

ANNUAL REPORT 2017-18

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**JAWAHARLAL NEHRU CENTRE
FOR ADVANCED SCIENTIFIC RESEARCH**



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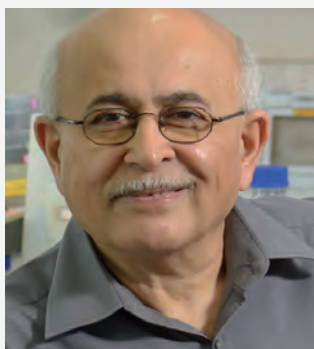
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ANNUAL REPORT 2017-18



**JAWAHARLAL NEHRU CENTRE
FOR ADVANCED SCIENTIFIC RESEARCH**

WORD FROM THE PRESIDENT



“

Bharat Ratna Prof. C.N.R. Rao, Linus Pauling Research Professor, JNCASR became the first Asian to win the prestigious von Hippel Award, the highest honour from the Materials Research Society, USA. It is a matter of great pride and inspiration for all of us at JNCASR to see Prof. Rao win this honour. He was also awarded the Wockhardt Research Prize 2017 by Centre for Organization Development, Hyderabad and crossed 100,000 citations with his publications meanwhile!

”

With great pleasure I am presenting the twenty-ninth Annual Report of the Centre for the year 2017-18. As an institution JNCASR has been continued to be noted one among the four research institutions listed under Special Mention Institutions in the National Institutional Ranking Framework (NIRF) 2018 released by the Ministry of Human Resource Development (GoI). You may recall that we were 4th among the universities and 11th overall, when we are assessed with all the larger institutions. This year we were not assessed along with larger universities for reasons unknown to us. Globally, we stand at 722 (top 2.6%) out of 18,000 universities worldwide in the 2017 CWUR World University Rankings (cwur.org), the largest academic ranking of global universities. The Centre has also received the Clarivate Analytics India Innovation Award for two consecutive years, 2017 and 2018. The award which is in the Academic Institutions category, placed JNCASR among the two innovators in India in this category. In view of our success in imparting world-class education and training in science and engineering during the reporting period, we have been granted greater autonomy by UGC which we hope to translate into even better and more comprehensive degree and fellowship programmes.

Under various academic programmes, with the joining of 60 students, our current student strength has reached to 308. Forty-three students have been awarded Ph.D. degrees this year, three with M.S. (Engg.), and eighteen students M.S. in Integrated Ph.D. One student was also awarded the Postgraduate Diploma in Materials Science (PGDMS).

We are delighted that Bharat Ratna Prof. C.N.R. Rao, Honorary President, JNCASR is the first Asian to win the prestigious von Hippel Award, the highest honour from the Materials Research Society, USA. It is a matter of great pride and inspiration for all of us at JNCASR to see Prof. Rao win this honour. He was also awarded the Wockhardt Research Prize 2017 by Centre for Organization Development, Hyderabad. Another outstanding achievement is that citations of his publications crossed 100,000. Among other faculty honours, during 2017-18 Prof. Kaustuv Sanyal, MBGU received the DBT Tata Innovation Fellowship, Dr. Ranjan Datta (ICMS) and Dr. Ranjani Viswanath (NCU & ICMS), MRSI Medals 2018, Dr. Jayanta Haldar (NCU) the CRSI Bronze Medal 2018, Dr. Kanishka Biswas (NCU), the Young Scientist Wiley Award from International Union of Materials Research Society, and

Dr. Sarit Agasti (NCU & CPMU), the SERB Early Career Award, the DAE-Young Scientist and Wellcome Trust Intermediate Fellowship. The recent advancement of the team led by Prof. Sebastian Peter (NCU) into the final round of the global NRG COSIA Carbon XPrize competition shows the competitive edge held by JNCASR research at an international level. The competition provides incentives to accelerate the development of technologies that can convert carbon dioxide, a greenhouse gas, into value-added products.

During the year, some of our faculty have also become fellows of the top science and engineering academies and members of societies in India and abroad. Another major achievement for JNCASR has been the selection of two startups founded by our faculty members among the State Government of Karnataka's top 100 innovative startups in its ELEVATE 100 programme for a shared funding of Rs. 35cr. Under the able guidance and supervision of our faculty members, JNCASR students have also marked their presence at national and international platforms with several fellowships and awards to their credit. I also welcome Dr. Bivas Saha within our fold who has joined JNCASR as Faculty Fellow (jointly with ICMS and CPMU).

In keeping with our foundational objective of pursuing science and technology and breaking barriers among disciplines with our research, I am delighted to see researchers in JNCASR excelling in their scientific pursuits through groundbreaking discoveries in not just 'pure' science but also making direct societal impact through their technological innovations. A number of publications in reputed high-impact factor international journals bears testimony to that fact, as do the number of patents. We have published altogether 277 papers during the year while 28 patent applications have been filed and 7 patents been granted.

We believe in our mandate of raising science awareness and committed in our efforts to increase trained manpower in science in India. Like the previous year, this year too several science outreach programmes have been organised under the visionary guidance of

Prof. CNR Rao and Mrs. Indumati Rao for school and college students and teachers. We encourage events like these as they go a long way in inculcating the joy of learning science and imparting genuine interest in hands-on research at a young age. Extending our outreach programmes further, Programmes like Project-oriented Biology Education and Project-oriented Chemistry Education for undergraduate students and several other extension programmes under Fellowships and Extension Programmes have witnessed large-scale participation from across the country. Through these programmes, we have made efforts towards promoting science in society and encouraged scientists from institutions across the country to establish collaborative research.

