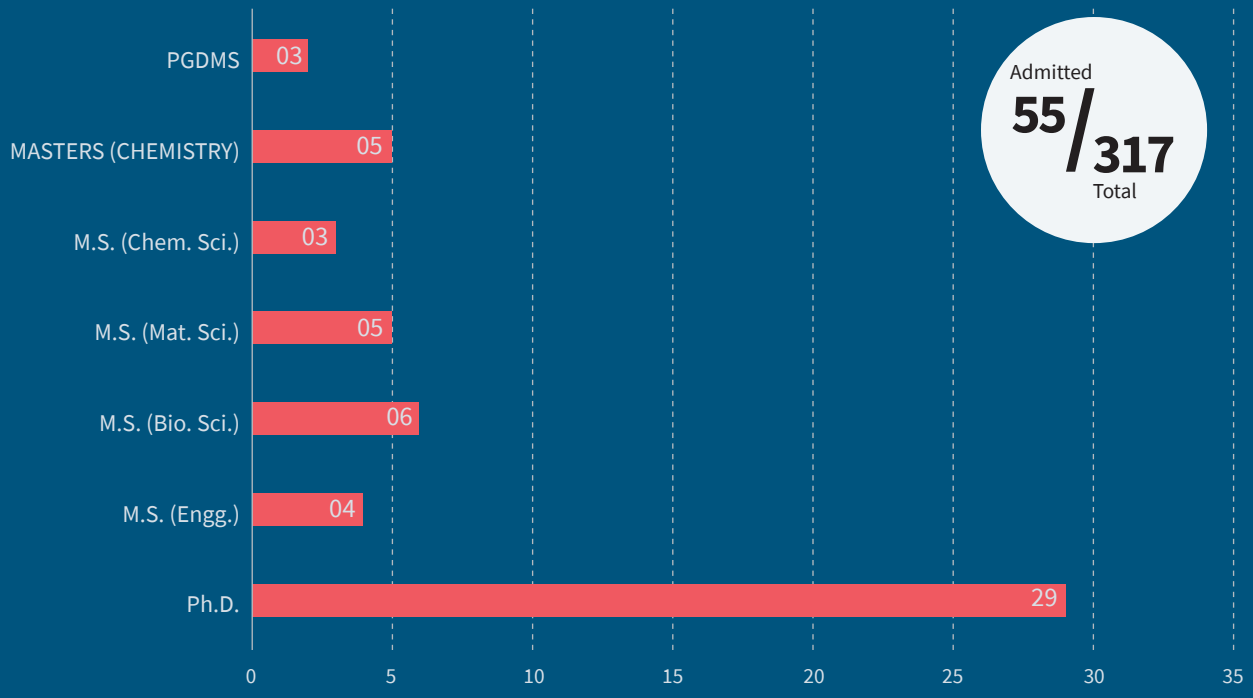
Research Admissions

In the academic year of 2019-20, 55 students enrolled in various degree programmes at the Centre – **29** in Ph.D., **04** in M.S. (Engg.), **06** in M.S. Biological Science, **05** in M.S. Materials Science, **03** in M.S. Chemical Science, **05** in Masters in Chemistry and **03** in PGDMS. The current student strength at JNCASR is **317.**

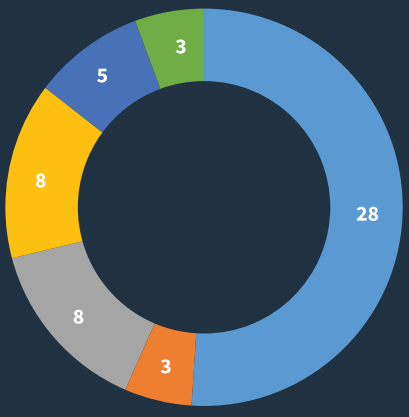
Degrees Awarded

In the past year, the Centre awarded **28** Ph.D. degrees, **03** M.S. (Engg.) degrees, **08** M.S. in Biological Sciences, **08** M.S. in Materials Sciences, **05** M.S. in Chemical Science, and **03** PGDMS.

RESEARCH ADMISSIONS (2019-2020)



DEGREES AWARDED



- Ph.D. - 28
- M.S. (Engg.) - 3
- M.S. (Biological Science) - 8
- M.S. (Materials Science) - 8
- M.S. (Chemical Science) - 5
- PGDMS - 3

ACADEMIC OFFICE MEMBERS

Dean, Academic Affairs

Prof. Umesh V. Waghmare, Ph.D., FASc, FNASc, FNA

Academic Co-ordinator

Dr. Princy J. Pereira, Ph.D.
(on lien w.e.f. 18.11.2019)

Dr. Paneer Selvam, Ph.D.
(30.10.2019 onwards)

Jr. Admin Assistants

Bhagya Shree S.

Vinutha P.


Nikon

RESEARCH & DEVELOPMENT

CHEMISTRY AND PHYSICS OF MATERIALS UNIT (CPMU)

CPMU, the first research unit established at JNCASR, has turned 25 this year! It incorporates an interdisciplinary approach to materials science. Since its inception, the Unit has made many ground-breaking discoveries and advances in research. CPMU is often at the forefront in terms of publications, awards and fellowships with laboratories attracting both national and international collaborations. Several academic events are being conducted as a part of silver jubilee celebrations of CPMU.

RESEARCH AREAS

CPMU carries out research in the following areas:

- Raman and Brillouin spectroscopy
- High-pressure research
- Nanofabrication and devices
- Organic electronics
- Photovoltaics
- Device physics and bio-electronics
- Magnetism and magnetoelectricity
- Superconductivity
- Functional materials
- Computational molecular science

RESEARCH HIGHLIGHTS

- Linear magnetoelectric effect and multiferroic properties were discovered in the green phase compounds R_2BaCuO_5 (R=rare-earths).
- The mechanism of CO_2 gas uptake by a nonporous molecular crystal was elucidated.
- A promising anode material for Li-ion hybrid capacitor was engineered, opening up new possibilities for next-generation energy storage devices.
- A simple, ultrafast combustion synthesis of Co_3O_4 dispersed carbon for enhanced oxygen evolution kinetics was reported.
- A cost-effective and energy-efficient wafer-scale photodetector was fabricated and is expected to have important applications in security systems.
- Electrical transport properties of conducting polymers were shown to be significantly enhanced when confined within nanopores.
- The origin of commonly observed and much debated blue luminescence in Mg-doped GaN was uncovered by a combined First-principles calculation and X-ray spectroscopic study.
- A solvent responsive dynamic nanoscale metal-organic framework [Zn(1a)(H_2O)$_2$] was devised with potential applications in drug delivery.
- Rigid-band electronic structure of ScN across the n-type to p-type carrier transition regime was reported.
- A DNA nanosensor with multichannel output was designed for sensitive and high-throughput proteomics analysis.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. Sundaresan A. Ph.D., FASc
Professor and Chair, CPMU

Towards the mission of exploring new magnetoelectric and multiferroic materials, we identified Sm_2BaCuO_5 as a linear magnetoelectric material based on the symmetry consideration.

We showed that $Gd_{0.5}Dy_{0.5}MnO_3$, a mixed rare-earth manganite, exhibits a spontaneous electric polarization along a general direction in the crystallographic ac plane; this polarization is suppressed below 10 K, but re-emerges in an applied magnetic field. This unusual behaviour was shown to originate from the coupling between the transition-metal and rare-earth magnetic subsystems.

From magnetoelectric and dielectric-relaxation studies, we showed the presence of the memory effect beyond the antiferromagnetic ordering temperature in a single crystal of $Gd_{0.5}Dy_{0.5}MnO_3$, and we believe the effect is caused by the Debye-like relaxation behaviour.

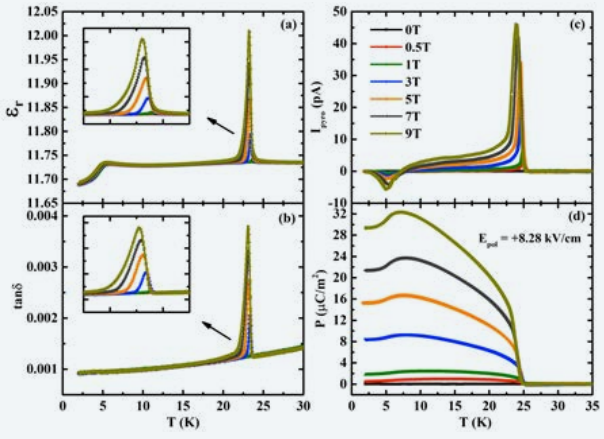


Fig. Linear magnetoelectric effect in Sm_2BaCuO_5.

KEY PUBLICATIONS:

- Ghara S, *et al.* (2017) Ordered aeschynite-type polar magnets $RFeWO_6$ (R=Dy, Eu, Tb and Y): A new family of type-II multiferroics. *Phys Rev B* 95:224416–224427.
- Sundaresan A, *et al.* (2006) Ferromagnetism as a universal feature of nanoparticles of the otherwise nonmagnetic oxides. *Phy Rev B* 74:161306 R.

EVENTS ORGANISED:

- Organized BRICS project meeting that involved researchers from China and Russia from December 12–13, 2019.
- Workshop on data analysis of neutron scattering and muon spectroscopy from February 7–8, 2019.

INVITED AS SPEAKER AT:

- International Winter School on Frontiers in Materials Science held at JNCASR, Bengaluru from December 2–6, 2019.
- The 13th PACRIM conference organised by The Ceramic Society of Japan held at Okinawa (Japan) from October 27 to November 1, 2019.
- International Conference on Materials for Advanced Technologies (ICMAT), organised by Materials Research Society of Singapore (MRS-S) from June 23–28, 2019.
- 47th National Seminar on Crystallography (NSC47) organised by BARC Mumbai from June 19–22, 2019.

Prof. Balasubramanian S. Ph.D., FASc

Professor

The isodesmic and cooperative pathways of assembly can be experimentally identified using spectroscopy and in simulations via determination of the dependence of the association constant on the oligomer size. Employing large-scale free energy calculations, we showed the independence of the free energy change of oligomerization on size in the self-assembly of a [2.2]paracyclophane-tetracarboxamide ([2.2]pCpTA) derivative ([2.2]pCpTA-hex), which was experimentally shown to follow the isodesmic pathway. In contrast, simulations showed that the free energy change in the case of benzene-1,3,5-tricarboxamide depended on the oligomer size.

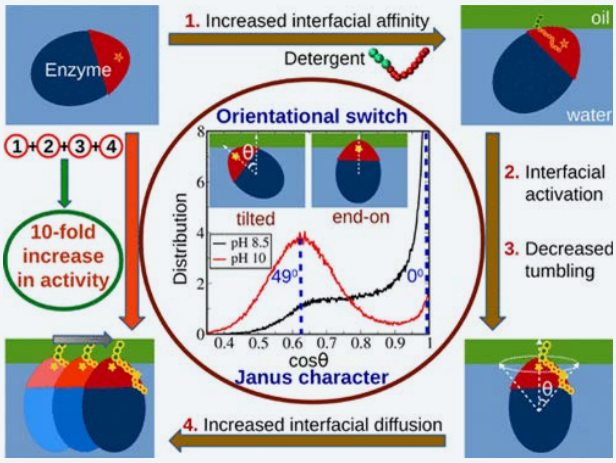


Fig. The increase in activity of Lipase A at an oil-water interface is explained through molecular simulations.

KEY PUBLICATIONS:

- Dwarkanath N, et al. (2019) Unraveling the sorption mechanism of CO_2 in a molecular crystal without intrinsic porosity. *J Phys Chem B* 123(34):7471–7481.
- Korlepara DB, et al. (2019) Differentiating the mechanism of self-assembly in supramolecular polymers through computation. *Chem Commun* 55:3773–3776.

EVENT ORGANISED:

- Modern Approaches in Chemistry and Biology – 2020 symposium, organised along with Prof. U.V. Waghmare, and held at JNCASR from February 18–20, 2020.

INVITED AS SPEAKER AT:

- Modelling Supramolecular Polymers, held at Department of Chemistry, Indian Institute of Technology, Kanpur on January 18, 2019.
- Invited Lecture in Multiscale Simulation and Mathematical Modelling of Complex Biological Systems Conference held at Jawaharlal Nehru University, New Delhi on January 31, 2019.
- Invited Lecture in Advanced Simulation Methods 2019 Conference, Indian Institute of Technology, Delhi on March 9, 2019.
- Invited Speaker in Chemistry of Functional Materials Conference, Goa, organized by Indian Institute of Technology, Bombay on August 24, 2019.

Prof. Chandrabhas Narayana Ph.D., FASC, FRSC, FNASc

Professor & Dean, Research and Development

We synthesized dendrons with thiophenol groups on their periphery and tested them as a Surface-Enhanced Raman Spectroscopy (SERS) analyte, with simple gold nanoparticles as a substrate. As a result, we observed a 10^2 fold enhancement in detection upon going from a mono-thiophenol to a tetra-thiophenol.

Through simulation of resonance Raman (RR) spectra of guanosine-5′-monophosphate (GMP) in two ππ* singlet excited states, we showed that the explicit hydrogen-bonded local solvation structure of the chromophore influences the RR intensities of GMP by modulating both the ground-state normal mode vectors and the excited-state energy gradients.

High pressure Raman spectroscopy studies on 1T-$TiSe_2$ were carried out up to ~20.5 GPa, whereby a novel reversible high-pressure phase was identified beyond ~15 GPa. We also unambiguously established the high-pressure phase diagram and identified three phases of GeTe up to 57 GPa.

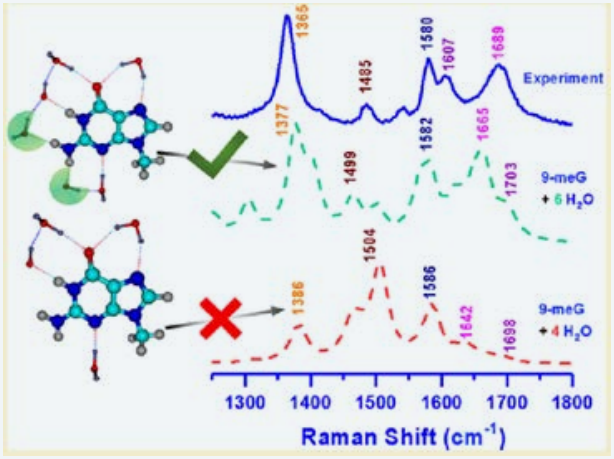


Fig. Effect of the structure of first solvation shell on the computed Resonant Raman spectra of guanosine 5'–monophosphate (GMP) and its comparison with experimental spectra (Mondal S and Narayana C, 2019).

Polymorphs of $LiCe(WO_4)_2$ [α-$LiCe(WO_4)_2$ and β-$LiCe(WO_4)_2$] were successfully synthesized by a citric acid-assisted sol–gel method for the first time, providing insights into the design of new insertion anode electrodes for Li-ion batteries. We also showed that pulsed laser deposition is suitable for growing ReS_2 thin film both on c plane sapphire substrate and MoS_2 template and over large area (10 × 10 mm^2) for practical device application.

KEY PUBLICATIONS:

- Pavan Kumar GV, et al. (2007) Hot spots in Ag core-Au shell nanoparticles potent for surface-enhanced Raman scattering studies of biomolecules. *J. Phys. Chem. C* 111:4388–4392.
- Kumari G, et al. (2013) Temperature Induced Structural Transformations and Gas Adsorption in ZIF-8: A Raman Study. *J. Phys. Chem. A* 117:11006–11012.

EVENT ORGANISED:

- The 8th International Conference on Perspectives in Vibrational Spectroscopy (ICOPVS)- 2020 held at JNCASR from February 24–28, 2020.

INVITED AS SPEAKER AT:

- Discovering New Topological Phases in Materials under Pressure using Raman Spectroscopy, Platinum Jubilee Lecture Award talk in Indian Science Congress, held at University of Agricultural Sciences, Bengaluru on January 4, 2020.

Prof. Eswaramoorthy Muthusamy Ph.D.

Professor

We recently reported a new and simple methodology to quantify the amount of metallic Ni present in the mixed nickel hydroxide/nickel surface using galvanic replacement reaction. This approach can be extended to synthesize various nickel-containing bimetallic nanoparticles that would be useful for many industrially significant catalytic reactions.

Covalent organic polymers (COPs) are a new class of materials offering diverse functionality. We showed that effective interface engineering between conducting (graphene) and non-conducting COP phase (containing redox-active viologen moieties) retains electrochemical activity even after prolonged cycling. These findings can be used to realize enhanced pseudocapacitive energy storage.

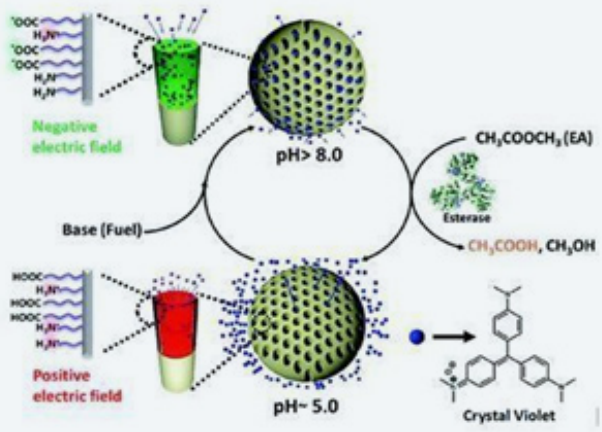


Fig. Bio-inspired temporal regulation of ion-transport in nanochannels. Herein, we demonstrated biochemical reaction-mediated temporal regulation of mass transport in nanochannels of mesoporous silica sphere, thereby developing a unique approach to create autonomous artificial cellular models of biological systems. The rationally designed nanochannels with pH-responsive electrostatic gating were fabricated through a hetero-functionalization approach utilizing propylamine and carboxylic acid moieties.

KEY PUBLICATIONS:

- Gond R, et al. (2019) Sodium cobalt metaphosphate as an efficient oxygen evolution reaction catalyst in alkaline solution. *Angewandte Chemie* 131(25): 8418–8423.
- Singh DK, et al. (2019) Nanoscale engineering of graphene-viologen based 3D covalent organic polymer interfaces leading to efficient charge-transfer for pseudocapacitive energy storage. *ChemistrySelect* 4(27):8089–8094.

EVENTS ORGANISED:

- International Winter School 2019 on Frontiers in Materials Science held at JNCASR from December 2–6, 2019.
- CPMU Unit Day 2019, the 25th Celebrations held at JNCASR on September 7, 2019.
- JNCASR In-House Symposium held at JNCASR from November 13–14, 2019.
- JNCASR-Shiv Nadar University Joint Symposium on Emerging Materials, held at JNCASR from November 8–9, 2019.

INVITED AS SPEAKER AT:

- International Conference on Nanotechnology -2019, Opportunities and Challenges, held at St. Aloysius College, Mangalore from January 10–11, 2019.
- 7th Asian Conference on Coordination Chemistry 2019 (ACCC7 2019) held at Kuala Lumpur, Malaysia from October 15–18, 2019.
- One day workshop on Atoms, Molecules and Materials, held at Manipal Academy of Higher Education, Manipal on November 23, 2019.
- 6th National Conference on Recent Trends in Materials Science and Technology 2019, held at IIST, Trivandrum from December 18–20, 2019.
- 11th edition of Bengaluru India Nano-2020, held at Bengaluru from March 2–3, 2020.

Prof. G.U. Kulkarni Ph.D., FNASc, FASc, FAPAM

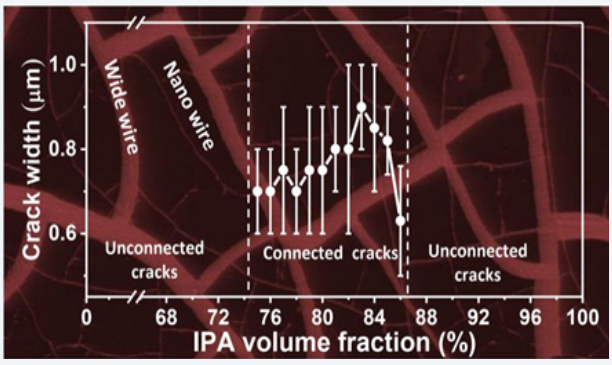
Professor & President, JNCASR

Using grazing incidence X-ray scattering, we showed the formation of a two-dimensional ordered structure of a charge-transfer complex (dodecyl methyl viologen (DMV) coronene tetracarboxylate potassium salt (CS)) at the air–water interface, thereby providing novel insights into the fishing net-type structure.

We recently reported the fabrication of a stable planar supercapacitor with the highest operating voltage window reported till date and with retention of 86% capacitance even after 50000 charge-discharge cycles. This device provides a foundation for designing novel efficient energy storage devices.

Through simulations, we studied the relevance of desiccation crack patterns in electrical conductivity, and identified broad features that may be useful to fabricate effective transparent conducting electrodes. We also investigated the crack formation process using a mixture of solvents (water and isopropyl alcohol) the results may be relevant for optoelectronic applications.

Desiccation crack patterns are associated with the rearrangement of particles upon solvent evaporation, while adhesion to the substrate resists such movements. The nature of solvent, which is often overlooked, plays a key role in the process as it dictates evaporation and wetting properties of the colloidal film. We studied the crack formation process using a mixture of solvents, water, and isopropyl alcohol.



KEY PUBLICATIONS:

- Sow C, et al. (2020) Unraveling the spatial distribution of catalytic non-cubic Au phases in a bipyramidal microcrystallite by X-ray diffraction microscopy. *ACS Nano 14(8):9456-9465.*
- Kundu S, et al. (2019) A planar supercapacitor made of supramolecular nanofibre based solid electrolyte exhibiting 8 V window. *Nano Energy* 61C:259–266.

EVENT ORGANISED:

- Celebrations of International Year of Periodic Table of Chemical Elements (IYPT-2019) held at J.N. Tata Auditorium in the Indian Institute of Science campus on May 29, 2019.

INVITED AS SPEAKER AT:

- 10th International Conference on Materials for Advanced Technologies (ICMAT 2019), Symp X - Von Hippel Award Symposium in Honor of Prof. C.N.R. Rao FRS, Singapore, June 13–28, 2019.
- IYPT 2019, Higher Education Academy, Dharwad held on September 06, 2019.
- Physics at Surfaces and Interfaces of Soft Materials (PSISM-2019) Conference; delivered talk on 'Supramolecular nanofibres as active elements in sensors and energy devices' at Jadavpur University held on September 26 2019.
- A one-day workshop on Atoms, Molecules and Materials and delivered Talk on Rediscovering the periodic table of chemical elements at MAHE held on November 23, 2019.
- The 64th DAE Solid State Physics Symposium (DAE-SSPS 2019); Plenary Talk in the symposium 'A New Twist in Graphene Research: Twisted Graphene' held at IIT Jodhpur on December 18, 2019.

Prof. Narayan K.S. Ph.D., FNASc, FASc, FNA, Sir J. C. Bose National Fellow
Professor

It was demonstrated that efficiencies in non-fullerene acceptor (NFA)-based solar cells can be further improved upon insertion of $PC_{70}BM$ as an interlayer between the electron transport layer and the active layer. With this strategy, we obtained a series resistance, whose magnitude is one of the lowest reported in the literature for 0.3 cm × 0.3 cm area dimensions of non-fullerene acceptor (NFA) molecules, Organic solar cells (OSC).

The effective carrier diffusion length (L_d) and lifetime (τ) dependence on the carrier generation density in single crystals of $MAPbBr_3$ was studied. Based on the trends of L_d and τ, it was inferred that the sub-band-gap trap recombination influences carrier transport in the low-intensity excitation regime, while bimolecular recombination and transport dominate at high intensity, thereby revealing key insights into the trap states that render hybrid perovskites highly defect-tolerant.

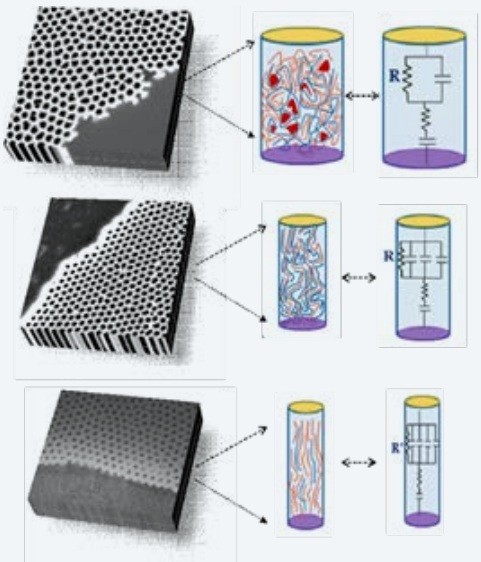


Fig. Confinement effects of PEDOT:PSS in nanopores: Ac conductivity and Capacitance.

A 3D-fluidic device (3D-FD) was designed and developed with the capability of auto bubble guidance via a helical pathway in a 3D geometry. This assembly was integrated to a multi-electrode array (MEA) to maintain secondary cell lines, primary cells, and primary retinal tissue explants of chick embryos for continuous and long-term monitoring of the growth and electrophysiology recording.

KEY PUBLICATIONS:

Sukanya Das and K.S. Narayan (2019) Significant Increase in Electrical Transport of Conducting Polymers Confined in Alumina Nanopores. *J Phys Chem C,* https://doi.org/10.1021/acs.jpcc.9b01563

N. Ganesh et al. (2019) Wavelength Dependent Charge Carrier Dynamics for Single Pixel Color Sensing using Graded Perovskite Structures. *Nano Lett,* 123(17):11284–11291.

EVENT ORGANISED:

- SUNRISE Symposium: 'Strategic University Network to Revolutionise Indian Solar Energy', held at JNCASR on February 11, 2020.

INVITED AS SPEAKER AT:

- XXth International Workshop on Physics of Semiconductor Devices (IWPSD 2019), held at Kolkata, on December 17–20, 2019

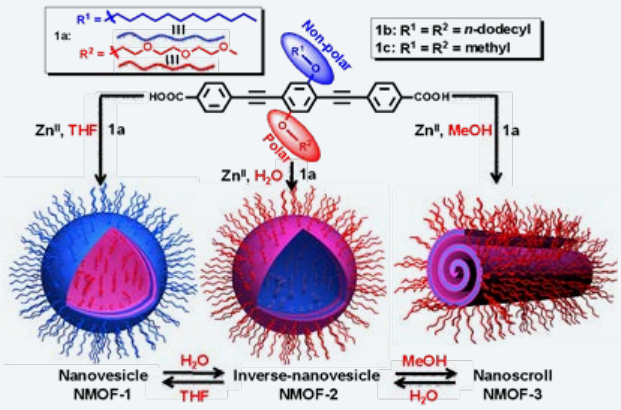
Prof. Tapas Kumar Maji Ph.D., FRSC, FASc

Professor

A metal-free topological approach was demonstrated to mimic the photophysical properties of natural gfp by synthesizing two gfp chromophore-integrated conjugated microporous polymers (o-HBDI-TEB-CMP and o-MBDI-TEB-CMP).

We reported a novel in situ method for synthesis of metal nanoparticles (NPs)–CMP (conjugated microporous polymer) composites based on a redox-active, donor–acceptor CMP, tris-(4-aminophenyl) amine–perylenediimide. We also designed and synthesized a series of donor–acceptor CMPs [tetraphenylethylene and 9-fluorenone as the donor and the acceptor, respectively], which exhibited tunable bandgaps and photocatalytic hydrogen evolution from water.

We synthesized a redox active porous organic polymer (TAPA-PG) by the Schiff base condensation reaction. TAPA-PG is efficient for in situ reduction of the Co(II) to Co(0), and Co@TAPA-PG displayed bifunctional electrocatalytic activity for oxygen reduction reaction as well as oxygen evolution reaction.



A solvent-responsive dynamic nanoscale metal-organic framework (NMOF) [Zn(1a)$(H_2O)_2$] was devised based on the self-assembly of Zn(II) and asymmetric bola-amphiphilic oligo-(p-phenyleneethynylene) (OPE) dicarboxylate linker 1a having a dodecyl and triethyleneglycolmonomethylether side chains. The flexible NMOFs showed strong cyan emission and no cytotoxicity, allowing live cell imaging. Cisplatin was successfully encapsulated in NMOF-1 by non-covalent interactions. In-vitro and in-vivo drug release studies showed high cytotoxicity (IC_{50} ~1.5 μM) of the drug-loaded NMOFs against HeLa cells.

KEY PUBLICATIONS:

- Sutar P, et al. (2018) Binder driven self-assembly of metal-organic cubes towards functional hydrogels. *Nat Commun* 9:3587.
- Suresh MV, et al. (2013) MOF nano-vesicles and toroids: self-assembled porous soft-hybrids for light harvesting. *Adv Funct Mater* 23:5585–5590.

INVITED AS SPEAKER AT:

- IPanel Discussion on "Future trends in Science and Technology Research, Needs and Ideas for Societal Benefit" organized by Department of Science & Technology and Biotechnology, Government of West Bengal held at Science City, Kolkata from February 28–29, 2020.
- Frontier Symposium in Chemistry (FS-CHM) 2020, School of Chemical Sciences, held at IISER, Trivandrum from January 17–18, 2020.
- BRICS Workshop – 2020: Frontiers in Inorganic Chemistry: Catalytic and Biomedical Applications, held at IISER Kolkata on January 3, 2020.
- International Conference on 'Modern Trends in Molecular Magnetism', Department of Chemistry, held at IISER Bhopal from November 27–30, 2019.
- 15th JNCASR Research Conference 'Chemistry of Materials-2019' held at Kovalam, Kerala from September 30–October 2, 2019.

Dr. Bivas Saha Ph.D.

Faculty Fellow (jointly with ICMS)

We reported the rigid-band electronic structure of ScN across n-type to p-type carrier transition regime. The ZrN/carrier compensated ScN metal/semiconductor superlattices were demonstrated. We also demonstrated the wave-vector dependent Raman scattering and Fano resonance in ScN.

We determined the Schottky barrier height in TiN/AlScN metal/semiconductor superlattices.

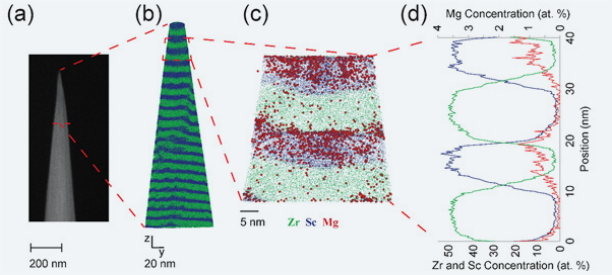


Fig. (a) STEM image of FIB-prepared APT tip, (b) Entire APT dataset. (c) An enlarged 10 nm thick section of the tip shows the distribution of Mg throughout ZrN and ScN layers. (d) 1D concentration profile along the length direction corresponding to the section shown in (c).

KEY PUBLICATIONS:

- Nayak S, et al. (2019) Rigid-band electronic structure of scandium nitride across the n-type to p-type carrier transition regime. *Phys Rev B* 99:161117(R).
- Nayak S, et al. (2019) Schottky barrier height of epitaxial lattice-matched TiN/$Al_{0.72}Sc_{0.28}N$ metal/semiconductor superlattice interfaces for thermionic energy conversion. *Appl Phys Lett* 115:251901.

EVENT ORGANISED:

- J.A. Woollam Ellipsomery Workshop in JNCASR.

INVITED AS SPEAKER AT:

- International Conference on Materials for Advanced Technologies (ICMAT), Singapore, held on June 25–27, 2019.
- International Conference on Metallurgical Coatings and Thin Films (ICMCTF), by American Vacuum Society (AVS), San Diego, California, US, held on May 19–24, 2019.
- Indus Synchrotron User Meeting, organised by Raja Ramanna Centre for Advanced Technology (RRCAT), held on March 28, 2019.
- International Workshop on Advanced Materials (IWAM), held at Ras Al Khaimah UAE, held on February 26, 2019.

Dr. Sarit S. Agasti Ph.D.

Faculty Fellow (jointly with NCU)

Dynamic supramolecular recognition between fluorescently labelled guest molecules and complementary cucurbit[7]uril hosts were exploited to obtain stochastic switching between fluorescence ON- and OFF-states. This strategy can enable efficient PAINT-based nanoscopic imaging in biological cells and tissues.

We developed a fluorescent fingerprinting method to efficiently discriminate between various cellular alterations based on their entire proteomic signatures. Our strategy combines a surface functionalized gold nanoparticle receptor with color-coded DNA transducers to generate an integrated sensor array that simultaneously generates multi-channel fluorescence output for analyte identification via a machine learning algorithm. We employed this ability of the sensor to rapidly identify cell states based on lysate composition. Importantly, we showed that such a sensor could be applied in discriminating cellular responses against pharmacological effectors.

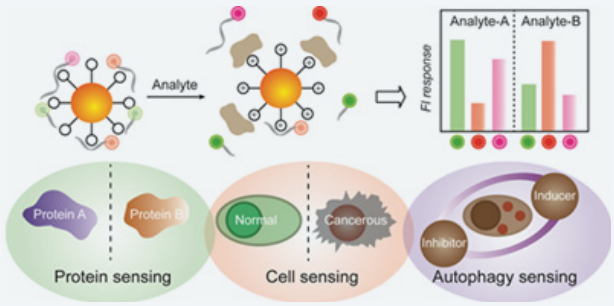


Fig. Schematic illustration of single and multi-channel sensing strategy based on DNA-mediated signal transduction. Competitive interaction between the quenched AuNP-DNA and the analyte molecule creates a unique pattern of responses for analyte identification via a pattern recognition algorithm. This sensor simultaneously produces three channel fluorescence output for signature-based single well identification of analytes.

KEY PUBLICATIONS:

- Sasmal R, et al. (2019) Dynamic host–guest interaction enables autonomous single molecule blinking and super-resolution imaging. *Chem Commun* 55:14430–14433.
- Saha ND, et al. (2019) Multichannel DNA sensor array fingerprints cell states and identifies pharmacological effectors of catabolic processes. *ACS Sens* 4:3124–3132.

INVITED AS SPEAKER AT:

- Chemical Science in India: Leaders in the Field Symposium held at IISER, Kolkata from October 18–20, 2019.
- 3rd Asian Conference on Chemosensors and Imaging Probes (Asian-ChIP), held from November 6–8, 2019.
- ILS Cell Biology Conference and Microscopy, held at ILS, Bhubaneshwar from December 9-15, 2019.
- Signals and Sensors, held at NCBS, Bengaluru from December 11–12, 2019.
- FCS National Workshop on Fluorescence and Raman Spectroscopy, held at Tata Institute of Fundamental Research, Hyderabad from December 16–21, 2019.

UNIT MEMBERS

Professor and Chair

Prof. Sundaresan A.

Linus Pauling Research Professor

Prof. C.N.R. Rao

Professors

Prof. Balasubramanian S.

Prof. Chandrabhas Narayana

Prof. Eswaramoorthy Muthusamy

Prof. G.U. Kulkarni

Prof. Narayan K.S.

Prof. S.M. Shivaprasad (on lien w.e.f 11.08.17)

Prof. Tapas Kumar Maji

Associate Professors

Dr. Rajesh Ganapathy (jointly with ICMS)

Dr. Ranjan Datta (jointly with ICMS)

Dr. Sridhar Rajaram (jointly with ICMS)

Faculty Fellows

Dr. Bivas Saha (jointly with ICMS)

Dr. Sarit S. Agasti (jointly with NCU)

Associate Faculty from Theoretical Sciences Unit

Prof. N.S. Vidhyadhiraja

Prof. Shobhana Narasimhan

Prof. Srikanth Sastry

Prof. Swapan K. Pati

Prof. Umesh V. Waghmare

Sr. Technical Officers

Sreenath V.

Srinivas S.

Research Students

Ph.D. Programme: Bharath B, Chaitali Sow, Sudip Das, Abhijit Chatterjee, Badri Vishal, Korlepara Divya Bharathi, 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, Surishi Vashishth, Swarnamayee Mishra, Sudarshan Behera, Purohit Sumukh Anil, Anjana Joseph, Alolika Ganguly, Krishna Chand Maurya, Arindam Mukherjee, 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.

M.S.(Engg.): Mohit Chaudhary

Int. Ph.D. Programme: Shantanu Aggarwal, Abhiroop Lahiri, Nikita Gupta, 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, Gurshidali P, Gunjan Sharma, Manish Tiwari, Swapnasopan Datta, Aashish Kumar, Sohini Chatterjee, Surabhi Menon, Uttam Tiwari, Dipanjana Patra

UNIT MEMBERS

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

Research Associates
Ashish Singh, Vasudeva Rao Bakuru, Rajaji Vincent, Abhishek Sharma, Prashant Kumar, Anwesa Karmakar

Research Associate (P)
Soumitra Barman

Junior Research Fellows
Samyabrata Sen, Deepak Kumar Patel, Sudip Das, Manvendra Singh, Ishan Chhaganji Ghosekar, Monica Swetha Bosco

Senior Research Fellow
Korlepara Divya Bharathi

R&D Assistants
Manik Sharma, Anil Krishna Konduri

Research Scientist B
Anoop S., Suresh J.

SERB (TARE)
Shafeekh Kulathinte Meethal

SERB NPDF
Manoj Kumar Barman

Consultants
Usha G. Tumkurkar

Project Assistant
Gaurav Vinayak Dhopeshwarkar

Project Technical Assistant
Abhinandana Reddy B.

Instrumentation Facility In-charge
Rahul Bhardwaj

Secretarial Assistant Trainee
Prema M.S.

Mectronic Lab Support
Sunoj K.R.

Glass Blower
Nandha Kishore

UNIT AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. Sundaresan A.

- Elected as the Fellow of Indian Academy of Sciences, Bengaluru.

Prof. Chandrabhas Narayana

- Invited to be a member of the Editorial Advisory Board of Journal of Applied Physics.
- The paper authored by Sorb YA et al, which publishes collaborative work from laboratories of Prof. Chandrabhas Narayana and Dr. Sebastian C. Peter (NCU), was one among the top 1% most-cited papers in Physics between 2016 and 2018, as published by Institute of Physics.
- Platinum Jubilee Lecture Award of Indian Science Congress 2020.

Prof. G.U. Kulkarni

- Received MRSI-Distinguished Lecturership Award from Materials Research Society of India.
- SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences .
- Received Dr. Raja Ramanna State Award for Scientist for the year 2018 in the field of science education, awarded by Karnataka State Council for Science and Technology (KSCST).
- Honoured as Outstanding Achiever Past Student by Karnataka Education Board Dharwad.
- The Prof. C.N.R. Rao National Prize for Chemical Research-2020, by Chemical Research Society of India (CRSI).

Prof. Narayan K.S.

- Chair Working Group of Physics in Industry of IUPAP.

Dr. Sarit Agasti

- Sheikh Saqr Fellowship, International Centre for Materials Science (ICMS), JNCASR, 2020.
- Emerging Investigator by Chemical Communications, Royal Society of Chemistry, UK, 2020.

Dr. Bivas Saha

- SERB Start-Up Research Grant.

Prof. Tapas K. Maji

- Received the Shanti Swarup Bhatnagar Prize for the year 2019 in Chemical Sciences.
- Selected as Fellow of the Royal Society of Chemistry.
- Among the top 10% of highly cited authors of RSC in 2018 in general chemistry portfolios of journals.
- Appointed as Associate Editor of the ACS Journal: ACS Applied Materials & Interfaces.

Awards received by STUDENTS

Yanda Premakumar received the Best Poster Presentation Award at the 53rd Course of the International School of Crystallography held at Erice, Italy from May 31–Jun 9, 2019. Research supervisor: Prof. A. Sundaresan.

Chaitali Sow received the following awards under the research supervision of Prof. G.U. Kulkarni:

- Best Poster Award at 10th International Conference on Materials for Advanced Technologies (ICMAT), Singapore held at Marina Bay Sands, Singapore from June 23-28, 2019.
- Best Poster Award at Fifteenth JNC Research Conference on Chemistry of Materials held at Trivandrum, India from September 30 - October 2, 2019.
- Poster teaser award at JNCASR In-House Symposium, 2019 held at JNCASR, India from November 13-14, 2019.
- Best Poster Award at International Conference on Nano Science and Technology (ICONSAT) 2020, held at Biswa Bangla Convention Centre, New Town, Kolkata, India from March 5-7, 2020.

Sudarshan Behera received the CSIR-Shyama Prasad Mukherjee Fellowship. Research supervisor: Prof. S. Balasubramanian.

Abdul Azeez won the best poster prize at Sunrise Symposium, IISc, Bengaluru. Research supervisor: Prof. K.S. Narayan.

Soumen Pradhan received the CSIR-Shyama Prasad Mukherjee Fellowship. Research supervisor: Dr. Sarit Agasti.

Tarandeep Singh and Brijesh, members of Team ZincAir, won the Silver Award at KPIT Sparkle 2020 iInnovate contest. Research supervisor: Prof. Tapas K. Maji.

STUDENTS ADMITTED

11

Ph.D.: 6 students

Rohan Jena
Anupam Dey
Ashish Biswa
Rahul Kumar
Abhijith Krishnan
Suhas K T

Int. Ph.D.: 5 students

Aashish Kumar
Sohini Chatterjee
Surabhi Menon
Uttam Tiwari
Dipanjana Patra

STUDENTS GRADUATED

16

Ph.D.: 7 students

Sanjay Kumar Nayak
Sreedhara M. B.
Uttam Gupta
Chandan De
Suchitra
Rajaji V.
Sohini Bhattacharyya

M.S. (Engg.): 1 student

Avula Venkata Siva Nikhil

M.S. in Materials Science: 8 students

Shashank Chaturvedi
Pragya Arora
Raagya Arora
Nijita Mathew
Tarandeep Singh
Shivani Grover
Ashutosh Kumar Singh
Brijesh

Total Publications
77

On Going Projects
16

Amount received during 2019-2020
₹25.62 Cr

New Projects
06

Amount received during 2019-2020
₹80.7 L

EVOLUTIONARY AND INTEGRATIVE BIOLOGY UNIT (EIBU)

To understand biological systems, it is important to study them at various levels of biological complexity, ranging from molecules to ecosystems. Researchers at EIBU aim to address conceptually fundamental questions in functional whole-organism biology with a strong underpinning of evolutionary explanation. The Unit's faculty have been leaders in addressing fundamental questions in new areas of ecology, evolution, and behaviour that have not been studied previously and have pioneered the use of methodologies like experimental evolution and non-invasive approaches to assess genetic diversity in wild populations in India. In terms of graduate teaching, too, the Unit is very well known in India for its extensive coursework.

RESEARCH AREAS

Unit faculty have combined theoretical analysis with laboratory experiments and/or field observations for research on:

- Interplay of the evolution of life-histories and competitive ability, and its effects on population dynamics
- Evaluating predictions from socioecological theory regarding the interplay of ecological, behavioural, and genetic factors in affecting social organization
- Re-conceptualizing the core of evolutionary theory by re-interpreting basic phenomena like fitness and heredity, to analyse the adaptive evolutionary dynamics of diverse phenotypes under genic and non-genic inheritance.

RESEARCH HIGHLIGHTS

- Experimental evolution revealed various important aspects of the relationship between selection, canalization, and plasticity, thereby providing insights into the complexity of the evolutionary process.
- Larval and adult density were found to interact in their effects on female fecundity in fruit flies: this has serious implications for experimental design in life-history evolution studies.
- Larval and adult food regimes were found to interact with generation time in their effects on constancy and persistence of fruit fly populations in the laboratory.
- Musth in male Asian elephants was found to be an age-specific roving strategy, with old but not young males in musth obtaining increased access to females.
- NDVI was found to have limited utility for assessing elephant forage abundance in tropical forests

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

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

Associate Professor and Chair, EIBU

We examined whether musth in elephants was primarily a roving strategy for old males or a strategy for young males to temporarily gain an advantage over old males. Based on long-term data from Kabini and using two broad age-categories, we found support for the former hypothesis. Counterintuitively, young (15–30 years old) males spent less time with females when they were in musth than when not in musth, making the payoff from musth age-specific.

We also worked on the utility of normalized difference vegetation index as a proxy for food resource availability for elephants.

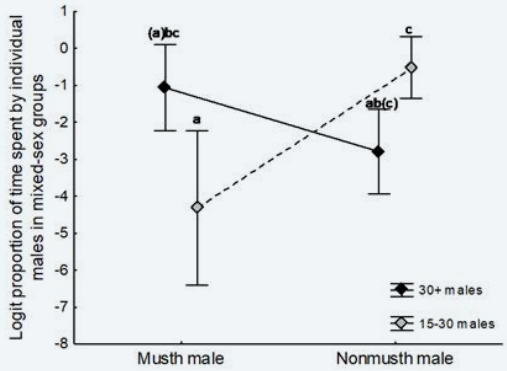


Fig. Logit transformed proportion of time (out of the time that male was sighted in a musth status) spent by individual adult male Asian elephants with female groups across age-classes and musth statuses. Two age-classes, 15–30 and 30+ years, were used. Shared letters above the bars indicate no statistical significance in pairwise comparisons (a<b<c). Letters within parentheses include a flat Bonferroni correction of p<0.008 for six comparisons (Keerthipriya et al. 2020, *J Mammal*).

KEY PUBLICATIONS:

- Nandini S, Keerthipriya P, Vidya TNC*. 2018. Group size differences may mask underlying similarities in social structure: a comparison of female elephant societies. *Behav Ecol* 29(1): 145-159.
- Vidya TNC*, Sukumar R, Melnick DJ. 2009. A range-wide phylogeography of the Asian elephant (Elephas maximus) based on mitochondrial DNA. *P Roy Soc B-Biol Sci* 276(1658): 893-902.

EVENTS ORGANISED:

- Co-organizer of SPEEC-UP conference for Bangalore-based students and postdocs to present their work on behaviour, ecology, and evolution, held at JNCASR, Bengaluru on August 30, 2019.
- Co-organizer of ISEB1: Celebrating Ecology and Evolution in India, First Conference of the Indian Society of Evolutionary Biologists (ISEB), held at JNCASR, Bengaluru from October 24–25, 2019.
- Co-organizer of ISEB2: Indo-Swiss Meeting on Evolutionary Biology, First International Conference of the Indian Society of Evolutionary Biologists (ISEB), held at the Centre for Human Genetics, Bengaluru from December 12–14, 2019.

INVITED AS SPEAKER AT:

- National Seminar on Wildlife Biology, held at St. Joseph's College, Bengaluru on March 12, 2020 (Keynote address).
- Foundations of Biology discussion meeting organised by Ashoka University, held at Ashoka University, Sonepat from February 28–March 1, 2020.
- ISEB2: Indo-Swiss Meeting on Evolutionary Biology, First International Conference of the Indian Society of Evolutionary Biologists (ISEB), held at the Centre for Human Genetics, Bengaluru from December 12–14, 2019.
- 10th Meeting of the IUCN SSC Asian Elephant Specialist Group, held at Kota Kinabalu, Sabah, Malaysia from December 4-6, 2019.
- INYAS National Frontiers of Science meeting (NatFoS 2019), held at Samod Bagh, Jaipur, from November 6–8, 2019.

Prof. Amitabh Joshi Ph.D.

Professor

The relationship between selection, canalization, and plasticity, which determines the robustness and evolution of a trait, remains largely unclear. Using experimental evolution, we investigated whether long-term directional selection for reduced pre-adult development time in *Drosophila melanogaster* results in the evolution of increased canalization for development time, the trait under primary selection. Our study revealed that the answer to that question is trait- and environment-specific, thus underscoring that experimental evolution can be a powerful tool to understand the intricacies of the evolutionary process, with a particular focus on trait variation.

In studies on population dynamics in *Drosophila*, different combinations of larval and adult food levels are known to generate temporal dynamics of adult numbers exhibiting differing levels of constancy and persistence. We found for the first time that generation time interacts with food regime in its effects on constancy and persistence. Similarly, larval and adult density interact in their effect on female fecundity in *Drosophila*, which adds one more layer of complexity to how resources and life-history traits affect population dynamics.

We found that testis and accessory gland size allometry with body size evolves to differ among *Drosophila* populations subjected to different levels of selection for rapid development and age at reproduction.

KEY PUBLICATIONS:

- Dey S and Joshi A (2006) Stability via asynchrony in *Drosophila* metapopulations with low migration rates. *Science* 312:434–436.

