Annual Report 2018-19

JAWAHARLAL NEHRU CENTRE
FOR ADVANCED SCIENTIFIC RESEARCH
Jakkur P.O, Bengaluru, Karnataka 560 064


C·N·R·RAO

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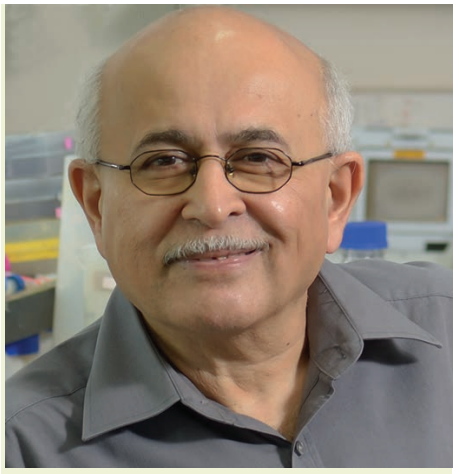
WORD FROM THE PRESIDENT



It is with great pride that I present the 30th Annual Report of the Centre for the year 2018-19. As an institution, JNCASR has come a long way since its foundation, and its presence and impact is now widely recognised in the country as well as internationally. It was recently ranked the 7th among the top 10 research institutes around the world in the 2019 Nature Index Annual Tables, announced by the leading scientific publisher *Nature*. This is a proud and significant moment for us; especially considering that we have achieved this in the short span of 30 years, while being assessed along with several long-established larger participating institutions. Globally, we stand at 781 out of 18,000 universities worldwide, according to the 2018-2019 CWUR World University Rankings (cwur.org), the largest academic ranking of global universities. Furthermore, JNCASR was also rated as the best institution from research productivity point of view, as per recent studies on performance (per capita) of different Indian Institutions by Current Science (June, 2018).

Based on our success and impact on the scientific community in India, we have been graded as category-I Deemed to be University, which makes us eligible for the benefits stipulated under clause-4 (Dimensions of Autonomy for Category-I Universities) of UGC Regulations. We hope to utilize this to better our academic and fellowship programmes. In other achievements, the project on "Life science research, education, and training at JNCASR" was granted INR 28.56 Cr. by the Department of Biotechnolog, Government of India. The Centre also recently signed MoUs with Centre for Human Genetics, Bengaluru, and International Iberian Nanotechnology Laboratory, Portugal. I am also proud to say that together with IISc, we have set up the National Supercomputing Facility at JNCASR; this facility boasts of 500 terraflop CPU power and 150 terraflop of accelerator power of computational infrastructure.

As in the past, this year too saw several faculty members achieving different awards and honours in the country as well as abroad. I would like to congratulate Bharat Ratna Prof. C.N.R. Rao for achieving the feat of greater than 100,000 publications and receiving the Top cited Author Award 2018, presented by the Institute of Physics Publishing. He also received the First Sheikh Saud International Prize for Materials Research given by the Centre for Advanced Materials of the UAE, and Honorary Doctorate from University of Manchester, UK and Presidency University, Kolkata. I would also like to congratulate all other faculty for receiving recognition and awards for their exemplary works. Prof. Maneesha Inamdar won the Dr. Kalpana Chawla Award for Women Scientist in the field of Science & Technology for 2017, awarded by KSCST, Govt. of Karnataka, along with being named a member of the following committees: World Health Organization (WHO) expert advisory committee on Developing global standards for governance and oversight of Human Genome editing, Global Forum on Bioethics in Research Planning Committee 2019, Expert Group on Stem Cell Research of the Indian Council for Medical Research, Govt. of India, and "Women in Science" Panel of the Indian Academy of Science. Prof. K.S. Valdiya was awarded the Lifetime Excellence Award from Ministry of Earth Sciences, GoI. Prof. G.U. Kulkarni won the MRSI-Distinguished Lectureship Award (2019-20) and the SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences. Prof. T. Govindraju won the CDRI Award 2019 for Excellence in Drug Research in the chemical sciences category. Prof. Jayanta Haldar was awarded the 8th National Award for Technology Innovation by the Ministry of Chemicals and Fertilizers, Government of India as well as the CRSI Bronze Medal in 2018. Apart from these and other recognitions, several faculty members have received different fellowships as well as become members of prestigious academic societies here and abroad. I would also like to mention the achievements of "Team Breathe", who were the first runner up at the 12th Clean Equity Forum. The team is currently in process of developing and commercializing its cutting-edge technology of converting carbon dioxide into commercially viable products such as methanol, making it a perfect start-up business (named Breathe Applied Sciences Pvt. Ltd.) that fits under the umbrella of Methanol economy, import substitution, and Make in India. I also welcome Dr. Kushagra Bansal within our fold who has joined JNCASR as Faculty Fellow of MBGU.

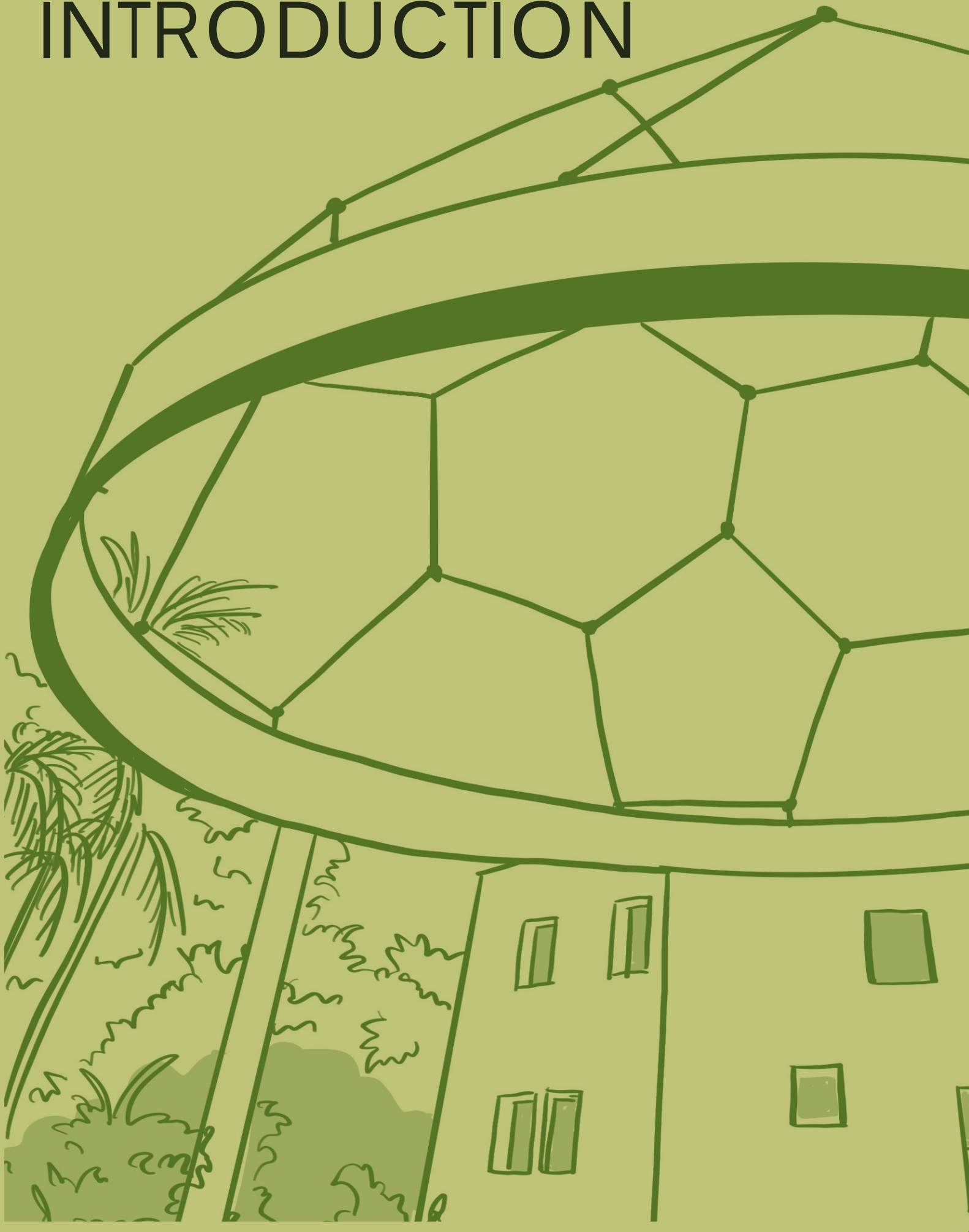
In keeping with the Centre's objective of pursuing interdisciplinary science and technology, our researchers have made excellent progress in their scientific pursuits, while also making direct societal impact through their technological innovations. This is obvious through the number of publications in quality journals and patent applications. In the past year, we have published a total of 250 articles, and of the 15 patent applications filed, 11 were granted. I hope all of the above-mentioned achievements will continue to inspire and motivate all of us to accomplish good science and succeed in our endeavours.

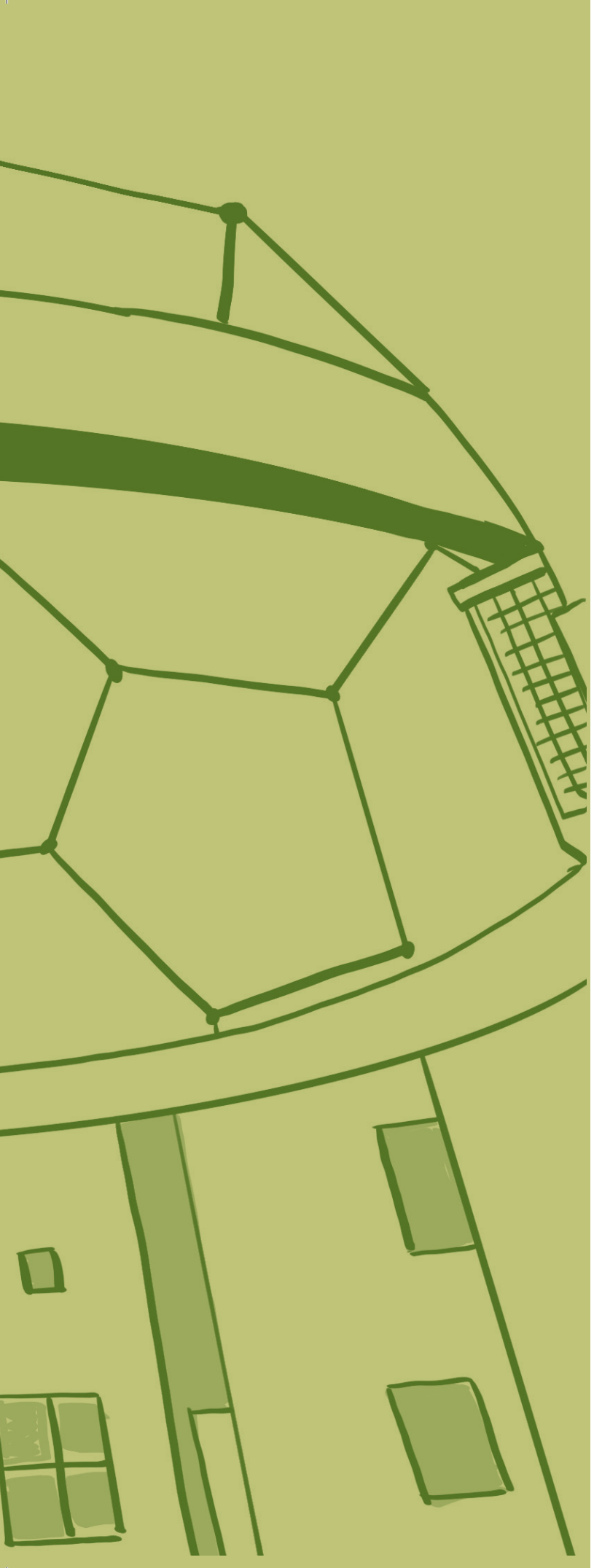
Our major commitment has always been to students. This year saw 33 Ph.D. admissions and 46 M.S. admissions, making the total student strength 325. A total of 30 Ph.D., 17 Int. Ph.D., 1 M.S., and 2 PGDMS degrees were awarded this past year under various programmes. Staying true to our pledge of taking our research from the laboratory to the society, several science outreach programmes and workshops were organised in the past year. These events have been a great success, with all participants showing a positive response towards continuing such endeavours that expose young minds to the scientific research process. These programmes have also been successful at promoting science and making society aware of the scientific progress in the country.

I believe our institution has achieved great things in a short period of time, and none of this would have been possible without the talented, committed, and diverse team that we have at JNCASR. Our diversity, determination, and ambition have been our strengths, allowing us to grow and flourish in multiple fields. The following pages provide a glimpse of our achievements in the past year. I would like to end by thanking each and every one of the institute members who have shared in the Centre's vision and strived to make it successful and I look forward to another successful year.

Prof. V. Nagaraja
President
Jawaharlal Nehru Centre for Advanced Scientific Research

INTRODUCTION





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The Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) was established in 1989 to commemorate the birth centenary year of Pandit Jawaharlal Nehru, the first Prime Minister of India and a pioneer of scientific progress and development in independent India. JNCASR is funded by the Department of Science and Technology of the Government of India.

JNCASR is a multidisciplinary research institute, with ten different research units and a range of academic programmes and several educational outreach activities. Since 2002, the Centre is recognised as a deemed university by the University Grants Commission and students' degrees are awarded directly by the institute. Over the years, the institute has expanded considerably and currently hosts more than 330 graduate students. Today, the Centre is one of the premier institutes of the country, and with excellence, innovation, and collaborative interdisciplinary approaches as some of its core values, contributes significantly in multiple areas of research.

30 YEARS OF JNCASR

With humble beginnings and a clear vision to promote scientific research at the highest level in frontier and interdisciplinary areas of Science and Engineering, the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) was established in 1989 through the initiative of the Department of Science and Technology of the Government of India. Prof. C.N.R. Rao, currently affiliated to the Chemistry and Physics of Materials Unit (CPMU); Chairman, New Chemistry Unit (NCU) and Director, International Centre for Materials Science (ICMS), held office as the President from 1989 to 1999. Prof. V. Krishnan, who succeeded him, served as President from 2000 to 2003. Prof. M.R.S. Rao was President from 2003 to 2013 and Prof. K.S. Narayan was the President from 2013 to 2015. Prof. V. Nagaraja is the current President since October 2015.

When the idea of JNCASR was being envisaged, it was decided that an association with one of the country's oldest and established research institute, Indian Institute of Science (IISc), would be desirable and conducive for the Centre's growth. Indeed, IISc lent full support to the idea and the first offices of JNCASR were established at the IISc campus. In 1994, the main campus of JNCASR at Jakkur, a 15-acre plot gifted by the Government of Karnataka, became fully operational. The JNCASR campus, which is 11 km away from that of IISc, still maintains strong collaborative ties with IISc. Although relatively young, the Centre has come a long way and has made a profound impact on the science scenario in India. Today, in its 30th year, it is one of the leading institutes in the country for interdisciplinary research in the areas of science and engineering.

Over the years, several research units have been established on the JNCASR campus. These include CPMU, ICMS, NCU, Evolutionary and Integrative Biology Unit, Molecular Biology and Genetics Unit, Neuroscience Unit, Engineering Mechanics Unit, Theoretical Science Unit (TSU), Geodynamics Unit, and Thematic Unit of Excellence in Computational Materials Science. There are over 50 eminent research faculties spread across these research units. One of the strengths of JNCASR has been its multidisciplinary campus, which fosters numerous on-campus collaborations, allowing bright minds to come together to solve grand challenges. Recently, the School of Advanced Materials was set up to provide a more efficient materials science programme at the Centre; this enterprise involves faculties from ICMS, NCU, and TSU. JNCASR also boasts of state-of-the-art experimental, computational, and infrastructural facilities, inspiring faculty and students to develop creative ideas. Currently, a new computational facility comprising 500 teraflop CPU power and 150 teraflop of accelerator power is being installed in the Centre, funded by the National Supercomputing Mission.

One of the important objectives of the Centre has been to train and provide opportunities to graduate students. In 2002, the Centre was recognised as a deemed university. Today, JNCASR has over 330 bright and enthusiastic students, with the majority pursuing their Ph.D. degrees. The Centre offers Integrated Ph.D. as well as Masters programmes in various disciplines. Several academic

courses with theory and practical components as well as seminar courses are offered to these students. Since 1990, the Centre also offers the short-term Summer Research Fellowship programme, Project Oriented Chemical Education, and Project Oriented Biological Education programmes to students at the undergraduate levels.

The success of JNCASR is evident from the numerous publications, prestigious faculty and student awards, patents, as well as the high number of Ph.D. and Masters degrees that have been awarded to students. Over the years, JNCASR faculty members have received numerous accolades. Recently, Prof. C.N.R. Rao, the founder President of the Centre and who achieved the highest civilian award of the Bharat Ratna in 2014, became the first Indian scientist to cross the H-index of 100 and achieve over 1,00,000 citations, which very few scientists across the world have accomplished. JNCASR as an institute has also received recognition and several awards on national and international platforms. In 2018, it won the Clarivate Analytics India Innovation Award for the second time, making the Centre one of the top innovators in India. *Current Science* also rated JNCASR as one of the best institutes in the country based on research productivity in 2018.

Towards fulfilling its objective of connecting with the society, the Centre engages in several outreach activities through workshops, festivals, and extension programmes. School teachers and students are invited to visit the Centre and attend talks and experimental demonstrations in an attempt to popularize science. The recently started Student Buddy programme, where school students make a day-long visit to the Centre, has been a great success.

Over the past several years, the Centre has accomplished much, as it has enthusiastically pushed forward to meet each of its objectives. This year, as JNCASR commemorates 30 years since inception, it can look back at several memorable and exciting moments and many major discoveries and successful innovations. No doubt, it has been an arduous and challenging journey, but the accomplishments and contribution that JNCASR has made to so many fields makes it worthwhile to continue to pursue its missions.

OBJECTIVES

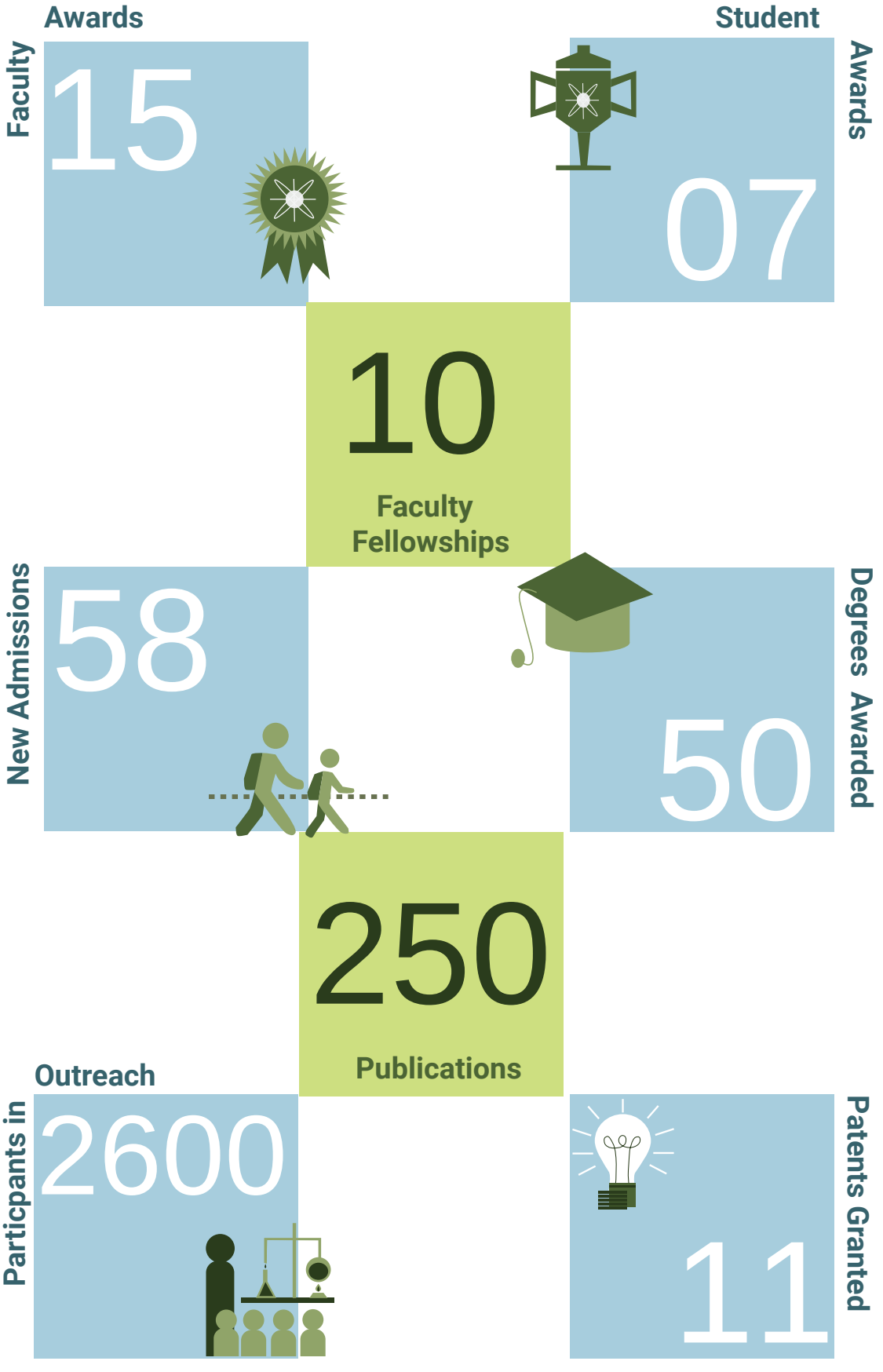
- Establish and conduct world-class research in science and engineering
- Foster interdisciplinary and collaborative research
- Establish state-of-the-art laboratories and computational and infrastructural facilities to facilitate scientific research
- Capacity building through high-quality Ph.Ds in 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

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 2018-19, there were no cases pertaining to the Centre that appeared before the CAT.

JNCASR THIS YEAR 2018-2019



AWARDS AND ACHIEVEMENTS

UGC has graded JNCASR as Category-I Deemed to be University
With this, JNCASR will now be eligible for the benefits stipulated under clause-4 (Dimensions of Autonomy for Category-I Universities) of UGC regulations.

JNCASR was rated as the best institution from research productivity
point of view, as per recent studies on performance (per capita) of different Indian Institutions – Current Science, June 10, 2018 (https://goo.gl/TFK6Kj).

DBT-JNCASR project on "Life science research, education and training at JNCASR" was granted a project grant of INR 28.56 cr. by the Department of Biotechnology, Government of India.

Memorandum of Understanding: The Centre signed MoUs with Centre for Human Genetics, Bengaluru, and International Iberian Nanotechnology Laboratory, Portugal.

NSM - National Supercomputing Facility, an MoU signed with IISc to set up the facility comprising of 500 terraflop CPU power and 150 terraflop of accelerator power of computational infrastructure at JNCASR.

Best Maintained Garden Trophy: JNCASR bagged the "Best Maintained Garden" Trophy for the 6th consecutive year from the Mysore Horticultural Society. The Chamundi Campus also received the same for its first time.

EVENTS IN 2018-2019

87 SEMINARS	12 MEETINGS
12 SCHOOLS AND CONFERENCES	12 LECTURES

Appointment

Dr. Kushagra Bansal
Faculty Fellow, MBGU

Superannuation

Prof. Namita Surolia

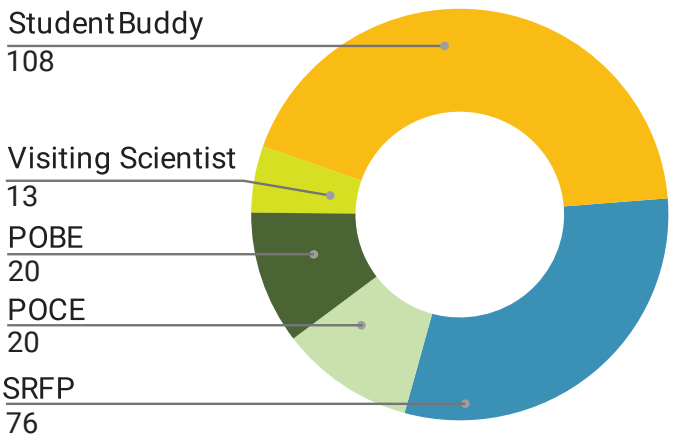
Promotions

Associate Professor
Dr. Kanishka Biswas

Professors

Dr. Subir K. Das
Dr. N.S. Vidhyadhiraja

PARTICIPATION IN FELLOWSHIP AND EXTENSION PROGRAMMES IN 2018-2019

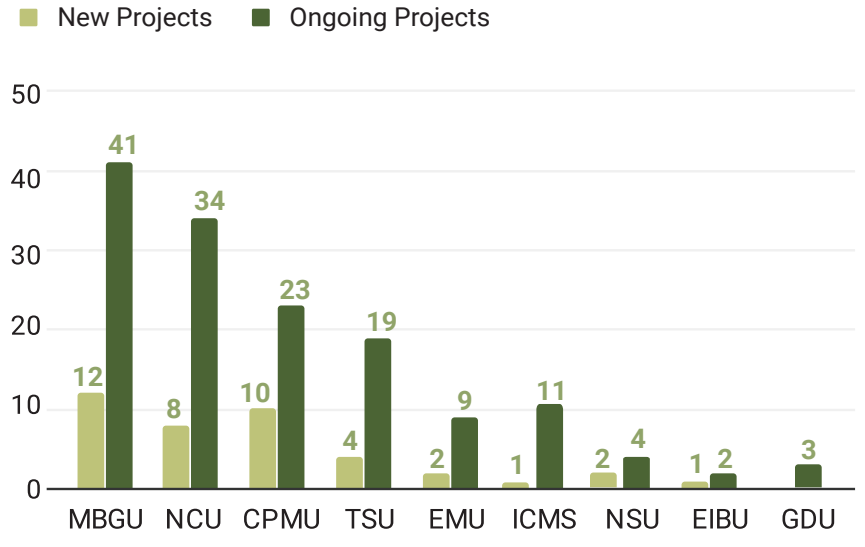


EDUCATIONAL TECHNOLOGY PROGRAMMES

14
NUMBER OF PROGRAMMES

2351
PARTICIPANTS

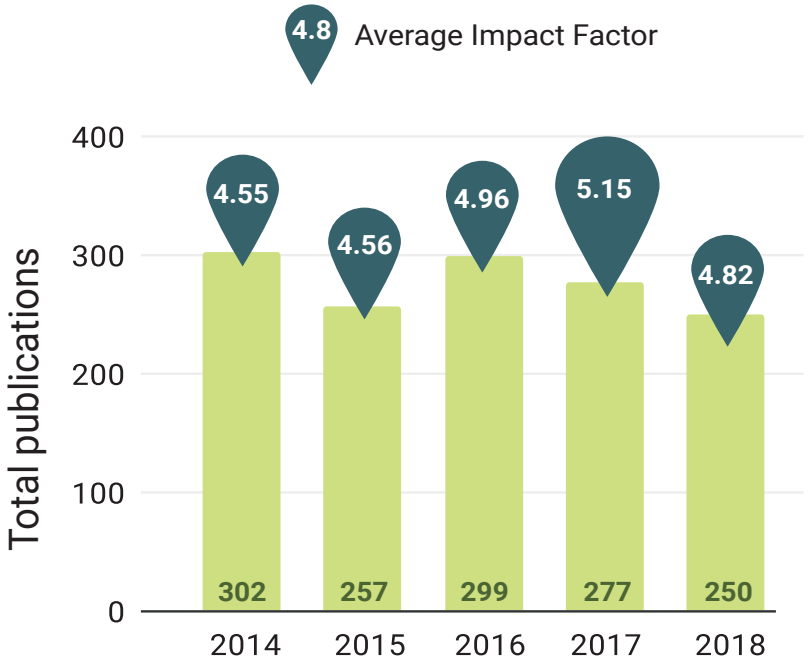
SPONSORED PROJECTS



40
NEW SPONSORED PROJECTS

144
ONGOING SPONSORED PROJECTS

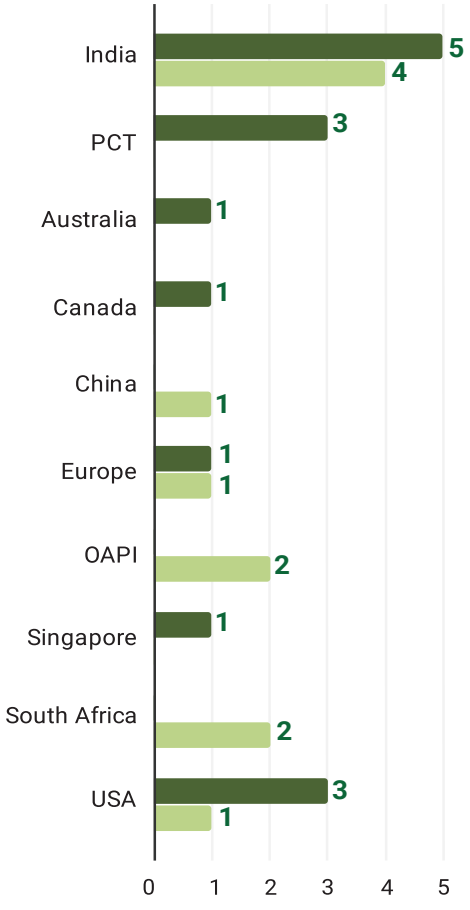
RECENT PUBLICATIONS



TOTAL PUBLICATIONS IN IMPACT FACTOR JOURNALS **247**

AVERAGE IMPACT FACTOR **4.82**

PATENT APPLICATIONS 2018-2019



Number of applications filed
Number of patents granted

11 PATENTS GRANTED 2018-2019

PATENT APPLICATIONS FILED SINCE INCEPTION

- National Phase under PCT 140
- India 88
- International Phase under PCT 55

FACULTY ACHIEVEMENTS

Prof. C.N.R. Rao

- Received the Honorary Causa Doctorate from Presidency University, Kolkata
- Received Honorary Doctorate from the University of Manchester, UK
- Top cited Author Award 2018 by Institute of Physics Publishing
- COSINE Award 2017
- First Sheikh Saud International Prize for Materials Research given by the Centre for Advanced Materials of the UAE

Prof. M.R.S. Rao

- SERB-Year of Science Chair Professorship

Prof. K.S. Valdiya

- Lifetime Excellence Award from Ministry of Earth Sciences, GoI

Prof. Roddam Narasimha

- Sr. Alumnus Award by Chief Minister of Karnataka at the inauguration of Bangalore Central University, Central College on 7th March 2018

Prof. Amitabh Joshi

- Member of Inter-Academy Committee of the three Science Academies for drafting "A National Framework for Open Access to Scientific Literature", 2019.

Prof. Anuranjan Anand

- Adjunct Professor (Honorary), Centre for Human Genetics, Bangalore

Prof. G.U. Kulkarni

- MRSI-Distinguished Lectureship Award (2019-20)
- SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences (2019-20)

Prof. Namita Surolia

- DBT Distinguished Biotechnology Research Professorship Award

Prof. Tapas Kumar Maji

- Fellowship of Indian Academy of Sciences, Bangalore

Prof. Chandrabhas Narayana

- Fellowship of Indian Academy of Sciences, Bangalore
- Mizushima-Raman Lecture 2018

Prof. T. Govindaraju

- CDRI Award 2019 for Excellence in Drug Research in chemical sciences category
- Visiting Professorship-University of Paris - Sud

Prof. Kaustuv Sanyal

- Fellow of American Academy of Microbiology
- Associate Editor, Frontiers in Cellular and Infection Microbiology

Prof. Jayanta Haldar

- Editorial Board Member of MedChemComm of RSC,
- 8th National Award for Technology Innovation, Ministry of Chemicals and Fertilizers, Govt. of India in 2018
- CRSI Bronze Medal in 2018
- Sheikh Saqr Career Award Fellowship in 2018

Prof. Sebastian C. Peter

- Swarnajayanthi Fellowships (Chemical Sciences) 2018

Dr. Kanishka Biswas

- Associate Editor of Journal ACS Applied Energy
- Materials, Emerging Investigator, Chem Comm, RSC
- CRSI Bronze Medal 2019 from Chemical Research Society of India

Prof. Ranjani Viswanatha

- MRSI Medal 2018

Prof. Subi George

- Fellowship of Indian Academy of Sciences

Prof. Swapan K. Pati

- Fellowship of Indian National Science Academy

Dr. Kushagra Bansal

- Ramalingaswami Re-entry Fellowship by Dept. of Biotechnology

Prof. Maneesha Inamdar

- Dr. Kalpana Chawla Award for Women Scientist in the field of Science & Technology for 2017 by KSCST, Govt. of Karnataka
- Member, World Health Organization expert advisory committee on Developing global standards for governance and oversight of human genome editing
- Member, Global Forum on Bioethics in Research Planning Committee 2019.
- Member, "Women in Science" Panel of the Indian Academy of Science.
- Member, Sectional Committee for Animal and Plant Sciences, Indian Academy of Science
- Member, Scientific & Technical Appraisal & Advisory Group on Medical Biotechnology, of DBT, GoI
- Co-Chair - Technical Expert Committee on Stem Cells and Regenerative Medicine of DBT, GoI

Prof. Umesh V. Waghmare

- Top cited Author Award 2018 by Institute of Physics Publishing
- Associate Editor, Nanoscale
- Member, Council of the National Academy of Sciences, Allahabad
- Fellow, Asia Pacific Academy of Materials.

Prof. Tapas K. Kundu

- DSc Honoris Causa of Uttar Banga Krishi Viswaidyalaya

STUDENT ACHIEVEMENTS

Mr. Abhilash Lakshman's (Ph.D. student, Chronobiology Lab) entry to 2018 Society for Research in Biological Rhythms (SRBR) Meeting, ChronoVideo Competition earned the Runner Up position.

Ms. Keerthipriya P. (Ph.D. student, EIBU), was awarded the runner up prize for her talk at the SPEEC-UP meeting held at the Centre for Ecological Sciences, IISc, Bangalore on August 31, 2018.

Mr. Rajaji Vincent (Ph.D. student, CPMU) received the best poster presentation award at the 56th European High Pressure Research Group (EHPRG) meeting, held in Aveiro, Portugal, from September 2-7, 2018.

Ms. Ananya Banik was awarded the "Best Thesis Award" for KPIT Shodh Awards in Energy & Mobility Conference at IISER, Pune.

Mr. Gaurav Barve (Ph.D. student, Autophagy Lab), a lead author in JCS publication gave an interview in JCS.

Ms. Somya Vats, a Ph.D. student with Prof. Ravi Manjithaya, won the Newton-Bhabha fellowship. Her work in collaboration with Dr. Sovan Sarkar's lab opens up new possibilities for treating neurodegenerative disorders, including Parkinson's, Alzheimer's, Huntinton's, and ALS.

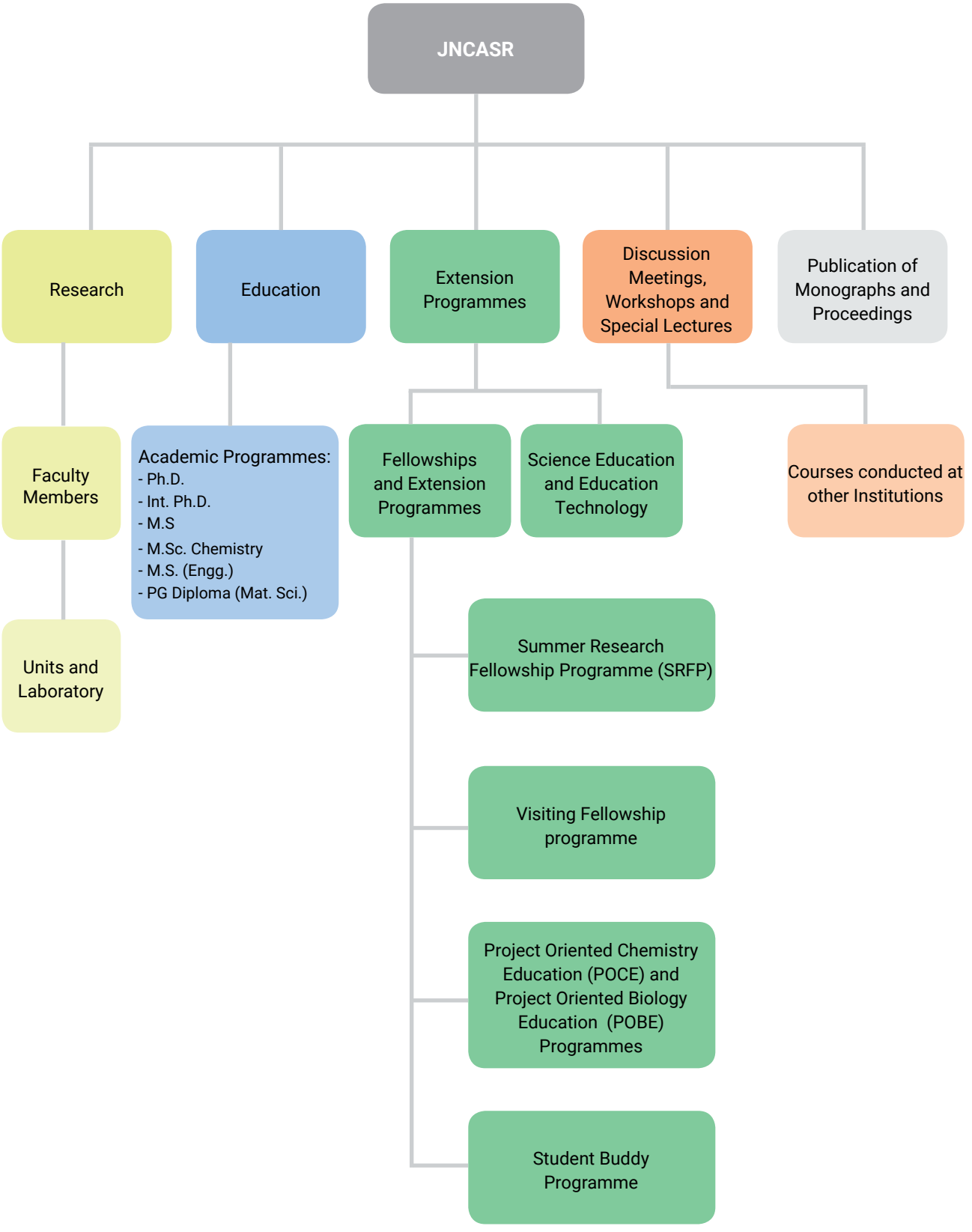
Dr. Sreedevi Padmanabhan bagged the AWSAR award in the Post-doctoral Fellow category.

Ms. Srimayee Mukherji, a Ph.D. student with Prof. Rajesh Ganapathy recently published in Physical Review Letters, which became an Editorial suggestion and a cover-page for that week's issue.

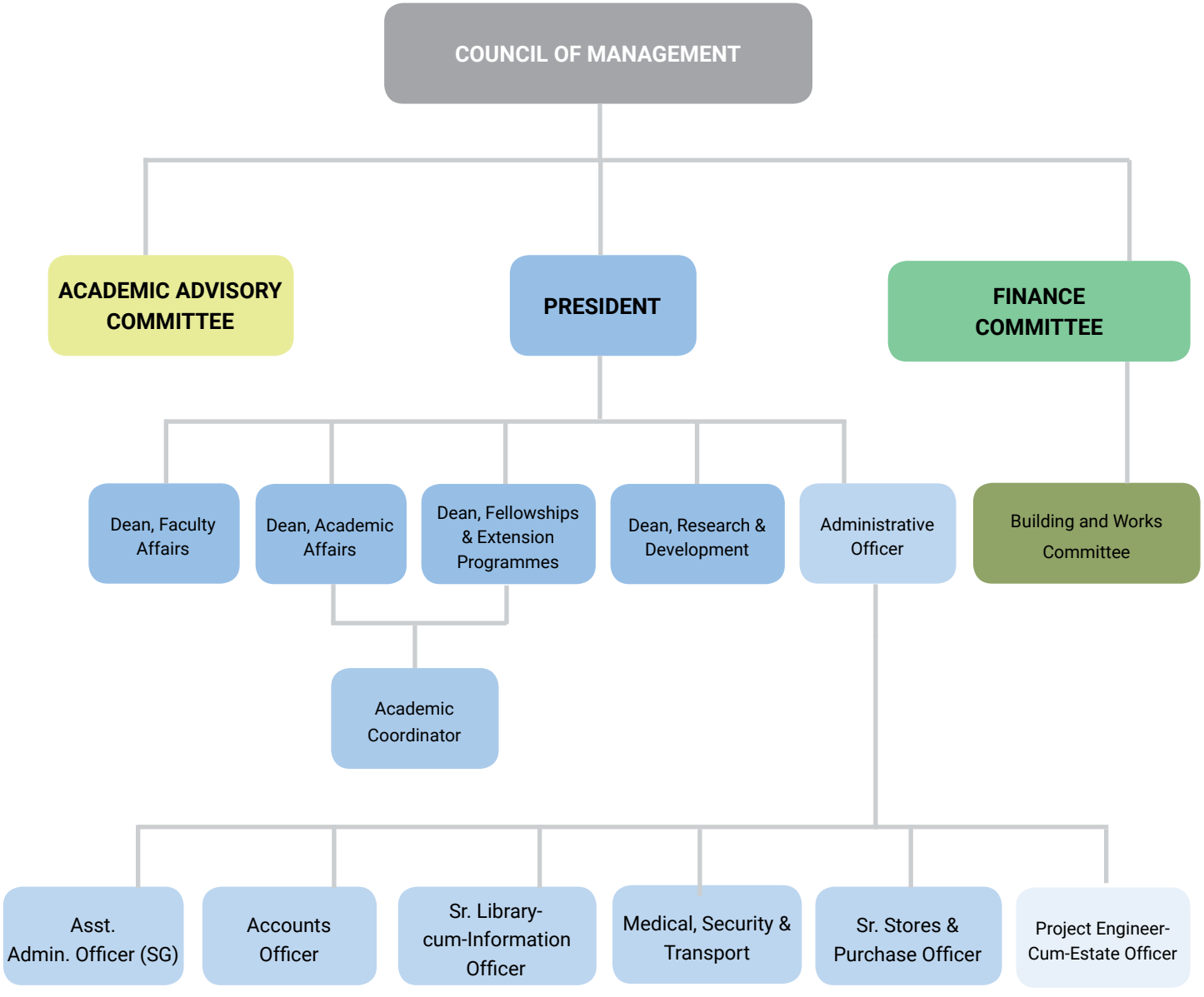
Mr. Subhajit Roychowdhury, a Ph.D. student with Prof. Kanishka Biswas (NCU), received "Graduate Student Silver Award" in 2019 MRS Spring Meeting, Phoenix, Arizona, USA, and CSIR travel grant to attend the meeting.

Ms. Neha Varshney, a Ph.D. student with Prof. Kaustuv Sanyal, received the *PLoS Genetics* Best Poster award at the Chromosome Stability meeting in December 2018.

ACTIVITIES CHART



ORGANISATION 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.

Prof. Goverdhan Mehta
Chairperson (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

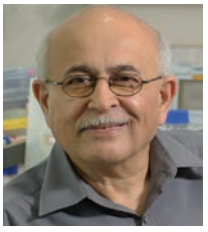
Prof. Virander S. Chauhan
Member (UGC Nominee)
Executive Chairman
NAAC, New Delhi

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

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

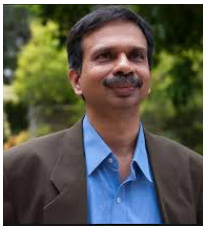
Prof. Anurag Kumar
Member (Ex-officio)
Director, IISc , Bengaluru

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



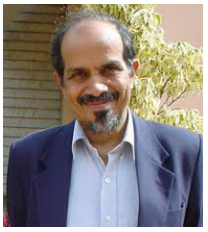
Prof. V. Nagaraja
Member (Ex-officio)
President, JNCASR

Prof. Hemalatha Balaram
Member
Dean, Faculty Affairs, JNCASR



Prof. K.S. Narayan
Member
Dean, R&D, JNCASR

Prof. Anuranjan Anand
Member
Professor, MBGU, 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. V. Nagaraja, President. JNCASR	Chairman (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	Member (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. V. Nagaraja, President, JNCASR	Chairman (Ex-officio)
Prof. K.S. Narayan, Dean, R&D, 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. Maneesha Inamdar, Dean, Fellowships & Extension Programmes, JNCASR	Member (Ex-officio)
Prof. U. Ramamurty, MAE, NTU, SIngapore	Member
Prof. D.D. Sarma, SSCU, IISc	Member
Prof. Devang V. Khakhar, Director, IIT, Bombay	Member (UGC Nominee)
Prof. R. Murugavel, IIT, Bombay	Member
Prof. Raghavan Varadarajan, MBU, IISc	Member
Mr. Joydeep Deb, Administrative Officer, JNCASR	Member (Ex-officio)

FACULTY AND ADMINISTRATION

POSITION	NAME OF THE MEMBER
President	V. Nagaraja, Ph.D., FASc, FNASc
Dean, Faculty Affairs	Hemalatha Balaram, Ph.D., FASc, FNASc
Dean, Academic Affairs	Umesh V. Waghmare, Ph.D., FASc, FNASc, FNA
Dean, Fellowships and Extension Programmes	Maneesha S. Inamdar, Ph.D., FASc, FNASc
Dean, Research and Development	K.S. Narayan, Ph.D., FNASc, FASc
Warden & Student Counsellor	Tapas K. Maji, Ph.D., FASc
Associate Warden	Ranjani Viswanatha, Ph.D.
Administrative Officer & Public Information Officer	Joydeep Deb, M.Sc. (Electronics), M.Sc. (Telecommunication)
Assistant Administrative Officer	C.S. Chitra, B.Com.
Academic Coordinator	Princy Jaison Pereira, Ph.D.
Accounts Officer	Sampad Patra, B.Com, PGDCA, MBA (Finance)
Sr. Stores & Purchase Officer	K. Bhaskara Rao, M.Sc.
Sr. Library-cum-Information Officer	Nabonita Guha, MLIS
Sr. Secretary to President	A. Srinivasan, B.A.
Jr. Accounts Officer	B. Venkatesulu, B.Sc.
Asst. Public Information Officer	Susheela G., B.Sc.
Sr. Public Relations Assistant Gr.I	Sachin S. Belvadi, B.A.
Project Engineer	Mahadevan N., B.E., MIE
Project Engineer Gr. II	Nadiger Nagaraj, DCE
Assistant Project Engineer (Elec.)	Sujeeth Kumar S., DEE
Junior Project Engineer (Civil)	Veeresha N.R., DCE
Consulting Medical Officer	G.R. Naghabhushan, MBBS, FCCP, FCGP, P.G. Dip. in M&CHL
	R. Thyagaraju, MBBS
Consulting Lady Medical Officers	Kavitha Sridhar, MBBS Archana, M.L.V., MBBS H.V. Chandralekha, MBBS Elizebath Daniel, M.A., M. Phil., Ph.D.
Physiotherapist	Y. Yogesh, BPT
Honorary Medical Officer	C. Satish Rao, MBBS R. Nirmala, MBBS
Adviser- Special Projects and Initiatives	A.N. Jayachandra, B.Com, P.G. Diploma (Finance)
Honorary Security Officer	M.R. Chandrasekhar, B.Sc., LLB

ACADEMICS

02

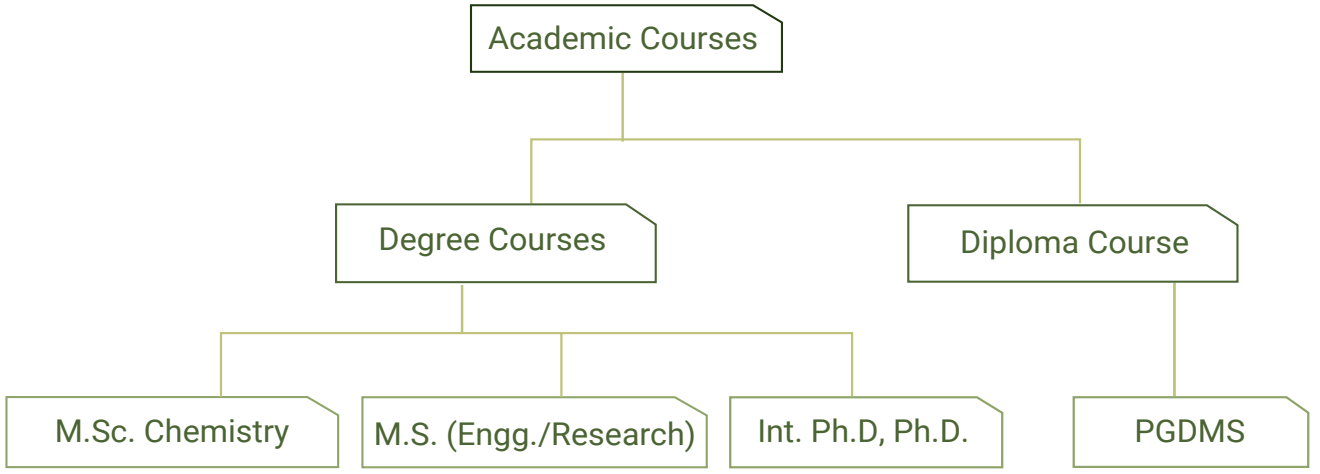
JNCASR is a vibrant Centre that offers Ph.D., Integrated (Int.) Ph.D., M.S. (Research) and M.S. (Engg.) degree programmes in Sciences and Engineering. Candidates with an M.Sc., B.E., B.Tech., M.E., M.Tech. or MBBS are eligible to apply for these Ph.D. programmes. In addition, the candidate should have at least 50% in their highest University examination, and be qualified in the nationalized tests like GATE/JEST/GPAT or 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. Int. Ph.D. programmes are offered in the areas of Materials Science, Chemical Science, and Biological Sciences. The programme is offered only during the August session of admissions. Enrolled students are expected to take courses and actively participate in research. The research students receive monthly fellowship as per the Govt./Centre's norms. On successful completion of coursework and thesis, students are awarded the relevant degrees. The students get ample opportunity to interact with renowned scientists and other fellow students via national and international conferences and workshops. Every department also conducts its own seminars where faculty and students get opportunities to discuss their research. Students have access to world-class infrastructure and cutting-edge facilities.