Finally, 2017-18 has also been a year when we have been successful in formalising our research ties with some of the most prominent research organisations around the world in our fields of interest. MoUs have been signed in this period with the International Iberian Nanotechnology Laboratory (INL), Braga, Portugal for promotion of research in Nano Science technology and with the University of Newcastle, Australia for enhanced cooperation on functionalized advanced nanostructures.

Prof. V. Nagaraja

President, JNCASR

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INTRODUCTION

The **Jawaharlal Nehru Centre for Advanced Scientific Research** (JNCASR), Bangalore, a premier research institute in the country, was established in the year 1989, the birth centenary year of Pandit Jawaharlal Nehru, by the Department of Science and Technology (DST). Now, in its twenty-ninth year, JNCASR has not only been fulfilling its initial objective of pursuing cutting-edge scientific research at the highest level using a holistic, interdisciplinary approach but has also made great strides in promoting frontier science and engineering across the country because of the institute-level stress on education, training, and outreach. The number of publications in tier I international journals are increasing year by year as are filing of patents. In the current year itself the number stands at 277 publications and 7 total granted patents. Besides, JNCASR faculty and students are regularly creating news in the scientific world and outside, with breakthrough discoveries in pure and applied science with direct societal impact. The Centre's research collaborations are strong with MoUs being signed every year with renowned national and international institutions. Faculty members of the Centre have received several national and international recognitions every year with many of them being elected as Fellows of National and International science and engineering academies. In recognition of the achievements of the Centre, JNCASR has been **Deemed to be University** by the Ministry of Human Resource Development (GOI), to enable the Centre to train quality manpower in science.

Bharat Ratna **Prof. C.N.R. Rao**, the founder President of the Centre and currently affiliated to Chemistry and Physics of Materials Unit (CPMU); Chairman, New Chemistry Unit (NCU) and Director, International Centre for Materials Science (ICMS) held office as President from 1989 to 1999. He is also the Honorary President of the Centre. **Prof. V. Krishnan** currently Chairman, Education Technology Unit (ETU) who succeeded him, served as President from 2000 to 2003. **Prof. M.R.S. Rao**, Neuroscience Unit (NSU) was President since 2003 to 2013. **Prof. K.S. Narayan**, (CPMU and Dean, Research & Development) served as President In-charge from 2013 to 2015. **Prof. V. Nagaraja** is serving as President since October 2015.

ABOUT JNCASR

“ Our mission is to pursue and promote scientific research and training at the highest level in the frontier and interdisciplinary areas of science and engineering. ”

India's premier multidisciplinary science and engineering research institute, Jawaharlal Nehru Centre for Advanced Scientific Research, JNCASR, was established in 1989, on Pandit Jawaharlal Nehru's birth centenary with the objective to pursue and promote research in science and technology but with a difference. JNCASR's strengths lie in materials science and biological sciences. The difference has been a well-balanced approach to research, that combines viewpoints from both fields and include not just science, but also engineering. This has led to the institute becoming one of the best materials and biological sciences innovation centres in the country within less than thirty years of its establishment.

The three key branches of research at the Centre despite being quite diverse have converged to give rise to an extremely dynamic and vibrant research environment with easy networking and collaborating opportunities for faculty and students across units. It is easy to see that

when a scientist from the Chemical and Physical Sciences of Materials unit collaborates with one from Biological Sciences, the Centre becomes a proverbial melting pot of cross-disciplinary answers to any science question. Collaborations such as these have even led to the birth of new units such as the Centre for Computational Materials Science (2006), the New Chemistry Unit (2008), and the Neuroscience Unit (NSU) (2014). The institute plans to initiate new interdisciplinary areas of Soft Condensed Matter, Biological Physics, advanced materials among others, to further broaden its scientific scope.

Over the years JNCASR has filed 268 patent applications and obtained 69 patent grants of which 57 are international, in addition to registering industrial designs, copyrights, trademarks and making successful technology transfers. Multiple startups have been founded within the walls of the institute along with technical research centre for facilitating translational research being pursued here. Science at JNCASR,

clearly, is not limited to discoveries that advance science but extend to discoveries that advance society too.

Home to 53 eminent research faculty, JNCASR's eight research units that now also include the Neuroscience Unit (NSU) and the first-of-its-kind in India, the International Centre for Materials Science (ICMS), together form an independent as well as collaborative research-driven institute with an outstanding publication record of an average of two hundred publications a year. These publications constitute some of the world's top scientific journals with highest Impact Factors.

The Centre's faculty members have received several prestigious international acclaim for their academic achievements.

The institute prides itself not only on its research but also on the quality of education and training it has been imparting as a Deemed university with (153) of research students having been awarded with their PhD degree and (104) of them a MS degree in the last five years. Its faculty student ratio is an amazing 1:6. This factor along with access to state-of-the-art facilities has led to a very high PhD and MS turnover. The students have brought JNCASR many accolades in terms of fellowships and awards at both national and international platforms.

JNCASR believes in dedicated science outreach and science popularisation among youth from across the length and breadth of the country to build scientific awareness. Our existing programmes such as the Summer Research Fellowship, Visiting Fellowship Programme, Project-Oriented Biology Education (POBE), Project-Oriented Chemistry Education (POCE), Student Buddy Programme, Programs for Biology and Program for Chemistry cater to a diverse

audience – school students, undergraduates, teachers, and promising young biologists and chemists.