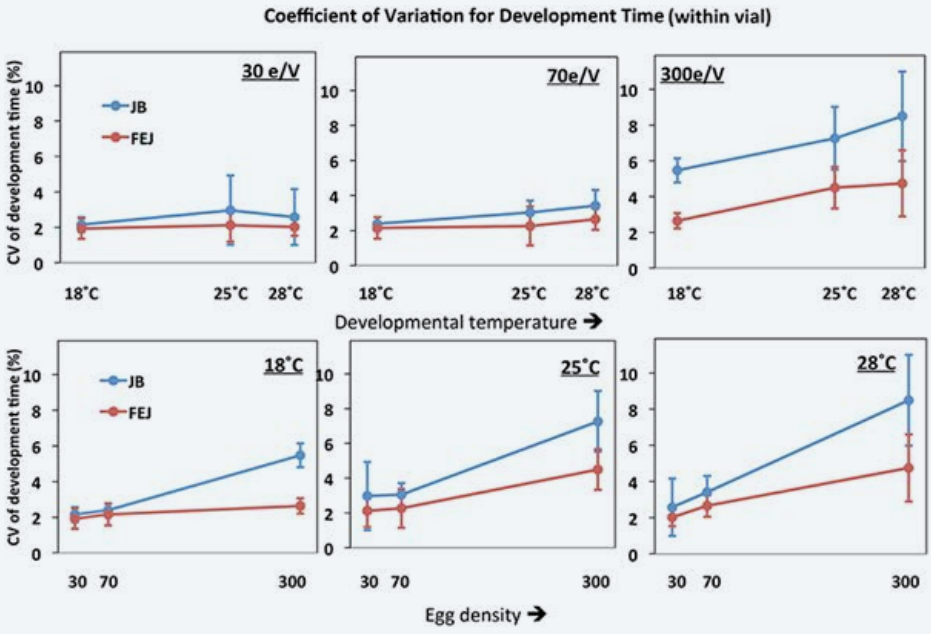


Fig. Coefficient of variation (CV) of pre-adult development time of FEJ (selected for rapid development and early reproduction) and JB (ancestral controls) populations across individuals within a vial. The upper panel shows CV of the trait plotted across temperature for each treatment density (e/V = eggs per vial). The lower panel shows CV of the trait plotted across egg density for each treatment temperature. The error bars show 95% confidence intervals calculated from the variation among replicate populations in each combination of selection regime, temperature, and density (Ghosh et al. (2019) *Front Ecol Evol* 7:228).

contd. in next page

Prof. Amitabh Joshi

... continued.

KEY PUBLICATIONS

- Sarangi M, et al. (2016) Evolution of increased larval competitive ability in *Drosophila melanogaster* without increased larval feeding rate. *J Genet* 95:491–503.

EVENTS ORGANISED:

- Co-organizer of Half-day Public Discussion Meeting on 'Institutions and Innovators: What can Research and Educational Institutions do to Nurture Innovation', organized by the Dialogue Initiative of the Indian Academy of Sciences, Bengaluru on August 10, 2019.
- Co-organizer of SPEEC-UP conference for Bangalore-based students and postdocs to present their work on behaviour, ecology, and evolution, held at JNCASR, Bengaluru on August 30, 2019.
- Co-organizer of ISEB1: Celebrating Ecology and Evolution in India, First Conference of the Indian Society of Evolutionary Biologists (ISEB), held at JNCASR, Bengaluru from October 24–25, 2019.
- Co-organizer of ISEB2: Indo-Swiss Meeting on Evolutionary Biology, First International Conference of the Indian Society of Evolutionary Biologists (ISEB), held at the Centre for Human Genetics, Bengaluru from December 12–14, 2019.
- Co-organizer of Mini-symposium on "Science Education and Research: What India needs to do?" organized as part of the annual meeting of the Indian National Science Academy at Goa, from December 16–18, 2019.
- Co-organizer of Discussion Meeting on "Foundations of Biology", organized at Ashoka University, Sonipat, from February 28–March 1, 2020.

INVITED AS SPEAKER AT:

- NALANDA, Ahmedabad University, Ahmedabad on April 5, 2019.
- Symposium entitled 'Culture of Reason', organized by Bharat Gyan Vigyan Samiti at IISc, Bengaluru on August 31, 2019.
- The session 'Ecology and Evolution' at the 5th Asia-Pacific *Drosophila* Research Conference, organized at IISER, Pune on January 9, 2020.
- The first 'Pale Blue Dot – IIT Palakkad Public Lecture', Palakkad on January 24, 2020.
- One-day 'Symposium on Evolutionary Biology', organized at IIT Bombay on March 7, 2020.

UNIT MEMBERS

Associate Professor and Chair

Prof. T.N.C. Vidya

Professor

Prof. Amitabh Joshi

Research Students

Ph.D. Programme: Pavitra Prakash, Anuj Menon, Neha Pande, Revathe T., Satyabrata Nayak, Medha Rao, Athira T.K., Ankana Sanyal, Chinmay Krishna Yadav Temura, Avani Mital, Hansraj Gautam

Int. Ph.D. Programme: Srikant Venkitachalam

M.S.-Ph.D. Programme: Anvitha S.

Research Associate

Keerthipriya P.

R&D Assistants

Ramesh M.K.

Sajith V.S.

Tryambak Dasgupta

Helper

Rajanna N.

Total Publications

11

On Going Projects

02

Amount received during 2019-2020

₹1.16 Cr

UNIT AT A GLANCE

Awards received by STUDENTS

Hansraj Gautam won the Best Poster Award at the "ISEB1: Celebrating Ecology and Evolution in India" national conference held at Bengaluru from October 24–25, 2019. Research supervisor: Prof. T.N.C. Vidya.

Anvitha S. was one of the winners of Speed Talks in "SPEEC-UP conference for Bangalore-based students and postdocs on behaviour, ecology, and evolution, held at the Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru on August 30, 2019. Research Supervisor: Prof. T.N.C. Vidya.

Keerthipriya P. won a Speed Talk prize at the "Understanding Behaviour" conference held at IISER-Kolkata from January 11–13, 2019. Research Supervisor: Prof. T.N.C. Vidya

Revathe T. won a Best Poster prize at the "Understanding Behaviour" conference held at IISER-Kolkata from January 11–13, 2019. Research Supervisor: Prof. T.N.C. Vidya.

Medha Rao won the Best Poster Award at the ISEB2: Indo-Swiss Meeting on Evolutionary Biology" international conference held from December 12–14, 2019 at Bengaluru. Research supervisor: Prof. Amitabh Joshi.

STUDENT ADMITTED

01

Ph.D.: 1 student

Chinmay Krishna Yadav Temura

STUDENTS GRADUATED

04

Ph.D.: 3 students

Manaswini Sarangi

Keerthipriya P.

Manishi Srivastava

M.S. in Biological Science: 1 student

Kulkarni Rutvij Kaustubh

ENGINEERING MECHANICS UNIT (EMU)

EMU carries out research in various topics related to transport processes in simple and complex fluids over a range of length and time scales, addressing both fundamental concepts and application-oriented scenarios. EMU has established research-based and funding-based collaborations with leading institutions in India and worldwide. Research endeavours currently underway concern the study of both complex micro-structured fluids (suspensions and emulsions, granular materials, polymer solutions and melts, active matter) and complex flows (linear and non-linear evolution of hydrodynamic instabilities, mechanisms of pattern formation, turbulence and dynamical systems theory). Biological problems and natural phenomena – such as insect flight & fluid dynamics of cloud and predicting the onset of fog – are also being investigated by employing both theoretical and experimental methods.

RESEARCH AREAS

Research at EMU is focused on the following areas:

- Granular Matter and Suspensions
- Numerical simulation of turbulent flows
- Dynamics, rheology, and stability studies of complex fluids
- Microphysics of clouds & radiation fog; atmospheric convection
- Transition, flow-control and re-laminarization
- Hydrodynamic stability and turbulence
- Nocturnal Atmospheric Boundary layer, prediction of fog.
- Aeroponics and thermal regulation for high value crops.
- Flow and interfacial instability under micro-gravity conditions.

RESEARCH HIGHLIGHTS

- New insights were obtained for the time-dependent nonlinear rheology for a pair of linear flows in response to impulsive initiation and cessation.
- Flow reversal for a vortex-ring in polymeric solution: observation demonstrates elastic energy modifying energy cascading process in turbulence.
- Development of a novel method for the estimation of surface tension coefficient using pendant droplet volume measurement.
- Developed the first Direct Numerical Simulation of a cumulus cloud flow by extending the fundamental Navier-Stokes-Boussinesq equations with the important and new addition of the thermodynamics of water vapour and liquid water.
- Developed a unified nonlinear theory for granular and gas-solid suspensions based on the maximum entropy principle - the underlying transport coefficients have been validated via particle-level simulations over a wide range of density and Stokes number.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. K.R. Sreenivas, Ph.D.
Professor and Chair, EMU

Radiation fog activity has been identified as an emerging and important issue in airport management. Our group, along with the Bengaluru International Airport Limited (BIAL), established an observation station next to the runway for monitoring various parameters that impact fog formation. We aim to study transport processes in nocturnal atmospheric boundary layer and microphysics of cloud formation and radiation-fog. Eventually, research in this area would lead to the development of a numerical code that will help in predicting the onset of radiation fog over the airport area well in advance to help in air-traffic management.

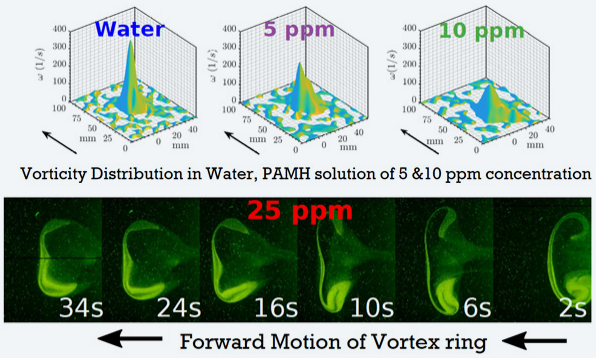


Fig. Vorticity distribution in a vortex ring translating in water and polymeric solution of PAMH with 5 ppm and 10 ppm concentration. Lower panel depicts process of flow-reversal observed for a vortex ring propagating in a PAMH polymeric solution of 25-ppm concentration.

Another development of significance is the joint project between IISc, UAS, JNCASR, and other institutes under ICAR, for developing an energy and water efficient aeroponics chamber, for the growth of potato seed in Southern Indian climatic conditions. Our group is also studying turbulent drag reduction phenomenon by addition of minute amount of drag reducing polymers. We explore the impact of the drag reducing polymer on the flow stability and vortex dynamics.

KEY PUBLICATIONS:

- Mukund V, et al. (2014) Field and laboratory experiments on aerosol-induced cooling in the nocturnal boundary layer. *Q J R Meteorol Soc* 140(678):151–169.
- Sreenivas KR, et al. (2009) On the relationship between finger width, velocity, and fluxes in thermohaline convection. *Phys Fluids* 21(2):026601.

EVENT ORGANISED:

- 16th Asian Congress of Fluid Mechanics held at JNCASR, Bengaluru, India from December 13–17, 2019.

INVITED AS SPEAKER AT:

- 16th Asian Congress of Fluid Mechanics held at Bengaluru, India from December 13–17, 2019

Prof. Ganesh Subramanian Ph.D.
Professor

We carried out a detailed theoretical study on bacterial turbulence using a stochastic kinetic theory framework, leading to characterization of correlations, tracer diffusivities, and suspension viscosity, which in turn led to a non-equilibrium version of a fluctuation-dissipation relation for active suspensions. We theoretically and computationally studied turbulent suspensions of anisotropic particles, with applications towards predicting radiation characteristics of ice (Cirrus) clouds.

We performed a detailed theoretical-cum-computational study of shear-induced migration and dispersion of microbial populations, and leveraging this behaviour towards shear-enhanced isolation of bacterial strains with selected characteristics. We calculated the orientation dynamics of anisotropic particles in viscoelastic shearing flows with application towards viscoelastic suspension rheology. We also calculated lift forces, of inertial and viscoelastic origin, on non-spherical particles in pressure-drive flows, with applications towards shape-sorting using microfluidic devices.

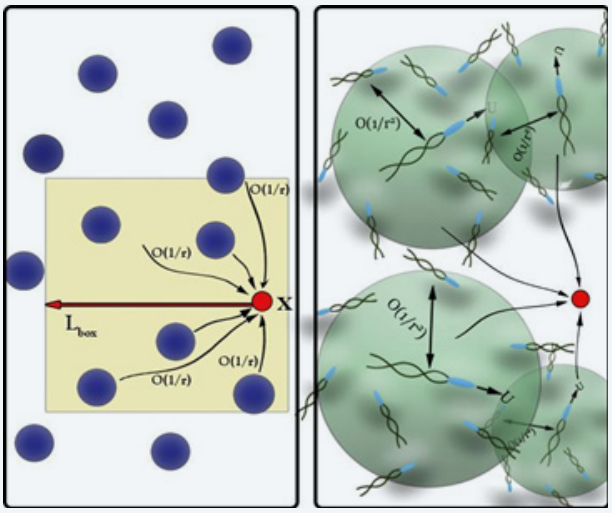


Fig. (a) STEM image of FIB-prepared APT tip, (b) Entire APT dataset. (c) An enlarged 10 nm thick section of the tip shows the distribution of Mg throughout ZrN and ScN layers. (d) 1D concentration profile along the length direction corresponding to the section shown in (c).

We studied the interaction of a vortex ring with a bubble, from a hydrodynamic stability perspective. We carried out a theoretical study on passive particle motion in an ambient stratified medium with application towards estimating the biogenic ocean-mixing contribution. We calculated the heat and mass transport from drops in complex shearing flows, with application towards disperse multiphase systems found in the chemical industry.

KEY PUBLICATIONS:

- Anand P, et al. (2020) Orientation dynamics of sedimenting anisotropic particles in turbulence. *Phys Rev Lett* 125:034501.
- Garg P, et al. (2018) Viscoelastic pipe flow is linearly unstable. *Phy Rev Lett* 121(2):024502.

EVENT ORGANISED:

- One among the group of editors who brought out: 'Lecture Notes in Mechanical Engineering' (Series title) Proceedings of 16th Asian Congress of Fluid Mechanics (December 2019).

INVITED AS SPEAKER AT:

- Bacterial Turbulence: Collective motion in suspensions of microswimmers, held at IISER Pune Physics Seminar Series on January 17, 2020.
- IUTAM Symposium on Discrete Simulation of Fluid Dynamics (DSFD 2019, Bengaluru), held at Bengaluru from July 22–26 2019.
- Micro-swimmer suspensions: Shear-induced migration and banding instabilities Fluids Days, held at JNCASR, Bengaluru from January 24–25, 2019.

Prof. Meheboob Alam Ph.D.
Professor

In the past year, we developed a consistent second-order nonlinear theory for granular and gas-solid suspensions, which is likely to hold from the 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 also shows a constitutive relation for 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.

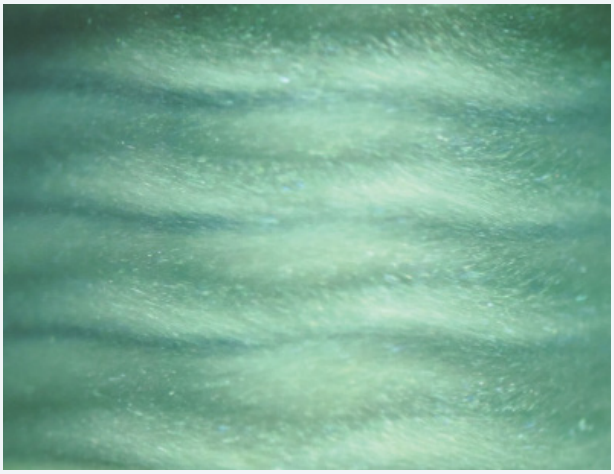


Fig.: Wavy Taylor vortices in suspension Taylor Couette flow.

The maximum entropy principle and kinetic theory have been employed to develop a unified nonlinear theory for gas-solid suspensions. The expressions for transport coefficients (viscosity and normal stress differences) have been validated using particle dynamics simulations of gas-solid suspensions ranging from ignited to quenched states.

Experiments on suspension Taylor-Couette flow uncovered a variety of coexisting states of travelling and stationary waves: stationary Taylor vortices coexisting with (i) spiral vortices and (ii) wavy vortices; interpenetrating spiral vortices. A non-linear mode-interaction theory might be able to explain such Chimera-like co-existing patterns.

Roles of compressibilty and axial boundary conditions on “anomalous’’ Taylor vortices and symmetry-breaking bifurcations have been revealed via direct numerical simulations and molecular dynamics simulations.

KEY PUBLICATIONS:

- Ramesh P, Alam, M. 2020. Interpenetrating spiral vortices and other co-existing states in suspension Taylor-Couette flow. *Phys Rev Fluids* 5:042301 (Rapid Communication)
- Saha S, Alam M. 2020. Burnett-order constitutive relations, second-moment anisotropy and co-existing states in sheared dense gas-solid suspensions. *J Fluid Mech*. 887: A9.

Prof. Santosh Ansumali Ph.D.

Associate Professor (on lien w.e.f 01.07.2019)

For Computational Fluid Dynamics (CFD), simulation of turbulent flows continues to remain a challenge, particularly in case of transient behaviour, or if the flow separates from the solid body that it is flowing past. Separated flows occur in several situations of practical interest, such as in aircraft and automobiles. Conventional approaches of CFD require creation of explicit empirical models that incorporate the effect of small scales on the large eddies. Alternative approaches that allow linear scalability across massively parallel computing environments have limited applications, as these algorithms become unstable while simulating flows with low viscosity or high spatial gradients – conditions where the distribution of the evolving particles deviates too far from the ideal Maxwell-Boltzmann distribution. A standard approach towards constraining these large deviations and restoring stability, is the entropic lattice Boltzmann model, which involves an additional demand that the entropy of the system decrease across each step of evolution. Instead of demanding equality of entropy, we modified the model to demand an inequality based on the second law of thermodynamics. In doing so, the problem was recast to a search for solutions satisfying a non-linear inequality. We found exact solutions to a non-linear inequality, which enforces the second law of thermodynamics on particles evolving on a lattice according to the Boltzmann equation. Using these solutions, we formulated an algorithm that is unconditionally stable, uses significantly less computational resources, and can potentially replace the use of explicit models for turbulence in accurately simulating hydrodynamics for aerospace, automobile, and other industrial systems. As demonstration, we performed transient simulations of airflow past a benchmark airfoil for angles of attack around the stall angle on a tera-scale computing cluster. The simulations showed excellent match with experimental results, a feat which has remained unattainable till now. The low computational requirement and high accuracy of the simulation highlights the potential of the algorithm in efficiently simulating flow past entire aircraft and automobiles on even peta-scale clusters.

Prof. Roddam Narasimha Ph.D., FASc, FNA, FTWAS, FRS

Honorary Professor, SERB National Science Chair

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 to a Conference at San Jose, CA by INVIDIA on our latest work on GPUs. Dr. N.H. Maruthi represented the JNC team at the Conference.

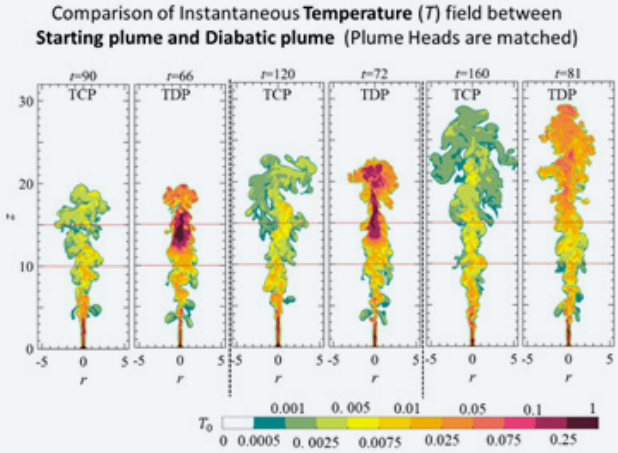


Fig.: Cumulus clouds are familiar, but still far from being completely understood. Computations of idealized clouds can throw much light on the basic dynamics. Such an idealized cloud flow has been called a Transient Diabatic Plume (TDP), because of its finite life and higher temperature compared to 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:

- Narasimha R, et al. (2011) Laboratory simulations show diabatic heating drives cumulus-cloud evolution and entrainment. *Proc Natl Acad Sci* 108(39):16164–16169.
- Narasimha R and Sreenivasan K.R. (1979) Relaminarization of Fluid Flows. *Adv Appl Mech* 19:221–309.

EVENT ORGANISED:

- Member, Organizing Committee, 16th Asian Congress of Fluid Mechanics from December 13–17, 2019

INVITED AS SPEAKER AT:

- 16th Asian Congress of Fluid Mechanics on Memories of the First Asian Congress of Fluid Mechanics, held at JNCASR, Bengaluru on December 13, 2019.
- DRDO Golden Jubilee Celebration, held at Delhi on February 25 2020.
- 15th Raja Ramanna Memorial Lecture on Algorithms or axioms? A view of Indic, Greek and Modern Mathematics, held at National Institute of Advanced Studies, Bengaluru on January 8, 2020.
- The XLIII Indian Social Congress, organized by the Indian Social Science Academy and Bengaluru Central University on January 17, 2020.
- Satish Dhawan Centenary Lecture on The Cumulus cloud as a Fascinating Turbulent Shear Flow, held at IISc on January 24, 2020.

Dr. Diwakar S. Venkatesan Ph.D.

Faculty Fellow

Our primary research activities have been oriented towards obtaining a deeper understanding of different multiphase flow and instability phenomena. In this regard, we have developed a sophisticated experimental setup to understand the nuances of Rayleigh-Bénard convection in two-layer systems. This involves setting up a precise temperature gradient across the fluid layers and accurately measuring the critical temperature for the onset of buoyancy and Marangoni-driven convection in the layers. The process of identifying the convection onset is performed via a Z-type schlieren.

In addition to this, we have also been working on developing a novel method for estimating surface tension coefficient by volume measurement in a pendant droplet tensiometer. Further, our efforts on the computational front have been focused on developing a novel approach for solving transient systems using explicit schemes that have higher CFL limit. This would allow for efficient computation of multiscale phenomena in massively parallel computer architecture. Our other computational effort has been on understanding the process of liquid atomization in a catalytic converter nozzle.

KEY PUBLICATIONS:

- Diwakar SV, et al. (2018) Influence of capillarity and gravity on confined Faraday waves. *Phys Rev Fluids* 3:073902.
- Diwakar SV, et al. (2014) Stability and resonant wave interactions of confined two-layer Rayleigh-Bénard systems, *Journal of Fluid Mechanics,* Vol. 754, pp. 415-455.

EVENT ORGANISED:

- 28th International Conference on Discrete Simulation of Fluid Dynamics (DSFD 2019), held at JNCASR, Bengaluru from July 22–26, 2019.

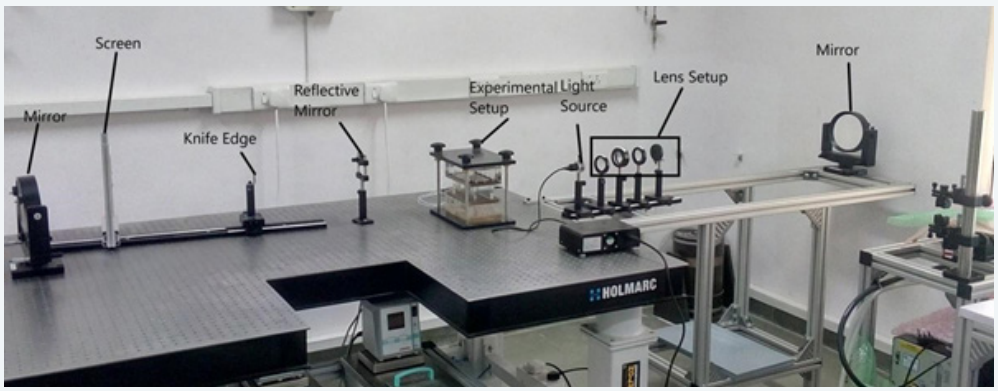


Fig. A Schlieren setup for analysing two-layer convection process.

UNIT MEMBERS

Professor and Chairman

Prof. K.R. Sreenivas

Professors

Prof. Ganesh Subramanian

Prof. Meheboob Alam

Associate Professor

Prof. Santosh Ansumali (On lien w.e.f 01.07.2019)

Honorary Professor, SERB National Science Chair

Prof. Roddam Narasimha

Faculty Fellow

Dr. Diwakar S. Venkatesan

Research Students

Ph.D. Programme: K. Siddharth, Vybhav G.R., Praveen Kumar K, Mohammad Raifuddin, Mahan Raj Banerjee, Mohammad Atif, Piyush Garg, Prateek Anand, Arun Kumar Varanasi, Shaurya Kaushal, Akshaysingh Bhawarsingh Shekhawat, Suryadev Pratap Singh.

M.S. (Engg.) Programme: Mayank Toprani, Biswadeep Roy, Albin Prince John, Nishant Soni, Tanumoy Dhar, Akanksha Bohra, Akshay Chandran, Sabarish V.N., Ritwik Das, Saumyakanta Mishra.

Research Associates

Laxminarsimharao V.

Deepak Govind Madival

Subrat Kotoky

Research Associate (Provisional)

Akhilesh M. Prabhu

R&D Assistants

Suman D.H.

Shashank

Project Assistant

Mohammad Rafiuddin

Helper

Rajanna N.

Total Publications

28

On Going Projects

05

Amount received during 2019-2020

₹92.09 L

Amount received during 2019-2020

₹7.5 L

New Project

01

UNIT AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. Meheboob Alam

- Selected as Plenary Speaker at the 9th "Powders and Grains" Conference (2021, July 6-9) to be held in Buenos Aires, Argentina.

Prof. Roddam Narasimha

- Nature Award for Best Mentoring in Science 2019 – Lifetime Achievement, given in Delhi, December 2019.
- National Science Chair Professorship, awarded by SERB/DST.
- Establishment of the Roddam Narasimha Endowment Annual Lecture, by the Department of Aerospace Engineering, Indian Institute of Science.

Prof. Santosh Ansumali

- The first startup company from JNCASR, by EMU Faculty Member Prof. Santosh Ansumali, Sankhya Sutra Labs, received Series-A funding from RIL, India.

Dr. Diwakar S Venkatesan

- Dr. S.V. Diwakar's proposal on Microgravity experiment has been selected for Space mission by ISRO; an MoU on this is being worked out between JNCASR and ISRO.

STUDENTS ADMITTED

03

Ph.D.: 1 student
Suryadev Pratap Singh

M.S. (Engg.): 2 students
Ritwik Das
Saumyakanta Mishra

STUDENTS GRADUATED

02

M.S. (Engg.): 2 students
Samarth Agrawal
Swastik Hegde

GEODYNAMICS UNIT (GDU)

The primary goal of GDU for the reporting period was to characterize the main thrust belts in central and western Himalayas to gauge their role in Himalayan seismicity. The locations, ruptures, and sizes of the earthquakes during the latter half (1803 and 1833 CE) of the millennium are well documented, but ambiguities exist about the first half of the last millennium (1255, 1344, and 1505 CE). We used seismological and geological tools to investigate the mechanisms of the earthquake Himalayan arc and its contiguous regions. We also investigated tsunami hazard areas of the Indian Coasts and climate evolution in the Himalayan region using various geological proxies.

RESEARCH AREAS

GDU focuses on the following research areas:

- Tectonics and earthquake generation processes along the Himalayas and seismogenesis of the Himalayan earthquakes
- Reconstruction of the Late Quaternary climatic changes in the Himalayas using geological proxies with multiple parameters including chronology, sedimentology, stable isotopes, and geochemistry.

RESEARCH HIGHLIGHTS

- Established the evidence of an elusive mid-14th century earthquake in the central Himalayas.
- The seismic gap in terms of great earthquakes (Mw >8) in the central Himalayas that lasted for 600 years to the present was established.
- Discovered the traces of River Saraswati, the life-line of the Harappans in middle Holocene time, in northwestern plains of India.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. K.S. Valdiya Ph.D., FASc, FNASc, FTWAS
Honorary Professor and Chair, GDU

Our research work focuses on active faults and mechanisms of evolution of high mountains and drainage anomalies in Southern Indian Shield, and identification of zones of potential hazards. We also investigate the anomalous weather events in Central Himalayas.

We discovered the traces of River Saraswati in northwestern plains of India. The river disappeared approximately 2000 years ago due to tectonic activity combined with drastic climate change.

EVENT ORGANISED:

- Science Outreach Programme: A Unique Initiative In Uttarakhand (June and November, 2019).

Dr. C.P. Rajendran Ph.D.

Senior Associate

The timing and size of the last great earthquakes in the central Himalayas remains a scientific controversy. We evaluated the available evidence, which implicated 1344 CE as the last of the medieval sequence of earthquakes. This earthquake showed a magnitude of Mw ≥ 8.5, with a rupture length of ~600 km of the central Indian Himalayas and an average slip of 15 m. Notably, an earthquake of similar size is overdue in this part of the Himalayas.

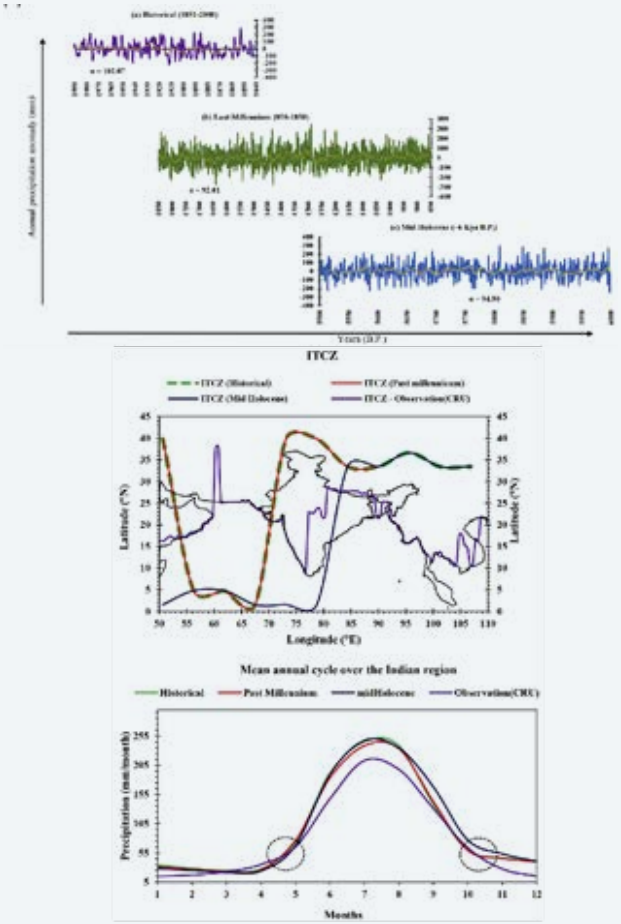


Fig.: Variation of annual rainfall anomaly (mm) averaged over Indian monsoon region B. (a) ISM Inter Tropical Convergence Zone for various time period. (b) mean annual precipitation cycle over (67-98°E, 7-38°N) for CRU (observational) (violet line), Historical (green line), Past Millennium (red line) and Mid Holocene (blue line) for the model CSIRO-MK3L. The black dashed circle shows onset and withdrawal of monsoon.

Geological investigations suggest two preceding major tsunami inundations in the Indian Ocean around the tenth and fourteenth centuries. These tsunamis (pre-2004) may have originated from the Andaman–Sumatra subduction front, and the inferred fourteenth-century Indian Ocean tsunami might have occurred in the year 1343 C.E.

We reconstructed the climatic changes starting from the late Pleistocene to the early Holocene, as recorded from a fluvio-lacustrine section located within the Kumaun Central Himalayas. Our analyses revealed two major climatic events corresponding to the Last Glacial Maximum (LGM) and Older Dryas (OD).

We studied the contribution of diverse monsoon precipitation over Central and Northern India during mid to Late Holocene based on a computationally efficient coupled atmosphere-sea ice-ocean general circulation model (CSIRO-Mk3L-1-2). The precipitation shifted from central to the western Himalayas during Mid to Late Holocene (Fig.).

KEY PUBLICATIONS:

- Rajendran CP, et al. (2019) Footprints of an elusive mid-14th century earthquake in the central Himalaya: Consilience of evidence from Nepal and India. *Geol J* 54:2829−2846.
- Rajendran CP (2019) Historical accounts of sea disturbances from south India and their bearing on the penultimate predecessor of the 2004 tsunami. *Seismol Res Lett* 90:774−783.

EVENT ORGANISED:

- Seminar on “Earthquake hazard in the central Himalayas”, held at the Central Scientific Instruments Organization (CSIO-CSIR), Chandigarh from September 24–25, 2019.

contd. in next page

Dr. C.P. Rajendran
continued.

INVITED AS SPEAKER AT:

- The Scientific Expert Consultation on Tsunami Hazard Assessment of the Makran Subduction Zone on March 8, 2019 and 12th Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System at Kish Island, Iran from March 9–12, 2019.
- Keynote speaker (Extreme Events in the Himalayan Region: Are We Prepared for the Big One?) at a workshop, held at IIT Mandi from April 18–20, 2019.
- Chief presenter at a meeting organized in New Delhi by Overseas Security Advisory Council (OSAC) on the earthquake scene in India on June 7, 2019.
- Keynote speaker at the 2nd Triennial Congress of Federation of Geosciences Associations (FIGA): Earthquake Hazard in the Central Himalayas: Elaborating the past to explore the future, held at National Geophysical Research Institute, (NGRI), Hyderabad on October 15, 2019.
- QIP Short-term course on Non-linear analysis in earthquake engineering from November 25–29, 2019.
- As a resource person, delivered a talk on "Liquefaction of ground during earthquakes", at Dept. of Civil Engineering, Indian Institute of Sciences, Bengaluru on November 26, 2019

UNIT MEMBERS

Honorary Professor and Chair
Prof. K.S. Valdiya

Senior Associate
Dr. C.P. Rajendran

Women Scientist
Dr. Jaishri Sanwal Bhatt

Research Associates
M. Raja

Ananya Divyadarshini

Total Publications
07

New Project
01

Amount received during 2019-2020
₹11.11 L

INTERNATIONAL CENTRE FOR MATERIALS SCIENCE (ICMS)

ICMS, the first international centre of its kind, is a leading facility in the country for high impact interdisciplinary research. The objectives of ICMS include carrying out in-house research on high-quality selected areas of materials science, promote collaboration in research and education with important centres and individuals in India and abroad, organize winter/summer schools on materials science, and provide visiting fellowships to teachers and young researchers from other institutions in India. ICMS is a member of several international forums like EICOON, WMRIF, and IUSSTF.

RESEARCH AREAS

The research carried out at ICMS is focused on the following:

- Solid state and structural chemistry
- Heteroepitaxial growth and formation of self-assembled nanostructures
- Aberration corrected high resolution transmission electron microscope
- Semiconductor nanostructures
- Soft condensed matter physics
- Organic-inorganic hybrid materials
- Physics and chemistry of nanomaterials
- Plasmonic materials, metamaterials and nano-photonics

RESEARCH HIGHLIGHTS

- The role of interlayer spacing in the nanocomposites involving MoS_2 and graphene sheets and its control over electronic structures and catalytic properties was investigated.
- The origin of the blue luminescence peak in a Mg-doped GaN thin film was discovered.
- We have for the first time extended atomic heteroepitaxy concepts to steer the self-assembly of micrometre-sized colloidal particles on lattice-mismatched surfaces.
- A simple, ultrafast combustion synthesis of Co_3O_4 dispersed carbon for enhanced oxygen evolution kinetics was reported.
- The properties of quantum dots were engineered by studying the electronic structure interaction of dopants with the host and thereby modulating the host properties.
- High capacity and high rate NASICON-$Na_{3.75}V_{1.25}Mn_{0.75}(PO_4)_3$ cathode was developed for Na-ion batteries
- The rigid-band electronic structure of ScN across the n-type to p-type carrier transition regime was investigated.
- Zn and O atoms in zinc oxide epitaxial thin film were quantitatively examined by different routes, and the phase detection limits and the atomic model used to count the atoms were discussed.
- A potential approach was suggested for manipulating the properties of semiconductors by dual doping engineering.
- Sodium cobalt metaphosphates, a new class of robust and economic OER electrocatalysts were reported.
- The electronic band alignments and Schottky barrier heights in $TiN/Al_{0.72}Sc_{0.28}N$ superlattice interfaces were determined by a combination of spectroscopic and first-principles density functional theory analyses.
- Novel dendrons with thiophenol groups were synthesized as analytes for surface-enhanced Raman spectroscopy.
- The encoding of single and multiple mechanical memories in an amorphous bubble raft was experimentally shown.

ACHIEVEMENTS AND ACTIVITIES OF ICMS

Prof. C.N.R. Rao Bharat Ratna, D.Sc., Ph.D., FRS, Hon. FRSC
Linus Pauling Research Professor and Director, ICMS

Water splitting by photochemical and electrochemical reactions is an important area of research related to renewable energy. This year, we reported good HER activity in exfoliated solid solutions of $MoS_xSe_{(2-x)}$/ $MoSe_xTe_{(2-x)}$ both photo and electrocatalytically. We also investigated the superior HER activity for a number of nanocomposites, including phosphorene-MoS_2 and phosphorene-$MoSe_2$ composites and electrostatic interaction-based nanocomposites of PDDA-functionalised RGO or BCN with MoS_2 and $MoSe_2$. Additionally, we investigated the role of interlayer separation of covalently cross-linked 2D nanosheets and its effect on photochemical catalytic activity of hydrogen evolution. We studied photoelectrochemical water splitting of different manganese oxides electrodeposited on $BiVO_4$ photoanode.

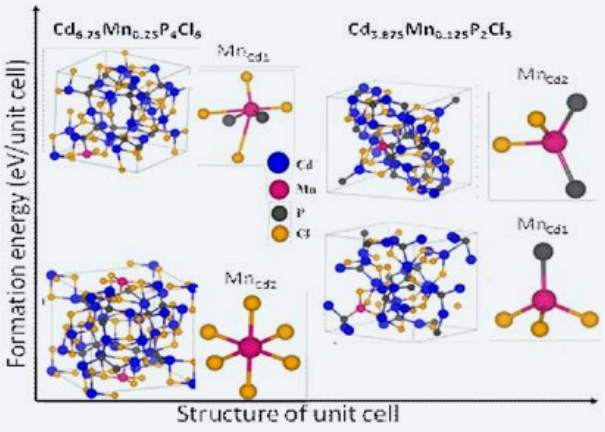


Fig. Mn^{2+} substitution at two different Cd-sites in $Cd_4P_2Cl_3$ and $Cd_7P_4Cl_6$ was studied. In $Cd_7P_4Cl_6$, Mn^{2+} substitution at the octahedral Cd-site ($MnCd_2$) (left panel bottom figure) is more favoured than substitution at distorted octahedral Cd-site ($MnCd_1$) (left panel top figure). Similarly, in $Cd_4P_2Cl_3$, Mn^{2+} prefers the tetrahedral Cd-site (MnCd1) (right panel bottom figure) over the distorted tetrahedral Cd-site (MnCd2) (right panel top figure). Broken crystal field and inversion symmetry of distorted octahedral $MnCd_1$ (in $Cd_7P_4Cl_6$) and distorted tetrahedral $MnCd_2$ (in $Cd_4P_2Cl_3$) are responsible for higher formation energy in these configurations.

We studied the relatively new classes of 2D materials, PbFCl and BaFCl for their supercapacitor performance and metal phosphochalcogenides were studied for their good photocatalytic HER properties. We also studied the low thermal conductivity in borocarbonitride nanosheets and designed a chemical route to synthesize twisted graphene, graphene oxide, and boron nitride.

Another active area of research in the lab is aliovalent anion substitution. We reported variation in electronic and optical properties of cadmium phosphosulphides of different compositions and investigated their superior photo(electro)chemical HER activity. We also studied manganese substitution in these compounds and corresponding changes in carrier dynamics and related photochemical activity and stability. We investigated the selective fabrication of β-phase of nickel sulphide (NiS) and vanadium oxide (VO_x) thin films via atomic layer deposition technique.

KEY PUBLICATIONS:

- CNR Rao, et al. (2009) Graphene: the new two-dimensional nanomaterial. *Angew Chem Int* 48:7752–7777.
- CNR Rao, et al. (2004) Metal carboxylates with open architectures. *Angew Chem Int* 43:1466–1496

EVENTS ORGANISED:

- Research Conference on Chemical Frontiers (CFM2019) held at Goa from August 22–25, 2019.
- JNCASR-FCBS Programme and Workshop for Chemistry Students and Teachers from October 31–November 1, 2019.
- JNC Research Conference on Chemistry of Materials held at Trivandrum during September 30–October 1, 2019

contd. in next page

Prof. C.N.R. Rao

... continued.

INVITED AS SPEAKER AT:

- International Symposium on Advances in Electrochemical Science and Technology held at Chennai on January 8, 2019 (Plenary lecture).
- Science Outreach Programme in School Chandana at Laxmeshwar from January 22–24, 2019
- Wiley Global Innovation Conclave held at Bengaluru on January 31, 2019.
- International Workshop on Advanced Materials-2019 held at RAK-CAM, UAE from February 23–26, 2019.
- Symposium on Frontiers in Sciences: Past, Present and Future in Physical, Chemical and Earth Sciences held at Banaras Hindu University from March 8–12 2019.
- India Higher Education Summit-2019 – Innovation in Education for a Competent Industry held at Mysore on March 15, 2019.
- Nano India 2019 held at M.G. University, Kottayam on April 26, 2019.
- Science Outreach Programme – International Year of Periodic Table of Chemical Elements - 2019 held at Bengaluru on May 17, 2019.
- 10th International Conference on Materials for Advanced Technologies, von Hippel Award Symposium held at Singapore from June 23–28, 2019.
- First DBT-BIRAC Leadership Dialogue Series held at Bengaluru on July 18, 2019.
- Platinum Jubilee Lecture at IICT, Hyderabad on August 5, 2019.
- Public Lecture at the NIAS-DST Training Programme on Science, Technology and Innovation Policy on August 26, 2019.
- The 2019 Professor M.G.K. Menon Memorial Lecture at New Delhi on August 28, 2019.
- Centenary celebrations programme of Karnataka High School Past Students Association, Dharwad and Celebration of the International Year of the Periodic Table IYPT-2019 organized by the Karnataka Higher Education Academy, Dharwad on September 4–5, 2019.
- DAE Theme Meeting Commemorating “150 Glorious Years of Periodic Table” at Mumbai on November 27, 2019.
- Public Lecture in the INSA Annual Meeting at Goa on December 16, 2019.
- SAMat Annual Retreat: A Brain Storming Meeting at Chikmagalur on November 17–18, 2019.

Prof. M. Eswaramoorthy Ph.D.

Professor & Associate Director, ICMS

We recently reported a new and simple methodology to quantify the amount of metallic Ni present in the mixed nickel hydroxide/nickel surface using galvanic replacement reaction. This approach can be extended to synthesize various nickel-containing bimetallic nanoparticles that would be useful for many industrially significant catalytic reactions.

Covalent organic polymers (COPs) are a new class of materials offering diverse functionalities. Recently, we showed that effective interface engineering between conducting (graphene) and non-conducting COP phase (containing redox-active viologen moieties) retains electrochemical activity even after prolonged cycling. These findings can be used to realize enhanced pseudocapacitive energy storage.

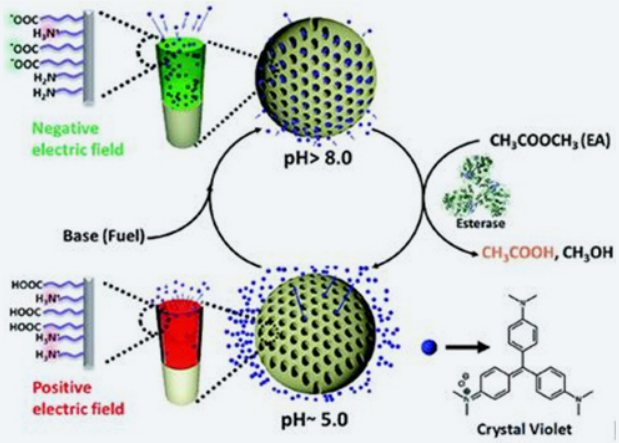


Fig.: Bio-inspired temporal regulation of ion-transport in nanochannels. Herein, we demonstrate biochemical reaction mediated temporal regulation of mass transport in nanochannels of mesoporous silica sphere. The rationally designed nanochannels with pH responsive electrostatic gating are fabricated through a hetero-functionalization approach utilizing propylamine and carboxylic acid moieties. This system represents a unique approach to create autonomous artificial cellular models.

KEY PUBLICATIONS:

- Gond R, et al. (2019) Sodium cobalt metaphosphate as an efficient oxygen evolution reaction catalyst in alkaline solution. *Angewandte Chemie* 131(25):8418–8423.
- Singh DK, et al. (2019) Nanoscale engineering of graphene-viologen based 3D covalent organic polymer interfaces leading to efficient charge-transfer for pseudocapacitive energy storage. *ChemistrySelect* 4(27):8089–8094.

EVENTS ORGANISED:

- International Winter School 2019 on Frontiers in Materials Science held at JNCASR, held at Bengaluru from December 2–6, 2019.
- CPMU Unit Day 2019, the 25th Celebrations held at JNCASR, Bengaluru on September 7, 2019.
- JNCASR In-House Symposium, held at JNCASR, Bengaluru from November 13–14, 2019.
- JNCASR-ShivNadarUniv Joint Symposium on Emerging Materials, held at JNCASR, Bengaluru from November 8–9, 2019.

INVITED AS SPEAKER AT:

- International Conference on Nanotechnology-2019, Opportunities and Challenges, held at St. Aloysius College, Mangalore from January 10–11, 2019.
- Bangalore Nano-2020, held at Hotel Lalit Ashok, Bengaluru from March 2–3, 2020.
- National Conference on Recent Trends in Materials Science and Technology 2019, held at IIST, Trivandrum from December 18–20, 2019.
- One day workshop on Atoms, Molecules and Materials, held at Manipal Academy of Higher Education, Manipal on November 23, 2019.
- 7th Asian Conference on Coordination Chemistry 2019 (ACCC7 2019) held at Kuala Lumpur, Malaysia from October 15–18, 2019.

Prof. S.M. Shivaprasad Ph.D.

Professor (on lien w.e.f. 11.08.2017)

Currently our focus is on growth of high quality III-nitride nanostructures and heterostructures using a number of non-native substrates such as Si, Al_2O_3, and TiN. Theoretical modelling was done to understand the growth mechanism of nanostructures to aid in further optimization of properties. Morphology-dependent electronic and transport properties of quasi 2D GaN nanowall network were studied to understand the underlying mechanism for potential applications. Efficient hole doping of the nanostructures with Mg dopant was carried out for device applications. Luminescence properties of Mg-doped GaN was studied experimentally and theoretically by first principles calculation to probe the emission mechanisms and concerned native defects. We also investigated the photoelectrochemical properties of $In_xGa_{1-x}N$ thin film and nanostructures.

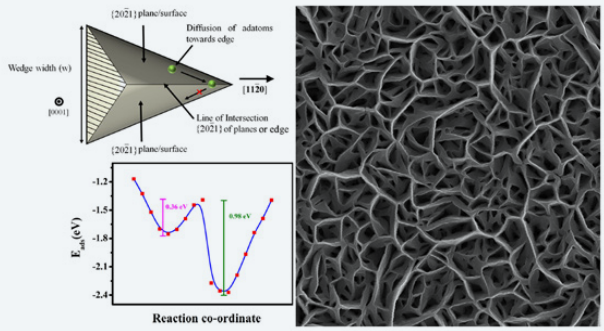


Fig. Early stage growth mechanism of GaN nanowall network grown using plasma-assisted molecular beam epitaxy. The figure shows enhanced growth along the edge of facet leading to shape transition from a tetrahedron shaped island to a nanowall network. The first-principle calculation showed that the reduced diffusion barrier towards the edge of facet is responsible for the anisotropic growth leading to the formation of NwN.

KEY PUBLICATIONS:

- Chatterjee A, et al. (2020). Morphology-related functionality in nanoarchitectured GaN. *Ann Rev Mater Res* 50:7.1–7.28.
- Nayak S, et al. (2018). Edge enhanced growth induced shape transition in the formation of GaN nanowall network. *J Appl Phys* 123(1):014302.

Prof. Rajesh Ganapathy Ph.D.

Associate Professor (jointly with CPMU)

We experimentally showed that both single and multiple mechanical memories can be encoded in an amorphous bubble raft, a prototypical soft glass, subjected to an oscillatory strain. Further, our study suggests that the evolution of force networks on training plays a decisive role in memory formation in jammed packings.

Through a combined numerical and experimental investigations, we showed that long-wavelength Mermin–Wagner fluctuations are relevant at high temperature, where the liquid dynamics do not reveal a transient solid-like response. In this regime, these fluctuations induce an unusual but ubiquitous decoupling between long-time diffusion coefficient, D and structural relaxation time, τ, where $D \propto \tau^{-\kappa}$, with $\kappa>1$. Long-wavelength fluctuations have a negligible influence on the relaxation dynamics only at extremely high temperatures in molecular liquids or at extremely low densities in colloidal systems.

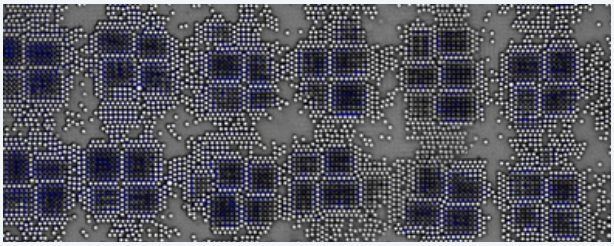


Fig. Colloidal Heteroepitaxy – Exploiting strain relaxation to create laterally-ordered surface structures. (Particles shown in the above image are micrometer-sized colloidal particles)

In lattice-mismatched surface growth, relaxation of the pent-up stress often results in strain-relief patterns that act as templates for further self-assembly. We showed for the first time that this can also be used to steer the self-assembly of micrometer-sized colloidal particles.

KEY PUBLICATIONS:

- Nagamanasa H, et al. (2015) Direct measurements of growing amorphous order and non-monotonic dynamic correlations in a colloidal glass former. *Nat Phys* 11:365–368.
- Krishnamurthy S, et al. (2016) A micrometer-sized heat engine operating between bacterial reservoirs. *Nat Phys* 12:1134.