Research Admissions

In the past academic year of 2018-19, 58 students were enrolled in various degree programmes at the Centre. The current student strength at JNCASR is 325.

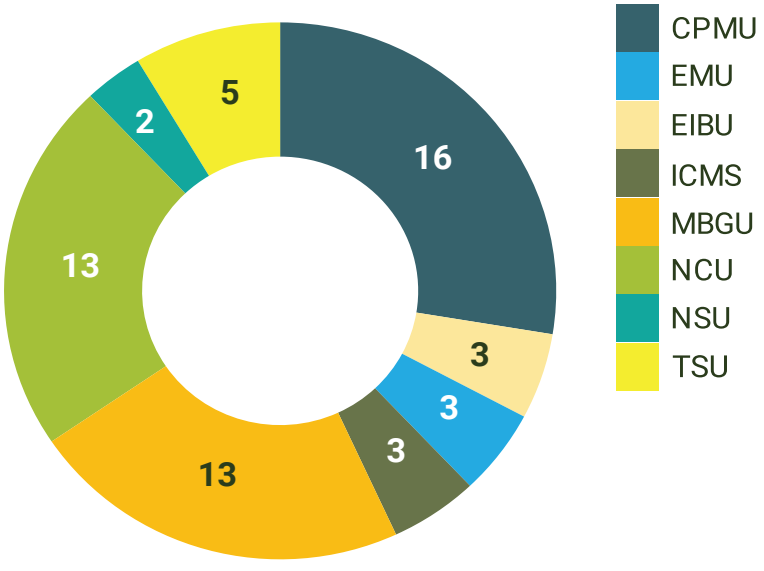
Degrees Awarded

In the past year, the following number of degrees were awarded: 30 Ph.Ds., 17 Int. Ph.Ds., 1 M.S. (Engg.), 6 M.S. in Biological Science, 6 M.S. in Materials Science, and 5 M.S. in Chemical Science.

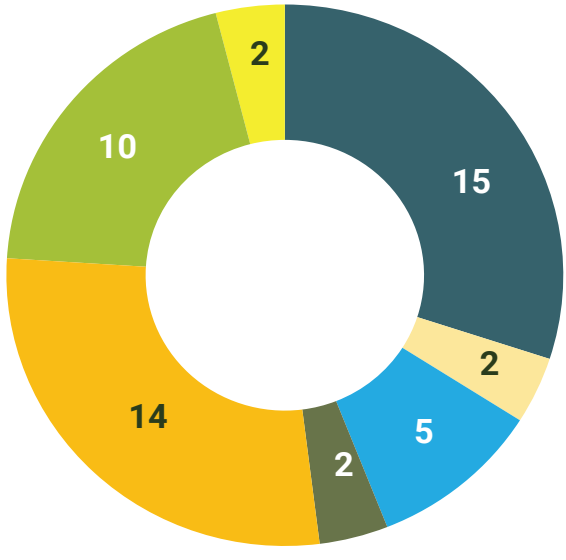


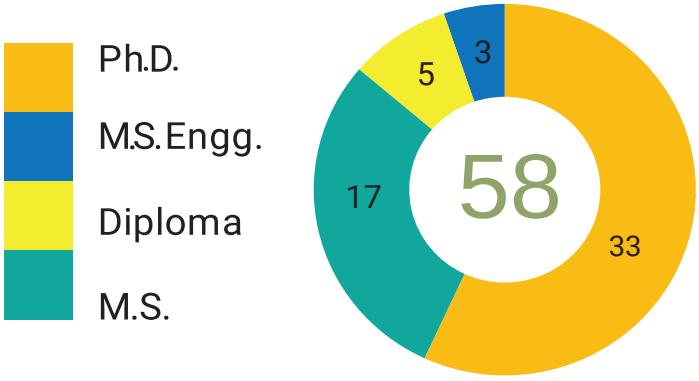
2018-2019

STUDENTS ADMISSIONS

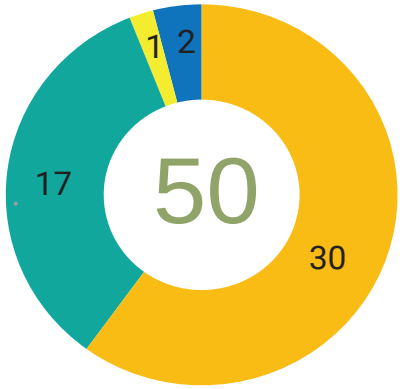


DEGREES AWARDED





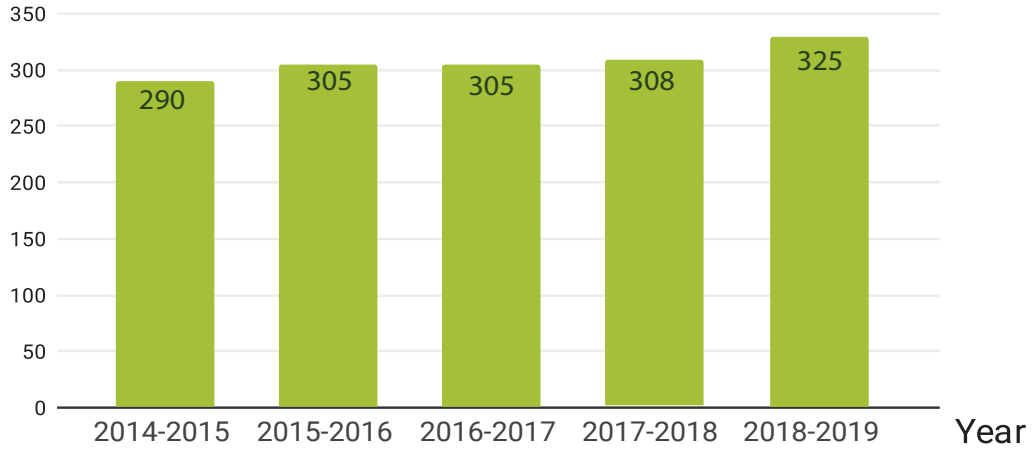
Student Admissions



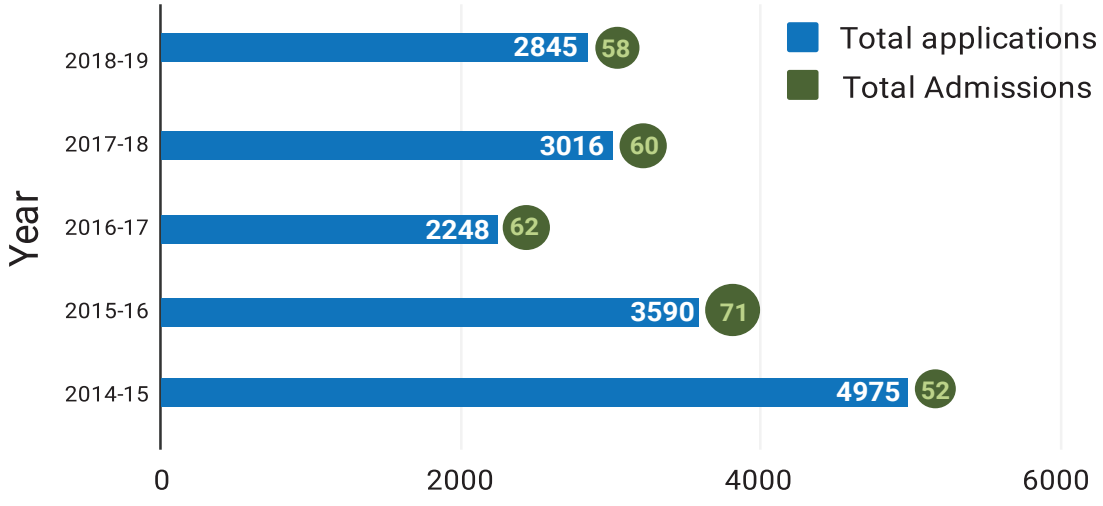
Degrees Awarded

5 YEARLY DATA (2014-2019)

TOTAL STUDENT STRENGTH

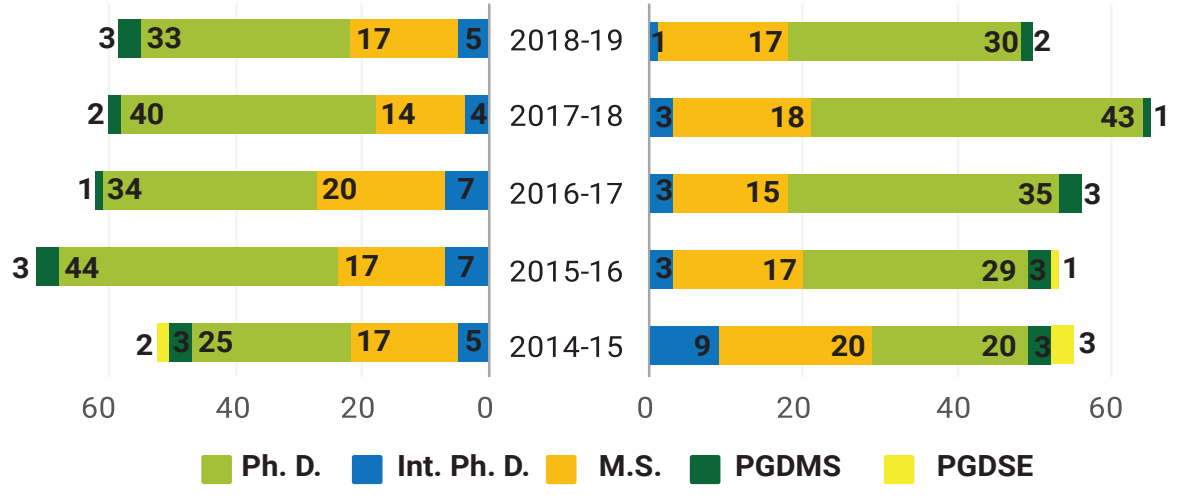


APPLICATIONS AND ADMISSIONS AT JNCASR



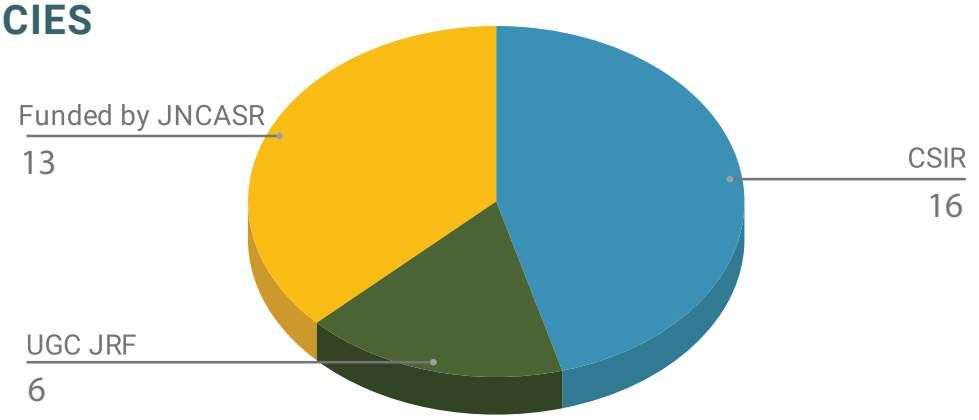
NEW ADMISSIONS

DEGREES AWARDED




THE COLLEGE

STUDENTS SUPPORTED BY FUNDING AGENCIES



WHO CAN APPLY ?

M.S./Ph.D. **with M.Sc./B.E./B.Tech./M.E./M.Tech./MBBS degree/s and at least 50% marks in candidate's highest University examination and qualified in GATE/UGC-CSIR-JRF/ICMR-JRF/DBT-JRF/ INSPIRE-JRF /GPAT examination**

Int. Ph.D. **with Masters in Chemistry with at least 55% marks in their Bachelor's degree in any area of science or statistics**

WHEN TO APPLY ?

For August admissions
March (all programmes)

For January admissions
October-November (Ph.D. and M.S.)

STIPEND

M.S.:
INR 25,000 (until Dec. 31, 2019)
INR 31,000 (since January 01, 2019)

Ph.D.:
INR 25,000 - 28,000 (until Dec. 31, 2019)
INR 31,000 - 35,000 (since January 01, 2019)

Int. Ph.D.:
INR 15,000 - 28,000 (until Dec. 31, 2019)
INR 19,000 - 35,000 (since January 01, 2019)

RESEARCH AND DEVELOPMENT

03

Research and development is the Centre's primary objective, with emphasis on interdisciplinary research and the highest standards of quality and integrity. Since its foundation, researchers at JNCASR have made important discoveries and innovations, which has led to the recognition of the Centre as a top research institute, not only in the country, but also among the international scientific community. In the past year alone, the significant and impactful research carried out at the Centre has resulted in 250 publications and 11 patents being granted. Moreover, these accomplishments have consistently made news in the scientific community and in the media for their direct social relevance. The following section describes in detail the progress made in 2018-19 by each of our 9 research units, namely Chemistry and Physics of Materials Unit (CPMU), Evolutionary and Integrative Biology Unit (EIBU), Engineering Mechanics Unit (EMU), Geodynamics Unit (GDU), International Centre for Materials Science (ICMS), Molecular Biology and Genetics Unit (MBGU), New Chemistry Unit (NCU), Neuroscience Unit (NSU), and Theoretical Sciences Unit (TSU).

CHEMISTRY AND PHYSICS OF MATERIALS UNIT (CPMU)

ABOUT

CPMU was the first research unit established at JNCASR. With a novel interdisciplinary approach to Materials Science, the Unit has made many ground-breaking discoveries and advances in research since inception. In this academic year, the Unit has again been at the forefront in terms of publications, awards, and fellowships, with laboratories attracting both national and international collaborations. Based on an international review in December 2017, wherein the contribution of CPMU was highly appreciated, the School of Advanced Materials Science (SAMat) was set up for enhancing the visibility of CPMU at the international level.

RESEARCH AREAS

The research focus at CPMU has been in the following areas:

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

RESEARCH INSIGHTS

- New insights into the origin of topological transition in materials were obtained through high pressure Raman studies.
- A tunable approach to fabricate light-dependent position-sensitive detector devices was demonstrated based on dielectric super-lattice structures with photochromic azobenzene molecules.
- The Schottky barrier height of epitaxial single crystalline TiN/(Al,Sc)N metal/semiconductor superlattices were determined..
- Rigid-band electronic structure of scandium nitride across the n-type to p-type carrier transition regime was established.
- High oxygen evolution kinetics was shown for a cobalt oxide@C catalyst prepared by a simple, one-step combustion method.
- A pseudo helical nonpolar ground state was identified in mixed rare-earth manganite by neutron diffraction.
- New doubly ordered polar multiferroic perovskites were synthesized at high pressures and high temperatures.
- A water-soluble metal-organic cube of Ga(III) that self-assembles to hydrogel via charge-assisted hydrogen bonding was designed and synthesized.
- A solvent adaptive dynamic metal-organic soft hybrid for imaging and biological delivery was reported.

Chandrabhas Narayana

Ph.D., FASC, FRSC, FNASc; Professor and Chair, CPMU

A newly developed portable Raman spectrometer for use in bio-diagnostics under TRC

Light Scattering Laboratory

New toplogical insulators were discovered during high pressure Raman studies, which provided new insights into the origin of Topological Transition in materials. Studies on ZIF 8, a metal organic framework material, was undertaken to understand its usability in applications in gas adsorption. Its different forms were identified using Raman spectroscopy. The work on SERS leads to two new findings. One of the applications of SERS is in trace detection of biomolecules like DNA and RNA for disease diagnostics. A new strategy that modified the Raman marker using dendrimeric structures showed that it is better, cheaper, and has wide potential in bio-diagnostics. In another application of SERS, we used Raman as an identification tool for exosomes, which are important markers for diseases and is an upcoming field. Preliminary studies are encouraging, and we were able to identify different exosomes from different cell lines.

Key publications:

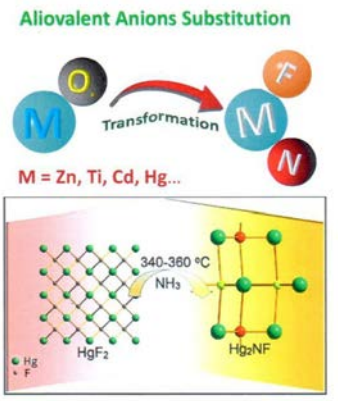
Rajaji V, et al. 2018. Pressure induced band inversion, electronic and structural phase transitions in InTe: A combined experimental and theoretical study. *Phys Rev B*. 97: 155158.

Rajaji V, et al. 2018. Structural, vibrational and electrical properties of 1T-TiTe2 under hydrostatic pressure: Experiments and theory. *Phys Rev B*. 97: 085107.

C.N.R. Rao

D.Sc., Ph.D., FRS, Hon. FRSC; Linus Pauling Research Professor

Our research group specialises in the synthesis, characterisation, and measurement of various organic and inorganic nanomaterials, including oxides, nitrides, sulfides, and layered materials such as graphene and beyond. Current research interests of his group include solar photochemical hydrogen generation by splitting water, semiconducting metal chalcogenides and their physical properties, and layer materials beyond graphene.



Key publications:

Roy A, et al. 2019. Structural features and HER activity of cadmium phosphohalides. *Angew Chem Int Ed.* 58: 6926–31.

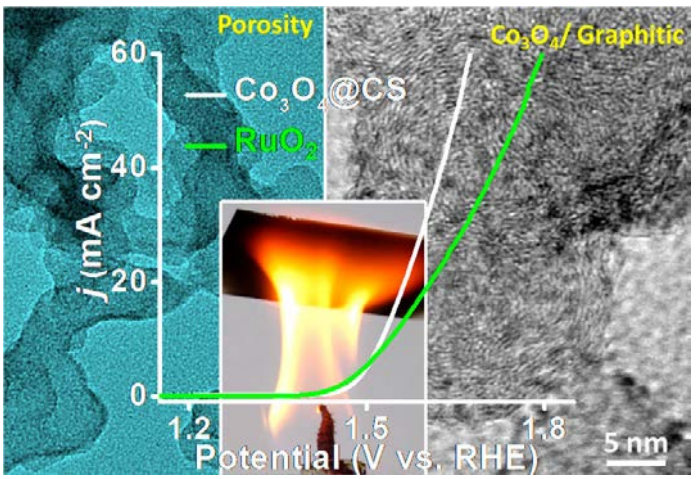
Manjunath K, et al. 2019. Front Cover: Hg_2NF, Analogue of HgO. *Euro J Inorg Chem.* 19: 2396.

Eswaramoorthy M.

Ph.D., Professor

Nanomaterials and Catalysis Laboratory

The development of environment-friendly active and selective catalysts for oxidative dehydrogenation of propane for propene synthesis is one of the challenging catalytic reactions. This reaction has tremendous industrial potential. Recently, we showed high catalytic activity for hexagonal boron nitride for oxidative dehydrogenation of propane. Remarkable selectivity for alkenes (~70%) at very high conversion (~50%) of propane was achieved. The catalyst was found to retain its activity for more than 100 h in presence of ammonia. We also showed high oxygen evolution kinetics for a cobalt oxide@C catalyst prepared by a simple, one-step combustion method.



One-step combustion synthesis of Co_3O_4@C catalyst for OER reaction

Key publications:

Kumar BP, et al. 2018. Supramolecular switching of ion-transport in nanochannels. *ACS Appl Mater Interfaces.* 10: 23458–65.

Singh DK, et al. 2018. Pick a wick: A simple, ultrafast combustion synthesis of Co_3O_4 dispersed carbon for enhanced oxygen evolution kinetics. *ACS Appl. Energy Mater.* 1: 4448–52.

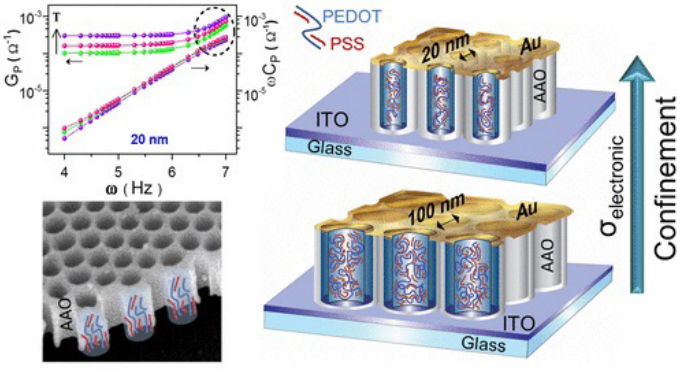
K.S. Narayan

Ph.D., FNASc, FASc; Professor

Molecular Electronics Laboratory

A light-dependent position-sensitive detector was demonstrated using an active layer of organic-inorganic halide perovskite. We demonstrated a tunable approach to fabricate such devices based on rationally designed dielectric super-lattice structures with photochromic azobenzene molecules. These nanodielectrics possessing ionic, molecular, and atomic polarization are utilized in polymer thin-film transistors to realize high-performance electronics with a p-type field-effect mobility exceeding 2 $cm^2 V^{-1} s^{-1}$.

We carried out studies on the adhesion and optical properties of eutectic metal alloys for solution-processed electronics. We reported a clear correlation of the features observed in photocurrent noise-fluctuations to the performance parameters of hybrid perovskite solar cells. The general trend of increasing noise amplitude, which spreads over a wider range of frequency, was established as a function of aging. High-resolution spatial mapping of the photocurrent in typical devices and the associated variation in the noise spectrum confirmed the underlying trend.



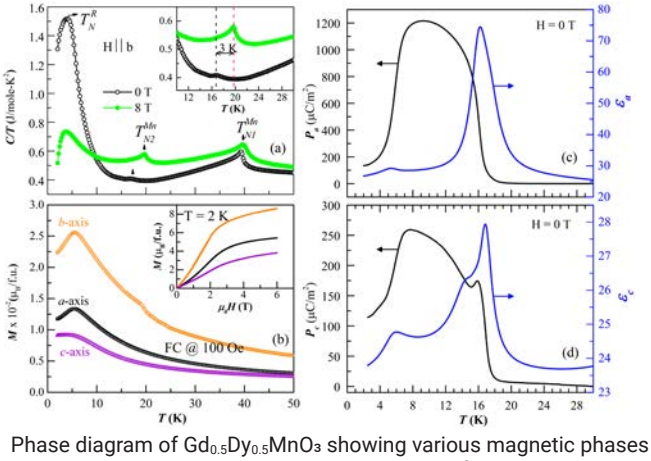
Electronic confinement

A. Sundaresan

Ph.D., Professor

Superconductivity and Magnetism Laboratory

We recently discovered that the doubly ordered perovskites $NaRMWO_6$ (R = rare earths and M = Mn, Co and Ni) exhibit interesting magnetoelectric multiferroic properties. Unlike type-II multiferroics, the spin structure in these compounds is commensurate but non-collinear. The magnetoelastic coupling is believed to be responsible for change in polarization observed at the magnetic ordering of these polar magnetics. Interestingly, we discovered isovalent cation ordering in a double perovksite Bi_2FeAlO_6, which exhibits ferroelectricity and magnetism at ambient temperature. Another important study was the unusual enhancement of polarization along a-direction under applied magnetic fields and a nonpolar ground state in $Gd_{0.5}Dy_{0.5}MnO_3$.



Phase diagram of $Gd_{0.5}Dy_{0.5}MnO_3$ showing various magnetic phases with temperature and magnetic field

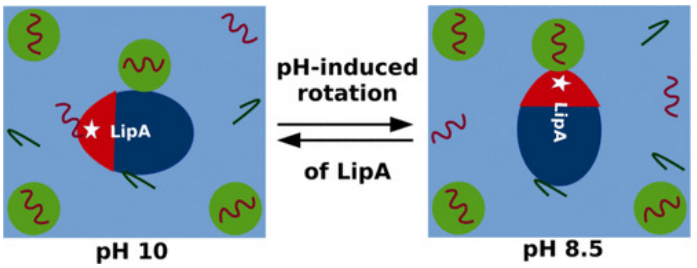
Key publications:

De H, et al. 2019. Highly tunable magnetic spirals and electric polarization in $Gd_{0.5}Dy_{0.5}O_3$. *Phys Rev Mat.* 03: 044401–10.

Sen A, et al. 2019. Unprecedented 30 K hysteresis across switchable dielectric and magnetic properties in a bright luminescent organic-inorganic halide $(CH_6N_3)_2MnCl_4$. *J Mater Chem C*. 16: 4838–45.

Balasubramanian S.

Ph.D. FASc; Professor



Rotation of lidless lipase LipA in the presence of Thesit, surfactant with change in pH

Molecular Simulations Laboratory

Using advanced molecular simulations, we discovered the rotation of lidless lipase LipA with change in pH in the presence of Thesit surfactant.

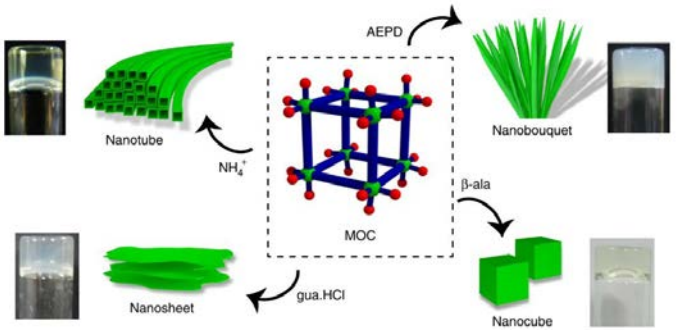
Key publications:

Avula NVS, et al. 2018. Charge environment and hydrogen bond dynamics in binary ionic liquid mixtures: a computational study. *J Phys Chem Lett*. 9: 3511–6.

Mishra A, et al. 2018. Biomimetic temporal self-assembly via fuel-driven controlled supramolecular polymerization. *Nat Commun*. 9: 1295.

Tapas K. Maji

Ph.D., FRSC, FASc; Professor



Self-assembly of MOC with different molecular binders

Molecular Materials Laboratory

Recently, we showed binder driven self-assembly of metal-organic cubes towards functional hydrogels. In addition, we developed solvent adaptive dynamic metal-organic soft hybrid for imaging and biological delivery. Flexible MOF was effectively used for separation of small hydrocarbons. Conjugated microporous polymers doped with metal nanoparticles were used for electrocatalysis and electrochemical water-splitting.

Key publications:

Samanta D, et al. 2019. Solvent adaptive dynamic metal-organic soft hybrid for imaging and biological delivery. *Angew Chem Int Ed*. 58: 5008.

Rajesh Ganapathy

Ph.D., Associate Professor

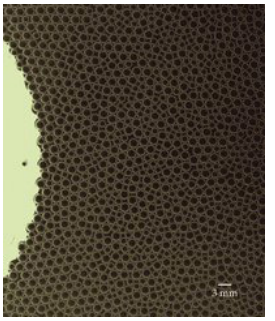
Soft Matter Laboratory

In a recent experimental study, our group demonstrated for the first time the encoding of mechanical memories in a dense disordered packing of bi-disperse bubbles. The study also showed the encoding of multiple memories and provided fundamental insights into how these memories are formed. This work was published in PRL, was taken as an Editor's Suggestion, and appeared on the Cover Page of the journal. It was also covered by Physics Today – a popular science magazine published by the American Institute of Physics. In addition, our group has completed two other studies – on shear-thickening in suspensions of colloidal rods and on self-organised growth of colloidal crystals on strain-relief patterns.

Key publications:

Mukherji S, et al. 2019. Strength of mechanical memories is maximal at the yield point of a soft glass. *Phys Rev Lett.* 122: 158001.

Ganapathi D, et al. 2018. Measurements of growing surface tension of amorphous-amorphous interfaces on approaching the colloidal glass transition. *Nat Commun*. 9: 397.



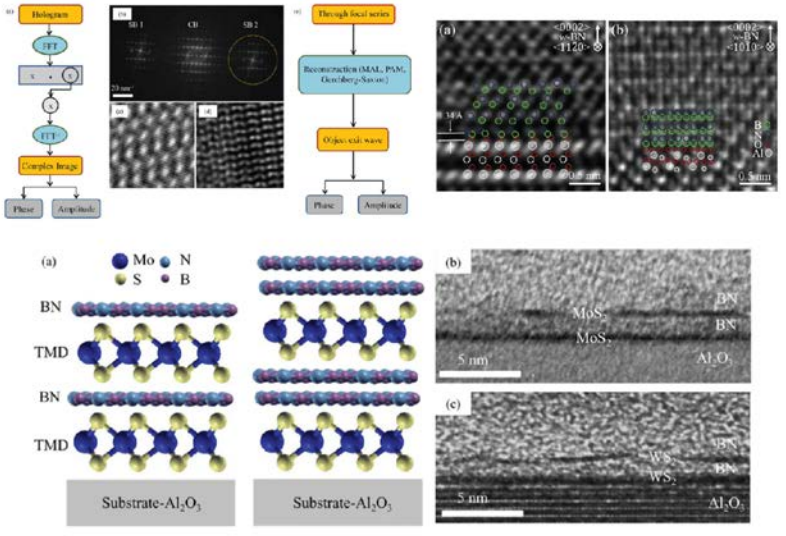
Amorphous bubble raft

Ranjan Datta

Ph.D., Associate Professor

High Resolution Transmission Electron Microscopy (HRTEM) Laboratory

In the past academic year, we successfully applied quantitative HRTEM both by inline and off axis holography. We could stabilize super hard meta-stable w-BN over large area thin film form. We developed thin film heterostructures of 2D transition-metal dichalcogenides for energy application. We are now actively engaged in p-doping and magnetism in ZnO in thin film form for application in bi-polar devices and spintronics. We are trying to understand the issues using the unique capability of our TITAN microscope.



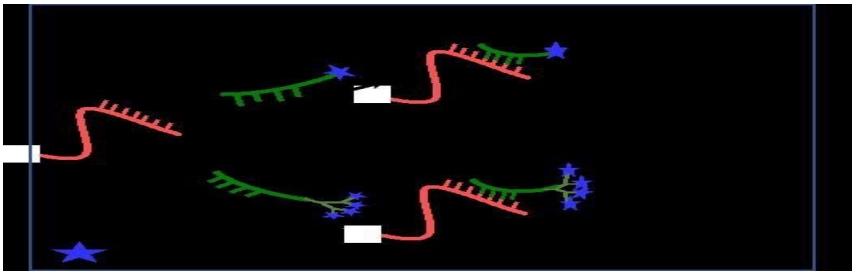
(a) and (e) Steps involved in reconstruction methods to extract phase and amplitude from the hologram and HRTEM image series, respectively. (b) Fourier transform of the hologram showing one CB and two SBs. (c) and (d) are the examples of an atomic resolution hologram and an HRTEM image of a ZnO epitaxial thin film along <11−20> Z.A

Sridhar Rajaram

Ph.D., Associate Professor

Polymer Laboratory

Polycarbonates are durable, tough, and biodegradable polymers that are used extensively in daily life. However, a major concern with their use is the presence of bisphenol-A as the monomer unit. In the previous year, we initiated a project to develop bis-Phenol A-free polycarbonates. In this regard, in this past year, we worked on the regioselective ring opening polymerization (ROP) of cyclic carbonates. The cyclic carbonates could be easily made from 1,3-diols, which in turn could be obtained by reduction of aldol products. Thus, a range of polymers with varying properties could be readily accessed. In case of unsymmetrical carbonates, the mechanical properties of the polymer will depend on its regioregularity. Controlling the regioregularity of (ROP) is a difficult task and we have developed novel organocatalysts that can ring open carbonates with good regioregularity. We are in the process of exploring the properties of these novel polymers.



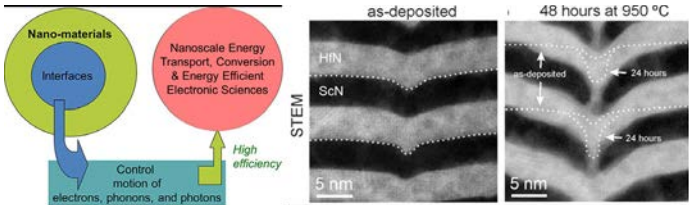
Dendritic Raman markers enhance detection efficiency

Bivas Saha

Ph.D., Faculty Fellow

Heterogeneous Integration Research Laboratory

Along with several other research, we made two important discoveries in the past academic year. Firstly, with a combination of synchrotron-based X-ray absorption and emission spectroscopy measurements, and first-principles modelling analysis, we demonstrated the rigid-band electronic structure of scandium nitride (ScN) across the n-type to p-type carrier transition regime. Our results showed that, unlike other III-nitride semiconductors, intentional Mg hole doping and unintentional O impurity does not introduce defective states inside ScN's fundamental band gap and that the band gap and band-edges remain unchanged. Secondly, with a combination of X-ray photoemission spectroscopy and modelling analysis, we determined for the first time the Schottky barrier height of TiN/AlScN metal/semiconductor superlattices for their thermionic emission based on the thermoelectric, plasmonic, and nano-photonic energy conversion.



High resolution transmission electron micrograph showing dislocation pipe diffusion formation in superlattice meta-materials is presented

Key publications:

Nayak S, et al. 2019. Rigid-band electronic structure of scandium nitride (ScN) across n–type to p–type carrier transition regime. *Phys Rev B*. 99: 161117.

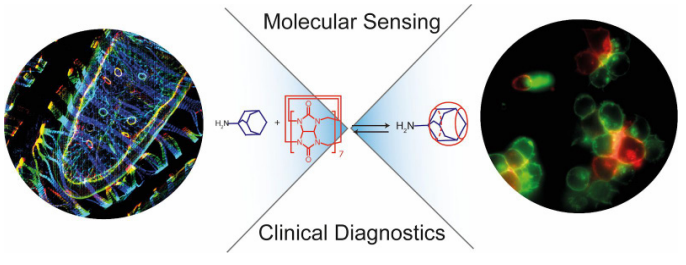
Maurya KC, et al. 2019. Wave-vector dependent Raman scattering from coupled plasmon-LO phonons in epitaxial n-type ScN thin films. *Phys Status Solidi Rapid Res Lett*.13: 1900196.

Sarit Agasti

Ph.D.; Faculty Fellow

Programmable Molecular Design Laboratory

Among the available repertoire of non-covalent building blocks, synthetic host-guest motifs based on macrocyclic molecules are particularly attractive due to their specific recognition property in biological complexities. Recently, we combined synthetic host-guest systems with a biological interface to develop various novel technologies relevant to both fundamental and medical research. Examples include bioorthogonal imaging and sensing, methods for super-resolution imaging, and new approaches for delivery and activation of therapeutic materials. The host-guest interactions between CB[7], attached with primary targeting agents (e.g. antibodies) and ADA-conjugated fluorophore provides in situ non-covalent coupling mechanism for bioorthogonal imaging in cells. This non-covalent labelling platform was translated to image target molecules in complex tissue samples of *Drosophila melanogaster*. Additionally, we used this system to provide a completely orthogonal labelling platform against the existing covalent system (e.g., tetrazine ligation); thus, their combination can be used for simultaneous labelling of multiple biomolecules within a single biological system. We also established this system for imaging metastatic cancer-associated cell surface protein marker and showing distribution and dynamics of small molecule targeted F-actin in living cells.



Synthetic host-guest system mediated molecular sensing and clinical diagnostic strategy

Key publications:

Sasmal R, et al. 2018. Synthetic host-guest assembly in cells and tissues: fast, stable and selective bioorthogonal imaging via molecular recognition. *Anal Chem.* 90(19): 11305–14.

Sinha S, et al. 2018. Reversible encapsulations and stimuli-responsive biological delivery from dynamically assembled cucurbit [7] uril host and nanoparticle guest scaffold. *J Mater Chem B*. 6: 7329–34.

UNIT MEMBERS

Professor and Chair
Chandrabhas Narayana

Professors
Balasubramanian S.
Eswaramoorthy Muthusamy
G.U. Kulkarni (on lien w.e.f. 21.4.2015)
K.S. Narayan
A. Sundaresan
S.M. Shivaprasad (on lien w.e.f. 11.08.2017)
Tapas K. Maji

Associate Professors
Rajesh Ganapathy (Associate Faculty, ICMS)
Ranjan Datta (Associate Faculty, ICMS)
Sridhar Rajaram (Associate Faculty, ICMS)

Faculty Fellows
Bivas Saha (jointly with ICMS)
Sarit Agasti (jointly with NCU)

Research Students
Abdul Azeez H., Abhijit Chatterjee, Abhijit Sen, Abhiroop Lahiri, Abhishek Kumar, Abhishek Paul, Alolika Ganguly, Anaranya Ghorai, Anirudha Mirmira, Anjali Gaur, Anjana Joseph, Arindam Mukherjee, Arunava Saha, Ashutosh Kumar Singh, Avula Venkata Siva Nikhil, Badri Vishal, Bharath B., Bidesh Biswas, Brijesh, Chaitali Sow, C.S. Deepak, Debendra Prasad Panda, Dheemahi, Divya, Divya C., Faruk Ahamed Rahimi, Ganesh N., Gunjan Sharma, Gurshidali P., Janaky S., Kompella V.K. Srinath, Korlepara Divya Bharathi, Krishna Chand Maurya, Lakshay Dheer, Manish Tiwari, Manodeep Mondal, Meenakshi Pahwa, Mohit Chaudhary, Momin Ahamed, Narendra Kumar, Navneet Singh, Nijita Mathew, Nikita Gupta, Niloyendu Roy, Nimish D., Parul Verma, Pavitra Nityanand Shanbhag, Pragya Arora, Priyanka Jain, Purohit Sumukh Anil, Raaghesh A.V., Raagya Arora, Rajendra Kumar, Ravi Shankar P.N., Sanchita Karmakar, Shantanu Aggarwal, Sharona Thomas Horta, Shashank Chaturvedi, Shivani Grover, Shivaram B. Kubakaddi, Sinay Simanta Behera, Sohini Bhattacharyya, Sonu K.P., Soumita Chakraborty, Soumen Pradhan, Sourjyadeep Chakraborty, Srimayee Mukherji, Subhajit Laha, Sudarshan Behera, Sudip Das, Sukanya Das, Surishi Vashishth, Swapnasopan Datta, Swaraj Servottam, Swarnamayee Mishra, Tarandeep Singh, Usha Manjunath Bhat, V. Rajaji, Yanda Premakumar

Research Scientists B
Anoop S., Suresh J.

Research Associates
Ashish Singh, Kamali Kesavan, Prashant Kumar, Shivanna M., Syamantak Roy, Venkata Suresh Mothika

SERB (TARE)
Shafeekh Kulathinte Meethal

SERB National PDFs
Mehraj Ud Din Sheikh, Monoj Kumar Barman, Sandra Dias, Subarna Dey

Project Assistants
Gaurav Vinayak Dhopeshwarkar, Sunami S. Morrison

Junior Research Fellows
Manvendra Singh, Monica Swetha Bosco

Senior Technical Officers
Sreenath V., Srinivas S.

Project Technical Assistant
Abhinandana Reddy B.

R&D Assistants
Anil Krishna Konduri, K.P. Sonu, Rahul Kumar

Mectronic Lab Support
Sunoj K.R.

Instrumentation Facility In-Charge
Rahul Bhardwaj

Glass Blower (Temporary)
Nandha Kishore

Consultant
Suman Banerjee

Technician
Soumya C.

CPMU AT A GLANCE

Awards received by faculty

Prof. G.U. Kulkarni – MRSI-Distinguished Lectureship Award (2019-20); SASTRA-CNR Rao Award for Excellence in Chemistry & Materials Sciences (2019 - 20)

Prof. Tapas Kumar Maji – Fellowship of Indian Academy of Sciences, Bangalore

Prof. Chandrabhas Narayana – Fellowship of Indian Academy of Sciences, Bangalore; Mizushima-Raman Lecture 2018

Prof. A. Sundaresan– National Prize for Research on Solid State and Materials Chemistry (2018); MRSI-ICSC & Materials Science Annual Prize (2019)

Bivas Saha – SERB International Travel Award

Awards received by student

Srimayee Mukherji – Published a research article, which became an Editorial suggestion and a cover-page for that week's issue.

Rajaji Vincent – Best poster presentation award at the 56th European High Pressure Research Group (EHPRG) meeting, held in Aveiro, Portugal, from September 2-7, 2018.

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	10	19.33 Cr
ONGOING PROJECTS	23	24.45 Cr

12 Ph.D. & 3 M.S.
STUDENTS ADMITTED

9 Ph.D. & 6 M.S.
STUDENTS GRADUATED

79
PUBLICATIONS

EVOLUTIONARY AND INTEGRATIVE BIOLOGY UNIT (EIBU)

ABOUT

Biological systems are structurally organized in an hierarchical manner, and can be studied at levels ranging from molecules to ecosystems. However, functionality in these systems is typically integrated across scales of structural complexity. In many cases, the principal structural level of complexity that is also a functionally integrated ecological entity is the multicellular organism, which is also most often the primary unit upon which natural selection acts. Thus, the information and insights gleaned from understanding the organism at various structural levels of biological complexity is none other than the grand unifying concept of evolution. Hence, the research objective of our Unit (previously Evolutionary and Organismal Biology Unit) has been to focus on 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, not earlier studied in India, and have pioneered the use of methodologies like experimental evolution and non-invasive approaches to assess genetic diversity in wild populations in India. In addition, the Unit faculty have been fairly unique among Indian evolutionary biologists in deploying a balanced blend of theoretical as well as empirical laboratory and field-based approaches to address fundamental questions. 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 in research on:

- Interplay of 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 through reinterpreting basic phenomena like fitness and heredity, in order to analyse the adaptive evolutionary dynamics of diverse phenotypes under genic and non-genic inheritance.

RESEARCH INSIGHTS

- Development of an individual-based model to predict key aspects of *Drosophila* population dynamics under diverse selection and food regimes.
- Experimental demonstration of *r-K* tradeoffs mediating the evolution of increased constancy stability in crowding-adapted *Drosophila* populations.
- Demonstration of the necessity for conventional biomass harvesting to assess forage for a large herbivore in a multistorey tropical forest, rather than using satellite-based NDVI.
- Evidence for the possible influence of old competitive males on the occurrence of musth in Asian elephants.

T.N.C. Vidya

Ph.D., Associate Professor and Chair, EIBU; Founding Member and Member, Executive Council, Indian Society of Evolutionary Biologists; Member of the IUCN SSC (World Conservation Union's Species Survival Commission) Asian Elephant Specialist Group

Our lab studies the social structure of female and male Asian elephants in Nagarahole and Bandipur National Parks. Recently, we showed that satellite-based Normalized Difference Vegetation Index (NDVI) is not a suitable proxy for estimating elephant forage abundance, due to the multistorey nature of the forest and discordance between food species and total species distributions in various strata (Figure 1). Spatially interpolated total graminoid abundance based on kriging model from field data was found to outperform NDVI in predicting total graminoid abundance, although field estimation of forage was better than kriging (Figure 2). In a study of male elephants, we recently found a lower proportion of musth males in Nagarahole and Bandipur National Parks than in two other populations, possibly due to the differences in the numbers of old, competitive males (Figure 3). We have also recently been examining the intestinal parasite loads of jungle myna communal roosts in order to test a hypothesis about communal roosting. We found that parasite loads were similar at different distances from the centre to the periphery of the roost, suggesting that the two-strategies hypothesis may not explain communal roosting in this species.

Key publications:

Gautam H, et al. 2019. NDVI is not reliable as a surrogate of forage abundance for a large herbivore in tropical forest habitat. *Biotropica.* 51: 443–56.

Nandini S, et al. 2018. Group size differences may mask underlying similarities in social structure: a comparison of female elephant societies. *Behav Ecol*. 29(1): 145–59.

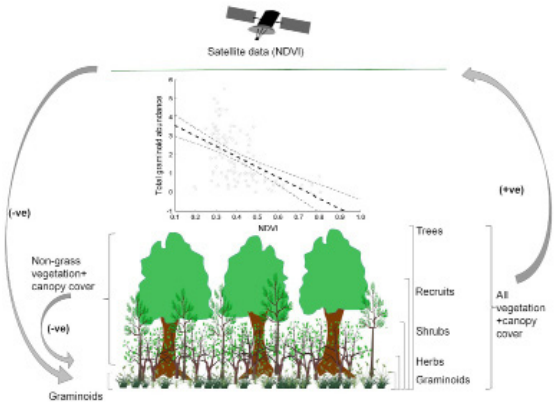


Figure 1: Schematic representation of the relationship between graminoid abundance, non-graminoid vegetation and satellite-derived NDVI productivity (Gautam *et al.* 2019, Biotropica).

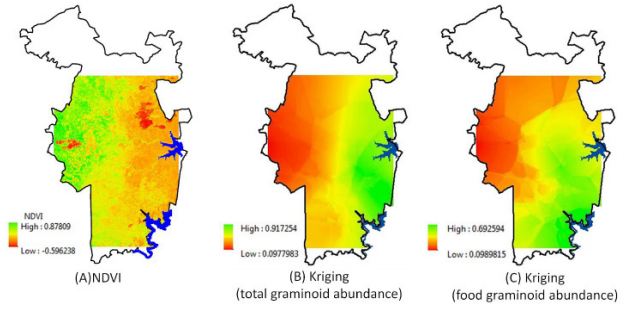


Figure 2: Maps showing (A) NDVI, (B) kriging (spatial interpolation) model of total graminoid abundance, and (C) kriging model of food graminoid abundance in the dry season. The red patches in the NDVI map are areas affected by forest fire (Gautam *et al.* 2019, Biotropica).