The past 29 years have been a celebration for JNCASR in terms of scientific impact and reputation within the scientific community. What has been a surprise though, is its popularity as an innovation centre. The journey has been incredible in terms of the number of inventions from the Centre's Research Groups that can, and already are, contributing in a meaningful way to everyday lives whether that be in the area of renewable energy or pollution, climate change or materials science, healthcare or technology.

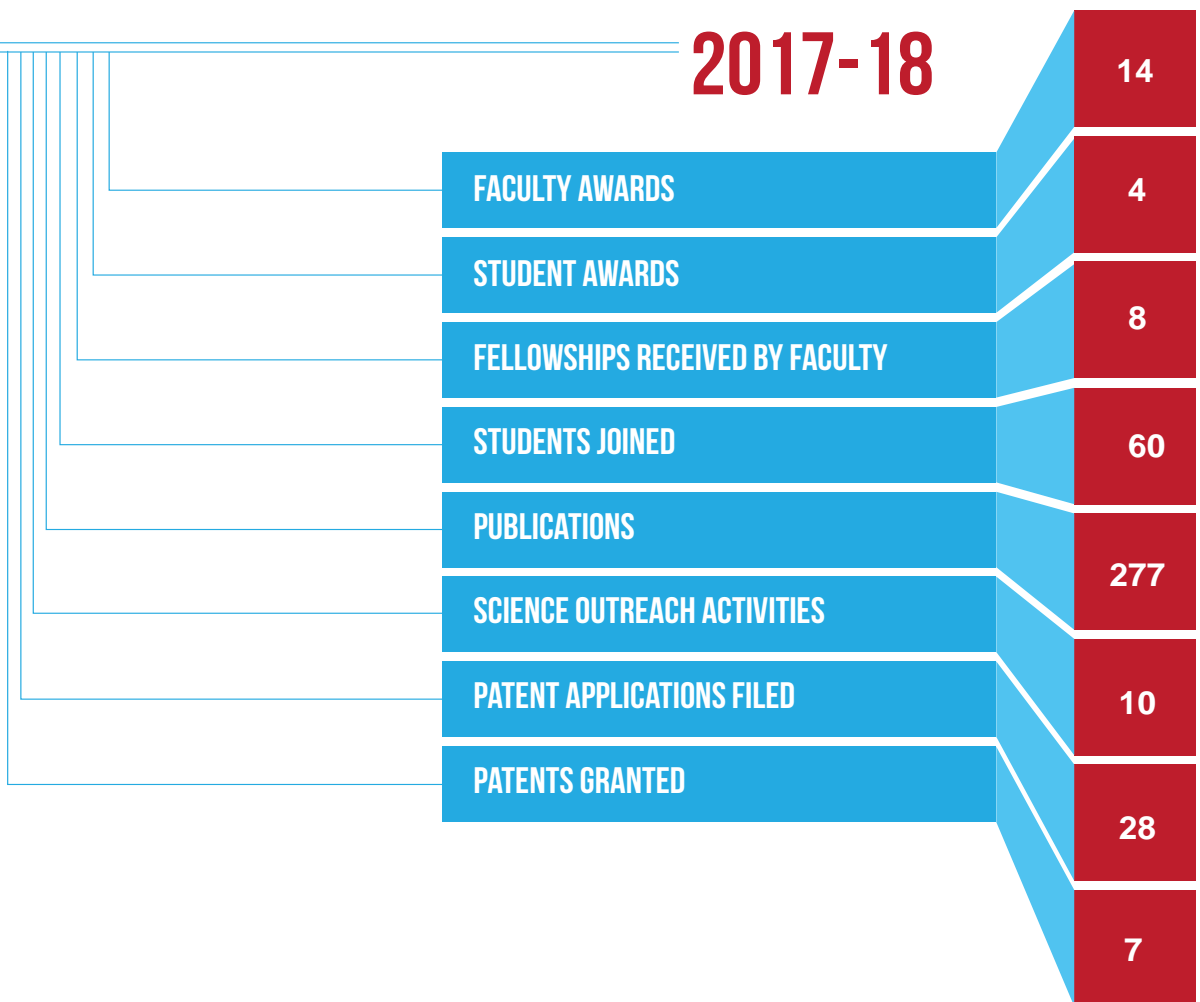
Objectives

The Centre's mission objectives are

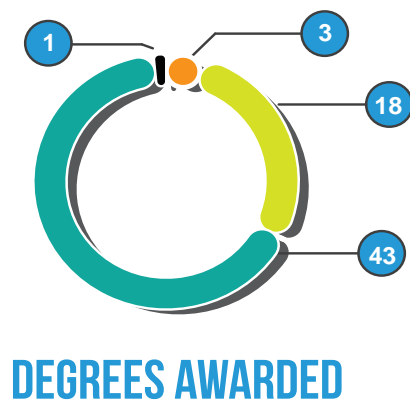
1. Establish and conduct world-class research in science and engineering
2. Foster interdisciplinary and collaborative research
3. Establish state-of-the-art laboratories, computational and infrastructural facilities to facilitate this scientific research
4. Capacity building through high-quality Ph.Ds in science and engineering
5. Increase awareness about science and research among school and college students through extensive science outreach, novel fellowship and extension programmes
6. Take research from laboratory to society by making a conscious effort to connect with society