INVITED AS SPEAKER AT:

- Discrete Simulations of Fluid Dynamics, held at JNCASR, Bengaluru, India from July 22–26, 2019.
- International Workshop on Glass Physics, Institute for Theoretical Physics-Chinese Academy of Sciences, held at Beijing, China, from September 25–28, 2019.
- 15th JNCASR Conference on Chemistry of Materials, held at Kovalam, India from September 30–October 2, 2019.

Prof. Sridhar Rajaram Ph.D.

Associate Professor (jointly with CPMU)

We synthesized dendrons with thiophenol groups on their periphery and tested them as a Surface-Enhanced Raman Spectroscopy (SERS) analyte, with simple gold nanoparticles as a substrate. A 102-fold enhancement in detection was observed upon going from a mono-thiophenol (MT) to a tetra-thiophenol (TT). Dendronic Raman markers increased the probability of SERS occurrence at lower concentrations when compared to a single Raman active molecule. This strategy extends the applicability of SERS, as these analyte molecules can be just mixed or drop-casted on any kind of SERS substrate.

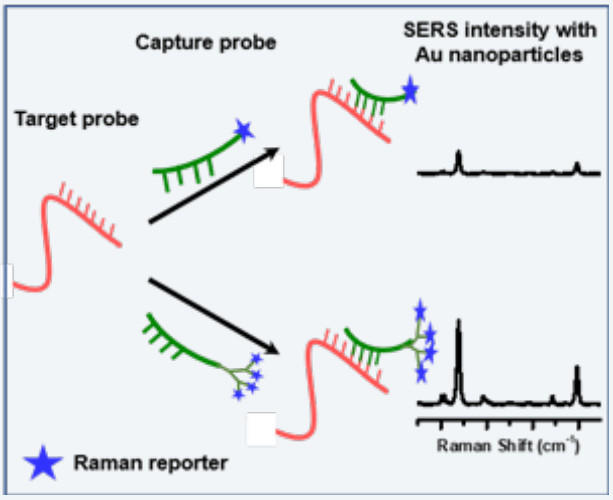


Fig. Schematic describing the enhancement of intensity using dendronic Raman Markers.

KEY PUBLICATIONS:

- Rajaram S, et al. (2012) Nonplanar–perylene diimides as potential alternatives to fullerenes in organic solar cells. *J Phys Chem Lett* 3:2405.
- Jain P, et al. (2019) Designing dendronic-Raman markers for sensitive detection using surface-enhanced Raman spectroscopy. *RSC Adv* 9:28222–28227.

Prof. Ranjani Viswanatha Ph.D.

Associate Professor (jointly with NCU)

Mn doping in II-VI semiconductors has been extensively studied. We explored various phenomena of energy and charge transfer mechanisms to better understand spin driven optoelectronics. We showed the presence of transient Mn^{3+} state using materials with band gaps in resonance with the energy of the Mn emission to understand the nature of the absorbing, transient, and emitting species. The electron back-transfer from Mn^{2+} to the host conduction band in the prototypical example of Mn-doped $CsPbX_3$ (X = Cl, Br) NCs through vibrational coupling was coined as the "vibrationally assisted delayed fluorescence."

We addressed challenges associated with dual doping of semiconductor quantum dots (QDs) within the constraints of one host under similar conditions of temperature, time, and chemical parameters such as solubility and reactivity using CoPt-doped CdS QDs as a model system.

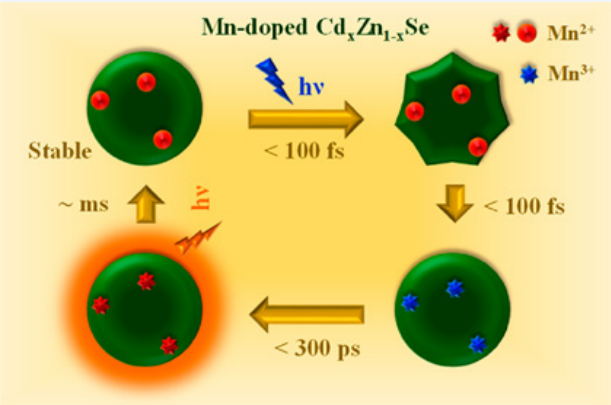


Fig.: Mechanism of Mn emission in II-VI semiconductors passing through a transient state with a lifetime of ~300 ps.

Similarly, the oxidation state of Cu has long been a challenge in doped quantum dots. We have used single molecule spectroscopy to image individual Cu doped quantum dots and have provided an ultimate proof to the oxidation state of Cu ending long-standing debate in literature.

We demonstrated a two-step synthesis of $CoO/CoFe_2O_4$ core–shell QDs and the direct synthesis of Sn and Pb-based alloy perovskite nanocrystals.

KEY PUBLICATIONS:

- Saha A and Viswanatha R (2017) Magnetism at the interface of magnetic oxide and nonmagnetic semiconductor quantum dots. *ACS Nano* 11(3):3347–3354.
- Pradeep KR et al. (2020) Harvesting delayed fluorescence in perovskite nanocrystals using spin-forbidden Mn d states. *ACS Energy Lett* 5(2):353–359.

INVITED AS SPEAKER AT:

- CRSI Bronze medal Lecture at VIT, Vellore.
- Winter School 2019, JNCASR, Bengaluru, from December 2–6, 2019.

Dr. Premkumar Senguttuvan Ph.D.

Faculty Fellow (jointly with NCU)

We developed a new topochemical methodology to convert the 1D-$FeF_3 \cdot 3H_2O$ precursor structure to a higher dimensional iron fluoride framework through incorporation of a "structure-stabilizing" agent, i.e., sodium fluoride (NaF) into it. The as-synthesized 3D-$Na_2Fe_2F_7$ cathode showed reversible capacities above 50 mAh/g for 30 cycles with an average intercalation voltage of 3.25 V vs Na^+/Na^0, the highest value reported for iron fluorides in NIBs.

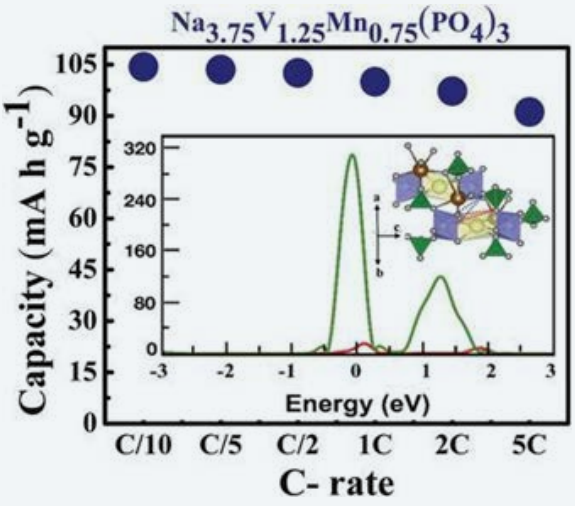


Fig. A comprehensive study on the sodium superionic conductor (NASICON)-Na_{3+y} V_{2-y} Mny $(PO_4)_3$ ($0 \le y \le 1$) series showed a phase miscibility gap at y = 0.5, defining two solid solution domains with low and high Mn contents. The observed higher capacity and rate capability of the $Na_{3.75}V_{1.25}Mn_{0.75}(PO_4)_3$ cathode is attributed to its optimum bottleneck size (≈5 Å^2) and modulated V- and Mn-redox centers.

Sodium superionic conductor (NASICON) cathodes exhibit both high structural stability and high sodium ion mobility, making them attractive for Na-ion battery applications. We carried out a comprehensive study on the structural and electrochemical properties of the NASICON-Na_{3+y} V_{2-y} Mny $(PO_4)_3$ ($0 \le y \le 1$) series. Our study showed the importance of manipulating electronic and crystal structures to achieve high-performance NASICON cathodes.

We also explored Sn-, Bi-, Pb-, and Sb-based alloys as anodes for Na-ion batteries.

KEY PUBLICATIONS:

- Dey UK, et al. (2019) Topochemical bottom-up synthesis of 2D- and 3D-sodium iron fluoride frameworks. *Chem Mater* 31:295.
- Ghosh S, et al. (2019) High Capacity and High Rate NASICON-$Na_{3.75}V_{1.25}Mn_{0.75}(PO_4)_3$ cathode for Na-ion batteries via modulating electronic and crystal structures. *Adv. Energy Mater.* DOI: 10.1002/aenm.201902918.

INVITED AS SPEAKER AT:

- 6th International Conference on Na-ion Batteries, held at Chicago, USA, in November 2019.

Dr. Bivas Saha Ph.D.

Faculty Fellow (jointly with CPMU)

We reported the rigid-band electronic structure of ScN across n-type to p-type carrier transition regime.

Combining first principle based DFT calculation and experimental works (XAS, UPS), we showed that oxygen and magnesium, which act as n and p type dopant in ScN respectively, do not create any defect states inside the ScN bandgap. The rigid nature of the ScN electronic structure makes it promising for different ScN-based device applications with better efficiency.

We determined the Schottky barrier height in TiN/AlScN metal/semiconductor superlattices experimentally and compared it with the values calculated theoretically. Though the measured Schottky barrier height value of 1.72 ± 0.2 eV is slightly larger for thermionic devices, it is ideal for solar photo-voltaic, photodiodes, and photocatalysis; hence, our findings can lead to development of such devices based on TiN/AlScN.

The ZrN/carrier compensated ScN metal/semiconductor superlattices were demonstrated. Thermal stability of the superlattice was also examined up to 950°C using HRTEM and EDX. This ZrN/ carrier compensated ScN superlattice could lead to the development of thermionic devices.

We also demonstrated the wave-vector dependent Raman scattering and Fano resonance in ScN. This finding will help us to understand the nature of electron phonon interaction in ScN.

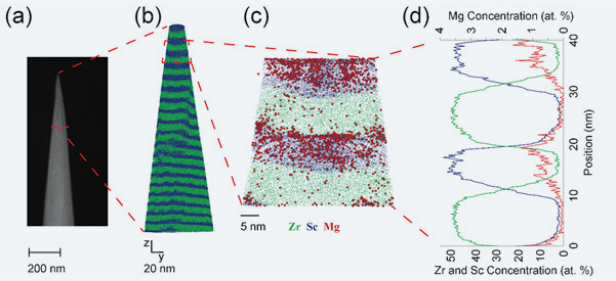


Fig. (a) STEM image of FIB-prepared APT tip, (b) Entire APT dataset. (c) An enlarged 10 nm thick section of the tip shows the distribution of Mg throughout ZrN and ScN layers. (d) 1D concentration profile along the length direction corresponding to the section shown in (c).

KEY PUBLICATIONS:

- Nayak S, et al. (2019) Rigid-band electronic structure of scandium nitride across the n-type to p-type carrier transition regime. Phys Rev B 99:161117(R).
- Nayak S, et al. (2019) Schottky barrier height of epitaxial lattice-matched TiN/Al0.72Sc0.28N metal/semiconductor superlattice interfaces for thermionic energy conversion. Appl Phys Lett 115:251901.

EVENT ORGANISED:

- J.A. Woollam Ellipsomery Workshop in JNCASR, Bengaluru.

INVITED AS SPEAKER AT:

- International Conference on Materials for Advanced Technologies (ICMAT) Singapore held from June 25–27, 2019.
- International Conference on Metallurgical Coatings and Thin Films (ICMCTF), organised by American Vacuum Society (AVS), San Diego, California, US, held from May 19–24, 2019.
- Indus Synchrotron User Meeting, organised by Raja Ramanna Centre for Advanced Technology (RRCAT), held on March 28, 2019.
- International Workshop on Advanced Materials (IWAM), held at Ras Al Khaimah UAE, on February 26, 2019.

ICMS MEMBERS

Director
Prof. C.N.R. Rao

Professor and Associate Director
Prof. Eswaramoorthy Muthusamy

Professor
Prof. S.M. Shivaprasad (on lien w.e.f. 11.08.17)

Associate Professors
Prof. Rajesh Ganapathy (jointly with CPMU)

Prof. Sridhar Rajaram (jointly with CPMU)

Prof. Ranjani Viswanatha (jointly with NCU)

Prof. Ranjan Datta (jointly with CPMU)

Faculty Fellows
Dr. Bivas Saha (jointly with CPMU)

Dr. Premkumar Senguttuvan (jointly with NCU)

Associate Faculty (From CPMU, NCU & TSU)
Prof. Balasubramanian Sundaram

Prof. Chandrabhas Narayana

Prof. M. Eswaramoorthy

Prof. G.U. Kulkarni

Prof. K.S. Narayan

Prof. A. Sundaresan

Prof. Tapas Kumar Maji

Prof. Kanishka Biswas

Prof. Shobhana Narasimhan

Prof. Srikanth Sastry

Prof. Swapan K. Pati

Prof. Umesh V. Waghmare

Board of Management
Prof. C.N.R. Rao, F.R.S., Director, ICMS

President, JNCASR

Prof. Ashutosh Sharma, Secretary, DST, Government of India

Prof. M. Eswaramoorthy, Associate Director, ICMS

Prof. S.B. Krupanidhi, IISc

Prof. S.M. Shivaprasad, JNCASR

Mr. Joydeep Deb, Administrative Officer, JNCASR (Secretary)

International Advisory Board
Prof. C.N.R. Rao, FRS

Prof. Anthony K. Cheetham, FRS

Prof. Michael L. Klein, FRS

Prof. J. Paul Attfield, FRS

Prof. John Wang

Honorary Faculty
Prof. A.K. Sood, IISc.

Prof. U. Ramamurthy, Univ. of Singapore

Adjunct Professors
Prof. Milan K. Sanyal, Saha Institute of Nuclear Physics

Prof. Arunava Gupta, University of Alabama

Prof. Ram Seshadri, University of California

Prof. Prashant V. Kamat, University of Notre Dame

ICMS MEMBERS

Senior Research Officer
Dr. Jay Ghatak

Research Associates
Manjodh Kaur, K. Pramoda, Anand Kumar Roy, Shashidhara Acharya, Supriya Ghanty

Research Associate (Provisional)
Badri Vishal

Students of Post Graduate Diploma in Materials Science
Golla Prudhvi, S. Sowmeya, Pankaj Kumar Samal

Technical Assistant (Inst.)
Mahesh J.I.

Technical Assistant (Trainee)
Deepak V., Prajwal G.

R&D Assistant
Subhashri Mannar

Project Assistant
Krithika Upadhya

Laboratory Assistant
Mune Gowda H.

Jr. Admin Assistant
Ramya C.

Total Publications
45

New Projects
02

Amount received during 2019-2020
₹40.20 L

On going Projects
09

Amount received during 2019-2020
₹32.93 Cr

STUDENTS ADMITTED
PGDMS: 3 students

Golla Pridhvi
S. Sowmeya
Pankaj Kumar Samal

03

STUDENTS GRADUATED
PGDMS: 3 students

M. Subhashri
Nirmal Jose
Bibekananda Paikaray

03

ICMS AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. C.N.R. Rao

- Received the TV9 Lifetime Achievement Award.
- Received the KAYAK SHREE Award (Gokak) (2019) from Shoonya Sampadana Math, Gokak.
- Received the COSINE Award from Chaldean Syrian Higher Secondary School, Trissur (2019).
- Received the Saud International Prize For Materials Research (2019) from RAK-CAM, UAE.
- Conferred Honoris Causa from Jadavpur University, Kolkata (2019).
- Conferred with the 80th Honorary Doctorate in Science by the University of Kerala, Thiruvananthapuram.
- Highly Cited Researcher for 2019 from Web of Science Group.

Prof. Ranjani Viswanatha

- Featured in the article “Women in the forefront of Energy Research” by ACS Energy Letters (2020).
- Awarded the CRSI Bronze Medal (2020).
- Received the C. V. Raman Award for Young Scientist by Karnataka State (2019).

Dr. Bivas Saha

- SERB Start-Up Research Grant.

Awards received by STUDENTS

Navneet Singh won the best oral presentation award at Compflu 2019 held in IISER Bhopal. Research supervisor: Prof. Rajesh Ganapathy.

Mahima Makkar was awarded the Best Popular Science Story award at the AWSAR event. Research Supervisor: Dr. Ranjani Viswanatha.

MOLECULAR BIOLOGY AND GENETICS UNIT (MBGU)

Research in the Molecular Biology and Genetics Unit (MBGU) uses fundamental principles and advanced approaches to increase understanding of concepts in biology as well as provide solutions applicable to healthcare and medicine. Facilities, funding and training programs are geared to promote high calibre research in biology and also cross-disciplinary interactions. MBGU faculty have established a worldwide network of research collaborations and have made key contributions to science in the country.

With their vast experience of several decades, the faculty holds key administrative and advisory positions at JNCASR both in national and international level.. The Unit has also made the highest impact in contributions to science in the country as evidenced by the large number of awards and honours bestowed on its members over the years.

RESEARCH AREAS

MBGU research areas are broadly grouped under cell and molecular biology, biochemistry, immunology and molecular and developmental genetics and also assimilate inputs from other areas of science and engineering. Research questions include understanding biomolecules at one end of the spectrum to studying human development and disease at the other. A large number of model systems and organisms are studied at MBGU, including viruses, yeast, protozoans, Drosophila, mouse, stem cells as well as human clinical samples.

RESEARCH HIGHLIGHTS

- A case-control study revealed that drug resistance mutations acquired in cell-associated DNA in children infected with HIV-1 and initiated NNRTI-based antiretroviral therapy that can predict the virological failure in these children.
- Genes implicated in human bipolar disorder were identified through a decade-long study.
- An *asrij* null mouse model was generated and found to be an efficient model to study myeloproliferative diseases. Asrij was established as a potential target in cancer treatment.
- A variant histone H3 protein was found to act as a negative regulator of biofilm development in the *C. albicans* pathogen, providing important clues regarding its transition from a commensal to a pathogen.
- Rudhira/BCAS3 was shown to crosslink microtubules and intermediate filaments and regulate angiogenesis.
- An important interplay between AurkB and Tip60 was uncovered to be a potential initial event in carcinogenesis.
- AEBP1 was revealed to be a potential oncogenic driver in glioblastoma, providing a basis for developing novel therapeutic strategies.
- PD180970, a small molecule inhibitor of c-abl kinase, was identified and this molecule was found to exhibit strong neuroprotective effects, making it a promising drug in the management of Parkinson's disease model.
- Plasmodium phosphoglycolate phosphatase was revealed to be a potential therapeutic target for malaria treatment.
- RecovER-phagy and associated mechanisms were identified in *Plasmodium falciparum*, opening up new avenues for investigating therapeutic targets against malaria.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. Maneesha S. Inamdar Ph.D., FASc, FNASc

Professor and Chair, MBGU

We quantitatively analysed the Drosophila melanogaster lymph gland (LG) proteome under genetic conditions that either maintain precursor blood cells or promote their differentiation in vivo, by perturbing expression of Asrij, a conserved endosomal regulator of haematopoiesis. Our study provided, for the first time, an *in vivo* proteomics resource for identifying novel regulators of haematopoiesis that would in turn be applicable to understand vertebrate blood cell development.

Inactivation of the tumour suppressor p53 is essential for unrestrained growth of cancers. Studies carried out to decipher the mechanisms that cause wild-type p53 dysfunction revealed Asrij as a posttranslational regulator of p53 and a potential target for pharmacological intervention. Moreover, we generated the first asrij null (knockout [KO]) mice and found that it is an efficient mouse model to study myeloproliferative diseases.

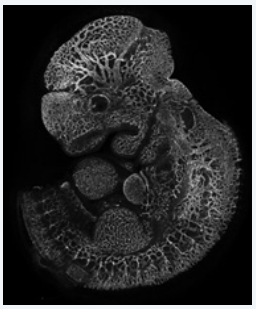


Fig. Mouse embryo stained to show intricate network of blood vessels.

Rudhira/Breast Carcinoma Amplified Sequence 3 (BCAS3) is a cytoskeletal protein essential for endothelial cell migration and sprouting angiogenesis during mouse development and is implicated in metastatic disease. We found that Rudhira mediates cytoskeleton organization and dynamics during EC migration, thereby identifying novel and essential roles of the protein. Furthermore, our study revealed that targeting Rudhira could allow tissue-restricted cytoskeleton modulation to control cell migration and angiogenesis in development and disease.

KEY PUBLICATIONS:

- Sinha S, et al. (2019) Asrij/OCIAD1 suppresses CSN5-mediated p53 degradation and maintains mouse hematopoietic stem cell quiescence. Blood 133:2385–2400.
- Shetty D et al. (2018) OCIAD1 controls electron transport chain complex I activity to regulate energy metabolism in human pluripotent stem cells. Stem Cell Rep 11(1): 128–141.

INVITED AS SPEAKER AT:

- Keynote speaker and panel discussion expert at the GFBR meeting on human genome editing and gene drives, held at Singapore from November 12–13, 2019.
- Organelle level regulation of blood cell homeostasis at GReD, Faculté de Médecine, U. Clermont Ferrand, France in September 2019.
- Delivered Sanjay Biswas Memorial Lecture at BSSE department at IISc Bengaluru on January 24, 2020.
- Prof. CNR Rao Oration Award lecture “Swalpa adjust maadi: Tweaking longevity pathways in stem cells” given on August 13, 2019.
- 54th Anniversary celebration Visvesvaraya Industrial & Technological Museum, on July 27, 2019.
- RGUHS-IISc Molecular Biology Training Program, on November 5, 2019.
- Indian Academy of Science workshop at Jai Hind College, Mumbai on July 12, 2019.
- ADBS iPSC workshop at Bangalore Life Sciences Cluster on June 14, 2019.
- Symposium “Thirsting for Theoretical Biology” at ICTS, Bengaluru on June 6, 2019.
- Summer School for Women in Mathematics and Statistics at ICTS Bengaluru on May 13, 2019.
- The iPSC workshop at CSCR, CMC Vellore on February 19, 2019.

Prof. Anuranjan Anand Ph.D., FASc, FNA, FNASc.
Professor and Chair, NSU

We carried out a whole genome-based analysis of an extended family of 45 members, including 23 affected with hearing impairment and 22 unaffected members in Dhadkai village, India. In addition, multiple known genes associated with deafness were analysed in seven smaller families with hearing impairment. We identified novel mutations in OTOF, CLDN14, and SLC26A4, with p.R708X (c.2122C>T mutation in OTOF) as the major cause of hearing impairment (Figure). Our results suggest considerable genetic heterogeneity in the causation of hearing loss in this population. Detailed examination of ~750 families with congenital, autosomal recessive, prelingual, non-syndromic, and severe-to-profound hearing loss, revealed a large spectrum of pathogenic mutations in deafness-causing genes, extending our understanding of allelic heterogeneity at these genes. Knowledge of the relative contributions of these genes to the load of hereditary hearing loss could help devise a 'genetic algorithm' for early detection of the disorder and implementation of suitable intervention therapies.

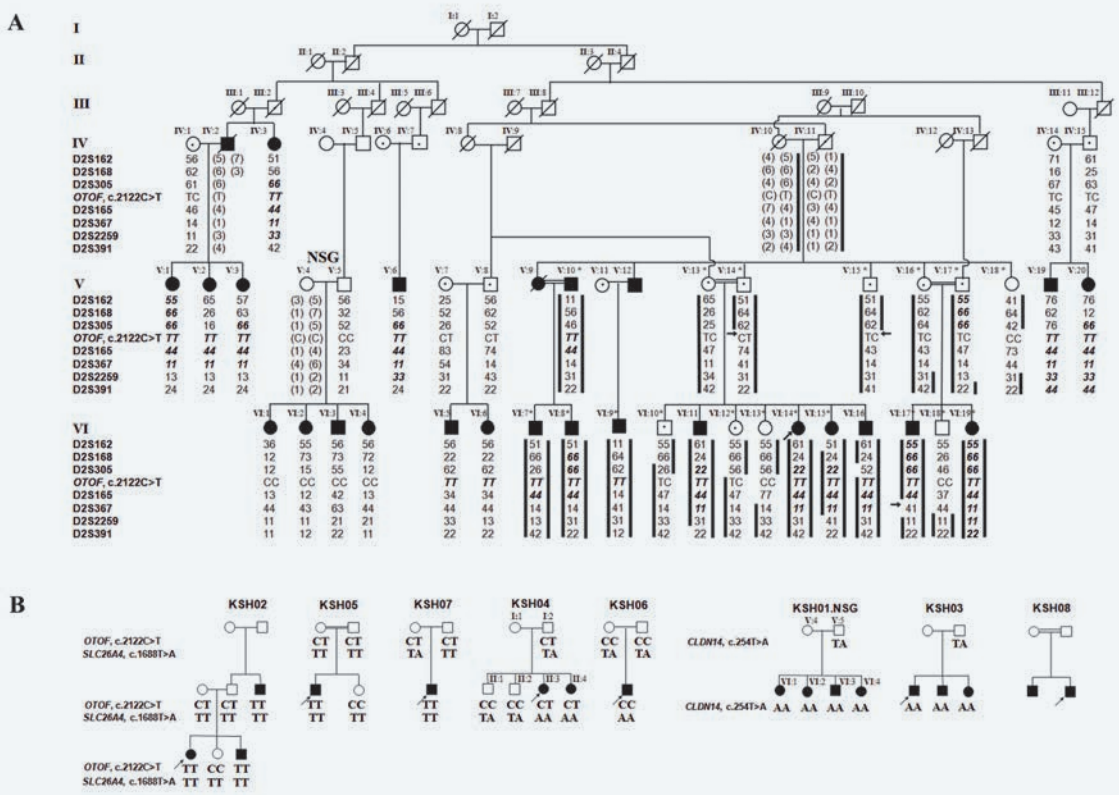


Fig. Pedigrees KSH01-KSH08 A: 2p24-p22 marker haplotypes and OTOF, c.2122C>T in KSH01. Members taken up for genome-wide scan (asterisk) and additional affected members genotyped and their parents/ancestors are depicted. Microsatellite markers (left-side), affected chromosomes (black bars), critical recombination boundaries (arrows), autozygous genotypes (bold italics) and inferred genotypes (parenthesis) are indicated. NSG denotes the branch where linkage to 2p24-p22 was absent. B: KSH02-KSH08 and KSH01.NSG showing the segregating mutations: c.2122C>T, c.254T>A and c.1668T>A.

Prof. Hemalatha Balaram Ph.D., FASc, FNASc

Professor and Dean, Faculty Affairs

Studies on metabolism associated with adenosine monophosphate deaminase (AMPD) and phosphoglycolate phosphatase (PGP) of Plasmodium were concluded in 2019.

The interplay between ATP generating and utilizing pathways in a cell maintain energy homeostasis. Adenylate kinase (AK), which plays a major role in this process, is regulated by AMP levels. Hence, AMPD and nucleotidases, which catabolize AMP, indirectly regulate AK activity and in-turn energy homeostasis. We completed the first study on AMPD from Plasmodium, and showed that allosteric activators of Plasmodium AMPD could serve as anti-parasitic agents.

We showed that a misannotated 4-nitrophenyl-phosphatase from Plasmodium is PGP with specificity for 2-phosphoglycolate and 2-phospho-L-lactate. These metabolites generated during repair of damaged DNA ends and as a by-product of pyruvate kinase reaction potently inhibits glycolysis. Our PGP gene knockout studies in *P. berghei* confirmed that this metabolic proofreading enzyme is essential and that its inhibitors hold promise as anti-malarial agents.

KEY PUBLICATIONS:

- Carrique L, et al. (2020) Structure and catalytic regulation of *Plasmodium falciparum* IMP specific nucleotidase. *Nat Commun* 11:3228.
- Kumar S, et al. (2016) Unexpected functional implication of a stable succinimide in the structural stability of *Methanocaldococcus jannaschii* glutaminase. *Nat Commun* 7:12798.

INVITED AS SPEAKER AT:

- Symposium on Biomolecular Interactions at National Centre for Biological Sciences, Bengaluru, from February 18–19, 2019.
- SBCI 2019, BARC-Mumbai from October 31–November 3, 2019.

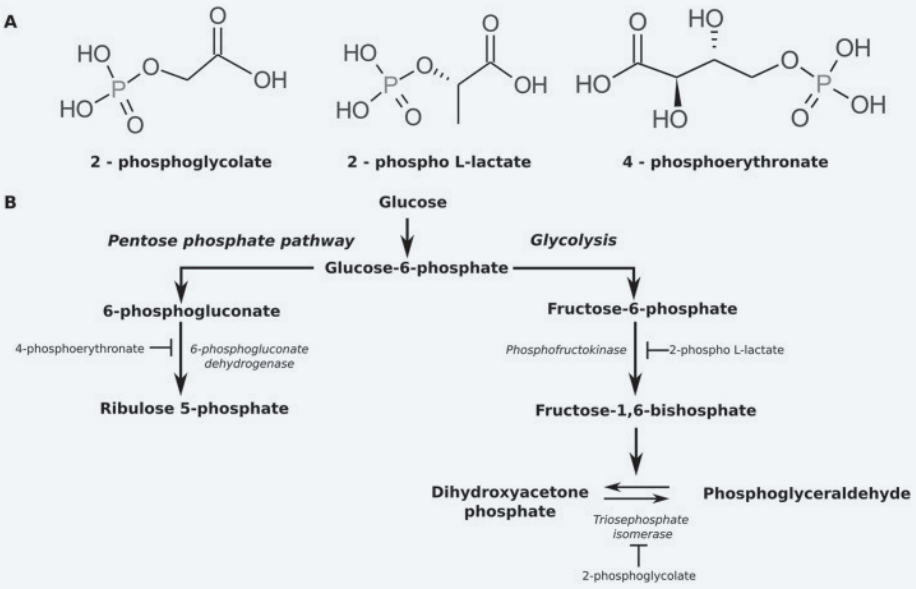


Fig. Metabolic proof-reading in Plasmodium.

Prof. Tapas Kumar Kundu Ph.D., DSc, FASc, FNA, FNASc.

Professor (On Lien w.e.f. 08.08.18)

In the past year, we found that the transcriptional coactivator PC4 is essential for homeostasis of the nucleus, chromatin organization, and epigenetic state of the human cell. Using an oral cancer cell line with an inducible-knockdown of NPM1 gene, which encodes a histone chaperone, we demonstrated that NPM1 regulates several cancer-associated pathways. Mechanistically, it regulates RNA Polymerase II-mediated chromatin transcription through its histone chaperone activity and interaction with other proteins.

We found that the tumour suppressor p53 is also an inducer of autoacetylation of the master epigenetic enzyme, p300. To elucidate the underlying mechanisms, we solved the structure of the p300-p53 complex by cryo-electron microscopy. We identified a relatively rare proline to leucine mutation (P152L) in p53 in an oral cancer patient. Our study established P152L as a new gain-of-function p53 mutant associated with enhanced tumorigenic potential.

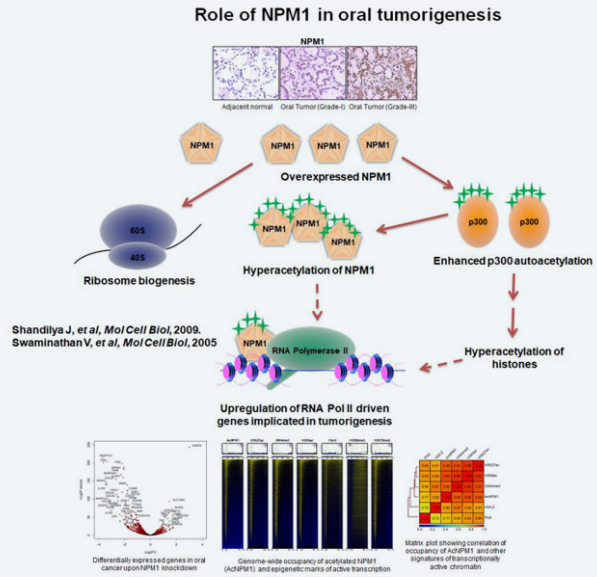


Fig. Histone chaperon NPM1 regulates RNA polymerase II-driven transcription.

We identified a semi-synthetic derivative of garcinol that specifically inhibited histone butyrylation without affecting acetylation. Our study, for the first time, not only causally linked histone butyrylation with adipogenesis but also presented a novel small molecule modulator that could be developed for anti-obesity therapeutics and as a reagent for studying rare acylation modifications. We synthesized the first known small molecule activator of p300/CBP called CTBP. Upon conjugating this class of activator with glucose-based carbon nanosphere, the system could almost completely recover the memory deficiency in Alzheimer mice model as well as promote spinal cord injury repair in rodent model. Our discovery of the carbon nanosphere, which is capable of delivering a drug-like molecule to the brain, has now been selected by the DBT, GoI for next level of translation.

KEY PUBLICATIONS:

- Sikder S, et al. (2019) Non-histone human chromatin protein, PC4 is critical for genomic integrity and negatively regulates autophagy. *FEBS J* 286(22):4422–4442.
- Chatterjee S, et al. (2018) Reinstating plasticity and memory in a tauopathy mouse model with an acetyltransferase activator. *EMBO Mol Med* 10(11):e8587.

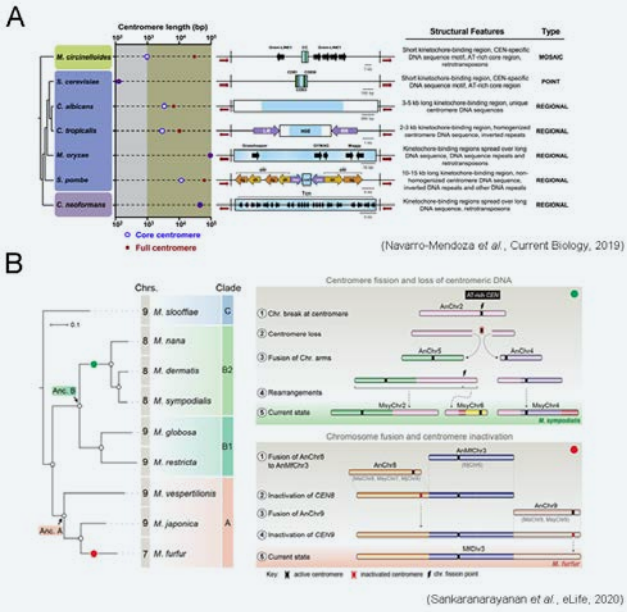
INVITED AS SPEAKER AT:

- INSA Anniversary Meeting, NIO, Goa at NIO, Goa from December 16–18, 2019.
- Dr. Nuggehalli Narayana Memorial Lecture at Bengaluru on November 11, 2019.
- International Chemical Biology Society Meeting at CSIR-IICT, Hyderabad from November 2–4, 2019.
- Kick-off Symposium of Advanced Graduate Program for Future Medicine and Health Care at Tohoku University, Sendai, Japan from March 5–7, 2019.
- International Conference on Advances in Chemical Biology & Biologics (ICACB-2019) at CSIR-IICT, Hyderabad from February 28 – March 2, 2019.
- International Conference on Genome Biology at Madurai on February 27, 2019.

Prof. Kaustuv Sanyal Ph.D., FASc, FNASc, Fellow of AAM.

Professor

We identified AT-rich centromeres in *Malassezia* species, a fungus that causes dermatitis and dandruff, and determined that the AT-rich centromeres drive karyotype changes in this species complex by breakage and inactivation. In collaboration with international scientists, we discovered a novel mosaic type of centromere in an ancient fungal species, *Mucor circinelloides.* This was the first report of loss of prime conserved proteins CENP-A and CENP-C in the fungal kingdom.



(Navarro-Mendoza *et al.*, Current Biology, 2019)

(Sankaranarayanan *et al.*, eLife, 2020)

Fig. Centromeres, the rapidly evolving loci in the genome, bring about karyotype evolution in closely related species. (A) Diversity and classification of fungal centromeres as point, regional, and mosaic based on structural features across Ascomycota (blue), Basidiomycota (purple), and Mucoromycota (green). (B) Schematic of the centromere loss by breakage or inactivation (upon fusion of two chromosomes) resulting in karyotype evolution, as observed in *Malassezia sympodialis* and *Malassezia furfur* respectively.

We identified a species centromere-proximal domain that specifies and restricts centromeric activity to a unique region in *Candida albicans.* We showed that Aurora kinase B homolog Ipl1 in *C. albicans* has a longer activation loop than that of the well-studied ascomycete *S. cerevisiae*. Our investigation suggested that Ipl1 spatiotemporally ensures bilobed kinetochore distribution to facilitate bipolar spindle assembly crucial for ploidy maintenance in *C. albicans.*

We identified a variant histone H3 protein exclusively present in the CTG-clade, including *C. albicans.* This variant was found to act as a negative regulator of biofilm development in *C. albicans.*, suggesting that chromatin changes may be involved in the transition of the fungus from a commensal to a pathogen.

We developed the Amphotret antifungal drug containing polycaprolactone-Fe_3O_4 magnetic nanofibers (MNFs) using the electrospinning technique. These MNFs generate heat in the presence of AC magnetic field and release drug upon heating, suggesting that magnetic hyperthermia could be an adjunctive therapy for fungal keratitis.

KEY PUBLICATIONS:

- Rai LS, et al. (2019) The *Candida albicans* biofilm gene circuit modulated at the chromatin level by a recent molecular histone innovation. *PLoS Biol* 17(8): e3000422.
- Yadav V, et al. (2018) RNAi is a critical determinant of centromere evolution in closely related fungi. *Proc Natl Acad Sci* U S A 115(12):3108–3113.

INVITED AS SPEAKER AT:

- Chromopalooza at Vienna BioCenter, Vienna, Austria in February, 2020.
- Indian Science Congress at Bengaluru, India in January 2020.
- 11th International Conference on Biology of Yeast and Filamentous Fungi at Hyderabad, India in November, 2019.
- EMBO Conference on Comparative Genomics on Eukaryotic Microorganisms at Costa Brava, Spain in October, 2019.
- Tamasek Life Science Laboratories at Singapore in August, 2019.

Prof. Ranga Udaykumar Ph.D.

Professor

We carried out a case-control study and used cell-associated DNA and cell-free RNA of human immunodeficiency virus type-1 (HIV-1) to investigate the role of drug-resistant viral variants that emerged during early antiretroviral therapy (ART) in determining virological outcome. The study compared virologic nonresponder children (two viral loads [VLs] ≥ 200 copies/mL within 2 years of ART) and responder children (two VLs < 200 copies/mL after six months of ART) infected with HIV-1 and initiated on nonnucleoside reverse-transcriptase inhibitor (NNRTI)-based ART.

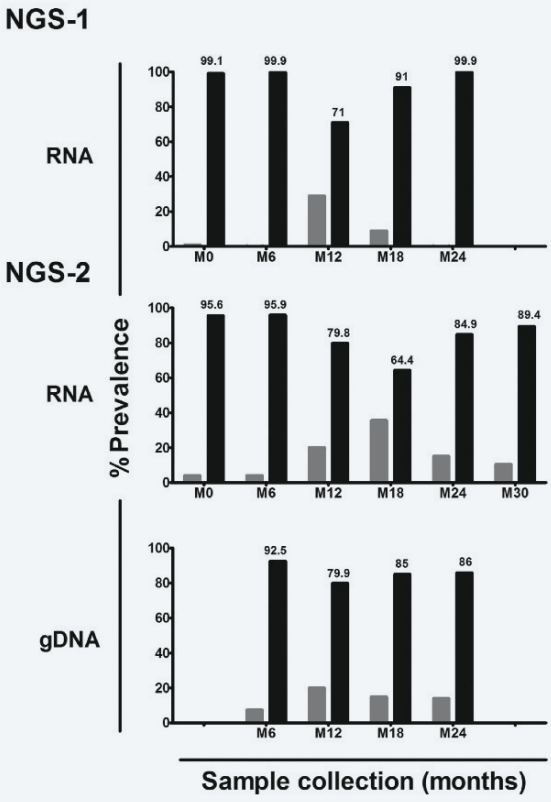


Fig. Two independent rounds of NGS on a patient harbouring a 14 aa PTAP duplication using only plasma viral RNA (NGS-1) and both plasma viral RNA and genomic DNA from peripheral blood (NGS-2). The dark bars represent the per-cent prevalence of the double-PTAP forms of the viral quasispecies, and the grey bars represent the wild type forms containing a single PTAP variant. Across 6-month time intervals, the data clearly demonstrate the dominance of the double-PTAP variant over the wild type virus.

Our analyses revealed that drug resistance mutations acquired in cell-associated DNA during the first six months of ART can predict virological failure in children initiated on NNRTI-based ART.

KEY PUBLICATIONS:

- Ranga U, et al. (2004) Tat protein of human immunodeficiency virus type 1 subtype C strains is a defective chemokine. *J Virol* 78(5):2586–2590.
- Sharma S, et al. (2018) PTAP motif duplication in the p6 Gag protein confers a replication advantage on HIV-1 subtype C. *J Biol Chem* 293(30): 11687–11708.

EVENTS ORGANISED:

- Four-day workshop on Fundamentals and Advanced Concepts of Flow Cytometry Experimental Design, Data Analysis and Presentation at JNCASR, Bengaluru, from June 4-7, 2019.
- Three-day workshop on Cell Sorting, Data Analysis and Multi-Omics approach at JNCASR, Bengaluru, from February 11–13, 2020.
- COVID-19 Diagnostic Training Centre established at JNCASR, Bengaluru; multiple batches are being trained in the diagnosis of COVID-19 starting from June 2020.

INVITED AS SPEAKER AT:

- Combat HIV conference at the School of Life Sciences, University of Hyderabad on January 20, 2019.
- Pre-Scientific Advisory Committee meeting of ICMR-NIRT at Chennai on October 13, 2019.

Prof. M.R. Satyanarayana Rao Ph.D., FASc, FNA, FNASc, FAMS, FTWAS

Honorary Professor, SERB YOS-Chair Professor

Our lab previously identified adipocyte enhancer binding protein 1 (AEBP1) as a differentially regulated gene in glioblastoma (GBM) and found that both cellular proliferation and survival were affected upon AEBP1 silencing in glioma cells, resulting in cell death. We further probed the mechanism of AEBP1, and showed that cell death induced by AEBP1 down regulation requires the PTEN, an established negative regulator of cell growth and survival signalling pathway. Our findings indicated that AEBP1 is a potential oncogenic driver in glioma, and that it mediates its effects *via* the PTEN/PI3K pathway.

TH2B is a major histone variant that replaces about 80-85% of somatic H2B in mammalian spermatocytes and spermatids. We attempted to decipher the unique function(s) of TH2B in spermatocytes. Our study revealed a modification in the N-terminal tail, namely serine 11 phosphorylation of TH2B (TH2BS11ph).This modification was found to be densely localised in the unsynapsed axes of the XY body of the pachytene spermatocyte and was predominantly associated with H3K4me3-positive genomic regions like gene promoters. Thus, it may function to recruit the appropriate transcription or XY body recombination protein machinery at specific genomic loci.

KEY PUBLICATIONS:

- Jayashree Ladha et al. (2010) Glioblastoma specific protein interaction network identifies PP1A and CSK21 as connecting molecules between cell cycle associated genes. *Cancer Research* 70:6437-6447.
- Gayatri, G. et al. (2012) Mrhl, a long non-coding RNA, negatively regulates wnt signaling through its protein partner Ddx5/p68 in mouse spermatogonial cells. *Mol Cell. Biol.* 32(15):3140-3152.

Prof. Ravi Manjithaya Ph.D.
Associate Professor

Using chemical biology approach, we identified a small molecule inhibitor of c-abl kinase, PD180970 that could potentially clear toxic protein aggregates. PD180970 can induce autophagy, ameliorate α-synuclein-mediated toxicity, and exert anti-neuroinflammatory effects by inhibiting the release of proinflammatory cytokines. Thus, PD180970 is neuroprotective by degrading the toxic protein oligomers through induction of autophagy and subsiding the microglial activation. We also showed that the small molecule AGK2 has cytoprotective potential against α-synuclein-mediated toxicity in different model systems.

We showed that during intracellular *Salmonella typhimurium* infection, the activity of TFEB (transcription factor EB), a master regulator of autophagy and lysosome biogenesis, is suppressed by maintaining it in a phosphorylated state on the lysosomes. Furthermore, we identified a novel, antibacterial small molecule autophagy (xenophagy) modulator, acacetin, which was found to be effective in reducing intracellular Salmonella burden.

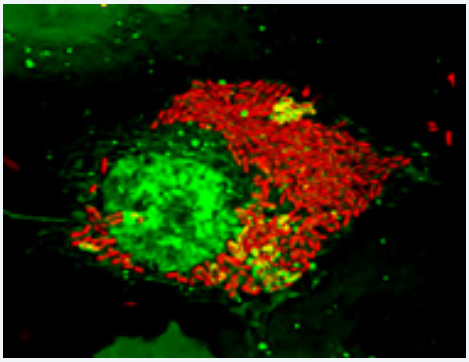


Fig. Human cells (HeLa) expressing a GFP- labelled autophagy marker infected with the typhoid-causing bacteria Salmonella (Red rods). Some of the bacteria are surrounded by green labelled xenophagosomes-vesicles that capture intracellular pathogens. The selective autophagy process that captures pathogens is known as xenophagy.

We reported a novel small molecule EACC that inhibits autophagic flux by blocking autophagosome–lysosome fusion. We showed that the effects of EACC were robust as well as reversible, and that EACC is a promising tool to study autophagosomal SNARE trafficking. We also studied the involvement of exocyst, an octameric tethering complex with known functions in tethering post-Golgi secretory vesicles to plasma membrane, in autophagy.

KEY PUBLICATIONS:

- Barve G, et al. (2018) Septins are involved at the early stages of macroautophagy in *S. cerevisiae*. *J Cell Sci* 131(4):jcs209098.
- Vats S and Manjithaya R (2019) A reversible autophagy inhibitor blocks autophagosome–lysosome fusion by preventing Stx17 loading onto autophagosomes. *Mol Biol Cell* 30:2283–2295.

EVENT ORGANISED:

- 3rd Autophagy Core Group Meeting at JNCASR on September 24, 2019.

INVITED AS SPEAKER AT:

- FluoMicro 2019 from October 2–4, 2019.
- XXV11 Annual meeting of Indian Academy of Neurosciences, from November 18–21, 2019.
- 11th International Conference on Biology of Yeast and Filamentous Fungi, from November 27–29, 2019.
- ILS Cell Biology conference and workshop, from December 9–15, 2019.
- International conference on autophagy and lysosomes, from January 16–18, 2020.

Dr. Kushagra Bansal Ph.D.
Faculty Fellow

Aire, a transcriptional regulator expressed in thymus, controls immunological tolerance by driving promiscuous expression of a large repertoire of peripheral tissue self-antigens in medullary thymic epithelial cells (mTECs). However, its molecular mechanism remains unclear. We demonstrated that cohesin complex together with mediator complex concentrates on super-enhancers in the presence of Aire. In contrast, cohesin:CTCF interactions were lost at genomic boundaries. Through series of experiments utilizing mouse with mTEC-specific deletion of one of the cohesin subunits, Stag2 and Aire knock-out mice, we revealed a novel cross-talk between Aire and the regulators of chromatin organization and highlighted the contribution of this tenet in negative selection of T cells in thymus.

With our collaborators, we also demonstrated that Aire utilizes its CARD domain to form filamentous homo-multimers *in vitro*, making it susceptible to interaction with promyelocytic leukaemia (PML) bodies, thereby revealing a new regulatory role of PML bodies in Aire function.

We also initiated two new research programs – one focusing on the relationship between regulatory factors that control superstructure of genetic material and behaviour of immune cells, and the other concentrating on the molecular mechanism(s) involved in chromatin loading and localization of Aire at super-enhancers.

KEY PUBLICATIONS:

- Bansal K, et al. (2017) The transcriptional regulator Aire binds to and activates super-enhancers. *Nat Immunol* 18(3):263–273.
- Yang S, et al. (2013) Aire's plant homeodomain (PHD)-2 is critical for induction of immunological tolerance. *Proc Natl Acad Sci USA* 110(5):1833–1838.

EVENT ORGANISED:

- Flow cytometry workshop at JNCASR, Bengaluru, in June 2019 and February 2020.

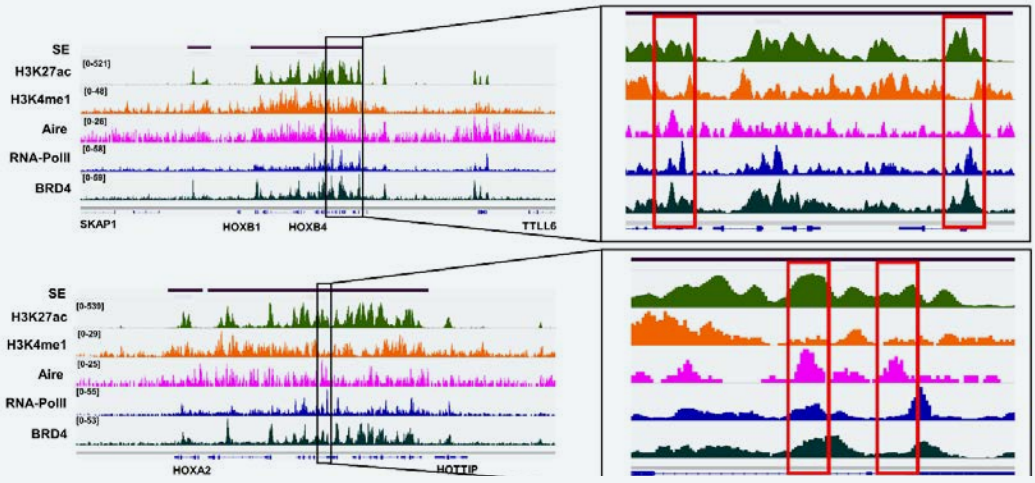


Fig. Normalized ChIP-seq profiles for indicated proteins at exemplar super-enhancers in HEK293T cells. Zoomed-in view with red boxes displays genomic regions with highest density for Aire within super-enhancer. SE, super-enhancers.