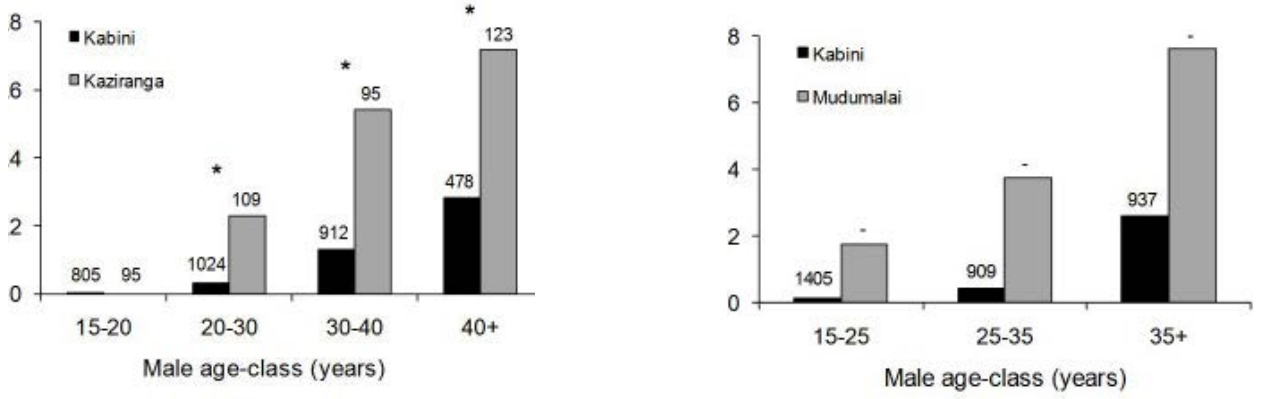


Figure 3: Comparison of proportions of sightings of males of different age-classes seen in musth between (left) Kabini and Kaziranga, and (right) Kabini and Mudumalai.

Amitabh Joshi

Ph.D.; Professor; Founding Member and Member, Executive Council, Indian Society of Evolutionary Biologists; Member, Panel on Scientific Values, Indian Academy of Sciences, Bengaluru; Member, Publications Advisory Board, Indian National Science Academy, New Delhi; Member, Inter-Academy Group for drafting National Policy recommendations on Scientific Publishing; Member, Editorial Board of Halteres, and International Journal of Evolutionary Biology; Editor of Publications, Indian Academy of Sciences, Bengaluru.

Our lab has been involved in the development of several models to understand evolution and behavior using the fruit fly *Drosophila* as our model system. We developed an individual based model of *Drosophila* population dynamics to predict major aspects of dynamics under diverse selection and food regimes, including time series summary statistics, stability measures, and population size distributions. This is the best functioning fruitfly dynamics model yet, and the first major advance in modeling fruitfly population dynamics since LD Mueller's 1988 model. We have also used the model to understand the ecology and evolution of a crowded *Drosophila* culture. We also experimentally demonstrated the role of *r-K* tradeoffs in mediating the evolution of increased constancy stability in crowding-adapted *Drosophila* populations. We have also experimentally demonstrated the relative contributions of sexual selection and selection for rapid development in mediating male-female coevolution in fruitflies.

Key publications:

Dey S., Joshi A. 2018. Two decades of *Drosophila* population dynamics: modelling, experiments, and implications. In Hand Book of Statistics, Vol. 39, pp. 275–312: Integrated Population Biology and Modelling, Part A (Eds. C. R. Rao, A. S. R. Srinivasa Rao), Elsevier, Amsterdam and Oxford (by invitation).

Joshi, A. 2018. The relevance of experimental evolution studies in times of rapid anthropogenic change. Pp. 113–25 in Proceedings of the Symposium on Basic Research - its Role in National Development, 87th National Session of NASI, 8th-10th December, 2017 (Eds. P. N. Tandon, M. Sharma), National Academy of Sciences, India, Allahabad (by invitation).

UNIT MEMBERS

Associate Professor and Chair
T.N.C. Vidya

Professor
Amitabh Joshi

Research Students
Abhilash Lakshman, Ankana Sanyal, Anuj Menon, Anvitha S, Athira T.K., Avani Mital, Hansraj Gautam, Manan Gupta, Medha Rao, Neha Pandey, Pavitra Prakash, Revathe T., Rutvij Kaustubh, Satyabrata Nayak, Srikant Venkitachalam, Viveka Jagdish.

Research Associates (Provisional)
Avani Mital, Keerthipriya P.

R&D Assistants
Sajith V.S., Ramesh M.K.

EIBU AT A GLANCE

3 Ph.D.
STUDENTS
ADMITTED

2 Ph.D.
STUDENTS
GRADUATED

6
PUBLICATIONS

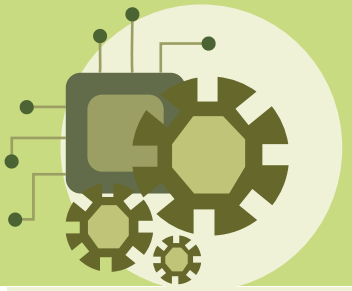
Award received by student

Keerthipriya P. – Ph.D. student; Runner up prize for talk at the SPEEC-UP meeting held in Centre for Ecological Sciences, IISc, Bengaluru on August 31, 2018.

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECT	1	15.89 Lakhs
ONGOING PROJECTS	2	4.13 Lakhs

ENGINEERING MECHANICS UNIT (EMU)



ABOUT

The EMU is focused on research in various topics related to transport processes in simple and complex fluids over a range of length and time scales. Our research objectives include both fundamental concepts and application-oriented scenarios, which have resulted in both research-based and funding-based collaborations with leading institutions in India and around the world. Research endeavors 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), spanning an enormous range of length and time scales. The research problems being investigated by the Unit members are aerodynamics, complex fluids and rheology, flow and interfacial stability, and computational science. Biological problems and natural phenomena – from insect flight to the fluid dynamics of clouds – are also being investigated by employing both theoretical and experimental methods.

RESEARCH AREAS

Specifically, the Unit is focused on research in the following fields:

- Numerical simulation of turbulent flows
- Dynamics, rheology, and stability studies of complex fluids
- Fluid dynamics of clouds and atmospheric convection; geophysical convective flows
- Transition, flow-control, and relaminarization
- Hydrodynamic stability and turbulence
- Vortex dynamics
- Rheology, flow, and microstructure studies of active non-equilibrium suspensions
- Flow under micro-gravity conditions

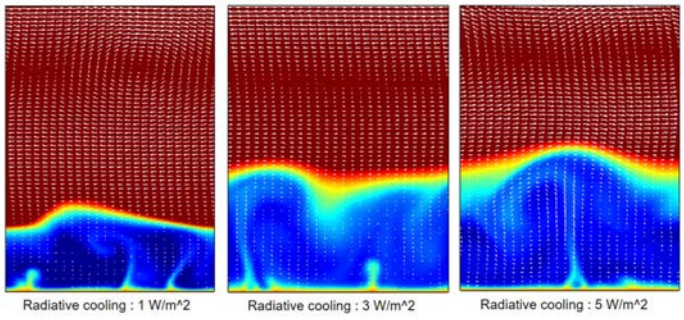
RESEARCH INSIGHTS

- Discovery of linear instability in pipe flow.
- Development of a consistent second-order nonlinear theory for granular and gas-solid suspensions.
- Discovery of an exotic state, in which both the stationary and travelling waves were found to co-exist in suspension Taylor-Couette flow.
- Recent DNS study evaluating the performance of a GPU-accelerated in-house code ANUROOP revealed that it was more cost-effective and consumed lower power compared with performance on CPUs.

K.R. Sreenivas

Ph.D., Professor and Chair, EMU

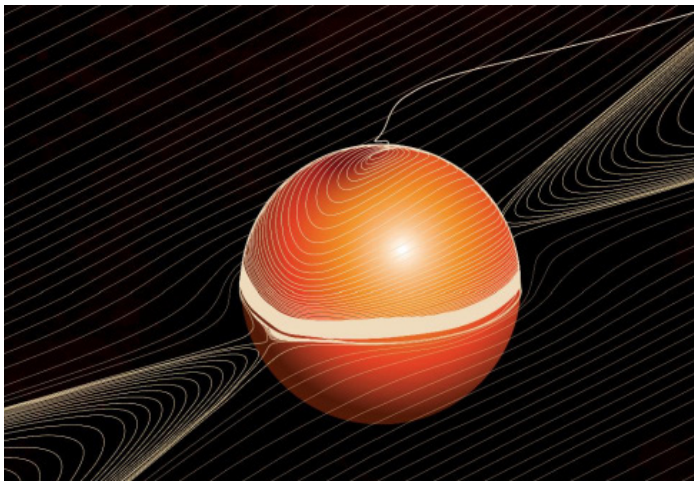
Radiation fog activity has been identified as an emerging and important issue in airport management. Our group, along with the Bangalore International Airport Limited (BIAL), established an observation station next to the runway for monitoring various parameters that impact fog formation. We aim to study 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. 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. A part of this project also involves the development of a solar chimney that can help in passive ventilation of polyhouses. Another area of research pursued by the group is on the turbulent drag reduction 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.



Penetrative convection in the nocturnal atmospheric boundary layer due to different radiative cooling rates.

Ganesh Subramanian

Ph.D., Professor



The streamlines around a drop immersed in a hyperbolic linear flow at finite Reynolds number

Using theory and computations, we recently explained myriad phenomena in active suspensions, including shear induced migration and banding, regimes of apparent superfluidity, anomalous enhanced tracer diffusivities, and most intriguingly, transition to a state of long-ranged correlations (termed collective motion) beyond a critical concentration-based threshold. Research conducted in collaboration with Prof. Shankar's group at IIT Kanpur, showed that pipe flow of a viscoelastic fluid (a dilute polymer solution) is linearly unstable. Newtonian pipe flow is well known to be linearly stable. Therefore, our finding is the first discovery of a linear instability in pipe flow since Reynold's pioneering experiments demonstrating the sub-critical transition to turbulence more than a hundred and thirty years ago! The discovery goes against a deeply entrenched belief in the prevailing literature, of such viscoelastic shearing flows being linearly stable.

Key publications:

Krishnamurthy D, Subramanian G. 2018. Heat or mass transport from drops in shearing flows. Part I. The open streamline regime. *J Fluid Mech.* 850: 439–83.

Garg P, et al. 2018. Viscoelastic pipe flow is linearly unstable. *Phys Rev Lett*. 121(2):024502.

Meheboob Alam

Ph.D.; Professor

Granular Physics Laboratory

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.

We also re-analysed the well-known Knudsen paradox via stochastic simulations, yielding new insights on the role of wallparticle interactions on the mass-flow rate in Poiseuille flow for both molecular and granular gases. Recent experiments on "suspension Taylor-Couette flow" uncovered an exotic state, wherein both stationary and travelling waves were found to co-exist. A non-linear mode-interaction theory might be able to explain such Chimera-like co-existing patterns.

Wavy Taylor vortices in suspension Taylor Couette flow.

Key publications:

Ramesh P, et al. 2019. Suspension Taylor-Couette flow: co-existence of stationary and travelling waves, and the characteristics of Taylor vortices and spirals. *J Fluid Mech*. 870: 901–40.

Saha S, Alam M. 2017. Revisiting ignited-quenched transition and the non-Newtonian rheology of a sheared dilute gas-solid suspension. *J Fluid Mech*. 833: 206–46.

Santosh Ansumali

Ph.D.; Associate Professor

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.

Roddam Narasimha

Ph.D., FASc, FNA, FTWAS, FRS; Honorary Professor

Our research group predominantly focuses on Direct Numerical Simulation (DNS) of the complex flow over gas turbine blades, and carries out fluid dynamical investigation of clouds using laboratory experiments and DNS studies. Recently, we carried out DNS study for a small turbofan engine (STFE) designed at DRDO-GTRE. DNS on finer meshes (258M and 516M cells) suggested the presence of a separation bubble, whereas DNS on a coarse mesh (94M) and RANS models were unable to capture the bubble. However, DNS at high Re is computationally expensive. Some relief comes from the use of GPUs as the compute elements are heterogenous. Figure 1 shows the performance of a GPU-accelerated in-house code ANUROOP in comparison to performance on CPUs. Notably, the GPU-based cluster costed 30% less and required 25% less power than a CPU-based cluster of similar performance.

Earlier work on cloud flows has shown that a transient diabatic plume (TDP) offers a good fluid-dynamical model for a cumulus cloud. Recent work has provided both experimental and computational (DNS is the present case) results on TDPs, with appropriately scaled heat injected to the TDP to mimic heat release in a cloud. Figure 2 shows a comparison of these results. Figure 2a is a natural cumulus. The DNS results show the TDP as it appears from the outside, but with the vortical structure as seen at the surface (Figure 2b), and an axial section showing the vorticity magnitude within the TDP (Figure 2c). Figure 2d is an axial section of the TDP, showing the azimuthal vorticity field. Similarities between DNS and experimental results were clearly seen, and explained how the heating creates new vorticity through the baroclinic torque, and the entraining/detraining velocity field in the ambient fluid.

Key publications:

Patel KS, et al. 2018. A critical comparison of DNS versus model results on an HPT turbine blade. In the 20th AeSI Annual CFD Symposium, NAL.

Maruthi NH, et al. 2018. Performance of a compressible DNS code on the latest GPU architectures. In GPU Technology conference 2019, San Jose, CA, USA.

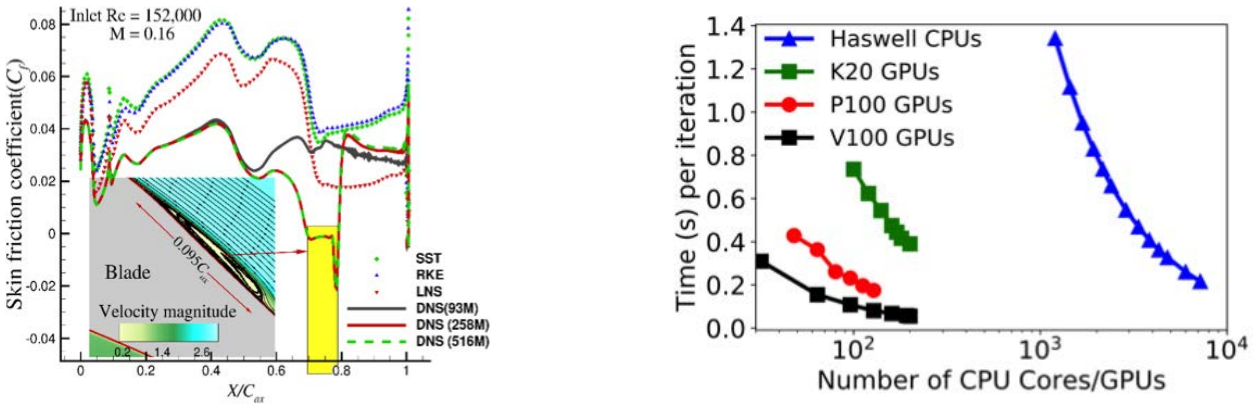


Figure 1. (left) Variation of skin friction coefficient along the suction side of an STFE high-pressure turbine blade at the Reynolds no. (Re) shown, based on inlet velocity and chord length. (right) Strong scaling performance of ANUROOP with three generations of GPUs in comparison to CPUs (Haswell). (Maruthi et al. 2019, GPU Technology Conference, San Jose CA, USA.)

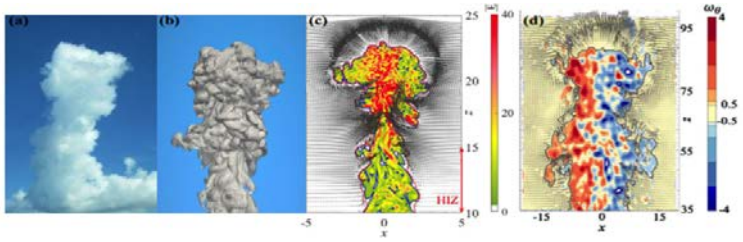
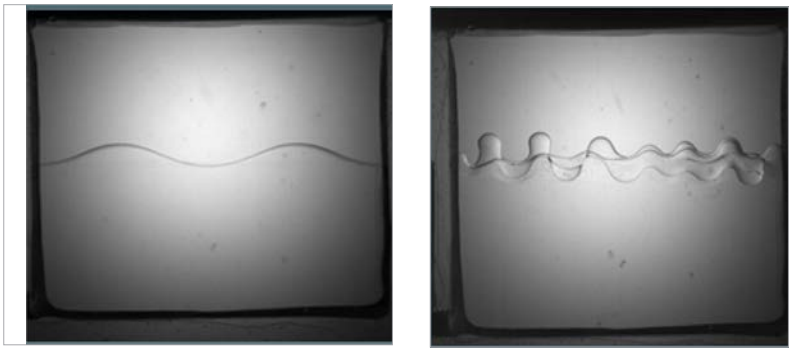


Figure 2. Visualizations of a natural cloud (a) and cloud flows in a TDP by DNS ((b) and (c)) and experimental (d)studies (Samrat Rao et al., Vybhav et al.)

Diwakar S. Venkatesan

Ph.D., Faculty Fellow

We have been involved in parabolic flight experimentation for the characterization of Faraday instability in Micro-gravity. This was carried out as a part of the CNES (French space agency) parabolic flight campaign organized between 27th March 2017 and 7th April 2017. The results of these experiments, for the first time, confirmed the dual role played by gravity, wherein it makes a vibrating fluid system more stable at lower frequencies of vibration and vice-versa at higher frequencies. The experiments also physically demonstrated the counterintuitive stabilization that can result from a reduction in interfacial tension.



Evolving interface in normal gravity and micro-gravity conditions

UNIT MEMBERS

Professor and Chair
K.R. Sreenivas

Professors
Ganesh Subramanian
Meheboob Alam

Associate Professor
Santosh Ansumali

Faculty Fellow
Diwakar Seyyanur Venkatesan

Honorary Professor
Roddam Narasimha

Research Students
Akanksha Bohra, Akshay Chandran, Akshaysingh Bhawarsingh Shekhawat, Albin Prince John, Amit Kumar Mishra, Arun Kumar Varanasi, Biswadeep Roy, K. Siddharth, Mahan Raj Banerjee, Mayank Toprani, Mohammad Atif, Mohammad Raifuddin, Nishant Soni, Piyush Garg, Prashanth Ramesh, Prateek Anand, Praveen Kumar K, Pulkit Kumar Dubey, Sabarish V.N., Saifuddin V., Sankalp Nambiar, Shashank H.J., Shaurya Kaushal, Swastik Hegde, Tanumoy Dhar, Vybhav G.R.

Junior Research Fellow
Samarth Agrawal

Project Assistant
Pulkit Kumar Dubey

Research Associates
Deepak Govind Madival, Kishore Singh Patel, Ramakrishna Rongali

SERB Young Scientist Fellows
Lakshminarasimharao, Shailendra Kumar Singh

R&D Assistants
Albin P. John, Suman D.H., Sankalp Radhakrishnan Nambiar, Pravesh Shukla, Rhoheth Radhakrishnan

EMU AT A GLANCE

3 M.S. (Engg.)
STUDENTS
ADMITTED

4 Ph.D. &
1 M.S. (Engg.)
STUDENTS
GRADUATED

13
PUBLICATIONS

Award received by faculty

Prof. Roddam Narasimha – Sr. Alumnus Award by Chief Minister of Karnataka on the occasion of inauguration of Bangalore Central University, Central College on 7th March 2018.

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	3	403 Lakhs
ONGOING PROJECTS	9	439.8 Lakhs

First Startup Sankhyasutra labs from EMU, incubated in JNCASR received series-A funding to the tune of INR 600 million.

GEODYNAMICS UNIT (GDU)

ABOUT

The paradigms in solid Earth sciences are essentially rooted in geodynamic concepts, and there are many unresolved questions on the linkages between geodynamics, tectonics, and various other processes. A primary goal of GDU is to characterize the main thrust belts in central and western Himalaya to gauge their role in Himalayan seismicity. Earthquake history and geodesic studies report a greater proclivity of these regions to host a major earthquake. 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 use seismological and geological tools to investigate the earthquake mechanisms of the Himalayan arc and its contiguous regions. Additionally, we investigate tsunami hazard areas of the Indian Coasts and climate evolution in the Himalayan region using various geological proxies.

RESEARCH AREAS

The research carried out by the Unit is focused on:

- Tectonics and earthquake generation processes along the Himalaya and seismogenesis of the Himalayan earthquakes
- Reconstruction of the late Quaternary climatic changes in the Himalaya. using multiple parameters including chrology, sedimentology, stable isotopes, and geochemistry.

RESEARCH INSIGHTS

- Identification of earthquake patterns in the central Himalayan region, indicating that the region is ready for another great earthquake.
- High resolution reconstruction of past climate changes in the Himalayan and highly-resolved time series, providing new insights into climatic and environmental processes on timescales ranging from seasonal to glacial/interglacial cycles.
- Constraint the recurrence interval of tsunamis from the Indian Ocean sources and impact evaluation.

K.S. VALDIYA

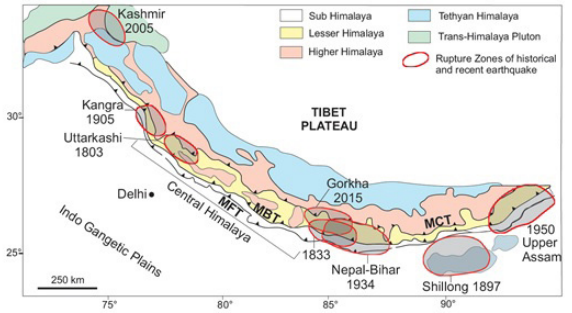
Ph.D., FASc, FNASc, FTWAS; Honorary Professor and Chair, GDU

Our study focuses on identifying belts where sudden and swift geological phenomena may occur, particularly in vulnerable regions, such as the central sector of the Himalayan arc (Kumaun in the Uttaranchal), the Biligirirangan Range in southeastern Karnataka, and the Sahyadri Range in western Karnataka and central Kerala. The physical changes occurring in these regions are identified by patterns in topographical maps and satellite imagery, fieldwork, and atypical behaviours of rivers and streams towards tectonic movements.

C.P. Rajendran

Ph.D.; Senior Associate

Recently, we identified the occurrence of a cluster of great earthquakes in the central Himalaya in medieval period (11th and 14th centuries CE), establishing the fact that the central Himalaya, recognized currently as a seismic gap had indeed produced great earthquakes in the past, and is now ready for another great earthquake.



Tectonic domains and major thrusts of the Himalaya (MCT: Main Central Thrust, MBT: Main Boundary Thrust and MFT: Main Frontal Thrust). Rupture zones of major historical and recent earthquakes

UNIT MEMBERS

Honorary Professor and Chair
K.S. Valdiya

Senior Associate
C.P. Rajendran

Research Associates
Thulasiraman Natarajan, Jaishri Sanwal Bhatt

GDU AT A GLANCE

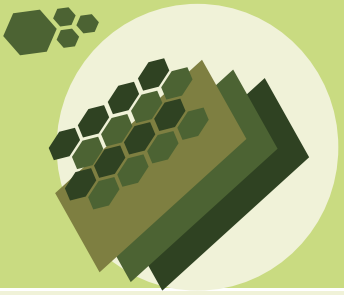
Award received by faculty

Prof. K. S. Valdiya – Lifetime Excellence Award from Ministry of Earth Sciences, GoI.

SPONSORED PROJECTS

		Money received 2018-2019
ONGOING PROJECTS	3	18.99 Lakhs

INTERNATIONAL CENTRE FOR MATERIALS SCIENCE (ICMS)



ABOUT

ICMS, the first international centre of its kind, came into being on December 3, 2011 and was inaugurated by the then Prime Minister of India, Dr. Manmohan Singh. ICMS has emerged as one of the leading facilities in the country for high impact interdisciplinary research. The Centre is financially supported by the Department of Science and Technology, Government of India and directed by Prof. C.N.R. Rao. The objectives of ICMS include carrying out in-house research of high quality in 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. The Centre has also established various collaborations and has signed MoUs with international research institutions such as Weizmann, SISSA, RMIT –Australia, Waterloo Canada, and University of Manchester, through which there are constant exchanges of students and researchers along with frequent technical meetings and workshops. ICMS is a member of several international forums like EICOON, WMRIF, and IUSSTF.

RESEARCH AREAS

The research carried out by the Unit is focused on:

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

RESEARCH INSIGHTS

- Investigations of solar photochemical hydrogen generation by splitting water, semi-conducting metal chalcogenides and their physical properties, and layered materials, among other things are being published. Synthesis of various nanomaterials (Prof. C.N.R. Rao's group).
- Novel supramolecular strategy based on host guest chemistry was analysed for noncovalent functionalization of 2D nanosheets with organic chromophores.
- Elucidation of formation of GaN quasi one-dimensional nanorods and quasi two-dimensional nanowalls.
- Encoding of mechanical memories in a dense disordered packing of bi-disperse bubbles was shown for the first time.
- Quantitative high-resolution transmission electron microscopy (HRTEM) was performed both by inline and off axis holography.
- Identification of transient Mn^{3+} state, which opens up a unique opportunity to realize a reversible photochemical reaction and high radiative efficiency in a semiconductor nanostructure.
- Development of novel organocatalysts that can ring open carbonates with good regioregularity.
- Demonstration of rigid-band electronic structure of scandium nitride across n-type to p-type carrier transition regime.
- Determination of the Schottky barrier height of epitaxial single crystalline TiN/(Al,Sc)N metal/semiconductor superlattices for application in thermionic energy conversion device.

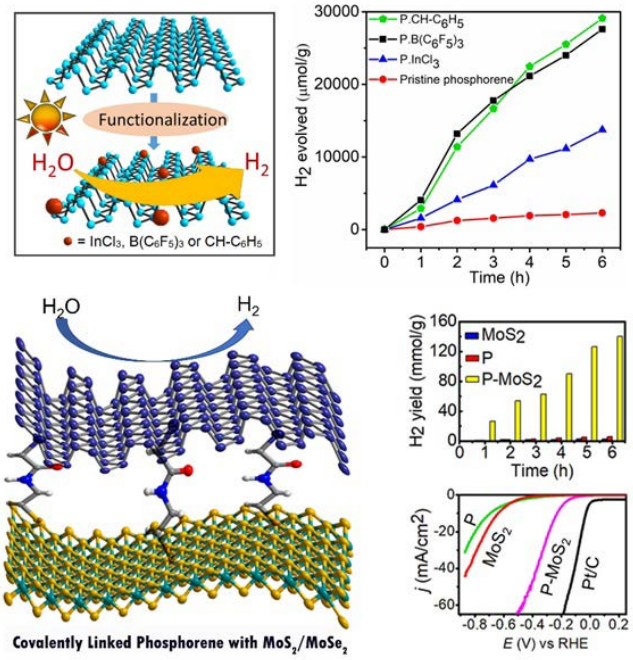
C.N.R. Rao

D.Sc., Ph.D., FRS, Hon. FRSC; Linus Pauling Research Professor and Director, ICMS

Chemistry of Materials

Phosphorene, a monolayer of elemental phosphorus, has recently emerged as a sensational 2D semiconductor that shows a thickness tuneable band-gap in the 0.3-2.0 eV range, high charge carrier mobility (~1,000 $cm^2V^{-1}s^{-1}$) and I_{ON}/I_{OFF} ratio >10^5. However, the application of phosphorene is limited by its poor stability under ambient conditions. We showed stabilization of phosphorene under ambient conditions upon chemical functionalization with Lewis acids, without losing its properties. The functionalized phosphorene exhibits good dispersibility in water as well as superior and robust H_2 evolution reaction (HER) activity compared with that of the pristine sample. The HER activity of phosphorene was further enhanced by covalently cross-linking it with other 2D materials such as MoS_2 and $MoSe_2$.

In the past year, we have made much progress in the field of 2D materials. Stable phosphorene quantum dots (PQDs) with average sizes varying between 1.0 and 5.0 nm were prepared by the sonication of black phosphorus in highly non-polar solvents such as toluene and mesitylene. The PQDs exhibit excitation wavelength-dependent blue photoluminescence. Arsenene nanosheets and quantum dots were prepared by liquid exfoliation of grey arsenic in suitable solvents. The stability of 1T-MoS_2 and $MoSe_2$ was improved by simple hydrothermal and solvothermal methods. Covalent cross-linking of 2D structures such as graphene, MoS_2, C_3N_4, and BCN using coupling reactions afforded the generation of novel materials with new or improved properties, such as increased surface areas, superior supercapacitor performance, and hydrogen evolution. Moreover, a novel supramolecular strategy based on host–guest chemistry was analysed for the noncovalent functionalization of 2D nanosheets with organic chromophores. The strategy has been extended to the synthesis of supramolecular heterostructures for HER activity. Mechanical and thermal properties of polymer matrices were enhanced upon reinforcing with layered BCN of varied composition. Aliovalent anion substitution in metal oxides and sulphides can be done to engineer the band structures. Cd_2NF and TiNF were synthesized by the complete substitution of O in the lattice of the corresponding oxide. Complete substitution of S^{2-} in CdS by aliovalent P^{3-} and X (X = Cl, Br, I) ions was found to yield a compound of the composition $Cd_4P_2X_3$ with direct band gaps and with excellent hydrogen evolution and CO_2 reduction properties. Efficient reduction of seawater to hydrogen under visible light irradiation was studied by various catalysts known for water splitting with pure water. Photostability of the Cu_2O photocathode film for photoelectrochemical (PEC) water splitting was improved by engineering the interfacial band edge energetics with Ni_xP_y as the co-catalyst. The heterojunction electrodes are stable for the PEC hydrogen evolution, because of facile charge transfer from the bulk of Cu_2O to the electrolyte via CuO and Ni_xP_y. Atomic layer deposition is a chemical vapour deposition technique based on the sequential use of the gas phase chemical process. Single crystalline epitaxial films of MoS_2 nanowall networks were successfully grown on c-sapphire by thermal ALD.



Functionalization of phosphorene and HER study

Key publications:

Rao CNR, Chhetri M. 2019. Borocarbonitrides as metal-free catalysts for the hydrogen evolution reaction. *Adv Mater*. 31(13): e1803668.

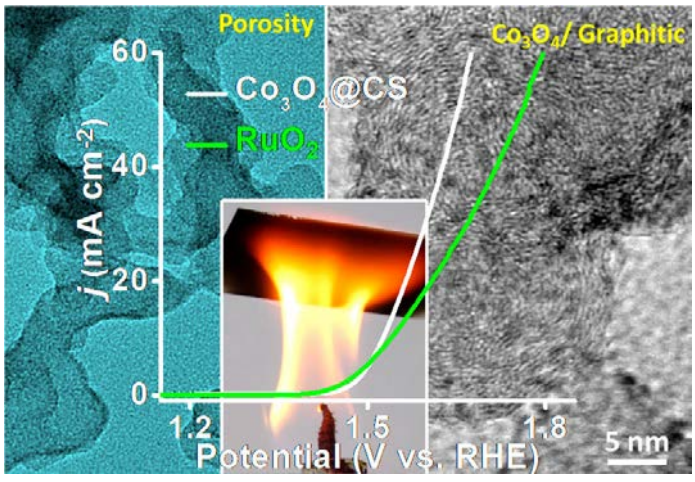
Roy A, Rao CNR. 2019. Novel inorganic materials generated by aliovalent anion substitution. *APL Materials*. 7(9): 090901.

Eswaramoorthy M.

Ph.D., Professor and Associate Director, ICMS

Nanomaterials and Catalysis Laboratory

The development of environment-friendly active and selective catalysts for oxidative dehydrogenation of propane for propene synthesis is one of the challenging catalytic reactions. This reaction has tremendous industrial potential. Recently, we showed high catalytic activity for hexagonal boron nitride for oxidative dehydrogenation of propane. Remarkable selectivity for alkenes (~70%) at very high conversion (~50%) of propane was achieved. The catalyst was found to retain its activity for more than 100 h in presence of ammonia. We also showed high oxygen evolution kinetics for a cobalt oxide@C catalyst prepared by a simple, one-step combustion method.



One-step combustion synthesis of Co_3O_4@C catalyst for OER reaction

Key publications:

Kumar BP, et al. 2018. Supramolecular switching of ion-transport in nanochannels. *ACS Appl Mater Interfaces.* 10: 23458–65.

Singh DK, et al. 2018. Pick a wick: A simple, ultrafast combustion synthesis of Co_3O_4 dispersed carbon for enhanced oxygen evolution kinetics. *ACS Appl. Energy Mater.* 1: 4448–52.

S.M. Shivaprasad

Ph.D., Professor (on lien w.e.f. 11.08.2017)

Our Epitaxy laboratory is involved in growth of thin films and nanostructures of III-nitride semiconductors such as GaN, InN, and AlN, and their alloys with novel functionality and properties. We have carried out experimental and first principles theoretical studies to elucidate the atomistic processes at play during the formation of GaN quasi one-dimensional nanorods and quasi two-dimensional nanowalls.

Optoelectronic and electronic devices based on GaN materials are an established industry. However, some properties related to doping of GaN are not yet completely understood. Process of efficient hole doping of GaN by Mg incorporation and resulting effects in optical and transport properties was studied. We performed spectroscopic studies and theoretical calculations to understand the origin of blue luminescence of doped GaN. It was found that a complex of substitutional and interstitial Mg creates defect states inside the forbidden gap of GaN and is responsible for the aforementioned blue luminescence.Additionally, the influence of Mg on the growth process of GaN nanorods was examined. It was found that Mg enhances the radial growth of the nanorod.

GaN-based heterostructures have shown promise in water splitting applications. It was found that the photocatalytic properties are enhanced by nanostructuring of GaN. GaN nanowall–TiO_2 heterostructures were found to be efficient photoanode for hydrogen evolution reaction.

Rajesh Ganapathy

Ph.D., Associate Professor

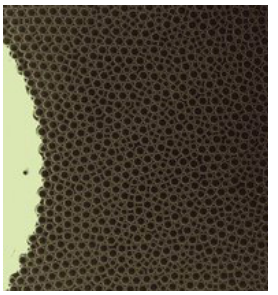
Soft Matter Laboratory

In a recent experimental study, our group demonstrated for the first time the encoding of mechanical memories in a dense disordered packing of bi-disperse bubbles. The study also showed the encoding of multiple memories and provided fundamental insights into how these memories are formed. This work was published in PRL, was taken as an Editor's Suggestion, and appeared on the Cover Page of the journal. It was also covered by Physics Today – a popular science magazine published by the American Institute of Physics. In addition, our group has completed two other studies – on shear-thickening in suspensions of colloidal rods and on self-organised growth of colloidal crystals on strain-relief patterns.

Key publications:

Mukherji S, et al. 2019. Strength of mechanical memories is maximal at the yield point of a soft glass. *Phys Rev Lett.* 122: 158001.

Ganapathi D, et al. 2018. Measurements of growing surface tension of amorphous-amorphous interfaces on approaching the colloidal glass transition. *Nat Commun*. 9: 397.



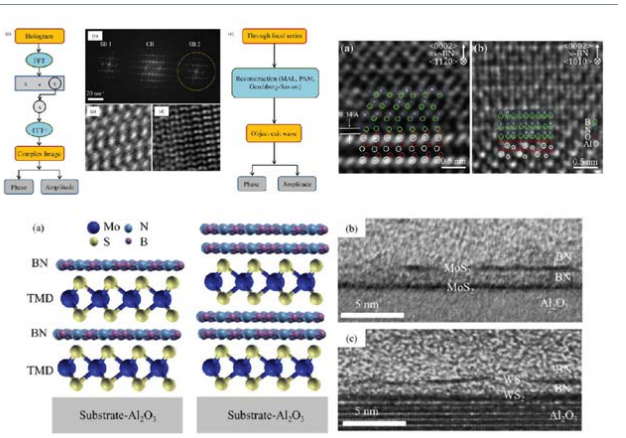
Amorphous bubble raft

Ranjan Datta

Ph.D., Associate Professor

High Resolution Transmission Electron Microscopy Laboratory

In the past academic year, we achieved multiple things. We successfully applied quantitative high- resolution transmission electron microscopy (HRTEM) both by inline and off axis holography. We could stabilize super hard meta-stable w-BN over large area thin film form. We developed thin film heterostructures of 2D transition-metal dichalcogenides for energy application. We are now actively engaged in p-doping and magnetism in ZnO in thin film form for application in bi-polar devices and spintronics. We are trying to understand the issues using the unique capability of our TITAN microscope.



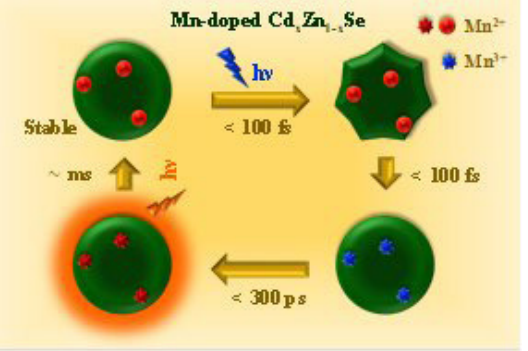
(a) and (e) Steps involved in reconstruction methods to extract phase and amplitude from the hologram and HRTEM image series, respectively. (b) Fourier transform of the hologram showing one CB and two SBs. (c) and (d) are the examples of an atomic resolution hologram and an HRTEM image of a ZnO epitaxial thin film along <11−20> Z.A

Ranjani Viswanatha

Ph.D., Associate Professor

Quantum Dot Laboratory

The nature of transient species leading to emission from the spin/orbital forbidden Mn d-d transition in doped semiconductor quantum dots has intrigued scientists for a long time. Our lab has been attempting to elucidate the nature of these species. We uncovered an important long-standing puzzle regarding Mn emission using transient absorption and clever modification of the host material to increase the lifetime of the transient species. This concept was extended to perovskite materials. We synthesized Sn and Fe-doped perovskite materials with excellent optical properties. Work is ongoing to understand several unsolved problems in high performance of perovskites using EXAFS as a tool. We worked extensively on doping transition metals into II-VI semiconductor and perovskite quantum dots and using them to probe and alter the electronic structure of host quantum dots. Additionally, we doped magnetic ions into CdS nanocrystals and its optical influence on the host. We also studied magnetism arising out of the interface of magnetic/non-magnetic materials.



Mechanism of Mn emission in nanomaterials

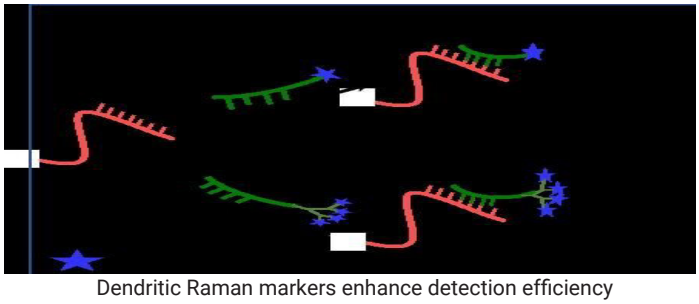
Key publications:

Gahlot K, et al. 2019. Transient species mediating energy transfer to spin-forbidden Mn d States in II–VI semiconductor quantum dots. *ACS Energy Let*t. 4: 729–35.

Saha A, Viswanatha R. 2017. Magnetism at the interface of magnetic oxide and non-magnetic semiconductor quantum dot. *ACS Nano.* 11: 3347–54

Sridhar Rajaram

Ph.D., Associate Professor



Dendritic Raman markers enhance detection efficiency

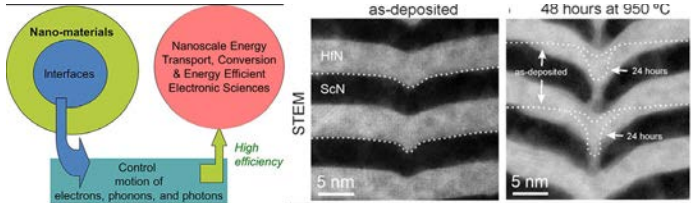
Polymer Laboratory

Polycarbonates are durable, tough, and biodegradable polymers that are used extensively in daily life. However, a major concern with their use is the presence of bisphenol-A as the monomer unit. In the previous year we initiated a project to develop bis-Phenol A-free polycarbonates. In this regard we are working on the regioselective ring opening polymerization (ROP) of cyclic carbonates.

The cyclic carbonates can be easily made from 1,3-diols, which in turn can be obtained by reduction of aldol products. Thus, a range of polymers with varying properties can be readily accessed. In the case of unsymmetrical carbonates, the mechanical properties of the polymer will depend on its regioregularity. Controlling the regioregularity of ROP is a difficult task and we have developed novel organocatalysts that can ring open carbonates with good regioregularity. We are in the process of exploring the properties of these novel polymers.

Bivas Saha

Ph.D., Faculty Fellow



High resolution transmission electron micrograph showing dislocation pipe diffusion formation in superlattice meta-materials is presented

Heterogeneous Integration Research Laboratory

We have made three major discoveries in the past academic year (along with several other research developments). Firstly, with a combination of synchrotron-based X-ray absorption and emission spectroscopy measurements, and first-principles modelling analysis, we demonstrated the rigid-band electronic structure of scandium nitride (ScN) across the n-type to p-type carrier transition regime. Secondly, wave-vector dependent plasmon-longitudinal phonon (LO) coupling and Fano resonance in epitaxial ScN was demonstrated. Third, the Schottky barrier height of epitaxial single crystalline TiN/(Al,Sc)N metal/semiconductor superlattices were determined for the first time for thermionic energy conversion device applications

Key publications:

Nayak S, et al. 2019. Rigid-band electronic structure of scandium nitride (ScN) across n–type to p–type carrier transition regime. *Phys Rev B*. 99: 161117.

Maurya KC, et al. 2019. Wave-vector dependent raman scattering from coupled plasmon-LO phonons in epitaxial n-type ScN thin films. *Phys Status Solidi Rapid Res Lett*. 13: 1900196.

Premkumar Senguttuvan

Ph.D., Faculty Fellow

Energy Storage and Conversion Laboratory

Vanadium based NASCION cathode-$Na_3V_2(PO_4)_3$ was demonstrated with stellar cycling performance in Na-ion batteries. To improve the capacity, we synthesized a series of Na_3+yV1-yM'y$(PO_4)_3$ compounds. Combined electrochemical, XRD and XAFS studies revealed interesting insights into the structural evolution along with the participation of different vanadium and manganese redox couples, which were further validated by DFT calculations. High reversible capacity, rate capability, and better cyclability was achieved for y=0.75, which could be corroborated to the optimum bottleneck size for sodium ion diffusion as well as superimposed V- and Mn-redox centers. We also developed a new topochemical method to convert one-dimensional-$FeF_3{\cdot}3H_2O$ precursor structure to a higher dimensional iron fluoride framework through incorporation of a "structure-stabilizing" agent.

UNIT MEMBERS

Linus Pauling Research Professor and Director
C.N.R. Rao

Associate Director
M. Eswaramoorthy

Professor
S.M. Shivaprasad (on lien w.e.f. 11.08.2017)

Associate Professors
Rajesh Ganapathy (Associate Faculty, CPMU)
Ranjan Datta (Associate Faculty, CPMU)
Ranjani Viswanatha (Associate Faculty, NCU)
Sridhar Rajaram (Associate Faculty, CPMU)

Faculty Fellows
Bivas Saha (jointly with CPMU)
Premkumar Senguttuvan (jointly with NCU)

Senior Research Officer
Jay Ghatak

PGDMS Students
Bibekananda Paikaray, M. Subhashri, Nirmal Jose

Research Associates
Anand Kumar Roy (Provisional), Kavita Sharma, Manjodh Kaur, Pramoda K., Pratap Vishnoi, Shashidhara

SERB National PDF
Mokurala Krishnaiah

Women Scientist Scheme A
Saraswathi C.

Project Assistant
Angira Roy

Technical Assistant Trainee
Deepak V.

ICMS AT A GLANCE

Awards received by faculty

Prof. C.N.R. Rao – Received the Honorary Causa Doctorate from Presidency University, Kolkata (80th Hon Causa Doctorate)
Received Honorary Doctorate from University of Manchester, UK
Top cited Author Award 2018 by Institute of Physics Publishing (IOP)
COSINE Award 2017
First Sheikh Saud International Prize for Materials Research given by the Centre for Advanced Materials of the UAE
Adjunct Professor (Honorary), Centre for Human Genetics, Bangalore

Prof. Ranjani Viswanatha – MRSI Medal 2018

Bivas Saha – SERB International Travel Award

3 PGDMS
STUDENTS
ADMITTED

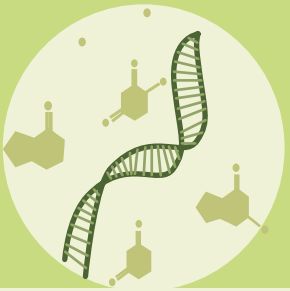
2 PGDMS
STUDENTS
GRADUATED

32
PUBLICATIONS

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	1	42.36 Lakhs
ONGOING PROJECTS	11	3.91 Cr

MOLECULAR BIOLOGY AND GENETICS UNIT (MBGU)



ABOUT

Research in MBGU uses fundamental principles and advanced approaches to increase understanding of concepts in biology as well as provide solutions applicable to healthcare and medicine. Given the unique array of research areas that JNCASR has expertise in, biologists can easily traverse disciplines and have a worldwide network of collaborations. Our research impacts understanding of and application to clinical and translational studies. Biological concepts and processes are unraveled by studying a wide variety of organisms including, viruses, yeast, protozoans, *Drosophila* and mouse, stem cells as well as human clinical samples. Research questions include understanding biomolecules at one end of the spectrum to studying human development and disease at the other. Facilities, funding, and training programs are geared to promote cross-disciplinary interactions. With their vast experience of several decades, faculty hold key administrative and advisory positions at JNCASR as well as nationally and internationally. The Unit also has made the highest impact in contributions to science in the country

The Unit has been academically quite active and productive during 2018-19, with several publications, theses defenses, guest lectures, and conferences. The contributions of several faculty members were recognized in the form of awards and memberships of professional bodies. A new area of research on "molecular basis of immune cell differentiation and function" was initiated in 2018 with the joining of Dr. Kushagra Bansal as a Faculty Fellow.

RESEARCH AREAS

Research at MBGU is focused on the following areas:

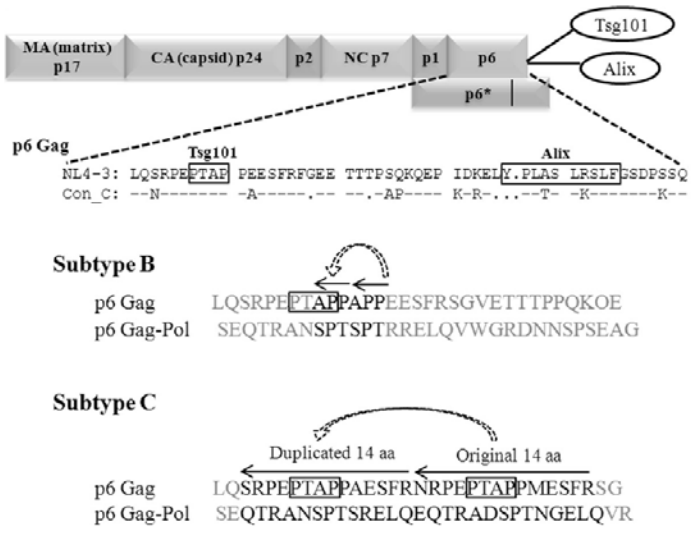
- Autophagy and neurodegenerative diseases
- Chromatin biology and genomics
- HIV-1 subtype - C strain
- Mechanism of chromosome segregation
- Genetic basis of human diseases
- Protein engineering and molecular parasitology
- Stem cells and cardiovascular development
- Transcription
- Immune cell differentiation and function

RESEARCH INSIGHTS

- Identification of key functional residues of *Plasmodium* AMP deaminase.
- Establishment of phosphoglycolate phosphatase as a metabolic proof-reading enzyme essential for cellular function in *Plasmodium berghei*.
- Identification of RNAi is a critical component in centromere evolution
- Generation of the first knockout mouse model from India for cardiovascular defects by deleting the gene *rudhira*.
- Demonstration of metabolic sub-states in human pluripotent stem cells and their potential for differentiation.
- Discovery that the non-histone chromatin-associated protein PC4 is critical for genomic integrity.
- Identification of the role of the exocyst complex in autophagy.
- Identification of a novel mechanism involving the dynamic regulation of three-dimensional chromatin structure in orchestration of the negative selection of autoreactive T cells

Ranga Udaykumar

Ph.D.; Professor and Chair, MBGU



Schematic representation of HIV-1 Gag protein domains highlighting the 14 aa duplication identified in subtype C p6 (sequence from clinical isolate T004) versus the most common 3 aa duplication in subtype B, with the core PTAP motif marked in black boxes.