YEAR AT A GLANCE

2017-18



REGISTRATION OF STUDENTS



DEGREES AWARDED

FACULTY



FACULTY AND STUDENT RECOGNITIONS 2017-2018

C.N.R. RAO

Materials Research Society's highest honor - the **von Hippel Award** presented in Boston on November 29, 2017, first Asian to receive the award;

Wockhardt Research Prize (September 2017);
Hon. Doctorate of IIT, Guwahati (June 2017);
Hon. Doctorate of University of Guwahati (2017)

AMITABH JOSHI

Selected for the **Prof. Har Swarup Memorial Lecture award of INSA** (2017)

HEMALATHA BALARAM

Dr. Raja Ramanna State Award 2015-16 from Government of Karnataka

JAYANTA HALDAR

CRSI Bronze Medal 2018

KANISHKA BISWAS

Young Scientist Wiley Award by International Union of Materials Research Societies in IUMRS-ICAM 2017 Japan.; Profile selected in "New Frontier in Indian Research" by Royal Society of Chemistry (RSC), UK

RANJAN DATTA

MRSI Medal 2018

RANJANI VISWANATHA

MRSI Medal 2018

TAPAS K. KUNDU

Banga Ratna (prestigious Civilian Award of Govt. of West Bengal), 2018.

SARIT AGASTI

SERB Early Career Award;
DAE-Young Scientist Award

STUDENTS

RADHA BOYA (JNCASR ALUMNUS)

for being selected to the MIT technology review innovators of 2017.

NIKHIL KL (JNCASR ALUMNUS)

(Research supervisor: Late Prof. Vijay K. Sharma) received **Humboldt Fellowship for Postdoctoral Researchers**, presently working in Universitätsmedizin Berlin.

EKASHMI RATHORE

(Ph.D. student) **Falling Walls Lab India 2017 winner**- India for her presentation 'Breaking the Walls of slow death – safer water, smarter tomorrow'. Her win qualifies Ekashmi to participate in the Finale in Berlin, Germany and participation in the prestigious Falling Walls Conference where renowned scientists from the world over present their research. Her visit will be sponsored by the German House for Research and Innovation (DWIH) New Delhi.

VIJAYA VERMA

Ph.D. Student from Chelliah Lab, was awarded the **best poster at 16th Molecular cellular and Cognition Society conference held at National University of Singapore** from 1-3 August 2017. She also received a travel grant of S\$500 to attend this conference.

PROMOTIONS 2017-2018

PROFESSORS

KAUSTUV SANYAL
GANESH SUBRAMANIAN
TAPAS KUMAR MAJI

ASSOCIATE PROFESSORS

SHEEBA VASU
RANJANI VISWANATHA
SEBASTIAN PETER
RAVI MANJITHAYA
TNC VIDYA

NEW APPOINTMENTS

VIGILANCE OFFICER
K.R. SREENIVAS

FACULTY FELLOW
BIVAS SAHA - CPMU & ICMS

ADMINISTRATIVE OFFICER
LT. CDR. (RETD.) JOYDEEP DEB

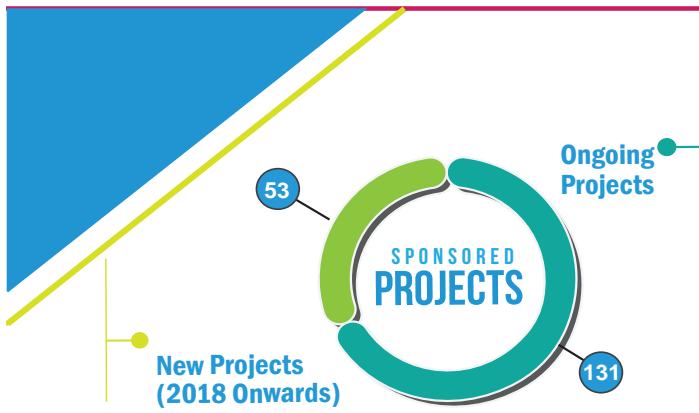
TECHNICAL ASSISTANT
(INSTRUMENTATION)
SHIVAKUMAR K M

- 09 Endowment Lectures
- 04 Annual Lectures
- 02 Special Lectures
- 05 Discussion Meetings
- 92 Seminars
- 03 Conferences
- 03 Workshops
- 02 SCHOOLS
- 08 Fluid Dynamics Colloquia
- 03 Hindi workshops