UNIT MEMBERS

Professor and Chairperson
Prof. Maneesha S. Inamdar

Professors
Prof. Anuranjan Anand
Prof. Hemalatha Balaram
Prof. Kaustuv Sanyal
Prof. Ranga Udaykumar
Prof. Tapas Kumar Kundu (On Lien w.e.f. 08.08.18)

Honorary Professor & SERB YOS-Chair Professor
Prof. M.R. Satyanarayana Rao

Associate Professor
Prof. Ravi Manjithaya

Faculty Fellow
Dr. Kushagra Bansal

Sr. Technical Officer (Animal Facility)
Dr. Prakash R.G.

Technical Officer Gr II
Suma B.S.

Technical Assistant (Instrumentation)
Mohan V.

Scientist-B
Ashwathy Narayanan

Women Scientist Scheme- A
Shweta Panchal

Teacher's Research Associate
Dhanalakshmi H.

Research Associates
Suchismita Dey, Saloni Sinha, M. Jayaprakash Rao, Santosh Shivakumaraswamy, Gokulanth M

Research Associate II
Narendra Nala

DBT- Research Associates
V Shalini, Sangeeta Dutta, Keerti, Sreedevi P, C.N. Rahul, Md. Hashim Reza, Mukesh Kumar Chaurasia

R & D Assistants
Swati Singh, Harshit Kumar Prajapati, Anish D'Silva, S Deepak, Afzal Amanullah, Archit Singh, Vijeta Jaiswal, Sameesh Ravindra Kher, Sundar Ram S, Anjhana C.R., Aishvaryaa Prabhu

R&D Assistant-Mass Spectrometry Operator
Chitralekha Sen Roy

Project Assistants
Sukanya Majumdar, Girija J Subodhi, Dharaneeswar Reddy M

Junior Research Fellows
Tejal R. Gujarathi, Tharun Selvam Mahendran, Sajan C Achi, Miti Mathur, Patel Tejas Mahendra, Rima Singha, Ila Joshi, Dongre Aparna Vilas, Haider Ali, Kavita Mehta, Subrata Mandal

Senior Research Fellows
Aksah Sam, Diana Rodrigues

Project Technician - II
Sunil Kumar R

Project Technical Officer
Kruthi H.T.

Laboratory Managers
Swathi L.R., Ligy Thomas

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

Helpers (Animal Facility)
Ambarisha G, Muniraju M

UNIT MEMBERS

Total Publications
45

New Projects
11

Amount received during 2019-2020
₹3.81 Cr

On going Projects
27

Amount received during 2019-2020
₹30.83Cr

STUDENTS ADMITTED

14

Ph.D.: 8 students

A. K. Sultana Parveen
Prerana M
Bharat
Swarnima Mishra
Amit Kumar
Nazia
Ankita Chattopadhyay
Aarti Pant

Int. Ph.D.: 6 students

Harshit Arya
Vanshika Sood
Jayendra Singh
Amrutha A S
Vaishali Bisht
Arghakusum Das

STUDENTS GRADUATED

16

Ph.D.: 9 students

Sweta Sikder
Shukla Aprit Prakashkumar
Sutanuka Chakraborty
Shalini Roy Choudhury
Arnab Bose
Lakshmi Sreekumar
Debosree Pal
Divyesh Joshi
Santosh S.

M.S. in Biological Science: 7 students

Chhavi Saini
Irine Maria Abraham
Rashi Aggarwal
Kuladeep Das
Ankit Sharma
Saheli Roy
Shubham Singh

UNIT AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. Hemalatha Balaram

- Received the SERB J.C. Bose Fellowship 2019.

Prof. Kaustuv Sanyal

- Extension of Tata Innovation Fellowship supported by Dept. of Biotechnology, Government of India.
- Visiting Professor, Osaka University, Osaka, Japan (04/2020-03/2021).
- Travel Award, Chromopalooza, Vienna BioCenter, Vienna, Austria.
- Travel Award, EMBO (Barcelona, Spain).

Dr. Kushagra Bansal

- Awarded the Wellcome Trust/DBT India Alliance Intermediate Fellowship under basic biomedical research category.

Prof. Maneesha S. Inamdar

- Received the SERB J.C. Bose Fellowship 2019.
- Awarded the Prof. CNR Rao Oration Award for the lecture “Swalpa adjust maadi: Tweaking longevity pathways in stem cells” given on August 13, 2019.

HONORS:

- Invited to attend Leadership for Academicians Program (LEAP) at IIT Bombay during Feb 24, 2019 - Mar 9, 2019 and at NTU, Singapore from March 17-23, 2019.

INTERNATIONAL RESPONSIBILITIES:

- 2019–current: Member, Global Forum on Bioethics in Research (GFBR). http://www.gfbr.global/about-the-gfbr/.
- 2019–current: Member, World Health Organization (WHO) expert advisory committee on Developing global standards for governance and oversight of Human Genome editing. https://www.who.int/ethics/topics/human-genome-editing/committee-members/en/.

Prof. Ravi Manjithaya

- Joint recipient of the CDRI Award 2020 for excellence in Drug Research in Life Science category.

Prof. Tapas Kumar Kundu

- Shri Om Prakash Bhasin Award 2019 in the field of Health & Medical Sciences awarded by Shri Om Prakash Bhasin Foundation.

Awards received by STUDENTS

Arun Panchapakesan won the best poster award at the Combat HIV conference held at the School of Life Sciences, University of Hyderabad in January 2019. Research Supervisor: Prof. Ranga Udayakumar.

Disha Bhange's poster got selected for an oral presentation at the Combat HIV conference held at the School of Life Sciences, University of Hyderabad in January 2019. Research Supervisor: Prof. Ranga Udayakumar.

Md. Hashim Reza was awarded the DBT-RA-I fellowship. Research Supervisor: Prof. Kaustuv Sanyal.

Md. Hashim Reza received financial support from SERB-NPDF to attend the "30th Fungal Genetics Conference" held during March 12–17, 2019 at Pacific Grove, California, USA. He also received the DBT-CTEP travel grant to attend the "8th International Rice Blast Conference" held at Chengdu, China from May 27–31, 2019. Research Supervisor: Prof. Kaustuv Sanyal.

Mukesh Kumar Chaurasia received DBT-Research Associate Fellowship on the project entitled 'Deciphering the molecular mechanism of immunological tolerance'. Research Supervisor: Dr. Kushagra Bansal.

Neha Varshney was awarded Research Associate Fellowship from CSIR. Research Supervisor: Prof. Kaustuv Sanyal.

Ruchika Kumari received the Best Poster Award at the XIth International Conference on Biology of Yeasts and Filamentous Fungi held at the University of Hyderabad, Hyderabad. Research Supervisor: Dr. Ravi Manjithaya.

Shreyas Sridhar received the EMBO travel grant to attend the "Chromosome segregation and Aneuploidy meeting" at Cascais, Portugal. Research Supervisor: Prof. Kaustuv Sanyal.

Shweta Panchal was awarded DST-WOS-A. Research Supervisor: Prof. Kaustuv Sanyal.

Sreedevi P. received the Best Poster Award at the International Conference on Autophagy and Lysosome held at the Indian Institute of Science, Bengaluru. Research Supervisor: Dr. Ravi Manjithaya.

Swetha Sikder won the Best Thesis Medal in Biological sciences (2018-2019) in JNCASR, Bangalore, India. Research Supervisor: Prof. Tapas Kumar Kundu.

Vikas Yadav received the NASI Young Scientist award and the INSA Young Scientist award. Research Supervisor: Prof. Kaustuv Sanyal.

Yanda Premakumar was awarded the CSIR travel grant to attend the 60th Annual Drosophila Research Conference, Houston Texas, in March 2019. Research Supervisor: Prof. Maneesha Inamader.


New Chemistry Unit
NCU

NEW CHEMISTRY UNIT (NCU)

NCU follows an interdisciplinary approach and conducts research at the interface of Chemical Biology, Chemical Science, and Materials Science. NCU has developed state of the art experimental facilities for complete characterization and analysis of various materials, and actively collaborates with various national and international research centres. NCU has emerged as one of the leading chemistry departments of the country, and has excelled in translational research, with faculty member-initiated start-ups, along with many national and international patents.

RESEARCH AREAS

NCU researches in the following areas:

- Solid state and materials chemistry
- Organic synthesis and biomaterials
- Alzheimer's disease
- Peptide chemistry, antibiotics, and antimicrobial peptide mimics
- Supramolecular chemistry, patternable polymers, and conducting polymers
- Super resolution imaging, DNA nano-technology, and semiconducting nanomaterials
- Multifunctional metal-organic hybrids and medicinal chemistry
- Chemical neuroscience and theoretical chemistry
- Carbon and oxide based materials; catalysis and chemistry of carbon nanostructures
- Water splitting, fuel cell, CO_2 reduction, Li/Na batteries, and thermoelectrics

RESEARCH HIGHLIGHTS

- Superior hydrogen evolution reaction (HER) was achieved by functionalizing phosphorene with indium(III) chloride, tris(pentafluorophenyl) borane and a benzyl group.
- Novel dendrons as efficient surface-enhanced Raman spectroscopy (SERS) analytes were synthesized, and these showed enhanced detection and extend the scope for SERS applicability.
- A multichannel DNA nanosensor suitable for rapid and high-throughput diagnosis was designed.
- The nature of the transient species mediating the energy transfer to spin-forbidden Mn d states in II–VI semiconductor quantum dots was demonstrated.
- A novel approach for the bottom-up synthesis of 2D- and 3D-sodium iron fluoride frameworks was demonstrated.
- Switchable coumarin-morpholine conjugates as off-on fluorescence probes were synthesized for the detection of elevated levels of hypochlorous acid associated with Alzheimer's disease.
- Aza-annulation of novel 1,2,3,4-tetrahydro-β-carboline derived enaminones and nitroenamines was investigated.
- Chemical fuel-driven self-assemblies were shown to be receptive to multiple molecular cues, allowing precise control over the assembly and disassembly kinetics.
- Effective antibacterial polymers based on polymer-silver nanocomposites as well as water-insoluble cationic hydrophobic polymers were developed, with potential applications in coating of biomedical devices.
- The amorphous limit of κ_{lat} in SnTe was achieved via engineering configurational and vibrational entropies in pseudoternary $(SnTe)_{1-2x}(SnSe)_x(SnS)_x$.
- Palladesite ($Pd_{17}Se_{15}$) via a one pot colloidal method was synthesized and this material exhibited the highest stability towards oxygen reduction reaction, reported till date.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. C.N.R. Rao Bharat Ratna, D.Sc., Ph.D., FRS, Hon. FRSC
Linus Pauling Research Professor and Chair, NCU

Water splitting by photochemical and electrochemical reactions is an important area of research related to renewable energy. This year, we reported good HER activity in exfoliated solid solutions of $MoS_xSe_{(2-x)}$/ $MoSe_xTe_{(2-x)}$ both photo and electrocatalytically. We also investigated the superior HER activity for a number of nanocomposites, including phosphorene-MoS_2 and phosphorene-$MoSe_2$ composites and electrostatic interaction-based nanocomposites of PDDA-functionalised Reduced Graphene Oxide (RGO) or BCN with MoS_2 and $MoSe_2$. Additionally, we investigated the role of interlayer separation of covalently cross-linked 2D nanosheets and its effect on photochemical catalytic activity of hydrogen evolution. We studied photoelectrochemical water splitting of different manganese oxides electrodeposited on $BiVO_4$ photoanode.

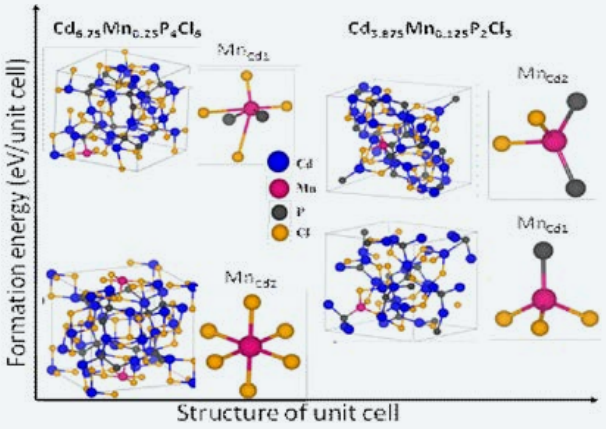


Fig. Mn^{2+} substitution at two different Cd-sites in $Cd_4P_2Cl_3$ and $Cd_7P_4Cl_6$ was studied. In $Cd_7P_4Cl_6$, Mn^{2+} substitution at the octahedral Cd-site (Mn_{Cd2}) (left panel bottom figure) is more favoured than substitution at distorted octahedral Cd-site (Mn_{Cd1}) (left panel top figure). Similarly, In $Cd_4P_2Cl_3$, Mn^{2+} prefers the tetrahedral Cd-site (Mn_{Cd1}) (right panel bottom figure) over the distorted tetrahedral Cd-site (Mn_{Cd2}) (right panel top figure). Broken crystal field and inversion symmetry of distorted octahedral Mn_{Cd1} (in $Cd_7P_4Cl_6$) and distorted tetrahedral Mn_{Cd2} (in $Cd_4P_2Cl_3$) are responsible for higher formation energy in these configurations.

We studied the relatively new classes of 2D materials PbFCl and BaFCl for their supercapacitor performance and metal phosphochalcogenides (MPX_3) for their good photocatalytic HER properties. We also studied the low thermal conductivity in borocarbonitride nanosheets and designed a chemical route to synthesize twisted graphene, graphene oxide (GO), and boron nitride (BN).

Another active area of research in the lab is aliovalent anion substitution. We reported variation in electronic and optical properties of cadmium phosphosulphides of different compositions and investigated their superior photo(electro) chemical HER activity. We also studied manganese substitution in these compounds and corresponding changes in carrier dynamics and related photochemical activity and stability. We investigated the selective fabrication of β-phase of nickel sulphide (NiS) and vanadium oxide (VO_x) thin films via atomic layer deposition technique.

KEY PUBLICATIONS:

- CNR Rao, et al. (2009) Graphene: the new two-dimensional nanomaterial. *Angew Chem Int* 48:7752–7777.
- CNR Rao, et al. (2004) Metal carboxylates with open architectures. *Angew Chem Int* 43:1466–1496.

EVENTS ORGANISED:

- Research Conference on Chemical Frontiers (CFM2019) held at Goa from August 22–25, 2019.
- JNCASR-FCBS Programme and Workshop for Chemistry Students and Teachers from October 31–November 1, 2019.
- JNC Research Conference on Chemistry of Materials, held at Trivandrum from September 30–October 1, 2019.

contd. in next page

Prof. C.N.R. Rao

... continued.

INVITED AS SPEAKER AT:

- International Symposium on Advances in Electrochemical Science and Technology held at Chennai on January 8, 2019 (Plenary lecture).
- Science Outreach Programme in School Chandan, at Laxmeshwar from January 22–24, 2019.
- Wiley Global Innovation Conclave, held at Bengaluru on January 31, 2019.
- International Workshop on Advanced Materials-2019, held at RAK-CAM, UAE from February 23–26, 2019.
- Symposium on Frontiers in Sciences: Past, Present and Future in Physical, Chemical and Earth Sciences, held at Banaras Hindu University from March 8–12 2019.
- India Higher Education Summit-2019 – Innovation in Education for a Competent Industry held at Mysore on March 15, 2019.
- Nano India 2019, held at M.G. University, Kottayam on April 26, 2019.
- Science Outreach Programme – International Year of Periodic Table of Chemical Elements - 2019, held at Bengaluru on May 17, 2019.
- 10th International Conference on Materials for Advanced Technologies, Von Hippel Award Symposium, held at Singapore from June 23–28, 2019.
- First DBT-BIRAC Leadership Dialogue Series, held at Bengaluru on July 18, 2019.
- Platinum Jubilee Lecture held at IICT, Hyderabad on August 5, 2019.
- Public Lecture at the NIAS-DST Training Programme on Science, Technology and Innovation Policy, on August 26, 2019.
- The 2019 Professor M.G.K. Menon Memorial Lecture held at New Delhi on August 28, 2019.
- Centenary celebrations programme of Karnataka High School Past Students Association, Dharwad and Celebration of the International Year of the Periodic Table IYPT-2019 organized by the Karnataka Higher Education Academy, Dharwad from September 4–5, 2019.
- DAE Theme Meeting Commemorating "150 Glorious Years of Periodic Table" held at Mumbai on November 27, 2019.
- Public Lecture in the INSA Annual Meeting held at Goa on December 16, 2019.
- SAMat Annual Retreat: A Brain Storming Meeting at Chikmagalur on November 17–18, 2019.

Prof. Subi Jacob George Ph.D., FASc.;
Associate Professor and Associate Chair, NCU

We successfully validated preparation of orthogonal self-sorted and coassembled block and alternating supramolecular polymers by demonstrating a two-component supramolecular co-polymerization with sequence and microstructural (alternate, random, and block) control, using fluorescent core-substituted NDIs and exploiting thermodynamic and kinetic routes in the pathway complexity of self-assembly of the constitutive monomers.

We synthesized temporal supramolecular materials such as self-erasable ink, self-regenerating gel, and transient reconfigurable material with tunable signaling property by using redox as a tool.

We uncovered an unprecedented ambient triplet-mediated emission in core-substituted naphthalene diimide cNDI derivatives, via delayed fluorescence and room temperature phosphorescence, enabling new design insights into the triplet harvesting of cNDIs.

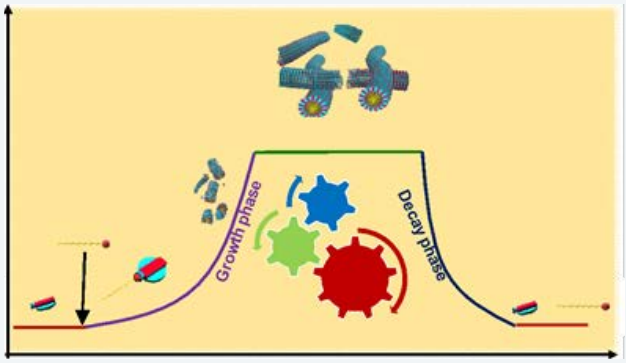


Fig. Out-of-equilibrium systems are ubiquitous in nature. Here, our approach was temporal control over supramolecular organization using a bio-inspired, chemical fuel-driven approach to precisely control the growth, steady-state, and decay of self-assembly and aim towards controlling the novel functions associated with the steady-state assembly that features a unique class of living supramolecular polymerization and transient assemblies. Further, in our biomimetic approach, we deployed two orthogonal enzymatic reaction networks to create adaptive, autonomous, and like-life out-of-equilibrium supramolecular materials.

We demonstrated strategies through which a chemical fuel-driven self-assembly could be made receptive to multiple molecular cues such that the inherent growth and decay characteristics are programmed into the ensemble.

Supramolecular hybrid co-assembly between a brominated aromatic carbonyl derivative (BrPhS) and laponite clay particles (LP) was shown to exhibit remarkable triplet stabilization and room temperature phosphorescence (RTP) in aqueous solution and amorphous thin films.

We reported the fabrication of a planar supercapacitor with an operating voltage window that was the highest reported to date. We investigated supramolecular layered heterostructures formed by nanosheets of MoS_2 with BC_7N, g-C_3N_4 and graphene that showed good visible-light-driven hydrogen evolution reaction activity as well as other properties.

KEY PUBLICATIONS:

- Sarkar A, et al. (2020) Self-sorted, random, and block supramolecular copolymers via sequence controlled, multicomponent self-assembly. *J Am Chem Soc* 142:7606–7617.
- Dhiman S, et al. (2017) Adenosine-phosphate-fueled, temporally programmed supramolecular polymers with multiple transient states. *J Am Chem Soc* 139:16568–16575.

EVENTS ORGANIZED:

- The 15th JNCASR Research Conference, Chemistry of Materials-2019, held at Kovalam, Kerala from September 30-October 02, 2019.
- NCU@10 Mini Symposium held at JNCASR, Bengaluru on January 10, 2020.
- JNCASR-SNU Joint Symposium on Emerging Materials held at JNCASR, Bengaluru from November 8–9, 2019.

INVITED AS SPEAKER AT:

- Meijer Lab Reunion Symposium held at the Technology University Eindhoven, The Netherlands from February 27–28, 2020.
- 12th Annual International Workshop on Advanced Materials (IWAM-2020), held at Ras Al Khaimah, UAE, from February 23–25, 2020.
- 1st Chemical Science In India: Leaders In The Field Symposium, held at IISER Kolkata from October 18–20, 2019.
- Supra Bio 2019, held at Barcelona, Spain from May 15–17, 2019 (Plenary speaker).
- Diamond Jubilee Symposium, held at IIT Bombay from February 25–28, 2019.

Prof. H. Ila Ph.D., FNA, FASc.
Hindustan Lever Research Professor

Aza-annulation of novel 1,2,3,4-tetrahydro-β-carboline derived enaminones and nitroenamines with various 1,2- and 1,3-bis electrophiles, such as oxalyl chloride, maleic anhydride, 1,4-benzoquinone, 3-bromopropionyl chloride, itaconic anhydride, and imines (from formaldehyde and primary amines) was investigated, leading to a variety of β-carboline-fused five- and six-membered heterocycles. These are core structures of several naturally occurring indole alkaloids with diverse biological activity.

A novel unprecedented transition metal free, base mediated intramolecular C-S coupling leading to new synthesis of benzothiazoles was developed.

KEY PUBLICATIONS:

- Ila H and Junjappa H (2013) Molecular diversity through novel organosulfur synthons: versatile template for heterocycle synthesis. *Chimia (Aarau)* 67:17–22.
- Ila H et al. (2001) The Junjappa-Ila heteroaromatic annulation: a new general α-oxoketene dithioacetals mediated inverse method for the synthesis of benzo/condensed heterocycles and related heteroaromatization processes. *in Progress in Heterocyclic Chemistry, Gribble, G. W.; Gilchrist, T. l. Eds.*: 13: Chapt. 1, p. 1–24.

INVITED AS SPEAKER AT:

- Eurasian Conference on Heterocyclic Chemistry (EAHMC-10) at Milano—Marittima-Cervia, Italy, from September 15–19, 2019 (Plenary Speaker).
- CRSI Life Time Achievement Lecture, at IIT Kanpur from July 18–20, 2020.
- Recent Trend in Catalysis (RTC-2020) at NIT, Calicut, from February 26–29, 2020 (Plenary Lecture).
- 107 Indian Science Congress at GKVK, Bengaluru on January 6, 2020 (Plenary Lecture).
- Invited Session Chair at International Conference on Organometallics and Catalysis (ICOC-2020) at Holiday Inn, Goa from March 7–10, 2020.

Prof. Govindaraju T. Ph.D.
Associate Professor

We designed and characterized switchable coumarin-morpholine conjugates as off-on fluorescence probes for the specific detection of elevated levels of hypochlorous acid, which is produced and proximally localized within amyloid plaques in Alzheimer's disease.

We carried out a rational design, synthesis, and detailed study to identify a small molecule multifunctional modulator (MFM) that chelates and sequesters metal ions, disrupts their redox cycles, prevents excessive ROS production and oxidative stress, ameliorates oxidative DNA damage and mitochondrial dysfunction, and modulates Nrf2 protein signalling under oxidative stress conditions by eliminating the toxic stress elements. The MFM was found to inhibit metal-dependent and -independent Aβ aggregation and could be a suitable candidate to inhibit Aβ-induced neuronal toxicity in Alzheimer's disease.

We identified 2-phosphoglycolate and 2-phospho-L-lactate as the relevant physiological substrates of Plasmodium berghei phosphoglycolate phosphatase (PGP), and further experiments indicated that PGP could be a therapeutic target for treatment of malaria.

Prof. Jayanta Haldar Ph.D.

Associate Professor

Over the past year, we have immensely contributed to the field of novel antibacterial agents through the development of new, amphiphilic, membrane-targeting agents which destabilize the bacterial membrane, as well as interact with bacterial cell wall, leading to selective bacterial killing. We have developed membrane-active small- and macro-molecules which demonstrate excellent activity against multidrug resistant pathogenic bacteria and fungi with no detectable resistance development by the microbes. Some of our designs have been patented and are being tested for their antiviral effects too. One of our designs involving amino acid-conjugated polymers has displayed particular antibacterial activity against the dangerous multi drug-resistant Gram-negative pathogen *A. baumannii.*

We developed semisynthetic glycopeptide antibiotics, which have potent activity against vancomycin-resistant Gram-positive pathogens and the Gram-negative drug-resistant *A. baumannii*. We also demonstrated the effectivity of certain polymeric adjuvants that can be used for repurposing antibiotics such as rifampicin or re-sensitize tetracyclines against drug-resistant Gram-negative bacteria.

We developed antibacterial and antifungal paints that can be spray-coated on various surfaces to prevent the easy spread of infections. We also developed effective antimicrobial surface coatings that can be coated on a variety of surfaces such as cotton and plastic to render them antimicrobial. One such coating has displayed potent activity against the infectious influenza virus.

We made commendable advances in the treatment of eye infections through development of drug-loaded injectable hydrogels.

KEY PUBLICATIONS:

- Yarlagadda V et al. (2016) A vancomycin derivative with a pyrophosphate-binding group: a strategy to combat vancomycin-resistant bacteria. *Angew Chem Int Ed Engl* 55:7836–7840.
- Sarkar P et al. (2020) Vancomycin derivative inactivates carbapenem-resistant Acinetobacter baumannii and induces autophagy. *ACS Chem Biol* 15:884–889

INVITED AS SPEAKER AT:

- ACS Spring National Meeting at Orlando, FL, from March 31–April 4, 2019.
- UK-India Meet on Emerging Innovations in AMR, held at Bengaluru on June 7, 2019.
- The Université de Strasbourg, France on June 25, 2019.
- The Max Planck Institute of Colloids and Interfaces, Potsdam on June 20, 2019.

Prof. Kanishka Biswas Ph.D.

Associate Professor

Pristine SnTe exhibits poor thermoelectric (TE) performance primarily because of high lattice thermal conductivity, κ_{lat}. We achieved the amorphous limit of κ_{lat} via engineering configurational and vibrational entropies in pseudoternary $(SnTe)_{1-2x}(SnSe)_x(SnS)x$. The Seebeck coefficient also improved via the synergistic effect of resonant doping (In) and valence band convergence (Ag), lead to a high TE figure of merit, zT, of ~1.3 at 854 K..

We demonstrated the synergistic effects of In and Bi co-doping in GeTe, resulting in a high zT of ~2.1 at 723 K and an extremely high η of ~12.3% in single-leg TE generator for the temperature difference of 445 K. This co-doping approach with synergistic effects paves the way for the new generation of GeTe thermoelectrics.

We demonstrated high zT of ~2.1 at 873 K in 2D nanoplates of Ge-doped SnSe synthesized by a simple hydrothermal route followed by spark plasma sintering. (SPS)

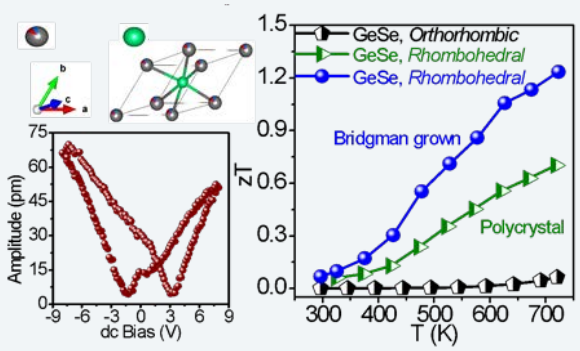


Fig. (a) Rhombohedral (space group: R3m) crystal structure of $(GeSe)_{0.9}(AgBiSe_2)_{0.1}$. (b) Temperature variation zT of orthorhombic pristine GeSe, rhombohedral polycrystal $(GeSe)_{0.9}(AgBiSe_2)_{0.1}$ and Bridgman grown rhombohedral $(GeSe)_{0.9}(AgBiSe_2)_{0.1}$. (c) Amplitude of switching spectroscopy PFM (SS-PFM) signal obtained from rhombohedral $(GeSe)_{0.9}(AgBiSe_2)_{0.1}$.

"We demonstrated a single-pot solution-based transformation of 3D $CsPbBr_3$ to 2D $CsPb_2Br_5$ nanosheets. We investigated the origin of its luminescence properties by detailed experiments and density functional theory calculations. We synthesized thallium selenide (TlSe), which comprises intertwined stiff and weakly bonded substructures and exhibits intrinsically ultralow lattice thermal conductivity (κ_L) of 0.62–0.4 W/mK in the range 295–525 K.

KEY PUBLICATIONS:

- Kundu K et al. (2020) Synthesis and localized photoluminescence blinking of lead-free 2D nanostructures of Cs3Bi2I6Cl3 perovskite. *Angew Chem Int Ed.* 59(31):13093-13100.
- Sarkar D, et al. (2020) Ferroelectric instability induced ultralow thermal conductivity and high thermoelectric performance in rhombohedral p-type GeSe crystal. *J Am Chem Soc.* 142(28): 12237–12244.

INVITED AS SPEAKER AT:

- Editorial Board Meeting, ACS Applied Energy Materials, ACS Meeting, held at San Diego, USA in August 2019.
- Thermoelectric Symposium, held at ICMAT, Singapore in June 2019.
- MRS Spring Meeting, held at Phoenix, USA in April 2019.
- 8th Indo-Japan seminar "Designing Emergent Materials", held at The University of Tokyo, Hongo campus, Japan in January 2019.

Prof. Ranjani Viswanatha Ph.D.

Associate Professor (Associate Faculty, ICMS)

Mn doping in II-VI semiconductors has been extensively studied. We explored various phenomena of energy and charge transfer mechanisms to better understand spin driven optoelectronics. We showed the presence of transient Mn^{3+} state using materials with band gaps in resonance with the energy of the Mn emission to understand the nature of the absorbing, transient, and emitting species. The electron back-transfer from Mn^{2+} to the host conduction band in the prototypical example of Mn-doped $CsPbX_3$ (X = Cl, Br) NCs through vibrational coupling was coined as the "vibrationally assisted delayed fluorescence" (VADF).

We addressed challenges associated with dual doping of semiconductor quantum dots (QDs) within the constraints of one host under similar conditions of temperature, time, and chemical parameters such as solubility and reactivity using CoPt-doped CdS QDs as a model system.

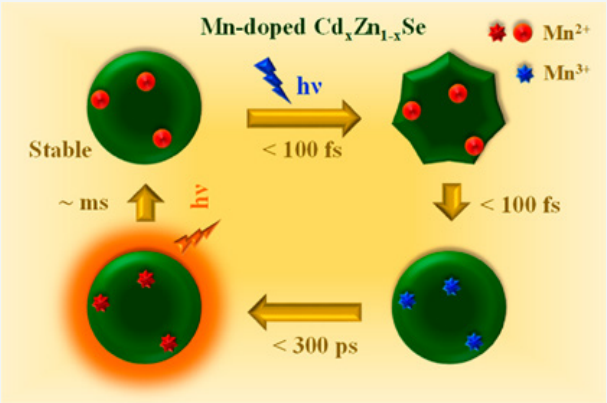


Fig. Mechanism of Mn emission in II-VI semiconductors passing through a transient state with a lifetime of ~*300 ps.*

Similarly, the oxidation state of Cu has long been a challenge in doped quantum dots. We have used single molecule spectroscopy to image individual Cu doped quantum dots and have provided an ultimate proof to the oxidation state of Cu ending a long-standing debate in literature.

We demonstrated a two-step synthesis of $CoO/CoFe_2O_4$ core–shell QDs and their characterization to study the effect of magnetic interaction at the interface. We also synthesized Sn and Pb-based alloy perovskite nanocrystals by direct synthesis method, taking a mixture of Pb and Sn precursors in the desired ratio leading to QDs of $CsPb_{1-x}Sn_xBr_yI_{3-y}$ with successful Sn incorporation into the host lattice.

KEY PUBLICATIONS:

- Saha A and Viswanatha R (2017) Magnetism at the interface of magnetic oxide and nonmagnetic semiconductor quantum dots. *ACS Nano* 11(3):3347–3354.
- Pradeep KR et al. (2020) Harvesting delayed fluorescence in perovskite nanocrystals using spin-forbidden Mn d states. *ACS Energy Lett* 5(2):353–359.

INVITED AS SPEAKER AT:

- CRSI Bronze medal Lecture, held at VIT, Vellore.
- Winter school 2019, held at JNCASR, Bengaluru from December 2–6, 2019.

Prof. Sebastian Chirambatte Peter Ph.D.

Associate Professor

We discovered novel catalysts that can efficiently convert CO_2 to methanol. The catalysts can convert 300 kg CO_2/day to methanol with an estimated cost of 18-20 INR/litre, which is much cheaper than the market price of ~30 INR/litre of methanol in India and the global rate of ~35 INR/litre.

We reported a comprehensive approach to access nanocrystalline Pd_xM_y (M = Cu, Zn, Ga, Ge, Sn, Pb, Cd, In) intermetallics for industrial benzylamine oxidation. We also discovered palladesite ($Pd_{17}Se_{15}$) mineral that exhibits exceptionally high stability towards the oxygen reduction reaction several times higher than that of many of the best reported materials. We demonstrated the role of PdIn as well-dispersed intermetallic nanoparticles (IMNPs) for the semihydrogenation of phenylacetylene selectively to styrene at ambient conditions.

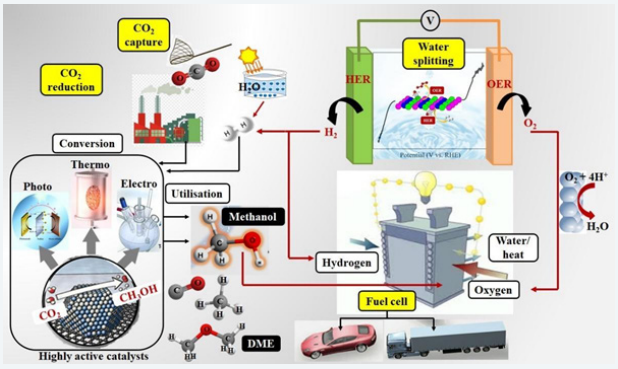


Fig. Translation of fundamental research in catalytic chemistry to recycle carbon into a technological solution to tackle the grand-challenge global problem of climate change and energy. Schematic shows the development an economic, sustainable and scalable solution that reduces the most dominant green house gas, CO_2, into useful product (methanol, CO, methane, DME), which can be used as a fuel in energy sector including fuel cell. The reductant H_2 is produced by water splitting.

We previously developed Pd_2Ge as a highly active and stable catalyst for ethanol electrooxidation because of its ordered structure and the presence of Ge. Recently, we used it as a platform to further enhance its efficiency by Ni substitution ($Pd_{2-x}Ni_xGe$). A kinetic phase Ni_3In is stabilized in under operando conditions for the conversion of CO_2 to methanol.

We developed transition metal-based pnictides for energy conversion and storage. CoSb was reported as a cathode material for sodium ion batteries. Mn-substituted Ni_2P was developed for efficient electrochemical water splitting. We discovered $BiVO_4$-WO_3 heterostructures that can effectively convert CO_2 to methane under visible light. Lattice charge distribution concept was exploited to design materials for the electrochemical conversion of CO_2 to desired product.

KEY PUBLICATIONS:

- Roy S, et al. (2018) Thermochemical CO_2 hydrogenation to single carbon products: scientific and technological challenges. *ACS Energy Lett* 3:1938–1966.
- Sarma SC, et al. (2018) "Inverse strain effect in atomic scale" – Enhanced hydrogen evolution activity and durability in Cu substituted palladseite. *ACS Energy Lett.* 3:3008–3014.

INVITED AS SPEAKER AT:

- ADB Asia Clean Energy Forum 2019, held at Manila, Philippines from June 17–21, 2019.
- ICMAT 2019, held at Marina Bay Sands, Singapore from June 23–29, 2019.
- European Methanol Summit 2019, held at Dusseldorf, Germany from November 13–14, 2019.
- E-Summit'20, held at IIT Bombay from February 1–2, 2020.
- 11th Bengaluru India Nano, held at The Lalit Ashok, Bengaluru from March 2–4, 2020.

Prof. Sridhar Rajaram Ph.D.

Associate Professor (jointly with CPMU)

We synthesized dendrons with thiophenol groups on their periphery and tested them as a Surface-Enhanced Raman Spectroscopy (SERS) analytes, with simple gold nanoparticles as a substrate. A 10^2 fold enhancement in detection was observed upon going from a mono-thiophenol (MT) to a tetra-thiophenol (TT). Dendronic Raman markers increased the probability of SERS occurrence at lower concentrations when compared to a single Raman active molecule. This strategy extends the applicability of SERS, as these analyte molecules can be just mixed or drop-casted on any kind of a SERS substrate.

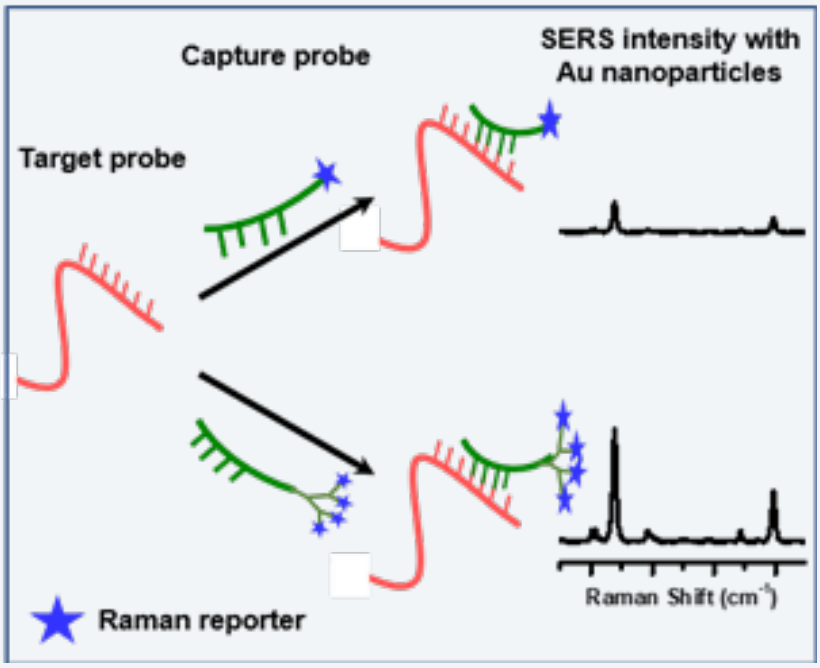


Fig. Schematic describing the enhancement of intensity using dendronic Raman Markers.

KEY PUBLICATIONS:

- Rajaram S, et al. (2012) Nonplanar–perylene diimides as potential alternatives to fullerenes in organic solar cells. *J Phys Chem Lett* 3:2405.
- Jain P, et al. (2019) Designing dendronic-Raman markers for sensitive detection using surface-enhanced Raman spectroscopy. *RSC Adv* 9:28222–28227.

Dr. Bani Kanta Sarma Ph.D.
Faculty Fellow

I joined JNCASR on October 14, 2019 and am in the process of setting up my new lab. COVID-19 pandemic has affected the process significantly. However, I still have 3 Ph.D. students at my previous institution Shiv Nadar University (SNU), and our ongoing work at SNU is described below.

We successfully demonstrated the solid-phase synthesis of a novel hybrid 2,5-diketopiperazine scaffold using acylhydrazide, carbazate, semicarbazide, amino acid, and primary amine submonomers [*J. Org. Chem.* 2020, 85, 2927-2937].

We showed that unusual N(amide)×××C-X noncovalent carbon bonding interactions stabilize the trans-cis (t-c) amide bond rotamers of N-methyl-N,N'-diacylhydrazines over the expected *trans-trans (t-t)* rotamers [*Chem. Commun.* 2020, 56, 4874-4877].

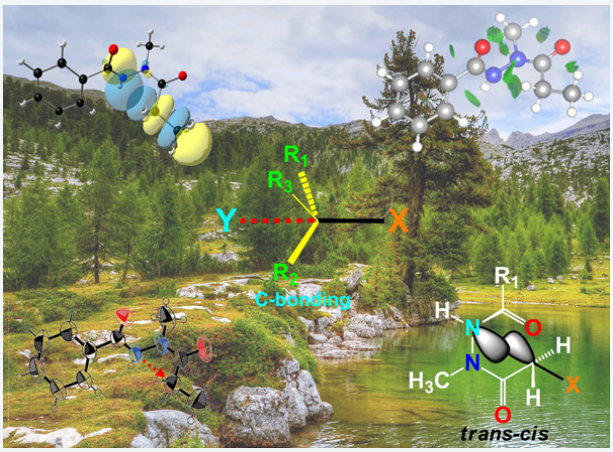


Fig. In recent years, some X-ray structural and computational evidence have emerged for non-covalent carbon bonding (C-bond). From the conformational analyses of strategically designed N-methyl-N,N'-diacylhydrazines, we discovered that the C-bond can be modulated to control the conformational preferences of small molecules in solution. We showed that unusual N(amide)×××C-X noncovalent carbon bonding interactions stabilize the *trans-cis (t-c)* amide bond rotamers of N-methyl-N,N'-diacylhydrazines over the expected *trans-trans (t-t)* rotamers.

We studied the conformational properties of many N,N'-diacylhydrazines using gas phase theoretical calculations, solution phase 1D and 2D NMR spectroscopy, and solid-state X-ray crystallography. We also studied the conformational properties of azapeptoid and peptoid derived aryl-, N-alkoxy- and N-hydroxyl amines to understand the origin of stabilization of trans amide bonds in these peptoid molecules. We discovered that N-methyl-azapeptides are stabilized by an unusual N(amide)….H-N(amide) hydrogen bonding. We also discovered that polyproline II (PPII) conformation is stabilized by a unique cascade of reciprocal carbonyl-carbonyl (CO···CO) interactions among the backbone CO groups, which extend over the whole PPII helical region.

KEY PUBLICATIONS:

- Rahim A, et al. (2017) Reciprocal carbonyl-carbonyl interactions in small molecules and proteins. *Nat Commun* 8(1):78.
- Sahariah B and Sarma BK (2019) Relative orientation of the carbonyl groups determines the nature of orbital interactions in carbonyl-carbonyl short contacts. *Chem Sci* 10:909–917.

INVITED AS SPEAKER AT:

- The workshop on hydrogen bonding, held at Faculty Hall and MRC Auditorium from January 9–10, 2020.

Dr. Premkumar Senguttuvan Ph.D.

Faculty Fellow (jointly with ICMS)

We developed a new topochemical methodology to convert the 1D-$FeF_3 \cdot 3H_2O$ precursor structure to a higher dimensional iron fluoride framework through incorporation of a "structure-stabilizing" agent, i.e., sodium fluoride (NaF) into it. The as-synthesized 3D-$Na_2Fe_2F_7$ cathode showed reversible capacities above 50 mAh/g for 30 cycles with an average intercalation voltage of 3.25 V vs Na^+/Na^0, the highest value reported for iron fluorides in NIBs.

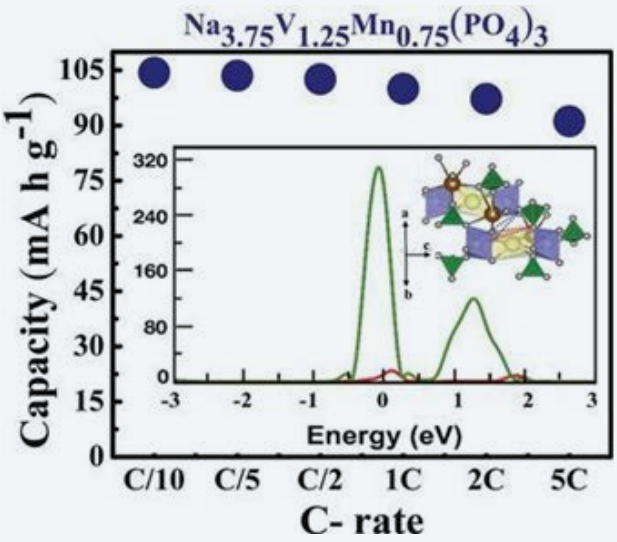


Fig. A comprehensive study on the sodium superionic conductor (NASICON)-Na_{3+y} V_{2-y} Mny $(PO_4)_3$ ($0 \le y \le 1$) series showed a phase miscibility gap at y = 0.5, defining two solid solution domains with low and high Mn contents. The observed higher capacity and rate capability of the $Na_{3.75}V_{1.25}Mn_{0.75}(PO_4)_3$ cathode is attributed to its optimum bottleneck size (≈5 Å2) and modulated V- and Mn-redox centers.

Sodium superionic conductor (NASICON) cathodes exhibit both high structural stability and high sodium ion mobility, making them attractive for Na-ion battery applications. We carried out a comprehensive study on the structural and electrochemical properties of the NASICON-Na_{3+y} V_{2-y} Mn_y $(PO_4)_3$ ($0 \le y \le 1$) series. Our study showed the importance of manipulating electronic and crystal structures to achieve high-performance NASICON cathodes.

We also explored Sn-, Bi-, Pb-, and Sb-based alloys as anodes for Na-ion batteries.

KEY PUBLICATIONS:

- Dey UK, et al. (2019) Topochemical bottom-up synthesis of 2D- and 3D-sodium iron fluoride frameworks. *Chem Mater* 31:295.
- Ghosh S, et al. (2019) High Capacity and High Rate NASICON-$Na_{3.75}V_{1.25}Mn_{0.75}(PO_4)_3$ cathode for Na-ion batteries via modulating electronic and crystal structures. *Adv Energy Mater.* 10(6):1902918.

INVITED AS SPEAKER AT:

- 6th International Conference on Na-ion Batteries, held at Chicago, USA in November 2019.

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

Dynamic supramolecular recognition between fluorescently labelled guest molecules and complementary cucurbit[7]uril hosts were exploited to obtain stochastic switching between fluorescence ON- and OFF-states. This strategy can enable efficient PAINT-based nanoscopic imaging in biological cells and tissues.

We developed a fluorescent fingerprinting method to efficiently discriminate between various cellular alterations based on their entire proteomic signatures. Our strategy combines a surface functionalized gold nanoparticle receptor with color-coded DNA transducers to generate an integrated sensor array that simultaneously generates multi-channel fluorescence output for analyte identification via a machine learning algorithm. We employed this ability of the sensor to rapidly identify cell states based on lysate composition. Importantly, we showed that such a sensor could be applied in discriminating cellular responses against pharmacological effectors.

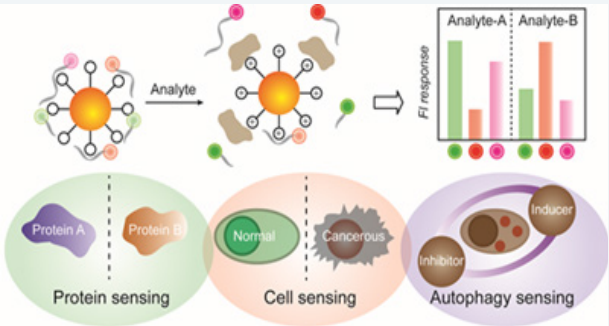


Fig. Schematic illustration of single and multi-channel sensing strategy based on DNA-mediated signal transduction. Competitive interaction between the quenched AuNP-DNA and the analyte molecule creates a unique pattern of responses for analyte identification via a pattern recognition algorithm. The multi-channel sensor was created by complexing a single AuNP receptor with three different lengths of ssDNA sequences bearing spectrally distinguishable fluorescent signatures. This sensor simultaneously produces three channel fluorescence output for signature-based single well identification of analytes.

KEY PUBLICATIONS:

- Sasmal R, et al. (2019) Dynamic host–guest interaction enables autonomous single molecule blinking and super-resolution imaging. *Chem Commun* 55:14430–14433.
- Saha ND, et al. (2019) Multichannel DNA sensor array fingerprints cell states and identifies pharmacological effectors of catabolic processes. *ACS Sens* 4:3124–3132.

INVITED AS SPEAKER AT:

- 3rd Asian Conference on Chemosensors and Imaging Probes (Asian-ChIP), from November 6–8, 2019.
- ILS Cell Biology Conference and Microscopy, held at ILS, Bhubaneshwar from December 9–15, 2019.
- Signals and Sensors, held at NCBS, Bengaluru from December 11–12, 2019.
- FCS National Workshop on Fluorescence and Raman Spectroscopy, held at TIFR Hyderabad from December 16–21, 2019.
- Chemical Science in India: Leaders in the Field Symposium, held at IISER Kolkata from October 18–20, 2019.