HIV-AIDS Laboratory

Our laboratory studies viral transcriptional silencing. Breaking transcriptional silence is critical to effectively manage diseases and develop vaccines. In a study performed in collaboration with four institutes across India, we observed that a large number of promoter-variant viral strains have emerged in the recent years. The central theme of these promoter variations appears to strengthen the transcriptional strength of the promoter and simultaneously reinforce the stability of viral latency. We categorised approximately 10 variant viral strains into two broad classes depending on whether only the NF-κB motif was duplicated in the viral promoter or the duplication was accompanied with that of the RBEIII motif. We showed that such variations appear to be unique to the subtype-C of HIV-1. We are investigating how viral latency and reservoirs are affected in these infections and how sequence duplications in the viral promoter and Gag-p6 will affect viral replication fitness, drug resistance, and evolution. We also plan to examine the subtype-specific properties of reverse transcriptase.

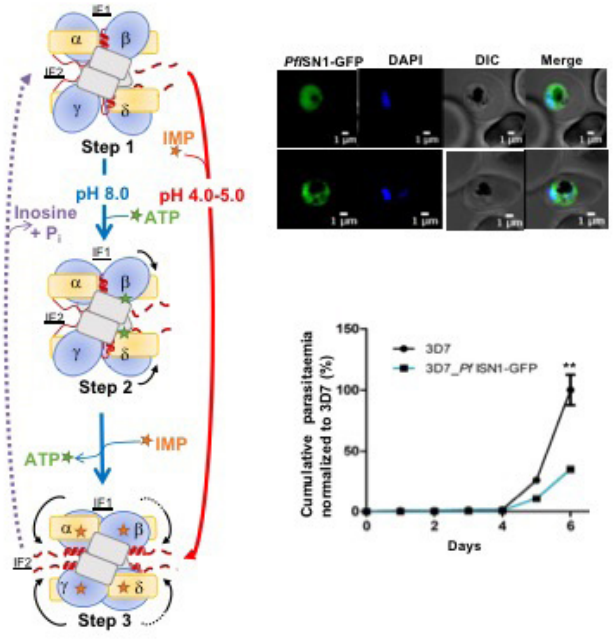
Key publications:

Sharma S, et al. 2017. The PTAP sequence duplication in HIV-1 subtype C Gag p6 in drug-naive subjects of India and South Africa. *BMC Infect Dis*. 17: 95.

Sharma S, et al. 2018. PPTAP motif duplication in the p6 Gag protein confers a replication advantage on HIV-1 subtype C. *J Biol Chem*. 293: 11687–708.

Hemalatha Balaram

Ph.D., FASc, FNASc; Professor



Plasmodium falciparum ISN1. Structure-biochemical function, localization, physiological significance

Molecular Parasitology Laboratory

Our lab recently carried out biochemical characterization of *Plasmodium* AMP deaminase (AMPD) by functional complementation in yeast, leading to the identification of key functional residues. Knockout of AMPD was not lethal in all stages of the parasite lifecycle, while increased expression completely arrested growth. Structural basis for catalytic regulation and in vivo significance of *Plasmodium falciparum* IMP-specific 5'-nucleotidase was elucidated. In addition, phosphoglycolate phosphatase was established to be a metabolic proof-reading enzyme essential for cellular function in *P. berghei*. Succinimide-induced mechanism of thermostability in *Methanocaldococcus jannaschii* glutaminase was unraveled using structure and molecular dynamic simulations.

Key publications:

Jayaraman V, et al. 2018. Biochemical characterization and essentiality of *Plasmodium* fumarate hydratase. *J Biol Chem*. 293: 5878–94.

Nagappa LK, et al. 2019. Phosphoglycolate phosphatase is a metabolic proofreading enzyme essential for cellular function in *Plasmodium berghei*. *J Biol Chem*. 294: 4997–5007.

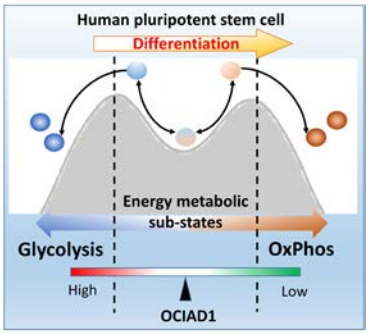
Maneesha S. Inamdar

Ph.D., FASc, FNASc; Professor

Stem Cell and Vascular Biology Laboratory
Our lab recently showed the existence of energy metabolic sub-states in human pluripotent stem cells. We also generated the first knockout mouse model from India for cardiovascular defects and cancers.

Key publications:
Shetty R , et al. 2018. Rudhira/BCAS3 is essential for mouse development and cardiovascular patterning. *Sci Rep*. 8: 5632.

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: 128–41.

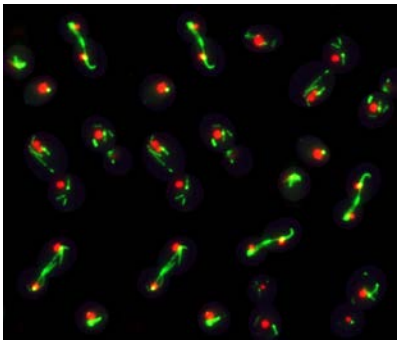


Energy metabolic sub-states in human pluripotent stem cells

Kaustuv Sanyal

Ph.D., FASc, FNASc, Fellow of AAM; Professor

Molecular Mycology Laboratory
Recent research in our laboratory revealed that RNAi is a critical component in centromere evolution, as loss of RNAi leads to attrition of retrotranposons from the centromeres of RNAi-proficient species, leading to shorter centromeres in the RNAi-deficient species of *Cryptococcus* (Yadav et al., 2018, PNAS). In addition, we identified a protein Sad1 that anchors chromosomes to the nuclear envelope in *Cryptococcus neoformans*, and this interaction is important for the spatiotemporal regulation of chromosome segregation (Yadav and Sanyal, 2018, mSphere).


Chromosome segregation

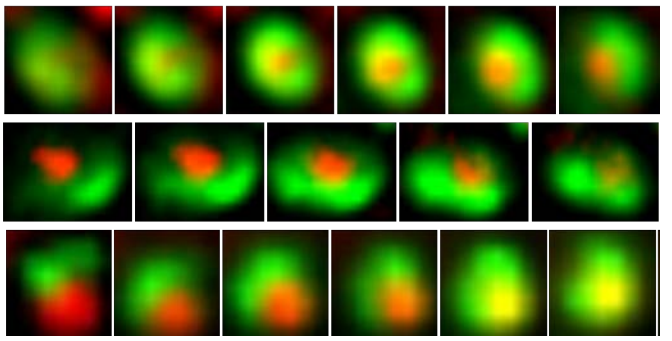
Key publications:
Yadav V, et al. 2018. RNAi is a critical determinant of centromere evolution in closely related fungi. *Proc Natl Acad Sci USA*. 115: 3108–13.

Varshney N, et al. 2019. Spatio-temporal regulation of nuclear division by Aurora kinase B Ipl1 in *Cryptococcus neoformans*. *PLOS Genet*. 15: e1007959.

Ravi Manjithaya

Ph.D.; Associate Professor (jointly with NSU), GRC member

Autophagy Laboratory
Our lab aims to understand the process of autophagy across different model systems, ranging from yeast to humans. To achieve this, we use – (1) genetic approaches, where different essential and non-essential genes are screened for their involvement in autophagy, and (2) chemical approach, where small molecules are used to modulate autophagy; these are further validated in disease models. Recently, we revealed the role of the exocyst complex in autophagy, which is otherwise known to be canonically involved in secretion in *Saccharomyces cerevisiae*. The exocyst complex was a candidate obtained from a genetic screen carried out in the lab. Another similar complex, called septin complex was also shown to have a non-canonical role in autophagy. Moreover, we showed the role of a reversible inhibitor in preventing autophagosome and lysosome fusion, thereby providing a novel efficient tool to study the autophagosomal trafficking process.


GFP tagged Cdc10, Cdc11 and Shs1 form non-canonical ring formation around autophagosomes (mCherry labelled Atg8) in *Saccharomyces cerevisiae*.

Key publications:
Vats S., Manjithaya R. 2019. A reversible autophagy inhibitor blocks autophagosome-lysosome fusion by preventing Stx17 loading onto autophagosomes. *Mol Biol Cell*. 17: 2283–95.

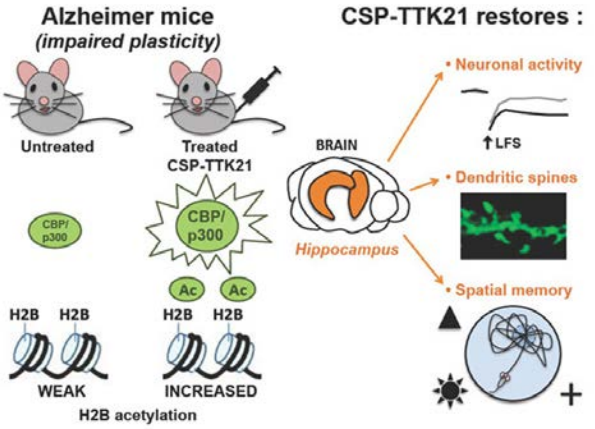
Singh S, et al. 2019. Exocyst subcomplex functions in autophagosome biogenesis by regulating Atg9 trafficking. *J Mol Biol*. 431: 2821–34.

Tapas Kundu

Ph.D., DSc, FASc, FNA, FNASc; Professor (jointly with NSU) (on lien w.e.f. 08.08.2018*)*

Transcription and Disease Laboratory

We have discovered that the non-histone chromatin-associated protein PC4 is critical for genomic integrity, and its depletion in cells results in alteration of nuclear shape, the opening of chromatin, and a changed epigenetic landscape. Our studies showed that PC4 is a regulator of autophagy and it maintains cellular homeostasis (Sikder et al., 2019). Further, we demonstrated the role of the methyltransferase enzyme, CARM1, in adipogenesis and oral cancer, and the underlying mechanisms of regulation of its expression in these processes (Behera et al., 2018; Behera et al., 2019). Our extensive research has also shown that activation of the lysine acetyltransferase enzyme, p300/CBP, using a small molecule conjugated nanoparticle CSP-TTK21, can potentially restore the spatial memory and plasticity deficits associated with Alzheimer's disease (Chatterjee et al., 2018), as well as aid in the recovery of sensory and motor functions in mouse and rat models of spinal cord injury (Hutson et al.).



Restoration of memory deficits associated with Alzheimer's disease

Key publications:

Sikder S, et al. 2019. Non-histone human chromatin protein PC4 is critical for genomic integrity and negatively regulates autophagy. *FEBS J*. doi: 10.1111/febs.14952.

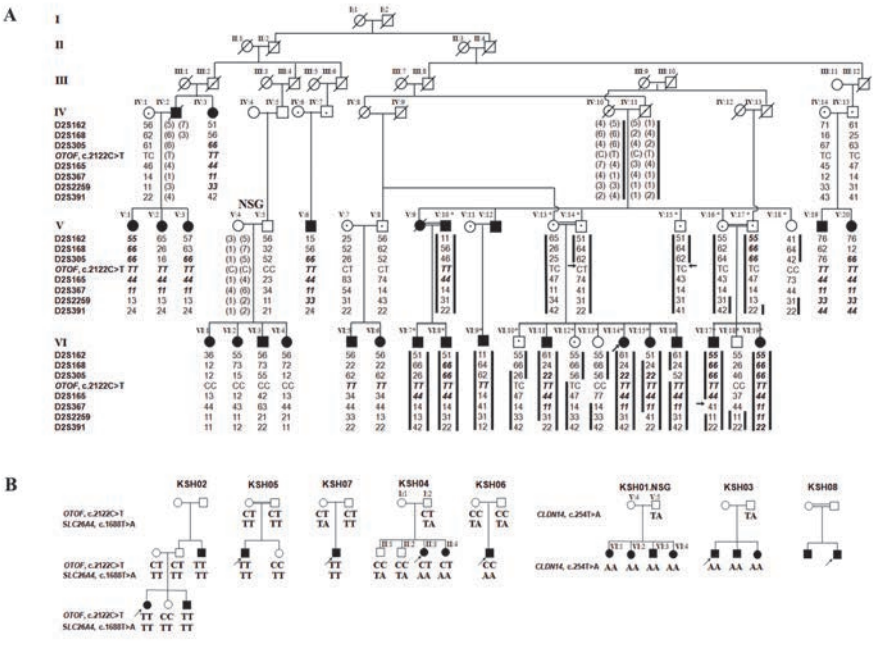
Chatterjee S, et al. 2018. Reinstating plasticity and memory in a tauopathy mouse model with an acetyltransferase activator. *EMBO Mol Med*. 10(11): e8587.

Anuranjan Anand

Ph.D., FASc, FNA, FNASc; Professor

Human Genetics Laboratory

To investigate causes of hearing impairment in Dhadkai village, India, we carried out a whole genome-based analysis of an extended family of 45 members, including 23 affected and 22 unaffected members. Additionally, multiple known genes associated with deafness were analyzed 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. Furthermore, 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.



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.

M.R. Satyanarayana Rao

Ph.D., FASc, FNA, FNASc, FAMS, FTWAS; Honorary Professor, SERB YOS-Chair Professor

Chromatin Biology Laboratory

The mrhl long non-coding RNA is expressed in mouse embryonic stem (ES) cells. Loss of function studies showed that mrhl lncRNA is not necessary for pluripotency, but necessary for lineage specific differentiation of ES cells. Genome wide occupancy of lncRNA and transcriptome studies indicated that regions of chromatin occupancy and the genes that are perturbed following down regulation of mrhl lncRNA are completely different from those observed earlier in B type spermatogonial cells. We characterized the human homolog of mrhl RNA and observed that it is syntenically conserved as its muse counterpart. TH2B is a major histone variant that replaces about 80-85% of somatic H2B in mammalian spermatocytes and spermatids. The post-translational modifications (PTMs) on TH2B have been well characterized in spermatocytes and spermatids. However, the biological function(s) of these PTMs on TH2B have not been deciphered in great detail. In an attempt to decipher the unique function(s) of histone variant TH2B, we detected the modification in the N-terminal tail, Serine 11 phosphorylation on TH2B (TH2BS11ph) in spermatocytes. Immunofluorescence studies with highly specific antibodies revealed that TH2BS11P histone mark is enriched in the unsynapsed axes of the sex body and is associated with XY body-associated proteins like Scp3, γH2AX, pATM, and ATR. Genome-wide occupancy studies, as determined by ChIP sequencing experiments in P20 C57BL6 mouse testicular cells, revealed that TH2BS11P is enriched in X and Y chromosomes confirming the immunofluorescence staining pattern in the pachytene spermatocytes. Apart from the localization of this modification in the XY body, TH2BS11ph is majorly associated with H3K4me3-containing genomic regions such as gene promoters. These data were also found to corroborate with the ChIP sequencing data of TH2BS11ph histone mark carried out in P12 C57BL6 mouse testicular cells, wherein we found the predominant localization of this modification at H3K4me3-containing genomic regions. Mass spectrometry analysis of proteins that associate with TH2BS11ph-containing mononucleosomes revealed key proteins linked with the functions of XY body, pericentric heterochromatin, and transcription.

Key publications:

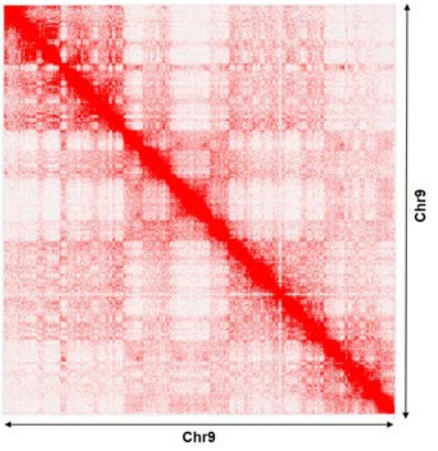
Akhade VS, et al. 2016. Mechanism of Wnt signalling induced down regulation of mrhl long non coding RNA in mouse spermatogonial cells. *Nucleic Acids Res*. 44(1): 387–401.

Kataruka S, et al. 2017. Mrhl long non coding RNA mediates meiotic commitment of mouse spermatogonial cells by regulating Sox8 expression. *Mol Cell Biol.* 37(14): e00632-16.

Kushagra Bansal

Ph.D.; Faculty Fellow

The primary focus of our lab is to build a detailed mechanistic understanding of the complex regulatory codes that govern the behaviors of immune cells in mammals. Particularly, we explore how 'cis' and 'trans' acting factors encoded by the genome are integrated into the transcriptional and epigenetic machinery facilitating a healthy immune response and try to decipher how these molecular circuits fail in immune-mediated diseases. By combining a series of multidisciplinary experimental approaches, ranging from flow cytometry, transcriptomics (RNA-seq, microarray), genome-wide chromatin-mapping techniques (ChIP-seq, ATAC-seq), high-throughput chromosome conformation capture methodologies (Hi-C) to genetic perturbation in mice, we uncovered novel molecular mediators of immune cell functions. Currently, we are focused on establishing the relationship of the regulators of DNA topology and genomic superstructure with the phenotype of immune cells, and preliminary results suggest the regulatory role of these mediators in innate as well as adaptive immune responses. Our lab also identified a novel mechanism involving the dynamic regulation of three-dimensional chromatin structure in orchestration of the negative selection of autoreactive T cells.



Chromosomal contact maps of Chr9 in medullary thymic epithelial cells

Key publications:

Bansal K, et al. 2017. The transcriptional regulator Aire binds to and activates super-enhancers. *Nat Immunol*. 18(3): 263–73.

Fujikado N, et al. 2016. Aire inhibits the generation of a perinatal population of interleukin-17A-producing γδ T Cells to promote immunologic tolerance. *Immunity*. 45(5): 999–1012.

UNIT MEMBERS

Professor and Chair
Ranga Udaykumar

Professors
Anuranjan Anand (Associate Faculty, NSU)
Hemalatha Balaram
Kaustuv Sanyal
Maneesha S. Inamdar
Tapas Kumar Kundu (Associate Faculty, NSU) (on lien w.e.f. 08.08.2018)

Associate Professor
Ravi Manjithaya (Associate Faculty, NSU)

Honorary Professor
M.R.S. Rao

Faculty Fellow
Kushagra Bansal

Research Students
Aditya Bhattacharya, Aishwarya Prakash, Akash Kumar Singh, Akshaya C. Nambiar, Alice Sinha, Ananya Ray, Anjali Amrapali Vishwanath, Ankit Sharma, Anusha Chandrashekarmath, Anushka Chakravorty, Arindam Ray, Arpitha A. Suryavanshi, Arun Panchapakesan, Asutosh B. R., Barve Gaurav Ramanand, Bhange Disha Ramesh, Bhat Mallika Dattatray, Bhavana Kayyar, Chhavi Saini, Cuckoo Teresa Jetto, Dongre Aparna Vilas Pushpalata, Dongre Prathamesh Rajesh, Harshdeep Kaur, Irine Maria Abraham, Ishfaq Ahmad Baba, Iyer Aditya Mahadevan, Jyotsna Karan, Kamat Kajal Murli, Karandeep Singh, Koyel Roy, Krishnendu Guin, Kuladeep Das, Kumari Ruchika Ranjan, Lakshmeesha K.N., Moumita Basu, Nivedita Pandey, Padmalaya, Palak Agrawal, Pallabi Mustafi, Pallawi Choubey, Polisetty V.S. Satya Dev, Pooja Barak, Preeti Jindal, Priya Brahma, Priya Jaitly, Rahul Madaan, Rajarshi Batabyal, Ranabir Chakraborty, Rashi Aggarwal, Resmi Ravi, Rima Singha, Rohit Goyal, Saheli Roy, Saloni Sinha, Sambhavi Puri, Santosh S, Sharma Pragya Niraj, Shreyas Sridhar, Shrilaxmi V. Joshi, Shveta Jaishankar, Siddharth Singh, Smitha A.S., Somya Vats, Sreshtha Pal, Srijana Dutta, S. Sundar Ram, Suchismita Dey, Sunaina Singh Rajput, Veena A., Wulligundam Praveen, Yashashwinee Rai

Research Scientist B
Lakshmi Sreekumar

Research Associates
C.N. Rahul (DBT), Divesh Joshi (Provisional), Keerti (DBT), M. Jayaprakash Rao, Narendra Nala, Neha Varshney, Rajaji Vincent (Provisional), Sangeeta Dutta (DBT), Santosh Shivakumaraswamy (Provisional), Sarmistha Halder Sinha, Sreedevi P. (DBT), Sweta Sikder, V Shalini (DBT)

SERB(TARE)
Dhanalakshmi

SERB NPDF
Aswathy Narayanan, Mamta Negi, Md. Hashim Reza, Suman Yadav, Shrinka Sen

Junior Research Fellows
Abhijit Das, Dongre Aparna Vilas, Haider Ali, Ila Joshi, Kavita Mehta, M.K. Shruti, Priyadarshini Sanyal, Tejal R. Gujarathi, Utsa Bhaduri, Vinay J Rao

Senior Research Fellows
Aksah Sam, Diana Rodrigues, Zenia

Lab Manager
Swathi LR

Senior Technical Officer
Prakash R.G.

Technical Officer Gr. II
Suma B.S.

Women Scientist Scheme A
Shweta Panchal, Lakshmi Garimella

Project Assistants
Dharaneeswar Reddy M., Girija J. Subodhi, Vishakha Gangadhar Shewale

Project Technical Officer
Kruthi HT

R&D Assistants
Afzal Amanullah, Anangi Brahmaiah, Harshit Kumar Prajapati, Mridhula Giridharan, S. Deepak, Swati Singh, Vijeta Jaiswal

Research Assistant
Shalini Roy Choudhury

Project Technician
Sunil Kumar R.

Trainee
Sahana Ravi

MBGU AT A GLANCE

Awards received by faculty

Prof. M.R.S. Rao – SERB-Year of Science Chair Professorship

Prof. Kaustav Sanyal – Fellow of American Academy of Microbiology, Associate Editor, Frontiers in Cellular and Infection Microbiology, Awarded Tata Innovation Fellowship.

Kushagra Bansal – Ramalingaswami Re-entry Fellowship by Dept. of Biotechnology.

Prof. Maneesha Inamdar – Dr. Kalpana Chawla Award for Women Scientist in the field of Science & Technology for 2017 by KSCST, Govt. of Karnataka; Member, World Health Organization (WHO) expert advisory committee on Developing global standards for governance and oversight of Human Genome editing; Member, Global Forum on Bioethics in Research (GFBR) Planning Committee 2019; Member, "Women in Science" Panel of the Indian Academy of Science; Member, Sectional Committee for Animal and Plant Sciences, Indian Academy of Science; Member, Scientific & Technical Appraisal & Advisory Group (STAG) on Medical Biotechnology, of DBT, GoI; Member, Expert Group on Stem Cell Research of the Indian Council for Medical Research (ICMR), Govt. of India (September 2019 onwards); Co-Chair - Technical Expert Committee on Stem Cells and Regenerative Medicine of DBT, GoI; Member, Project Advisory & Monitoring Committee for Nidan Kendra Projects, Department of Biotechnology, Govt. of India; Member, Task Force on Genome Engineering Technologies and their Applications of the Department of Biotechnology, Govt. of India (June 2017-Oct. 2018)

Prof. Tapas Kundu – DSc Honoris Causa of Uttar Banga Krishi Viswaidyalaya; Visiting Professor, Adichunchanagiri University, B. G Nagara, Karnataka, (2019- present); Distinguished Visiting Professor- SDU Academy of Higher Education and Research, Kolar Karnataka; Faculty Recruitment Committee member of IIT, IISER, and CSIR

Prof. Hemalatha Balaram – Dr. Raja Ramanna Award for Scientists, Karanataka State Council for Science and Technology, 2015; Indian National Science Academy Fellowship, 2018; Membership to the following: Member, Sectional Committee (Biology), Indian Academy of Sciences (2019–); Member, Animal Sciences and Biotechnology RC, CSIR (2019–2022); Member, Technical Expert Committee (TEC), Medical Biotechnology - II for North Eastern Region (2019–); Member, DBT-NER Scientific and Technical Appraisal and Advisory Group (STAG) on Medical Biotechnology (2019–).

Prof. Namita Surolia – DBT Distinguished Biotechnology Research Professorship Award

MBGU AT A GLANCE

Awards received by student

Gaurav Barve – Lead author in JCS publication and gave an interview in JCS

Somya Vats – Awarded the Newton-Bhabha fellowship

Neha Varshney – PLoS Genetics Best Poster award in the Chromosome Stability meeting in December 2018

Sreedevi Padmanabhan – AWSAR award in the Post-doctoral Fellow category

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	12	19.41 Cr
ONGOING PROJECTS	41	3.69 Cr

4 Ph.D. & 9 M.S.
STUDENTS ADMITTED

8 Ph.D. & 6 M.S.
STUDENTS GRADUATED

38
PUBLICATIONS

NEW CHEMISTRY UNIT (NCU)

ABOUT

The NCU was created by JNCASR as part of the 11th Five Year Plan in the year 2010. The Unit works on interdisciplinary aspects of chemical science, with emphasis on research areas 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 to obtain access to the state of the art facilities such as the synchrotron facility. Over the last years, NCU has emerged as one of the leading chemistry departments of the country, and has excelled in translational research, with two start-ups initiated by its faculty members, along with many national and international patents.

RESEARCH AREAS

The research focus at NCU has been in the following areas:

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

RESEARCH INSIGHTS

- Covalently linked 2D-layered heterostructures for water splitting
- Development of hybrid peptoids and small molecule-based tools for early diagnosis of Alzheimer's disease
- Evidence that specific arrangements of polar and apolar moieties in a molecular structure determine its antibacterial activity with minimal toxicity.
- Novel strategy to significantly reduce the K_L of material without degrading carrier mobility by engineering the material's ferroelectricity instability.
- Development of integrated technology for conversion of anthropogenic CO_2 to chemicals and fuels.
- Introduction of a chemical-fuel driven approach for living and out-of-equilibrium supramolecular polymerization.
- Vanadium based NASCION cathode $Na_3V_2(PO_4)_3$ was demonstrated with stellar cycling performance in Na-ion batteries.
- Bioorthogonal imaging and sensing, methods for super-resolution imaging, and new approaches for delivery and activation of therapeutic materials were developed.

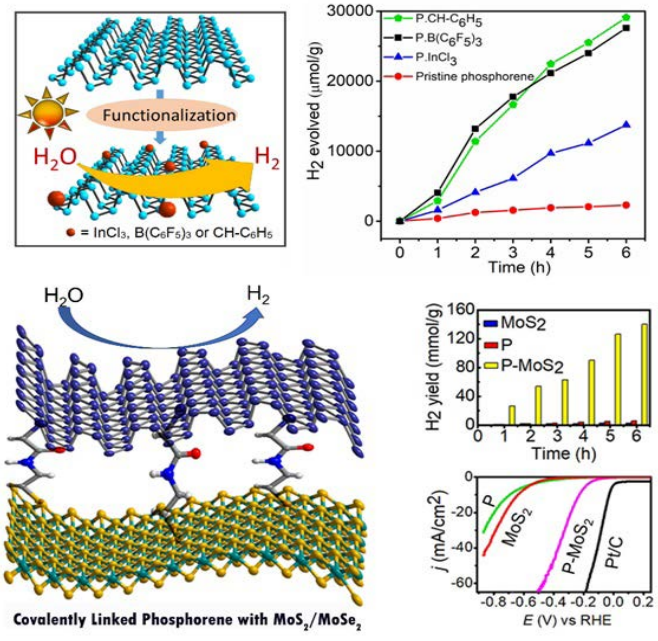
C.N.R. Rao

D.Sc., Ph.D., FRS, Hon. FRSC; Linus Pauling Research Professor and Chair, NCU

Materials Synthesis Laboratory

Phosphorene, a monolayer of elemental phosphorus, has recently emerged as a sensational 2D semiconductor that shows a thickness tuneable band-gap in the 0.3-2.0 eV range, high charge carrier mobility (~ 1,000 $cm^2V^{-1}s^{-1}$) and I_{ON}/I_{OFF} ratio >10^5. However, the application of phosphorene is limited by its poor stability under ambient conditions. We showed that phosphorene can be stabilized under ambient conditions after chemical functionalization with Lewis acids (such as $InCl_3$ and $B(C_6H_5)_3$), without losing its properties. The functionalized phosphorene exhibits good dispersibility in water as well as superior and robust H_2 evolution reaction (HER) activity compared with that of the pristine sample. The HER activity of phosphorene was further enhanced by covalently cross-linking it with other 2D materials such as MoS_2 and $MoSe_2$. Excellent HER activity of the phosphorene–MoS_2 nanocomposite can be attributed to the ordered cross-linking of the 2D sheets

In the past year, we have made several progresses in the field of 2D materials. Stable phosphorene quantum dots (PQDs) with average sizes varying between 1.0 and 5.0 nm were prepared by the sonication of black phosphorus in highly non-polar solvents such as toluene and mesitylene. The PQDs exhibit excitation wavelength-dependent blue photoluminescence. Arsenene nanosheets and quantum dots were prepared by liquid exfoliation of grey arsenic in suitable solvents. The stability of 1T-MoS_2 and $MoSe_2$ was improved by simple hydrothermal and solvothermal methods. Covalent cross-linking of 2D structures such as graphene, MoS_2, C_3N_4, and BCN using coupling reactions afforded the generation of novel materials with new or improved properties, such as increased surface areas, superior supercapacitor performance, and hydrogen evolution. Moreover, a novel supramolecular strategy based on host–guest chemistry was analysed for the noncovalent functionalization of 2D nanosheets with organic chromophores. The strategy has been extended to the synthesis of supramolecular heterostructures for HER activity. Mechanical and thermal properties of polymer matrices were enhanced upon reinforcing with layered BCN of varied composition. Aliovalent anion substitution in metal oxides and sulphides can be done to engineer the band structures. Cd_2NF and TiNF were synthesized by the complete substitution of O in the lattice of the corresponding oxide. Complete substitution of S^{2-} in CdS by aliovalent P^{3-} and X (X = Cl, Br, I) ions was found to yield a compound of the composition $Cd_4P_2X_3$ with direct band gaps and with excellent hydrogen evolution and CO_2 reduction properties. Efficient reduction of seawater to hydrogen under visible light irradiation was studied by various catalysts known for water splitting with pure water. Photostability of the Cu_2O photocathode film for photoelectrochemical (PEC) water splitting was improved by engineering the interfacial band edge energetics with Ni_xP_y as the co-catalyst. The heterojunction electrodes are stable for the PEC hydrogen evolution, because of facile charge transfer from the bulk of Cu_2O to the electrolyte via CuO and Ni_xP_y. Atomic layer deposition is a chemical vapour deposition technique based on the sequential use of the gas phase chemical process. Single crystalline epitaxial films of MoS_2 nanowall networks were successfully grown on c-sapphire by thermal ALD.



Functionalization of phosphorene and HER study

Key publications:

Rao CNR, et al. 2009. Graphene: the new two-dimensional nanomaterial. Angew Chem Int Ed. 48(42): 7752–77.

Rao CNR, et al. 2004. Metal carboxylates with open architectures. Angew Chem Int Ed. 43(12): 1466–96.

Govindraju T.

Ph.D.; Associate Professor

Research carried out at our laboratory is at the interface of chemistry, biology, and (bio)materials science, and in particular, organic chemistry, peptide chemistry (peptidomimetics), functional and disease amyloids, molecular probes, nucleic acids and bioinspired (nano) architectonics. Our recent efforts were in the development of diagnostics and therapeutics for currently incurable neurodegenerative diseases such as Alzheimer's (AD) and Parkinson diseases (PD). Several solutions were explored to address issues related to these diseases by elegantly combining multidisciplinary chemical biology approaches. Because both these diseases are caused by multi-pathway failure, our strategy is to work on targeting multiple pathways involved in their pathogenesis. We developed hybrid peptoids and small molecule based molecular tools have been developed in our laboratoy, which were found to clear toxic plaques through the natural cellular process. We are in the process of developing molecular probes to detect AD biomarkers in cerebrospinal fluids, blood and brain tissue samples, for use as viable tools in early AD diagnosis. Another important area of work has been the development of biomimetics of functional amyloids (e.g. silk) and studying their potential applications as biomaterials in different contexts.

Jayanta Haldar

Ph.D.; Associate Professor

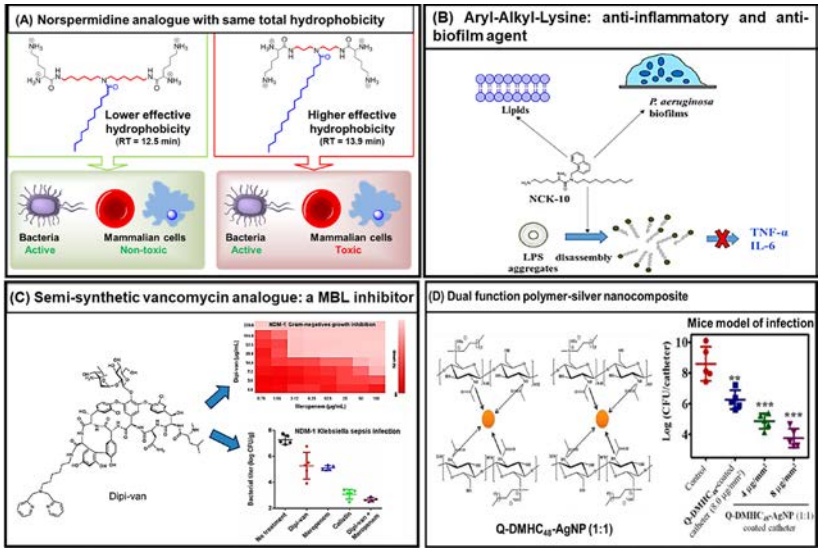
Antimicrobial Research Laboratory

Lipidated norspermidine derivative was developed to prove that specific arrangement of polar and apolar moieties in the molecular structure has a significant role in determining its antibacterial activity with minimal toxicity. Alongside, Aryl-Alkyl-Lysines were developed that elicited appreciable anti-inflammatory and antibiofilm properties. We also reported a highly active dual-function polymer- silver nanocomposite consisting of an inherently antimicrobial and biodegradable polymer, which reduced methicillin resistant *Staphylococcus aureus* (MRSA) burden in mice model upon coating the nanomaterial on the catheter surface. Most importantly, a semi-synthetic vancomycin analogue was developed that restored meropenem's activity against MDR Gram-negative bacteria harbouring New Delhi Metallo β-lactamase (NDM-1). This combination of the new semi-synthetic analogue and meropenem significantly reduced the bacterial burden in case of sepsis infection in mice model.

Key publications:

Yarlagadda V, et al. 2018. Vancomycin analogue restores meropenem activity against NDM-1 Gram-negative pathogens. *ACS Infect Dis*. 4: 1093–101.

Hoque J, et al. 2019. Dual-function polymer–silver nanocomposites for rapid killing of microbes and inhibiting biofilms. *ACS Biomater Sci Eng.* 5: 81–91.



(a) Norspermidine analogues with same total hydrophobicity selectively target bacteria with minimal toxicity towards mammalian cells; (b) Aryl-Alkyl-Lysines elicit anti-inflammatory and anti-biofilm activity; (c) A semi-synthetic vancomycin analogue restores meropenem's activity against NDM-1 Gram-negative pathogens; (d) Dual function polymer-silver nanocomposite rapidly kill microbes and inhibit biofilm

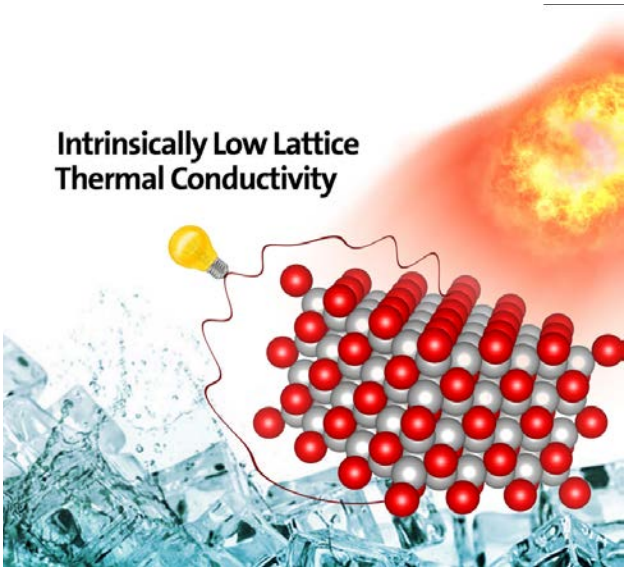
Kanishka Biswas

Ph.D.; Associate Professor

Solid State Chemistry Laboratory

Our laboratory explored a fundamentally new strategy to significantly reduce the κL of material without degrading carrier mobility by engineering the material's ferroelectricity instability. Substitution of Ge in SnTe strengthens its ferroelectric instability near room temperature and significantly reduces the K_L. With the synergy among ultralow κL, high carrier mobility and enhanced Seebeck coefficient, highest zT, of ~ 1.6 was achieved at 721 K in Sb-doped $Sn_{0.7}Ge_{0.3}Te$. [Energy Environ. Sci., 2019, 12, 589]. We further explored new materials with intrinsically low K_L along with a microscopic understanding that the underlying correlations among bonding, lattice dynamics and phonon transport are fundamentally important towards designing promising thermoelectric materials. We showed that the localized vibrations of Bi bilayer lead to ultralow K_L and high thermoelectric performance in weak topological insulator n-type BiSe near room temperature [J. Am. Chem. Soc., 2018, 140, 5866]. Using solution-based route, we synthesized ultrathin few-layer 2D nanoplates Cs3Bi2I9, which shows photoluminescence blinking behaviour down to the level of an individual $Cs_3Bi_2I_9$ nanoplate [Inorg. Chem., 2018, 57, 15558].

We further demonstrated a single pot solution-based transformation of 2D $CsPb_2Br_5$ nanosheets from the nanocrystals of 3D $CsPbBr_3$ and investigated the origin of its luminescence properties by detailed experiments and density functional theory (DFT) calculations [Nanoscale, 2019, 11, 4001]. The n-type cubic GeSe was stabilized at ambient conditions by entropy driven solid solution with $AgBiSe_2$, which demonstrated promising thermoelectric properties with ultralow thermal conductivity. With increasing $AgBiSe_2$ concentration in GeSe, band gap of the system changes anomalously. [Angew. Chem. Int. Ed., 2018, 57, 15167]. We also synthesized inexpensive graphene oxide- tin(IV) disulfide (SnS_2) composite (GO@SnS_2) for removal of Hg^{2+} from water, even from 0.3 ppb Hg(II)-contaminated water in pH range 0.5-11 with capacity of 342.02 ± 8 mg/g. For convenient application, we designed a tea bag filled with GO@SnS_2 powder that can capture 99.9% of Hg(II) from contaminated water economically [J. Mater. Chem.A, 2018, 6, 13142]. Further, n-type few-layer (2–4 layers) Bi-doped SnSe 2D nanosheets (1.2–3 nm thick) were synthesized via a facile low-temperature solution-based route. The presence of nanoscale grain boundaries and layered anisotropic structure enables the heat carrying phonons to be scattered significantly, thereby decreasing K_L to as low as 0.3 W/mK over 300–720 K range [ACS Energy Lett., 2018, 3, 1153]. We synthesized n-type bulk cubic $AgBiS_2$, which exhibits exceptionally low K_L of 0.68-0.48 W/mK in the temperature range 298-820 K. The low K_L is attributed to significant lattice anharmonicity due to local structural distortions along the [011] direction, arising from stereochemical activity of the $6s^2$ lonepair of Bi, as suggested by pair distribution function analysis [Chem. Mater., 2019, 31, 2106].



Thermoelectric waste heat electrical energy conversion by solid inorganic compounds

Key publications:

Banik A, et al. 2019. Engineering ferroelectric instability to achieve ultralow thermal conductivity and high thermoelectric performance in $Sn_{1-x}Ge_xTe$. *Energy Environ. Sci.* 12: 589–95.

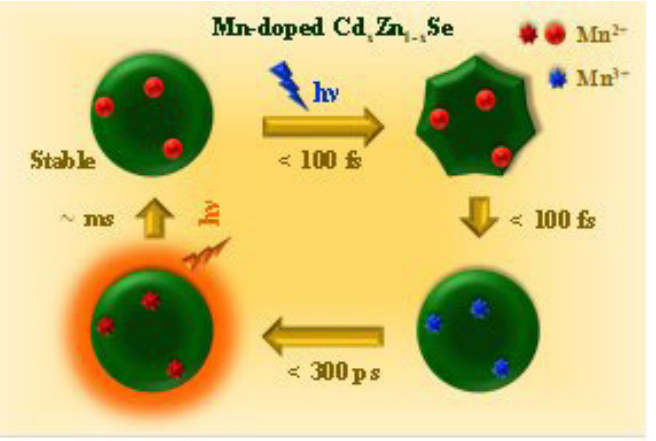
Samanta M, et al. 2018. Localized vibrations of Bi bilayer leading to ultralow lattice thermal conductivity and high thermoelectric performance in weak topological insulator n-type BiSe. *J Am Chem Soc.* 140: 5866–72.

Ranjani Viswanatha

Ph.D., Associate Professor

Quantum Dot Laboratory

The nature of transient species leading to emission from the spin/orbital forbidden Mn d-d transition in doped semiconductor quantum dots has intrigued scientists for a long time. This understanding is important in the quest for energy efficiency, as the energy from the conduction band is transferred efficiently to Mn in femtosecond timescales, overcoming other non-radiative recombination pathways. Our lab has been working towards elucidating the nature of these species. We uncovered an important long-standing puzzle regarding Mn emission using transient absorption and clever modification of the host material to increase the lifetime of the transient species, which has so far been elusive. This concept was extended to perovskite materials. We also synthesized Sn and Fe-doped perovskite materials with excellent optical properties. Work is ongoing to understand several unsolved problems in high performance of perovskites using EXAFS as a tool in undoped, Sn or Mn doped perovskite materials. We have worked extensively on doping transition metals into II-VI semiconductor and perovskite quantum dots and using them to probe and alter the electronic structure of the host quantum dots. In addition, we have worked on doping magnetic ions into CdS nanocrystals and its optical influence on the host. We have also studied the magnetism arising out of the interface of magnetic/non-magnetic materials giving rise to exchange bias at the interface using EXAFS as a tool.



Mechanism of Mn emission in nanomaterials

Key publications:

Gahlot K, et al. 2019. Transient species mediating energy transfer to spin-forbidden Mn d States in II–VI semiconductor quantum dots. *ACS Energy Lett.* 4: 729–35.

Saha A, Viswanatha R. 2017. Magnetism at the interface of magnetic oxide and non-magnetic semiconductor quantum dot. *ACS Nano.* 11: 3347–54.

Premkumar Senguttuvan

Ph.D., Faculty Fellow

Energy Storage and Conversion Laboratory

Vanadium based NASCION cathode-$Na_3V_2(PO_4)_3$ was demonstrated with stellar cycling performance in Na-ion batteries. To improve the capacity, we synthesized a series of Na_3+yV1-yM'y$(PO_4)_3$ (M' is the 1st and 2nd row transition metal ions) compounds. Combined electrochemical, XRD and XAFS studies revealed interesting insights into the structural evolution along with the participation of different vanadium and manganese redox couples, which were further validated by DFT calculations. High reversible capacity, rate capability, and better cyclability was achieved for y=0.75, which could be corroborated to the optimum bottleneck size for sodium ion diffusion as well as the superimposed V- and Mn-redox centers.

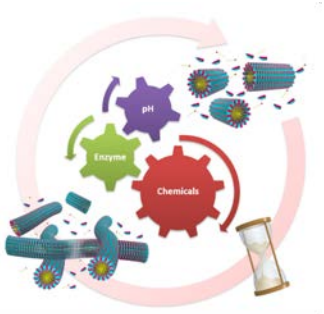
We also developed a new topochemical methodology to convert one-dimensional (1D)-$FeF_3{\cdot}3H_2O$ (hereafter denoted as IF) precursor structure to a higher dimensional iron fluoride framework through incorporation of a "structure-stabilizing" agent, i.e. sodium fluoride (NaF).

Subi Jacob George

Ph.D, FASc.; Associate Chair, Associate Professor

Supramolecular Chemistry Laboratory

Our group works at the interface of organic chemistry, supramolecular chemistry, and functional materials, with an aim to design bio-inspired materials with dynamic, reversible, self-repairing, and adaptive properties. One class of materials we extensively investigate is the dynamic supramolecular polymers, where monomers are held together by non-covalent interactions. This year, taking cue from the self-assembly of filamentous proteins, we developed a unique fuel-driven self-assembly approach for the structural and temporal programming of dynamic materials. Additionally, we created temporally programmed out-of-equilibrium transient materials using various fuel-driven approaches such as enzymes, chemical reaction, and redox processes. We also worked on triplet harvesting of organic chromophores to improve the emission quantum yield. We successfully demonstrated the supramolecular scaffolding design of an ambient phosphorescence using Laponite as the inorganic component and appropriately designed naphthalene diimide (NDI) derivatives as the organic phosphor. An electrostatically driven co-assembly of NDI phosphor with laponite gives RTP both in solution and solution-processed transparent thin films. We also investigated the mechanism of the excited state photophysical properties of a very important class of triplet emitting materials, namely thermally activated delayed fluorescence emitters, and have come up with many new molecular designs for the same.



Schematic representation of the temporal and structural control over supramolecular polymerization by fuel (i.e. pH, enzyme or chemical) driven approach

Key publications:

Jain A, et al. 2019. Chemical fuel-driven living and transient supramolecular polymerization. *Nat Commun*. 10: 450.

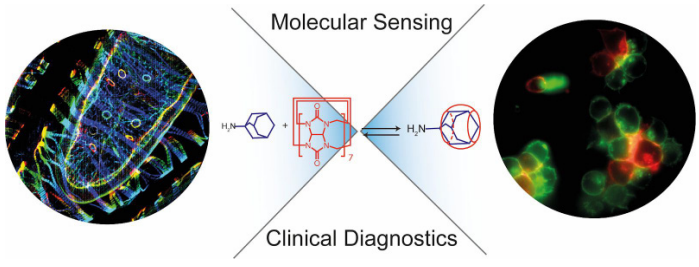
Kulkarni C, et al. 2015. Dipole-moment-driven cooperative supramolecularpolymerization. *J Am Chem Soc*. 137: 3924–32.

Sarit Agasti

Ph.D.; Faculty Fellow

Programmable Molecular Design Laboratory

Among the available repertoire of non-covalent building blocks, synthetic host-guest motifs based on macrocyclic molecules are particularly attractive due to their specific recognition property in biological complexities. Recently, we combined synthetic host-guest systems with the biological interface to develop various novel technologies relevant to both fundamental and medical research. Examples include bioorthogonal imaging and sensing, methods for super-resolution imaging, and new approaches for delivery and activation of therapeutic materials. The host-guest interactions between CB[7], attached with primary targeting agents (e.g. antibodies) and ADA-conjugated fluorophore provides in situ non-covalent coupling mechanism for bioorthogonal imaging in cells. This non-covalent labelling platform was translated to image target molecules in complex tissue samples of *Drosophila melanogaster* model system. Additionally, we used this system to provide a completely orthogonal labelling platform against the existing covalent system (e.g. tetrazine ligation) and thus their combination can be used for simultaneous labelling of multiple biomolecules within a single biological system. We also established this system for imaging metastatic cancer-associated cell surface protein marker and showing distribution and dynamics of small molecule targeted F-actin in living cells.