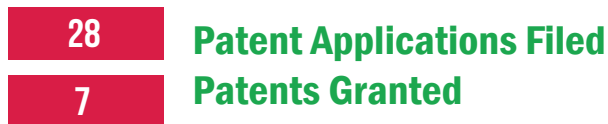
EVENTS 2017-2018

OTHER EVENTS

Annual faculty meeting
Hindi week
Swachchata Pakhwada
Vigilance Awareness week



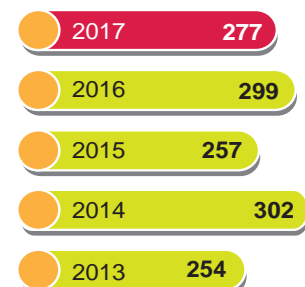
2017-2018 PATENTS



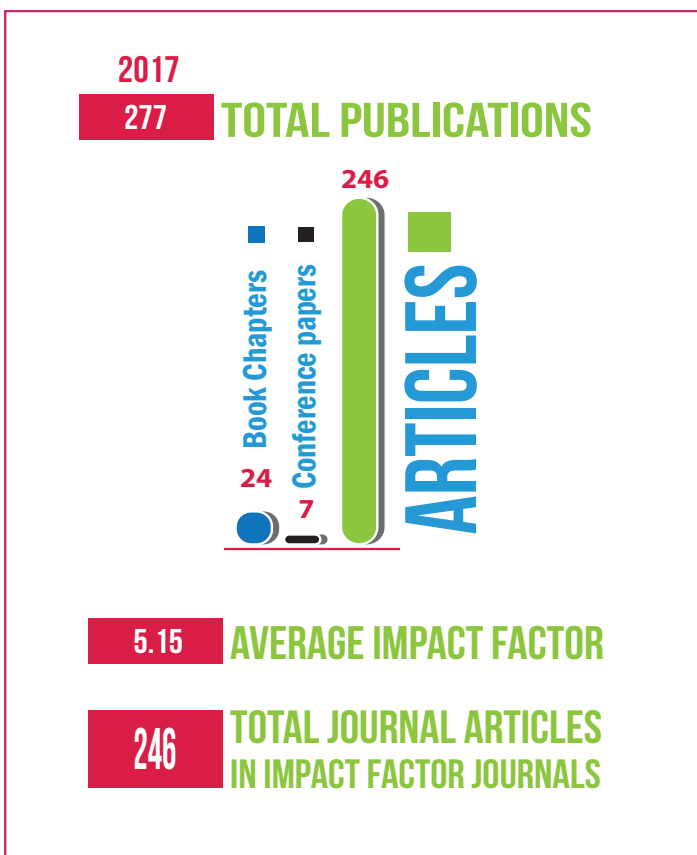
AVERAGE IMPACT FACTOR OF PUBLICATIONS



PUBLICATIONS



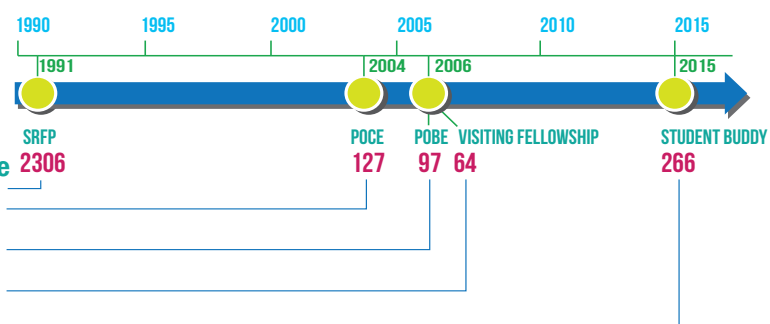
2017 PUBLICATIONS



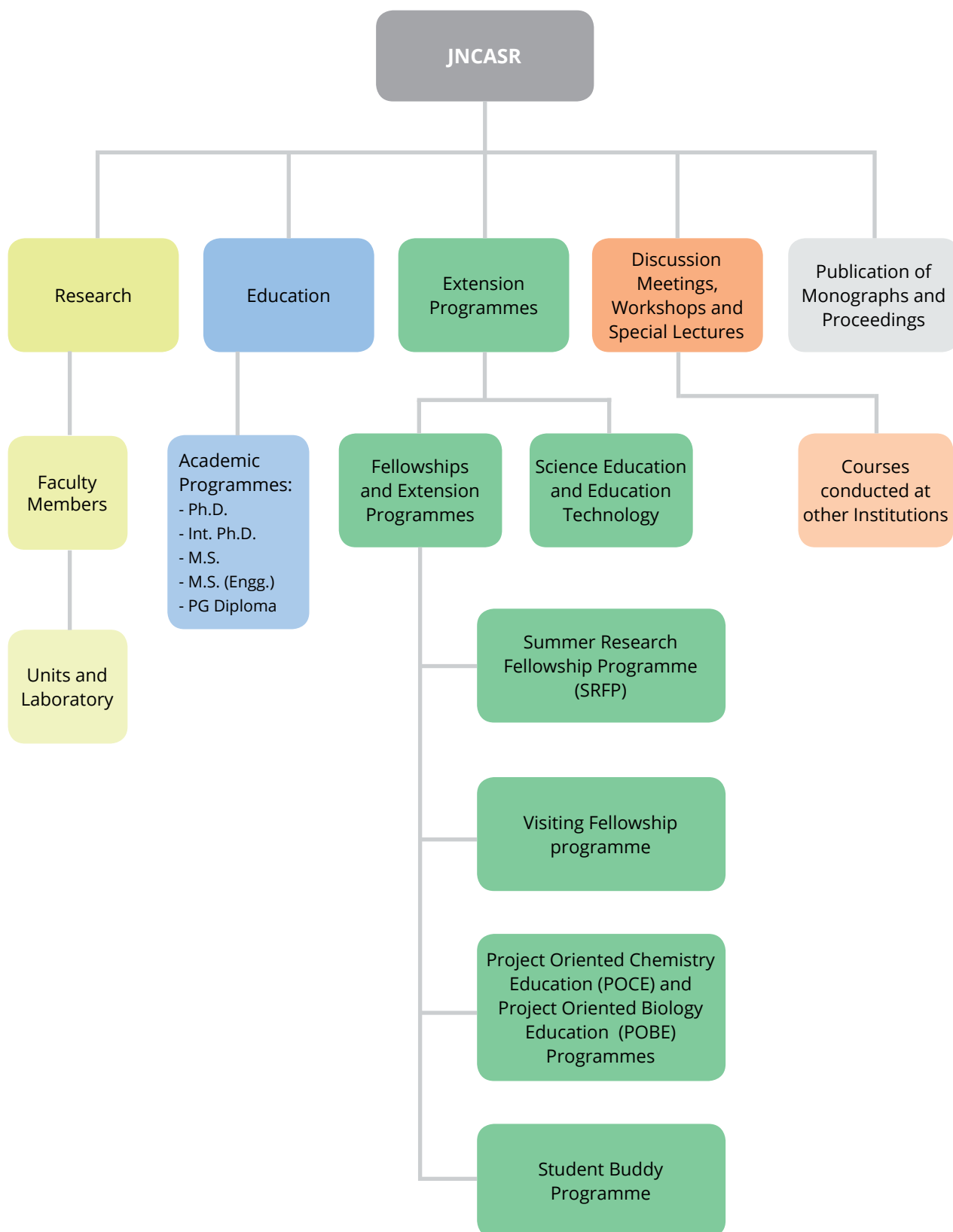