UNIT MEMBERS

Linus Pauling Research Professor and Chair

Prof. C.N.R. Rao

Associate Chair

Prof. Subi Jacob George

Hindustan Lever Research Professor

Prof. H. Ila

Associate Professors

Prof. Govindaraju T

Prof. Jayanta Haldar

Prof. Kanishka Biswas

Prof. Ranjani Viswanatha (Associate Faculty, ICMS)

Prof. Sebastian Chirambatte Peter

Prof. Subi Jacob George

Prof. Sridhar Rajaram (jointly with ICMS)

Faculty Fellows

Dr. Bani Kanta Sarma

Dr. Premkumar Senguttuvan (jointly with ICMS)

Dr. Sarit Agasti (jointly with CPMU)

Research Associates

Mouli Konar, Lakshmi Priya Datta, Chenikkayala Balachandra, Pardhasaradhi Satha, Y.V. Suseela, B. Senthilkumar, Shikha Dhiman, Iniyavan P., Gautam Achar N.B., Nilanjana Das Saha, Suman Das, Rimzhim Gupta, Saurav Chandra Sarma, Debajyoti Basak, Prabir Dutta

Research Students

Ph.D. Programme: Suman Kuila, Ramesh M.S., Aritra Sarkar, Swagatam Barman, Sourav Samanta, Ranjan Sasmal, Manisha Samanta, Shreya Sarkar, Anusha S. Avadhani, Pradeep K.R., 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, Satyajit Patra, Arindam Ghosh.

M.S.(Engg.): Rohit, Devesh Chandra Binwal

Int. Ph.D. Programme: 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

Masters in Chemistry: Acharya Yash Sanjay, Subhajit Das, Arnab Sinhababu, Abhishek Rawat, Subham Singh, Triasha Pal, Anustup Mukherjee, Aditya Bhardwaj, Amit Ghoshal, Naral Vinay Srinivas

UNIT MEMBERS

Research Associate (P)
Tanmoy Ghosh

DBT- Research Associate-1
Riya Mukherjee

Technical Assistant (Inst)
Shivakumar K.M.

R&D Assistants
Nirmal Jose, Rishikesh V., Kathakali De, Krishnendu Maji, Priyanka C., Kavana H. S., Punith S. Kumar, Shubhashri Mannar, Jithu Raj, Ms. Monica Swetha Bosco, Subrata Mandal.

Junior Research Fellows
Chinthu Prasad S. D., Punith S., Subhankar Chowdhury

Research Person
Archana K. Munirathnappa

Technician
Shilpa

Teacher's Research Associate
Dr. Ashly P.C., Dr. Shafeekh Kulathinte Meethal SERB (TARE)

Technical Support
Meenakshi Baburao Tayade

SERB-NPDF
Dr. Kaushik Kundu

Secretarial Assistant Trainee
Melissa Mendonza-Mascarenhas

Helper
Naveen D.N.

UNIT AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. C.N.R. Rao

- Received the TV9 Lifetime Achievement Award.
- Received the KAYAK SHREE Award (Gokak) (2019) from Shoonya Sampadana Math, Gokak.
- Received the COSINE Award from Chaldean Syrian Higher Secondary School, Trissur (2019).
- Received the Saud International Prize For Materials Research (2019) from RAK-CAM, UAE.
- Conferred Honoris Causa from Jadavpur University, Kolkata (2019).
- Conferred with the 80th Honorary Doctorate in Science by the University of Kerala, Thiruvananthapuram.
- Highly Cited Researcher for 2019 from Web of Science Group.

Prof. H. Ila

- Awarded the Lifetime Achievement Award Gold Medal by the Chemical Research Society of India.

Prof. Kanishka Biswas

- Received the DST Swarnajayanti Fellowship.
- Among the top 10% of highly cited authors in the Materials portfolio of Journals of Royal Society of Chemistry in 2018.
- Selected for MRSI-ICSC Materials Science Annual Prize, 2020.
- Invited to be an Editorial Advisory Board Member, *Journal of Materials Chemistry A*, RSC.
- Invited to be an Editorial Board Member, *Journal of Solid State Chemistry*, Elsevier.

Prof. Ranjani Viswanatha

- Featured in the article "Women in the forefront of Energy Research" by *ACS Energy Letters* (2020).
- Awarded the CRSI Bronze Medal (2020).
- Received the C. V. Raman Award for Young Scientist by Karnataka State (2019).

Dr. Sarit S. Agasti

- Sheikh Saqr Fellowship, International Centre for Materials Science (ICMS), JNCASR, 2020.
- Emerging Investigator by *Chemical Communications,* Royal Society of Chemistry, UK, 2020.

Prof. Sebastian C Peter

- Received the DST Swarna Jayanti Fellowship.

Prof. Subi J. George

- Selected as a Fellow of Indian Academy of Sciences, Bangalore, 2019.
- Invited to be an Editorial Advisory Board Member of *Chem* (Cell press).
- Invited to be an Editorial Advisory Board Member of *Organic Materials* (Thieme).

UNIT AT A GLANCE

Awards received by STUDENTS

Soumen Pradhan received the prestigious CSIR-Shyama Prasad Mukherjee Fellowship. Research Supervisor: Dr. Sarit Agasti.

Mouli Konar a post-doctoral fellow, won the Best Oral Presentation award at the Student Indian Peptide Symposium 2020, held at Madurai Kamaraj University, Madurai, on February 20–21, 2020. Research Supervisor: Prof. Govindaraju. T.

Lakshmi P Datta, a post-doctoral fellow, won the Best Poster award at the 26th CRSI-National Symposium, held at VIT University, Vellore, on February 7-9, 2020. Research Supervisor: Prof. Govindaraju. T.

Geetika Dhanda received the Bapu Narayanswamy Award for the Best Master's thesis in Chemical and Materials Science. She also won the award for the Best Oral Presentation at the Chemical Frontiers conference held at Goa. Research Supervisor: Prof. Jayant Haldar.

Mohd Monis Ayyub received the Malhotra Weikfield Foundation Nano Science fellowship held at Bengaluru India Nano, 2020. Research Supervisor: Prof. C.N.R. Rao.

Reetendra Singh received the Best Short Oral Presentation at Chemical Frontiers Conference, held at Goa from August 22–25, 2019. He also won the Best Oral Presentation at International Winter School 2019 held at Bengaluru, India from December 2–6, 2019. Research Supervisor: Prof. C.N.R. Rao.

Rohit Attri received the Best poster award at the 15th JNC Research Conference on Chemistry of Materials 2019, Kerala, India. Research Supervisor: Prof. C.N.R. Rao.

Swaraj Servottam received the Best poster award, Chemical Frontiers Conference, held at Goa from August 22–25, 2019. Research Supervisor: Prof. C.N.R. Rao

Subhajit Roychowdhury won the Best Thesis Award (2nd Prize) in the area of 'Energy & Mobility' by KPIT in IISER, held at Pune. He also won the Graduate Student Silver Award, 2019 from Materials Research Society, USA. Research Supervisor: Prof. Kanishka Biswas.

Paribesh Achyarya won the Best Poster Award at the International Conference on Nano Science and Technology, 2020, held at Kolkata. Research Supervisor: Prof. Kanishka Biswas.

Sushmita Chandra won the Best Poster Award at the International Conference on Nano Science and Technology, 2020, held at Kolkata. Research Supervisor: Prof. Kanishka Biswas.

Mahima Makkar was awarded the Best Popular Science Story award at the AWSAR event. Research Supervisor: Prof. Ranjani Viswanatha.

Soumyabrata Roy bagged first prize in the best poster category of KPIT Shodh Awards. Research Supervisor: Prof. Sebastian C. Peter.

Awards received by STUDENTS

Arjun Cherevotan won the Best Poster Award at the 26th CRSI-National Symposium, held at VIT University, Vellore, from February 7–9, 2020. He also won the Best Poster award at the Virtual Conference on "Materials for Energy Harvesting and Catalysis" held via Zoom on May 1–3, 2020. Research Supervisor: Prof. Sebastian C. Peter.

Saurav Ch. Sarma received the prestigious Marie-Curie postdoctoral fellowship 2020. Research Supervisor: Prof. Sebastian C. Peter.

Angshuman Das was awarded the prestigious CSIR-Shyama Prasad Mukherjee Fellowship. Research Supervisor: Prof. Subi J. George.

Ananya Mishra won the BIRAC-SRISTI Gandhian Young Technological Innovation award. Research Supervisor: Prof. Subi J. George.

Total Publications
97

New Projects
11

Amount received during 2019-2020
₹11.49 Cr

On going Projects
20

Amount received during 2019-2020
₹11.49 Cr

STUDENTS ADMITTED

16

Ph.D. : 7 students

Devender Goud G
Animesh Bhui
Dikshaa Padhi
Hariharan M
Soumi Mondal
Satyajit Patra
Arindam Ghosh

M.S. (Engg.) : 1 student

Devesh Chandra Binwal

Int. Ph.D. : 3 students

Mohd Arif
Tarak Nath Das
Animesh Das

M.Sc. Chemistry : 5 students

Triasha Pal
Anustup Mukherjee
Aditya Bhardwaj
Amit Ghoshal
Naral Vinay Srinivas

STUDENTS GRADUATED

13

Ph.D.: 8 students

Soumyabrata Roy
Ananya Banik
Manjeet Chhetri
Shubhajit Das
Anand Kumar Roy
Y.V. Susheela
Subhajit Roychowdhury
Mohini Mohan Konai

M.S. in Chemical Science: 5 students

Harshit Arora
Amit
Sushmita Chandra
Geetika Dhanda
Aditi Chiring

NEUROSCIENCE UNIT (NSU)

NSU conducts research in the field of human neurological disorders as well as normal neurobiological traits using model organisms (*Drosophila* and mice). Understanding the molecular underpinnings of circadian rhythms, intellectual disability, and seizure disorders are the current main objectives of the unit. NSU faculty members have collaborative projects among its members, among scientists in the Centre as well as with those in other national and international organisations.

RESEARCH AREAS

Research at NSU is focused in the following areas:

- Synaptic function and its relationship with intellectual disability and autism spectrum disorder
- Circadian rhythms and sleep circuits
- Molecular and cellular mechanisms of human brain disorders.

RESEARCH HIGHLIGHTS

- A genetic correlation between timing of behaviour and temperature sensitivity of the circadian clock was shown in *Drosophila melanogaster*.
- PD180970, a small molecule inhibitor of c-abl kinase, was identified and this molecule was found to exhibit strong neuroprotective effects, making it a promising drug in the management of Parkinson's disease.
- Evidence for the molecular mechanism underlying the altered neuronal protein synthesis in a mouse model of autism, *Syngap1*$^{-/+}$, was reported.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. Anuranjan Anand Ph.D., FASc, FNA, FNASc
Professor and Chair, NSU

Juvenile myoclonic epilepsy (JME) accounts for about 10% of all human epilepsies and has substantial genetic basis to its etiology. We have been studying CASR, a causative gene for JME using genetic and cell biology approaches. To investigate the causative locus EIG8, which was reported previously from the laboratory, we conducted studies that revealed six mutations in CASR present exclusively in JME patients. CASR encodes a G-protein coupled receptor responsible for sensing extracellular calcium levels (Brown et al., Nature 1993). The six mutations identified are rare and a part of conserved CASR residues. Functional studies employing MAPK (mitogen-activated protein kinase) assay indicated that the signalling activity of CASR followed a sigmoidal dose-response curve, with exponentially increasing activity of Ca^{2+}. This suggests that the G-protein receptor shows enhanced responsiveness to Ca^{2+}. We believe that the function of CASR in the brain is crucial to maintain normal neuronal excitability and that CASR could be a potential therapeutic target to treat epilepsies.

Prof. Sheeba Vasu Ph.D.

Associate Professor

The timing of eclosion in *Drosophila melanogaster* shows remarkable accuracy. We showed that accurate eclosion rhythms seem to have evolved primarily by strengthening circadian gating of eclosion rather than due to fine-tuning of clock-independent developmental processes. We also found that *Drosophila* populations selected for eclosion in the morning do not vary their phases with a change in temperature regimes, whereas those selected for eclosion in the evening show phase lability of up to ~5 h, implying a genetic correlation between the timing of behaviour and temperature sensitivity of the circadian clock.

Through a series of experiments involving *D. melanogaster*, we also confirmed that accuracy and phase of entrained rhythm are governed by both intrinsic clock period and the length of the external cycle; however, we found that the relationship between intrinsic period and precision does not fit previous predictions.

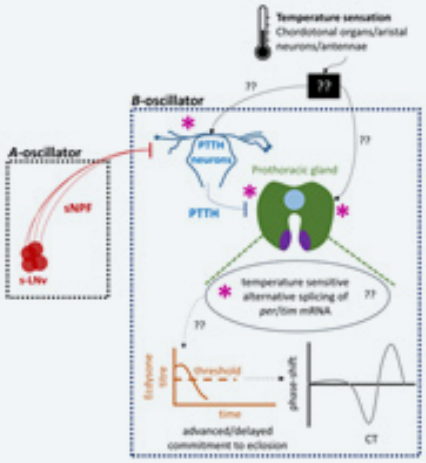


Fig. A speculative model integrating intra-cellular and organizational level circuitry regulating the eclosion rhythm in *Drosophila*. Putative pathways to relay temperature information to the clock regulating gating are shown. Asterisks indicate potential areas of the control centre that may have evolved differently in the early chronotype and late chronotype populations.

As a step toward providing reliable and free access to tools for the analysis of biological time-series data, we have written RhythmicAlly, an open-source program using R and Shiny that has the following advantages: (1) it is free, (2) allows subjective marking of phases on actograms, (3) provides high interactivity with graphs, (4) allows visualization and storing of data for a batch of individuals simultaneously, and (5) is more efficient and user-friendly than other free tools.

KEY PUBLICATIONS:

- Abhilash L and Vasu S (2019) RhythmicAlly: your R and Shiny-based open-source ally for the analysis of biological rhythms. *J Biol Rhythms* 34:551–561.
- Potdar S, et al. (2018) Sleep deprivation negatively impacts reproductive output in *Drosophila melanogaster*. *J Exp Biol* 221: jeb174771.

EVENT ORGANISED

- Organised InSearch 2020, a one-day event for school/college students and teachers that showcased research in science, held at JNCASR, Bengaluru on January 17, 2020.

INVITED AS SPEAKER AT:

- Ahmedabad University, in January 2019.
- Serge Daan Memorial Symposium at 5th World Congress on Chronobiology, held at Suzhou, China in April 2019.
- Workshop on Animal models in neuropsychiatric disorders, at NIMHANS, Bengaluru in May 2019.
- Hall of Science, at JNCASR, Bengaluru in July 2019.
- 5th Asia Pacific Drosophila Research Conference (APDRC) held at Pune, India on January 7, 2020.
- School Chandan, Lakshmeshwar, Gadag in January 2020.

Dr. James P.C. Chelliah Ph.D.
Faculty Fellow

We recently showed how proteins from the complimentary pathway can compensate for the loss of function of another protein. Using electrophysiology, and advanced molecular techniques, we identified that the translational regulator FMRP is upregulated during development and, thereby, modulates synaptic plasticity.

Heterozygous mutation in *SYNGAP1 (SYNGAP1*$^{-/+}$*)* can cause intellectual disability in children. We reported the reduced expression of FMRP during a specific developmental period in *SYNGAP1*$^{-/+}$ mice, which further leads to altered response of eEF2 phosphorylation downstream of NMDA receptor-mediated signalling. Our results suggest a cross-talk between FMRP and *SYNGAP1* mediated signalling in these impaired mice.

We showed the ability of a small molecule inhibitor of tyrosine kinases, PD180970, to induce autophagy (in vitro and in vivo) in an mTOR-independent manner and ameliorate the α-synuclein mediated toxicity. Our study showed that PD180970 has neuroprotective effects by degrading the toxic protein oligomers through induction of autophagy and ameliorating the microglial activation, suggesting its potential use in treatment of Parkinson's disease.

Designer receptors exclusively activated by designer drugs (DREADD)-based tools are extensively used to manipulate neuronal activity in a cell type-specific manner. We recently showed that clozapine-N-oxide-mediated activation of the hM3Dq DREADD results in dose-dependent regulation of excitatory hippocampal neurotransmission, highlighting the importance of careful interpretation of behavioural experiments involving chemogenetic manipulation.

KEY PUBLICATIONS:

- Pati S, et al. (2019) Chemogenetic activation of excitatory neurons alters hippocampal neurotransmission in a dose-dependent manner. *eNeuro 6:ENEURO*.0124-19.2019.
- Paul A, et al. (2019) Differential regulation of Syngap1 translation by FMRP modulates eEF2 mediated response on NMDAR activity. *Front Mol Neurosci* 12:97.

EVENT ORGANISED:

- Mechanisms of synapse development and function in health and disease, Indian Academy of Neuroscience, at AIIMS, India, in October 2019.

INVITED AS SPEAKER AT:

- International Conference on Neurological Disorders and Therapeutics, at NIPER, Ahmedabad, in November 2019.
- Indian Academy of Neuroscience, at AIIMS, in October 2019.
- Korea Research Institute of Bioscience and Biotechnology, Daejeon, South Korea, in September 2019.
- IBRO-APRC Workshop, at Sree Chitra Tirunal Institute for Medical Sciences and Technology, Trivandrum, in April 2019.
- IISER-Tirupathi, in March 2019.

UNIT MEMBERS

Professor and Chair
Prof. Anuranjan Anand

Associate Professor
Prof. Sheeba Vasu

Faculty Fellow
Dr. James P.C. Chelliah

Associate Faculty
Prof. K.S. Narayan (Professor, CPMU)
Prof. M.R. Satyanarayana Rao (Honorary Professor, MBGU)
Prof. Ravi Manjithaya (Associate Professor, MBGU)
Prof. Tapas Kundu (Professor, MBGU) (on lien w.e.f. 08.08.2018)

Honorary Professor
Prof. M.R. Satyanarayana Rao (SERB YOS-Chair Professor)

Research Students (Ph.D. Programme)
Iyengar Aishwariya Prasan, Kulkarni Rutvij Kaustubh, Vijaya Verma, Iyer Aishwarya Ramakrishnan, Arijit Ghosh, Dani Chitrang Kamal, Vijay Kumar M.J., Angshumi Dutta, Manjushree Sarda, Yashwini Dewan.

Int Ph.D. Students
Pragya Sharma and Ranabir Chakraborty

R&D Assistants
Sushma S. Rao
Zahid Mushtaq Dar
Pratishtha P. Wadnerkar

Sr. Helper
Samuel S.

Total Publications
10

New Projects
02

Amount received during 2019-2020
₹52.57L

On going Project
01

Amount received during 2019-2020
₹26.13L

STUDENTS ADMITTED

Ph.D.: 4 students

Aneesh Mohan
Arun Karthikeyan Kanthasamy,
Manjushree Sarda
Yashwini Dewan

04

UNIT AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. Ravi Manjithaya

- Joint recipient of the CDRI Award 2020 for excellence in Drug Research in Life Science category

Prof. Tapas Kumar Kundu

- Shri Om Prakash Bhasin Award 2019 in the field of Health & Medical Sciences awarded by Shri Om Prakash Bhasin Foundation

Awards received by STUDENTS

Swetha Sikder won the Best Thesis Medal in Biological sciences (2018-2019) in JNCASR, Bangalore, India. Research Supervisor: Prof. Tapas Kumar Kundu.

Ruchika Kumari received the Best Poster Award at the XIth International Conference on Biology of Yeasts and Filamentous Fungi held at the University of Hyderabad, Hyderabad. Research Supervisor: Prof. Ravi Manjithaya.

Sreedevi P. received the Best Poster Award at the International Conference on Autophagy and Lysosome held at the Indian Institute of Science, Bengaluru. Research Supervisor: Prof. Ravi Manjithaya.

Abhik Paul received CSIR travel grant to attend AWCBR neuroscience conference in New Zealand. Research Supervisor: Dr. James P.C. Chelliah.

Chitrang Dani won the third prize in AWSAR for his story titled 'Out of the Lab: a Clock Conversation". Research supervisor: Prof. Sheeba Vasu.

Rutvij Kulkarni won the best poster award in the Master's category at the Understanding Behaviour Conference held at IISER Kolkata from January 11–13, 2019. Research supervisor: Prof. Sheeba Vasu.

Arijit Ghosh won the Bhagwati Devi Memorial Award for best oral presentation in the International Symposium on Biological Rhythms held at Chaudhary Charan Singh University, India from March 11–13, 2019. Research supervisor: Prof. Sheeba Vasu.

Arijit Ghosh and Aishwarya Iyer received the Global Diversity Award for Young Investigators from the Society for Research on Biological Rhythms 2020. Research supervisor: Prof. Sheeba Vasu.

THEORETICAL SCIENCES UNIT (TSU)

Research at TSU aims to understand the physics of the world we see around us. An interdisciplinary approach is used to predict and identify new phenomena and circumstances that modify observed patterns in nature and address problems in very diverse areas from evolutionary biology to materials science. The research at TSU is inspired largely by two common unifying physical principles – a search for universality and pattern formation, and an exploration of any deviation from an observed pattern.

RESEARCH AREAS

TSU carries out research in the following areas:

- Theory of catalysis for energy and environment
- Low dimensional materials, defects, surface reconstructions, and self-assembly
- Thermoelectrics and magnetoelectrics; drug molecule and biological membrane interactions
- Jamming, self-organization, void space, cluster growth, and evaluations
- Method development at various energy and length scales
- Polygenic adaptation in changing environments and adaptation dynamics in nonequilibrium populations
- Anderson localization in phononic systems with correlated disorder
- Non-Hermitian quantum systems
- Dynamical quantum phase transitions

RESEARCH HIGHLIGHTS

- The Lyapunov property for C_0-semigroups defined on non-commutative L^p spaces was studied.
- The joint effect of linked beneficial and deleterious mutations on the rate of adaptation in an asexual population was reported.
- The relaxation phenomena during vapor–liquid transitions in a single component Lennard-Jones system were studied.
- The growth and sintering behaviour of potential catalytic metal clusters were studied.
- A Green's function method was developed for computational investigation of phonon localization in binary alloys with mass and force-constant disorder.
- A statistical panel was established for developing quantitative descriptors for the biological complexity of viruses.
- A new 3D nickel-based hybrid structure with long-range ferromagnetism and semiconductor behaviour was reported.
- A lead-free hybrid halide perovskite system with a very high piezoelectric charge density was reported.
- Conditions for jamming in sheared-sphere assemblies were reported.

ACHIEVEMENTS AND ACTIVITIES OF THE UNIT

Prof. Swapan K. Pati Ph.D., FNA, FASc, FNASc, FTWAS

Professor and Chair, TSU

We studied the vibrational properties of SnO and PbO in their single layer and bulk form and compared their spectroscopic characteristics.

We studied the dynamics of site-energy-disorder and correlated-charge-transport mechanisms in molecular solids using density functional theory, molecular dynamics, and kinetic Monte-Carlo simulations.

We demonstrated a broadband colossal dielectric constant in superionic halide $RbAg_{4I5}$ with a low dielectric loss. The maximum ε′ reaches a colossal value of 6.4×10^8 at 0.1 Hz at 300 K.

Combining theoretical and experimental approaches, we explored the electronic and electrochemical properties of the NASICON-$Na_{3+y}V_{2-y}Mn_y(PO_4)_3$ ($0 \le y \le 1$) series, particularly the role of Mn^{2+} on the voltage profile and (de)-intercalation dynamics.

We developed a strategy for delocalization of the positive charge of a transient H-substituted 1,2-carbodication by an intramolecular base coordination and studied the 1-e oxidation reaction of trisubstituted geminal diazaalkenes.

We computationally studied the MOF-derived Co_3O_4@Co/NCNT nanocomposites for their potential applications in hydrogen evolution reaction.

Unprecedented ambient triplet-mediated emission in core-substituted naphthalene diimide derivatives was uncovered via delayed fluorescence and room temperature phosphorescence.

An NHC-coordinated diphosphene was employed as ligand for the synthesis of a hydrocarbon-soluble monomeric Au^{I} hydride.

We achieved the amorphous limit of κ_{lat} of pristine SnTe via engineering configurational and vibrational entropies in pseudo ternary $(SnTe)_{1-2x}(SnSe)_x(SnS)_x$.

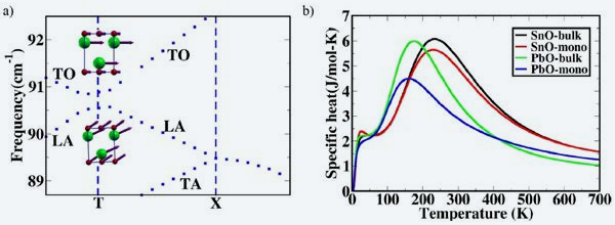


Fig. a) Avoided crossing occurred near the high-symmetry point X. LA and TO bands cross each other at frequency 90.8 cm^{-1}. The inset crystal structures signify phonon eigenvectors (arrows) corresponding to bands 1 and 2 at T-point. Both the phonon modes show the same point group symmetry (E_u) at the vicinity of avoided crossing for SnO and only in bulk PbO. b) Specific heat (C_v) is plotted with respect to temperature. We observed a kink in specific heat for bulk SnO, bulk PbO and monolayer SnO but not in single-layer PbO at temperatures of ~100 K, corresponding to the frequency of avoided crossing of bands in the three systems.

KEY PUBLICATIONS:

- Dutta S, et al. (2009) Intrinsic half-metallicity in modified graphene nanoribbons. *Phys Rev Lett* 102(9):096601.
- Pandey B and Pati SK (2017) Triplet superfluidity on a triangular ladder with dipolar fermions. *Phys Rev B* 95(8):085105.

EVENTS ORGANISED:

- Workshop and symposium on “Advanced Simulation Methods: DFT, MD and Beyond”, held at IIT, Delhi from March 6–10, 2019.
- Chemistry Seminar Series, held at IISER Trivandrum on September 21, 2019.
- Conference on “Recent Advances in Chemistry”, held at NIT, Meghalaya from October 14–15, 2019 (Keynote speaker).
- International conference on “Modern Trends in Molecular Magnetism”, held at IISER, Bhopal from November 27–29, 2019.

Prof. Shobhana Narasimhan Ph.D., FNASc

Professor

We showed that the support work function could serve as a descriptor for the morphology and charge of deposited Au nanoparticles, enabling one to quickly predict which systems might have the desired morphology and charge desirable for as an efficient nanocatalyst.

Using DFT, we explained the experimental findings of our collaborators (Prof. Ranjani Viswanatha's group) that Mn-doped $CsPbBr_3$ displays a delayed fluorescence. Particularly, we found that the Mn impurity levels get buried deep within the conduction band due to spin-orbit effects on the Pb atoms, and that there is significant vibrational coupling between the Mn atoms and host atoms, which leads to the delayed fluorescence.

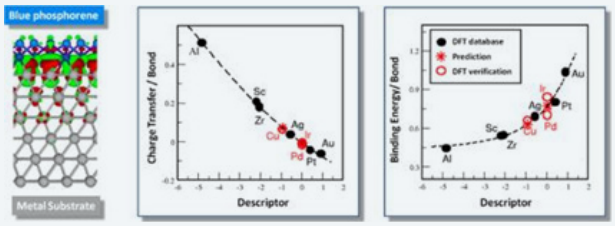


Fig. A simple descriptor, which depends only on the electronegativities and atomic sizes of phosphorus and the metal, is able to capture the charge transfer and binding that occurs when a layer of blue phosphorene is deposited on various metal substrates.

We found that there are simple scaling relations that relate the diffusion barriers of selected small metal clusters on an oxide support, to the melting temperature of the bulk metal. This has important consequences for the sintering of small metal particles, and hence the degradation of metal nanocatalysts.

We explained that the ordered superstructure formed when a Fe(II) molecule is deposited on an Au(111) surface is due to a partial spin-crossover driven by epitaxial strain from the substrate.

We found a simple descriptor to capture the charge transfer that occurs when a monolayer of blue phosphorene is deposited on various metal substrates.

KEY PUBLICATIONS:

- Zalake P, et al. (2017) Descriptor-based rational design of two-dimensional self-assembled nanoarchitectures stabilized by hydrogen bonds. *Chem Mater* 29:7170–7182.
- Mammen N, et al. (2011) Tuning the morphology of gold clusters by substrate doping. *J Am Chem Soc* 133:2801–2802.

EVENT ORGANISED:

- Career Development Workshop for Women in Science at ICTP Trieste, from October 28–November 1, 2019.

INVITED AS SPEAKER AT:

- ICONSAT 2020, held at Kolkata from March 5–7, 2020.
- Frontier Problems in Nanoscience and Nanotechnology, held at IIT Gandhinagar, from February 14–15, 2020.
- ACCMS-ICMG 2020, held at Amravathi from February 5–7, 2020.
- ICTP Solid State Physics Online Course, on May 14, 2020.
- ICTS, Bengaluru, on February 26, 2020.

Prof. Srikanth Sastry Ph.D., FASc, FNASc, FNA

Professor

Through computer simulations, we obtained a comprehensive phase diagram of cyclically-shear deformed sphere packings, which involves reversible-irreversible, jamming, unjamming and yielding transitions.

We showed that a qualitative change arises in the yielding behaviour of glasses as a function of annealing.

We analysed recent approaches to computing information content in equilibrium and nonequilibrium systems, and proposed new methods for computing information content.

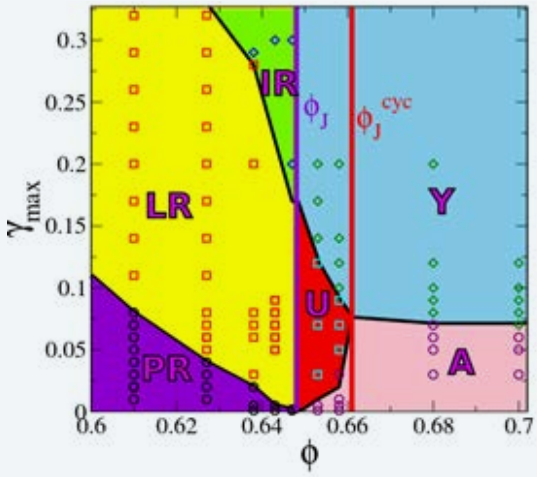


Fig. The response of amorphous matter to externally imposed deformation is of interest in a variety of contexts. In particular, cyclic-shear deformation has been employed to probe the emergence of irreversibility in colloidal suspensions, yielding and annealing of glasses, jamming, and memory formation. We investigated soft-sphere assemblies computationally to obtain a comprehensive understanding of their self-organization and response over a wide range of densities and deformation amplitudes. We constructed a unified phase diagram that exhibits reversible and irreversible regimes and transitions among them that embody yielding, jamming, unjamming, and shear jamming phenomena.

We showed that dilatancy, a phenomenon associated with frictional interactions, can arise in frictionless granular systems as well.

We analysed hyperuniformity in glasses and showed that interesting new phenomena, associated with heterogeneous hyperuniformity, arise accompanying yielding.

We performed extensive analysis of memory formation in driven glasses through the method of constructing transition graphs.

We developed an equilibrium sampling algorithm to generate equilibrium ensembles of configurations in glassy systems, employing cyclic shear.

We investigated issues associated with the liquid-liquid transition and crystallisation in silicon. We showed that finite barriers to crystallisation are present under conditions where presence of such barriers have been controversial in the literature.

KEY PUBLICATIONS:

- Das P, et al. (2020) Unified phase diagram of reversible-irreversible, jamming, and yielding transitions in cyclically sheared soft-sphere packings. *Proc Natl Acad Sci USA* 117:10203–10209.
- Mungan M, et al. (2019) Networks and hierarchies: how amorphous materials learn to remember. *Phys Rev Lett* 123:178002.

EVENT ORGANISED:

- Co-organizer of "2019 International Workshop on Glass Physics", held at CAS Beijing from September 25–28, 2019.

INVITED AS SPEAKER AT:

- American Physical Society March meeting conducted online from March 2–6, 2020.
- CECAM@50, at Lausanne, Switzerland from September 9–12, 2019.
- 4th international Conference on Packings, at Yale University from June 3–7, 2019.
- Statistical Physics of Amorphous Solids, Centro Internacional de Ciencias, at Cuernavace, Mexico from October 7–18, 2019.
- 2019 International Workshop on Soft Matter and Biophysics Theories, at Beijing from May 11–14, 2019.

Prof. Subir K. Das Ph.D.
Professor

We performed molecular dynamics simulations to study relaxation phenomena during vapor–liquid transitions in active matter systems. We studied the characteristics of decay of order-parameter autocorrection and growth of clusters in two cases with differing densities. Even though the corresponding exponents in the two cases differed drastically, our results suggested that the power-law behaviour is rather universal in coarsening dynamics.

Following quenches from critical points to state points inside coexistence, we have studied aging during evolution of the Ising model towards equilibrium, via Monte Carlo simulations, in spatial dimensions d = 2 and 3. Thus, we estimated the relaxation exponents for a new coarsening universality class.

Recently, we have been working on the spread of the COVID-19 epidemic by mapping the problem to those related to the kinetics of phase transitions.

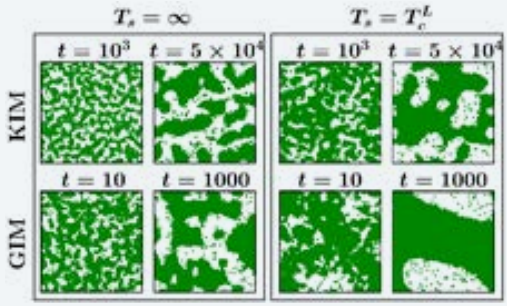


Fig. Snapshots depicting evolutions of Ising model with nonconserved (GIM) and conserved (KIM) order-parameter dynamics for quenches from infinite and critical temperatures.

KEY PUBLICATIONS:

- Midya J and Das SK (2017) Kinetics of vapor-solid phase transitions: structure, growth, and mechanism. *Phys Rev Lett* 118:165701.
- S Roy, et al. (2019) Aging phenomena during phase separation in fluids: decay of autocorrelation for vapor-liquid transitions. *Soft Matter* 15:4743–4750.

INVITED AS SPEAKER AT:

- Seminar at the Institute for Theoretical Physics, University of Leipzig, Germany on May 23, 2019.
- Seminar at the Institute for Physics, Johannes-Gutenberg University of Mainz, Germany, on May 29, 2019.
- Symposium on Computational Materials Science, organized by Karnataka State Higher Education Academy and Karnataka University, held at Dharwad on September 5, 2019.
- International Winter School on Frontiers in Materials Science, held at JNCASR, Bengaluru, December 3, 2019.
- International Conference on Complex Fluids, held at IISER Bhopal on December 6, 2019.

Prof. Umesh V. Waghmare Ph.D., FASc, FNASc, FNA

Professor and Dean, Academic Affairs

We reported a lead-free hybrid-halide-perovskite system with a very high piezoelectric charge density, opening up a route to high-performance nanogenerators.

Using first-principles density functional theoretical analysis, we predicted coexisting ferroelectric and semimetallic states in a two-dimensional monolayer of h-NbN subjected to an electric field and in-plane strain.

We developed a new approach wherein machine learning with the Bootstrapped projected gradient descent algorithm is constrained with Buckingham Pi theorem-based dimensional analysis and scaling laws of relationships between different input descriptors (properties). This model enables us to learn from small data and develop predictive models that are accurate, computationally inexpensive, and physically interpretable.

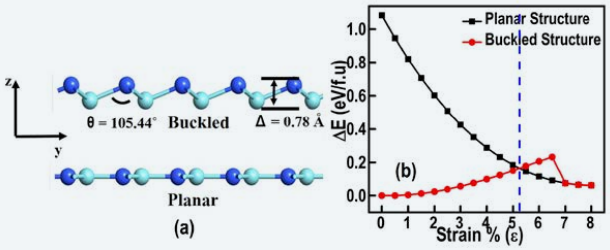


Fig. Theoretical prediction of ferroelectricity in 2-dimensional NbN (a) subjected to in-plane tensile strain of 4.8 % (b), just before its puckered structure transforms to planar structure. The origin of ferroelectricity involves interesting interplay between electrons and phonons, from which it was shown that the rare phenomenon of electronic ferroelectricity may arise in a material with (i) high polarizability, (ii) soft phonons, which (iii) couples strongly with electrons.

Using femtosecond pump-probe differential reflectivity measurements, we generated symmetric A_{1g} optical phonons in Bi_2Se_3. A remarkable anomalous behaviour around ~180 K was observed in the temperature dependence of optical and acoustic phonons as well as the optical constants due to thermally activated formation of stacking faults.

We showed that thermodynamically stable octahedral phase of monolayer MoS_2 can be achieved in coexistence with the 1H phase, at temperatures below ~500 K, by forming a van der Waals hybrid with another layered solid, such as hexagonal boron nitride or graphene.

We demonstrated how catalytic and electronic properties of the N-doped graphene: MoS_2 hetero-structure depends on the chemical identity of N-sites, uncovering a route to 2D hetero-structures with high catalytic activity.

KEY PUBLICATIONS:

- Chanana A and Waghmare UV (2019) Prediction of coupled electronic and phononic ferroelectricity in strained 2D h-NbN: first-principles theoretical analysis. *Phys Rev Lett* 123(3):037601.
- Kumar N, et al. (2019) Machine learning constrained with dimensional analysis and scaling laws: simple, transferable, and interpretable models of materials from small datasets. *Chem Mater* 31:314–321.

EVENT ORGANISED:

- Co-convened International Winter School on Frontiers of Materials Science, December 2–6, 2019.

INVITED AS SPEAKER AT:

- Workshop on 2D Materials at the Weizmann Institute of Science, Israel on January 15, 2019.
- A seminar on "Electronic and Phonon Ferroelectricity" at Banaras Hindu University, on March 9, 2019.
- A talk on "Ferroelectricity in 2D Materials" in a workshop at the University of Oslo, Norway, on May 21, 2019.
- A seminar on "Simulations and Design of Functional Materials" at Ulsan National Institute of Science and Technology, Ulsan, S Korea, on September 6, 2019.
- A lecture on "Design of Materials based on Quantum Mechanics and Machine Learning" at the RSC Roadshow at IIT-Guwahati, on November 6, 2019.

Prof. Vidhyadhiraja N.S. Ph.D.

Professor and Dean, Fellowships and Extension Programmes

Recently, we developed a method for carrying out computational investigations on the effects of mass and force-constant disorder on phonon spectra. The method is based on the Green's functions-based typical medium dynamical cluster approach. Excellent quantitative agreement with previous exact diagonalization results was achieved, and new insights were obtained in outstanding open issues such as the Boson peak, interplay of mass and force constant disorder and the effect of vacancies.

KEY PUBLICATIONS:

- Vidhyadhiraja NS, et al. (2009) Quantum critical point at finite doping in the 2D Hubbard model: A dynamical cluster quantum Monte Carlo study. *Phys Rev Lett* 102(20):206407.
- Dasari N, et al. (2012) Weak ferromagnetism and magnetization reversal in $YFe_{1-x}Cr_xO_3$. *EPL* 99(1):17008.

INVITED AS SPEAKER AT:

- Mark Jarrell Memorial symposium on computational condensed matter physics, held at Louisiana State University, USA from February 28–March 1, 2020.
- Workshop on 2D Electronic Systems in Magnetic Field, held at IISER Kolkata from December 14–15, 2019.
- Young investigator meet on quantum condensed matter, held at SNBNCBS, Kolkata from December 11–13, 2019.
- JNC Research conference on the chemistry of materials, held at Trivandrum, Kerala from September 30–October 2, 2019.
- Conference on Quantum Condensed Matter (Q-Mat2019), held at IISc, Bengaluru from July 8–10, 2019.
- Forum on Quantum Materials, held at NISER, Bhubaneshwar, from May 2–3, 2019.
- Physics Department, NITK, Surathkal, on February 27, 2019.
- Science Day, held at NMAM Institute of Technology, Mangalore, on February 27, 2019.
- DPS@10, held at IISER Kolkata, from February 23–25, 2019.

Prof. K.B. Sinha Ph.D.

Honorary Professor

We studied the Lyapunov property for C_0-semigroups defined on non-commutative L^p spaces. We also focussed on: (i) 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.

Prof. Kavita Jain Ph.D.

Associate Professor

The effect of weakly deleterious mutations on the rate of adaptation has not been fully explored. Recently, I obtained an accurate analytical expression for the fixation probability of a beneficial mutant in an asexual population at mutation-selection balance. This, along with clonal interference theory was used to investigate the joint effect of linked beneficial and deleterious mutations on the rate of adaptation, and to identify parameter regions where it is reduced due to interference by either beneficial or deleterious or both types of mutations. Further, it was found that linked beneficial mutations have a stronger influence than the deleterious mutations on mutator fixation.

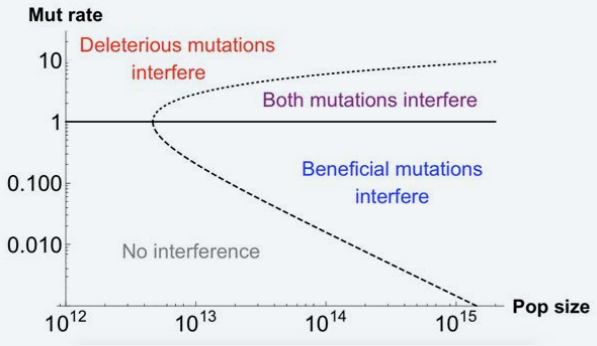


Fig. Asexual adaptation slows down when mutations interfere. As the figure shows, these effects are important when population size or/and mutation rates are large.

KEY PUBLICATIONS:

- Jain K and Stephan W (2017) Rapid adaptation of a polygenic trait after a sudden environmental shift. *Genetics* 206:389.
- Priyanka and Jain K (2016) Critical dynamics of classical systems under slow quench. *EPL* 116:26003.

EVENTS ORGANISED:

- 4th Bangalore School on Population Genetics and Evolution, held at ICTS, Bengaluru from January 27–February 7, 2020.
- 7th Indian Statistical Physics Community Meeting, held at ICTS, Bengaluru from February 19–21, 2020.

INVITED AS SPEAKER AT:

- Society for Molecular Biology and Evolution meeting, held at Manchester, UK from July 21–25, 2019.
- Mathematical & Statistical Explorations in Disease Modeling & Public Health, held at ICTS, Bengaluru, on July 2, 2020.
- Science Academies' Refresher Course in Statistical Physics, held at Surat from June 13-18, 2020.
- 7th NCBS-Simons Monsoon School, held at NCBS, Bengaluru from June 17-26, 2019.

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

Using fine-grained amino acid level information and their evolutionary characteristics obtained from large-scale genomic data, we developed a statistical panel that can be used to develop quantitative descriptors for the biological complexity of viruses. Networks were constructed from pairwise covariation of amino acids and were statistically analyzed. The calculated covariance network-density correlated well with the mortality strengths of viruses on the viral-Richter scale, suggesting that the network density could be a surrogate for the viral-Richter scale.

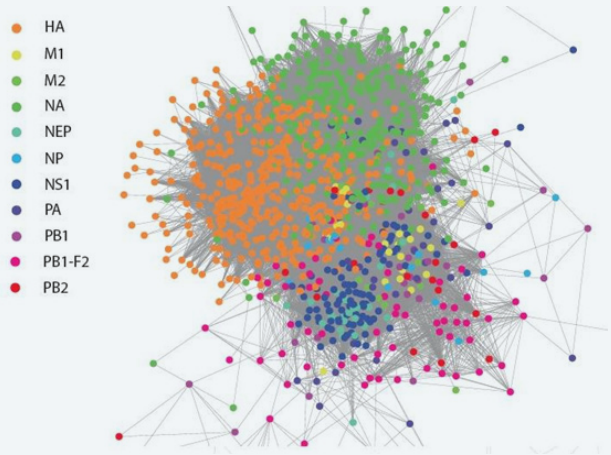


Fig. Complexity of Viruses. Most viruses code for about 10 types of proteins, at least a few hundred times less than bacteria. However in an infection with this small set of proteins, some viruses can be overcome within a few weeks, while others can be fatal. How can we capture the details of this complexity using mathematical modeling? We construct amino acid co-evolutionary networks which show characteristic differences in intra-protein and inter-protein networks as the complexity of viruses increases.

We developed a one drug multiple target approach to screen drugs with anti-bacterial effects. As an example, we curated the data on the activity of daptomycin against Staphylococcus-aureus strains with different membrane compositions. With the limited systematic data available, we could build a neural network-based model that predicted the activity and suggested that the composition in the outer leaflet reflects the drug activity better.

Additionally, we developed a neural network based quantitative model for the rational design of antimicrobial peptides by relating their physicochemical properties to their activity.

KEY PUBLICATIONS:

- Sruthi CK and Prakash MK (2020) Deep2Full: Evaluating strategies for selecting the minimal mutational experiments for optimal computational predictions of deep mutational scan outcomes. *PloS One* 15.1:e0227621.
- Sruthi CK and Prakash MK (2019) Statistical characteristics of amino acid covariance as possible descriptors of viral genomic complexity. *Sci Rep* 9:18410.

UNIT MEMBERS

Professor and Chair

Prof. Swapan K. Pati

Professors

Prof. Shobhana Narasimhan

Prof. Srikanth Sastry

Prof. Subir K. Das

Prof. Umesh V. Waghmare

Prof. Vidhyadhiraja N.S.

Honorary Professor

Prof. K.B. Sinha

Associate Professor

Prof. Kavita Jain

Faculty Fellow

Dr. Meher K. Prakash

Research Students (Ph.D. Programme)

Alok Kumar Dixit, Pawan Kumar, Monoj Adhikari, Sruthi C.K., Meha Bhogra, Sourav Mondal, Malay Ranjan Biswal, Pallabi Das, Neha Bothra, 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, Nandana S.K., Vinayak M. Kulkarni, Bidhan Chandra Garain, Supriti Dutta, Soumik Ghosh, Arpan Das, Khandare Pushkar Gopalrao, Arijit Sinha, Anita Gemmy Francis.

SERB NPDF

Devina Sharma

Teacher's Research Associate

Jyoti Roy Choudhuri

Research Associate

S. Siva Nasarayya Chari, Rajneesh Kumar, Himangsu Bhaumik, Arunkumar Bupathy, Sanat Kumar Singha, K. Navamani, Paramita Banerjee, Prashant Vijay Gaikwad, Shazia Janwari, Anuja Chanana, Matukumilli V.D. Prasad, Meghna Manae A., Sayani Chatterjee.

R&D Assistants

Palaparthi Neehar, Sujan K.K.

Secretarial Assistant Trainee

Vandana R.

Total Publications
50

New Projects
04

Amount received during 2019-2020
₹57.86L

On going Projects
16

Amount received during 2019-2020
₹6.36Cr

STUDENTS ADMITTED

03

Ph.D.: 2 students

Arijit Sinha
Anita Gemmy Francis

M.S. (Engg.): 1 student

Abhijit Sinha

STUDENT GRADUATED

01

Ph.D.: 1 student

Sukanya Ghosh

UNIT AT A GLANCE

Awards received by FACULTY MEMBERS

Prof. Shobhana Narasimhan

- Elected International Honorary Member of the American Academy of Arts and Sciences.
- Awarded the Anna Boyksen Fellowship of the Technical University Munich.

Prof. Subir K Das

- Institute Invited Professor, École normale supérieure de Lyon, France (2019).

Prof. Umesh Waghmare

- Elected Member and Secretary, Council of the Indian Academy of Sciences, Bengaluru.
- Elected Member, Council of the National Academy of Sciences, Allahabad.

Prof. K.B. Sinha

- Awarded the Srinivasa Ramanujan Medal in Mathematics by the Indian National Science Academy (2019).

Awards received by STUDENT

Raagya Arora received the best poster presentation award in the JNCASR conference in October 2019. Research Supervisor: Prof. Umesh V. Waghmare.

THEMATIC UNIT OF EXCELLENCE IN COMPUTATIONAL MATERIALS SCIENCE (TUE-CMS)

TUE-CMS was established in April 2006 and is supported by the Department of Science and Technology, Govt. of India, through its Nano Science and Technology Initiative. The Unit uses numerical simulations to explore materials sciences, glass, and other computation-intensive research areas.

RESEARCH AREAS

- Using in-house developed time-dependent adaptive density-matrix renormalization group (tDMRG) method, which was developed in-house, in a dipolar Fermionic system with quantum many-body correlated models, we showed many-body localized phases of both charge and spin degrees of freedom, even in the presence of SU(2) symmetry. These phases are robust, as verified by including disorder, long time dynamics and long system sizes (finite size scaling).
- We doped the A (Ca) site with inexpensive cations to tune the occupancy of the eg level of B (Mn) site ion in an oxygen-deficient double perovskite, $Ca_2Mn_2O_5$, for improved oxygen evolution reaction and found the overpotential value to be 0.16 V for 30% Cerium-doped $Ca_{1.7}Ce_{0.3}Mn_2O_5$ in alkaline medium.
- We developed a computational scheme to construct interpretable and transferable predictive models of material properties using machine learning, constrained by dimensional analysis and scaling laws.
- We uncovered descriptors and mechanisms of catalytic activity of B and N-substituted graphene, amorphous CoMoP, and a few topologically non-trivial chalcogenides towards hydrogen and oxygen evolution reactions.
- We demonstrated how engineering ferroelectric instabilities and similar local vibrations can cause ultra-low thermal conductivity and hence high thermoelectric performance in metal chalcogenides.
- Complemented experimental work to uncover the physics of pressure-dependent electronic topological transitions and Lifshitz transition in a few chalcogenide semiconductors.
- We developed a multi-scale modeling scheme to construct first-principles effective Hamiltonian for structural phase transitions in metallic systems.
- We predicted coupled electronic and phonon ferroelectricity in 2-D h-NbN, showing that the rare ferroelectricity arises in a system that is highly polarizable and exhibits a strong coupling of electrons with soft phonons.
- We identified and explained simple scaling relations for the diffusion barriers of small metal clusters on oxide supports. This has relevance for the sintering and resulting degradation of nanocatalysts.
- We explained the sources of various features observed in STM images of black phosphorene. These were traced to various types of topological and impurity defects present at or near the surface.
- We found a simple descriptor that captures the charge transfer and binding at phosphorene-metal interfaces.
- We elucidated the self-assembly mechanism of a coordination complex cage with asymmetrical ligands using all-atom molecular dynamics simulation, in collaboration with an experimental group.
- Using coarse-grained molecular dynamics simulations, we showed that the interfacial orientation of Lipase A enzyme at an oil-water interface can be controlled by pH.
- We unified the dynamical phase diagram of driven sphere packing, including jamming, unjamming, shear jamming and yielding transitions.
- We demonstrated dilatancy in frictionless sphere packing under special circumstances.