Synthetic host-guest system mediated molecular sensing and clinical diagnostic strategy

Key publications:

Sasmal R, et al. 2018. Synthetic host-guest assembly in cells and tissues: fast, stable and selective bioorthogonal imaging via molecular recognition. *Anal Chem.* 90(19): 11305–14.

Sinha S, et al. 2018. Reversible encapsulations and stimuli-responsive biological delivery from dynamically assembled cucurbit [7] uril host and nanoparticle guest scaffold. *J Mater Chem B*. 6: 7329–34.

Sebastian Chirambatte Peter

Ph.D.; Associate Professor

Solid State and Inorganic Chemistry Laboratory

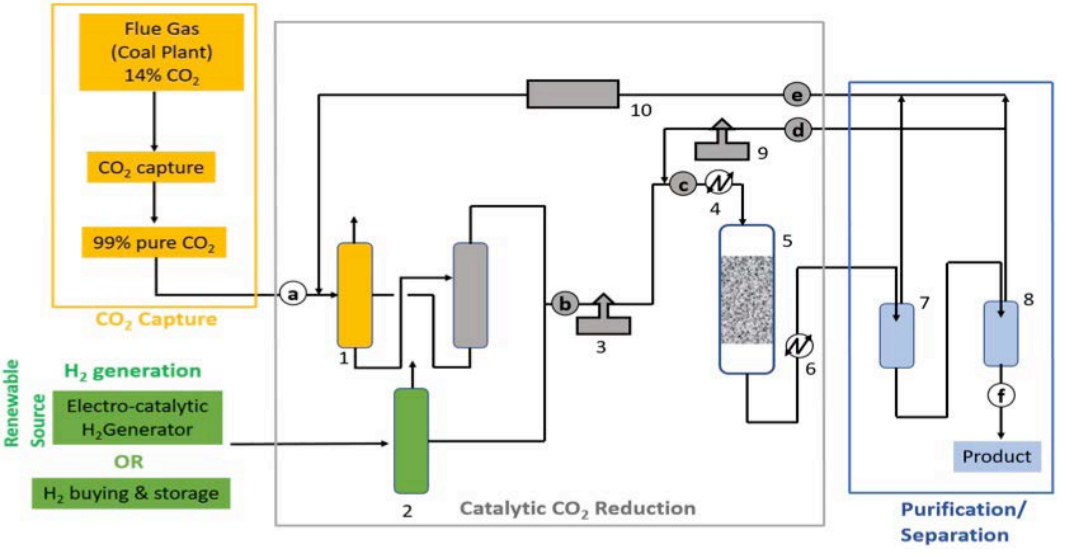
Our laboratory developed an integrated technology for the conversion of CO2 to chemicals and fuels with a capacity of 5 kg CO2/day. We scaled up the synthesis of the catalysts, processing technology, and integration to pilot scale (250 kg CO2/day capacity) and it is commissioning at a specially designed building at the new campus of JNCASR. The scaling up was done by the start up BREATHE applied sciences Pvt Ltd founded by myself. This technology development was highlighted in various newspapers (The Hindu, Times of India, and Deccan herald) and Television (ETV). During this course, my team entered into the final round of NRG COSIA Carbon XPRIZE competition and won 20M USD prize. As a part of the competition, we are developing a large plant at Wyoming, USA with a capacity of 2TPD. During this process we developed all chemical technologies (Thermo, photo and electro-chemical) for the conversion of CO2 to chemicals. We have achieved the production of methanol, CO, methane, formic acid, isopropanol, ethanol, and acetic acid from CO2.

We developed non-Pt compounds as the efficient electrodes for fuel cell applications. We utilized various strategies such as alloying, dealloying, ordered structure, heterostructure, and substitution to tune the electrochemical properties. We filed two patents and initiated device fabrication for their commercial applications. We designed materials for electrochemical water splitting. We coined a term “Inverse strain effect in atomic scale” in a natural mineral Pd17Se15 with the substitution of Cu. We observed an inverse strain due to unique crystal structure, which caused a dramatic improvement in the hydrogen evolution process (ACS Energy Lett. 2018, 3, 3008–3014). We developed a novel electrochemical sensor, Pt/CeO2@Cu2O nanocomposites for the simultaneous detection of neurotransmitter dopamine and analgesic paracetamol. This sensor is highly preferred due to their large surface area, reversible redox activity, high surface oxygen mobility, chemical inertness, bio-compatibility, non-toxicity and applicability over a wide range of areas. This work was published in ACS Applied Nano Materials (2018, 1, 5148−5157) and also highlighted in “The Hindu” newspaper on 8th Sep 2018. We also developed Half heusler compounds and heavy metal-based materials as topological insulators, and many intermetallics and chalcogenides for applications in condensed matter physics.

Key publications:

Roy S, et al. 2018. Thermochemical CO_2 hydrogenation to single carbon products: Scientific and technological challenges. *ACS Energy Lett*. 3: 1938–66.

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: 3008–14.



Schematic of the integrated technology for the conversion of CO_2 to chemicals and fuels

UNIT MEMBERS

Linus Pauling Research Professor and Chair
C.N.R. Rao

Endowed Professor
H. Ila

Associate Professors
Govindaraju T.
Jayanta Haldar
Kanishka Biswas
Ranjani Viswanatha (Associate Faculty, ICMS)
Sebastian Chirambatte Peter
Subi Jacob George
Sridhar Rajaram (jointly with ICMS)

Faculty Fellows
Premkumar Senguttuvan (jointly with ICMS)
Sarit Agasti (jointly with CPMU)

Research Students
Abhishek Rawat, Acharya Yash Sanjay, Aditi Chiring, Aditi Saraswat, Adrija Ghosh, Ahuja Vinita Ashok Kumar, Akshay Saroha, Anand Kumar Roy, Ananya Mishra, Angshuman Das, Anriban Pal, Anusha S. Avadhani, Aritra Sarkar, Arjun C. H., Arka Som, Arnab Sinhababu, Ashish Kumar, Biswanath Maity, Bitan Ray, Brinta Bhattacharjee, Darshana Deb, Debabrata Bagchi, Debasis Ghosh, Debattam Sarkar, Ekashmi Rathore, Geetika Dhanda, Krishnendu Jalani, Madhu R., Madhulika Mazumder, Mahima Makkar, Manaswee Barua, Manisha Samanta, Mary Antony P., Mohd Monis Ayyub, Mohini Mohan Konai, Moinak Dutta, Oishika Jash, Paramita Sarkar, Paribesh Acharyya, Payel Mondal, Pradeep K.R., Prasenjit Mandal, Rajib Dey, Ramesh M.S., Ranjan Sasmal, Riddhimoy Pathak, Risov Das, Reetendra Singh, Robi Sankar Patra, Rohit, Saptarshi Chakraborty, Saurav Chandra Sarma, Shreya Sarkar, Shikha Dhiman, Sourav Samanta, Souvik Sarkar, Sreyan Ghosh, Subhajit Das, Subhajit Roychowdhury, Subham Ghosh, Subham Singh, Suchi Smita Biswas, Sudip Mukherjee, Suman Kuila, Sumon Pratihar, Sushmita Chandra, Swadhin Garain, Swagatam Barman, Yelisetty Venkata Suseela, Yogendra Kumar

Research Associates
Bappaditya Roy, Chenikkayala Balachandra, Debajyoti Basak, Iniyavan P., Lakshmi Priya Datta, L. Jyothish Kumar (Provisional), Manjeet Chhetri, Mouli Konar (Provisional), Nabadynti Barman, Nilanjana Das Saha, Riya Mukherjee, Sandip Samaddar, S. Dasaradha Ramarao, Shidaling Mattepanavar, Surbhi Sharma, Tanmoy Ghosh, Y.V. Suseela (Provisional)

SERB (TARE)
Ashly P.C.

SERB National PDFs
Kamna Sharma
Kaushik Kundu
G.L. Balaji
Pardhasaradhi Satha

Project Assistant
Nikhitha Sreenivas

Junior Research Fellow
Kathakali De

R&D Assistants
Akhil V. Gopal
Jithu Raj
Krishnendu Maji
Rishikesh V.
Utsav Kumar Dey

NCU AT A GLANCE

Awards received by faculty

Prof. C.N.R. Rao – Received the Honorary Causa Doctorate from Presidency University, Kolkata (80th Hon Causa Doctorate); Received Honorary Doctorate from University of Manchester, UK; Top cited Author Award 2018 by Institute of Physics Publishing (IOP); COSINE Award 2017; First Sheikh Saud International Prize for Materials Research given by the Centre for Advanced Materials of the UAE; Adjunct Professor (Honorary), Centre for Human Genetics, Bangalore

Prof. Ranjani Viswanatha – MRSI Medal 2018

Prof. Govindaraju T. – CDRI Award 2019 for Excellence in Drug Research in chemical sciences category; Visiting Professorship University of Paris-Sud.

Prof. Jayanta Haldar – Editorial Board Member of MedChemComm of RSC; 8th National Award for Technology Innovation, Ministry of Chemicals and Fertilizers, Government of India in 2018; CRSI Bronze Medal in 2018; Sheikh Saqr Career Award Fellowship in 2018; Member of Chemical Research Society of India, 2018; Member of American Chemical Society, 2018; Member of The Society for Polymer Science, India, 2019; Guest editor of the journal "Microbial Pathogenesis" of Elsevier, 2018.

Prof. Sebastian C. Peter – Swarnajayanthi Fellowships (Chemical Sciences), 2018

Prof. Kanishka Biswas – Associate Editor of Journal ACS Applied Energy Materials, Emerging Investigator, Chem Comm, RSC; CRSI Bronze Medal 2019 from Chemical Research Society of India (CRSI)

Prof. Subi George – Fellowship of Indian Academy of Sciences, Editorial Advisory Board of Cell Chem

Award received by student

Ananya Mishra (Research Supervisor: Prof. Subi J. George) received the BIRAC-SRISTI GYTI 2019 award from the Hon. Vice President of India, Shri Venkaiah Naidu (2019).

Anand Roy (Research Supervisor: Prof. C.N.R. Rao) received Malhotra Weikfield award for thesis in the 10th Bangalore Nano 2018.

Soumyabrata Roy (Research supervisor: Prof. S. C. Peter) received the best post prize award of KPIT-Shodh Award in IISER Pune (2019).

Subhajit Roychowdhuri (Research supervisor: Prof. Kanishka Biswas) received the Graduate Student Silver Award, Materials Research Society (MRS), USA (2019).

Ananya Banik (Research supervisor: Prof. Kanishka Biswas) received the KPIT Shodh Best Thesis Award in "Energy & Mobility" for her work in SnTe Thermoelectrics (2019).

7 Ph.D. & 5 M.S. STUDENTS ADMITTED

5 Ph.D. & 5 M.S. STUDENTS GRADUATED

78 PAPERS

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	8	2.86 Cr
ONGOING PROJECTS	34	6.18 Cr

NEUROSCIENCE UNIT (NSU)

ABOUT

Research at NSU focuses on clinically relevant neurological phenotypes as well as normal neurobiological traits using model organisms such as *Drosophila*, mice, and human patients. Understanding the molecular and network-level underpinnings of circadian rhythms, intellectual disabilities, and seizure disorders are the current main objectives of the unit. Several collaborative projects are underway between members of NSU and other scientists within the Centre as well as with clinicians and researchers at NIMHANS, IISc, NCBS and other national and international organisations.

RESEARCH AREAS

NSU mainly focuses on the following research areas:

- Synaptic function and its relationship with neurodegenerative diseases
- Circadian rhythms and sleep circuits
- Molecular and cellular mechanisms of human brain/mind disorders

RESEARCH INSIGHTS

- Development of an open source application, called RhythmicAlly, for analysis of rhythm data.
- Identification of pathways between circadian clock and the sleep homeostat.
- Identification of FMRP as a potential target to restore function of syngap1 in Autism spectrum disorder model.
- Autophagy inducers were identified as potential therapeutic agents to treat neurodegenerative disorders.

ANURANJAN ANAND

Ph.D., FASc, FNA, FNASc; Professor and Chair, NSU

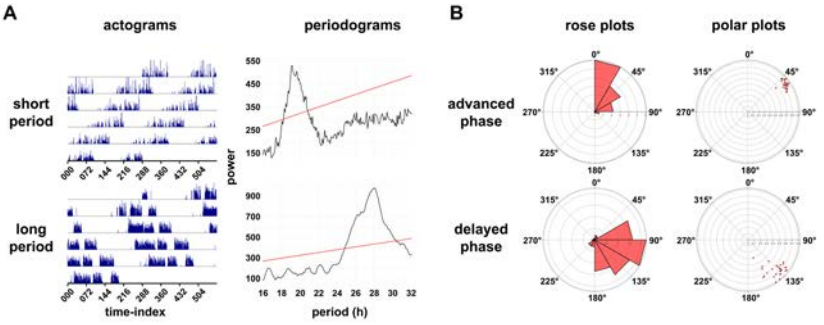
Our lab is studying CASR, a causative gene for juvenile myoclonic epilepsy (JME) using genetic and cell biology approaches. JME accounts for about 10% of all human epilepsies and has substantial genetic basis to its etiology (Thomas and Berkovic, *Nat Rev Neurol 2014*). To investigate the causative locus EIG8, which was reported previously from the laboratory, we conducted studies which 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. CASR is a potential therapeutic target in epilepsies.

Sheeba Vasu

Ph.D., Associate Professor

Behavioural Neurogenetics and Chronobiology Laboratory

Our laboratory investigates neuronal circuits and rhythms governed by the circadian clock. Recently, we identified an interaction between circadian clock and the sleep homeostat and found evidence of electrical synapse proteins in circadian pacemaker circuits. We also showed a unique relationship between circadian clock period and its ability to accurately and precisely modulate rhythmic output. We found evidence for circadian clock photosensitivity modification that allowed accurate circadian clocks to evolve in flies. Furthermore, next generation whole-genome sequencing of flies suggested that along with changes in circadian clock gene sequences, there are alterations in genes with known roles in light, temperature sensitivity, and the immune system. We identified changes in rhythms and non-clock properties found in fly populations maintained in an outdoor enclosure. Importantly, we developed an open-source application for analysis of rhythms, which will be useful to the chronobiology community worldwide (Figure). Using a fly model of neurodegeneration, we also found that upregulation of autophagy pathways can rescue pathogenicity due to human Huntington's Disease.



RhythmicAlly - An Open Source application in R, designed in-house for analysis of rhythm data. (A) Top and bottom rows show activity-rest graphs or Actograms and Periodograms for short and long period individual flies respectively. (B) Top and bottom rows show Rose and Polar plots depicting the phases of populations of individuals exhibiting phase advanced and delayed chronotypes.

Key publications:

Potdar S, et al. 2018. Sleep deprivation negatively impacts reproductive output in *Drosophila melanogaster*. *J Exp Biol*. 221: jeb174771.

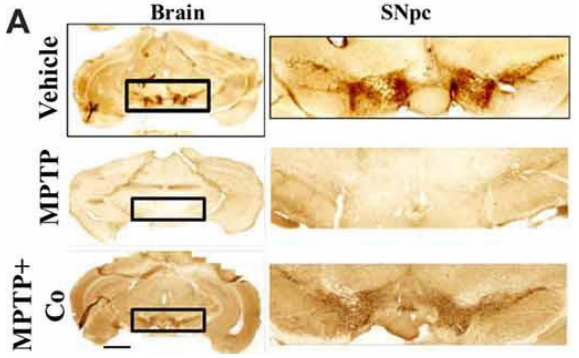
Potdar S, Sheeba V. 2018. Wakefulness is promoted during day time by PDFR signalling to dopaminergic neurons in *Drosophila melanogaster*. *eNeuro*. 5: ENEURO.0129-18.2018.

Ravi Manjithaya

Ph.D.; Associate Professor (joint with MBGU), GRC member

Autophagy Laboratory

Our lab screens autophagy modulators in various model systems with an aim to understand the molecular mechanisms and uses autophagy as a tool to enhance the clearance of aggregates in various neurodegenerative conditions. Recently, we identified a molecule, XCT790, which is an inverse agonist of ERRα and a novel molecular player in Aggrephagy - ERRα. We showed that this inducer, XCT790, confers neuroprotection in the pre-clinical mouse model of Parkinson's disease. This molecule ameliorates the pathology of Parkinson's disease and increases the motor control and coordination. Presently, one of our studies focuses on characterizing the basal autophagy level in a transgenic animal model of Huntington's disease – R6/2. The basal level of autophagy is unaltered, even with temporal increase in the Huntington aggregates, thereby proving that there is no adequate change in autophagy to clear the rising toxic aggregate levels. As multiple steps of autophagy are blocked in Huntington's disease, our efforts are on testing a cocktail of small molecules that can specifically target each of these blocked steps. Other ongoing study is to decipher the role of autophagy in the synapse by using *Drosophila* neuromuscular junction. Impairment of autophagy in synapse is considered one of the early causes of neurodegenerative diseases; therefore, we are now trying to understand the process of autophagy in synapse regulation. role of autophagy in the synapse by using *Drosophila* neuromuscular junction. It has been reported that impairment of autophagy in synapse is one of the early causes of neurodegenerative diseases. We are now trying to understand the process of autophagy in synapse regulation.



Neuroprotective effects of XCT790 (Co) in MPTP treated mice. XCT 790 alleviates dopaminergic loss in Substantia Nigra pars compacta (SNpc).

Key publications:

Suresh SN, et al. 2018. Modulation of autophagy by a small molecule inverse agonist of ERRα is neuroprotective. *Front Mol Neurosci*. 11: 109.

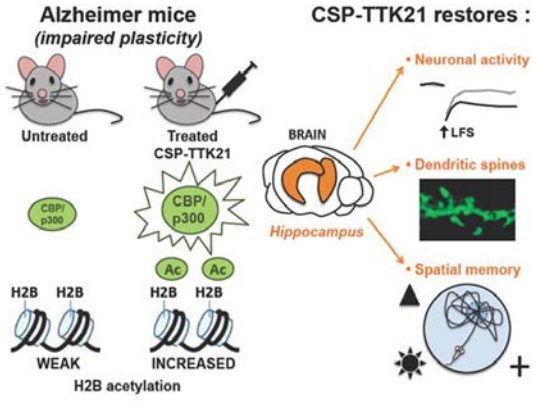
Suresh SN, et al. 2018. Neurodegenerative diseases: model organisms, pathology and autophagy. *J Genet.* 97: 679–701.

Tapas Kundu

Ph.D., DSc, FASc, FNA, FNASc; Professor (joint with MBGU) (on lien w.e.f. 08.08.2018*)*

Transcription and Disease Laboratory

We have discovered that the non-histone chromatin-associated protein PC4 is critical for genomic integrity, and its depletion in cells results in alteration of nuclear shape, the opening of chromatin, and a changed epigenetic landscape. Our studies showed that PC4 is a regulator of autophagy and it maintains cellular homeostasis (Sikder et al, 2019). Further, we demonstrated the role of the methyltransferase enzyme, CARM1, in adipogenesis and oral cancer, and the underlying mechanisms of regulation of its expression in these processes (Behera et al, 2018; Behera et al, 2019). Our extensive research has also shown that activation of the lysine acetyltransferase enzyme, p300/CBP, using a small molecule conjugated nanoparticle CSP-TTK21, can potentially restore the spatial memory and plasticity deficits associated with Alzheimer's disease (Chatterjee et al, 2018), as well as aid in the recovery of sensory and motor functions in mouse and rat models of spinal cord injury (Hutson et al).



Restoration of memory deficits associated with Alzheimer's disease

Key publications:

Sikder S, et al. 2019. Non-histone human chromatin protein PC4 is critical for genomic integrity and negatively regulates autophagy. *FEBS J*. doi: 10.1111/febs.14952.

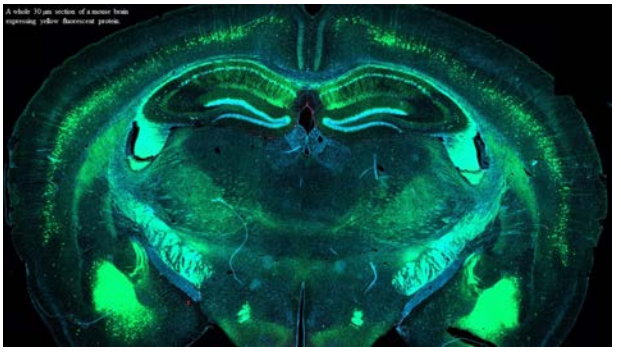
Chatterjee S, et al. 2018. Reinstating plasticity and memory in a tauopathy mouse model with an acetyltransferase activator. *EMBO Mol Med.* 10(11): e8587.

James P.C. Chelliah

Ph.D., Faculty Fellow

Neurophysiology Laboratory

A major problem in the field of neurobiology is the inability to restore brain function in adult stages. Recently, neuroscientists have considered the prospect of targeting the complementary protein signalling pathway to restore the function of a mutant gene encoding the dysfunctional protein. Similarly, using *Syngap1*$^{+/-}$ as a model to study Autism spectrum disorder, we showed that to alleviate the symptoms and restore the function of *Syngap1*, Fragile X mental retardation protein (FMRP) is a potential target. Besides, FMRP regulates the expression of SYNGAP1 during development. Apart from this study, a major issue facing our society is that of neurodegenerative diseases. Using MPTP-based Parkinson's disease model, we showed that a small molecule that can induce autophagy could protect against further degeneration of neurons. Thus, autophagy inducers could be potential therapeutic agents for treating neurodegenerative diseases.



A whole 30-µm section of a mouse brain expressing yellow fluorescent protein

Key publications:

Suresh SN, et al. 2018. Modulation of autophagy by a small molecule inverse agonist of ERRα is neuroprotective. *Front Mol Neurosci*. 11: 109.

Singh AK, et al. 2018. Epigenetic modulation by small molecule compounds for neurodegenerative disorders. *Pharmacol Res*. 132: 135–48.

UNIT MEMBERS

Professor and Chair
Anuranjan Anand

Professor
Tapas Kundu (Associate Faculty, MBGU) (on lien W.e.f. 08.08.2018)
M.R.S. Rao (jointly with MBGU)
K.S. Narayan (jointly with CPMU)

Associate Professors
Sheeba Vasu
Ravi Manjithaya (Associate Faculty, MBGU)

Faculty Fellow
James P.C. Chelliah

Research Students
Abhik Paul, Angshumi Dutta, Arijit Ghosh, Bhupesh Vaidya, Dani Chitrang Kamal, Iyengar Aishwarya Prasan, Iyer Aishwarya Ramakrishnan, Vijaya Verma, Vijay Kumar M.J.

NSU AT A GLANCE

Awards received by faculty

Prof. Anuranjan Anand – Adjunct Professor (Honorary), Centre for Human Genetics, Bangalore

James P.C. Chelliah – Awarded DST-SERB Fellowship

Award received by student

Abhilash Lakshman –Entry to 2018 Society for Research in Biological Rhythms (SRBR) Meeting, ChronoVideo Competition won Runner Up position (https://youtu.be/a63UUZ9o11c).

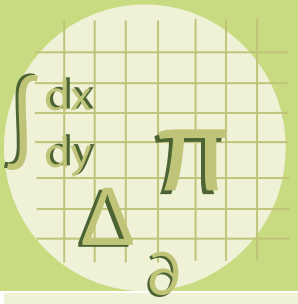
2 Ph.D. STUDENTS ADMITTED

7 PUBLICATIONS

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	2	41.85 Lakhs
ONGOING PROJECTS	4	64.45 Lakhs

THEORETICAL SCIENCES UNIT (TSU)



ABOUT

The TSU aims to understand and explain the underlying physics that governs the world we see around us. By taking an interdisciplinary approach to problems in very diverse areas such as evolutionary biology and materials science, we hope to predict and identify new phenomena and circumstances that modify observed patterns in nature, whether that be in the case of matter or life. The research in our Unit 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

In the past year, our research focus has been 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 evolutions
- Method development at various energy and length scales
- Polygenic adaptation in changing environments and adaptation dynamics in nonequilibrium populations
- Anderson localization in phononic systems
- Non-Hermitian quantum systems
- Dynamical quantum phase transitions

RESEARCH INSIGHTS

- Development of a computational scheme that allows learning from small data and existing knowledge to predict complicated phenomena in materials.
- Tailoring of $Ca_2Mn_2O_5$-based perovskites to improve oxygen evolution reaction, with achievement of lowest overpotential value of 0.14 V for some composition in basic media.
- A simple descriptor was found that captures the charge transfer in various systems, and the strength of binding of 2D materials to metal substrates.
- In a continually-changing environment, lag between rate of change of population fitness and environment was found to increase with time, thereby posing high risk of extinction.
- Uncovering of important features in the field of nucleation related to curvature dependence of interfacial tension. In kinetics of phase transitions, differences were identified in various nonequilibrium scaling functions.
- Strain localization and emergence of shearbands above the yielding point was shown in cyclically deformed glasses.
- The emergence of non-Fermi liquid dynamics was shown through nonlocal correlations in an interacting disordered system through a new Green's function based computational technique called typical medium dynamical cluster approach.

Swapan Pati

Ph.D., FNA, FASc, FNASc, FTWAS; Professor and Chair, TSU

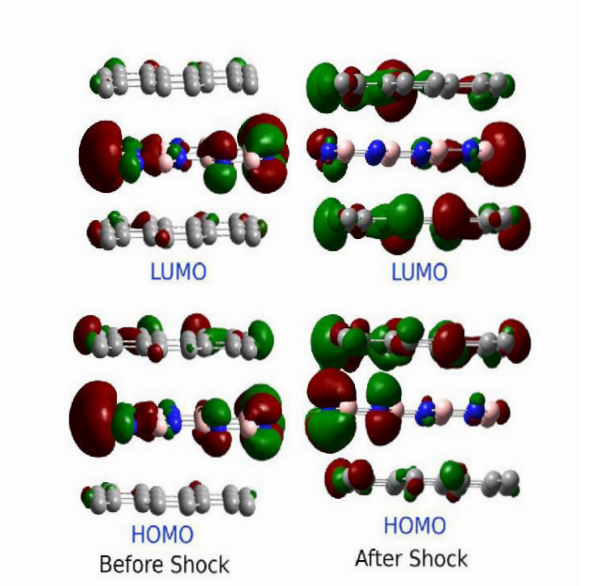
Advanced Quantum Theory Laboratory

In the past year, we studied the catalytic hydrogenation of carbonyl compounds using tin-based frustrated Lewis pair catalyst(s), and the structural and magneto-electronic properties of various point defects in MXenes using first principles. We also showed that a new 2D material, alpha lead oxide (α-PbO) shows visible light sensitivity. For oxygen reduction reaction, we clarified the reason for the experimentally obtained performance of cobalt- based metal-organic framework. Furthermore, we found that one can harvest triplet state through aqueous phase phosphorescence in purely organic phosphors via supramolecular scaffolding.

Key publications:

Bandyopadhyay A, et al. 2018. Shining light on new generation two dimensional materials in computational viewpoint. *J Phys Chem Lett*. 9: 1605–12.

Pandey B, Pati SK. 2017. Triplet superfluidity on a triangularladder with dipolar Fermions. *Phys Rev B*. 95: 85105–10.

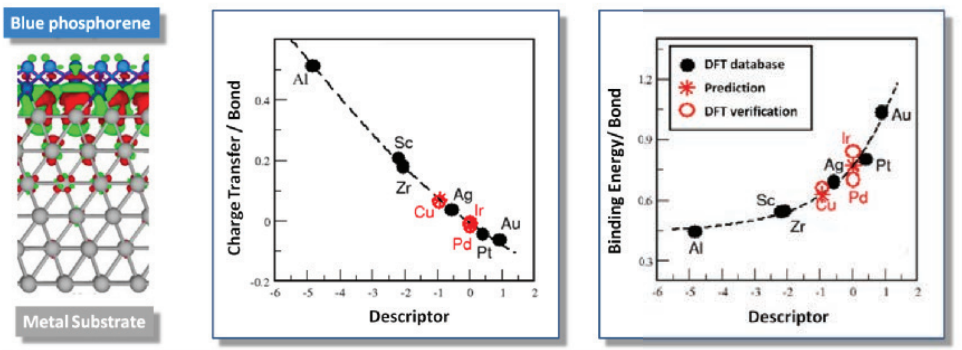


Wave functions of Lowest Unoccupied and Highest Occupied energy levels before and after laser shock in Gr/BN/Gr heterostructure (Graphene–Boron Nitride Moiré Superlattices) [Ref: Nano Lett. 19, 283 (2019)].

Shobhana Narasimhan

Ph.D., FNASc; Professor

Our research is focused on using theoretical techniques to explore the physics and chemistry at the nanoscale and determine how properties change upon lowering the dimensionality and/or reducing size. Recently, we found a descriptor that seemed to capture the charge transfer in a variety of systems, and also the strength of binding of 2D materials to metal substrates. This descriptor is simple to evaluate and depends only on the properties of atoms of the isolated systems.

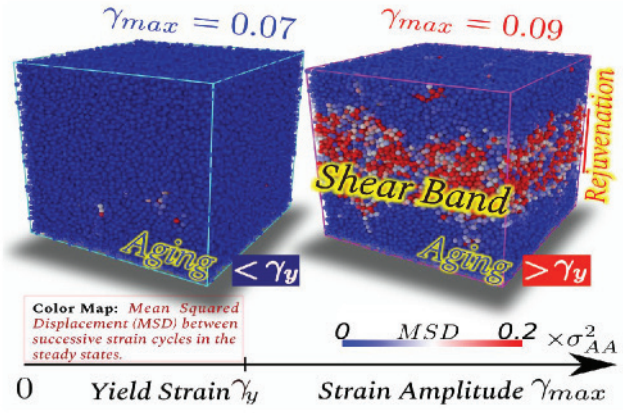


The charge transfer and the binding energy for various blue phosphorene on metal systems can be successfully described by a simple descriptor that depends only on the properties of the isolated atoms.

Srikanth Sastry

Ph.D., FASc, FNASc, FNA; Professor

Our research has been focused on computationally studying the yielding behaviour of a model glass under cyclic athermal quasistatic deformation at finite rate and temperature. We showed that yielding is characterized by the discontinuous appearance of shear bands, whose width is about ten particle diameters at their initiation, in which the strain gets localized. Strain localization is accompanied by corresponding change in the energies and a decrease in the density of the shear band. The glass remains well annealed outside the shear band. Diffusive motion of particles characterizing the yielded state is confined to the shear bands, whose mean positions display movement over repeated cycles. Outside the shear band, particle motions are subdiffusive, but remain finite. Despite the discontinuous nature of their appearance, shear bands are reversible; a reduction in the amplitude of cyclic deformation to values below yielding leads to the healing and disappearance of the shear bands.



Appearance of shearband for a computationally studied model glass formerly under cyclic shear with given strain amplitude. Left: When the strain amplitude is less than yielding strain, there is no sign of shear band. Right: Emergence of shear band when the strain amplitude is larger than yielding strain.

Subir K. Das

Ph.D.; Professor

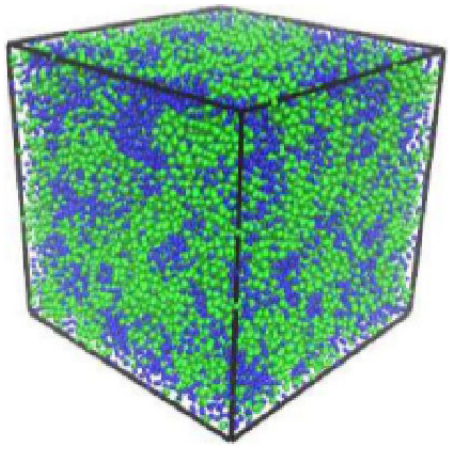
Soft Matter and Statistical Mechanics Laboratory

Our group studies problems in the area of Statistical Mechanics, with specific interest in issues related to nucleation, growth, aging, and wetting in various condensed matter systems. In the past year, we uncovered important features related to curvature dependence of interfacial tension, which are expected to play an important role in the understanding of formation energy of stable embryos and their growth. Using appropriate formulation of finite-size scaling methods, we also made significant progress in the field of phase transition kinetics by identifying differences in various non-equilibrium scaling functions, based on initial correlation, space dimensionality, order-parameter conservation, interface-roughness, and relevance of hydrodynamics.

Key publications:

Vadakkayil N, et al. 2019. Finite-size scaling study of aging during coarsening in non-conserved Isingmodel: The case of zero temperature quench. *J Chem Phys*. 150: 054702.

Das SK, et al. 2018. Do the contact angle and line tension of surface-attached droplets depend on the radius of curvature? *J Phys Condens Matter*. 30: 255001.

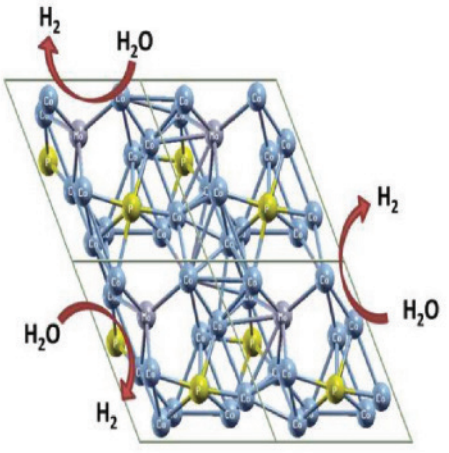


Snapshot during the evolution of a fluid binary mixture

Umesh V. Waghmare

Ph.D., FASc, FNASc, FNA; Professor

We recently predicted a linear magnetoelectric effect in THz range originating from phonons in chiral elemental selenium; this was verified experimentally by Ayyub et al. Furthermore, we successfully modeled amorphous Co-Mo-P as an electrocatalyst of hydrogen evolution reaction in alkaline medium, thereby explaining experiments carried out by Strongin's group at Temple University. We identified electronic and structural descriptors of catalytic activity of B- and N-doped graphene towards oxygen reduction reaction relevant to fuel cells. We provided a theoretical explanation for ultra-low thermal conductivity and high thermoelectric performance of BiSe, in terms of localized vibrations of bilayer of Bi. From first-principles theoretical analysis, we uncovered the origin of blue luminescence in GaN.



Hydrogen evolution reaction over amorphous Co-Mo-P catalyst

Key publications:

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 (2): 314–21.

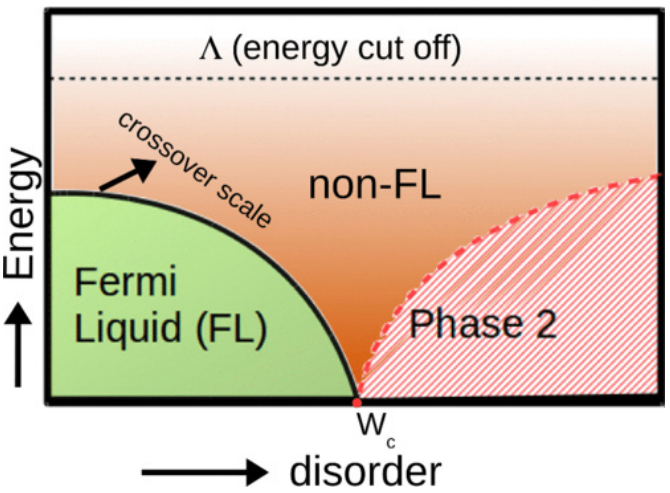
Banik A, et al. 2019. Engineering ferroelectric instability to achieve ultralow thermal conductivity and high thermoelectric performance in $Sn_{1-x}Ge_xTe$. *Energy Environ Sci*. 12: 589–95.

Vidhyadhiraja N.S.

Ph.D.; Professor

Strongly Correlated Electronics Systems

In the past year, we established a new typical medium dynamical cluster approach for investigating the phenomenon of Anderson localization of phonons, and applied it for studying mass-disordered and force-constant disordered alloys. We also investigated the three dimensional Anderson-Hubbard model, and showed that even for weak interactions, increasing disorder can lead to a wide and singular distribution of Kondo scales and eventually to a quantum critical point. A phase diagram was obtained and is shown in the accompanying figure.



Schematic representation of the obtained crossover energy scale separating Fermi liquid (FL) and non-FL dynamics: The black solid line represents the crossover scale derived within our T=0 calculations. This scale marks a crossover from FL dynamics to nFL dynamics with increasing energy, and its vanishing would eventually lead to a QCP at a critical disorder strength Wc. This dynamics would manifest in the finite-temperature fan of the QCP. The black dotted line represents a high-energy cut-off, Λ, beyond which such a description of the dynamics becomes invalid. The red dashed line separates the nFL phase from a second phase, the nature of which cannot be determined within the current theory, but is inferred from previous studies.

Key publications:

Sen S, et al. 2018. Emergence of non-Fermi liquid dynamics through nonlocal correlations in an interacting disordered system. *Phys Rev B*. 98 (7): 075112.

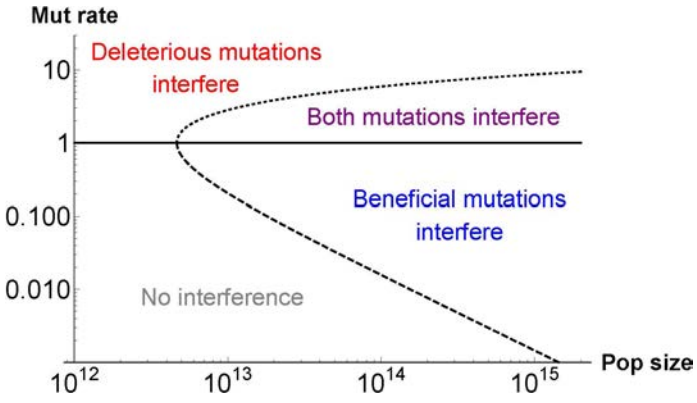
Terletska H, et al. 2018. Systematic quantum cluster typical medium method for the study of localization in strongly disordered electronic systems. *Appl Sci*. 8 (12): 2401.

Kavita Jain

Ph.D.; Associate Professor

Although many phenotypic traits are determined by a large number of genetic variants, how a polygenic trait adapts in response to environmental changes is still not well understood. In a gradually changing environment, modelled by a linearly moving phenotypic optimum, we found that the mean trait also moves linearly with time. But, the lag between the mean trait and phenotypic optimum increases, in contrast to the classical result that the lag remains constant.

The adaptation dynamics of an unstructured asexual population evolving under the joint action of selection, mutation, and random genetic drift may be classified into different regimes, depending on whether the interference by linked loci is important. We identified parameter regions where the adaptation rate is reduced due to interference by either beneficial or deleterious or both types of mutations.

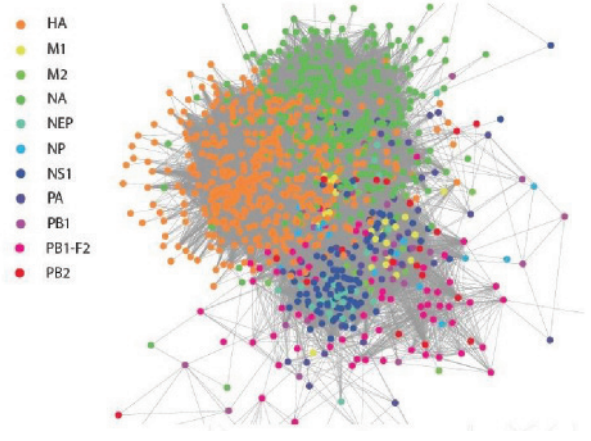


Regions in the space of population size and deleterious mutation rate where linked mutations interfere.

Meher K. Prakash

Ph.D.; Faculty Fellow

Our group uses the complexity theory and bioinformatics approaches to understand the complex host immune responses to the resistance mechanisms by viruses. Viruses are simultaneously simple and complex. They are simple because they do not have more than 10 different types of proteins, compared to the ~5000 in bacteria; and they are complex, because despite the low numbers of protein types, they effectively escape immunity due to a high mutation rate. Therefore, one of the questions we are addressing is whether it is possible to predict which viruses can be dealt effectively by the immune system. This question, among others, are important to understand the associated immunity and adaptation of the pathogen.



Viruses are deceptively simple, yet they encode complex resistance to immune response. Using complexity theory and bioinformatics approaches, we attempt to understand and quantify the differences in how immune systems respond to the viruses.

UNIT MEMBERS

Professor and Chair
Swapan K. Pati

Professors
Shobhana Narasimhan
Srikanth Sastry
Subir K. Das
Umesh V. Waghmare
Vidhyadhiraja N.S.

Honorary Professor
K.B. Sinha

Associate Professor
Kavita Jain

Faculty Fellow
Meher K. Prakash

Research Students
Abhishek Kumar Adak, Alok Kumar Dixit, Ankit Kumar, Arabinda Bera, Archana Devi, Arpan Das, Bidhan Chandra Garain, Debdipto Acharya, Dheeraj Kumar, Himanshu Joshi, Kaushlendra Kumar, Khandare Pushkar Gopalrao, Koyel Das, Koyendrila Debnath, Malay Ranjan Biswal, Meha Bhogra, Monoj Adhikari, Nalina V., Nandana S.K., Neha Bothra, Pallabi Das, Pallavi Sarkar, Pawan Kumar, Rajdeep Banerjee, Raju Kumar Biswas, Sachin Kaushik, Soumik Ghosh, Sourav Mondal, Sruthi C.K., Supriti Dutta, Varghese Babu, Vinayak M. Kulkarni, Wasim Raja Mondal, Yagyik Goswami

Research Associates
Anuja Chanana, Arunkumar Bupathy, Devina Sharma, Himangsu Bhaumik, K Navamani, Matukumilli V.D. Prasad, Paramita Banerjee, Rajneesh Kumar, Sayani Chatterjee, Shazia Janwari, Suchitra (Provisional)

R&D Assistants
Amarnath Chakraborty, Pawan Kumar, Wasim Raja Mondal

TSU AT A GLANCE

Awards received by faculty

Prof. Umesh V. Waghmare – Top cited Author Award 2018 by Institute of Physics Publishing (IOP); Member of the Council, National Academy of Sciences, Allahabad; Associate Editor, NanoScale (a journal published by Royal Society of Chemistry); Elected Asia Pacific Academy of Materials (APAM) Academician; Member of Inter-Academy Committee of the three Science Academies for drafting "A National Framework for Open Access to Scientific Literature", 2019.

Prof. Swapan Pati – Elected as the Fellow of Indian National Science Academy, 2018.

Prof. Subir K. Das – Invited professor at Ecole Normale Superieure, Lyon, France (September 2019).

Meher K. Prakash –Selected as an Associate at the International Center for Theoretical Physics, Italy.

SPONSORED PROJECTS

		Money received 2018-2019
NEW PROJECTS	4	43.1 Lakhs
ONGOING PROJECTS	19	1.43 Cr

5 Ph.D. STUDENTS ADMITTED

2 Ph.D. STUDENTS GRADUATED

62 PUBLICATIONS

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

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

RESEARCH INSIGHTS

- Using in-house developed time-dependent adaptive Density-matrix renormalization group (tDMRG) methods, 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. This phase is 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.
- Development of a computational scheme to construct interpretable and transferable predictive models of material properties using machine learning, constrained by dimensional analysis and scaling laws.
- Uncovered descriptors and mechanisms of catalytic activity of B and N-substituted graphenes, amorphous CoMoP, and a few topologically nontrivial chalcogenides towards hydrogen and oxygen evolution reactions.
- 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.
- Explanation of spin crossover transition in a monolayer of organic molecules, triggered by substrate-mediated epitaxial strain.
- Formulation of a descriptor for efficacy of aliovalent doping in oxides, and charge transfer and binding at the interface between 2D materials and metal substrates.
- Development of a novel force field for an array of room temperature ionic liquids, which is based on atom charges derived from quantum density functional theory of their condensed phases. The resulting ion charges are consistent with photoelectron spectroscopy data and enable the quantitative prediction of physical properties of these liquids.
- Two distinct mechanisms of supramolecular polymerization (cooperative and isodesmic) were computationally

delineated using changes in free energy of oligomerization with respect to oligomer size.

- Unified dynamical phase diagram of driven sphere packing, including jamming, unjamming, shear jamming, yielding transitions
- Dilatancy in frictionless sphere packing under special circumstances
- Inverse methods for materials design
- Exploration of information content and entropy in equilibrium and non-equilibrium systems.
- Development of force fields for the study of the activity of novel antibacterial compounds that act on bacterial membranes
- Illustration of the role of self-assembly of drugs inside bacterial membranes for their activity against bacterial membranes

UNIT MEMBERS

Professors
Balasubramanian Sundaram
Shobhana Narasimhan
Srikanth Sastry
Swapan K. Pati
Umesh V. Waghmare

Faculty Fellow
Meher K. Prakash

Research Associate
Devina Sharma

Research Scientists B
Anoop S.
Suresh J.

Helper
Basavaraj T.

INTELLECTUAL PROPERTY

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

The Centre has been one of the foremost research institutes in the country to realise the importance of IPAs created by its researchers. It encourages and facilitates the creation, development, protection and management of commercially exploitable IPs and its enforcement in addition to fostering Academia-Industry Partnership. Since its inception, the Centre has filed 283 patent applications (India-88, PCT-55, Australia-6, Brazil-3, Canada-10, China-6, Europe-27, Hong Kong-2, Israel-1, Japan-8, Korea-2, Singapore-4, S. Africa-5, S. Korea-3, USA-58, ARIPO-2, OAPI-2 and Vietnam-1) and obtained 79 patent grants (India-16, Australia-3, Canada-1, China-5, Europe-9, Japan-4, Korea-2, OAPI-2, S.Africa-4, S.Korea-1 and USA-32). Among other IPAs, 1 trademark, 1 industrial design, and 1 copyright have been registered.

Technologies Transferred

During 2018-2019, two patented technologies (namely, 'Method of Performing an Assay to Monitor Autophagy and Kit Thereof' and 'Modulators and Modulation Of Autophagy And Applications Thereof') developed by Prof. Ravi Manjithaya et al. has been licensed to M/s. Vipragen Biosciences Pvt. Ltd. In addition, three patented technologies (namely, 'Small Molecular Probes, Processes and Use Thereof', 'Compounds As DNA Probes, Methods And Applications Thereof', and 'Compounds As Stimuli-Responsive Probes, Methods And Applications Thereof') developed by Prof. Govindaraju Thimmaiah et al. has been licensed to M/s. VNIR Biotechnologies Pvt. Ltd.

The details of the patents applied and granted in the academic year 2018–19 are listed below.