OUTREACH SCIENCE PROGRAMMES

- Summer Research Fellowship Programme
- Project Oriented Chemical Education
- Project Oriented Biological Education
- Visiting Fellowship Programme
- Student Buddy

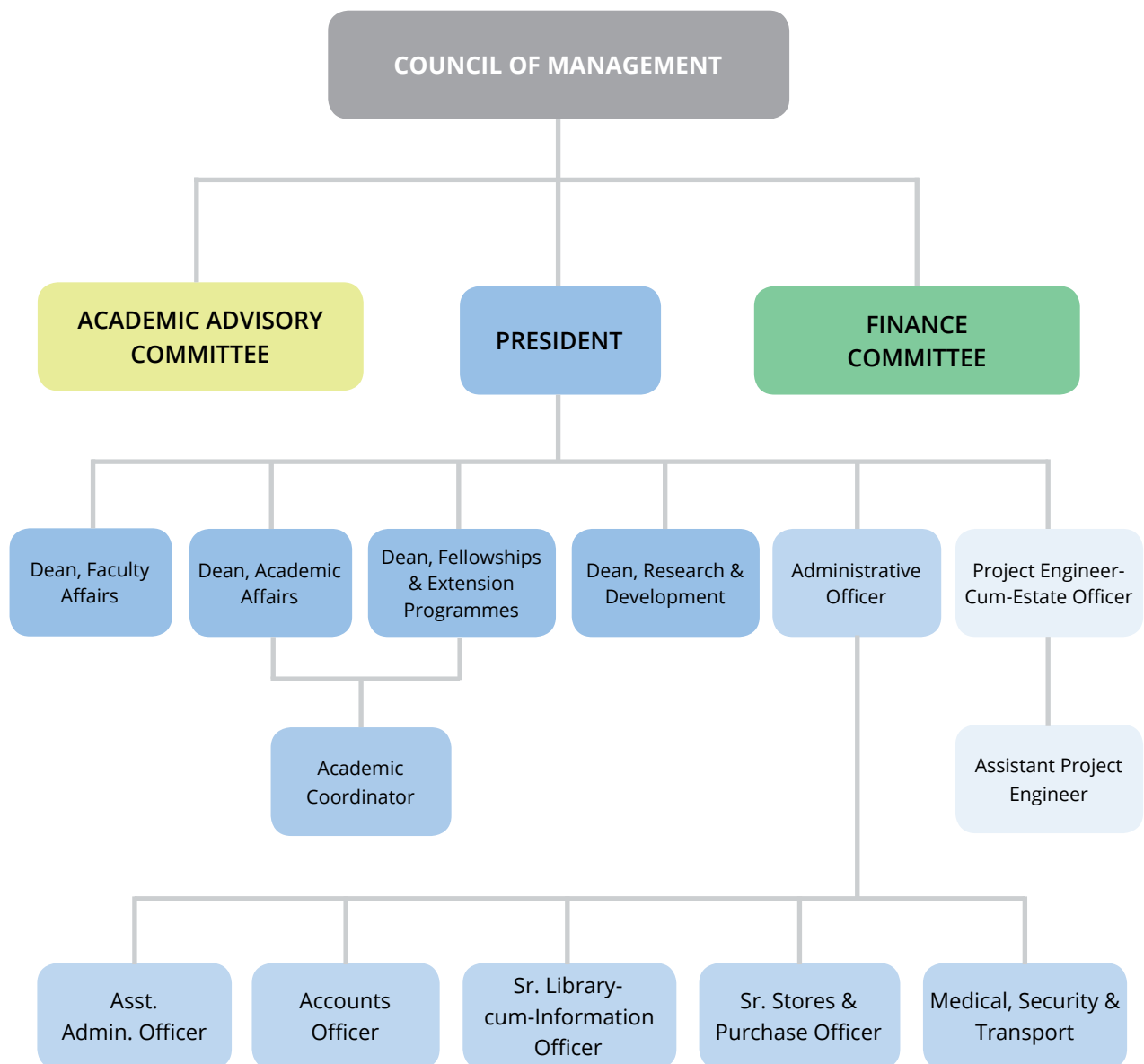
TOTAL STUDENTS/SCIENTISTS WHO AVAILED THE PROGRAMME UNTIL MARCH 2018



ACTIVITIES CHART



ORGANIZATION 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.