- We reported inverse methods for materials design.
- We explored information content and entropy in equilibrium and non-equilibrium systems.
- We developed an efficient equilibrium sampling algorithm of accelerated simulation of glassy systems.
- We illustrated the mechanism of signal transduction in the large ensemble of sensing – motor proteins in bacteria using large-scale molecular dynamics simulations.
- We demonstrated the correlations between the methylation sites and the distal ATP hydrolysis sites.

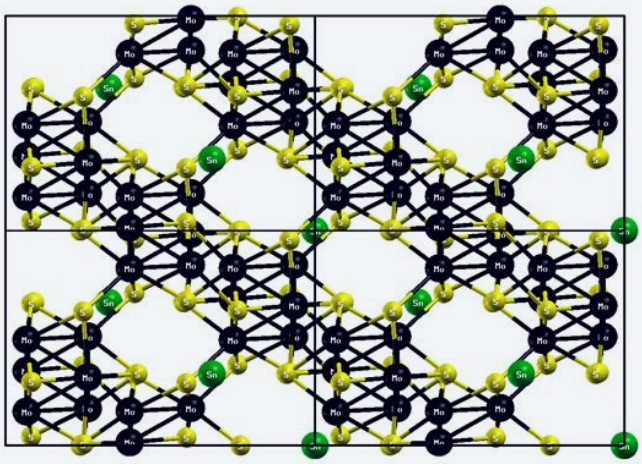


Fig. 1. Simulated cell of $SnMo_6S_8$ to understand structural origin of its unusual vibrational properties.

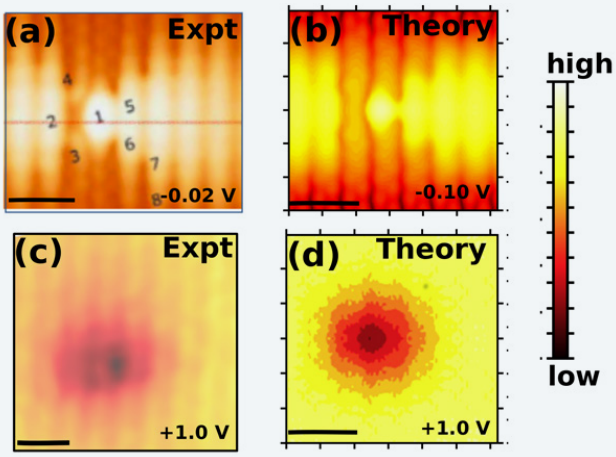


Fig. 2. Experimental and simulated STM images of defects on black phosphorene (Mondal and Narasimhan; Experimental data from Harsh and Lagoute).

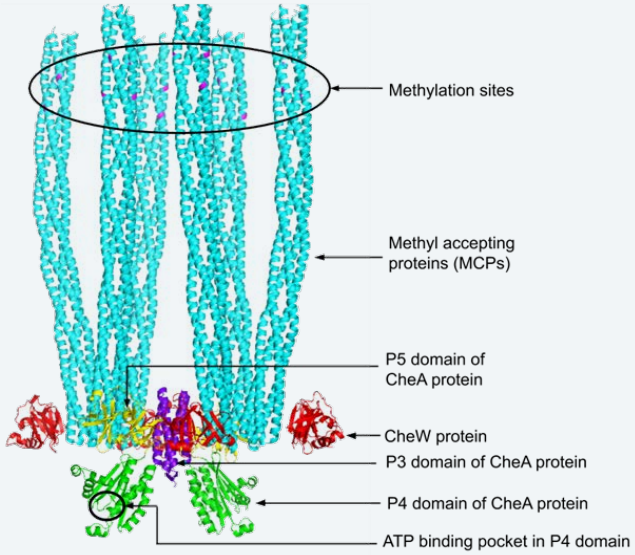


Fig. 3. The signalling system in bacterial motor proteins. The nutrients that are sensed and (un)bound to the receptor proteins allow the bacterial proteins to perform (de)methylation. These activities define the down-stream hydrolysis of the proteins that leads to flagellar movement. The correlations between the different regions in this complex ensemble were uncovered using all-atom molecular dynamics.

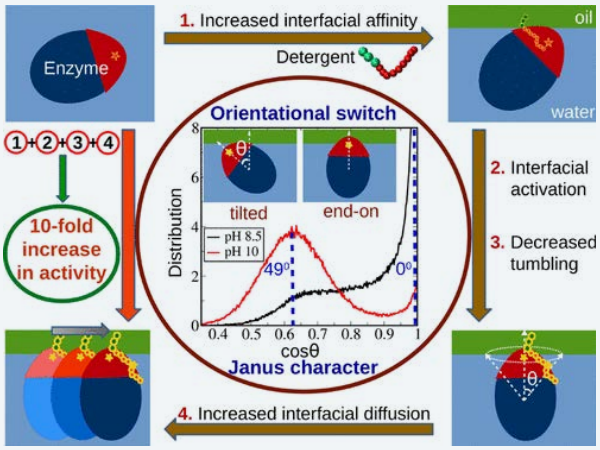


Fig. 4. Orientational switch of Lipase A at oil-water interface and the consequent activity enhancement explained through atomistic MD simulations (Balasubramanian group).

UNIT MEMBERS

Professors

Prof. Balasubramanian Sundaram

Prof. Shobhana Narasimhan

Prof. Srikanth Sastry

Prof. Swapan K. Pati

Prof. Umesh V. Waghmare

Faculty Fellow

Dr. Meher K. Prakash

Research Associate

Devina Sharma

Research Scientists B

Anoop S.

Suresh J.

Helper

Basavaraj T.

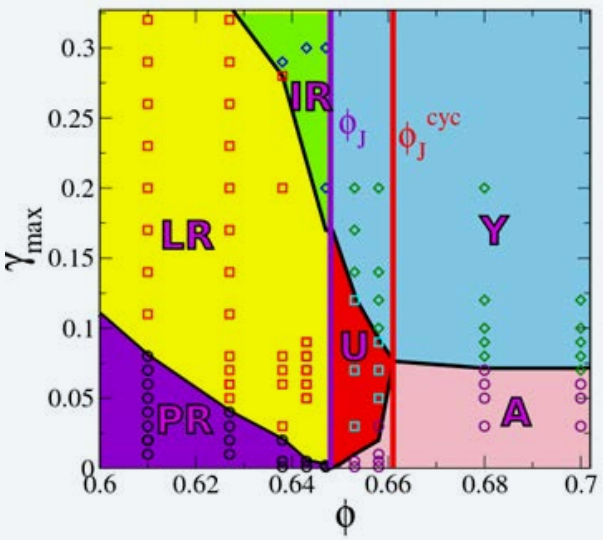
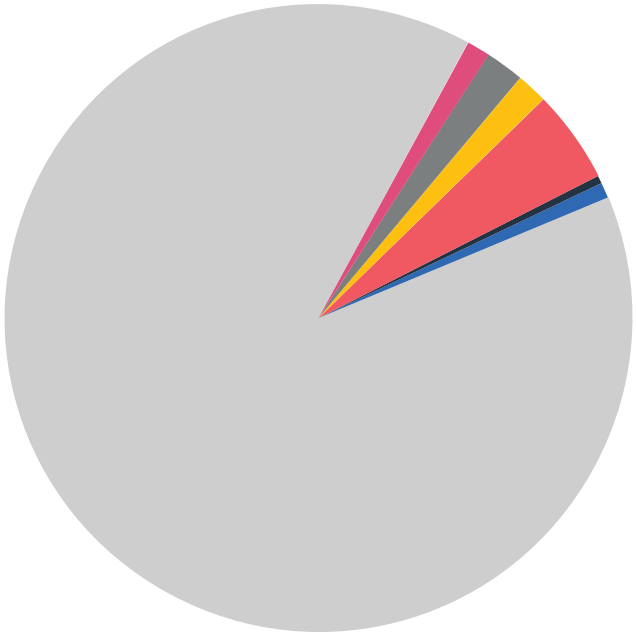


Fig. 5. The response of amorphous matter to externally imposed deformation is of interest in a variety of contexts. We investigated soft-sphere assemblies computationally to obtain a comprehensive understanding of their self-organization and response over a wide range of densities and deformation amplitudes. We constructed a unified phase diagram that exhibits reversible and irreversible regimes as well as transitions among them that embody yielding, jamming, unjamming, and shear jamming phenomena.

FACULTY PUBLICATIONS



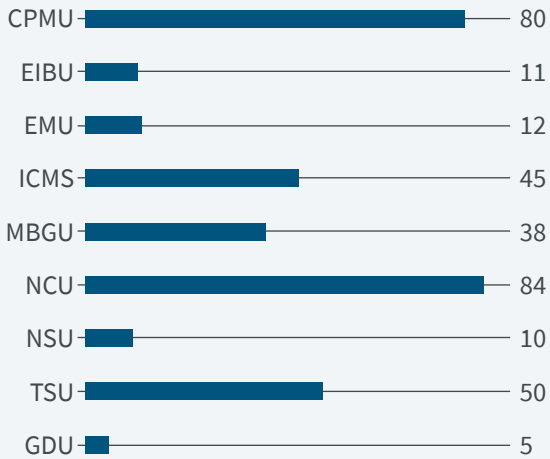
Articles	223
Books	2
Book Chapters	1
Reviews	12
Editorial & Editorial Note	4
Conference papers	5
Meeting abstracts	3

Total publications journals with Impact Factor: **250**

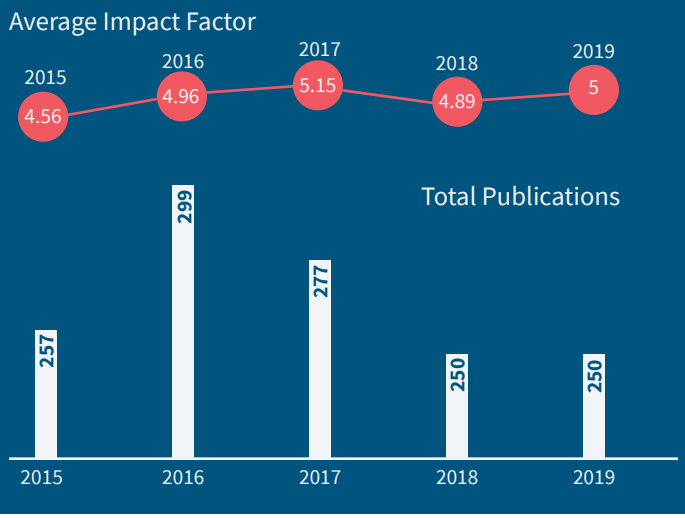
Total Impact Factor: **1351**

Average Impact Factor: **5**

UNIT-WISE PUBLICATIONS



KEY INFORMATION YEAR-WISE



INTELLECTUAL PROPERTY

Intellectual property (IP) assets (IPAs) are collections of 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 realize the importance of IPAs created by its researchers. The Centre encourages and facilitates the creation, development, protection and management of commercially exploitable IPs and its enforcement in addition to fostering Academia-Industry Partnership.

Until now, the Centre has filed 296 National Phase (i.e. foreign countries) and International Phase (i.e. PCT) Patent Applications under Patent Cooperation Treaty and obtained 94 patent grants.

Total IPRs Over the Years Until March 2020

Indian, National, and International Phase Patent Applications Filed - **296**

Patents Granted - **94**

Trade Marks Registered - **2**

Industrial Design Registered – **1**

Copyright Registered – **1**

PATENTS

During 2019-2020, 12 patent applications were filed (India-9, PCT-2, Australia-1) for inventions meeting territorial patentability criteria. The Centre has also obtained 13 (India-11, Japan-1 and USA-1) patent grants.

PATENT APPLICATIONS FILED (2019-20)

Indian Patent Applications Filed

Inventors	Unit	Territory	Application No.	Date of Filing
Jayanta Haldar, Geetika Dhanda	NCU	India (Prov)	201941015155	April 15, 2019
Kanishka Biswas, Subhajit Roychowdhury, Tanmoy Ghosh	NCU	India (Prov)	201941028467	July 15, 2019
Maneesha Shreedhar Inamdar, Saloni Sinha	MBGU	India (Prov)	201941039036	September 26, 2019
Maneesha Shreedhar Inamdar, Saloni Sinha	MBGU	India (Prov)	201941039037	September 26, 2019
Kavassery Sureswaran Narayan, Anil Krishna Konduri, Deepak Sundar Chakram	MBGU	India (Prov)	201941051888	December 13, 2019
Tapas Kumar Maji, Subhajit Laha, Ritesh Haldar	CPMU & NCU	India (Prov)	202041001843	January 15, 2020
Govindaraju Thimmaiah, Yelisetty Venkata Suseela	NCU	India (Prov)	202041009844	March 6, 2020
Govindaraju Thimmaiah, Yelisetty Venkata Suseela	NCU	India (Prov)	202041009838	March 6, 2020
Govindaraju Thimmaiah, Yelisetty Venkata Suseela	NCU	India (Prov)	202041009845	March 6, 2020

International Phase Patent Applications Filed Under PCT

Title of the Invention	Inventors	Unit	Territory	Application No.	Date of Filing
Catalyst, Its Process of Preparation, and Applications Thereof	Sebastian Chirambatte Peter, Soumyabrata Roy, Arjun C.H., Manoj Kaja Sai	NCU	PCT	PCT/IN2019/050873	November 29, 2019
Recombinant Vector Comprising HIV-LTR Promoter, and Associated High Throughput Screening Method	Ranga Udaykumar	MBGU	PCT	PCT/IN2020/050148	February 14, 2020

National Phase Patent Applications Filed Under PCT

Title of the Invention	Inventors	Unit	Territory	Application No.	Date of Filing
Method for Modulating Autophagy and Applications Thereof	Ravi Manjithaya, Piyush Mishra, Suresh Santhi Natesan, Somya Bats, Veena Ammanathan, Aravinda Chavalmane	MBGU	Austraila	2019275604	December 4, 2019

PATENTS GRANTED (2019-20)

Title of the Invention	Inventors	Unit	Territory	Application No.	Date of Filing
A Nanosphere-Histone Acethyltransferase (HAT) Activator Composition and Process Thereof	Tapas Kumar Kundu, Anne-Laurence Boutillier, Snehajyoti Chatterjee, Muthusamy Eswarmoorthy, Puspak Mizar, Chantal Mathis, Jean-Christophe Cassel, Romain Neidl, Mohankrishna Dalvoy Vasudevarao, Vedamurthy Bhusainahalli Maheswarappa	MBGU & CPMU	India	311070	April 10, 2019
Antimicrobial Compounds, Their Synthesis and Applications Thereof	Jayanta Haldar, Chandradhish Ghosh, Gautham Belagula Manjunath, Padma Akkapeddi	NCU	Japan	6533466	May 31, 2019
A Method of Synthesising Intermetallic Compounds and Applications Thereof	Sebastian Chirambatte Peter, Pradeep Prasannamurthy Shanbogh, Udumula Subbarao	NCU	India	314430	June 21, 2019
Semiconductor nanocrystals with defects for high efficiency emission	Ranjani Viswanatha, D. D. Sarma, Anshu Pandey, Shyamashis Das, Biswajit Bhattacharyya	NCU	India	316516	July 22, 2019
A Method of Oxidizing an Organic Compound	Chintamani Nagesa Ramachandra Rao, Ujjal Kam Gautam, Srinivasa Rao Lingampalli	CPMU & NCU	India	317610	August 5, 2019
A Process for Identification and Separation of Xylene Isomers	Ujjal Kam Gautam, Moumita Rana	NCU	India	318791	August 22, 2019
Wing And Propeller System, Method of Optimizing Wing and Propeller/ Rotor System and Method of Reducing Induced Drag	Roddam Narasimha, Suresh Madhusudan Deshpande, Praveen Chandrashekarappa, Rakshith Belur Raghavan	EMU	India	323000	October 17, 2019
A Process for Bromination of Arylene Dianhydrides and a Method of Synthesis of Diimides Thereof	Govindaraju Thimmaiah, Venkata Suseela Yelisetty	NCU	India	326517	December 2, 2019

Title of the Invention	Inventors	Unit	Territory	Application No.	Date of Filing
Chitin Derivatives, Method for Production and Uses Thereof	Jayanta Haldar, Jiaul Hoque, Goutham Belagula Manjunath, Padma Akkapeddi	NCU	India	328346	December 27, 2019
Antimicrobial Compounds, Their Synthesis and Applications Thereof	Jayanta Haldar, Chandradhish Ghosh, Gautham Belagula Manjunath, Padma Akkapeddi	NCU	India	329812	January 21, 2020
An Organic Solar Cell and Methods Thereof	Kavassery Sureswaran Narayan, Anshuman Jyothi Das	CPMU	India	329957	January 22, 2020
Compounds as Stimuli-Responsive Probes, Methods and Applications Thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy	NCU	USA	US 10,544,167 B2	January 28, 2020
Cd-based-Chalcogenide/CDs Core-Shell Nanomaterial, Defective/ Defect-Free Core Nanocrystal, Methods and Applications Thereof	Ranjani Viswanatha, Avijit Saha, Kavassery Sureshwaran Narayan, Kishore Velichappattu Chellappan	NCU & CPMU	India	331127	February 3, 2020

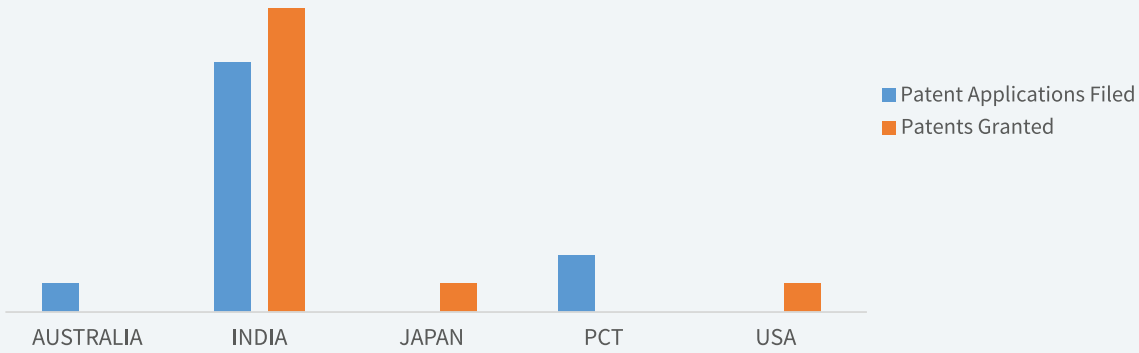
Technologies Transferred

During 2019-2020, three patented technologies (viz. 1. A Polymer Network, Method for Production, and Uses Thereof, 2. Cationic Antibacterial Composition, and 3. Glycopeptides Conjugates and Uses thereof) developed by Prof. Jayanta Haldar et al has been licensed to M/s. Vipragen Biosciences Pvt. Ltd.

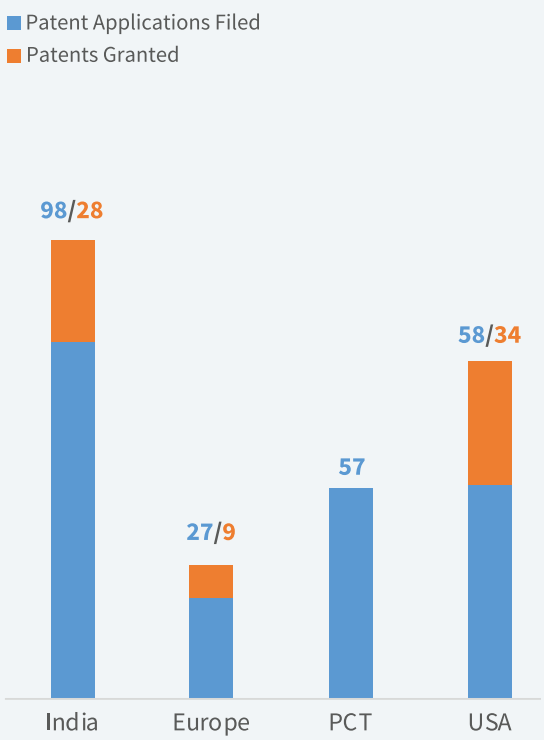
Two scientific know-how licensing agreements have been executed viz.

1. Stable PC4 Knockdown HEK293 Cell Lines to M/s. Applied Biological Materials Inc.
2. Bench-mark clinical data and the associated know-how for development of Computer Imaging assisted tools for the prediction of Fractional Flow Reserve using fluid dynamics technology, M/s. Sankhyasutra Labs Pvt. Ltd.

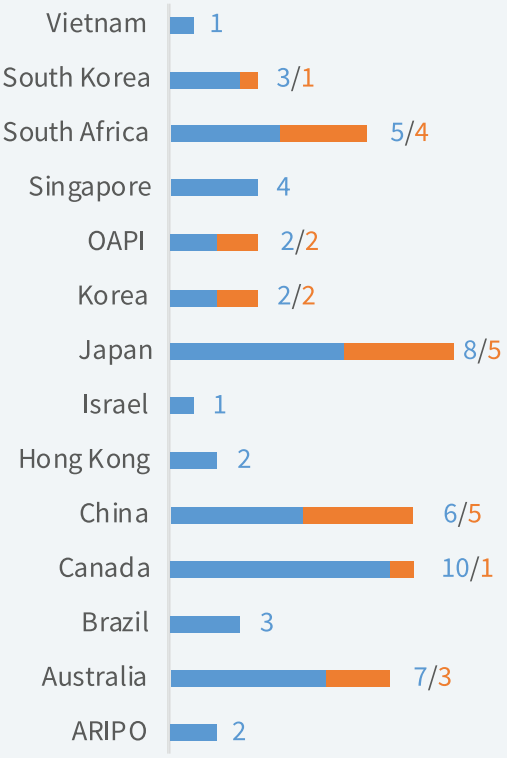
OVERVIEW OF INTELLECTUAL PROPERTY (2019-2020)



TERRITORY-WISE DISTRIBUTION OF IP (since inception till March 31, 2020)



MAJOR TERRITORIES



OTHER TERRITORIES

IPR Team

Dean, Research & Development

Prof. K.S. Narayan, Ph.D., FNASc, FASc, FNA, Sir J. C. Bose National Fellow
(until April 2019)

Prof. Chandrabhas Narayana, Ph.D., FASC, FRSC, FNASc
(May 2019 onwards)

Technical Officer Gr. I

A.V. Nagarathnamma

Office Executive

H.C. Kavyashree

AGREEMENTS SIGNED

Memorandum of Understandings

The memorandum of understandings signed during 2019-2020 were as follows:

Sl. No.	Title of the agreement	Signed on	Signatory/PI
1	MoU between Aster CMI Hospital and JNCASR	June 17, 2019	Administration
2	Renewal of MoU Between YourDost Health Solution Pvt. Ltd., Bengaluru and JNCASR	November 20, 2019	Dean (Academic Affairs)
3	MoU between Centre for Development of Advanced Computing, Bengaluru and JNCASR	December 5, 2019	Prof. Srikanth Sastry
4	MoU between Indian Space Research Organisation (ISRO) and JNCASR	April 15, 2020	Dr. Diwakar S. V.

Non-disclosure Agreements

Sl. No.	Title of the agreement	Signed on	Signatory/PI
1	Amendment agreement for Intellectual Property License agreement between VNIR Biotechnologies Pvt. Ltd. and JNCASR	July 9, 2019	Prof. Meher K. Prakash and Prof. Govindaraju T.
2	Agreement between JP Badminton Academy, Bengaluru and JNCASR	July 11, 2019	Administration
3	Research Agreement between Tata Steel Ltd., Mumbai and JNCASR	July 24, 2019	Prof. Kanishka Biswas
4	Intellectual Property Rights License and Commercialization agreement between VIPRAGEN Biosciences Pvt. Ltd. and JNCASR	August 2, 2019	Prof. Jayanta Haldar
5	Know-How License Agreement Between Applied Biological Materials Inc., Canada and JNCASR	August 27, 2019	Prof. Tapas K. Kundu
6	Technology Support Agreement between Breathe Applied Sciences Pvt. Ltd. and JNCASR	October 16, 2019	Prof. Sebastian Peter and Prof. Umesh Waghmare
7	Confidential agreement between Max-Planck Institute for Chemical Physics of Solids and JNCASR	December 4, 2019	Prof. C.N.R. Rao and Uttam Gupta
8	Data License and Data Generation agreement between Jayadeva Institute of Cardiovascular Sciences and Research, Sankhyasutra Labs Pvt. Ltd. and JNCASR	January 7, 2020	Prof. Santosh Ansumali
9	Collaborative Research Agreement between Sankhyasutra Labs Pvt. Ltd., Bengaluru and JNCASR	March 17, 2020	Prof. K.R. Sreenivas

TECHNICAL RESEARCH CENTRE (TRC)

Principal Investigator (Ex-officio):
Prof. G.U. Kulkarni, President, JNCASR

Co-ordinator: Prof. K.S. Narayan

In-charge - Business Relations/Technology Promotions (TRC): Dr. Sourabh Gargav

Consultant: Dr. Kripa V. Jalapathy

TRC at JNCASR was established in 2016 with support from the Department of Science & Technology, Government of India. TRC is a multifaceted platform that aims to provide support to scientists and researchers of JNCASR to achieve translation of research into products and processes for greater economic and societal benefits. Accordingly, TRC at JNCASR has been instrumental in building R&D translation ecosystem by supporting advancements in technology readiness, R&D capabilities, and intellectual properties, streamlining multi-stakeholder involvement (including industry-academia partnerships), technology out-licensing, setting-up platforms for start-ups, and strengthening state-of-the-art R&D infrastructure.

Recently, TRC initiated two new translational R&D projects. The first is the "Hypothesis-free clinical diagnosis via macrocyclic 'chemical-nose' sensor" undertaken by Dr. Sarit Agasti (NCU/CPMU), wherein the team, in collaboration with a hospital, is developing a chemical nose sensor, which can aid in sample testing and validation, thereby increasing the possibility of technology absorption by the wider community. The second is the "Development of Next Generation Materials for Water Purification, Storage and Harvesting" project, undertaken by Prof. Tapas K. Maji (CPMU).

TRC also helps in setting up state-of-the-art R&D infrastructure, with the Spectroscopic Ellipsometry being a recent addition. These facilities are being offered as services to the wider research community, both from academia and industry. To take the legacy and learning forward, TRC has been working to converge into a technology development and business incubator. As part of TRC's promotional activities, a short course on "Spectroscopic Ellipsometry" was organized at JNCASR. The participants included external academic and industrial users apart from the JNCASR community.

Under its technology commercialization activities, TRC facilitated a data license and data generation agreement with an industrial collaborator for the development of a method for cardiovascular prognosis and diagnosis based on the computer imaging assisted tools and prediction of Fractional Flow Reserve using fluid dynamics.

JNCASR out-licensed a set of antimicrobial assets, covered in three patents, which are on their route to pre-clinical and clinical testing and drug development, wherein the licensee (a biotech company) is roping-in financial and scientific resources for further development and trials of the compounds. The compounds owing to their unique properties are poised to work against resistant strains of an array of microorganisms, which is the need of the hour.

Image: Spectroscopic Ellipsometry workshop organized by TRC in collaboration with J.A. Woollam Co., Inc., USA, from November 4–5, 2019.

A study that provided the first direct evidence of an interlink among chromatin, nuclear architecture, chromatin state, and the process of autophagy, via the stable PC4-knockdown HEK293 cell line(s) has been licensed to an industrial partner.

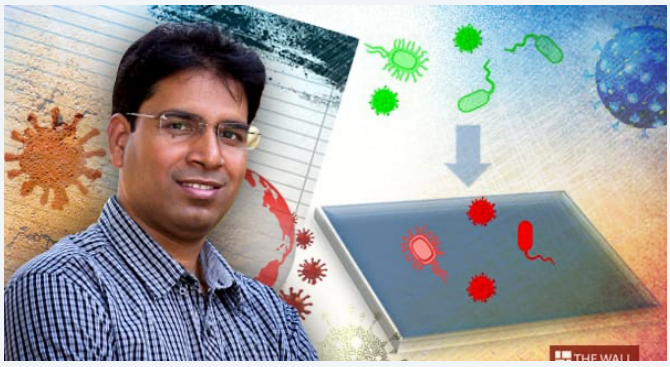
On the advanced materials front, TRC-funded JNCASR scientists entered into a collaboration agreement with Tata Steel Limited to convert the heat generated at iron/steel plants into electricity by deploying new devices with safe and efficient thermo-electric materials.

To develop and deploy a solution towards the fight against SARS-CoV-2, Prof. Jayanta Haldar and his team (NCU, JNCASR) developed an antimicrobial coating that can prevent surface-mediated spread of infections, and is observed to be efficacious against different drug-resistant bacteria, fungi, and viruses, including Influenza, and thus, may also be effective against SARS-CoV-2. While several novel compounds are being tested against SARS-CoV-2, TRC has been in discussions with multiple companies to deploy products based on the said technology.

MEDIA REPORTS

MEDIA REPORTS

The Centre has been in news for various achievements. The accomplishments that appeared between April 2019 and March 2020 have been listed below:



Surface-coating developed by JNCASR scientists has the potential to prevent transmission of infection

Prof. Jayanta Haldar and his team have developed anti-microbial coating that can be sprayed onto surfaces such as cotton, polyurethane, polystyrene, polyvinyl chloride to contain the spread of deadly community-acquired and hospital-acquired infections. This coating may be potent against the SARS-CoV-2.

Major news sources reporting this achievement are:

"Coating developed by JNCASR may prevent transmission of infection".
DST S&T Articles, April 01, 2020. **https://bit.ly/3gX5IPA**

"Coating developed by JNCASR may prevent transmission of infection",
Press Information Bureau (PIB Delhi), April 01, 2020. **https://bit.ly/30Sw13E**

"JNCASR develops versatile coating to stop spread of viruses like influenza and COVID 19",
Vigyan Samachar, April 06, 2020. **https://bit.ly/2PNrMQK**

"Indian researchers develop coating that kills Covid",
The Tribune, April 02, 2020. **https://bit.ly/31ULI9M**

"জড় বস্তুর ওপরে থাকা ভাইরাস মরবে ৩০ মিনিটেই, অ্যান্টি-মাইক্রোবিয়াল কোটিং বানাচ্ছেন বাঙালি বিজ্ঞানীরা"
The Wall, April 05, 2020. **https://bit.ly/2PTylBo**

"Covid-19: Scientists offer special 'coating' to contain virus",
The Times of India, March 29, 2020. **https://bit.ly/3fVh8lz**

"JNCASR coating may prevent COVID-19 transmission",
Indian Chemical News, April 02, 2020. **https://bit.ly/3iGd8qN**

"JNCASR ने बनाई एंटी-कोरोना कोटिंग, कपड़ों और प्लास्टिक पर लगाने से मरेंगे कोरोना वायरस!",
Navoday Times, April 03, 2020. **https://bit.ly/31UnCfD**

"JNCASR Develops Versatile Coating To Stop Spread Of Viruses",
NDTV Education, April 06, 2020. **https://bit.ly/3gWVgrg**

The 11th edition of Bengaluru India Nano

The 11th edition of Bengaluru India Nano, one of the front running events of the Department of Information Technology (IT), Biotechnology (BT) and Science & Technology (S&T), Government of Karnataka with the theme 'New Dimensions in Nanoscience and Nanotechnology for Industry 4.0' was inaugurated by Chief Minister B S Yediyurappa. Bengaluru India Nano is mentored by India's foremost scientist Prof. C.N.R. Rao, FRS, Chairman, Vision Group of Nanotechnology, Government of Karnataka. At this event, JNCASR showcased research work related to eco-friendly batteries, nanotechnology tools developed for agriculture, and novel approaches to tackle microbial infections.

BioSpectrum, March 3, 2020. **https://bit.ly/2Cuy9p4.**

The Viral Explosion: A State-Wise Projection Map For COVID-19 In India

Scientists at JNCASR and IISc have developed a predictive computer model that captures the trends of emergency and other supplies that will be required during the pandemic situation and capture the pattern of viral spread in the population. The model provides state-wise projections that can aid in better management of the situation. "The Viral Explosion: A State-Wise Projection Map For Covid-19 In India", Swarajya Magazine, March 25, 2020 (https://swarajyamag.com/science/the-viral-explosion-a-state-wise-projection-map-for-covid-19-in-india) and "States will be hit by Covid-19 wave in different time-frames: Projection",

Times of India, March 27, 2020.
https://bit.ly/3iRFYor

The 8th International Conference on Perspectives in Vibrational Spectroscopy (ICOPVS) at JNCASR, Bengaluru

8th International Conference On Perspectives in Vibrational Spectroscopy (ICOPVS)

JNCASR organized the 8th International Conference On Perspectives in Vibrational Spectroscopy (ICOPVS) to discuss recent advances and research in the field of vibrational spectroscopy.

Indus Dictum, March 4, 2020.
https://bit.ly/3kIbUgp

MEDIA REPORTS

Keeping electronic devices cooler with nanoscale superlattice materials

Dr. Bivas Saha and his team at JNCASR, Bangalore are working on a project funded by the Department of Science and Technology and have succeeded in recovering waste heat generated by their operation to make them more energy-efficient and extend their lifetimes.

Vigyan Samachar, DST, GOI.
https://bit.ly/3fY9arP

JNCASR scientists fabricate energy-efficient photodetector for security application

Prof. G.U. Kulkarni and his team fabricated an energy-efficient and cost-effective photodetector that can have significant value in security applications.

Vigyan Samachar, DST, GOI.
https://bit.ly/30VDZt2

Women Scientists at the Forefront of Energy Research

Prof. Ranjani Viswanatha was featured in an article celebrating the contributions of female energy researchers who have published new advances from their laboratories in the "Women Scientists at the Forefront of Energy Research: A Virtual Issue, Part 2", ACS Energy Letters.

Energy Lett, 2020. 5(2):623-633.

Discovery of Thermionic Energy Conversion Technique

Dr. Bivas Saha and his research group in collaboration with researchers from Faculty of Engineering, University of Sydney @Eng_IT_Sydney discovered Thermionic energy conversion with multilayers of thermally stable epitaxial ZrN & carrier-compensated $Sc_{0.99}Mg_{0.01}N$. This work was published in J Mat Sci (2020) 55:1592–1602.

Twitter **(https://bit.ly/3iDcpXq)**

Quantum Dot Lab group discussion at JNCASR Foyer.
Photo Courtesy: Pradeep K. R.

Team ZincAir from JNCASR won the silver award at KPIT Sparkle 2020 iInnovate Contest

Team ZincAir from JNCASR won the silver award at KPIT Sparkle 2020 iInnovate Contest, an innovation platform that supports aspiring entrepreneurs and helps them transform their inventive ideas into viable products. Team ZincAir designed a bi-functional material for making efficient and eco-friendly rechargeable zinc-air battery for electric vehicles.

https://bit.ly/2CryY1V

JNCASR among 'Top 50 Young Universities in Chemistry' in Nature Index 2019.
NDTV, January 8, 2020.

https://bit.ly/3iIt3Vo

Scientists Solve 50-Year-Old Mechanics Problem

The work by Prof. Rajesh Ganapathy's laboratory and his collaborators on the anomalous dynamics of 2D liquids (Li *et al*, PNAS 2019) was covered by numerous international popular science news outlets:

"Scientists Solve 50-Year-Old Mechanics Problem",
Popular Mechanics, January 14, 2020. **https://bit.ly/2XUQNOn**

"Physicists prove that 2D and 3D liquids are fundamentally different",
Science Daily, January 14, 2020. **https://bit.ly/2DSKe7Z**

EurekAlert (AAAS), January 13, 2020. **https://bit.ly/342SRHR**

Nanowerk News, January 14, 2020. **https://bit.ly/3gV5iJm**

phys.org, January 14, 2020. **https://bit.ly/3ixRVPQ**

Roving male: Ghatotgaja, a male aged above 45 years, sighted in musth. Temporal gland secretion is visible as a dark stain behind and slightly above the eye.

Musth does not necessarily give younger, male Asian elephants an edge

A 7-year study on Asian elephants from Nagarahole-Bandipur near Kabini conducted by Prof. T.N.C. Vidya's team from JNCASR (EIBU) was reported in the media recently. The study revealed interesting patterns of male elephant behaviour when in musth.

The Hindu, December 28, 2019.
https://bit.ly/3fQ08Ny

Tackling drug-resistant *A. baumannii*

Prof. Jayanta Haldar and his team developed a novel molecule that shows high antibacterial activity against multidrug-resistant *Acinetobacter baumannii,* an important pathogenic strain.

The Hindu, December 14, 2019.
https://bit.ly/3gRyjWm

MEDIA REPORTS

C.N.R. Rao conferred honorary doctorate

Prof. C.N.R.Rao was conferred with an honorary doctorate in science at a special convocation ceremony organised by the University of Kerala.

The Hindu, December 11, 2019.
https://bit.ly/2E3P1mK

Governor and Chancellor of the University of Kerala Arif Mohammed Khan confers the Doctor of Science Honoris Causa on Prof C.N.R. Rao at a special convocation in Thiruvananthapuram on Tueday. Higher Education Minister K.T. Jaleel looks on. | Photo Credit: S GOPAKUMAR

JNCASR Researcher awarded India Alliance fellowship to explore regulators of DNA metabolism',

Dr. Kushagra Bansal, faculty member at MBGU of JNCASR was recently awarded the Wellcome Trust/DBT India Alliance Intermediate Fellowship under basic biomedical research category.

Vigyan Samachar.
https://bit.ly/3fWZJss

IISER Pune, JNCASR & IISc Bengaluru scientists win CSIR-CDRI Awards for drug research

Dr T. Govindaraju from JNCASR received the CDRI (Central Drug Research Institute) award for excellence in the field of chemical science.

Indus Dictum, November 25, 2019.
https://bit.ly/2PNIfEy

Dr T. Govindaraju from Jawaharlal Nehru Centre For Advanced Scientific Research (JNCASR), Bengaluru, receives the award.

Celebrating Ecology and Evolution in India

The EIBU faculty along with the Indian Society of Evolutionary Biologists (ISEB) organised its first conference at JNCASR and an Indo-Swiss Meeting on Evolutionary Biology at the Centre for Human Genetics.

Research Matters, October 24, 2019.
https://bit.ly/2DY4qpc

India Bioscience
https://bit.ly/2E2B6O5

When scientists become startup founders

Prof. Sebastian C. Peter from NCU, JNCASR is the co-founder of Breathe Applied Sciences, a start-up venture established in 2016 and incubated at JNCASR campus for developing the technology to convert carbon dioxide from combustion fuel gas into useful and environment-friendly chemicals like methanol.

Livemint, October 1, 2019.
https://bit.ly/3kQbVPt

Genes implicated in bipolar disorder identified

The decade-long study by Prof. Anuranjan Anand and his team identified two specific genes that may be related to bipolar disorder, a neuropsychiatric disorder that is still poorly understood.

The Hindu, September 21, 2019.
https://bit.ly/3kNXtb0

How female elephants compete for patchy food availability

Prof. T.N.C. Vidya and team studied female Asian elephant clans in the grassland areas at Kabini, during the dry seasons of the year 2015 and 2016 and found that between-clan individual-level agonism is more frequent than within-clan agonism.

The Hindu, October 12, 2019.
https://bit.ly/2E2B6O5

Pachyderm agonists: Sunetra (right), the initiator from Victoria's clan, is seen approaching Nandini (left), who belongs to Nakshatra's clan, and is trying to check her. | Photo Credit: Hansraj Gautam

The 'ELEMENTS' exhibition in Bengaluru

Science Gallery Bengaluru teamed up with JNCASR to celebrate the International Year of the Periodic Table by organising a week-long interactive exhibition called *"ELEMENTS: Stuff that matters"*.

The Print, October 9, 2019.
https://bit.ly/2E3SSAe

MEDIA REPORTS

Prof. Maneesha S. Inamdar selected to be a member of the World Health Organization Expert Advisory Committee

Prof. Maneesha S. Inamdar has been selected to be a member of the World Health Organization Expert Advisory Committee on Developing Global Standards for Governance and Oversight of Human Genome Editing. *World Health Organization*, August 29, 2019.
https://bit.ly/2XYNhTd

Bhatnagar Award: 3 Bengaluru scientists honoured

Tapas K. Maji (CPMU, JNCASR) has been selected for the Shanti Swarup Bhatnagar Award in the category of Chemical Science.
Deccan Herald, September 26, 2019.
https://bit.ly/30Vhft1

Tapas Kumar Maji from Jawaharlal Nehru Centre for Advanced Scientific Research

India gets another supercomputer today, says will soon make our own

As part of the National Supercomputing Mission declared in 2014, a supercomputer has been set up at JNCASR.

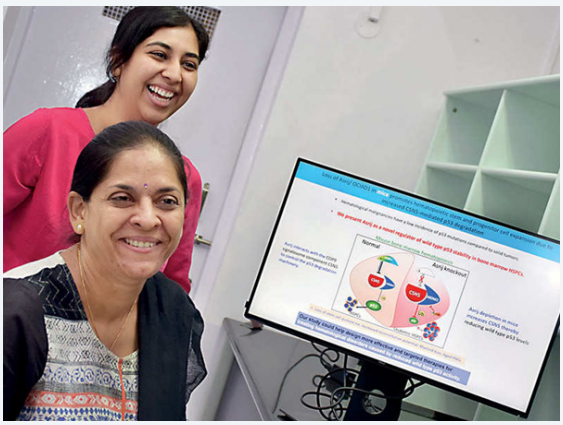
Hindustan Times, September 14, 2019.
https://bit.ly/3g4hiat

BIRAC-SRISTI Gandhian Young Technological Innovation award

Ms. Ananya Mishra (NCU, JNCASR) was one among fifteen students to receive the BIRAC-SRISTI Gandhian Young Technological Innovation award.

GYTI Awardees 2019, July 6, 2019.
https://bit.ly/3fX1eXQ

Bengaluru team inches closer to cancer cure?



Maneesha S Inamdar (sitting) and Saloni Sinha at their lab in JNCASR

Prof. Maneesha S. Inamdar and her team at JNCASR (MBGU) recently discovered a stem cell protein named *asrij,* which seems to play a key role in pathogenesis of myeloproliferative diseases. Their findings can aid in developing novel therapeutics against leukaemia.

Times of India, April 13, 2019.
https://bit.ly/30ViYhV

Remotely sensed indices unreliable in informing elephant forage

Prof. T.N.C.Vidya's team showed that the normalized difference vegetation index (NDVI) cannot be reliably used as a measure of forage abundance in a multi-storeyed forest with a low proportional abundance of food species.

The Hindu, June 22, 2019
https://bit.ly/2Y0ndal

JNCASR's molecule improves recovery after spinal cord injury

A team led by Tapas Kumar Kundu (MBGU, JNCASR) synthesized a small molecule, which when combined with 400 nanometre-size carbon nanospheres as carriers, can effectively promote repair of spinal cord injury.

The Hindu, April 13, 2019
https://bit.ly/30ViYhV

Cbp-mediated acetylation level is important in making new neurons and extending the length of the axons connecting injured neurons, says Tapas Kumar Kundu.

JNCASR finds key protein conferring radiation sensitivity in cancer cells

Researchers at JNCASR discovered a key autophagy pathway involved in radiation resistance of cancer cells. These findings can help in treatment of cancer patients that show resistance to gamma radiation during treatment.

The Hindu, June 15, 2019
https://bit.ly/2Y26CCP

Mystery unravelled: This is the first time any study has shown that genome organisation is directly responsible for autophagy regulation in cells, say Sweta Sikder (left), Tapas Kundu and Ravi Manjithaya.

A raft of soap bubbles remembers its past

Srimayee Mukherji, her master's thesis adviser Prof. Rajesh Ganapathy at JNCASR and their co-researchers, Prof. Ajay Sood and Neelima Kandula in Bengaluru, India, have shown experimentally that they can manipulate the information contained in a raft of soap bubbles (*Phys Rev Lett.* 2019. 122:158001).

Physics Today, July 19, 2019.
https://bit.ly/3atJpyv

FELLOWSHIPS & EXTENSION

For science research to make an impact on society, it is important to communicate research findings with as well as increase scientific awareness among the public, especially young minds. With this as one of its missions, JNCASR carries out several outreach programmes and events and fellowship activities for individuals at the school and college levels. These are conducted by the Education Technology Unit, and a full-fledged Fellowship and Extensions Programme Office. The following section outlines the achievements of the outreach wing of JNCASR.

FELLOWSHIPS AND EXTENSION PROGRAMMES (F&E)

In addition to the academic degree programmes, the Centre also offers Fellowship Programmes, whose brief description is given below:

Student Buddy Programme

This programme is offered to school/junior college students (class XI and XII) to give them the opportunity to learn about the latest advances in science and engineering, along with a taste of life in research. It also gives research scholars at the Ph.D. and postdoctoral level an opportunity to participate in educational programmes and inculcates a sense of responsibility towards education. Each school student spends a day of individual interactions with a research scholar in a scientist's group observing and/or participating in ongoing research or discussions. During 2019, 60 students and 4 teachers from Jawahar Navodaya and Kendriya Vidyalaya schools from Karnataka have benefitted. Under this programme since its inception 2015, so far 434 students and 33 teachers have participated in this programme.

Summer Research Fellowship Programme (SRFP)

This is a flagship programme of the JNCASR, introduced in 1991, and is meant for science and engineering undergraduate and post-graduate students, who are placed at institutes of repute all over the country, for two months training in the areas of their interest in the Life Sciences, Chemical Sciences, Physical Sciences, Mathematics and Engineering. Selection is based on purely merit on all India basis. Approximately 150 fellowships are offered each year. The admitted students are provided a fellowship of Rs. 10,000/- per month. This is one of the highly acclaimed programmes of the Centre and the students are very appreciative of the benefits, and are inspired towards scientific research during the early stage of their education. Several SRFP fellows have pursued a career in science, maths or engineering and hold responsible positions in India and abroad. During 2019, out of 2020 applications received, 147 were offered and 130 students availed fellowship under this programme. Since its inception in 1991, 2430 students have benefitted from this programme.

Project Oriented Chemistry Education (POCE)

POCE is a three-year diploma programme started in 2004 with a focus to inculcate an interest in chemical science and research in undergraduate science students. Approximately 10 meritorious students pursuing Bachelor's degree in Chemistry are selected from across the country each year. Students after their first year of B.Sc. visit the JNCASR for three years during semester breaks. They learn through structured lecture programmes given by highly accomplished scientists of the Centre as well as from other institutes in Bangalore. On successful completion of the programme, they are awarded a Diploma in Chemistry. Most of them are pursuing science/research education in renowned research institutions in the country and abroad. In 2019, out of 388 applications received, 10 were offered this opportunity, and all 10 availed of the fellowship. Since its inception in 2004, 122 students from different colleges across the country have benefited from this programme.

Project Oriented Biology Education (POBE):

Similar to POCE, approximately 10 meritorious students pursuing first-year B.Sc. in Life sciences are selected from across the country each year. On successful completion of the programme, they are awarded a Diploma in Biology. In 2019, out of 453 applications received, 11 were offered this opportunity, and 10 students availed of the fellowship. Since its inception in 2006, 96 students from different colleges across the country have benefited from this programme.

Institutional Visits during 2019-2020

To popularise science and encourage motivated students to pursue science education/research, the Centre encourages visits of students and teachers from colleges/universities/schools to the Centre. During the period 2019-20, 776 number of students and teachers from 16 different schools/colleges have visited the Centre.

Mid-Level Scientist/technocrats from DRDO/ISRO/ NAL/ICMR/DAE/ICAR/CSIR/TSIR and universities who were part of DST-sponsored training programme conducted by NIAS, visited JNCASR on 19.12.2019 and appreciated the ongoing research works.

Visiting Fellowships Programme:

This programme was initiated to foster collaborations with the Centre's faculty and provide research opportunities to faculty/scientist working in State or Central Universities and R&D laboratories in India. Visiting fellows are associated with faculty of JNCASR, and the research work is carried out at JNCASR. The research can be conducted in the following areas: Life Sciences (including molecular and developmental biology, chronobiology, genetics, ecology, behavior, 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 and experimental nanobiotechnology); Engineering Sciences (including fluid dynamics, nonlinear dynamics, and thermal and chemical engineering); and Atmospheric Sciences.