Indian patent applications filed in 2018-2019:

Title of invention	Inventor	Unit	Territory	Application number	Date of filing
Method and system to assess solar cells	Kavassery Sureswaran Narayan, Prashant Kumar, Suman Banerjee	CPMU	India	201841020900	2018-06-05
	Premkumar Senguttuvan	NCU	India	201841032648	2018-08-30
	Kanishka Biswas, Manisha Samanta	NCU	India	201841034822	2018-09-14
	Sebastian Chirambatte Peter, Soumyabrata Roy, Arjun C.H., Manoj Kaja Sai	NCU	India	201841045187	2018-11-29
	Ranga Udaykumar	MBGU	India	201941005934	2019-02-14

International phase patent applications filed under PCT in 2018-2019

Title of invention	Inventor	Unit	Territory	Application number	Date of filing
Dynamic host-guest interactive system	Sarit Sekhar Agasti, Ranjan Sasmal, Nilanjana Das Saha	NCU	PCT	PCT/IB2018/055375	2018-07-19
Method and system to assess solar cells	Kavassery Sureswaran Narayan, Prashant Kumar, Suman Banerjee	CPMU	PCT	PCT/IB2018/056731	2018-09-04
Enhancing photocatalytic water splitting efficiency of Weyl semimetals by a magnetic field	Chintamani Nagesa Ramachandra Rao, Claudia Felser, Catherine Ranjitha Rajamathi, Nitesh Kumar, Uttam Gupta	NCU and CPMU	PCT	EP2019/052874	2019-02-06

National phase patent applications filed under PCT in 2018-2019

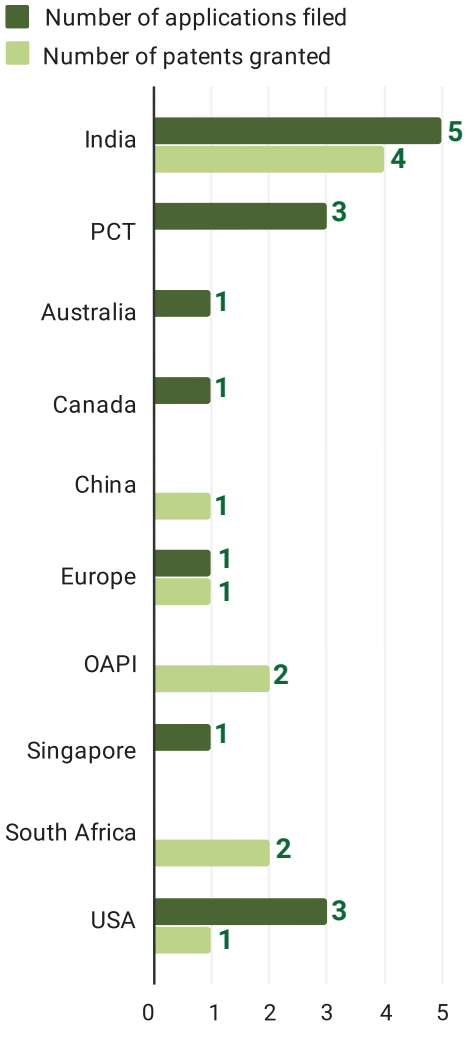
Title of invention	Inventor	Unit	Territory	Application number	Date of filing
Method for modulating autophagy and applications thereof	Ravi Manjithaya, Piyush Mishra, Suresh Santhi Natesan, Somya Bats, Veena Ammanathan, Aravinda Chavalmane	MBGU	Australia	2016366810	2018-06-08
			Singapore	11201804884P	2018-06-08
			Europe	16820017.8	2018-06-14
			USA	16/060,445	2018-06-08
A composite, scaffold and applications thereof	Govindaraju Thimmaiah, Shivaprasad Manchineella	NCU	USA	16/077391	2018-08-10
A polymer network, method for production, and uses thereof	Jayanta Haldar, Jiaul Hoque	NCU	USA	16/321,674	2019-01-29
			Canada	3032292	2019-01-29

Patents granted in 2018-2019

Title of invention	Inventor	Unit	Territory	Patent number	Granted on
A high sensitivity assay for molecular typing of biological sample, probes and a kit thereof	Ranga Udaykumar, Chandrabhas Narayana, Jayasuryan Narayana	MBGU and CPMU	India	295700	2018-04-12
Cationic antibacterial compound, composition, method and articles thereof	Jayanta Haldar, Yarlagadda Venkateswarlu, Akkapeddi Padma	NCU	India	296510	2018-05-03
Antimicrobial compounds, their synthesis and applications thereof	Jayanta Haldar, Chandradhish Ghosh, Gautham Belagula Manjunath, Padma Akkapeddi	NCU	China	ZL201380 070984.4	2018-06-19
Optimal wing planforms for reducing the induced or total drag of the wing of an aircraft driven by wing-mounted tractor propellers/rotors	Roddam Narasimha, Suresh Madhusudan Deshpande, Praveen Chandrashekarappa, Rakshith Belur Raghavan	EMU	Europe	2448819	2018-09-12
Cationic antibacterial compound, composition, method and articles thereof	Jayanta Haldar, Yarlagadda Venkateswarlu, Akkapeddi Padma	NCU	USA	10,081, 655 B2	2018-09-25
Small molecular probes, processes and use thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy, Kolla Rajasekhar	NCU	South Africa	2016/ 07051	2018-10-31
Compounds as DNA probes, methods and applications thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy	NCU	OAPI	18595	2018-12-28
Compounds as stimuli-responsive probes, methods and applications thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy	NCU	OAPI South Africa	18596 2018/ 01948	2018-12-28 2019-01-30
Nanoparticle compositions of antibacterial compounds and other uses thereof	Jayanta Haldar, Divakara Siva Sathyanarayana Murthy Uppu, Akkapeddi Padma, Goutham Belagula Manjunath	NCU	India	307423	2019-02-14
Monoclonal antibodies against NPM1 and acetylated NPM1, and process thereof	Tapas Kumar Kundu, Parijat Senapati, Gopinath Kodaganur Srinivasachar, Deepthi Sudarshan, Manjula Das, Smitha Pazhoor Kumaran, Manjunath Shivasangappa Devaraman, Ajithkumar Sumitrappa	MBGU	India	2016/ 07051 2018/ 01948	2019-03-21

PATENTS 2018-2019

PATENT APPLICATIONS FILED 2018-2019



11
PATENTS GRANTED 2018-2019

PATENT APPLICATIONS FILED SINCE INCEPTION

National Phase under PCT
140

India
88

International Phase under PCT
55

TOTAL PATENTS SINCE INCEPTION

79
PATENTS GRANTED

283
PATENT APPLICATIONS FILED

UNIT MEMBERS

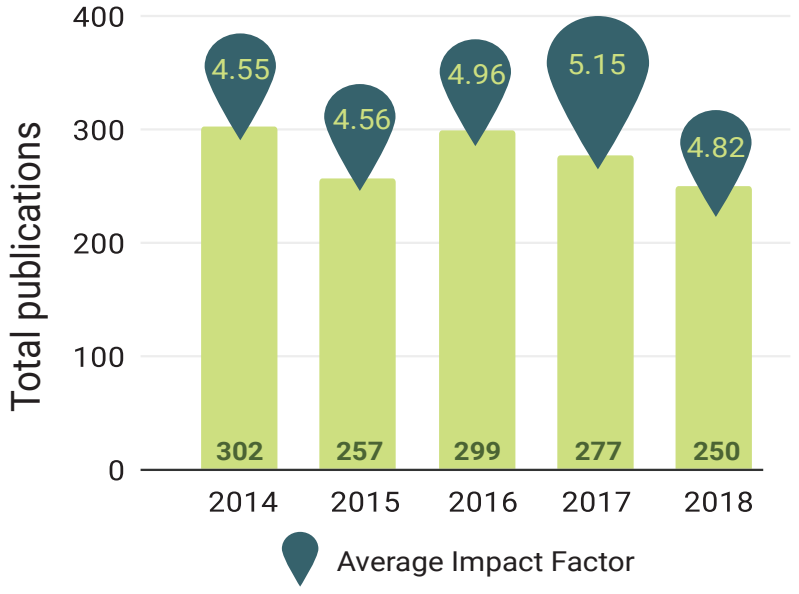
Dean, Research & Development
Prof. K.S. Narayan

Technical Officer Gr.-I
A.V. Nagarathnamma

Technical Staff
Yadati Rajyalakshmi

FACULTY PUBLICATIONS

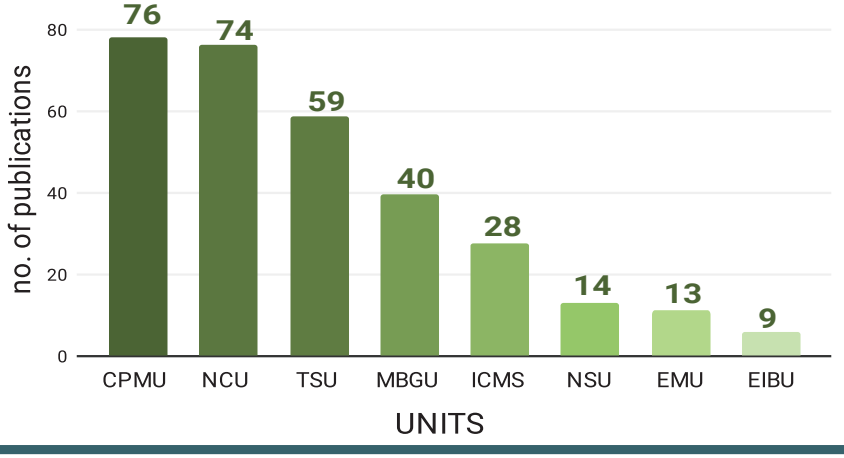
NUMBER OF PUBLICATIONS AND AVERAGE IMPACT FACTOR



TYPES OF PUBLICATIONS

- Journal Articles 214
- Reviews 18
- Conference papers 3
- Editorial/ Editorial Note 7
- Meeting Abstracts 6
- Book Chapters 2

NUMBER OF PUBLICATIONS PER UNIT IN 2018



247
TOTAL PUBLICATIONS IN IMPACT FACTOR JOURNALS

9
RESEARCH UNITS

4.82
AVERAGE IMPACT FACTOR

FACULTY STARTUPS

JNCASR, through its Technical Research Center (TRC), is among the very few Indian public funded R&D institutes that have taken up commercialization of 'high risk–high potential' technologies for global markets. TRC, established in 2016 with support from DST, GOI, is a multifaceted platform with a mission to provide techno-legal-commercial and financial support to scientists, entrepreneurs, and business fraternity to achieve translation of research into products and processes by:

- Supporting application-oriented projects to build upon background intellectual properties (IP) developed at JNCASR, and also to create new IP;
- Bolstering JNCASR-industry partnerships via out-licensing of IP/know-how, industry-sponsored R&D projects, industrial consulting, and collaborative R&D projects;
- Creating conducive ecosystem to spin-off technologies/intellectual properties developed by JNCASR through start-ups; and
- Developing R&D infrastructure required to perform translational R&D.

Examples include a research project, supported by TRC, focused on developing low-cost, non-invasive method for HIV diagnosis and other types of infectious diseases using Raman spectroscopy. A low-cost method for management of red palm weevil and rhinoceros beetle in coconut plantations has been licensed to two industrial partners. One project deals with thermoelectric materials and conversion of waste heat to electrical energy, while another project aims at developing non-Pt based ordered inter metallic nanoparticles as electrode materials for fuel cell green energy production. Through such projects, TRC aims to promote translational research, and contribute towards strengthening the country's excellence in science by striking the right balance between fundamental research, directed development, and deployment.

Since inception, TRC has supported ~30 R&D projects, licensed more than a dozen and a built a pipeline of ~10 technologies/IPs, initiated three start-up companies, with two more in the pipeline, supported more than 20 patents, collaborated with more than 10 industrial partners, set up a state-of-the-art R&D infrastructure, and built a wider network of R&D stakeholders with conducive innovation ecosystem.

Following are examples of the start-up ventures:

Sankhya Sutra Labs

Sankhya Sutra Labs (SSL) Pvt. Ltd.

SSL is the first start-up initiated at JNCASR in 2016, and was co-founded by Prof. Santosh Ansumali (EMU). The only company of its kind in Asia, SSL provides high-end Computational Fluid Dynamics and simulation solutions for complex product development problems, with applications ranging from precision engineering to aerospace to defense to cement plants. In a short span of time, SSL has made substantial progress in terms of garnering investments, building its core team and a robust sales pipeline, and securing angel and series-A investments. Recently, SSL successfully graduated from JNCASR.

HBAROMEGA Pvt. Ltd.:

This company was envisioned as a start-up with expertise in photovoltaics (PV), with the challenge to identify and filter out underperforming and defective PV panels. The company aims to accomplish this by making use of a simple yet powerful technique of light beam induced photocurrent (LBIC) to identify at an early stage the majority of defects that can compromise the performance of a PV panel. The start-up has been developing this technology and is geared-up to commercialize the technique of LBIC for large area panels in manufacturing and installation environments. The aim is to bring this technique into mainstream production and quality control process for both domestic and international markets in order to improve reliability of PV panels which will, in turn, improve lifetime and energy payback. Another important objective is to minimize the huge pileup of solar panels in landfills, resulting from sub-optimal panels, and ground water contamination that follows large-scale solar PV panel waste.

Vnir Biotechnologies Pvt Ltd

Vnir is a start-up created by two JNCASR faculty members. The company produces small fluorescence probes/molecules, developed by Dr. T. Govindaraju (co-founder and faculty member at NCU), with applications in biological imaging and diagnostics. This includes half a dozen near-infrared fluorescence probe-based products for addressing some of the unmet market needs, such as reactive oxygen species detection, live cell imaging, and safer alternatives for high throughput applications like real-time PCR. Additionally, it is developing point-of-care devices to diagnose communicable diseases (e.g. malaria) and non-communicable diseases (e.g. Alzheimer's). The start-up has already attracted angel investments, secured a few important grants such as the Biotechnology Ignition Grant, and was awarded a seed funding as one of the top 100 start-ups of Karnataka under the prestigious ELEVATE programme. Vnir has built a team of full time employees, and set-up manufacturing facility, sales, and distribution channels, and is now working to scale-up its business operations, while expanding its product portfolio.

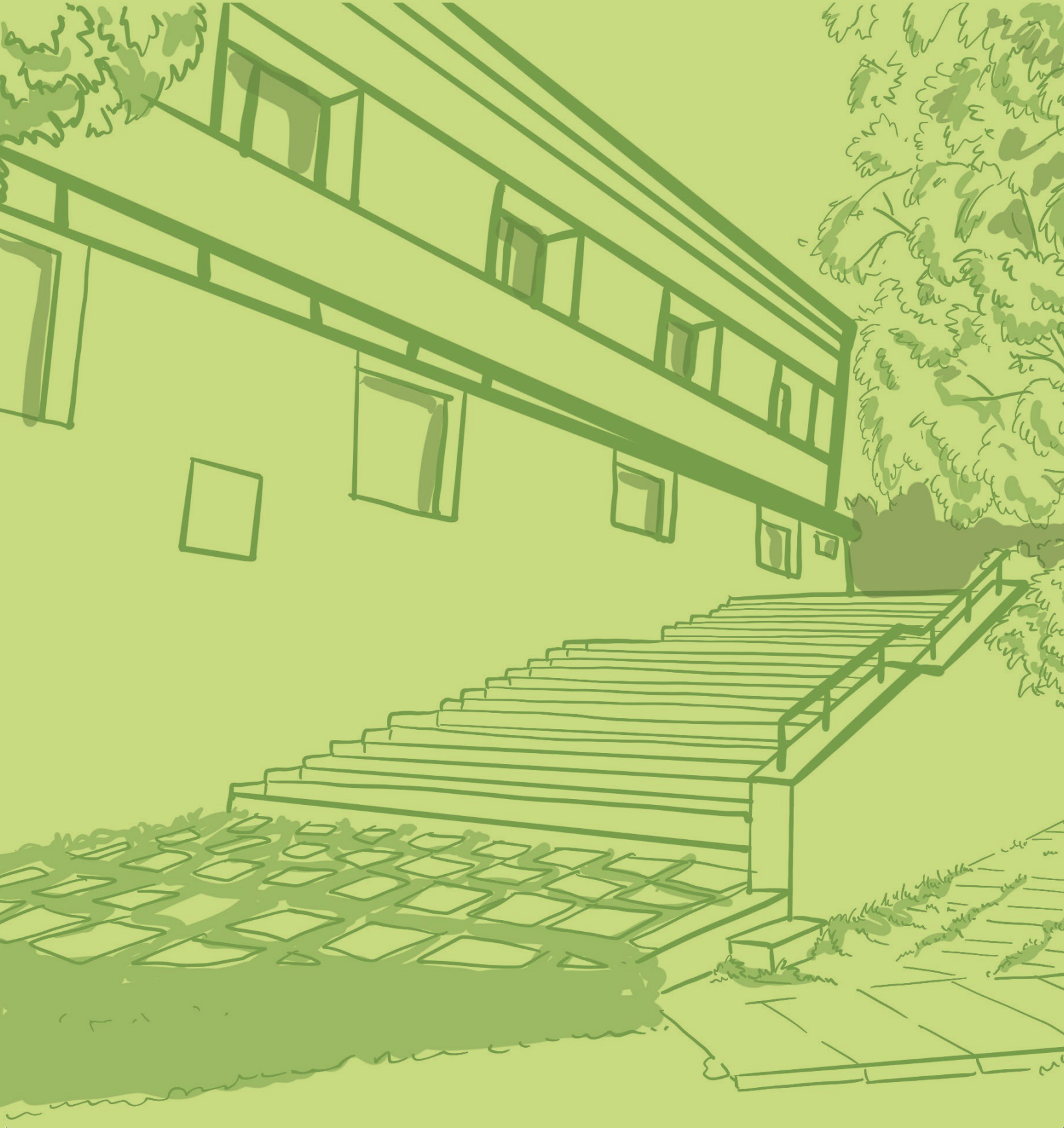
Breathe Applied Sciences Pvt. Ltd. (BAS)

JNCASR faculty members Prof. Umesh Waghmare and Prof. Sebastian Peter, along with Dr. Rakshith Raghavan (JNCASR alumni) formed a team to take part in the global $20 million NRG COSIA Carbon XPrize Competition, hosted by the XPrize Foundation, USA. The team led by Prof. Peter submitted its proposal focused towards converting carbon dioxide to methanol, based on which it entered the final round (only Indian team to do so). he overall technology development is centered with the discovery of novel catalysts by Prof. Sebastian C. Peter and his research group. The group also designed the process engineering, which integrated with other components to make a turnkey project for the efficient utilization of anthropogenic CO_2. The team is now in the process of developing and commercializing the proposed cutting-edge technology that fits perfectly under the umbrella of methanol economy, import substitution, and Make in India. Moreover, the technology can also be extended to a host of other chemicals. The team is currently refining its technology and business plan and scaling-up its technology.

In addition to the above four start-ups, TRC is in the preliminary stage to take 2-3 start-up propositions on the floor. To achieve the same, TRC is working towards creating a conducive ecosystem by way of a formal technology-business incubator.

JNCASR and ICAR CPRI jointly awarded the DBT Biotech Product, Process Development and Commercialisation Award 2018

FELLOWSHIPS AND OUTREACH



04

One of the primary objectives of the Centre is to improve scientific awareness and facilitate excellent science education at the school and college levels in the country. To realize this, JNCASR undertakes several outreach and fellowship programmes. 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.

FELLOWSHIP AND EXTENSION ACTIVITIES

In addition to the opportunities to pursue academic degrees in various areas, the Centre also offers Fellowship Programmes. A brief description of the available different programmes is given below.

Programmes/Fellowships offered by JNCASR:

For class XI-XII students:
Student Buddy Programme:
The aim of this programme is to expose class XI/XII students to a day in the life of a research scholar by inviting them to spend a day at JNCASR with a "buddy" (assigned Ph.D./Int-Ph.D. student/Postdoc). The visiting student is given the opportunity to observe and/or participate in ongoing research or discussions. Under this programme, 108 students from Jawahar Navodaya Vidyalaya, Kendriya Vidyalaya, and Sagar Science Forum benefited in the year 2018.

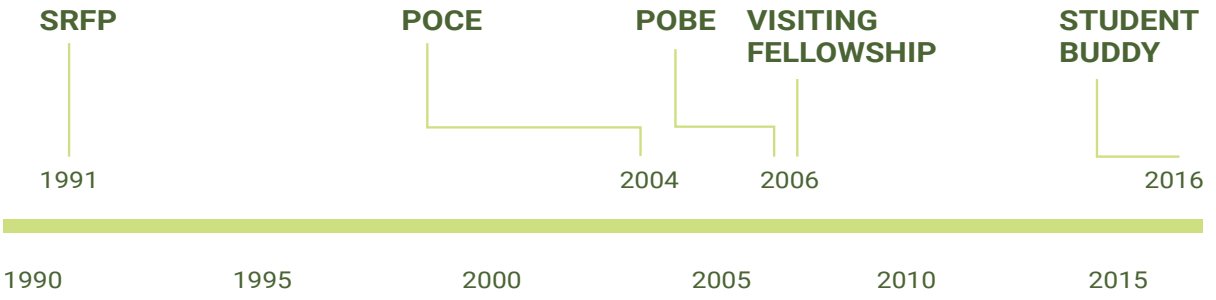
For undergraduates (BSc):
Summer Research Fellowship Programme (SRFP):
Since its inception in 1991, ~2300 students have benefited from this programme. A total of 70 students availed the scholarship for SRFP 2018 and received research training in various areas of Physics, Chemistry, Biology, or Engineering at research institutes in Bangalore, and elsewhere in the country. The advertisement for SRFP 2019 was announced in November 2018 on the JNCASR website and in two newspapers. The advertisement and application form were emailed to around 200 college principals in the country. In total, 2020 applications were received, and 147 students were selected for SRFP 2019. The Centre enhanced the SRFP fellowship from INR 6000 to INR 10000 per month, effective from April 2019.

Project Oriented Chemistry/Biology Education (POCE/POBE):
POCE and POBE, which have completed 15 and 13 years, respectively, select ten meritorious students each year from across the country for each of these programmes. Apart from summers (between April - July), these students undertake short term research projects with faculty members at the Centre during their mid-semester breaks. On completion of their training that lasts for 3 years, they are awarded a Diploma certificate in Chemistry or Biology as the Programme may be. For the 2018 programme, 10 each were selected out of 398 and 375 applicants for POCE and POBE, respectively. During the May 2019 selections, 10 each were selected out of 385 and 453 applicants for POCE and POBE, respectively. Nine and six students of the POCE and POBE 2016-18 batches, respectively, were awarded Diploma in Chemistry and Biology on 4 July 2018. The POCE/POBE fellowship has been increased from INR 6000 to INR 10000 per month, effective from May 2019 session.

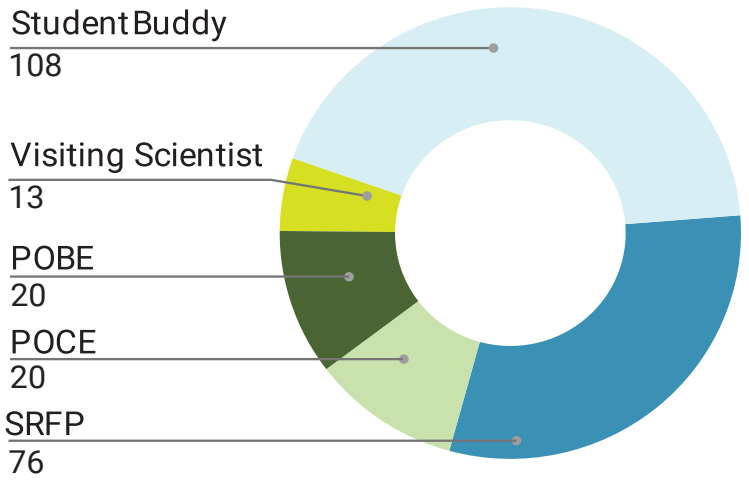
For Master students:
Summer Research Fellowship Programme:
The SRFP programme for Master students follows the same procedure as that for the bachelor students (details provided above).

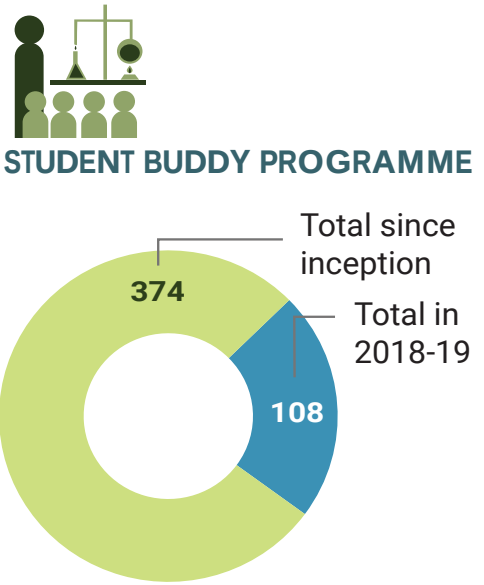
For scientists:
Visiting Fellowships:
The Centre also offers Visiting Scientist Fellowships to research scientists in educational institutions and R&D laboratories to work with the faculty of JNCASR. This programme has been welcomed by many young researchers, as they are able to hone their skills or develop research laboratory in their parent establishment after undergoing research training at the Centre. The advertisement for Visiting Fellowship was published in Current Science during July 2018. Thirteen scientists from research institutions across the country availed of this fellowship in 2018-2019. They were hosted by the faculty of CPMU, MBGU, NCU, NSU, and TSU.

TIMELINE OF ESTABLISHMENT OF PROGRAMMES

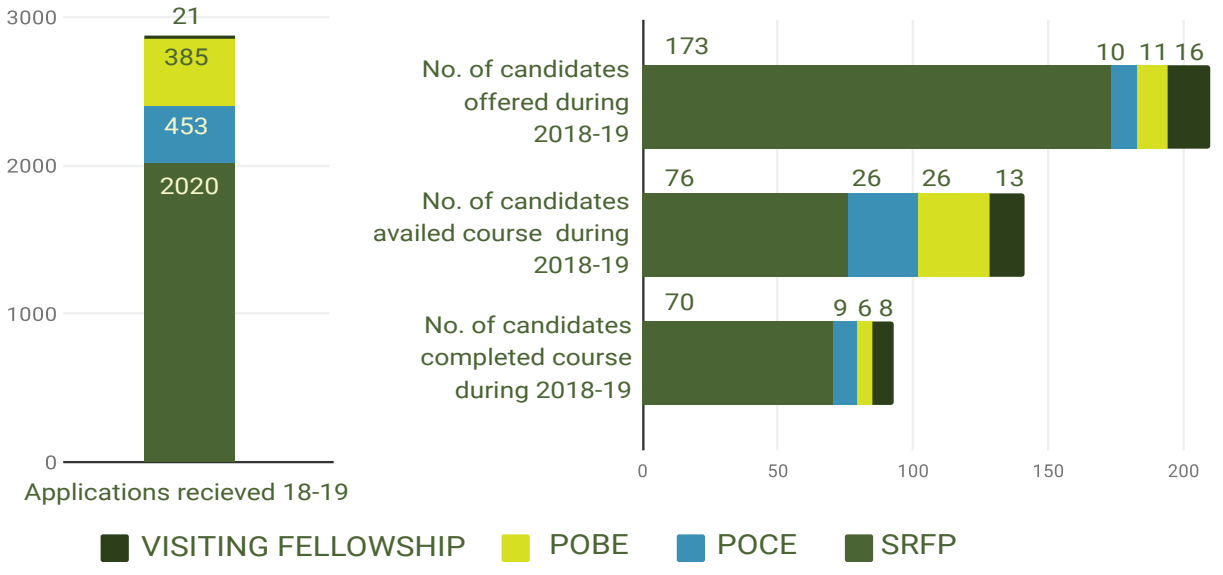


PARTICIPATION IN DIFFERENT PROGRAMMES





PARTICIPATION IN 2018-2019



EDUCATION TECHNOLOGY UNIT

The ETU was set up in 1996 with an aim to improve science education in schools and colleges by developing learning and teaching materials. This unit conducts lecture programmes/workshops in Physics, Chemistry, and Biology for both teachers and students. Some of the activities of ETU from the past year are highlighted below.

Science Outreach Programme (SOP):
An SOP on Physics and Chemistry was organized at Gangolihat Uttarakhand in May 2018, along with the Himalayan Gram Vikas Samiti, Uttarakhand and sponsored by the C.N.R. Rao Hall of Science, with involvement of faculty from JNCASR, IIT Bombay, and Kumaun University. Around 150 school students (Class XI & XII) from all over Uttarakhand participated in this programme.

"Program in Physics for Students" and "Program in Biology for Students" were organized in August and September 2018, respectively by C.N.R. Rao Hall of Science and ETU. The former consisted of lectures by Prof. Shashi Thutupalli (NCBS), Prof. S. M. Shivaprasad (JNCASR), and Dr. Meher Prakash (JNCASR), while the latter comprised of three lecturers by Dr. Akash Gulyani (ISCBRM, InStem), Dr. Phalguni Alladi (NIMHANS), and Dr. Sheeba Vasu (JNCASR). Around 185-200 school and college students (Class XI and XII) and teachers participated in each programme. In November, an SOP was conducted with lectures delivered by JNCASR faculty members. Around 180-200 school students and their teachers participated in the programme. As part of these SOPs, students also visited the 'Chemistry of Materials Exposition' and the 'Prof. CNR Rao Archives'.

In December 2018, about 200 students from Jakkur PU College, Parikrama, Jawahar Navodaya Vidyalaya, Yelahanka, and School Chandan, Laxmeshwar participated in an SOP organized by ETU. Students gave model-based and multimedia presentations on various science projects. In addition, the SOP included a "Fun with Hands-on Experiments" session and a puppet show, titled "Tripura Samhara", to encourage children to learn about our ancient art forms. Another SOP was conducted in December 2018, wherein the C.N.R. Rao Hall of Science and ETU conducted four workshops using college chemistry kits and involved the participation of 99 students and 9 teachers from four pre-university colleges.

Outstanding Science Teacher's Programme:
In July 2018, the `2017 Prizes for Outstanding Science Teachers' was organized by C.N.R. Rao Education Foundation and ETU of JNCASR. The award winners were Shri. Krishnamurthy L. Bhat and Dr. S. K. Samsul Alam. Around 225 students (of Class XI & XII) and teachers from various schools and colleges from different parts of Karnataka participated in the programme.

Student Mentoring Programme (SMP):
The SMP is supported by the C.N.R. Rao Hall of Science Fund; 9 and 12 students from Class XI participated in the SMP conducted in October 2018 and April-May, 2019, respectively. During their internship at JNCASR, the participants attended regular classes, worked in laboratories, and used the library.

Chetana Programme:
Department of Information Technology, Biotechnology and Science & Technology, Government of Karnataka in collaboration with C.N.R. Rao Hall of Science and ETU conducted the 'Chetana winter school' in October 2018. The objective of this programme, which is held each year, is to celebrate girl toppers in SSLC and expose them to the latest trends in science and encourage them to make a career in science. This year 33 girls and 2 faculty coordinators participated in the programme.

Parikrama Festival:
The Parikrama Festival of Science was held in January 2019, with the theme this year being 'Wildlife'. Over 200 students, teachers, guests, and volunteers participated in the event. The programme was held at the C.N.R. Rao Hall of Science and the AMRL Conference Hall.

Other workshops/camps:
The Salters Chemistry Camp was held in November 2018, in association with the Royal Society of Chemistry under the guidance of Prof. C.N.R. Rao and Dr. Indumati Rao. There were 60 students from rural government schools who participated in the camp along with their coordinators. Sagar Science Forum, jointly with the C.N.R. Rao Hall of Science (sponsor), organized and conducted an enrichment residential workshop in December 2018 for high school teachers at Sagar in Shimoga. The lectures and the experimental sessions were conducted by Prof. N.S. Vidhyadhiraja and Mr. Vinayak Pattar from ETU, JNCASR.

A 3-day workshop on physics and chemistry, supported by the C.N.R. Rao Education Foundation, was conducted in January 2019 at School Chandan in Laxmeshwar, Gadag.

A workshop was conducted with Sagar Science Forum at

Sagar, Shivamogga in March-April, 2019. It included physics experiments, and lectures and demonstrations on making low cost physics models (from NCERT VIII-X). Eight high school teachers and four students participated in the workshop and 20 physics kits were prepared, with each kit containing around 25 experiments.

To celebrate the International Year of the Periodic Table 2019 (IYPT 2019), a day-long programme was jointly organized by JNCASR., CeNS, Jalahalli, and IISc on 29th May, 2019. Over 850 PUC students and teachers participated in the event held at the J.N. Tata Auditorium, IISc. The participants had a chance to see various scientific demonstrations on superconductivity and levitation, a display of the elements in their real states, and play a series of games and quizzes based on the periodic table.

Besides the above, activities are ongoing to prepare for the Chem Expo.

OVERVIEW OF EDUCATION TECHNOLOGY UNIT

14
NUMBER OF PROGRAMMES

2351
PARTICIPANTS

SPONSORS

CNR Rao HOS Fund
CNR Rao Education Foundation
ETU, JNCASR
Department of Information Technology, Biotechnology and Science & Technology, Government of Karnataka
The Royal Society of Chemistry
Parikrma Humanity Foundation

EVENTS IN 2018-2019

06-08 May, 2018	Science Outreach Programme at Gangolihat, Uttarakhand.
02 July, 2018	Science Teachers Award Function (Lecture program)
21 August, 2018	Science Outreach Programme: Program in Physics for students
19 September, 2018	Science Outreach Programme: a lecture programme 'Program in Biology for Students'
13-18 October, 2018	Student Mentoring Program (SMP)
23-30 October, 2018	Chetana winter school
Nov-December, 2018	Four workshops on experiments using college chemistry kits
2-4 November, 2018	The Salters Chemistry Camp
16 November, 2018	Science outreach program: Lectures
19 November, 2018	Science outreach program: Lectures
10 December, 2018	Science outreach program: (model-based and multimedia presentations; "Fun with Hands-on Experiments" by Mr. Ashok Rupner from IISER Pune & a puppet show)
13-15 December, 2018	An enrichment residential workshop for high school teachers at Sagar in Shimoga
17-18 January, 2019	Parikrama Festival of Science
22-24 January, 2019	Three-day workshop at School Chandan in Laxmeshwar, Gadag

UNIT MEMBERS OF ETU

Linus Pauling Research Professor
Prof. C.N.R. Rao

Chair
Prof. V. Krishnan

Honorary Co-ordinator
Dr. (Mrs.) Indumati Rao

Technical Officer
Jatinder Kaur

Honorary Assistant
Sanjay S.R. Rao

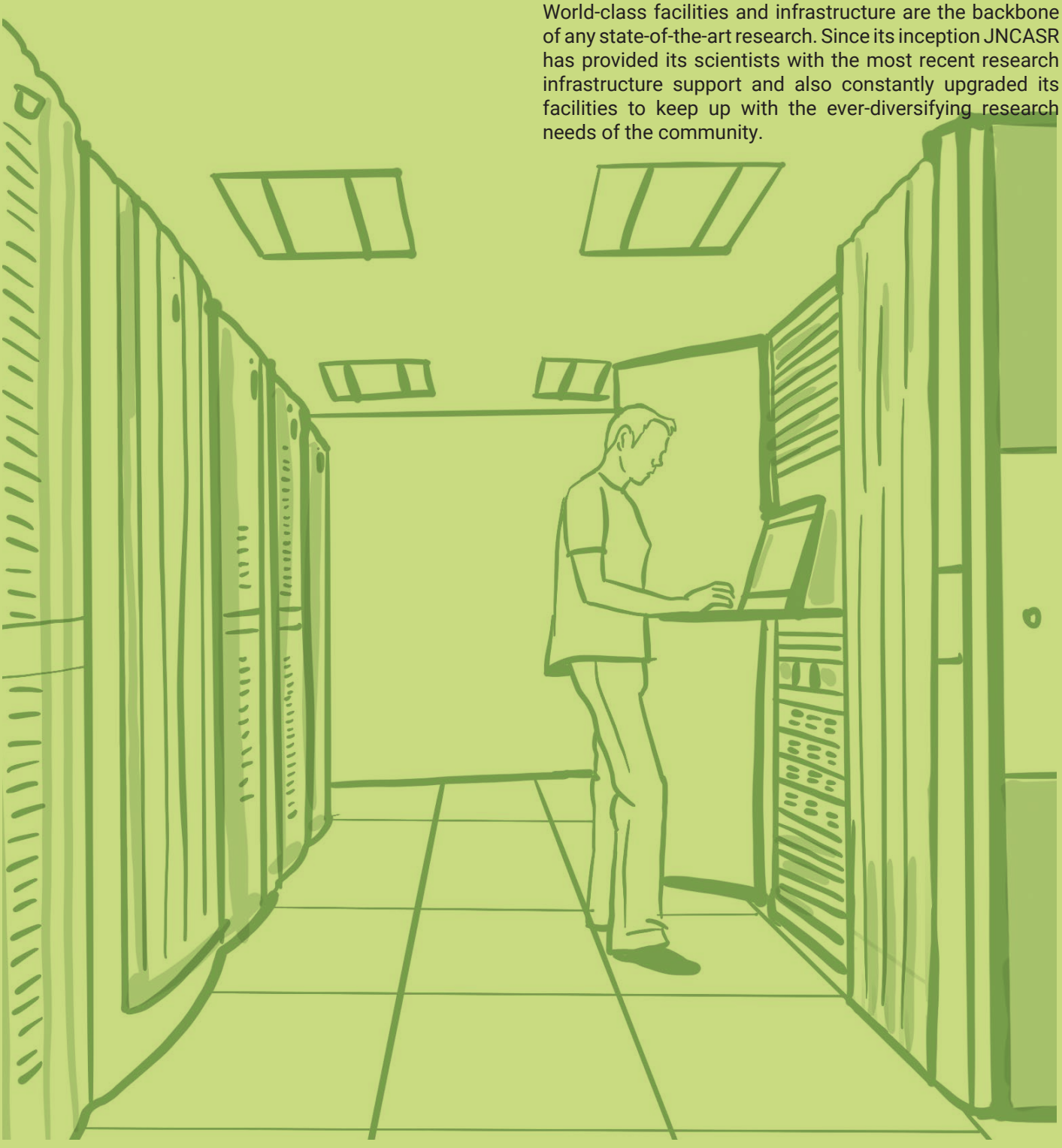
POCE Co-ordinator, ETU-SOP
Prof. S.N. Bhat

Technicians – Madan Mohan Malaviya Amphitheatre
Mehaboob Peer
H. Mune Gowda

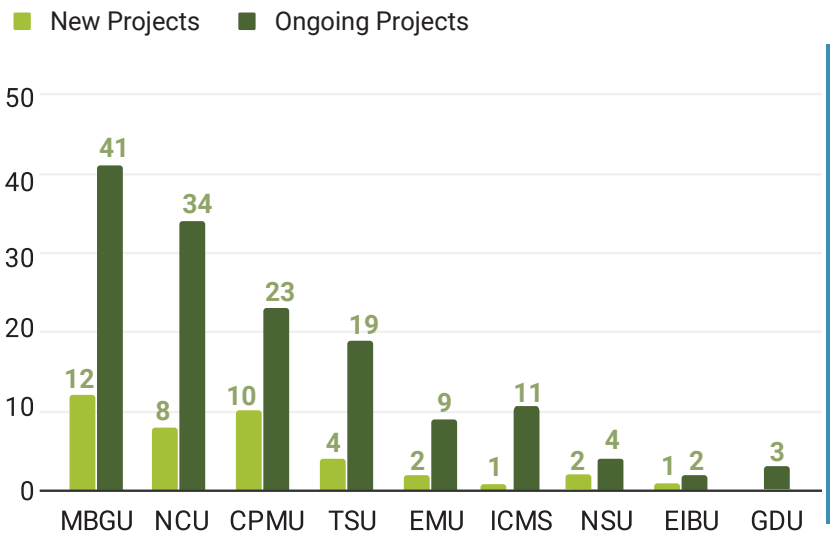
FUNDING AND FACILITIES

05

World-class facilities and infrastructure are the backbone of any state-of-the-art research. Since its inception JNCASR has provided its scientists with the most recent research infrastructure support and also constantly upgraded its facilities to keep up with the ever-diversifying research needs of the community.



SPONSORED PROJECTS



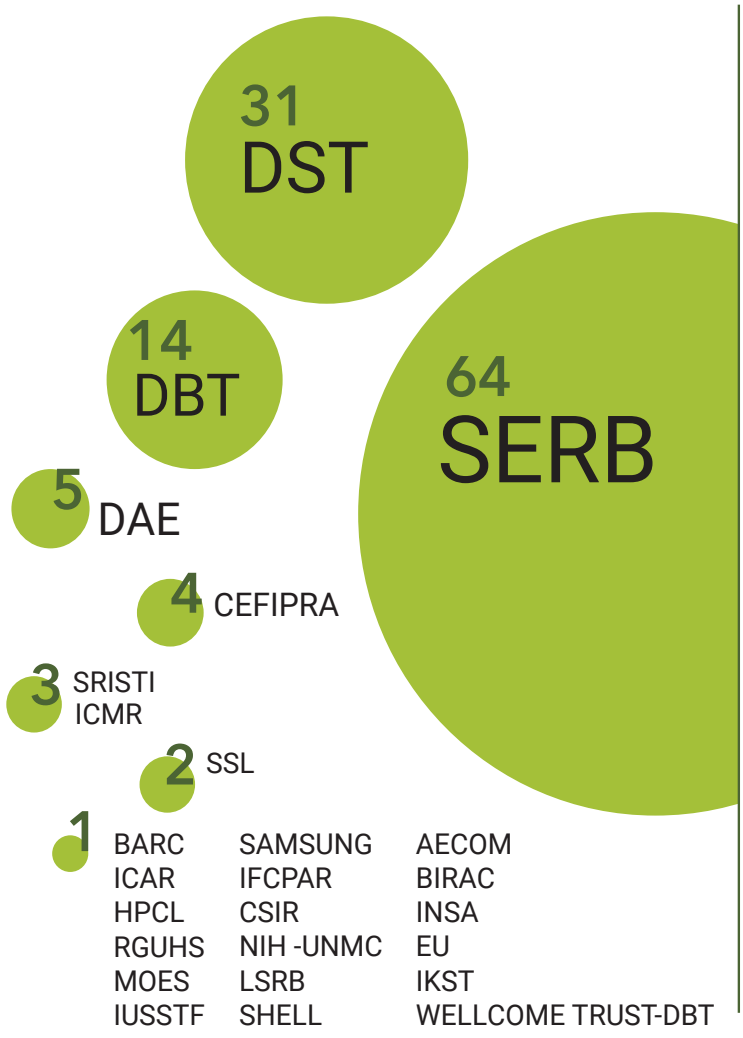
40
NEW SPONSORED PROJECTS

24.46 Cr
TOTAL AMOUNT RECEIVED FOR NEW PROJECTS DURING 2018-19

144
ONGOING SPONSORED PROJECTS

42.9 Cr
TOTAL AMOUNT RECEIVED FOR ONGOING PROJECTS DURING 2018-19

ONGOING PROJECT SPONSORS



NEW PROJECT SPONSORS

LIBRARY

JNCASR boasts of a well-stocked library, with over 9566 books in its collection and access to over 4000 scientific journals. The library continues to acquire, organize and disseminate information resources to render need-based information services to faculty, students, and researchers. Specifically, the library offers services such as document delivery, inter library loan, current awareness, and bibliometric studies.

In the year 2018-19, a total of 226 books were newly added, while 166 new subscriptions to journals were acquired. In the past year, 98 new patrons became part of the library, increasing the total to 692 current patrons. Other activities this year included –

- Article requests fulfilled: 84
- User orientation programmes: 3
- Total books circulated: Issued–1832, Renewed–1042, Returned–1961
- Resources supported by consortium (NKRC) :4000
- Author workshop conducted by Nature Publishing on 21st Dec 2018
- J-gate hands on training conducted by Informatics on 6th July 2018
- EBSCO hands on training conducted by EBSCO on 5th March 2019.

The total amount spent on books this year was **1,47,893 INR**, while that spent on journals was **94,02,360 INR**.

MEMBERS OF LIBRARY

Senior Library cum Information Officer
Nabonita Guha

Senior Library cum Information Assistant Grade I
Nanda E. Kumari
Nagesh Hadimani

Senior Helper
Rajeeva J

Total Patrons

692

New Patrons

98

4835

Total Circulation Transactions

Expenidture on Books

1.47 lakhs

Expenditure on Journals

98.02 lakhs

9566

Total Books in Stock

Books procured

226

Journals subscribed

166

COMPUTER LAB

JNCASR has a high-speed Local Area Network (LAN), which can support up to 10 Gbps intranet connectivity. In the year 2018-2019, efforts were made to ensure integrated Internet bandwidth of 600 Mbps. Infrastructural upgrades were made to increase the bandwidth to 1 Gbps, which will ensure an average bandwidth of 100 Mbps per person in the campus. A centralized storage facility of 25 TB was added to meet the data storage requirements in the campus. For critical data, such as email, a De-Duplication mechanism via Veeam 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 has been installed for maintaining the older servers' data.

Additionally, important changes were made with respect to the following:

Email: Several new policies were implemented to ensure proper functioning of the email facility.

Secured and enhanced Wi-Fi: High speed wireless network with 802.11 b/g/n/ac was successfully installed. The entire campus is now covered with 116 Instant 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. Center has also susbcribed 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.

Free software license for faculty and students: We have 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 and carry 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: Center has signed up with CDAC for Push SMS notification for campus users.

UNIT MEMBERS

Head
Prof. Subir K. Das

Consultants
Chandan N.
Udhaya Kumar S.

Onsite Engineers
Rajeev Ranjan
Abhishek Kumar

Trainee
Satish Kumar P.

NEW RESEARCH FACILITIES

Top-notch core research facilities and equipment are essential for carrying out cutting-edge research. JNCASR attempts to provide its entire faculty and research students with the latest technologies and facilities to carry out their research. Some of the new facilities and equipment procured in the last year are listed below.

Chemistry and Physics of Materials Unit (CPMU)

Rolad MDX milling machine, Cryosystem for imaging system, Pulse-P-1064 lasers, 350 MHz preamplifiers 4 channels, Tousimis 931.GL critical point dryer, Confocal microscope with STED, Accessories for upgradation of existing iHR-320, Applied Biosystems Genetic analyzer, Hydrogen gas generator, Laser head for picosecond pulses, Agilent Gas chromatography and HPLC system.

Engineering Mechanics Unit (EMU)

3D scanning with Lidar system, Boston X86-2U Socket server - 1 no.

International Centre for Materials Science (ICMS)

Low temperature transport PL system, Versalab cryogen free base system, ETO, Versalab DC, Innova 43R stackable shaker incubator, JASCO Spectrofluorometer FP8500, Spectroscopic ellipsometer with high temp, Non magnetic optical table, Bellsopr MaxII gas & vapor adsorption system, HT Tank 300 KV Mono EMC -Accessories for Titan microscope.

Molecular Biology and Genetics Unit (MBGU)

GEL documentation system, Liquid scintillation counter, Violet 405nm laser, BD FACS Melody cell sorter system, CFX 96 real time PCR detection system.

New Chemistry Unit (NCU)

Circularly polarized luminescence spectrometer, DLS equipment, Closed cycle cryostat, Pouch fuel cell fabrication system.

Neuroscience Unit (NSU)

Stereotaxis injection apparatus, Upgraded behaviour analysis facility with elevated plus maze, Morris water maze, novel object recognition arena.

Theoretical Science Unit (TSU)

Computer nodes and 128GB memory

Others

Atype IVC cage assembly & standard type ventilator, Standard type ventilator Citizen, Power cord with plugs & unity FC connectors, MAT lab software - 3 years, Automation of Accounts & Admin software –SFACTS, Eurosit furniture, 200 KW Grid solar PV power plant, Fire Alarm System

FINANCIAL STATEMENTS

06

B.R.V. Goud & Co.
Chartered Accountants

INDEPENDENT AUDITORS' REPORT

TO THE MEMBERS OF THE GOVERNING BODY OF JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH, BANGALORE

Opinion

We have audited the accompanying financial statements of **"Jawaharlal Nehru Centre For Advanced Scientific Research" Jakkur, Bangalore 560 064,** which comprises the Balance Sheet as at 31st March 2019, the Statement of Income & Expenditure for year then ended and a summary of significant accounting policies and other explanatory information.

In our opinion and to the best of our information and according to the explanations given to us, the aforesaid financial statements give the information required and give a true and fair view in conformity with the accounting principles generally accepted in India:

1) In the case of Balance Sheet, of the state of affairs of the **"Jawaharlal Nehru Centre For Advanced Scientific Research"** , as at 31st March 2019.

2) In case of Income and Expenditure Account, of **DEFICIT,** being **Excess of Expenditure over Income** for the year ended on that date.

Basis for Opinion

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by Institute of Chartered Accountants of India. 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 Centre in accordance with the Code of Ethics issued by the Institute of Chartered Accountants of India, and we have fulfilled our other ethical responsibilities in accordance with these requirements and the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of the financial statements. This responsibility also includes maintenance of adequate accounting records for safeguarding of the assets of the Centre and for preventing and detecting frauds and other irregularities; selection and application of appropriate implementation and maintenance of accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statement that give a true and fair view and are free from material misstatement, whether due to fraud or error.