Members of the Council of Management



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



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



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



Prof. Vinod K Singh
Member (DST Nominee)
Director-IISER, Bhopal



Shri K.N. Vyas
Member (DST Nominee)
Director-BARC, Mumbai



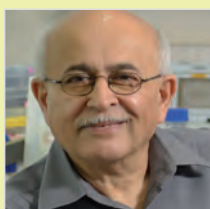
Prof. Anurag Kumar
Member (Ex-officio)
Director, IISc, Bengaluru



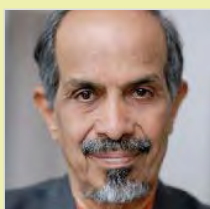
Prof. Ashutosh Sharma
Member (Ex-officio)
Secretary, DST



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



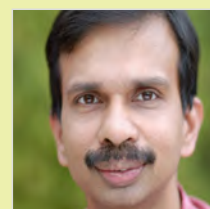
Prof. V. Nagaraja
Member (Ex-officio)
President, JNCASR



Prof. Roddam Narasimha
Member
Hon. Professor, JNCASR



Prof. Hemalatha Balam
Member
Dean, Faculty Affairs, JNCASR



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



Prof. Anuranjan Anand
Member
Professor, MBGU, JNCASR



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



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.

The constitution of the Finance Committee

NAME AND DESIGNATION	POSITION
Prof. V. Nagaraja , President, JNCASR	Chairman (Ex-officio)
Prof. Vinod K Singh , Director-IISER, Bhopal	Member
Prof. N. Balakrishnan , Professor, IISc	Member
Prof. Hemalatha Balaram , Dean, Faculty Affairs, JNCASR	Member
Shri B. Anand , JS & 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.

Members of the Academic Advisory Committee

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 , Mat. Sci. & Engg., IISc	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

All the faculty members are involved in various academic activities of the Centre and assist the Academic Advisory Committee in discharging its functions. The last Annual Faculty Meeting was held in November 2017 which included lectures by the faculty on the advances made in various research areas.

POSITION	NAME OF THE MEMBER
President	V. Nagaraja, Ph.D., F A Sc, F N A Sc
Dean, Faculty Affairs	Hemalatha Balaram, Ph.D., F A Sc, F N A Sc
Dean, Academic Affairs	Umesh V. Waghmare, Ph.D., F A Sc, F N A Sc, F N A
Dean, Fellowships and Extension Programmes	Maneesha S Inamdar, Ph.D., F A Sc, F N A Sc
Dean, Research and Development	K. S. Narayan, Ph.D., F N A Sc, F A Sc
Warden & Student Counsellor	Tapas Kumar Maji, Ph.D., F A Sc
Associate Warden	Ranjani Viswanatha, Ph.D.
Administrative 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
Project Engineer	Mahadevan N, B E, M I E
Project Engineer Gr. II	Nadiger Nagaraj, DCE
Assistant Project Engineer (Elec.)	Sujeeth Kumar S, DEE
Junior Project Engineer (Civil)	Veerasha 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 HV Chandralekha, MBBS Elizebath Daniel, M A, M Phil, Ph.D.
Physiotherapist	Y. Yogesh, BPT
Honorary Medical Officers	Sharada, MBBS C. Satish Rao, MBBS R. Nirmala, MBBS
Honorary Security Officer	M. R. Chandrasekhar, B Sc, LLB

ACADEMIC ACTIVITIES

JNCASR was founded with the objective to facilitate inter-disciplinary research. Through the twenty-nine years since its inception, it has built a reputation for regularly making scientific discoveries that make their presence felt in the scientific world. Moreover, it has also made its mark with cross-disciplinary new-age innovations that address societal problems, harnessing that very science in the process. Our comprehensive degree and diploma programmes have consistently produced world-class scientists working in cutting-edge inter-disciplinary fields of science.