This programme has been welcomed by many young researchers, as they are able to hone their skills or develop research laboratories in their parent establishment after undergoing research training at the Centre. In 2019, out of 23 applications received, 17 were offered and 03 research scientists/faculty members availed of the fellowship and were hosted by the faculty members of CPMU, MBGU and ICMS. Since its inception in 2006, 111 research scientists/ faculty members have benefited from this programme.

FELLOWSHIPS AND EXTENSION PROGRAMMES (F&E)

International Women's Day (IWD) 2020

The Centre organized many events on the eve of IWD 2020 as follows:

1. **Mini Marathon:** A run was organized on March 8, 2020 at 6 a.m. from I-House at JNCASR to the nearby Rachenahalli lake's inner boundary, covering a distance of about 5 km. There was enthusiastic participation by ~150 individuals (students/faculty/staff). The run was flagged off by Prof. Ranjani Viswanath, organizer of IWD and Prof. Umesh V Waghmare, Dean of Academic Affairs at 6 a.m. and ended at 7:30 a.m.

2. **Panel Discussion:** The panel discussion on "Challenges of Upcoming Women in Science, Technology, Engineering, and Mathematics (STEM)" by eminent Scientists was held on March 9, 2020, and was moderated by Prof. Ranjani Viswanath. A survey was conducted among women students, post-docs, and R&D assistants to find out the challenges faced by them and their suggestions regarding potential solutions to overcome them. The summary of the survey was presented to the audience and panel members. The panel members expressed their expert views on various important issues hindering women's progress in STEM in particular.

3. A lecture on "Challenges in health and career management in women" was delivered for the benefit of women at JNCASR in particular and JNCASR community in general by Dr. Prathiba Nadig, M.D., Head of Pharmacology, Vydehi Institute of Medical sciences and Research Centre, Bangalore on March 9, 2020 at 5 p.m. The lecture was attended by approximately 75 members and well received.

National Science Day - 2020

JNCASR celebrated National Science Day 2020 on February 28, 2020 with the theme "Women in Science" with a range of events starting from talks, a panel discussion and an 'open day' where all laboratories showcased their research along with posters and exhibits. The event saw approximately 250 students from Undergraduate and Master's courses coming to the campus from colleges across Bangalore city and from nearby areas. Prof. Shobana Narasimhan's talk on "Women who changed Science" gave a historical perspective on some notable women scientists and discussed inherent biases in perception of women as leaders in the scientific arena. Ms. Svathi Bhogle's talk on her journey as a scientist, technologist and social entrepreneur was illuminating in pointing out the potential roles that women scientists must fill to counter the many challenges that face our futures. Dr. Indumati Rao's talk prompted the audience to think about the importance of ensuring science education in the remotest parts of our country and highlighted that many women who may not have been scientists themselves have contributed to the flourishing of science over the centuries.

A panel, which included the speakers and two other faculty members of JNCASR, namely Prof. Hemalatha Balaram, Dean of Academics and Prof. Rajendran, Geodynamics Unit, enabled discussions between panelists and the audience on various aspects. These included discussions on what factors facilitate the entry and success of girls and women in scientific institutions, the need for societal change in perceptions of the abilities of women scientists and possible changes in policy that can ease the current obstacles that are uniquely faced by women.

Group photo of participants and JNCASR faculty during the National Science Day celebrations.

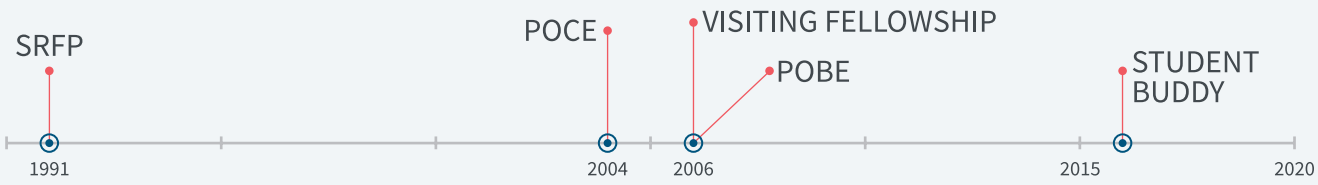
Ph.D. students from Evolutionary and Integrative Biology Unit demonstrating their work during the Open Day

Dr. Jaishri Sanwal, Scientist, Geodynamics Unit, explaining the work done by researchers of the Unit on the earthquakes in the Himalayas.

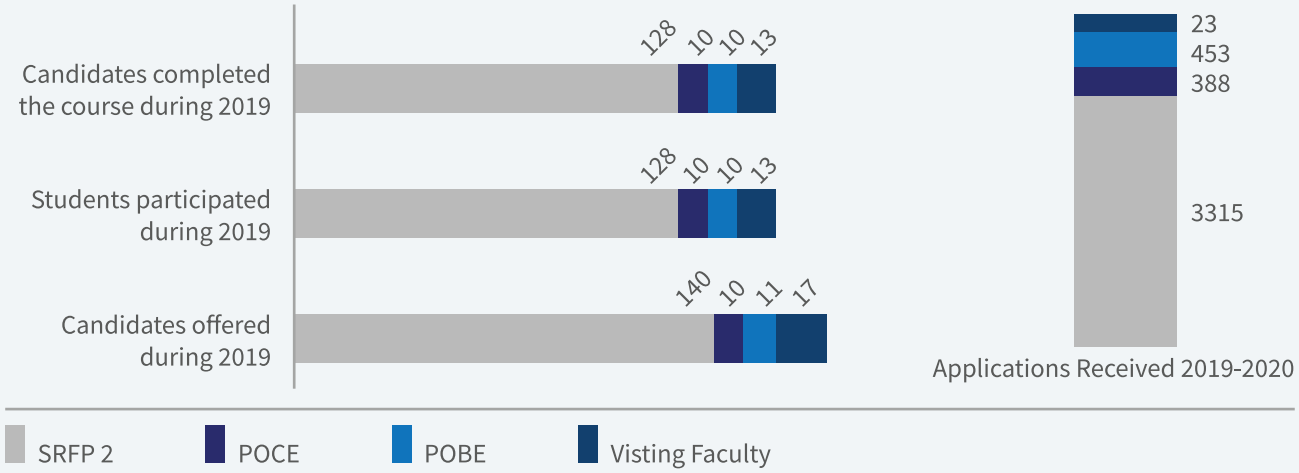
Ph.D. students from the Neuroscience Unit demonstrating their work during the Open Day

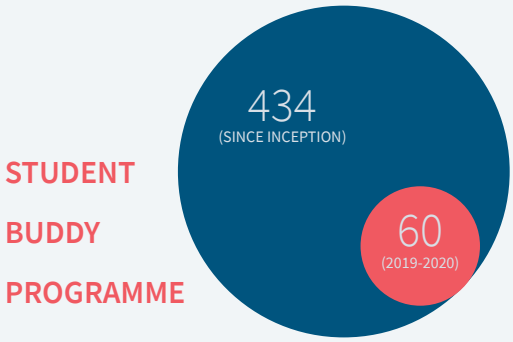
OVERVIEW OF FELLOWSHIPS AND EXTENSION PROGRAMMES

TIMELINE OF ESTABLISHMENT OF PROGRAMMES



PARTICIPATION IN 2019-2020





UNIT MEMBERS

Dean, Fellowships & Extension Programmes
Prof. N.S. Vidhyadhiraja, Ph.D.

Academic Co-ordinator
Dr. Princy J. Pereira, Ph.D.
(on lien w.e.f., November, 2019)

Dr. Paneer Selvam, Ph.D.
(November 2019 onwards)

Sr. Admin Assistant Gr. I
Bannaih R.

EDUCATION TECHNOLOGY UNIT (ETU)

Science outreach programme conducted at Gangolihat, Uttarakhand from May 6-8, 2019, organised by Himalayan Gram Vikas Samiti, Uttarakhand and CNR Rao Hall of Science. Faculty members from JNCASR, IIT Bombay, and Kumaun University, Uttarakhand gave lectures and demonstrated experiments in Physics and Chemistry. Around 150 XI & XII students from across Uttarakhand participated.

International Year of the Periodic Table conducted at the J.N. Tata Auditorium, IISc, Bengaluru organised by JNCASR, CeNS, and IISc on May 29, 2019; and at Srujana Rangamandira, Karnataka College, Dharwad organised by Karnataka State Higher Education Academy, JNCASR and CeNS on September 6, 2019. Prof. C.N.R. Rao inaugurated the event and delivered a talk on "The periodic table". Dr. Indumati Rao delivered a lecture on "The Agony and Ecstasy of Mendeleev's Life". Participants were shown various science demos on superconductivity and levitation and a display of the elements in their real states. A series of games and quizzes based on the periodic table were also conducted. ~850 PUC students and teachers (Bengaluru). ~750 PUC students and teachers (Dharwad) participated in this event.

2018 Prizes for Outstanding Science Teachers organised by ETU on July 2, 2019. The award winners were Shri. B.S Gireesh and Shri. Ajay Kumar Bahri. The award function was followed by two lectures in Physics and Biology by Prof. A. K. Sood (IISc) and Prof. Sheeba Vasu (JNCASR), respectively. The event also comprised of a music recital by Ustad Rafique Khan & team. ~225 students (Class XI & XII) and teachers from various schools and colleges of Karnataka participated in this event.

Interactive lecture programme in Chemistry organised by CNR Rao Hall of Science and ETU.

August 26: Lectures by Prof. Govindaraju T. and Prof. Sridhar Rajaram of JNCASR, followed by a Q&A session.

September 19: Lectures by Dr. Dasaradhi Palakodeti (NCBS) and Dr. Phalguni Anand Alladi (NIMHANS), followed by a Q&A session. In both events, students also visited the 'Chemistry of Materials Exposition' and the 'Prof. C.N.R. Rao Archives'. Around 125 school and 200 college students (Class XI and XII) and teachers participated.

Workshop on 'Experiments Using College Chemistry Kit' organised by CNR Rao Hall of Science and ETU. Post-workshop, students also visited the 'Chemistry of Materials Exposition' and the 'Prof. C.N.R. Rao Archives'.

September 23-24: 24 students and 4 teachers (Class XII) from Swami Vivekananda Youth Movement, Mysore.

October 4: 24 students and 2 teachers (Class XI & XII) from St. Claret PU College, MES ring road, Jalahalli.

Workshops for College Students: Multiple workshops were conducted using college chemistry experiment kits. The following colleges from Bengaluru participated: Sheshadripuram PU College, Yelahanka on November 5, 2019; MES Kishora Kendra PU College, Malleshwaram on November 19, 2019; and MES Vidya Sagara, MPL Sastry PU College, Rajajinagar on November 29, 2019. From each college, 24 students and 2 teachers participated.

Science Outreach Programme: Jawahar Navodaya Vidyalaya, Yelahanka, and School Chandan, Laxmeshwar participated in the programme conducted on December 18, 2019. A special lecture was delivered by Prof. SM Shivaprasad (JNCASR) and a science quiz was conducted by Dr. BR Guruprasad (ISRO). The attendees also visited the 'Chemistry of Materials Exposition' and the 'Prof. C.N.R. Rao Archives' at the C.N.R. Rao Hall of Science at JNCASR.

Workshop at School Chandan, Laxmeshwar:
A three-day workshop was conducted at the school from January 7-9, 2020, wherein Bharat Ratna Prof. C.N.R. Rao and Dr. A.S. Kiran Kumar (ISRO) inaugurated the Science Park and Science outreach programme as well as addressed the students. The programme was followed by an interactive session with Prof. C.N.R. Rao, Dr. Indumati Rao, and Dr. A.S. Kiran Kumar. In addition, lectures and experiments with physics and chemistry models were presented by faculties from JNCASR and CeNS. This programme was supported by the C.N.R. Rao Education Foundation. Over 700 students, 25 teachers, guests, and volunteers participated in the event.

Another workshop of two days was also conducted at the school from February 1-2, 2020. In this event, a lecture on 'how to prepare for exams' was delivered on the first day and 'a teacher training programme' was conducted on the second day. Approximately 250 students and 12 teachers participated.

Parikrama Festival of Science: The festival was conducted from January 21-22, 2020 and the theme this year was 'Marine Life'. The event was inaugurated by Pradip Dutta (Corp Vice President), Prof. P. Balaram (IISc), and Prof. Srikanth Sastry (JNCASR). Over 200 students, 50 teachers, 10 guests, and 15 volunteers participated in the event held at the C.N.R. Rao Hall of Science. They also visited the 'Chemistry of Materials Exposition' and the 'Prof. C.N.R. Rao Archives'.

Overview of the events conducted by the Education Technology Unit:

Number of programmes conducted : 10

Number of students participated : 3890

Number of teachers participated : 125

Chemical Heritage Exposition: The exposition was inaugurated on February 20, 2020 by students. Approximately 120 students and 6 teachers participated from Jawahar Navodaya Vidyalaya (Doddaballapur), School Chandan (Laxmeshwar), Parikrma Humanity Foundation, and Sagar Science Forum (Shimoga). Prof. C.N.R. Rao, foreign delegates, and JNCASR faculty & staff participated in this event. The inaugural dedication was read by Dr. Indumati Rao.

Ms. Divya Bhutani, Ph.D. student, CPMU inaugurating the Exposition Building, with Bharat Ratna Prof. C.N.R. Rao on the right

Bharat Ratna Prof. C.N.R. Rao explaining about the eminent scientists to the visitors after the inauguration of the Exposition

Mural painting by JNCASR students at the entrance of the Chemical Heritage Exposition

Bharat Ratna Prof. C.N.R. Rao explaining about the eminent scientists to the visitors after the inauguration of the Exposition

ETU MEMBERS

Chair
Prof. V. Krishnan, Ph.D., FASc, FNA, FTWAS

Co-ordinator (Hon.)
Dr. Indumati Rao, D.Sc. (Hon.), MA, MS, CE

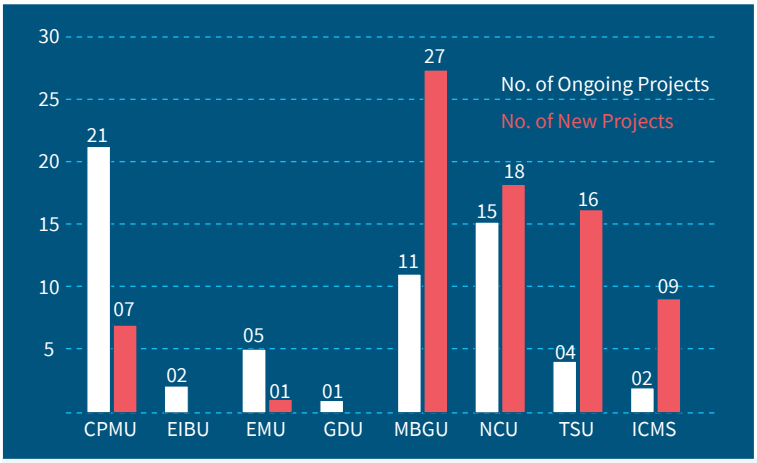
Faculty In-charge
Prof. Govindaraju T., Ph.D.

Multimedia Asst. (Hon.)
Sanjay Rao, B.Sc., Cert. Multimedia

FUNDING & FACILITIES

First-class research requires not only talented researchers but also specialized facilities, state-of-the-art equipment, and expensive infrastructure and resources. JNCASR provides its scientists with exactly this, along with constant upgradation of its facilities to keep up with the research needs, ensuring that the scientists have all necessary resources for their research. The following section summarizes the various facilities and sponsored projects at JNCASR, along with the information on newly acquired facilities/resources in this academic year.

SPONSORED PROJECTS



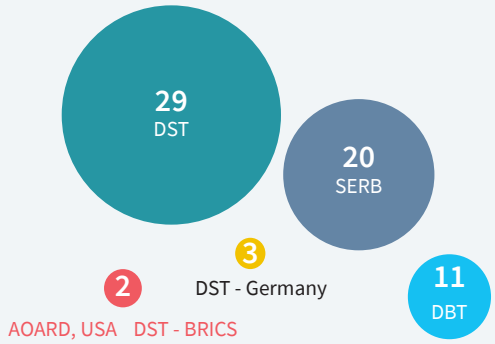
41
New Sponsored Projects

35.11 Cr.
Total Amount Received For New Projects During 2019-2020

90
Ongoing Sponsored Projects

195.29 Cr.
Total Amount Received For Ongoing Projects During 2019-2020

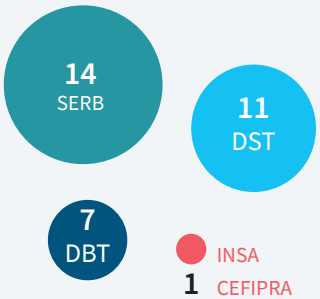
ONGOING PROJECT SPONSORS



AOARD, USA
IKST
DST - BRICS
Sheikh Saqr Laboratory

1
DBT
PHE
LSRB
BIAL
RHSPL
DST - Korea
LOREAL
SHELL
NIH - UNMC
SUNRISE
RGUHS
DBT-TIFA -
DBT-TIFA
CEFIPRA
IKST
DBT - Wellcome Trust
DST - United Kingdom
TIGS
European Union
ICMR

NEW PROJECT SPONSORS



1
INSA
CEFIPRA
Sankhyasutra Labs Pvt. Ltd.
SERB
SHELL
DAE-BRNS
Tata Steel Limited
BIRAC
IIT-ROORKEE

Projects Granted by Department of Science and Technology to JNCASR as the Nodal Agency

During 2019-2020:

Indian beamline for nano Science and technology at Petra III at Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany (Phase II). Prof. Chandrabhas Narayana as PI, received a grant of Rs.17.68 Cr.

Ongoing Projects are:

Implementation of phase II of Indian Beamline at Photon Factory, Kek, Tskuba, Japan, Prof. Chandrabhas Narayana as PI, received a grant of Rs.16.14 Cr.

Assured access to all the beam lines of ISIS Neutron Scattering Facility at Rutherford Appleton Laboratory (RAL), UK for carrying out research in nano science and technology. Prof. Sundaresan A. as PI, received a grant of Rs.19.75 Cr.

Setting up of Technical Research Centre at JNCASR Bengaluru, Prof. K. S. Narayan as PI, received a grant of Rs.54.35 Cr.

CENTRAL FACILITIES

First-class research requires not only talented researchers but also specialized facilities, hi-tech equipment, and expensive infrastructure and resources. JNCASR provides its scientists with exactly this, along with constant upgradation of its facilities to keep up with the research needs, ensuring that the scientists have all necessary resources for their research. The following section summarizes the various facilities and sponsored projects at JNCASR, along with the information on newly acquired facilities/resources in this academic year.

LIBRARY

The JNCASR library is well-stocked, with 9,662 books in its collection and access to over 4,000 scientific journals. The library continues to acquire, organize, and disseminate information resources to render need-based information services to faculty, students, and researchers. The library also offers services such as document delivery, inter-library loan, current awareness, and bibliometric studies.

In the year 2019-2020, 95 books were newly added, and 167 new subscriptions to journals were acquired. Furthermore, 77 new patrons became part of the library, increasing the total to 699 current patrons.

Total patrons: 699

New patrons: 77

Total books circulated: 3877

Issued | Returned | Renewed

NEW BOOKS

95/9662

COST

₹ 3.65 L

JOURNALS SUBSCRIBED TO

162

AMOUNT SPENT

₹ 92.49 L

Number Of Resources Supported By National Knowledge Resource Consortium (NKRC): **4,000+**

Articles on demand & User orientation programmes

Article requests fulfilled: **43**

User orientation programmes organized: **4**

List of user orientation programmes organized:

1. EBSCO user awareness programme conducted by EBSCO on July 30, 2019
2. Web of Science hands-on-training conducted by Clarivate Analytics on August 29, 2019
3. EBSCO hands-on-training conducted by EBSCO on November 29, 2019
4. Typeset Software demo conducted by Typeset on February 13, 2020

LIBRARY STAFF

Senior Library cum Information Officer
Nabonita Guha

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

Library Assistant Trainee
Shruti Kude

Senior Helper
Rajeeva J.

COMPUTER LABORATORY (COMPLAB)

The high-speed Local Area Network (LAN) at JNCASR can support up to 10 Gbps intranet connectivity. In the year 2019-2020, efforts were made to ensure integrated Internet bandwidth of 1 Gbps, and infrastructural upgrades were made to increase the bandwidth to 1.2 Gbps; these changes will ensure an average bandwidth of 100 Mbps per person in the campus. In addition, we added a centralized storage facility of 25 TB to meet the data storage requirements on the campus. For critical data, such as email, a de-duplication mechanism via VEEAM Backup software was installed and a secondary storage was created to ensure redundancy in the system. A dedicated storage for archived server backup of 5 TB was installed for maintaining the older server's data backup.

In addition to the above, a few important changes were made to the following:

Email: Several new policies were implemented to ensure proper functioning of the email facility.

Secure and enhanced Wi-Fi: High-speed wireless network with 802.11 b/g/n/ac was installed. The entire campus is now covered with 196 wireless Access Points, with each providing 350–500 Mbps network connectivity. Campus Wi-Fi is fully configured with security modules. Wi-Fi users are authenticated via our centralized LDAP and CPPM Server. Permanent staff members get MAC-based authentication and guests get authentication via mail and host verification. The Centre has also subscribed to eduroam Wi-Fi facility in campus.

Enhanced network management system: This was set up to ensure security and redundancy of servers and other interconnecting devices like core switch and firewall. All critical network components have been put on Active-Active redundancy mode to increase the network performance and provide continuous network connectivity in the campus.

Network Security: A new firewall with enhanced security (Network layer 7) has been installed to secure campus network. Server's access from non-JNCASR network uses are connected via secure full tunnel VPN.

Free software license for faculty and students: We have a free campus license policy where all faculty and students can avail of Mathematica, MATLAB, Intel Parallel Studio, and Microsoft Office 365 Licenses, which support up to 5 device installation along with 5 TB cloud storage.

Secure printing facility: Quota-based campus printing facility has been installed with LDAP authentication for all JNCASR staff and students. Campus also has a poster printing unit, which supports A0-size printing in gloss and matte paper.

SMS notification: The Centre has signed up with CDAC for Push SMS notification for campus users.

COMPLAB TEAM

Head
Prof. Subir K. Das, Ph.D.

System Administrator
Pandurang Bugade

Desktop Administrator
Chandan N., Sathish Kumar

Onsite Engineers
Rajeev Ranjan, Abhishek Kumar

Committee Members
Prof. Umesh V. Waghmere,
Prof. Meher K. Prakash, Prof. Meheboob Alam,
Prof. Rajesh Ganapathy

DHANVANTARI: JNCASR HEALTH CENTRE

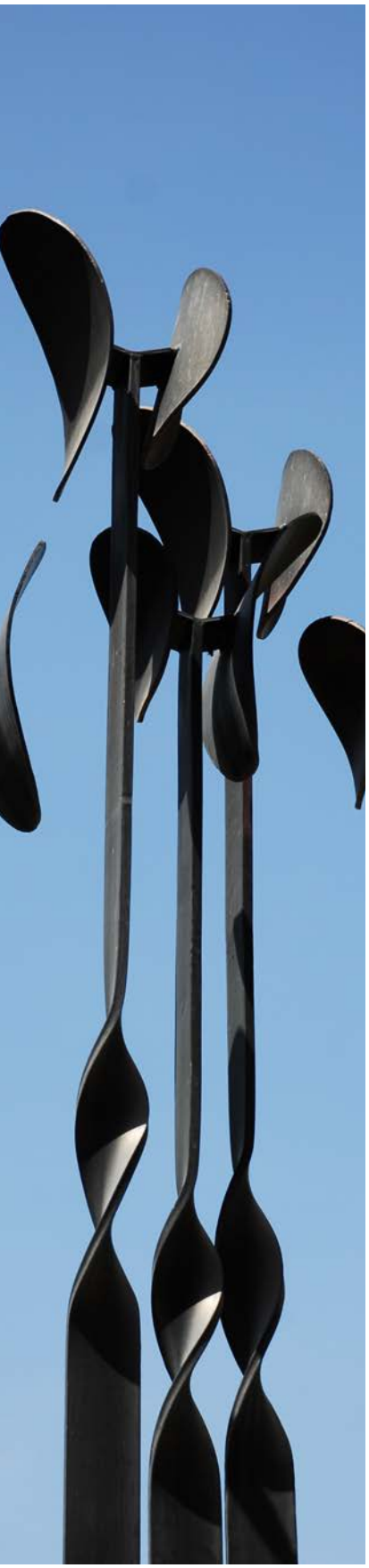
The Dhanvantari treats permanent staff and their dependents, students, and retirement staff, including spouses. They are covered under the CMS scheme of the Centre. It also gives free consultation to Temporary Employees who work at security, garden mess, and other areas. The Dhanvantri has four consulting doctors, a physiotherapist, and a clinical psychologist. It also has two nurses and two lab technicians.

It offers daily OPD services and daycare services, along with a fully-equipped clinical laboratory, physiotherapy unit, minor OT and ECG services. It conducts annual orientation programs about health, First-Aid, and laboratory safety measures for all newly joined students.

MOUs have been signed with Aster CMI hospital, Agarwal Eye Hospital, Baptist Hospital, M.S. Ramaiah Memorial Hospital, and Manipal Northside Hospital, Malleshwaram for referrals and admissions. An MOU has also been signed with RV Metropolis Laboratory, Malleswaram for testing samples.

DAYCARE CENTRE

The day care facility of JNC currently caters to children of faculty, staff, and students of JNCASR who are between ages 1 to 10 years. The facility is manned by one incharge member and three helpers. The operations are overseen by the chair of the day care centre, wherein normally one faculty would be incharge. Currently, this facility houses approximately 16 children who are enrolled either for the full day (in case of younger children) or for half-day to cater to children returning from their schools. During 2019-2020, this facility has had several events like fancy dress, red days along with celebrating the importance of several festivals. Some painting and other renovation of the building was carried out to facilitate the functioning of the Centre. Construction of a new washroom along with the existing one has been sanctioned and is currently in progress.



NEW RESEARCH FACILITIES

JNCASR has always strived to provide its entire faculty and research students with the latest technologies, equipment, and top-notch facilities, which are essential to be able to carry out cutting-edge research. Some of the new facilities and equipment procured in this year are listed below.

Chemistry and Physics of Materials Unit (CPMU)
Critical point dryer, Supercontinuum source with accessories, AOTF acousto-optics, Dynamic light scattering system, STA 6000 TG DTA.

Engineering Mechanics Unit (EMU)
Microwave radiometer.

International Centre for Materials Science (ICMS)
Boston X86 supermicro server, imaging spectrometer, JeolEPR spectrometer, CCD detector for existing Horiba Labram raman spec, Infrared Fourier vacuum spectrometer, Seebeck coefficient thermal electrical resistance system.

Molecular Biology and Genetics Unit (MBGU)
Q-Exactive HF High-performance Orbitrap mass spectrometer, Multiphoton high sensitive high-resolution microscope, Titanium femtosecond laser, Antivibration breadboard table with compressor, Single cell analysis system, iBright CL1500 imaging system, Confocal Quantitative Image cytometer CQ1, BD FACS Aria fusion 3 laser system, Phenobooth advance colony counter.

New Chemistry Unit (NCU)
Battery cycler, Jasco circular dichroism spectrometer, HPLC System for both analytical cum semi prep, Microwave synthesizer automated with auto sampler, Spectrometer.

Neuroscience Unit (NSU)
Leica DM18 system.

Theoretical Sciences Unit (TSU)
Boston super micro super server, High performance computation and data storage.

Sheikh Saqr Laboratory
iBright FL1500 imaging system, Combiflash Nextgen 100 automated flash chromatography.

FINANCIAL STATEMENTS

GRSM & ASSOCIATES
Chartered Accountants

No. 8/90, 1st Floor, Pampa Mahakavi Road,
Shankarapuram, Bangalore-560 004.
Ph : +91-80-41312149 / +91-80-2660 2810

INDEPENDENT AUDITOR'S REPORT

To
Members of Jawaharlal Nehru Centre for Advanced Scientific Research

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 2020, 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 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, 2020, 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 Opinion

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 opinion.

Emphasis of Matter

We draw attention to Note No. 3 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.

GRSM & Associates Bangalore Chartered Accountants

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

GRSM & Associates Bangalore Chartered Accountants

RAJGOPAL A
M.No.205296
Partner
UDIN: 20205296AAAACB7547

Place: Bangalore
Date: 11th August 2020

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
BALANCE SHEET AS AT 31ST MARCH 2020

Amount in Rs.

Description	Schedule No.	Current year 2019-20	Previous year 2018-19
Liabilities			
Capital/corpus fund (Centre's Development Fund)	1	58,25,83,909	34,91,37,774
Reserves & surplus	2	1,98,73,86,731	1,86,24,95,101
Earmarked and endowment funds	3	1,00,68,80,776	1,17,67,16,672
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	14,98,72,992	24,48,66,178
Total		**3,72,67,24,407**	**3,63,32,15,726**
Assets			
Fixed assets	8	1,98,73,86,731	1,86,24,95,101
Investments-From earmarked/endowment funds	9	36,65,92,000	26,42,05,500
Investment - Others	10	29,25,08,890	8,84,41,015
Current assets, loans, advances etc.	11	1,08,02,36,787	1,41,80,74,110
Total		**3,72,67,24,407**	**3,63,32,15,726**
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

vide our report of even date
For GRSM & Associates
Chartered Accountants
FRN : 000863S

GRSM & Associates * Bangalore * Chartered Accountants

Rajgopal A
Partner
Membership No.: 205296
Place : Bangalore, Date : 11/08/2020

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 2020

Amount in Rs.

Description	Schedule No.	Current year 2019-20	Previous year 2018-19
Income			
Income from sales/services	12	0	10,00,000
Grants/subsidies	13	68,14,70,000	84,84,11,000
		68,14,70,000	84,94,11,000
Less: Fixed assets acquired during the year from DST core grant		0	19,89,08,813
		68,14,70,000	65,05,02,187
Fees/subscriptions	14	61,68,379	40,42,858
Income from investments	15	0	0
Income from royalty, publication, licence fee etc.	16	3,73,941	2,54,976
Interest earned	17	51,32,407	86,42,431
Other income	18	89,25,605	75,71,969
Increase/decrease in stocks	19	0	0
Total (A)		**70,20,70,331**	**67,10,14,421**
Expenditure			
Establishment expenses	20	43,35,10,375	41,73,02,429
Other administrative expenses etc.	21	23,60,75,933	21,04,85,763
Expenditure on grants, subsidies etc.	22	0	0
Interest & bank charges	23	16,080	21,385
Depreciation		12,05,59,079	10,43,77,423
Less: Transferred from Capital Reserve		12,05,59,079	0
Total (B)		**66,96,02,388**	**73,21,87,001**
Balance being excess of income over expenditure **(A-B)**		3,24,67,944	-6,11,72,580
Less: Prior period expenses		55,58,544	0
Balance being surplus/deficit carried to Capital Fund		**2,69,09,400**	**-6,11,72,580**
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

Sampad Patra
Accounts Officer

Prof. G.U. Kulkarni
President

Joydeep Deb
Administrative Officer

vide our report of even date
For GRSM & Associates
Chartered Accountants
FRN : 000863S

GRSM & Associates * Bangalore * Chartered Accountants

Rajgopal A
Partner
Membership No.: 205296
Place : Bangalore, Date : 11/08/2020

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2020

Description	2019-20 Amount in Rs.	2018-19 Amount in Rs.
SCHEDULE 1- Capital/Corpus Fund :		
A: Capital fund		
Opening balance	17,14,09,746	23,25,82,326
Add : Surplus/deficit in income and expenditure account	2,69,09,400	-6,11,72,580
Total (A)	**19,83,19,146**	**17,14,09,746**
B: Corpus fund (Centre's Development Fund)		
Opening balance	29,21,21,295	26,39,30,384
Additions during the year	86,07,134	1,06,09,339
Income from investments out of Corpus funds	2,34,85,117	2,08,01,203
Sub total	**32,42,13,546**	**29,53,40,925**
Less : Funds-utilisation/expenditure incurred	87,26,122	32,19,631
Total (B)	**31,54,87,424**	**29,21,21,295**
C: Grants for creation of Capital Assets		
Opening balance	-11,43,93,267	-5,99,13,454
Add : Grants received during the year	41,13,46,000	14,44,29,000
Sub total	**29,69,52,733**	**8,45,15,546**
Less: Transferred to Capital Reserve upon acquisition of fixed assets	22,81,75,394	19,89,08,813
Total (C)	**6,87,77,339**	**-11,43,93,267**
Total (A+B+C)	**58,25,83,909**	**34,91,37,774**
SCHEDULE 2- Reserves and surpluses :		
A: Capital Reserve		
Balance as at the beginning of the year	1,86,24,95,101	1,73,46,54,311
Add : Fixed assets addition during the Year out of Core grant	22,81,75,394	19,89,08,813
Add : Fixed assets addition during the Year out of Earmarked and endowment funds	1,72,75,314	3,33,09,400
Sub total	**2,10,79,45,809**	**1,96,68,72,524**
Less : Depreciation for the current year transferred to Income and Expenditure account	12,05,59,079	10,43,77,423
TOTAL	**1,98,73,86,731**	**1,86,24,95,101**

GRSM & Associates Bangalore Chartered Accountants

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2020

SCHEDULE 3- Earmarked and endowment funds:	FUND - WISE BREAK UP					TOTAL	
	Scheme Funds	Kiran Mazumdar-Shaw- MBSRL	Chemical Heritage Exposition	Endowment Others	Student Residence,VSH& Dinning Hall	2019-20	2018-19
A) Opening balance of the funds	**1,09,19,32,860**	**-2,96,189**	**0**	**8,50,80,002**	**23,36,832**	**1,17,90,53,505**	**1,19,70,19,351**
B) Additions to the funds:							
i. Donations/grants	62,22,34,485	0	87,25,480	7,63,83,617	0	70,73,43,582	74,72,98,245
ii. Income from investment made on account of funds	4,82,41,777	0	0	0	0	4,82,41,777	6,01,01,833
iii. Others	0	0	0	0	1,82,23,991	1,82,23,991	27,92,44,936
Total (A+B)	**1,76,24,09,122**	**-2,96,189**	**87,25,480**	**16,14,63,619**	**2,05,60,823**	**1,95,28,62,854**	**2,28,36,64,366**
C) Utilisation/expenditure towards objectives of funds							
i. Capital expenditure							
- Fixed assets	32,25,33,364	85,49,834	87,25,480	0	0	33,98,08,678	**52,03,94,110**
- Others	13,44,50,707	0	0	0	0	13,44,50,707	**0**
Total	**45,69,84,071**	**85,49,834**	**87,25,480**	**0**	**0**	**47,42,59,385**	**52,03,94,110**
i. Revenue expenditure							
- Salaries, wages & allowances etc	6,16,72,907	0	0	0	0	6,16,72,907	**8,32,55,397**
- Other administrative expenses	38,79,45,976	0	0	41,71,792	1,79,32,018	41,00,49,786	50,32,98,187
Total	**44,96,18,883**	**0**	**0**	**41,71,792**	**1,79,32,018**	**47,17,22,693**	**58,65,53,584**
Total (C)	**90,66,02,954**	**85,49,834**	**87,25,480**	**41,71,792**	**1,79,32,018**	**94,59,82,078**	**1,10,69,47,693**
Net balance as at the year end (A + B - C)	**85,58,06,167**	**-88,46,023**	**0**	**15,72,91,827**	**26,28,805**	**1,00,68,80,776**	**1,17,67,16,672**

GRSM & Associates Bangalore Chartered Accountants

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2020

Description		2019-20 Amount in Rs.	2018-19 Amount in Rs.
SCHEDULE 4- Secured loans and borrowings:		0	0
SCHEDULE 5- Unsecured loans and borrowings:		0	0
SCHEDULE 6- Deferred credit liabilities:		0	0
Total		**0**	**0**
SCHEDULE 7- Current liabilities and provisions			
A. Current liabilities			
1. Sundry creditors :			
a. For goods	8,01,12,393		
b. Others - EMD/security deposit	1,28,26,544	**9,29,38,937**	**9,91,55,071**
2. Advances received :		**9,29,328**	**10,64,543**
3. Statutory liabilities :		**8,19,499**	**47,09,020**
4. Other current liabilities:		**4,55,40,746**	**13,23,81,756**
Total (A)		**14,02,28,510**	**23,73,10,390**
B. Provisions			
Stipend/salary payable		**35,32,131**	**36,13,754**
Expenses Payable		**61,12,351**	**39,42,034**
Total (B)		**96,44,482**	**75,55,788**
Total (A+B)		**14,98,72,992**	**24,48,66,178**

GREM & Associates Bangalore Chartered Accountants

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 2020

SCHEDULE 8 - FIXED ASSETS

DESCRIPTION	Rate	GROSS BLOCK				DEPRECIATION				NET BLOCK	
		Cost/Value as at beginning of the year 2019-20	Additions during the year 2019-20	Dedn. during the year 2019-20	Cost/value at the end of the year 2019-20	Depre. as at the beginning of the year 2018-19	Depre. during the year 2019-20	On Dedn. during the year 2019-20	Total upto the year end 2019-20	as at the Current year - end 2019-20	as at the Previous year - end 2018-19
Land :											
Free hold land	0.00	1,77,15,351	0	0	1,77,15,351.00	0	0	0	0	1,77,15,351	1,77,15,351
Buildings :											
Buildings	1.63	8,78,33,491	0	0	8,78,33,491.26	3,44,28,136	14,31,686	0	3,58,59,822	5,19,73,669	5,34,05,355
Hostel building	1.63	1,56,60,055	0	0	1,56,60,055.00	63,01,627	2,55,259	0	65,56,886	91,03,169	93,58,428
Advanced material research lab	1.63	2,59,30,339	0	0	2,59,30,339.00	67,46,943	4,22,665	0	71,69,607	1,87,60,732	1,91,83,396
Animal house	1.63	67,88,701	0	0	67,88,701.00	26,90,924	1,10,656	0	28,01,580	39,87,121	40,97,777
Staff housing	1.63	43,19,353	0	0	43,19,353.00	13,74,044	70,405	0	14,44,450	28,74,903	29,45,309
ETU building	1.63	30,91,348	0	0	30,91,348.00	7,61,296	50,389	0	8,11,685	22,79,663	23,30,052
Other buildings like extn. of hostel , college etc	1.63	1,18,83,626	0	0	1,18,83,626.00	27,62,217	1,93,703	0	29,55,920	89,27,706	91,21,409
Nano science lab	1.63	65,95,209	0	0	65,95,209.00	13,70,294	1,07,502	0	14,77,796	51,17,413	52,24,915
Engineering & mechanical lab	1.63	74,26,272	0	0	74,26,272.00	14,49,455	1,21,048	0	15,70,503	58,55,769	59,76,817
Dining hall & kitchen block	1.63	1,39,07,393	0	0	1,39,07,393.00	23,70,678	2,26,691	0	25,97,369	1,13,10,024	1,15,36,715
Hostel phase II	1.63	1,95,52,377	0	0	1,95,52,377.00	38,24,446	3,18,704	0	41,43,150	1,54,09,227	1,57,27,931
Lecture hall & academic block	1.63	96,36,712	0	0	96,36,712.00	18,67,336	1,57,078	0	20,24,414	76,12,298	77,69,376
Intl. centre for material sciences	1.63	5,01,48,316	0	0	5,01,48,316.00	90,14,458	8,17,418	0	98,31,876	4,03,16,440	4,11,33,858
International house	1.63	2,31,42,418	0	0	2,31,42,418.00	42,40,069	3,77,221	0	46,17,290	1,85,25,128	1,89,02,349
Hostel phase III	1.63	2,75,01,103	0	0	2,75,01,103.00	48,67,696	4,48,268	0	53,15,964	2,21,85,139	2,26,33,407
Prof. CNR Rao hall of science	1.63	1,03,33,669	0	0	1,03,33,669.38	18,32,209	1,68,439	0	20,00,648	83,33,021	85,01,460
Extention to HIV lab	1.63	10,16,085	0	0	10,16,085.00	1,82,183	16,562	0	1,98,745	8,17,340	8,33,902
Security office building	1.63	21,01,625	0	0	21,01,624.56	1,05,538	34,256	0	1,39,794	19,61,830	19,96,087
Radio activity - lab II	1.63	30,35,391	0	0	30,35,391.00	2,47,214	49,477	0	2,96,691	27,38,700	27,88,177
Sewage treatment building (STP)	1.63	2,91,699	0	0	2,91,699.00	57,057	4,755	0	61,812	2,29,887	2,34,642
Residential quarters - Adm. Officer	1.63	36,59,034	0	0	36,59,034.00	5,45,247	59,642	0	6,04,889	30,54,145	31,13,787
Child care centre	1.63	7,28,827	1,51,263	0	8,80,090.00	1,12,521	13,113	0	1,25,634	7,54,456	6,16,306
Extension to biology lab -2009	1.63	1,94,24,005	0	0	1,94,24,005.00	24,19,714	3,16,611	0	27,36,325	1,66,87,680	1,70,04,291
Animal house - Additional block	1.63	82,92,632	0	0	82,92,632.00	14,48,652	1,35,170	0	15,83,822	67,08,810	68,43,980
Hoster phase IV (62 rooms)	1.63	2,59,34,842	0	0	2,59,34,842.00	34,74,858	4,22,738	0	38,97,596	2,20,37,246	2,24,59,984
Extention to pauling building - Bio block	1.63	47,66,109	0	0	47,66,109.00	21,24,627	77,688	0	22,02,315	25,63,794	26,41,482
SCADA-DG room	1.63	2,40,660	0	0	2,40,660.00	27,460	3,923	0	31,383	2,09,277	2,13,200
President's residence	1.63	77,88,054	0	0	77,88,054.00	8,77,090	1,26,945	0	10,04,035	67,84,019	69,10,964
Visiting students hostel	1.63	3,39,82,070	0	0	3,39,82,070.00	38,47,292	5,53,908	0	44,01,200	2,95,80,870	3,01,34,778
Health centre	1.63	32,43,422	0	0	32,43,422.00	3,70,075	52,868	0	4,22,943	28,20,479	28,73,347
Nano institute-Shivanapura	1.63	37,09,242	0	0	37,09,242.00	4,23,226	60,461	0	4,83,687	32,25,555	32,86,016
Matrl. science block - CCMS	1.63	5,54,31,961	0	0	5,54,31,961.00	58,46,842	9,03,541	0	67,50,383	4,86,81,578	4,95,85,119
Post doc housing- Srirampura	1.63	1,54,86,086	0	0	1,54,86,086.00	11,93,971	2,52,423	0	14,46,394	1,40,39,692	1,42,92,115
New auditorium	1.63	2,20,24,759	0	0	2,20,24,759.00	17,10,104	3,59,004	0	20,69,108	1,99,55,651	2,03,14,655
New auditorium phase II	1.63	4,98,80,367	28,320	0	4,99,08,687.00	16,09,026	8,13,512	0	24,22,538	4,74,86,149	4,82,71,341
EOBU lab block	1.63	2,09,11,646	0	0	2,09,11,646.00	21,57,508	3,40,860	0	24,98,368	1,84,13,278	1,87,54,138
Modern Biomedical Science Research Laboratory	1.63	5,20,89,418	1,70,98,725	0	6,91,88,142.82	0	10,95,769	0	10,95,769	6,80,92,373	5,20,89,418
Chemical Heritage Exposition	1.63	1,04,29,345	87,25,480	0	1,91,54,824.52	0	3,00,169	0	3,00,169	1,88,54,655	1,04,29,345
Extension to Engineering & Machanical Unit (EMU)	1.63	29,91,732	94,95,104	0	1,24,86,836.00	0	1,43,744	0	1,43,744	1,23,43,092	29,91,732
Extension to Hall of Science	1.63	7,46,430	2,17,879	0	9,64,309.00	0	15,718	0	15,718	9,48,591	7,46,430
Infrastructure facility- Road, street lights, partitions etc	1.63	11,20,24,082	1,16,56,287	0	12,36,80,368.82	1,88,39,469	19,22,827	0	2,07,62,295	10,29,18,073	9,31,84,613

GRSM & Associates Bangalore Chartered Accountants

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 2020 (SCHEDULE 8 - FIXED ASSETS - Contd...)