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Basavanagudi, Bangalore - 560 004
Phone: 080 - 26566448, 26577448

TeleFax: 080 - 26566337
E-mail: audit@brvgoud.co.in
Website: www.brvgoud.co.in

Auditor's Responsibility for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements 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.

We further report that:

a) We have sought and obtained all the information and explanations which, to the best of our knowledge and belief, were necessary for the purpose of our audit and have found them to be satisfactory.

b) In our opinion, proper books of account as required by law have been kept by the Centre, so far as appears from our examination of those books.

c) The Balance Sheet and Income and Expenditure Account dealt with by this report, are in agreement with the books of accounts.

for B.R.V. GOUD & CO.,
Chartered Accountants
FRN: 000992S

(A B Shiva Subramanyam)
Partner
Membership No: 201108

Place: Bangalore
Date: 31/07/2019

UDIN :19201108AAAACR4429

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
BALANCE SHEET AS AT 31ST MARCH 2019

Amount in Rs.

Description	Schedule No.	Current year 2018-19	Previous year 2017-18
Liabilities			
Capital/corpus fund	1	2,15,46,16,396	1,99,85,84,695
Reserves & surplus	2	5,70,16,479	1,38,11,636
Earmarked and endowment funds	3	1,17,67,16,672	1,19,70,19,351
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	24,48,66,178	14,96,93,452
Total		**3,63,32,15,726**	**3,35,91,09,134**
Assets			
Fixed assets	8	1,86,24,95,101	1,73,46,54,311
Investments-From earmarked/endowment funds	9	26,42,05,500	22,82,55,463
Investment - Others	10	8,84,41,015	12,08,79,200
Current assets, loans, advances etc.	11	1,41,80,74,110	1,27,53,20,160
Total		**3,63,32,15,726**	**3,35,91,09,134**
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

As per our report of even date,
for B.R.V. Goud & Co.
Chartered Accountants

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

[A.B. Shiva Subramanyam]
Partner
Membership No. 201108

Prof. K. S. Narayan
President in Charge

Joydeep Deb
Administrative Officer

Place : Bangalore
Date : 31/07/2019

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019

Amount in Rs.

Description	Schedule No.	Current year 2018-19	Previous year 2017-18
Income			
Income from sales/services	12	10,00,000	0
Grants/subsidies	13	84,84,11,000	76,41,52,000
		84,94,11,000	76,41,52,000
Less: Fixed assets acquired during the year from DST core grant		19,89,08,813	21,68,63,612
		65,05,02,187	54,72,88,388
Fees/subscriptions	14	40,42,858	49,75,177
Income from investments	15	0	0
Income from royalty, publication, licence fee etc.	16	2,54,976	1,42,772
Interest earned	17	86,42,431	76,23,511
Other income	18	75,71,969	1,04,59,695
Increase/decrease in stocks	19	0	0
Total (A)		**67,10,14,421**	**57,04,89,543**
Expenditure			
Establishment expenses	20	41,73,02,429	39,67,78,829
Other administrative expenses etc.	21	21,04,85,763	23,49,64,714
Expenditure on grants, subsidies etc.	22	0	0
Interest & bank charges	23	21,385	9,950
Depreciation (Net total at the year end-Corresponding to sch.-8)		10,43,77,423	10,69,15,408
Total (B)		**73,21,87,001**	**73,86,68,902**
Balance being excess of income over expenditure **(A-B)**		-6,11,72,580	-16,81,79,358
- Prior period expenses		0	26,747
Reserve & surplus - Balance brought forward		-9,31,03,772	7,51,02,333
Balance being surplus/deficit carried to reserves and surpluses		**-15,42,76,352**	**-9,31,03,772**
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

As per our report of even date,
for B.R.V. Goud & Co.
Chartered Accountants

B.R.V. GOUD & CO CHARTERED ACCOUNTANTS B'LORE-A

[A.B. Shiva Subramanyam]
Partner
Membership No. 201108

Prof. K. S. Narayan
President in Charge

Joydeep Deb
Administrative Officer

Place : Bangalore
Date : 31/07/2019

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2019

Description	2018-19 Amount in Rs.	2017-18 Amount in Rs.
SCHEDULE 1- Capital/Corpus Fund :		
A: Capital		
Balance as at the beginning of the year	1,73,46,54,311	1,61,22,89,974
Add : Fixed assets acquired during the year from core grant	19,89,08,813	21,68,63,612
Add : Fixed assets acquired during the year from other funds	3,33,09,400	1,24,16,134
Sub total	**1,96,68,72,524**	**1,84,15,69,720**
Less : Depreciation for the current year	10,43,77,423	10,69,15,408
Total (A)	**1,86,24,95,101**	**1,73,46,54,311**
B: Corpus fund		
Opening balance	26,39,30,384	22,81,50,335
Additions during the year	1,06,09,339	1,69,10,767
Funds-Income from investments made	2,07,05,462	1,84,49,337
Interest from savings bank - Endowment account	95,741	4,20,267
Sub total	**29,53,40,925**	**26,39,30,707**
Less : Funds-utilisation/expenditure incurred	32,19,631	323
Total (B)	**29,21,21,295**	**26,39,30,384**
Total (A+B)	**2,15,46,16,396**	**1,99,85,84,695**
SCHEDULE 2- Reserves and surpluses :		
General reserve:		
Surplus/deficit in income and expenditure account	**-15,42,76,352**	**-9,31,03,772**
Capital reserve:		
Opening balance	**10,69,15,408**	
Depreciation reserve for Fy 2018-19	**10,43,77,423**	**10,69,15,408**
TOTAL	**5,70,16,479**	**1,38,11,636**

Sampad Patra
Accounts Officer

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2019

SCHEDULE 3- Earmarked and endowment funds:	FUND - WISE BREAK UP				TOTAL	
	Scheme Funds	Kiran Mazumdar-Shaw- MBSRL	Chemical Heritage Exposition	Endowment Others	2018-19	2017-18
A) Opening balance of the funds	**1,10,47,59,755**	**25,89,233**	**45,04,633**	**8,51,65,730**	**1,19,70,19,351**	**95,39,30,926**
B) Additions to the funds:						
i. Donations/grants	72,13,78,901	2,00,00,000	59,19,345	0	74,72,98,245	65,39,30,503
ii. Income from investment made on account of funds	5,47,32,151	0	0	53,69,682	6,01,01,833	8,06,33,058
iii. Others	27,92,44,936	0	0	0	27,92,44,936	40,86,387
Total (A+B)	**2,16,01,15,743**	**2,25,89,233**	**1,04,23,978**	**9,05,35,413**	**2,28,36,64,366**	**1,69,25,80,874**
C) Utilisation/expenditure towards objectives of funds						
i. Capital expenditure						
- Fixed assets	48,70,84,710	2,28,85,422	1,04,23,978	0	52,03,94,110	**18,63,69,122**
- Others	0	0	0	0	0	**0**
Total	**48,70,84,710**	**2,28,85,422**	**1,04,23,978**	**0**	**52,03,94,110**	**18,63,69,122**
i. Revenue expenditure						
- Salaries, wages & allowances etc	8,32,55,397	0	0	0	8,32,55,397	**8,28,58,589**
- Other administrative expenses	49,78,42,776	0	0	54,55,411	50,32,98,187	22,63,33,812
Total	**58,10,98,173**	**0**	**0**	**54,55,411**	**58,65,53,584**	**30,91,92,401**
Total (C)	**1,06,81,82,883**	**2,28,85,422**	**1,04,23,978**	**54,55,411**	**1,10,69,47,693**	**49,55,61,523**
Net balance as at the year end (A + B - C)	**1,09,19,32,860**	**-2,96,189**	**0**	**8,50,80,002**	**1,17,67,16,672**	**1,19,70,19,351**

Sampad Patra
Accounts Officer

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-A

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2019

Description		2018-19 Amount in Rs.	2017-18 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	8,96,25,062		
b. Others - EMD/security deposit	95,30,009	**9,91,55,071**	**3,23,03,863**
2. Advances received :		**10,64,543**	**16,13,035**
3.Statutory liabilities :		**47,09,020**	**1,54,16,289**
4. Other current liabilities:		**9,31,96,330**	**3,88,11,749**
Total (A)		**19,81,24,964**	**8,81,44,936**
B. Provisions			
7th pay commission arrears		**0**	**5,82,07,135**
Unpaid stipend/salary		**36,13,754**	**33,41,381**
Total (B)		**36,13,754**	**6,15,48,516**
Total (A+B)		**20,17,38,718**	**14,96,93,452**

Sampad Patra
Accounts Officer

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

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 2019

SCHEDULE 8 - FIXED ASSETS

DESCRIPTION	GROSS BLOCK				DEPRECIATION				NET BLOCK	
	Cost/Value as at beginning of the year 2018-19	Additions during the year 2018-19	Dedn. during the year 2018-19	Cost/value at the end of the year 2018-19	Depre. as at the beginning of the year 2017-18	Depre. during the year 2018-19	On Dedn. during the year 2018-19	Total upto the year end 2018-19	as at the Current year - end 2018-19	as at the Previous year - end 2017-18
Land :										
Free hold land	1,77,15,351		0	1,77,15,351	0	0	0	0	1,77,15,351	1,77,15,351
Buildings :										
Buildings	8,78,33,491	0	0	8,78,33,491	3,29,96,450	14,31,686	0	3,44,28,136	5,34,05,355	5,48,37,041
Hostel building	1,56,60,055	0	0	1,56,60,055	60,46,368	2,55,259	0	63,01,627	93,58,428	96,13,687
Advanced material research lab	2,59,30,339	0	0	2,59,30,339	63,24,278	4,22,665	0	67,46,943	1,91,83,396	1,96,06,061
Animal house	67,88,701	0	0	67,88,701	25,80,268	1,10,656	0	26,90,924	40,97,777	42,08,433
Staff housing	43,19,353	0	0	43,19,353	13,03,639	70,405	0	13,74,044	29,45,309	30,15,714
ETU building	30,91,348	0	0	30,91,348	7,10,907	50,389	0	7,61,296	23,30,052	23,80,441
Other buildings like extn. of hostel , college etc	1,18,83,626	0	0	1,18,83,626	25,68,514	1,93,703	0	27,62,217	91,21,409	93,15,112
Nano science lab	70,42,909	0	4,47,700	65,95,209	12,62,792	1,07,502	0	13,70,294	52,24,915	57,80,117
Engineering & mechanical lab	74,26,272	0	0	74,26,272	13,28,407	1,21,048	0	14,49,455	59,76,817	60,97,865
Dining hall & kitchen block	1,35,59,591	3,47,802	0	1,39,07,393	21,43,987	2,26,691	0	23,70,678	1,15,36,715	1,14,15,604
Hostel phase II	1,95,52,377	0	0	1,95,52,377	35,05,742	3,18,704	0	38,24,446	1,57,27,931	1,60,46,635
Lecture hall & academic block	96,36,712	0	0	96,36,712	17,10,258	1,57,078	0	18,67,336	77,69,376	79,26,454
Intl. centre for material sciences	5,01,48,316	0	0	5,01,48,316	81,97,040	8,17,418	0	90,14,458	4,11,33,858	4,19,51,276
International house	2,31,42,418	0	0	2,31,42,418	38,62,848	3,77,221	0	42,40,069	1,89,02,349	1,92,79,570
Hostel phase III	2,75,01,103	0	0	2,75,01,103	44,19,428	4,48,268	0	48,67,696	2,26,33,407	2,30,81,675
Prof. CNR Rao hall of science	1,03,33,669	0	0	1,03,33,669	16,63,770	1,68,439	0	18,32,209	85,01,460	86,69,899
Extention to HIV lab	10,16,085	0	0	10,16,085	1,65,621	16,562	0	1,82,183	8,33,902	8,50,464
Security office building	7,42,632	13,58,993	0	21,01,625	60,206	45,332	0	1,05,538	19,96,087	6,82,426
Radio activity - lab II	30,35,391	0	0	30,35,391	1,97,737	49,477	0	2,47,214	27,88,177	28,37,654
Sewage treatment building (STP)	2,91,699	0	0	2,91,699	52,302	4,755	0	57,057	2,34,642	2,39,397
Residential quarters - Adm. Officer	36,59,034	0	0	36,59,034	4,85,605	59,642	0	5,45,247	31,13,787	31,73,429
Child care centre	7,28,827	0	0	7,28,827	1,00,641	11,880	0	1,12,521	6,16,306	6,28,186
Extension to biology lab -2009	1,94,24,005	0	0	1,94,24,005	21,03,103	3,16,611	0	24,19,714	1,70,04,291	1,73,20,902
Animal house - Additional block	82,92,632	0	0	82,92,632	13,13,482	1,35,170	0	14,48,652	68,43,980	69,79,150
Hoster phase IV (62 rooms)	2,59,34,842	0	0	2,59,34,842	30,52,120	4,22,738	0	34,74,858	2,24,59,984	2,28,82,722
Extention to pauling building - Bio block	47,66,109	0	0	47,66,109	20,46,939	77,688	0	21,24,627	26,41,482	27,19,170
SCADA-DG room	2,40,660	0	0	2,40,660	23,537	3,923	0	27,460	2,13,200	2,17,123
President's residence	77,88,054	0	0	77,88,054	7,50,145	1,26,945	0	8,77,090	69,10,964	70,37,909
Visiting students hostel	3,39,82,070	0	0	3,39,82,070	32,93,384	5,53,908	0	38,47,292	3,01,34,778	3,06,88,686
Health centre	32,43,422	0	0	32,43,422	3,17,207	52,868	0	3,70,075	28,73,347	29,26,215
Nano institute-Shivanapura	37,09,242	0	0	37,09,242	3,62,765	60,461	0	4,23,226	32,86,016	33,46,477
Matrl. science block - CCMS	5,54,31,961	0	0	5,54,31,961	49,43,301	9,03,541	0	58,46,842	4,95,85,119	5,04,88,660
Post doc housing- Srirampura	1,54,86,086	0	0	1,54,86,086	9,41,548	2,52,423	0	11,93,971	1,42,92,115	1,45,44,538
New auditorium	2,20,24,759	0	0	2,20,24,759	13,51,100	3,59,004	0	17,10,104	2,03,14,655	2,06,73,659
New auditorium phase II	4,87,16,112	11,64,255	0	4,98,80,367	7,95,760	8,13,266	0	16,09,026	4,82,71,341	4,79,20,352
EOBU lab block	2,09,11,646	0	0	2,09,11,646	18,16,648	3,40,860	0	21,57,508	1,87,54,138	1,90,94,998
Infrastructure facility- Road, street lights, partitions etc	10,66,12,812	54,11,270	0	11,20,24,082	1,70,44,883	17,94,585	0	1,88,39,469	9,31,84,613	8,95,67,929
Equipments :										
Plant/machinery/scientific equipments	1,01,48,24,292	5,33,95,448	51,42,205	1,06,30,77,535	39,74,73,653	4,99,56,055	0	44,74,29,709	61,56,47,826	61,73,50,639
Equipments carbon & nano materials	3,41,82,430	38,579	0	3,42,21,009	3,42,21,008	0	0	3,42,21,008	1	-38,578
Equipments physics & chemistry of matrl.	98,78,095	0	0	98,78,095	98,78,094	0	0	98,78,094	1	1
Equipments cluster studies	26,87,514	0	0	26,87,514	25,37,808	1,27,657	0	26,65,465	22,049	1,49,706
Equipments advance technology lab	2,02,02,562	0	0	2,02,02,562	1,87,39,137	9,59,622	0	1,96,98,759	5,03,803	14,63,425
Equipment magnet	70,90,855	0	0	70,90,855	65,73,501	3,36,816	0	69,10,317	1,80,538	5,17,354
ICMS-lab equipment/ lab facilities	32,81,71,473	5,17,88,473	0	37,99,59,946	8,63,12,105	1,90,24,946	0	10,53,37,051	27,46,22,894	24,18,59,368
Vehicles	54,12,133	7,397		54,19,530	39,98,549	5,14,855	0	45,13,404	9,06,126	14,13,584
Furniture and fixtures	9,29,58,460	32,63,839	11,44,083	9,50,78,216	7,85,05,644	59,50,489	0	8,44,56,133	1,06,22,083	1,44,52,816
Office equipments	2,31,25,888	7,09,534	80,000	2,37,55,422	1,32,98,597	11,11,958	0	1,44,10,555	93,44,867	98,27,291
Computer/peripherals	8,42,38,889	22,91,079	1,000	8,65,28,968	8,30,19,977	2,36,796	0	8,32,56,773	32,72,195	12,18,912
Electrical installations	11,27,38,560	1,36,15,195	0	12,63,53,755	1,73,58,471	19,48,775	0	1,93,07,246	10,70,46,509	9,53,80,089
Library books	2,91,25,431	70,189	0	2,91,95,620	1,70,65,025	13,85,460	0	1,84,50,485	1,07,45,135	1,20,60,406
Library Journals	19,53,72,979	92,21,504	0	20,45,94,483	7,96,99,045	95,11,753	0	8,92,10,799	11,53,83,685	11,56,73,934
Tubewells & water supply	2,48,912	0	0	2,48,912	59,289	4,057	0	63,346	1,85,566	1,89,623
Other fixed assets										
Intangeable assets-Softwares	2,65,26,627	74,23,358	0	3,39,49,985	2,65,26,626	16,29,413	0	2,81,56,039	57,93,946	1
Capital work in progress										
Modern biomedical science research laboratory	1,24,10,767	3,96,78,651	0	5,20,89,418	0	0	0	0	5,20,89,418	1,24,10,767
Chemical heritage exposition	5,367	1,04,23,978	0	1,04,29,345	0	0	0	0	1,04,29,345	5,367
Basic infrastructure facilities - New campus - Chokkanalli	49,58,626	1,25,41,374	0	1,75,00,000	0	0	0	0	1,75,00,000	49,58,626
Electrical Installations - 2000 KVA DG SET	0	2,19,49,123	0	2,19,49,123	0	0	0	0	2,19,49,123	0
Extension to Engineering & Machanical Unit (EMU)	0	29,91,732	0	29,91,732	0	0	0	0	29,91,732	0
Extension to Hall of Science	0	7,46,430	0	7,46,430	0	0	0	0	7,46,430	0
Hostel Phase - V	0	5,69,040	0	5,69,040	0	0	0	0	5,69,040	0
Sports Complex	0	25,960	0	25,960	0	0	0	0	25,960	0
Total	2,73,17,63,573	23,90,33,201	68,14,988	2,96,39,81,785	99,71,09,261	10,43,77,423	0	1,10,14,86,684	1,86,24,95,101	1,73,46,54,311

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2019

Description	2018-19 Amount in Rs.	2017-18 Amount in Rs.
SCHEDULE 9- Investments - Earmarked/endowment funds		
Long term deposits		
Fixed deposits - Housing development finance corporation limited	9,77,05,500	8,77,05,500
Fixed deposits - Canara bank	0	3,50,00,000
Fixed deposits - State bank of india	0	1,00,49,963
Fixed deposits - PNB housing finance limited	10,35,00,000	3,25,00,000
Fixed deposits - Stock holding corporation of india	6,30,00,000	6,30,00,000
Total	**26,42,05,500**	**22,82,55,463**
SCHEDULE 10- Investments - Others		
Short term deposits	8,84,32,125	12,00,00,000
Others	8,890	8,79,200
Total	**8,84,41,015**	**12,08,79,200**
Schedule 11- Current assets, loans, advances etc.,		
Cash & bank balances (Schemes)		
Cash in hand	0	0
Cash at bank - Canara bank	13,25,10,629	1,28,37,801
Fixed deposits - Canara bank	17,12,96,082	12,00,00,000
Fixed deposits - Housing development finance corporation limited	20,10,00,000	22,00,00,000
Fixed deposits - PNB housing finance limited	49,66,07,807	64,76,01,317
Sub total	**1,00,14,14,518**	**1,00,04,39,118**
Loans and advances (Schemes)		
Interest accrued on fixed deposits	3,13,96,201	3,18,21,171
TDS receivable	37,48,981	14,49,675
Receivables from centre	13,22,967	2,53,39,683
Receivables from various funding agencies	5,40,50,192	4,57,10,108
Sub total	**9,05,18,341**	**10,43,20,637**
Total of Schemes	**1,09,19,32,860**	**1,10,47,59,755**
Cash & bank balances		
Cash in hand - Grant account	0	0
Cash in hand - Endowment account	0	0
Cash at bank - Canara Bank - Grants account	7,15,69,598	63,09,733
Cash at bank - Canara Bank - FCRA account	98,557	0
Cash at bank - Canara Bank - Endowments account	2,30,66,959	68,64,183
Cash at bank - SBI	3,21,29,131	1,09,04,360
Cash at bank - HDFC	60,10,180	15,94,100
Sub total	**13,28,74,426**	**2,56,72,376**
Loans and advances		
Advances to staff	5,18,772	49,350
Deposits	21,15,979	18,27,929
Interest accrued on earmarked/endowment funds	1,46,47,235	1,28,55,584
Other advances & receivables	4,11,91,463	1,11,40,540
Receivables- CSIR, UGC, DBT, DST	89,57,704	1,48,90,105
Endowment account - Receivable from scheme account	0	1,50,00,000
Endowment account - Advance to supplier	25,600	33,110
Endowment account - Receivable from CPF account	7,63,47,488	8,46,13,346
Endowment account - Receivable from grant account	4,34,14,011	3,16,978
TDS receivable - Grant account	38,48,122	27,50,374
TDS receivable - Endowment account	21,60,449	13,71,714
Imprest balance	40,000	39,000
Sub total	**19,32,66,824**	**14,48,88,029**
Total of other than Schemes	**32,61,41,250**	**17,05,60,405**
Total	**1,41,80,74,110**	**1,27,53,20,160**

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2019

Description	2018-19 Amount in Rs.	2017-18 Amount in Rs.
SCHEDULE 12- Income from sales/services	**10,00,000**	**0**
SCHEDULE 13- Grants/subsidies :		
Grants - DST	84,84,11,000	76,41,52,000
Grants - From governement agencies/travel grants etc.	0	0
Grants - From other institutes	0	0
Grants - Other international agencies	0	0
Total	**84,84,11,000**	**76,41,52,000**
SCHEDULE 14- Income from fee/subscriptions etc :		
Income from fee, subscriptions, medical contribution etc.	40,42,858	49,75,177
Total	**40,42,858**	**49,75,177**
SCHEDULE 15- Income from investments;	**0**	**0**
SCHEDULE 16- Royalty income, publication, licence fee etc:		
From royalty	0	0
Licence fee	2,54,976	1,42,772
Total	**2,54,976**	**1,42,772**
SCHEDULE 17- Interest earned:		
From term deposits	86,28,121	8,78,689
From SB acounts with nationalised banks	0	61,75,478
Interest earned - Others	14,310	5,69,344
Total	**86,42,431**	**76,23,511**
SCHEDULE 18- Other income:		
From visitors house, guest rooms, students residense etc.	18,54,996	75,33,657
CSIR fellowships, ICMS, SRFP reimbursement etc.	0	0
Prior year receipts	9,99,785	22,28,365
Miscellaneous income	44,10,188	5,39,020
From others (tender fee & other fee collected)	3,07,000	40,000
Other receipts (Uncashed cheques reversed)	0	1,18,654
Total	**75,71,969**	**1,04,59,695**
SCHEDULE 19- Increase/decrease in stock:	**0**	**0**

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2019

Description	2018-19 Amount in Rs.	2017-18 Amount in Rs.
SCHEDULE 20- Establishment expenses:		
Salaries & scholarship to students	27,46,03,178	27,60,39,593
Wages	8,95,34,821	8,52,81,342
Allowances (Medical reimbursements etc.,)	62,67,767	81,31,962
Bonus	0	0
Contribution to CPF	24,05,579	4,27,719
Contribution to new pension scheme	1,17,77,962	2,13,06,065
Contribution to group gratuity scheme	2,50,57,583	1,19,675
Leave encashment benefits	49,24,514	38,16,546
Retirement & Terminal Benefits- Pension	9,70,874	0
LTC	17,60,151	16,55,927
Total	**41,73,02,429**	**39,67,78,829**
SCHEDULE 21- Other Administrative expenses		
Electricity & power	5,65,07,965	5,87,44,857
Water charges	41,15,205	56,33,397
Insurance	8,92,749	7,67,394
Repairs & maintenance	5,87,11,472	6,28,77,396
Rents, rates & taxes	3,95,756	7,79,014
Vehicles running & maintenance	29,08,125	61,32,453
Postage, telephone & communication	22,27,727	25,95,437
Printing, stationery, books	53,06,076	60,71,450
Travelling and conveyance	47,34,273	44,51,066
Expenses on seminars/workshops/discussion meetings	1,02,56,530	80,76,512
Membership & subscriptions	18,82,692	1,17,95,518
Professional charges	1,44,900	15,27,260
Laboratory consumables	3,63,25,043	4,06,38,869
Advertisement & publicity	23,70,926	35,62,260
Student residence, guest house, I house, etc	9,97,320	2,50,428
Statutory audit fee	1,18,000	95,200
POBE & POCE prgramme	9,82,953	9,31,044
Summer research fellowship & student programme	10,85,215	13,12,022
ICMS - Workshops, Schools etc,.	37,99,513	8,73,656
ICMS - Visitor programmes (National & international)	53,101	1,45,754
ICMS - Recurring expenses	1,59,96,914	1,77,03,729
Loss : Nano Science Block - Fire Accident	6,73,309	0
Total	**21,04,85,763**	**23,49,64,714**
SCHEDULE 22- Expenditure on grants, subsidies etc:	**0**	**0**
SCHEDULE 23- Interest and bank charges:	**21,385**	**9,950**

B.R.V. GOUD & CO CHARTERED ACCOUNTANTS B'LORE-4

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2019
SCHEDULE 24: SIGNIFICANT ACCOUNTING POLICIES

OVERVIEW:

Jawaharlal Nehru Centre For Advanced Scientific Research is registered as a society under the Karnataka Societies Registration Act, 1960 and 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 Ph.Ds 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. **Accounting Conventions**: The financial statements are drawn up in accordance with historical accounting conventions and on the going concern concept. Accrual method of accounting is followed to record Income and Expenditure.
   The guidelines as per the Uniform Format of Accounts for Central Autonomous Institutions, as applicable and to the extent practicable, are followed in the presentation of the financial statements of the Centre.

2. **Investments**: Investments are stated at cost and Interest from Investments are accounted on accrual basis.

3. **Fixed Assets**: Fixed assets are accounted at cost of acquisition, inclusive of inward freight, duties, taxes and incidental expenses related to acquisition.

4. **Depreciation**: Depreciation on Fixed assets has been provided on Straight line Method.

5. **Government Grants / Other Grants**: The Grants received are recognized in the accounts on realisation basis. Grants received and utilized for procurement of Fixed Assets have been reduced from the total grants received in the Income and Expenditure Account and the same have been included under the Capital Fund Account.

6. **Retirement Benefits:**
   The centre has obtained group gratuity policy from the Life Insurance Corporation of India in respect of gratuity and accordingly, premium has been paid annually. No provision has been made in respect of the Leave Encashment as required by AS 15. However, the same is accounted on cash basis as and when the liability is discharged.

7. **Allocation / Transfer to Schemes :** The Centre has a policy to allocate / transfer interest earned on investments relating to certain schemes.

8. **Foreign Currency and its Fluctuations :** The Foreign currency transactions are translated at the rates prevailing on the date of transaction. Fluctuations in foreign currency on account of procurement of fixed assets are capitalized with the respective fixed assets.

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

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 liability	2018-19 (Amount)	2017-18 (Amount)
1. Claims against the entity not acknowledged as debts	Nil	Nil
2. Letter of Credit outstanding	Nil	Nil

B. NOTES ON ACCOUNTS:

1. The amount of Rs.84,84,11,000/- Indicated in Income and Expenditure Account Grants/ subsidies Income includes Rs.14,44,29,000/- towards capital component for which specific grants have been released by DST, GoI during the financial year.

2. Figures are rounded off to the nearest rupee and figures of previous year have been regrouped and reclassified to conform to that of the current year.

3. Depreciation on fixed assets amounting to Rs. 10,43,77,423/- calculated for the year is debited to the Income and Expenditure Account. Depreciation Reserve is Credited by debiting the corresponding amount to the Capital/corpus Fund.

4. **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.

5. Schedules 1 to 25 are annexed to and form an integral part of the Balance Sheet as at 31st March 2019 and the Income and Expenditure Account for the year ended on that date.

Prof. K. S. Narayan
President in Charge

Joydeep Deb
Administrative Officer

Sampad Patra
Accounts Officer

For M/s B.R.V. Goud & Co.
Chartered Accountants

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

[A.B. Shiva Subramanyam]
Partner
M.no.: 201108

Place : Bangalore
Date : 31/07/2019

JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019

Amount in Rs.

OPENING BALANCES & RECEIPTS	2018-19	2017-18	PAYMENTS & CLOSING BALANCES	2018-19	2017-18
I. Opening Balances :			I. Expenses :		
- Cash in hand & imprest at Centre	39,000	51,435	- Establishment Expenses	52,07,77,367	38,94,26,281
- Cash in hand & imprest at Scheme Fund	0	0	- Administrative Expenses	90,98,80,883	97,77,82,499
Bank balances:			- Expenditure out of Endowments	58,91,394	31,66,158
In savings bank Accounts :			Sub Total :	1,43,65,49,644	1,37,03,74,937
- Canara Bank - Grant A/c	63,09,733	5,59,91,316			
- Canara Bank - Endowment A/c	68,64,183	61,37,974			
- Canara Bank - Scheme A/c	1,28,37,801	47,53,917			
- State Bank Of India	1,09,04,360	28,33,039	II. Expenditure on Fixed assets and		
- HDFC BANK	15,94,100	37,018	Capital Work-in-progress :		
			- Purchase of fixed assets	67,36,37,095	36,92,72,193
In Deposit accounts :					
- At Canara Bank	3,50,00,000	5,34,67,000			
- At SBI	1,00,49,963	7,72,66,669	III. Refund of surplus money/loans	0	0
- At HDFC Trust	8,77,05,500	8,77,05,500			
- At PNB	3,25,00,000	1,75,00,000	IV. Finance charges(Bank charges)	36,697	20,054
- At SHC of India	6,30,00,000	3,80,00,000			
- At Canara Bank (Grant A/c)	12,00,00,000	7,25,00,000			
- Fixed Deposit (Scheme A/c)	98,76,01,317	78,25,35,423			
Sub Total :	1,37,44,05,957	1,19,87,79,292			
II. Grants Received :			V. Other payments :		
			- Earnest money deposit returned	0	0
- From DST-Grant in aid	84,84,11,000	76,41,52,000	- Staff advances (Festival adv. etc.)	0	49,350
- Scheme Funds	72,13,78,901	99,64,96,141	- Other advances	76,28,63,093	63,17,26,913
- On behalf of endowments/corpus,others	2,27,00,000	2,15,10,000	- Security deposit returned	5,23,940	14,54,048
	1,59,24,89,901	1,78,21,58,141	- TDS payments	5,44,76,006	2,87,40,442
III. Income on Investments :			- Professional tax	0	7,74,400
Interest on FD's :			- Provident fund	14,29,79,958	2,32,04,221
- From earmarked/endowment funds	1,37,41,092	2,12,44,419	- Advances to faculty	0	8,40,835
- From own funds	46,12,227	8,02,415	- Payment to sundry creditors	72,51,154	18,38,914
- From Scheme Funds	2,04,12,840	3,06,73,530	- Advances to CPF Account	0	8,15,80,000
Sub Total :	3,87,66,159	5,27,20,364	Sub Total :	96,80,94,151	77,02,09,123
IV. Interest received on SB accounts :			VI. Closing Balances :		
- From grant in aid	46,24,498	61,75,478			
- From own funds	0	5,69,344	- Cash in hand & Imprest at centre	40,000	39,000
- From Scheme Funds	33,11,986	33,95,516	- Bank balances:		
Sub Total :	79,36,484	1,01,40,338	*In savings bank accounts at :*		
			- Canara Bank - Grant A/c	7,15,69,598	63,09,733
			- Canara Bank - Endowment A/c	2,30,66,959	68,64,183
V. Other Income :			- State Bank Of India	3,21,29,131	1,09,04,360
- Collections from visitors, guest room etc	57,33,095	0	- HDFC BANK	60,10,180	15,94,100
- From fee, subscription etc	21,81,446	21,75,213	- Canara Bank - Scheme A/c	13,25,10,629	1,28,37,801
- CSIR fellowships,UGC, DBT, SRFP	2,39,12,487	91,27,755			
- Overhead recoveries	2,49,74,339	1,00,00,000			
Sub total :	5,68,01,367	2,13,02,968	Sub Total :	26,53,26,498	3,85,49,177
Balance carried forward	3,07,03,99,869	3,06,51,01,103	Balance carried forward	3,34,36,44,085	2,54,84,25,484

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS BANGALORE-4

JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2019 (Contd...)

Amount in Rs.

OPENING BALANCES & RECEIPTS	2018-19	2017-18	PAYMENTS & CLOSING BALANCES	2018-19	2017-18
Balance Brought Forward	3,07,03,99,869	3,06,51,01,103	Balance Brought Forward	3,34,36,44,085	2,54,84,25,484
VI. Other receipts :			*In deposit accounts at :*		
- Income tax refunds	0	0	- At Canara Bank	0	3,50,00,000
- From Sundry Creditors	0	0	- At SBI	0	1,00,49,963
- Staff advances recovered	2,662	37,919	- At HDFC Trust	9,77,05,500	8,77,05,500
- Settlement of advance to faculty	4,36,870	7,45,982	- At PNB	10,35,00,000	3,25,00,000
- Earnest money received	0	0	- At SHC of India	6,30,00,000	6,30,00,000
- Project funding received	0	0	- At Canara Bank (Grant A/c)	8,84,32,125	12,00,00,000
- GSLI receipt	66,85,425	69,437	- At Canara Bank (Grant A/c) FCRA	98,557	0
- Support to meetings	1,65,24,634	83,71,373	- Fixed Deposit (Scheme A/c)	86,89,03,889	98,76,01,317
- Other	1,47,12,34,697	80,99,56,450			
Sub Total :	1,49,48,84,287	81,91,81,161	Sub Total :	1,22,16,40,071	1,33,58,56,780
TOTAL	4,56,52,84,156	3,88,42,82,264	TOTAL	4,56,52,84,156	3,88,42,82,264

For Jawaharlal Nehru Centre for Advanced Scientific Research

As per our report of even date,
for B.R.V. Goud & Co.
Chartered Accountants

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

[A.B. Shiva Subramanyam]
Partner
Membership No. 201108

Place : Bangalore
Date : 31/07/2019

Prof. K. S. Narayan
President in Charge

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 2019

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	3,61,48,876		Government of India 8 % Bonds (SHCIL)	4,95,00,000	
Add : Subscriptions received during the year	83,45,682		Fixed Deposits at PNB housing finance	3,75,00,000	
Advances repayments	6,03,862		Fixed Deposits at Canara bank	1,50,00,000	
Interest on subscriptions	30,21,658		Fixed Deposit at HDFC	2,30,00,000	12,50,00,000
Sub total	4,81,20,078				
Less : Advances / part finals granted	29,47,195		Cash at Bank :		
Less : Final settlement	19,73,414		Canara Bank, SB A/C No. 0683101017513	2,80,681	2,80,681
Sub total	49,20,609				
Closing balance		4,31,99,469	TDS receivable :		
			GoI Bonds (2012-13) receivable	1,48,000	
Contribution :			GoI Bonds (2014-15) receivable	1,48,000	
Opening balance	2,58,85,116		GoI Bonds (2015-16) receivable	1,49,400	
Add : Contribution during the year	56,59,328		GoI Bonds (2016-17) receivable	63,333	
Interest on total contributions	19,75,596		GoI Bonds (2017-18) receivable	23,532	
Sub total	3,35,20,040		Canara Bank (2018-19) receivable	1,40,020	6,72,285
Less : Final settlement	11,16,919				
Closing balance		3,24,03,121	Accrued interest :		
			Accrued interest on deposits in GoI 8 % Bonds (SHCIL)	84,62,705	
Payable to Endowment		45,36,000	Accrued interest on Deposits in PNB housing finance	75,83,258	
			Accrued interest on Deposits in Canara bank	43,56,892	
Payable to Corpus		7,18,11,488	Accrued interest on Deposits in HDFC	67,44,120	2,71,46,975
Balance surplus/deficit (-)		11,49,863			
Total		15,30,99,941	Total		15,30,99,941

For Jawaharlal Nehru Centre for Advanced Scientific Research

For B.R.V. Goud & Co.
Chartered Accountants, FRN : 000992S

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

[A.B. Shiva Subramanyam]
Partner
Membership No. 201108

Place : Bangalore,
Date : 31/07/2019

Prof. K. S. Narayan
President in Charge

Joydeep Deb
Administrative Officer

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
STATEMENT OF ENDOWMENT, CORPUS & OTHER FUNDS BALANCES AS ON 31/03/2019
(2018 - 19)

Rs. in Lakhs

PARTICULARS	Principal Endow. Fund	Opening balance 2018-19	Additions during 2018-19	Interest Received 2018-19	Interest Accrued 2018-19	Total 2018-19	Expen-diture 2018-19	Balance as on 2018-19
ENDOWMENT CHAIRS	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Hindustan Lever Ltd. & Gharda Chemicals Chair	32.00	45.46	0.00	2.55	0.00	48.01	3.60	44.41
Astra Zeneca & IBM Chair	20.00	51.97	0.00	1.60	0.00	53.57	0.00	53.57
DAE - Dr.Vikram Sarabhai Chair	22.00	32.36	0.00	1.71	0.00	34.07	0.00	34.07
DRDO & CSIR Chair	30.00	69.37	0.00	2.38	0.00	71.75	3.60	68.15
Silver Jubilee Professorship -Prof. C.N.R. Rao	25.00	27.57	0.00	2.10	0.00	29.67	1.80	27.87
TOTAL- ENDOWMENT CHAIRS	**129.00**	**226.73**	**0.00**	**10.34**	**0.00**	**237.07**	**9.00**	**228.07**
RELIANCE INDUSTRIES								
Prof.Linus Pauling Professorship	**84.34**	**97.55**	**0.00**	**6.89**	**0.00**	**104.44**	**23.19**	**81.25**
OTHER ENDOWMENT FUNDS								
Contribution from Prof.CNR Rao	4.25	13.06	0.00	0.00	0.55	13.61	0.26	13.35
Shantha Seetharamaiah Award	1.00	3.55	0.00	0.00	0.13	3.68	0.17	3.51
Bapu Narayanaswamy Prize	1.00	2.83	0.00	0.00	0.12	2.95	0.06	2.89
Prof. Roddam Narasimha Prize	2.00	2.87	0.00	0.17	0.00	3.04	0.00	3.04
Prof. M.K.Chandrashekaran Fund	5.43	4.35	0.00	0.31	0.00	4.66	0.00	4.66
TOTAL - OTHER ENDOWMENT FUNDS	**13.68**	**26.66**	**0.00**	**0.48**	**0.80**	**27.94**	**0.49**	**27.45**
LECTURE SERIES								
Dr. A.V.Rama Rao Fund	31.00	31.14	0.00	2.35	0.00	33.49	1.71	31.78
ISRO-Dr. Satish Dhawan	14.00	21.42	0.00	1.11	0.00	22.53	0.56	21.97
DAE-Dr. Raja Ramanna	15.00	16.32	0.00	1.14	0.00	17.46	0.95	16.51
DBT-Prof. V Ramalingaswamy	7.00	12.36	0.00	0.56	0.00	12.92	0.00	12.92
TOTAL - LECTURE SERIES	**67.00**	**81.24**	**0.00**	**5.16**	**0.00**	**86.40**	**3.22**	**83.18**
C.N.R. RAO HALL OF SCIENCE FUND	**170.00**	**211.58**	**0.00**	**11.70**	**4.04**	**227.32**	**17.81**	**209.51**
MATERIALS RESEARCH FUND	**149.06**	**207.90**	**0.00**	**8.64**	**5.64**	**222.18**	**0.84**	**221.34**
JNC - CORPUS FUND	**1,682.07**	**2639.3**	**106.09**	**131.07**	**76.94**	**2,953.40**	**32.19**	**2,921.21**
GRAND TOTAL	**2,295.15**	**3,490.96**	**106.09**	**174.28**	**87.42**	**3,858.75**	**86.74**	**3,772.01**

Sampad Patra
Accounts Officer

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH

Details of Scheme funds for the financial year 2018-2019

Sl. No.	Code	Particular	Opening Balance		Additions to the Funds		Utilisation/Exp. towards objectives of funds			Closing Balance	
			Debit	Credit	Receipts	Recredits	Fxed Assets	Salaries	Oth. Admin. Exp.	Debit	Credit
1	4037	DST/MKC	1,63,516	0	0	0	0	0	0	1,63,516	0
2	4041	CSIR/AA	0	1,39,376	0	0	0	0	0	0	1,39,376
3	4042	UTC/USA/RN	0	0	0	0	0	0	-17,685	0	17,685
4	4044	INF/RR	0	2,20,968	0	0	0	0	0	0	2,20,968
5	4048	INSA/VKS	58,378	0	0	0	0	0	0	58,378	0
6	4051	ARDB/RN	0	4,000	0	0	0	0	0	0	4,000
7	4052	DBT/RUK	1,30,972	0	0	0	0	0	0	1,30,972	0
8	4053	DBT/AA	3,55,267	0	0	0	0	0	0	3,55,267	0
9	4058	DST/AJ	0	5,000	0	0	0	0	0	0	5,000
10	4059	SIG/HB	30,526	0	0	0	0	0	0	30,526	0
11	4062	CSIR/TKK	22,445	0	0	0	0	0	0	22,445	0
12	4063	DAE/CNR	0	7,87,513	0	0	0	0	0	0	7,87,513
13	4064	DST/CNR	0	2,61,088	0	0	0	0	0	0	2,61,088
14	4066	DBT/AA	3,28,461	0	0	0	0	0	0	3,28,461	0
15	4070	DRDO/CNR	15,075	0	0	0	0	0	0	15,075	0
16	4071	DST/RUK	0	3,54,148	0	0	0	0	0	0	3,54,148
17	4072	DBT/KNG	0	20,33,705	0	0	0	0	0	0	20,33,705
18	4073	CSIR/MI	0	2,450	0	0	0	0	0	0	2,450
19	4074	REL/CNR	0	1,27,700	0	0	0	0	0	0	1,27,700
20	4075	DRDO/RG	0	10,961	0	0	0	0	0	0	10,961
21	4076	ICMR/HB	4,615	0	0	0	0	0	0	4,615	0
22	4077	IT/KSN	0	335	0	0	0	0	0	0	335
23	4078	DAE/TKK	5,011	0	0	0	0	0	0	5,011	0
24	4079	DBT/NS	36,982	0	0	0	0	0	0	36,982	0
25	4082	DRDO/KSN	0	887	0	0	0	0	0	0	887
26	4083	DST/MI	10,856	0	0	0	0	0	0	10,856	0

B.R.V. SOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

27	4084	DBT/HB	0	79,865	0	0	0	0	0	0	79,865
28	4085	TWAS/CNR	0	65,891	0	0	0	0	0	0	65,891
29	4086	MULTIMEDIA	18,500	0	0	0	0	0	0	18,500	0
30	4087	IJMM/CNR-OB	4,50,000	0	0	0	0	0	0	4,50,000	0
31	4089	INSA/MM	0	6,99,975	0	0	0	0	0	0	6,99,975
32	4093	CSIR/SN	2,250	0	0	0	0	0	0	2,250	0
33	4095	DST/DRF/TKK	0	12,129	0	0	0	0	0	0	12,129
34	4096	DST/SN	0	1,500	0	0	0	0	0	0	1,500
35	4097	JNC/NS	0	3,00,492	0	0	0	0	0	0	3,00,492
36	4098	DST/TKK	2,75,295	0	0	0	0	0	0	2,75,295	0
37	4099	DST/GUK	97,970	0	0	0	0	0	0	97,970	0
38	4100	CSIR/SKP	2,527	0	0	0	0	0	0	2,527	0
39	4102	DBT/DG/AA	0	67,035	0	0	0	0	0	0	67,035
40	4104	INSA/KSV	1,05,343	0	0	0	0	0	0	1,05,343	0
41	4105	ICMR/NS	301	0	0	0	0	0	0	301	0
42	4106	DST/AKR	10,312	0	0	0	0	0	0	10,312	0
43	4107	DSERT	1,19,464	0	0	0	0	0	0	1,19,464	0
44	4109	AECOM/RUK	5,836	0	0	0	0	0	0	5,836	0
45	4111	DBT/SB	0	9,655	0	0	0	0	0	0	9,655
46	4113	ICMR/AA	0	2,29,542	0	0	0	0	0	0	2,29,542
47	4114	IUPAC/CNR-EQUIP.	0	5,69,013	0	0	0	0	0	0	5,69,013
48	4115	DBT/RUK	237	0	0	0	0	0	0	237	0
49	4116	DST/SKP	18,548	0	0	0	0	0	0	18,548	0
50	4117	DST/EDCS	326	0	0	0	0	0	0	326	0
51	4119	DBT/AA	17,17,113	0	0	0	0	0	0	17,17,113	0
52	4121	ISRO-LPSC/ARR	0	72,153	0	0	0	0	0	0	72,153
53	4122	MIT/KSN	32,794	0	0	0	0	0	0	32,794	0
54	4123	DST-VDPL/RUK	73,642	0	0	0	0	0	0	73,642	0
55	4124	DRDO/RN	22,425	0	0	0	0	0	0	22,425	0
56	4126	DUPONT/UW	0	1,62,570	0	0	0	0	0	0	1,62,570
57	4127	SOP/	0	1,41,885	0	0	0	0	0	0	1,41,885
58	4128	DST/PFNT	10,18,907	0	1,30,59,781	0	0	28,40,484	6,65,437	0	85,34,953
59	4129	DBT/MI	35,463	0	0	0	-4,406	3,581	-34,638	0	0

60	4130	DAE/BRNS/CNR	0	2,41,551	0	0	0	0	0	0	2,41,551
61	4131	CSIR/HB	81,231	0	0	0	0	0	0	81,231	0
62	4132	DBT/RUK	10,338	0	0	0	0	0	0	10,338	0
63	4133	CSIR/HB	1,64,849	0	0	0	0	0	0	1,64,849	0
64	4134	ICMR/RUK	15,141	0	0	0	0	0	0	15,141	0
65	4135	DST/MIPL/RUK	1,28,765	0	1,24,814	0	0	0	-3,951	0	0
66	4136	DST/AJ	18,509	0	0	0	0	0	0	18,509	0
67	4137	DBT/MRS.RAO	1,63,923	0	0	0	0	0	0	1,63,923	0
68	4138	NPOL/RG	65,453	0	0	0	0	0	0	65,453	0
69	4139	NPOL/KRS	38,614	0	0	0	0	0	0	38,614	0
70	4140	DST/GUK	0	34,52,216	0	0	0	0	0	0	34,52,216
71	4141	DST/SB	84,400	0	0	0	0	0	0	84,400	0
72	4142	IDS/RN	0	3,56,244	0	0	0	0	0	0	3,56,244
73	4143	CSIR/SB	21,028	0	0	0	0	0	0	21,028	0
74	4144	CSIR/MI	1,18,646	0	0	0	0	0	0	1,18,646	0
75	4145	DBT/TKK	1,01,515	0	0	0	0	0	0	1,01,515	0
76	4146	SMALL BAL.-CONTING.	0	6,89,158	0	0	0	0	0	0	6,89,158
77	4147	UGC-CONTINGENCY	0	1,82,576	0	0	0	0	0	0	1,82,576
78	4148	CSIR-CONTINGENCY	0	4,29,860	0	0	0	0	0	0	4,29,860
79	4150	DBT/TKK	1,94,103	0	0	0	0	0	0	1,94,103	0
80	4152	ICMR/TKK	2,47,382	0	0	0	0	0	0	2,47,382	0
81	4153	DST/RUK	0	1,53,454	0	0	0	0	0	0	1,53,454
82	4154	DAE/TKK	1,64,301	0	0	0	0	0	0	1,64,301	0
83	4155	DBT/NS	0	14,253	0	0	0	0	0	0	14,253
84	4157	CSIR/MRS RAO	7,483	0	0	0	0	0	0	7,483	0
85	4158	DBT/MI	0	4,26,528	0	0	0	0	0	0	4,26,528
86	4159	DAE/AA	0	2,15,630	0	0	0	0	0	0	2,15,630
87	4161	DBT/NS	1,05,786	0	0	0	0	0	0	1,05,786	0
88	4163	IFCPAR/NC	355	0	0	0	0	0	0	355	0
89	4164	DST/JCB/MRS	25,813	0	0	0	0	0	0	25,813	0
90	4165	AECOM/RUK	1,60,261	0	0	0	0	0	-1,40,261	20,000	0
91	4166	DBT/RUK	42,600	0	0	0	0	0	0	42,600	0
92	4168	DST/MI	18,329	0	0	0	0	0	0	18,329	0

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93	4169	CSIR/KS	3,260	0	0	0	0	0	0	3,260	0
94	4170	ICMR/NS	2,24,691	0	0	0	-2,24,691	0	0	0	0
95	4171	DBT/NS	0	2,34,213	0	0	0	0	0	0	2,34,213
96	4173	DST/NS	0	1,41,147	0	0	0	75,147	66,000	0	0
97	4175	DST/VK	21,016	0	0	0	0	0	0	21,016	0
98	4176	DST/KRS	0	2,13,033	0	0	0	0	21,408	0	1,91,625
99	4178	ICMR/NS	0	5,60,394	0	0	0	0	2,24,691	0	3,35,703
100	4179	BRUCKER AXS	0	98,108	0	0	0	0	0	0	98,108
101	4180	CSIR/SMD	0	6,37,635	0	0	0	0	0	0	6,37,635
102	4181	IFCPAR/SHN	0	52,507	0	0	0	0	0	0	52,507
103	4182	MIPL/SHN	1,483	0	0	0	0	0	0	1,483	0
104	4183	MIPL/UW	11,630	0	0	0	0	0	-11,630	0	0
105	4185	CSIR/SKP	0	74,616	0	0	0	0	0	0	74,616
106	4187	GTRE/SMD	0	5,80,015	0	0	0	0	0	0	5,80,015
107	4189	DBT/AA	12,32,132	0	0	0	0	0	0	12,32,132	0
108	4190	MPI/MA	0	12,713	0	0	0	0	0	0	12,713
109	4191	DST/KSN	12,318	0	0	0	0	0	0	12,318	0
110	4192	DST/KS	1,86,590	0	0	0	0	43,852	-2,30,442	0	0
111	4193	DBT/TKK-EM	0	1,766	0	0	0	0	0	0	1,766
112	4195	DST/TKM	94,586	0	0	0	0	0	0	94,586	0
113	4196	DST-FIST/KBS	0	32,000	0	0	0	0	0	0	32,000
114	4197	P&G/UW	0	96,291	0	0	0	0	12,241	0	84,050
115	4198	AOARD/SKP	37,731	0	0	0	0	0	0	37,731	0
116	4199	DBT/MRS	50,309	0	0	0	0	0	0	50,309	0
117	4200	IFCPAR/TKK	0	97,682	0	0	0	0	0	0	97,682
118	4201	AOARD/KRS	0	90,443	0	0	0	0	65,674	0	24,769
119	4203	DST/TNCV	13,32,342	0	0	0	0	0	0	13,32,342	0
120	4206	ICPCNN/GUK	14,50,159	0	0	0	0	0	5,677	14,55,836	0
121	4208	DBT/KS	3,62,295	0	0	0	0	0	0	3,62,295	0
122	4209	DST/SMD	0	4,01,722	0	0	0	0	0	0	4,01,722
123	4210	ICAR/TKK	0	2,48,986	0	0	0	0	0	0	2,48,986
124	4212	YNL/GUK/HB/EM	39,059	0	0	0	0	0	0	39,059	0
125	4213	DST/SA	36,30,285	0	0	0	0	0	0	36,30,285	0

126	4215	DAE/KSN	0	10,000	0	0	0	0	0	0	10,000
127	4216	BARC/MA	362	0	0	0	0	0	0	362	0
128	4218	DST/SKP	19,189	0	0	0	0	0	0	19,189	0
129	4219	DST/INS&T	48,928	0	0	0	0	0	0	48,928	0
130	4220	IUSSTF/GUK	9,16,740	0	0	0	0	0	0	9,16,740	0
131	4222	DBT/TKK	2,51,521	0	0	0	0	0	0	2,51,521	0
132	4223	IBM/UW	0	1,22,567	0	0	0	0	0	0	1,22,567
133	4225	DST/SS	2,17,136	0	0	0	0	0	0	2,17,136	0
134	4227	ICMR/RUK	0	7,936	0	0	0	0	0	0	7,936
135	4228	DST/SHN	1,57,085	0	0	0	0	0	0	1,57,085	0
136	4229	DST/HB	0	40,831	0	0	0	0	0	0	40,831
137	4230	DBT/MI	28,939	0	0	0	0	0	-28,939	0	0
138	4231	DBT/HB	46,243	0	0	0	0	0	0	46,243	0
139	4232	CSIR/TNCV	1,52,544	0	0	0	0	0	0	1,52,544	0
140	4233	DBT/AA	2,06,789	0	0	0	0	0	0	2,06,789	0
141	4234	NAL/RN	0	6,145	0	0	0	0	0	0	6,145
142	4235	DST/SMS	0	62,793	0	0	0	0	0	0	62,793
143	4237	INSA/HI	43,427	0	0	0	0	0	0	43,427	0
144	4238	VGST-SOP/	0	16,42,830	0	0	0	0	0	0	16,42,830
145	4239	DST/RUK	2,49,927	0	0	0	0	0	0	2,49,927	0
146	4240	DST/TG	7,52,659	0	0	0	0	0	0	7,52,659	0
147	4241	NGS/TNCV	36,500	0	0	0	0	0	0	36,500	0
148	4242	NPOL/KRS	6,09,511	0	0	0	0	0	0	6,09,511	0
149	4243	NPOL/KRS	0	4,52,016	0	0	0	0	0	0	4,52,016
150	4247	SRC/SHN	0	5,47,873	0	0	0	0	0	0	5,47,873
151	4248	ICMR/RUK	6,67,842	0	0	0	0	0	0	6,67,842	0
152	4251	AOARD/UW	24,192	0	0	0	0	0	-24,192	0	0
153	4252	DST-JCB/TKK	39,548	0	19,35,451	0	0	13,81,100	4,99,667	0	15,136
154	4253	DST/SKD	1,15,419	0	0	0	0	0	0	1,15,419	0
155	4254	DST/JH	3,12,285	0	0	0	0	0	0	3,12,285	0
156	4257	NAL/SMD	4,33,230	0	0	0	0	0	0	4,33,230	0
157	4258	DST/AKM	7,05,565	0	0	0	0	0	2,03,500	9,09,065	0
158	4259	DST/UW	1,56,934	0	0	0	0	0	0	1,56,934	0

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159	4262	DST/HB	3,60,110	0	0	0	0	0	0	3,60,110	0
160	4263	DST/TKK	16,674	0	0	0	0	0	0	16,674	0
161	4265	DAE/MA	1,39,028	0	0	0	0	-1,12,500	-26,528	0	0
162	4266	CSIR/HI	74,971	0	0	0	0	0	0	74,971	0
163	4267	GEGR/UW	0	1,62,265	0	0	0	0	0	0	1,62,265
164	4268	SRL/NC	5,594	0	0	0	0	0	0	5,594	0
165	4270	DST/RUK	0	20,000	0	0	0	0	0	0	20,000
166	4272	DST/UKG	3,219	0	0	0	0	0	0	3,219	0
167	4273	WT-DBT/RM	2,41,233	0	2,41,233	0	0	0	0	0	0
168	4274	DBT/KS	5,83,343	0	0	0	0	0	0	5,83,343	0
169	4275	NMRL-DRDO/SB	0	8,977	0	0	0	0	0	0	8,977
170	4276	DBT/TG	12,163	0	0	0	0	0	189	12,352	0
171	4277	SHELL/SB	0	7,63,521	0	0	0	0	7,668	0	7,55,853
172	4279	DST/GUK	166	0	0	0	0	0	0	166	0
173	4280	DST/GP	3,08,285	0	0	0	0	0	0	3,08,285	0
174	4281	DST/BMP	4,19,901	0	0	0	0	0	0	4,19,901	0
175	4282	DBT/TKK-RUK	0	3,14,167	0	0	0	0	0	0	3,14,167
176	4283	NCI/EM	0	92,001	0	0	0	0	43,398	0	48,603
177	4284	DBT/TKK-EM	0	30,162	0	0	0	0	0	0	30,162
178	4285	WT/MI	25,970	0	0	0	0	0	0	25,970	0
179	4286	DST/GUK	0	57,84,550	-1,01,818	0	32,49,341	0	4,98,996	0	19,34,395
180	4287	ADE/KRS	0	9,712	0	0	0	0	0	0	9,712
181	4288	INTEL/RN	6,16,803	0	0	0	0	0	0	6,16,803	0
182	4289	INTEL/SMD	1,80,424	0	0	0	0	0	0	1,80,424	0
183	4290	INTEL/SA	0	79,002	0	0	0	0	0	0	79,002
184	4292	SERB/AJ	0	11,12,771	4,13,366	0	0	9,85,630	4,30,034	0	1,10,473
185	4293	SERB/KB	9,55,091	0	0	0	0	0	0	9,55,091	0
186	4294	DST/SB	0	91,13,766	40,83,449	0	16,96,805	23,53,556	8,25,966	0	83,20,888
187	4295	DFRL/GUK	19,092	0	0	0	0	0	0	19,092	0
188	4297	UGC-DAE/SCP	99,865	0	0	0	0	0	0	99,865	0
189	4298	LEOS-ISRO/NC	7,37,221	0	0	0	0	0	0	7,37,221	0
190	4300	DBT/TKK	19,02,409	0	0	0	0	0	0	19,02,409	0
191	4301	DBT/KS	1,89,347	0	0	0	0	0	0	1,89,347	0

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192	4302	SERB/RD	1,07,814	0	0	0	0	0	0	1,07,814	0
193	4307	DBT/MI-HB	4,49,626	0	27,116	0	0	0	0	4,22,510	0
194	4308	HPCL/RM	0	2,39,309	0	0	0	0	0	0	2,39,309
195	4311	DST/RN	8,56,113	0	0	0	0	0	0	8,56,113	0
196	4312	DBT/KS	1,52,000	0	0	0	0	0	0	1,52,000	0
197	4313	ICMR/NS	0	9,61,929	0	0	0	0	7,60,743	0	2,01,186
198	4314	CSIR/TG	3,77,469	0	0	0	0	0	0	3,77,469	0
199	4316	DST-JCB/SKP	4,698	0	9,00,000	0	0	3,52,067	5,43,235	0	0
200	4317	DBT/KS	0	4,405	0	0	0	0	4,405	0	0
201	4318	SERB/KS	1,212	0	0	0	0	0	0	1,212	0
202	4319	ICMR/AA	0	6,54,036	0	0	0	4,93,023	1,76,998	15,985	0
203	4320	DST/RV	62,558	0	0	0	0	0	0	62,558	0
204	4323	DBT/MI	0	3,71,685	0	0	0	67,916	3,03,769	0	0
205	4324	EU/SKP/SJG	0	29,99,307	19,24,534	76,591	0	7,78,000	10,84,077	0	31,38,355
206	4325	INCOIS/CPR	0	24,994	0	0	0	0	0	0	24,994
207	4326	DST-JCB/UW	0	4,50,811	12,15,553	0	0	10,17,623	7,05,754	57,013	0
208	4327	SERB/SKN	47,323	0	0	0	0	0	0	47,323	0
209	4330	SERB/MRS	1,58,506	0	28,28,009	0	0	11,62,753	15,04,717	0	2,033
210	4331	SERB/KBS	0	22,572	28,78,505	0	0	8,44,800	18,24,895	0	2,31,382
211	4332	SERB/RJNMEETING	0	2,38,928	3,54,299	0	0	0	4,77,079	0	1,16,148
212	4333	SERB/TG	4,83,351	0	0	0	0	0	0	4,83,351	0
213	4334	SERB/JC	5,93,576	0	0	0	0	-27,048	-25,394	5,41,134	0
214	4335	UKIERI/UW	0	1,218	0	0	0	0	0	0	1,218
215	4336	IKST/UW	0	29,75,413	0	0	0	5,13,000	6,64,457	0	17,97,956
216	4337	DBT/MRS	3,42,306	0	48,18,966	0	0	8,43,675	25,36,179	0	10,96,806
217	4339	SHELL/SN	0	26,693	0	0	0	0	0	0	26,693
218	4340	DST/JH	14,447	0	14,447	0	0	0	5,233	5,233	0
219	4341	SERB/RUK	7,458	0	7,458	0	0	0	0	0	0
220	4342	SHELL/EM	0	12,57,713	0	0	0	0	1,84,755	0	10,72,958
221	4343	DST/KSN	0	3,75,732	11,862	0	80,825	1,03,120	2,72,576	68,927	0
222	4344	CSIR/SCP	31,768	0	0	0	0	0	77,682	1,09,450	0
223	4345	DBT/EM	0	13,612	0	0	0	0	13,612	0	0
224	4346	AOARD/UW	0	20,08,139	75,470	0	1,69,365	0	4,78,818	0	14,35,426

225	4347	CEFIPRA/UW	1,68,220	0	-13,500	0	0	0	-1,81,720	0	0
226	4348	DBT/TG	0	4,53,574	0	0	0	76,937	3,76,637	0	0
227	4349	SERB/JB	0	1,79,836	1,57,565	0	1,768	0	3,35,633	0	0
228	4350	BARC/MA	0	16,94,532	16,37,379	8,361	19,41,663	7,23,458	5,52,840	0	1,22,311
229	4351	DBT/TKK	0	3,55,923	4,844	0	0	0	4,20,044	59,277	0
230	4352	CEFIPRA/SN	6,89,813	0	45,500	0	0	0	48,192	6,92,505	0
231	4353	DST-PETRA/NC	0	17,32,13,122	18,78,20,935	2,64,510	16,54,95,728	1,61,677	13,51,64,453	0	6,04,76,709
232	4354	PHE/JH	0	6,96,279	0	0	0	0	2,95,910	0	4,00,369
233	4355	SERB/SA	0	1,31,771	86	0	0	0	1,95,699	63,842	0
234	4356	MDPL/RUK	1,13,575	0	0	0	0	0	-1,13,575	0	0
235	4357	ICMR/AA	0	19,19,131	10,000	0	0	0	15,43,416	0	3,85,715
236	4358	DST/KB	0	19,12,140	1,05,58,085	0	0	2,27,000	49,64,478	0	72,78,747
237	4359	SERB-JCB/KSN	0	9,91,878	15,54,657	0	0	14,07,647	7,07,163	0	4,31,725
238	4360	MOES/CPR	0	3,47,085	5,12,898	0	0	46,800	3,31,802	0	4,81,381
239	4361	DBT/RUK	76,389	0	0	0	0	3,90,000	2,69,490	7,35,879	0
240	4362	SERB/AS	51,798	0	2,50,000	0	0	0	1,02,191	0	96,011
241	4363	SERB/SCP	1,46,440	0	8,00,000	0	0	2,02,297	3,60,997	0	90,266
242	4364	DST/KSN	0	7,35,964	0	0	0	0	7,35,964	0	0
243	4365	DAE/KB	0	1,67,036	11,315	0	0	0	2,19,915	41,564	0
244	4366	SERB-JCB/SS	0	2,09,035	17,90,185	14,007	0	3,00,000	15,97,444	0	1,15,783
245	4367	SERB/VG	0	44,714	4,00,000	0	82	3,54,839	99,857	10,064	0
246	4368	HPCL/KRS	2,97,443	0	3,28,181	0	0	0	30,738	0	0
247	4369	AOARD/SKP	11,472	0	0	0	0	0	-11,472	0	0
248	4371	DST/TKK	0	3,07,828	12,282	0	0	7,74,800	56,038	5,10,728	0
249	4372	SHELL/UW	0	4,000	0	0	0	0	0	0	4,000
250	4373	SERB/VKS	0	6,34,951	0	0	-51,256	0	6,86,207	0	0
251	4374	DBT/HB	0	14,93,802	0	0	0	2,87,083	9,06,515	0	3,00,204
252	4375	SERB/HB	0	3,47,707	8,18,968	0	-17,678	33,500	7,88,957	0	3,61,896
253	4376	DST-TRC/KSN	0	36,17,24,957	4,21,31,737	15,500	15,04,85,984	73,96,578	4,22,54,518	0	20,37,35,114
254	4377	IKST/SN	0	10,59,600	0	0	0	0	87,694	0	9,71,906
255	4378	SRISTI/JH	3,29,970	0	15,000	0	0	0	27,127	3,42,097	0
256	4379	IKST/SKP	57,152	0	0	0	0	0	0	57,152	0
257	4380	SERB-JCB/VN	0	2,27,826	24,54,762	0	0	4,00,800	22,67,788	0	14,000

258	4382	SERB/TKM	0	2,84,599	7,59,010	0	0	3,67,251	3,82,047	0	2,94,311
259	4383	BIRAC/JH	0	73,848	1,15,448	0	0	0	1,89,296	0	0
260	4384	DBT/HB	0	8,08,590	11,863	0	0	3,38,893	5,46,826	65,266	0
261	4385	DST-OVF/JNC	0	23,08,465	1,01,33,597	0	0	0	29,23,856	0	95,18,206
262	4386	DST-BEAMLINE/NC	0	3,23,92,933	53,68,576	0	1,05,43,870	31,57,833	2,28,91,183	0	11,68,623
263	4387	DST/MKS-ANJ	0	4,15,93,800	17,00,178	0	1,87,27,350	5,09,516	1,00,58,751	0	1,39,98,361
264	4388	IFCPAR/MI	0	9,20,959	2,33,727	0	0	4,31,947	5,85,743	0	1,36,996
265	4390	SERB/SKS	0	62,415	8,09,093	0	0	6,60,000	73,612	0	1,37,896
266	4391	SERB/S.RAJARAM	0	44,447	3,276	0	0	0	1,82,857	1,35,134	0
267	4392	SERB/SKM	0	4,199	0	0	0	0	4,199	0	0
268	4393	SERB/NG	0	1,81,910	7,261	0	0	25,667	2,02,428	38,924	0
269	4394	DAE-NBHM/SJ	0	1,37,703	0	0	0	0	0	0	1,37,703
270	4395	TRC-JNC/KS	0	2,08,888	14,14,000	0	0	3,84,000	11,45,714	0	93,174
271	4396	TRC-JNC/KB	0	13,62,804	23,882	0	2,60,400	1,21,680	8,82,185	0	1,22,421
272	4397	TRC-JNC/SJG-KSN	0	3,26,766	0	0	0	58,777	0	0	2,67,989
273	4398	TRC-JNC/NC-RUK	0	69,55,169	0	0	27,54,729	2,14,500	5,25,713	0	34,60,227
274	4399	SRISTI/DSSM	1,971	0	7,84,251	0	0	5,63,109	59,646	0	1,59,525
275	4400	DST-DAAD/SCP	90,586	0	0	0	0	0	0	90,586	0
276	4401	SERB/KK	0	89,712	42	0	0	1,75,645	1,71,460	2,57,351	0
277	4402	SERB/RM	79,281	0	15,67,106	0	0	3,97,673	7,46,035	0	3,44,117
278	4403	SERB/VSM	0	1,88,578	0	0	0	0	1,88,578	0	0
279	4404	SERB/AG	2,48,492	0	0	0	0	0	0	2,48,492	0
280	4405	SERB/SREEDEVI P	99,223	0	3,00,274	0	0	2,20,000	-3,548	15,401	0
281	4406	SERB/LG	14,514	0	0	0	0	6,60,000	1,10,232	7,84,746	0
282	4407	DBT/TKK-EM	25,671	0	25,70,569	5,90,370	5,90,370	8,05,087	10,07,567	0	7,32,244
283	4408	SERB/KB	0	13,23,442	9,25,719	0	9,44,146	5,79,098	3,02,913	0	4,23,004
284	4409	CSIR/RUK	0	2,70,236	2,33,904	0	0	0	4,80,052	0	24,088
285	4410	SERB/NKK	0	2,85,439	0	0	0	0	2,85,439	0	0
286	4411	INSA/RV	0	1,62,693	4,006	0	0	60,806	2,17,616	1,11,723	0
287	4412	DST/SCP	0	13,61,458	72,423	0	11,00,427	3,90,000	7,00,098	7,56,644	0
288	4413	DBT/SSA	0	6,62,609	11,83,181	0	0	4,31,900	5,83,612	0	8,30,278
289	4414	DST/VN	0	1,09,637	0	0	0	0	10,45,282	9,35,645	0
290	4415	TRC-JNC/TKM	0	10,31,987	0	0	3,20,127	2,71,200	45,043	0	3,95,617

291	4416	TRC-JNC/KSN	0	49,48,463	16,20,000	0	7,33,639	0	3,66,216	0	54,68,608
292	4417	TRC-JNC/SCP	0	10,66,321	0	0	1,90,723	3,60,360	64,714	0	4,50,524
293	4418	DST/RG	2,52,580	0	17,25,018	0	0	15,37,431	4,42,936	5,07,929	0
294	4419	SRISTI/SG-JH	0	2,455	0	0	0	0	0	0	2,455
295	4420	CEFIPRA/SCP	0	3,98,695	9,39,090	0	0	4,68,000	2,15,792	0	6,53,993
296	4422	WT-DBT/SSA	0	25,10,125	30,49,415	56,556	20,41,404	8,95,597	12,80,176	0	13,98,919
297	4423	SHELL/UW	0	3,00,000	14,16,000	0	0	0	6,27,986	0	10,88,014
298	4424	SERB/SSA	0	3,83,233	7,10,355	0	2,93,400	2,05,798	6,97,060	1,02,670	0
299	4425	NIH-UNMC/RUK	31,18,092	0	49,23,968	28,000	0	18,56,560	59,35,229	59,57,913	0
300	4426	TRC-JNC/TG	0	19,58,961	0	0	0	7,48,339	10,38,380	0	1,72,242
301	4427	DST-SJF/TG	0	1,26,80,391	28,05,178	0	1,20,00,000	10,16,625	16,07,335	0	8,61,609
302	4428	DST/SMS	0	6,54,12,623	17,26,155	0	3,86,33,489	18,51,123	68,08,872	0	1,98,45,294
303	4430	DST-RUS/AS	0	7,92,245	2,67,437	0	0	1,12,945	11,19,163	1,72,426	0
304	4431	DAE-BRNS/CPR	0	37,027	13,12,407	0	0	5,65,200	3,41,033	0	4,43,201
305	4432	DAE-BRNS/JH	0	7,61,435	3,52,850	0	0	2,38,333	4,10,772	0	4,65,180
306	4433	DST-SJF/RG	0	60,58,986	97,148	0	38,48,403	3,00,000	10,27,671	0	9,80,060
307	4434	SERB/MS	0	48,145	7,07,451	9,935	0	5,50,000	2,82,058	66,527	0
308	4435	SERB/PP	0	1,16,983	7,00,000	0	0	1,28,333	1,50,827	0	5,37,823
309	4436	ICAR/KRS	0	3,75,534	3,06,227	0	97,880	2,99,583	3,21,766	37,468	0
310	4438	CEFIPRA/KS	0	2,72,525	9,28,093	0	0	4,00,234	6,52,504	0	1,47,880
311	4439	SERB/SKP	2,38,797	0	8,06,143	0	0	2,32,700	2,92,134	0	42,512
312	4440	SERB/JH	0	5,16,015	3,08,840	0	0	5,61,600	13,56,747	10,93,492	0
313	4441	SERB/S.BANDI	0	45,834	8,00,000	0	0	6,13,871	3,20,369	88,406	0
314	4442	SERB/A.SINGH	13,949	0	8,00,000	0	0	6,05,000	2,38,707	57,656	0
315	4443	DST/SJ	0	5,03,445	12,18,225	0	2,08,950	12,48,480	40,334	0	2,23,906
316	4444	SERB/RV	0	5,32,768	18,594	0	0	0	1,14,403	0	4,36,959
317	4445	SERB/MI	0	15,99,367	84,964	0	0	2,68,918	25,36,613	11,21,200	0
318	4446	ICMR/AA	2,50,970	0	16,70,650	0	0	70,150	8,48,415	0	5,01,115
319	4447	CEFIPRA/SS	0	26,76,549	8,27,311	0	25,25,776	5,36,439	50,403	0	3,91,242
320	4448	DST/CSARASWATHI	0	29,453	8,00,000	0	0	6,60,000	1,26,798	0	42,655
321	4449	SERB/SKV	0	4,24,767	7,11,816	0	0	6,60,000	1,78,908	0	2,97,675
322	4450	SERB/IP	0	47,572	7,83,000	0	0	6,60,000	2,69,266	98,694	0
323	4451	SERB/SRC	0	46,812	9,17,226	0	0	5,10,968	2,32,124	0	2,20,946

324	4452	SERB/S. SEN	0	61,053	9,13,887	0	0	6,60,000	3,56,966	42,026	0
325	4453	GTRE/RN	54,696	0	34,324	0	0	-41,600	21,228	0	0
326	4454	HIPL/NC	0	2,02,873	5,31,000	0	0	0	7,33,873	0	0
327	4455	LIPL/TG	0	2,37,298	0	0	0	0	39,004	0	1,98,294
328	4456	SERB/P.SATHE	0	52,925	8,00,670	0	0	6,60,000	1,41,210	0	52,385
329	4457	DAE-BRNS/SSA	0	4,52,120	3,52,344	0	0	3,40,708	5,39,656	75,900	0
330	4458	DBT/KS	0	1,459	5,95,542	0	0	0	6,00,873	3,872	0
331	4459	SERB/AN	0	1,64,421	9,19,070	0	0	6,60,000	3,30,360	0	93,131
332	4460	SERB/SHASHIDHAR	0	1,30,002	8,90,767	0	0	6,60,000	2,30,831	0	1,29,938
333	4461	SERB/SD	0	2,88,162	9,25,759	0	0	6,60,000	1,57,526	0	3,96,395
334	4462	SERB/RB	0	2,46,379	0	0	0	74,516	2,00,000	28,137	0
335	4463	DBT/KS-RM	0	16,73,475	15,73,168	0	7,46,819	0	13,72,498	0	11,27,326
336	4464	SERB/DSV	0	30,72,037	6,70,050	0	24,09,507	2,80,000	5,00,832	0	5,51,748
337	4465	TRC-JNC/JH	0	59,92,477	0	0	60,81,831	0	0	89,354	0
338	4466	TRC-JNC/SCP	0	95,06,427	10,00,000	0	62,70,000	3,13,625	77,193	0	38,45,609
339	4467	HPCL/SA	1,28,968	0	6,72,000	0	0	3,64,000	2,49,604	70,572	0
340	4468	DST/SCP	0	5,16,037	16,871	0	0	0	2,50,770	0	2,82,138
341	4469	DST/SB	0	12,53,093	42,539	0	0	1,42,690	75,332	0	10,77,610
342	4470	SERB/SY	0	2,18,244	9,10,928	0	0	1,82,742	30,322	0	9,16,108
343	4471	SERB/MN	0	1,73,777	9,21,081	0	0	6,45,806	3,48,434	0	1,00,618
344	4472	SERB/HR	0	2,17,241	9,20,592	0	0	6,60,000	3,53,409	0	1,24,424
345	4473	SERB/SP	0	1,01,338	0	0	0	1,10,000	1,13,150	1,21,812	0
346	4474	DBT/KS	0	1,66,073	7,38,673	12,000	0	3,58,000	4,79,856	0	78,890
347	4475	SRISTI/K RAJASE	0	53,725	3,77,811	0	0	0	1,87,838	0	2,43,698
348	4476	DST/SS	0	12,64,523	16,969	0	8,36,724	5,41,974	1,23,525	2,20,731	0
349	4477	DST/MA	0	24,88,138	8,67,833	0	8,00,419	10,80,188	5,10,275	0	9,65,089
350	4478	SERB/CM	0	50,318	7,86,789	0	0	6,06,774	2,42,863	12,530	0
351	4479	SERB/LV	0	2,52,089	9,22,214	0	0	6,60,000	2,96,908	0	2,17,395
352	4480	SERB/S.DEY	0	2,05,331	7,88,712	0	0	6,60,000	2,29,074	0	1,04,969
353	4482	SERB/D R	0	1,33,172	7,83,191	0	0	6,06,774	3,52,000	42,411	0
354	4483	DST/RV	0	9,33,105	26,363	0	0	3,21,100	1,33,655	0	5,04,713
355	4484	SERB/PS	0	30,91,479	67,671	0	20,52,778	3,90,000	5,15,981	0	2,00,391
356	4485	DST/KS	0	1,37,373	49,607	0	0	0	98,760	0	88,220

357	4486	TRC-JNC/EM	0	1,05,61,176	11,10,000	0	97,03,062	4,37,955	8,98,698	0	6,31,461
358	4487	SERB/GLB	0	1,43,920	8,04,478	0	0	6,60,000	3,37,007	48,609	0
359	4488	SERB/MUDS	0	1,43,210	8,00,253	0	0	6,60,000	1,96,597	0	86,866
360	4489	SERB/K SHARMA	0	22,860	8,13,071	0	0	6,60,000	1,66,638	0	9,293
361	4490	SERB/MK	0	1,83,602	3,224	1,15,498	0	1,10,000	1,89,100	0	3,224
362	4491	DST/SS	0	15,72,705	43,134	0	0	5,55,969	3,34,947	0	7,24,923
363	4492	DBT/NS	0	25,32,300	83,069	0	-38,030	5,34,049	9,53,083	0	11,66,267
364	4493	LSRB/RM	0	13,76,684	32,751	0	0	3,23,500	12,49,946	1,64,011	0
365	4494	RHSPL/EM	0	3,52,050	30,000	0	0	0	1,58,625	0	2,23,425
366	4495	DST-JSPS/SJG	0	1,24,060	3,907	0	0	0	21,329	0	1,06,638
367	4496	RGUHS/SA	0	6,07,200	17,514	0	0	2,26,290	61,740	0	3,36,684
368	4497	DST/KB	0	60,21,772	1,76,871	0	43,133	5,02,723	10,04,937	0	46,47,850
369	4498	DBT/EM	0	8,92,596	29,815	0	0	97,500	1,44,759	0	6,80,152
370	4499	DST-VBU/KSN	0	13,03,267	1,47,502	0	0	2,47,604	7,25,327	0	4,77,838
371	4500	DST/UW	0	79,35,800	1,83,577	0	0	3,83,354	46,57,118	0	30,78,905
372	4501	DBT/TKK	0	81,55,800	2,02,525	0	17,69,528	7,17,224	29,14,584	0	29,56,989
373	4502	JNC/RN	0	0	13,00,000	0	0	7,58,838	4,55,235	0	85,927
374	4503	DBT/RUK	0	15,40,000	15,37,887	0	15,00,000	3,57,500	14,66,473	2,46,086	0
375	4504	DST/KSN	0	0	11,61,900	0	0	2,73,629	9,14,420	26,149	0
376	4505	SUNRISE/KSN	0	0	14,66,706	0	0	3,05,500	15,99,962	4,38,756	0
377	4506	DBT/MI-VN	0	0	40,75,104	1,50,368	20,19,912	62,660	17,54,820	0	3,88,080
378	4507	DST/KB	0	0	4,07,134	0	0	0	99,223	0	3,07,911
379	4508	IUSSTF/SS	0	0	5,73,030	0	0	0	3,47,944	0	2,25,086
380	4509	SERB/ASHUTOSHKR	0	0	9,71,777	0	0	6,17,419	2,72,044	0	82,314
381	4510	DST/SJG	0	0	4,18,646	0	0	0	3,12,521	0	1,06,125
382	4511	DST/JH	0	0	8,08,376	0	0	0	1,22,223	0	6,86,153
383	4512	TRC-JNC/PS	0	0	75,36,044	0	1,38,277	44,662	1,06,594	0	72,46,511
384	4513	TRC-JNC/GS-DSV	0	0	45,24,000	0	8,92,500	50,000	20,407	0	35,61,093
385	4514	DST-SJF/SJG	0	0	2,26,01,520	0	25,587	5,92,382	8,19,044	0	2,11,64,507
386	4515	DBT-LSRET/VN	0	0	18,33,44,172	0	9,83,092	4,10,800	1,56,45,492	0	16,63,04,788
387	4516	ICMR/KS	0	0	23,41,356	0	0	3,80,100	8,97,687	0	10,63,569
388	4517	TRC-JNC/KRS	0	0	3,00,00,000	0	2,05,645	0	28,379	0	2,97,65,976
389	4518	SERB/JC	0	0	11,12,650	0	0	89,096	8,30,135	0	1,93,419

390	4519	DBT/RM	0	0	9,74,002	0	0	81,774	2,21,362	0	6,70,866
391	4520	EMBO/JC	0	0	30,72,986	59,249	0	0	31,32,235	0	0
392	4521	LSRET-JNC/AA	0	0	5,00,000	0	0	0	1,29,794	0	3,70,206
393	4522	LSRET-JNC/TKK	0	0	5,00,000	0	0	0	4,77,325	0	22,675
394	4523	LSRET-JNC/NS	0	0	5,10,000	0	0	0	3,04,190	0	2,05,810
395	4524	LSRET-JNC/MI	0	0	10,16,000	0	0	0	9,19,073	0	96,927
396	4525	LSRET-JNC/KS	0	0	12,00,000	0	0	0	4,79,017	0	7,20,983
397	4526	LSRET-JNC/RM	0	0	5,00,000	0	0	0	5,00,000	0	0
398	4527	LSRET-JNC/HB	0	0	5,00,000	0	0	0	4,68,644	0	31,356
399	4528	LSRET-JNC/RUK	0	0	5,00,000	0	0	0	4,99,576	0	424
400	4529	LSRET-JNC/VN	0	0	5,00,000	0	0	0	0	0	5,00,000
401	4530	LSRET-JNC/MRS	0	0	5,00,000	0	0	0	5,31,280	31,280	0
402	4531	LSRET-JNC/JC	0	0	5,00,000	0	0	0	4,38,325	0	61,675
403	4532	LSRET-JNC/SV	0	0	5,00,000	0	0	0	1,54,240	0	3,45,760
404	4533	LSRET-JNC/NC	0	0	5,00,000	0	0	0	0	0	5,00,000
405	4534	LSRET-JNC/TG	0	0	10,00,000	0	0	0	0	0	10,00,000
406	4535	LSRET-JNC/JH	0	0	5,00,000	0	0	0	1,23,978	0	3,76,022
407	4536	LSRET-JNC/SSA	0	0	5,00,000	0	0	0	3,24,956	0	1,75,044
408	4537	LSRET-JNC/SS	0	0	2,00,000	0	0	0	0	0	2,00,000
409	4538	LSRET-JNC/SKP	0	0	2,00,000	0	0	0	0	0	2,00,000
410	4539	LSRET-JNC/SKD	0	0	3,00,000	0	0	0	3,00,000	0	0
411	4540	LSRET-JNC/MKP	0	0	2,00,000	0	0	0	64,856	0	1,35,144
412	4541	LSRET-JNC/GS	0	0	2,60,000	0	0	0	2,60,000	0	0
413	4542	LSRET-JNC/AJ	0	0	4,00,000	0	0	0	0	0	4,00,000
414	4543	LSRET-JNC/TNCV	0	0	4,00,000	0	0	0	1,18,617	0	2,81,383
415	4544	LSRET-JNC/KSN	0	0	4,00,000	0	0	0	83,696	0	3,16,304
416	4545	LSRET-JNC/SB	0	0	4,00,000	0	0	0	2,44,374	0	1,55,626
417	4546	LSRET-JNC/EM	0	0	4,00,000	0	0	0	11,100	0	3,88,900
418	4547	LSRET-JNC/TKM	0	0	4,00,000	0	0	0	0	0	4,00,000
419	4548	LSRET-JNC/SJG	0	0	4,00,000	0	0	0	3,98,182	0	1,818
420	4549	SERB/NSV	0	0	15,65,540	0	0	1,62,500	1,27,902	0	12,75,138
421	4550	LSRET-JNC/KJ	0	0	2,00,000	0	0	0	0	0	2,00,000
422	4551	IKST/UW	0	0	5,00,000	0	0	0	5,83,216	83,216	0

423	4552	SERB/TNCV	0	0	15,89,144	0	1,16,902	0	34,857	0	14,37,385
424	4553	DST/NC	0	0	41,33,392	0	0	0	48,392	0	40,85,000
425	4554	SERB-JCB/SKP	0	0	19,09,491	0	0	71,226	10,78,000	0	7,60,265
426	4555	IRTSPL/TKM	0	0	9,44,000	0	0	70,200	3,48,545	0	5,25,255
427	4556	IISER/NC	0	0	4,45,410	0	0	54,553	2,50,000	0	1,40,857
428	4557	TRC-JNC/KB	0	0	39,90,000	0	0	0	0	0	39,90,000
429	4558	SERB-TARE/SCP	0	0	3,35,904	0	0	0	25,000	0	3,10,904
430	4559	SERB-TARE/SSA	0	0	3,35,904	0	0	0	9,166	0	3,26,738
431	4560	LSBU/KSN	0	0	0	0	0	0	87,547	87,547	0
432	4561	DBT-RLF/K.BANSA	0	0	10,50,000	0	0	0	0	0	10,50,000
433	4562	SERB/KAUSHIK K	0	0	9,60,000	0	0	0	0	0	9,60,000
434	4563	SERB/MKB	0	0	9,60,000	0	0	0	4,570	0	9,55,430
435	4564	SERB-TARE/HB	0	0	3,35,000	0	0	0	7,257	0	3,27,743
436	4565	DST/SHWETHA P	0	0	10,77,951	0	0	55,000	11,284	0	10,11,667
437	4566	SERB/MRS	0	0	38,00,000	0	0	0	2,76,710	0	35,23,290
438	4568	TIGS/MI	0	0	1,16,600	0	0	0	0	0	1,16,600
439	4571	SERB/RV	0	0	42,36,700	0	0	0	0	0	42,36,700
440	4572	DST-BRICS/AS	0	0	8,40,000	0	0	0	0	0	8,40,000
441	4573	DST/KS	0	0	71,266	0	0	0	618	0	70,648
442	4575	BIAL/KRS	0	0	9,00,000	0	0	0	0	0	9,00,000
443	4576	SERB-JCB/VN	0	0	0	0	0	0	2,44,180	2,44,180	0
444	4577	SERB-TARE/UW	0	0	3,35,000	0	0	0	0	0	3,35,000
445	5100	CSIR/COE	4,46,946	0	0	0	0	0	-36,216	4,10,730	0
446	5101	DST/SAC-PM/CNR	5,73,994	0	0	0	0	0	0	5,73,994	0
447	5102	DRDO/CNR	8,773	0	0	0	0	0	-773	8,000	0
448	5103	DST/CNR	1,64,650	0	0	0	0	0	0	1,64,650	0
449	5104	CSIR-COE/CNR	29,10,103	0	0	0	0	0	0	29,10,103	0
450	5105	DST-ICMS/CNR	24,28,431	0	0	0	0	0	0	24,28,431	0
451	6001	SSL/CNR	0	4,50,74,491	5,35,072	0	1,71,39,500	0	0	0	2,84,70,063
452	6002	DRDO/CNR	0	59,53,320	2,18,111	0	28,11,315	0	0	0	33,60,116
453	6003	CSIR-COE/CNR	0	54,71,592	0	0	0	21,70,745	0	0	33,00,847
454	6004	SSL/CNR	0	2,85,85,662	3,57,15,744	2,43,571	1,19,37,596	34,42,984	63,96,609	0	4,27,67,788
455	6005	JNCASR	0	0	3,59,031	0	0	0	20,981	0	3,38,050

456	9001	SWAPAN K PATI	0	68,951	28,356	0	0	0	0	0	97,307
457	9002	TAPAS K MAJI	0	9,971	34,467	0	0	0	25,904	0	18,534
458	9003	MANEESHA S INAM	0	53,574	48,800	0	0	0	49,947	0	52,427
459	9004	S.RAJARAM	0	56,712	28,358	0	0	0	0	0	85,070
460	9005	RAVI MANJITAYA	0	72,327	68,578	0	0	0	8,528	0	1,32,377
461	9006	TKK-EM	0	14,992	20,000	0	0	0	0	0	34,992
462	9007	KANISHKA BISWAS	0	39,697	1,60,364	0	0	0	51,943	0	1,48,118
463	9008	RANJANI VISWANA	0	51,425	10,000	0	0	0	31,349	0	30,076
464	9009	SEBASTIAN PETER	0	96,598	47,918	0	0	0	79,941	0	64,575
465	9010	SARIT S AGASTI	0	4,18,057	53,096	0	0	0	32,939	0	4,38,214
466	9011	GOVINDARAJU T	0	12,649	20,000	0	0	0	19,528	0	13,121
467	9012	SHIVAPRASAD SM	0	1,94,252	0	0	0	0	0	0	1,94,252
468	9013	SUNDARESAN A	0	13,328	17,000	0	0	0	12,941	0	17,387
469	9014	RAJENDRAN C P	0	18,742	12,510	0	0	0	15,747	0	15,505
470	9015	JAYANTA HALDAR	0	17,268	35,226	0	0	0	13,145	0	39,349
471	9016	SREENIVAS K R	0	7,225	6,400	0	0	0	0	0	13,625
472	9017	NAGARAJ KK	0	40,000	0	0	0	0	40,000	0	0
473	9018	SAJAD AHMED BHA	0	453	0	0	0	0	453	0	0
474	9019	SHAILENDRA K SI	0	21,113	13,074	0	0	0	34,187	0	0
475	9020	SHAFEEKH K MEET	0	9,908	0	0	0	0	9,908	0	0
476	9022	KAMALI KESAVAN	0	19,946	0	0	0	0	19,946	0	0
477	9023	VIJAYKUMAR S MA	5,431	0	0	0	0	0	-5,431	0	0
478	9024	AMIT GUPTA	0	20,000	0	0	0	0	0	0	20,000
479	9025	LAKSHMI GARIMEL	0	20,000	0	0	0	0	0	0	20,000
480	9026	RAJESH GANAPTI	0	0	20,000	0	0	0	0	0	20,000
481	9027	PROVAS PAL	0	20,760	16,329	0	0	0	37,089	0	0
482	9028	SUKANTA MONDAL	0	22,849	0	0	0	0	22,849	0	0
483	9029	SHIVANNA M	0	23,233	16,767	0	0	0	40,000	0	0
484	9030	S.BANDI	0	11,110	0	0	0	0	11,110	0	0
485	9031	HEMALATHA BALAR	0	68,200	34,000	0	0	0	0	0	1,02,200
486	9032	ASHISH SINGH	0	21,699	0	0	0	0	21,699	0	0
487	9033	SOUMALYA JOARDA	0	7,000	0	0	0	0	7,000	0	0
488	9034	ANURANJAN ANAND	0	9,432	9,529	0	0	0	14,433	0	4,528

489	9035	C SARASWATHI	0	18,828	0	0	0	0	18,828	0	0
490	9036	SUBHENDU ROY CH	0	20,000	20,000	0	0	0	40,000	0	0
491	9037	NARASIMHA R	0	63,750	0	0	0	0	0	0	63,750
492	9038	KAUSTUV SANYAL	0	29,000	61,464	0	0	0	11,717	0	78,747
493	9039	DIWAKAR S VENKA	0	33,210	33,210	0	0	0	0	0	66,420
494	9040	RANGA UDAY KUMA	0	1,92,776	1,03,806	0	0	0	0	0	2,96,582
495	9041	INIYAVAN P	0	20,000	0	0	0	0	20,000	0	0
496	9042	MEHEBOOB ALAM	0	2,076	47,312	0	0	0	0	0	49,388
497	9043	PARDHASARATHI S	0	13,763	0	0	0	0	13,763	0	0
498	9044	CHANDRAIAH M	0	0	20,000	0	0	0	20,000	0	0
499	9045	LAXMINARASIMHAR	0	20,000	20,000	0	0	0	40,000	0	0
500	9046	SUBARNA DEY	0	13,333	20,000	0	0	0	33,333	0	0
501	9048	DARSI RAMBABU	0	12,903	20,000	0	0	0	32,903	0	0
502	9049	SANDRA DIAS	0	20,000	20,000	0	0	0	40,000	0	0
503	9050	RUCHIKA BHARADW	0	20,000	0	0	0	0	20,000	0	0
504	9051	ESWARAMOORTHY M	0	10,000	20,000	0	0	0	0	0	30,000
505	9052	SHRINKA SEN	0	20,000	20,000	0	0	0	40,000	0	0
506	9053	ASWATHY NARAYAN	0	20,000	20,000	0	0	0	40,000	0	0
507	9054	MAMTA NEGI	0	20,000	20,000	0	0	0	40,000	0	0
508	9055	MD.HASHIM REZA	0	20,000	20,000	0	0	0	40,000	0	0
509	9056	SHWETA PANCHAL	0	20,184	0	0	0	0	20,184	0	0
510	9057	SRIKANTH SASTRY	0	1,26,063	36,332	0	0	0	3,625	0	1,58,770
511	9058	PREMKUMAR SENGU	0	587	14,138	0	0	0	0	0	14,725
512	9059	G L BALAJI	0	20,000	20,000	0	0	0	40,000	0	0
513	9060	MEHRAJ UD DIN S	0	10,611	20,000	0	0	0	30,611	0	0
514	9061	KAMAN SHARMA	0	13,366	20,000	0	0	0	33,366	0	0
515	9062	MOKURALA KRISHN	0	10,166	0	0	0	0	10,166	0	0
516	9063	SUMAN YADAV	0	20,000	0	0	0	0	20,000	0	0
517	9064	SHASHIDHARA ACH	0	20,000	20,000	0	0	0	40,000	0	0
518	9065	SAMPATH KUMAR V	0	20,000	0	0	0	0	20,000	0	0
519	9066	NAMITA SUROLIA	0	695	16,000	0	0	0	0	0	16,695
520	9068	UMESH V WAGHMAR	0	0	54,208	0	0	0	0	0	54,208
521	9070	NARAYAN K S	0	0	32,333	0	0	0	5,637	0	26,696

522	9071	SUBI JACOB GEOR	0	0	11,666	0	0	0	0	0	11,666
523	9072	NAGARAJA V	0	0	2,00,000	0	0	0	5,632	0	1,94,368
524	9073	JAMES CHELLAIAH	0	0	12,467	0	0	0	0	0	12,467
525	9074	VIDHYADHIRAJA N	0	0	13,635	0	0	0	0	0	13,635
526	9075	TNC VIDYA	0	0	6,971	0	0	0	0	0	6,971
527	9076	CHANDRABHAS N	0	0	55,000	0	0	0	18,756	0	36,244
528	9077	SANTOSH ANSUMAL	0	0	20,600	0	0	0	0	0	20,600
529	9078	MRS RAO	0	0	20,000	0	0	0	0	0	20,000
530		OTHER CREDIT BALANCES	0	14,49,19,076	0	32,39,92,487	0	0	14,09,48,635	0	32,79,62,928
		Total :	4,57,10,108	1,10,47,59,755	72,13,78,901	32,56,37,003	48,70,84,710	8,32,55,397	49,78,42,776	5,40,50,192	1,09,19,32,860

Sampad Patra
Accounts Officer

B.R.V. GOUD & CO. CHARTERED ACCOUNTANTS B'LORE-4

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