Equipments :											
Plant/machinery/scientific equipments	4.75	1,06,30,77,535	10,93,28,027	1,18,646	1,17,22,86,916.17	44,74,29,709	5,39,80,089	0	50,14,09,798	67,08,77,117.91	61,56,47,826
Equipments carbon & nano materials	4.75	3,42,21,009	0	0	3,42,21,009.00	3,42,21,008	0	0	3,42,21,008	1.00	1
Equipments physics & chemistry of matri.	4.75	98,78,095	0	0	98,78,095.00	98,78,094	0	0	98,78,094	1.00	1
Equipments cluster studies	4.75	26,87,514	0	0	26,87,514.00	26,65,465	22,048	0	26,87,513	1.00	22,049
Equipments advance technology lab	4.75	2,02,02,562	0	0	2,02,02,562.00	1,96,98,759	5,03,802	0	2,02,02,561	1.00	5,03,803
Equipment magnet	4.75	70,90,855	0	0	70,90,855.00	69,10,317	1,80,537	0	70,90,854	1.00	1,80,538
ICMS-lab equipment/ lab facilities	4.75	37,99,59,946	1,93,87,828	10,000	39,93,37,773.56	10,53,37,051	1,85,40,644	0	12,38,77,695	27,54,60,078.60	27,46,22,894
Vehicles	9.50	54,19,530	8,44,810	1,01,000	61,63,340.00	45,13,404	5,85,517	0	50,98,922	10,64,418	9,06,126
Furniture and fixtures	6.33	9,50,78,216	68,54,241	25,000	10,19,07,456.88	8,44,56,133	63,53,876	0	9,08,10,009	1,10,97,448	1,06,22,083
Office equipments	4.75	2,37,55,422	12,75,039	38,239	2,49,92,222.41	1,44,10,555	11,64,946	0	1,55,75,501	94,16,721	93,44,867
Computer/peripherals	16.21	8,65,28,968	96,30,307	3,500	9,61,55,775.00	8,32,56,773	41,93,466	0	8,74,50,239	87,05,536	32,72,195
Electrical installations	1.63	12,63,53,755	19,00,506	0	12,82,54,261.00	1,93,07,246	20,75,055	0	2,13,82,301	10,68,71,960	10,70,46,509
Electrical Installations - 2000 KVA DG SET	1.63	2,19,49,123	0	0	2,19,49,123.00	0	3,57,771		3,57,771	2,15,91,352	2,19,49,123
Library books	4.75	2,91,95,620	1,26,416	0	2,93,22,035.78	1,84,50,485	13,90,551	0	1,98,41,036	94,81,000	1,07,45,135
Library Journals	4.75	20,45,94,483	1,04,70,497	0	21,50,64,980.15	8,92,10,799	1,00,14,730	0	9,92,25,528	11,58,39,452	11,53,83,685
Tubewells & water supply	1.63	2,48,912	24,675	0	2,73,587.00	63,346	4,459	0	67,806	2,05,781	1,85,566
Other fixed assets											
Intangeable assets-Softwares	40.00	3,39,49,985	62,28,147	0	4,01,78,132.11	2,81,56,039	78,38,773	0	3,59,94,812	41,83,321	57,93,946
Capital work in progress											
Basic infrastructure facilities - New campus - Chokkanalli	0.00	1,75,00,000	33,44,669	0	2,08,44,669.00	0	0	0	0	2,08,44,669	1,75,00,000
Hostel Phase - V	0.00	5,69,040	2,89,58,873	0	2,95,27,913.00	0	0	0	0	2,95,27,913	5,69,040
Sports Complex	0.00	25,960	0	0	25,960.00	0	0	0	0	25,960	25,960
Total		2,96,39,81,785	24,57,47,093	2,96,385	3,20,94,32,493.42	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
Previous year		2,73,17,63,573	23,90,33,201	68,14,988	2,96,39,81,785.42	99,71,09,261	10,43,77,423	0	1,10,14,86,684	1,86,24,95,101	1,73,46,54,311

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2020

Description	2019-20 Amount in Rs.	2018-19 Amount in Rs.
SCHEDULE 9- Investments - Earmarked/endowment funds (Long term)		
Fixed deposits - Housing development finance corporation limited	6,50,25,000	9,77,05,500
Fixed deposits - PNB housing finance limited	23,85,67,000	10,35,00,000
Fixed deposits - Stock holding corporation of india	6,30,00,000	6,30,00,000
Total	**36,65,92,000**	**26,42,05,500**
SCHEDULE 10- Investments - Others (Current)		
Short term deposits	29,25,00,000	8,84,32,125
Others	8,890	8,890
Total	**29,25,08,890**	**8,84,41,015**
Schedule 11- Current assets, loans, advances etc.,		
Cash & bank balances (Schemes)		
Cash in hand	0	0
Cash at bank - Canara bank	9,25,78,835	13,25,10,629
Fixed deposits - Canara bank	15,47,76,135	17,12,96,082
Fixed deposits - Housing development finance corporation limited	24,12,40,000	20,10,00,000
Fixed deposits - PNB housing finance limited	26,15,00,000	49,66,07,807
Sub total	**75,00,94,970**	**1,00,14,14,518**
Loans and advances (Schemes)		
Interest accrued on fixed deposits	2,40,88,966	3,13,96,201
TDS receivable	66,97,847	37,48,981
Receivables from centre	1,43,83,329	13,22,967
Receivables from various funding agencies	6,05,41,056	5,40,50,192
Sub total	**10,57,11,198**	**9,05,18,341**
Total of Schemes	**85,58,06,167**	**1,09,19,32,860**
Cash & bank balances		
Cash in hand -Student Residence & VSH	22,010	0
Cash in hand - Dinning Hall	27,213	0
Cash at bank - Canara Bank - Grants account	2,03,09,314	7,15,69,598
Cash at bank - Canara Bank - FCRA account	11,31,185	98,557
Cash at bank - Canara Bank - Endowments account	2,41,90,411	2,30,66,959
Cash at bank - SBI	2,14,63,667	3,21,29,131
Cash at bank - HDFC	1,12,05,263	60,10,180
Cash at bank - Student Residence & VSH	20,07,225	0
Cash at bank - Dinning Hall	3,83,781	0
Sub total	**8,07,40,070**	**13,28,74,426**
Loans and advances		
Advances to staff	7,73,990	5,18,772
Deposits	27,02,467	21,15,979
Deposits - Dinning Hall	37,206	0
Interest accrued on earmarked/endowment funds	1,54,18,711	1,46,47,235
Other advances & receivables	3,22,58,970	4,11,91,463
Receivables- CSIR, UGC, DBT, DST	1,89,26,303	89,57,704
Endowment account - Receivables	6,31,51,778	11,97,87,099
TDS receivable - Grant account	40,99,012	38,48,122
TDS receivable - Endowment account	21,03,718	21,60,449
Imprest balance	75,000	40,000
Student Residence & VSH - Receivables	17,44,024	0
Dinning Hall -Receivables	12,52,006	0
Prepaid Expenses	11,47,364	0
Sub total	**14,36,90,549**	**19,32,66,824**
Total of other than Schemes	**22,44,30,619**	**32,61,41,250**
Total	**1,08,02,36,787**	**1,41,80,74,110**

GRSM & Associates Bangalore Chartered Accountants

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2020

Description	2019-20 Amount in Rs.	2018-19 Amount in Rs.
SCHEDULE 12- Income from sales/services	**0**	**10,00,000**
SCHEDULE 13- Grants/subsidies :		
Grants - DST	68,14,70,000	84,84,11,000
Grants - From governement agencies/travel grants etc.	0	0
Grants - From other institutes	0	0
Grants - Other international agencies	0	0
Total	**68,14,70,000**	**84,84,11,000**
SCHEDULE 14- Income from fee/subscriptions etc :		
Income from fee, subscriptions, medical contribution etc.	61,68,379	40,42,858
Total	**61,68,379**	**40,42,858**
SCHEDULE 15- Income from investments;	**0**	**0**
SCHEDULE 16- Royalty income, publication, licence fee etc:		
From royalty	0	0
Licence fee	3,73,941	2,54,976
Total	**3,73,941**	**2,54,976**
SCHEDULE 17- Interest earned:		
From term deposits	44,79,725	86,28,121
Interest earned - Others	6,52,682	14,310
Total	**51,32,407**	**86,42,431**
SCHEDULE 18- Other income:		
From visitors house, guest rooms, students residense etc.	40,22,053	18,54,996
Prior year receipts	3,39,011	9,99,785
Miscellaneous income	45,04,249	44,10,188
From others (tender fee & other fee collected)	60,292	3,07,000
Total	**89,25,605**	**75,71,969**
SCHEDULE 19- Increase/decrease in stock:	**0**	**0**

GRSM & Associates * Bangalore * Chartered Accountants

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2020

Description	2019-20 Amount in Rs.	2018-19 Amount in Rs.
SCHEDULE 20- Establishment expenses:		
Salaries & scholarship to students	27,44,06,322	27,46,03,178
Wages	12,21,78,744	8,95,34,821
Allowances (Medical reimbursements etc.,)	1,04,09,396	62,67,767
Contribution to CPF	22,09,892	24,05,579
Contribution to new pension scheme	1,79,24,796	1,17,77,962
Contribution to group gratuity scheme	2,27,076	2,50,57,583
Leave encashment benefits	37,02,608	49,24,514
Retirement & Terminal Benefits- Pension	12,38,731	9,70,874
LTC	12,12,810	17,60,151
Total	**43,35,10,375**	**41,73,02,429**
SCHEDULE 21- Other Administrative expenses		
Electricity & power	6,39,38,624	5,65,07,965
Water charges	56,39,118	41,15,205
Insurance	3,64,265	8,92,749
Repairs & maintenance	7,00,34,242	5,87,11,472
Rents, rates & taxes	3,48,556	3,95,756
Vehicles running & maintenance	22,21,473	29,08,125
Postage, telephone & communication	24,18,255	22,27,727
Printing, stationery, books	50,70,483	53,06,076
Travelling and conveyance	22,42,544	47,34,273
Expenses on seminars/workshops/discussion meetings	50,06,086	1,02,56,530
Membership & subscriptions	14,43,564	18,82,692
Professional charges	2,46,845	1,44,900
Laboratory consumables	4,47,33,292	3,63,25,043
Advertisement & publicity	16,05,403	23,70,926
Student residence, guest house, I house, etc	28,91,728	9,97,320
Statutory audit fee	1,18,000	1,18,000
POBE & POCE prgramme	14,45,713	9,82,953
Summer research fellowship & student programme	30,77,106	10,85,215
ICMS - Workshops, Schools etc,.	34,82,043	37,99,513
ICMS - Visitor programmes (National & international)	15,027	53,101
ICMS - Recurring expenses	1,95,82,643	1,59,96,914
Loss on Nano Science Block - Fire Accident	0	6,73,309
Loss on Asset Disposal	1,50,924	0
Total	**23,60,75,933**	**21,04,85,763**
SCHEDULE 22- Expenditure on grants, subsidies etc:	**0**	**0**
SCHEDULE 23- Interest and bank charges:	**16,080**	**21,385**

GASM & Associates Bangalore Chartered Accountants

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2020

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

GRSM & Associates Bangalore Chartered Accountants

c. Depreciation on Fixed assets are provided on straight-line method at the below mentioned rates.

Description of Asset	*Depreciation Rate*
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%

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	2019-20 (Amount)	2018-19 (Amount)
1. Claims against the entity not acknowledged as debts	Nil	Nil
2. Letter of Credit outstanding	Nil	Nil

B. NOTES ON ACCOUNTS:

1. Changes in Accounting Policies:

   a. Grants towards capital component released by DST, GOI during the financial year was previously credited to the Income and Expenditure Account after disclosing a deduction of fixed assets acquired out of these funds. It is considered more appropriate to credit the grant relating to Capital Component to the Capital find and transfer the amount utilised during the year for acquisition of fixed assets to Capital Reserve. Thus, the presentation is changed in the current year. This has resulted in decrease in the income of Rs.18,31,70,606/-

   b. Cumulative surplus/ deficit in the Income and Expenditure Account was shown as General Reserve under Reserves and Surplus. From the current year, such surplus/ deficit has been disclosed as an adjustment to the Capital Fund, which is a more appropriate presentation of the financial statements.

   c. Depreciation on assets created out of grants relating to capital components was debited to profit and loss account, but this amount was adjusted under the head Reserves and Surplus. For a more appropriate presentation of financial statements, amount proportionate to Depreciation is transferred from 'Grant towards Capital Component' and recognised as income in the Income & Expenditure Account. This has resulted in increase in the income of Rs.2,69,09,400/-

2. 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.

3. 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.

GRSM & Associates Bangalore Chartered Accountants

4. The transactions relating to operations of Student Residence & VSH and Dining hall and accounted for separately. From this year, the year end balances of assets and liabilities of this have been included in the financial statements of the Centre, without comparatives for previous year.

5. Figures have been rounded off to the nearest rupee.

6. Figures of previous year have been regrouped and reclassified to conform to current year's presentation.

7. Schedules 1 to 25 are annexed to and form an integral part of the Balance Sheet as at 31st March 2020 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

For M/s GRSM & ASSOCIATES
Chartered Accountants
FRN: 000863S

GRSM & Associates * Bangalore * Chartered Accountants

RAJGOPAL A
Partner
M. No.: 205296

Date : 11/08/2020
Place : Bengaluru

JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2020

Amount in Rs.

OPENING BALANCES & RECEIPTS	2019-20	2018-19	PAYMENTS & CLOSING BALANCES	2019-20	2018-19
I. Opening Balances :			I. Expenses :		
- Cash in hand & imprest at Centre	40,000	39,000	- Establishment Expenses	45,93,72,436	52,07,77,367
- Cash in hand & imprest at Scheme Fund	0	0	- Administrative Expenses	24,07,68,254	90,98,80,883
Bank balances:			- Expenditure out of Endowments	0	58,91,394
In savings bank Accounts :			Sub Total :	70,01,40,690	1,43,65,49,644
- Canara Bank - Grant A/c	7,15,69,598	63,09,733			
- Canara Bank (Grant A/c) FCRA	98,557	0			
- Canara Bank - Endowment A/c	2,30,66,959	68,64,183			
- Canara Bank - Scheme A/c	0	1,28,37,801			
- State Bank Of India	3,21,29,131	1,09,04,360	II. Expenditure on Fixed assets and		
- HDFC BANK	60,10,180	15,94,100	Capital Work-in-progress :		
			- Purchase of fixed assets	21,28,56,429	67,36,37,095
In Deposit accounts :					
- At Canara Bank	0	3,50,00,000			
- At SBI	0	1,00,49,963	III. Refund of surplus money/loans	0	0
- At HDFC Trust	9,77,05,500	8,77,05,500			
- At PNB	10,35,00,000	3,25,00,000	IV. Finance charges(Bank charges)	29,574	36,697
- At SHC of India	6,30,00,000	6,30,00,000			
- At Canara Bank (Grant A/c)	8,84,32,125	12,00,00,000			
- Fixed Deposit (Scheme A/c)	0	98,76,01,317			
Sub Total :	48,55,52,051	1,37,44,05,957			
II. Grants Received :			V. Other payments :		
			- Earnest money deposit returned	0	0
- From DST-Grant in aid	1,09,28,16,000	84,84,11,000	- Staff advances (Festival adv. etc.)	0	0
- Scheme Funds	0	72,13,78,901	- Other advances	66,63,77,353	76,28,63,093
- On behalf of endowments/corpus,others	4,43,35,456	2,27,00,000	- Security deposit returned	15,87,636	5,23,940
	1,13,71,51,456	1,59,24,89,901	- TDS payments	4,84,55,289	5,44,76,006
III. Income on Investments :			- Professional tax	7,70,000	0
Interest on FD's :			- Provident fund	4,66,58,923	14,29,79,958
- From earmarked/endowment funds	28,91,646	1,37,41,092	- Advances to faculty	6,22,260	0
- From own funds	39,66,881	46,12,227	- Payment to sundry creditors	61,39,448	72,51,154
- From Scheme Funds	0	2,04,12,840	- Advances to CPF Account	0	0
Sub Total :	68,58,527	3,87,66,159	Sub Total :	77,06,10,909	96,80,94,151
IV. Interest received on SB accounts :			VI. Closing Balances :		
- From grant in aid	63,66,511	46,24,498			
- From own funds	0	0	- Cash in hand & Imprest at centre	75,000	40,000
- From Scheme Funds	0	33,11,986	- Bank balances:		
Sub Total :	63,66,511	79,36,484	*In savings bank accounts at :*		
			- Canara Bank - Grant A/c	2,03,09,314	7,15,69,598
			- At Canara Bank (Grant A/c) FCRA	11,31,185	0
			- 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
V. Other Income :			- HDFC BANK	1,12,05,263	60,10,180
- Collections from visitors, guest room etc	46,05,284	57,33,095	- Canara Bank - Scheme A/c		13,25,10,629
- From fee, subscription etc	18,41,615	21,81,446			
- CSIR fellowships,UGC, DBT, SRFP	3,90,86,017	2,39,12,487			
- Overhead recoveries	0	2,49,74,339			
Sub total :	4,55,32,916	5,68,01,367	Sub Total :	7,83,74,841	26,53,26,498
Balance carried forward	1,68,14,61,460	3,07,03,99,869	Balance carried forward	1,76,20,12,443	3,34,36,44,085

GRSM & Associates Bangalore Chartered Accountants

JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019 (Contd...)

Amount in Rs.

OPENING BALANCES & RECEIPTS	2019-20	2018-19	PAYMENTS & CLOSING BALANCES	2019-20	2018-19
Balance Brought Forward	1,68,14,61,460	3,07,03,99,869	Balance Brought Forward	1,76,20,12,443	3,34,36,44,085
VI. Other receipts :			*In deposit accounts at :*		
- Income tax refunds	6,56,674	0	- At Canara Bank	0	0
- From Sundry Creditors	21,578	0	- At SBI	0	0
- Staff advances recovered	0	2,662	- At HDFC Trust	6,50,25,000	9,77,05,500
- Settlement of advance to faculty	3,15,747	4,36,870	- At PNB	23,85,67,000	10,35,00,000
- Earnest money received	5,78,400	0	- At SHC of India	6,30,00,000	6,30,00,000
- Project funding received	46,97,01,278	0	- At Canara Bank (Grant A/c)	29,25,00,000	8,84,32,125
- GSLI receipt	30,76,260	66,85,425	- At Canara Bank (Grant A/c) FCRA	0	98557
- Support to meetings	1,04,33,257	1,65,24,634	- Fixed Deposit (Scheme A/c)	0	86,89,03,889
- Other	25,48,59,789	1,47,12,34,697			
Sub Total :	73,96,42,983	1,49,48,84,287	Sub Total :	65,90,92,000	1,22,16,40,071
TOTAL	2,42,11,04,443	4,56,52,84,156	TOTAL	2,42,11,04,443	4,56,52,84,156

vide our report of even date
For GRSM & Associates
Chartered Accountants
FRN : 000863S

GRSM & Associates * Bangalore * Chartered Accountants

Rajgopal A
Partner
Membership No.: 205296
Place : Bangalore, Date : 11/08/2020

For Jawaharlal Nehru Centre for Advanced Scientific Research

Prof. G.U. Kulkarni
President

Joydeep Deb
Administrative Officer

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
CPF FUND STATEMENT OF AFFAIRS FOR THE YEAR ENDED 31ST MARCH 2020

Particulars	Amount in Rs.	Amount in Rs.	Particulars	Amount in Rs.	Amount in Rs.
Contributory provident fund			Investment of funds :		
Subscription :			Investments in :		
Opening balance	4,31,99,469		Government of India 8 % Bonds (SHCIL)	4,95,00,000	
Add : Subscriptions received during the year	56,82,019		Fixed Deposits at PNB housing finance	3,75,00,000	
Advances repayments	5,94,895		Fixed Deposits at Canara bank	1,50,00,000	10,20,00,000
Interest on subscriptions	31,56,171				
Sub total	5,26,32,554		Cash at Bank :		
Less : Advances granted	6,69,637		Canara Bank, SB A/C No. 0683101017513	1,93,111	1,93,111
Less : Part finals / Finals settlement	90,82,890				
Sub total	97,52,527		TDS receivable :		
Closing balance		4,28,80,027	GoI Bonds (2012-13) receivable	1,48,000	
			GoI Bonds (2014-15) receivable	1,48,000	
Contribution :			GoI Bonds (2015-16) receivable	1,49,400	
Opening balance	3,24,03,121		GoI Bonds (2016-17) receivable	63,333	
Add : Contribution during the year	29,58,970		GoI Bonds (2017-18) receivable	23,532	
Interest on total contributions	22,54,340		Canara Bank (2018-19) receivable	1,40,020	
Sub total	3,76,16,431		Canara Bank (2019-20) receivable	1,49,754	8,22,039
Less : Final settlement	56,76,560				
Closing balance		3,19,39,871	Accrued interest :		
			Accrued interest on deposits in GoI 8 % Bonds (SHCIL)	1,30,99,721	
Payable to Endow. (90,72,000/-) & Dining (1,125/-)		90,73,125	Accrued interest on Deposits in PNB housing finance	1,12,11,628	
			Accrued interest on Deposits in Canara bank	57,04,675	3,00,16,024
Payable to Corpus		4,69,78,840			
Balance surplus/deficit (-)		21,59,311			
Total		13,30,31,174	Total		13,30,31,174

For Jawaharlal Nehru Centre for Advanced Scientific Research

For GRSM & Associates
Chartered Accountants
FRN : 000863S

GRSM & Associates Bangalore Chartered Accountants

Rajgopal A
Partner
Membership No.: 205296
Place : Bangalore, Date : 11/08/2020

Prof. G.U. Kulkarni
President

Joydeep Deb
Administrative Officer

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
STATEMENT OF ENDOWMENT, CORPUS & OTHER FUNDS BALANCES AS ON 31/03/2020
(2019- 20)

Rs. in Lakhs

PARTICULARS	Principal Endow. Fund	Opening balance 2019-20	Additions during 2019-20	Interest Received 2019-20	Interest Accrued 2019-20	Total 2019-20	Expen-diture 2019-20	Closing balance 2019-20
ENDOWMENT CHAIRS	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Hindustan Lever Ltd. & Gharda Chemicals Chair	32.00	44.41	0.00	2.51	0.00	46.92	3.60	43.32
Astra Zeneca & IBM Chair	20.00	53.57	0.00	1.56	0.00	55.13	0.00	55.13
DAE - Dr.Vikram Sarabhai Chair	22.00	34.07	0.00	1.79	0.00	35.86	0.00	35.86
DRDO & CSIR Chair	30.00	68.15	0.00	2.36	0.00	70.51	1.20	69.31
Silver Jubilee Professorship -Prof. C.N.R. Rao	25.00	27.87	0.00	3.30	0.00	31.17	0.60	30.57
TOTAL- ENDOWMENT CHAIRS	**129.00**	**228.07**	**0.00**	**11.52**	**0.00**	**239.59**	**5.40**	**234.19**
RELIANCE INDUSTRIES								
Prof.Linus Pauling Professorship	**84.34**	**81.25**	**0.00**	**6.31**	**0.00**	**87.56**	**16.46**	**71.10**
OTHER ENDOWMENT FUNDS								
Contribution from Prof.CNR Rao	4.25	13.35	0.00	1.10	0.00	14.45	0.00	14.45
Shantha Seetharamaiah Award	1.00	3.51	0.00	0.26	0.00	3.77	0.16	3.61
Bapu Narayanaswamy Prize	1.00	2.89	0.00	0.26	0.00	3.15	0.05	3.10
Prof. Roddam Narasimha Prize	2.00	3.04	0.00	0.16	0.00	3.20	0.03	3.17
Prof. M.K.Chandrashekaran Fund	5.43	4.66	0.00	0.43	0.00	5.09	0.00	5.09
Sanjay S R Rao	25.00	0.00	26.70	0.00	0.00	26.70	0.20	26.50
Indumathi Rao	25.00	0.00	27.81	0.00	0.00	27.81	0.00	27.81
Reliance Fund - Sankhyasutra	431.37	0.00	431.37	0.00	10.06	441.43	0.00	441.43
TOTAL - OTHER ENDOWMENT FUNDS	**495.05**	**27.45**	**485.88**	**2.21**	**10.06**	**525.60**	**0.44**	**525.16**
LECTURE SERIES								
Dr. A.V.Rama Rao Fund	31.00	31.78	0.00	2.52	0.00	34.30	1.76	32.54
ISRO-Dr. Satish Dhawan	14.00	21.97	0.00	1.09	0.00	23.06	0.00	23.06
DAE-Dr. Raja Ramanna	15.00	16.51	0.00	1.27	0.00	17.78	0.95	16.83
DBT-Prof. V Ramalingaswamy	7.00	12.92	0.00	0.55	0.00	13.47	1.26	12.21
TOTAL - LECTURE SERIES	**67.00**	**83.18**	**0.00**	**5.43**	**0.00**	**88.61**	**3.97**	**84.64**
C.N.R. RAO HALL OF SCIENCE FUND	**170.00**	**209.51**	**0.00**	**23.38**	**0.00**	**232.89**	**15.36**	**217.53**
MATERIALS RESEARCH FUND	**341.45**	**221.34**	**192.39**	**26.64**	**0.00**	**440.37**	**0.07**	**440.30**
CORPUS FUND (Centre's Development Fund)	**1,682.07**	**2921.21**	**86.07**	**151.55**	**83.30**	**3,242.13**	**87.26**	**3,154.87**
GRAND TOTAL	**2,968.91**	**3,772.01**	**764.34**	**227.04**	**93.36**	**4,856.75**	**128.96**	**4,727.79**

GRSH & Associates Bangalore Chartered Accountants

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH

Details of Scheme funds for the financial year 2019-2020

Sl. No.	Code	Opening Balance		Additions to the Funds	Utilisation / Expenditure	Closing Balance	
		Debit	Credit			Debit	Credit
1	4037	163516	0	0	0	163516	0
2	4041	0	1,39,376	0	0	0	1,39,376
3	4042	0	17,685	0	17,685	0	0
4	4044	0	2,20,968	0	0	0	2,20,968
5	4048	58,378	0	0	0	58,378	0
6	4051	0	4,000	0	0	0	4,000
7	4052	1,30,972	0	0	0	1,30,972	0
8	4053	3,55,267	0	0	0	3,55,267	0
9	4058	0	5,000	0	0	0	5,000
10	4059	30,526	0	0	0	30,526	0
11	4062	22,445	0	0	0	22,445	0
12	4063	0	7,87,513	0	0	0	7,87,513
13	4064	0	2,61,088	0	0	0	2,61,088
14	4066	3,28,461	0	0	0	3,28,461	0
15	4070	15,075	0	0	0	15,075	0
16	4071	0	3,54,148	0	0	0	3,54,148
17	4072	0	20,33,705	0	0	0	20,33,705
18	4073	0	2,450	0	0	0	2,450
19	4074	0	1,27,700	0	0	0	1,27,700
20	4075	0	10,961	0	0	0	10,961
21	4076	4,615	0	0	0	4,615	0
22	4077	0	335	0	0	0	335
23	4078	5,011	0	0	0	5,011	0
24	4079	36,982	0	0	0	36,982	0
25	4082	0	887	0	0	0	887
26	4083	10,856	0	0	0	10,856	0
27	4084	0	79,865	0	0	0	79,865
28	4085	0	65,891	0	0	0	65,891
29	4086	18,500	0	0	0	18,500	0
30	4087	4,50,000	0	0	0	4,50,000	0
31	4089	0	6,99,975	0	0	0	6,99,975
32	4093	2,250	0	0	0	2,250	0
33	4095	0	12,129	0	0	0	12,129
34	4096	0	1,500	0	0	0	1,500
35	4097	0	3,00,492	0	0	0	3,00,492
36	4098	2,75,295	0	0	0	2,75,295	0
37	4099	97,970	0	0	0	97,970	0
38	4100	2,527	0	0	0	2,527	0
39	4102	0	67,035	0	0	0	67,035
40	4104	1,05,343	0	0	0	1,05,343	0
41	4105	301	0	0	0	301	0
42	4106	10,312	0	0	0	10,312	0
43	4107	1,19,464	0	0	0	1,19,464	0

GRSM & Associates Bangalore Chartered Accountants

44	4109	5,836	0	0	0	5,836	0
45	4111	0	9,655	0	0	0	9,655
46	4113	0	2,29,542	0	0	0	2,29,542
47	4114	0	5,69,013	0	0	0	5,69,013
48	4115	237	0	0	0	237	0
49	4116	18,548	0	0	0	18,548	0
50	4117	326	0	0	0	326	0
51	4119	17,17,113	0	0	0	17,17,113	0
52	4121	0	72,153	0	0	0	72,153
53	4122	32,794	0	0	0	32,794	0
54	4123	73,642	0	73,642	0	0	0
55	4124	22,425	0	0	0	22,425	0
56	4126	0	1,62,570	0	0	0	1,62,570
57	4127	0	1,41,885	0	0	0	1,41,885
58	4128	0	85,34,953	0	48,49,803	0	36,85,150
59	4130	0	2,41,551	0	0	0	2,41,551
60	4131	81,231	0	0	0	81,231	0
61	4132	10,338	0	0	0	10,338	0
62	4133	1,64,849	0	0	0	1,64,849	0
63	4134	15,141	0	0	0	15,141	0
64	4136	18,509	0	0	0	18,509	0
65	4137	1,63,923	0	0	0	1,63,923	0
66	4138	65,453	0	0	0	65,453	0
67	4139	38,614	0	0	0	38,614	0
68	4140	0	34,52,216	0	0	0	34,52,216
69	4141	84,400	0	0	0	84,400	0
70	4142	0	3,56,244	0	0	0	3,56,244
71	4143	21,028	0	0	0	21,028	0
72	4144	1,18,646	0	0	0	1,18,646	0
73	4145	1,01,515	0	0	1,364	1,02,879	0
74	4146	0	6,89,158	0	0	0	6,89,158
75	4147	0	1,82,576	0	0	0	1,82,576
76	4148	0	4,29,860	0	0	0	4,29,860
77	4150	1,94,103	0	0	0	1,94,103	0
78	4152	2,47,382	0	0	0	2,47,382	0
79	4153	0	1,53,454	0	0	0	1,53,454
80	4154	1,64,301	0	0	0	1,64,301	0
81	4155	0	14,253	0	0	0	14,253
82	4157	7,483	0	0	0	7,483	0
83	4158	0	4,26,528	0	0	0	4,26,528
84	4159	0	2,15,630	0	0	0	2,15,630
85	4161	1,05,786	0	0	0	1,05,786	0
86	4163	355	0	0	0	355	0
87	4164	25,813	0	0	0	25,813	0
88	4165	20,000	0	0	0	20,000	0
89	4166	42,600	0	0	0	42,600	0
90	4168	18,329	0	0	0	18,329	0
91	4169	3,260	0	0	0	3,260	0
92	4171	0	2,34,213	0	0	0	2,34,213
93	4175	21,016	0	0	0	21,016	0

GRSM & Associates Bangalore Chartered Accountants

94	4176	0	1,91,625	0	0	0	1,91,625
95	4178	0	3,35,703	0	0	0	3,35,703
96	4179	0	98,108	0	0	0	98,108
97	4180	0	6,37,635	0	0	0	6,37,635
98	4181	0	52,507	0	0	0	52,507
99	4182	1,483	0	0	0	1,483	0
100	4185	0	74,616	0	0	0	74,616
101	4187	0	5,80,015	0	0	0	5,80,015
102	4189	12,32,132	0	0	0	12,32,132	0
103	4190	0	12,713	0	0	0	12,713
104	4191	12,318	0	0	0	12,318	0
105	4193	0	1,766	0	0	0	1,766
106	4195	94,586	0	0	0	94,586	0
107	4196	0	32,000	0	0	0	32,000
108	4197	0	84,050	0	2,008	0	82,042
109	4198	37,731	0	0	0	37,731	0
110	4199	50,309	0	0	0	50,309	0
111	4200	0	97,682	0	0	0	97,682
112	4201	0	24,769	0	0	0	24,769
113	4203	13,32,342	0	0	0	13,32,342	0
114	4206	14,55,836	0	0	26,928	14,82,764	0
115	4208	3,62,295	0	0	0	3,62,295	0
116	4209	0	4,01,722	0	0	0	4,01,722
117	4210	0	2,48,986	0	0	0	2,48,986
118	4212	39,059	0	0	0	39,059	0
119	4213	36,30,285	0	0	0	36,30,285	0
120	4215	0	10,000	0	0	0	10,000
121	4216	362	0	0	0	362	0
122	4218	19,189	0	0	0	19,189	0
123	4219	48,928	0	0	0	48,928	0
124	4220	9,16,740	0	0	0	9,16,740	0
125	4222	2,51,521	0	0	0	2,51,521	0
126	4223	0	1,22,567	0	0	0	1,22,567
127	4225	2,17,136	0	0	0	2,17,136	0
128	4227	0	7,936	0	0	0	7,936
129	4228	1,57,085	0	0	0	1,57,085	0
130	4229	0	40,831	0	0	0	40,831
131	4231	46,243	0	0	0	46,243	0
132	4232	1,52,544	0	0	0	1,52,544	0
133	4233	2,06,789	0	0	0	2,06,789	0
134	4234	0	6,145	0	0	0	6,145
135	4235	0	62,793	0	0	0	62,793
136	4237	43,427	0	0	0	43,427	0
137	4238	0	16,42,830	0	0	0	16,42,830
138	4239	2,49,927	0	0	0	2,49,927	0
139	4240	7,52,659	0	0	0	7,52,659	0
140	4241	36,500	0	0	0	36,500	0
141	4242	6,09,511	0	0	0	6,09,511	0
142	4243	0	4,52,016	0	0	0	4,52,016
143	4247	0	5,47,873	0	0	0	5,47,873

GRSM & Associates Bangalore Chartered Accountants

144	4248	6,67,842	0	0	0	6,67,842	0
145	4252	0	15,136	19,29,371	13,58,995	0	5,85,512
146	4253	1,15,419	0	0	0	1,15,419	0
147	4254	3,12,285	0	0	0	3,12,285	0
148	4257	4,33,230	0	0	-9,53,230	0	5,20,000
149	4258	9,09,065	0	0	0	9,09,065	0
150	4259	1,56,934	0	0	0	1,56,934	0
151	4262	3,60,110	0	0	0	3,60,110	0
152	4263	16,674	0	0	0	16,674	0
153	4266	74,971	0	0	0	74,971	0
154	4267	0	1,62,265	0	0	0	1,62,265
155	4268	5,594	0	0	-11,188	0	5,594
156	4270	0	20,000	0	0	0	20,000
157	4272	3,219	0	0	0	3,219	0
158	4274	5,83,343	0	0	0	5,83,343	0
159	4275	0	8,977	0	0	0	8,977
160	4276	12,352	0	0	0	12,352	0
161	4277	0	7,55,853	0	56,761	0	6,99,092
162	4279	166	0	0	0	166	0
163	4280	3,08,285	0	0	0	3,08,285	0
164	4281	4,19,901	0	0	0	4,19,901	0
165	4282	0	3,14,167	0	0	0	3,14,167
166	4283	0	48,603	0	3,070	0	45,533
167	4284	0	30,162	0	0	0	30,162
168	4285	25,970	0	0	0	25,970	0
169	4286	0	19,34,395	0	19,67,944	33,549	0
170	4287	0	9,712	0	0	0	9,712
171	4288	6,16,803	0	0	0	6,16,803	0
172	4289	1,80,424	0	0	0	1,80,424	0
173	4290	0	79,002	0	0	0	79,002
174	4292	0	1,10,473	17,78,050	14,12,996	0	4,75,527
175	4293	9,55,091	0	8,86,543	-68,548	0	0
176	4294	0	83,20,888	0	39,02,722	0	44,18,166
177	4295	19,092	0	0	-38,184	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	0	0	4,22,510	0
184	4308	0	2,39,309	0	0	0	2,39,309
185	4311	8,56,113	0	8,56,113	0	0	0
186	4312	1,52,000	0	0	0	1,52,000	0
187	4313	0	2,01,186	0	0	0	2,01,186
188	4314	3,77,469	0	0	0	3,77,469	0
189	4318	1,212	0	0	0	1,212	0
190	4319	15,985	0	0	0	15,985	0
191	4320	62,558	0	0	0	62,558	0
192	4324	0	31,38,355	6,00,000	12,52,867	0	24,85,488
193	4325	0	24,994	0	0	0	24,994

GRSM & Associates Bangalore Chartered Accountants

194	4326	57,013	0	0	1,48,184	2,05,197	0
195	4327	47,323	0	0	0	47,323	0
196	4330	0	2,033	17,967	0	0	20,000
197	4331	0	2,31,382	-50,225	1,81,157	0	0
198	4332	0	1,16,148	-4,299	1,11,849	0	0
199	4333	4,83,351	0	0	0	4,83,351	0
200	4334	5,41,134	0	0	0	5,41,134	0
201	4335	0	1,218	0	0	0	1,218
202	4336	0	17,97,956	0	8,77,727	0	9,20,229
203	4337	0	10,96,806	0	13,55,676	2,58,870	0
204	4339	0	26,693	0	0	0	26,693
205	4340	5,233	0	0	0	5,233	0
206	4342	0	10,72,958	0	87,963	0	9,84,995
207	4343	68,927	0	78,927	0	0	10,000
208	4344	1,09,450	0	0	0	1,09,450	0
209	4346	0	14,35,426	0	2,70,950	0	11,64,476
210	4350	0	1,22,311	-1,22,311	0	0	0
211	4351	59,277	0	0	0	59,277	0
212	4352	6,92,505	0	0	0	6,92,505	0
213	4353	0	6,04,76,709	2,51,38,984	8,25,85,613	0	30,30,080
214	4354	0	4,00,369	0	2,53,872	0	1,46,497
215	4355	63,842	0	0	0	63,842	0
216	4357	0	3,85,715	0	0	0	3,85,715
217	4358	0	72,78,747	0	43,90,509	0	28,88,238
218	4359	0	4,31,725	15,21,452	10,57,329	0	8,95,848
219	4360	0	4,81,381	0	5,81,063	99,682	0
220	4361	7,35,879	0	13,17,830	10,22,022	4,40,071	0
221	4362	0	96,011	0	0	0	96,011
222	4363	0	90,266	-90,266	0	0	0
223	4365	41,564	0	0	0	41,564	0
224	4366	0	1,15,783	17,34,650	9,19,038	0	9,31,396
225	4367	10,064	0	10,064	0	0	0
226	4371	5,10,728	0	12,00,000	7,29,757	40,485	0
227	4372	0	4,000	0	0	0	4,000
228	4374	0	3,00,204	27,695	83,260	0	2,44,639
229	4375	0	3,61,896	2,994	6,31,051	2,66,161	0
230	4376	89,354	26,32,06,566	62,88,519	12,78,72,127	0	14,15,33,604
231	4377	0	9,71,906	0	1,95,385	0	7,76,521
232	4378	3,42,097	0	0	0	3,42,097	0
233	4379	57,152	0	0	0	57,152	0
234	4380	0	14,000	0	14,000	0	0
235	4382	0	2,94,311	-99,269	89,640	0	1,05,402
236	4384	65,266	0	9,81,069	4,96,251	0	4,19,552
237	4385	0	95,18,206	0	40,05,451	0	55,12,755
238	4386	0	11,68,623	6,50,50,000	2,94,65,975	0	3,67,52,648
239	4387	0	1,39,98,361	4,00,00,000	2,68,97,327	0	2,71,01,034
240	4388	0	1,36,996	89,130	15,40,055	13,13,929	0
241	4390	0	1,37,896	1,10,614	2,48,510	0	0
242	4391	1,35,134	0	520	21,318	1,55,932	0
243	4393	38,924	0	0	0	38,924	0

GRSM & Associates Bangalore Chartered Accountants

244	4394	0	1,37,703	0	37,574	0	1,00,129
245	4399	0	1,59,525	-12,138	1,47,387	0	0
246	4400	90,586	0	0	0	90,586	0
247	4401	2,57,351	0	0	0	2,57,351	0
248	4402	0	3,44,117	0	13,15,810	9,71,693	0
249	4404	2,48,492	0	0	0	2,48,492	0
250	4405	15,401	0	0	0	15,401	0
251	4406	7,84,746	0	0	2,46,613	10,31,359	0
252	4407	0	7,32,244	24,36,602	13,63,617	0	18,05,229
253	4408	0	4,23,004	6,02,198	10,25,202	0	0
254	4409	0	24,088	3,33,333	3,97,834	40,413	0
255	4411	1,11,723	0	0	3,18,134	4,29,857	0
256	4412	7,56,644	0	0	10,91,186	18,47,830	0
257	4413	0	8,30,278	0	6,56,528	0	1,73,750
258	4414	9,35,645	0	0	0	9,35,645	0
259	4418	5,07,929	0	21,18,190	22,33,258	6,22,997	0
260	4419	0	2,455	0	0	0	2,455
261	4420	0	6,53,993	4,08,873	17,06,078	6,43,212	0
262	4422	0	13,98,919	16,44,237	23,65,073	0	6,78,083
263	4423	0	10,88,014	4,47,500	7,81,840	0	7,53,674
264	4424	1,02,670	0	6,02,407	7,48,673	2,48,936	0
265	4425	59,57,913	0	69,64,123	33,02,495	22,96,285	0
266	4427	0	8,61,609	0	29,64,219	21,02,610	0
267	4428	0	1,98,45,294	0	2,26,68,941	28,23,647	0
268	4430	1,72,426	0	0	0	1,72,426	0
269	4431	0	4,43,201	14,21,876	12,19,016	0	6,46,061
270	4432	0	4,65,180	5,79,919	8,02,197	0	2,42,902
271	4433	0	9,80,060	5,00,000	15,20,998	40,938	0
272	4434	66,527	0	66,527	0	0	0
273	4435	0	5,37,823	-8,965	5,28,858	0	0
274	4436	37,468	0	5,70,086	2,64,795	0	2,67,823
275	4438	0	1,47,880	8,34,122	11,10,140	1,28,138	0
276	4439	0	42,512	6,00,516	8,28,241	1,85,213	0
277	4440	10,93,492	0	25,33,206	14,39,714	0	0
278	4441	88,406	0	88,406	0	0	0
279	4442	57,656	0	0	64,913	1,22,569	0
280	4443	0	2,23,906	-29,990	1,93,916	0	0
281	4444	0	4,36,959	0	12,95,584	8,58,625	0
282	4445	11,21,200	0	25,96,888	5,57,473	0	9,18,215
283	4446	0	5,01,115	10,25,887	13,25,703	0	2,01,299
284	4447	0	3,91,242	3,03,026	5,92,224	0	1,02,044
285	4448	0	42,655	6,00,000	9,50,070	3,07,415	0
286	4449	0	2,97,675	-592	2,97,083	0	0
287	4450	98,694	0	0	70,345	1,69,039	0
288	4451	0	2,20,946	-12,045	2,08,901	0	0
289	4452	42,026	0	0	0	42,026	0
290	4455	0	1,98,294	0	26,792	0	1,71,502
291	4456	0	52,385	4,00,000	3,96,455	0	55,930
292	4457	75,900	0	5,54,282	6,77,458	1,99,076	0
293	4458	3,872	0	3,17,184	3,62,452	49,140	0

294	4459	0	93,131	0	1,44,676	51,545	0
295	4460	0	1,29,938	207	1,13,634	0	16,511
296	4461	0	3,96,395	-1,176	3,95,219	0	0
297	4462	28,137	0	0	4,904	33,041	0
298	4463	0	11,27,326	6,679	11,42,558	8,553	0
299	4464	0	5,51,748	4,29,291	9,54,116	0	26,923
300	4467	70,572	0	0	84,000	1,54,572	0
301	4468	0	2,82,138	3,91,000	6,73,138	0	0
302	4469	0	10,77,610	0	5,21,636	0	5,55,974
303	4470	0	9,16,108	0	9,16,108	0	0
304	4471	0	1,00,618	133	1,17,660	16,909	0
305	4472	0	1,24,424	0	1,86,302	61,878	0
306	4473	1,21,812	0	0	0	1,21,812	0
307	4474	0	78,890	8,30,096	7,94,006	0	1,14,980
308	4475	0	2,43,698	3,75,000	2,75,714	0	3,42,984
309	4476	2,20,731	0	14,48,076	8,80,893	0	3,46,452
310	4477	0	9,65,089	0	5,73,732	0	3,91,357
311	4478	12,530	0	0	0	12,530	0
312	4479	0	2,17,395	932	2,30,645	12,318	0
313	4480	0	1,04,969	1,91,202	2,96,171	0	0
314	4482	42,411	0	42,411	0	0	0
315	4483	0	5,04,713	9,59,885	13,76,630	0	87,968
316	4484	0	2,00,391	6,05,828	9,98,219	1,92,000	0
317	4485	0	88,220	0	88,220	0	0
318	4487	48,609	0	4,40,000	5,02,913	1,11,522	0
319	4488	0	86,866	5,11,549	6,01,267	2,852	0
320	4489	0	9,293	5,00,000	3,13,279	0	1,96,014
321	4490	0	3,224	0	2,783	0	441
322	4491	0	7,24,923	11,03,837	8,69,742	0	9,59,018
323	4492	0	11,66,267	23,44,313	23,58,597	0	11,51,983
324	4493	1,64,011	0	14,99,192	14,27,378	92,197	0
325	4494	0	2,23,425	2,70,000	1,29,854	0	3,63,571
326	4495	0	1,06,638	-5,430	73,266	0	27,942
327	4496	0	3,36,684	6,13,877	3,93,616	0	5,56,945
328	4497	0	46,47,850	12,19,015	50,07,677	0	8,59,188
329	4498	0	6,80,152	3,53,836	6,74,037	0	3,59,951
330	4499	0	4,77,838	2,03,762	4,83,787	0	1,97,813
331	4500	0	30,78,905	73,844	13,85,511	0	17,67,238
332	4501	0	29,56,989	37,059	33,03,136	3,09,088	0
333	4502	0	85,927	2,50,000	1,41,787	0	1,94,140
334	4503	2,46,086	0	0	5,10,370	7,56,456	0
335	4504	26,149	0	0	4,69,092	4,95,241	0
336	4505	4,38,756	0	21,82,250	5,17,889	0	12,25,605
337	4506	0	3,88,080	21,33,918	13,32,710	0	11,89,288
338	4507	0	3,07,911	0	3,485	0	3,04,426
339	4508	0	2,25,086	0	8,23,526	5,98,440	0
340	4509	0	82,314	10,67,183	11,49,497	0	0
341	4510	0	1,06,125	0	78,061	0	28,064
342	4511	0	6,86,153	0	1,91,253	0	4,94,900
343	4514	0	2,11,64,507	0	2,07,29,336	0	4,35,171

GRSM & Associates Bangalore

344	4515	31,280	17,33,90,845	34,34,357	10,19,44,812	0	7,48,49,110
345	4516	0	10,63,569	8,15,644	13,56,684	0	5,22,529
346	4518	0	1,93,419	15,00,000	10,44,116	0	6,49,303
347	4519	0	6,70,866	8,823	8,33,428	1,53,739	0
348	4549	0	12,75,138	3,22,316	12,89,761	0	3,07,693
349	4551	83,216	0	2,00,000	1,15,699	0	1,085
350	4552	0	14,37,385	34,538	10,70,084	0	4,01,839
351	4553	0	40,85,000	0	2,90,345	0	37,94,655
352	4554	0	7,60,265	12,22,385	18,11,369	0	1,71,281
353	4555	0	5,25,255	8,00,000	11,82,149	0	1,43,106
354	4556	0	1,40,857	0	1,30,000	0	10,857
355	4558	0	3,10,904	9,527	72,402	0	2,48,029
356	4559	0	3,26,738	7,521	2,84,667	0	49,592
357	4560	87,547	0	86,721	10,12,994	10,13,820	0
358	4561	0	10,50,000	-3,10,734	7,39,266	0	0
359	4562	0	9,60,000	1,77,670	10,65,269	0	72,401
360	4563	0	9,55,430	1,67,466	9,73,942	0	1,48,954
361	4564	0	3,27,743	5,309	3,27,457	0	5,595
362	4565	0	10,11,667	0	11,00,321	88,654	0
363	4566	0	35,23,290	65,005	32,69,643	0	3,18,652
364	4567	0	0	16,45,309	9,84,747	0	6,60,562
365	4568	0	1,16,600	31,48,200	30,87,432	0	1,77,368
366	4569	0	0	12,35,960	8,95,820	0	3,40,140
367	4570	0	0	21,51,725	14,71,186	0	6,80,539
368	4571	0	42,36,700	1,17,834	37,33,903	0	6,20,631
369	4572	0	8,40,000	0	6,62,275	0	1,77,725
370	4573	0	70,648	0	53,635	0	17,013
371	4574	0	0	11,46,528	10,46,346	0	1,00,182
372	4575	0	9,00,000	1,41,00,000	95,92,632	0	54,07,368
373	4576	2,44,180	0	19,12,420	26,54,151	9,85,911	0
374	4577	0	3,35,000	10,474	85,000	0	2,60,474
375	4578	0	0	93,37,966	38,80,695	0	54,57,271
376	4579	0	0	24,59,160	3,35,133	0	21,24,027
377	4580	0	0	11,11,691	7,85,899	0	3,25,792
378	4581	0	0	60,29,022	7,75,768	0	52,53,254
379	4582	0	0	1,94,11,280	11,42,327	0	1,82,68,953
380	4583	0	0	14,12,566	5,33,812	0	8,78,754
381	4584	0	0	24,54,687	20,03,221	0	4,51,466
382	4585	0	0	10,47,000	9,78,871	0	68,129
383	4586	0	0	17,68,00,000	14,04,65,559	0	3,63,34,441
384	4587	0	0	79,65,631	31,33,430	0	48,32,201
385	4588	0	0	11,11,400	6,46,534	0	4,64,866
386	4589	0	0	11,46,182	7,46,128	0	4,00,054
387	4590	0	0	2,75,10,640	12,02,497	0	2,63,08,143
388	4591	0	0	22,50,000	6,72,823	0	15,77,177
389	4592	0	0	73,15,900	9,11,305	0	64,04,595
390	4593	0	0	14,80,558	7,52,022	0	7,28,536
391	4594	0	0	2,40,222	2,40,042	0	180
392	4595	0	0	25,00,000	8,15,348	0	16,84,652
393	4596	0	0	10,00,000	2,17,161	0	7,82,839

GnSM & Associates Bangalore

394	4597	0	0	63,60,508	6,57,276	0	57,03,232
395	4598	0	0	10,09,630	2,89,672	0	7,19,958
396	4599	0	0	23,36,235	88,735	0	22,47,500
397	4600	0	0	11,26,589	2,29,600	0	8,96,989
398	4601	0	0	17,18,795	25,000	0	16,93,795
399	4602	0	0	23,54,000	0	0	23,54,000
400	4603	0	0	53,30,586	38,314	0	52,92,272
401	4604	0	0	30,23,530	6,25,116	0	23,98,414
402	4605	0	0	3,00,000	43,202	0	2,56,798
403	4606	0	0	13,46,895	41,731	0	13,05,164
404	4607	0	0	22,05,431	0	0	22,05,431
405	4608	0	0	2,20,823	2,299	0	2,18,524
406	4609	0	0	28,59,749	13,176	0	28,46,573
407	4610	0	0	19,00,000	14,17,841	0	4,82,159
408	4611	0	0	39,27,288	9,960	0	39,17,328
409	4614	0	0	17,03,139	11,652	0	16,91,487
410	4615	0	0	21,36,300	12,213	0	21,24,087
411	4616	0	0	3,44,43,744	38,668	0	3,44,05,076
412	4617	0	0	28,62,732	10,602	0	28,52,130
413	4618	0	0	26,33,512	6,904	0	26,26,608
414	4621	0	0	0	2,621	2,621	0
415	5100	4,10,730	0	0	0	4,10,730	0
416	5101	5,73,994	0	0	0	5,73,994	0
417	5102	8,000	0	0	0	8,000	0
418	5103	1,64,650	0	0	0	1,64,650	0
419	5104	29,10,103	0	0	0	29,10,103	0
420	5105	24,28,431	0	0	0	24,28,431	0
421	6001	0	2,84,70,063	0	2,01,36,151	0	83,33,912
422	6002	0	33,60,116	0	33,60,116	0	0
423	6003	0	33,00,847	0	0	0	33,00,847
424	6004	0	4,27,67,788	3,58,60,697	2,75,87,834	0	5,10,40,651
425	6005	0	3,38,050	6,30,561	24,833	0	9,43,778
426	P.D.F.	0	27,33,589	14,53,647	7,97,750	0	33,89,486
427	O.C.B.	0	32,79,62,928	4,17,50,913	13,44,50,707	0	23,52,63,134
		5,40,50,192	1,09,19,32,860	66,39,85,398	90,66,02,954	6,05,41,056	85,58,06,167

GRSM & Associates Bangalore Chartered Accountants

Sampad Patra
Accounts Officer

ANNUAL FACULTY MEETING, IN-HOUSE SYMPOSIUM, DEGREE AWARD CEREMONY & POSTER SESSION (NOVEMBER 13–14, 2019)





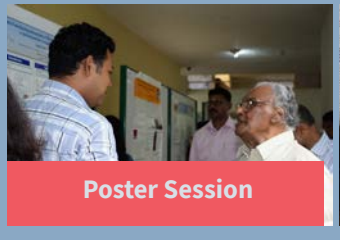

In-House Symposium

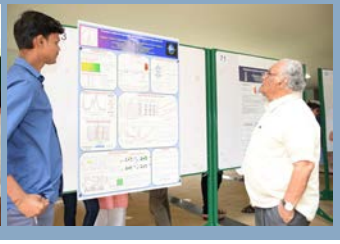
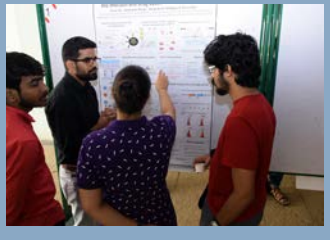
Group Photo


Degree Award Ceremony

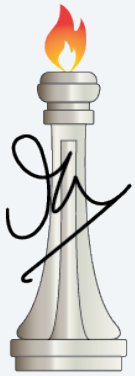






Poster Session



JNCASR

Jawaharlal Nehru Centre for Advanced Scientific Research

Jakkur Post, Bengaluru - 560 064
Karnataka, India
Phone: 91-80-22082750
E-mail: admin@jncasr.ac.in
Website: www.jncasr.ac.in