SECTION - 02



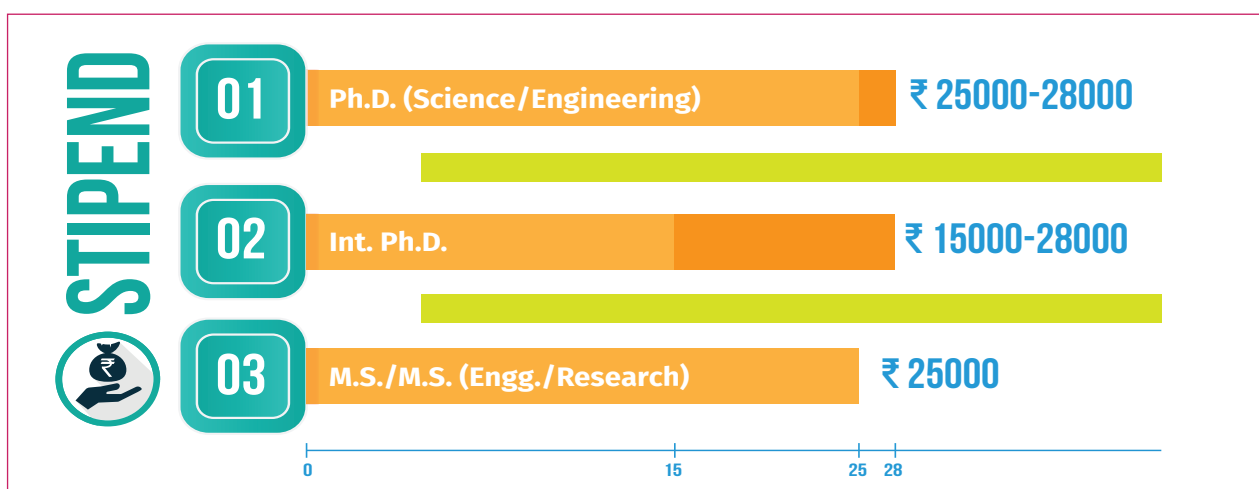
ACADEMIC ACTIVITIES

Interdisciplinary research at JNCASR addresses two main fields in science – materials research and biology and is carried out in eight individual Units: 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), Neuroscience Unit (NSU), New Chemistry Unit (NCU), and Theoretical Sciences Unit (TSU). JNCASR believes that approaching research problems through a combination of Science and Engineering viewpoints lead to far-reaching solutions. Thus, it offers not just degree programmes in Science but also in Engineering.

JNCASR offers Ph.D., Integrated Ph.D., M.S. (Research) and M.S. (Engg.) degree programmes in both Science and Engineering. Students are admitted to the Units mentioned above. The minimum academic qualification required to apply for the M.S./Ph.D. programmes of the Centre is M.Sc./ B.E./ B.Tech./ M.E./ M.Tech./ MBBS degree(s). Candidates applying for M.S./

Ph.D. programmes should (a) have at least 50% in their highest University examination, and (b) have qualified in GATE/UGC-CSIR-JRF/ICMR-JRF/DBT-JRF/JEST. Candidates are selected based on their academic record, performance in national-level qualifying exams, recommendations from referees, and performance in the interview. For both M.S. and Ph.D. programmes, the curricula require successful completion of courses for three semesters followed by supervised research. Candidates applying for Integrated Ph.D. Programme of the Centre should have at least 55% marks in their Bachelor's degree in any area of Science or Statistics. The selected candidates are offered coursework and provided with facilities for research. On successful completion of the coursework and thesis, they are awarded the degree.

JNCASR also has an active short-term academic programme by which it awards diplomas, the Postgraduate Diploma in Materials Science, and the Postgraduate Diploma in Science Education.



(a) Research Admissions

During 2017–18, 55 students joined various degree programmes at JNCASR in the August session and 5 students joined in the January 2018 session. The current student strength at JNCASR is 308. Advertisements for the regular admissions to the Integrated Ph.D., Ph.D. and M.S. programmes in the 2017–18 session were released in many prominent national and regional newspapers and announced on our website for both sessions.

(b) Degrees Awarded

Following students were awarded degrees under the various degree programmes during April 2017 – March 2018:

[Ph.D. - 43, M.S.(Engg.) - 3, M.S. in Biological Science - 12, Materials Science - 4, Chemical Science - 2]

Ph.D.

Karteek Kumar Bejagam
Ankit Jain
Dileep Krishnan
G. Ramana Reddy
Rana Saha
Umesha Mogera
Anindita Chakraborty
Prabhu S. A.
Simi Muraleedharan
Tarak Karmakar
Shivaprasad Manchineella
Ram Kumar
Sona John
Priyanka
Swastika Banerjee
Navaneeth K. M.
Radhika Dilip Shindey
Sunita Dey
Anirban Mondal
Jiarul Midya
G. Krishna Murthy Grandhi
Bradraj Pandey
Gopalakrishnan K.
Chandrathish Ghosh
Satya Narayan Guin
Nandini R. Shetty
S. Yugandar
Avijit Saha
Prashant Kumar
Anjali Singh
Chandan Kumar
Nivedita Sikdar
Jiaul Hoque
Saikat Chakraborty
Arkamita Bandyopadhyay
Arpita Paul

Devendra Singh Negi
Koushik Pal
Vijay J.
S. Kiruthika
Ananthu James
Pramoda K.
Somnath Ghara

M.S. (Engg.)

Nakul Pande
Ronak Gupta
Apoorva Singh

Master of Science (M.S.) in Biological Science

Goirik Gupta
Bhavana Kayyar
Srikant Venkitachalam
Aditi Batra
Sarika Chinchwadkar
Jigyasa Verma
Raktim Roy
C.V. Neha
Diwan Zeenat Javid Lubna
Neelakshi Varma
Akash Kumar Singh
Pritha Kundu

Master of Science (M.S.) in Materials Science

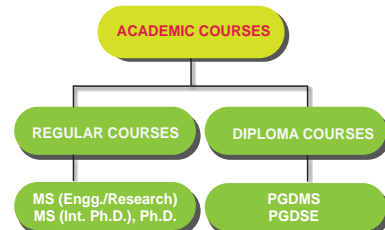
Srimayee Mukherji
Anirudha Mirmira
Pavitra Nityanand Shanbhag
Anaranya Ghorai

Master of Science (M.S.) in Chemical Science

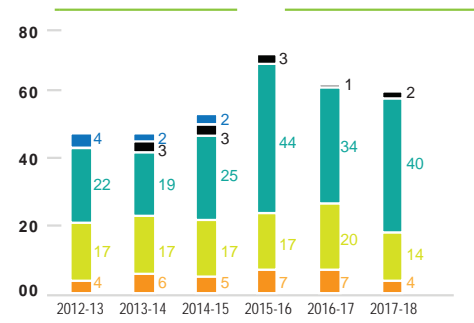
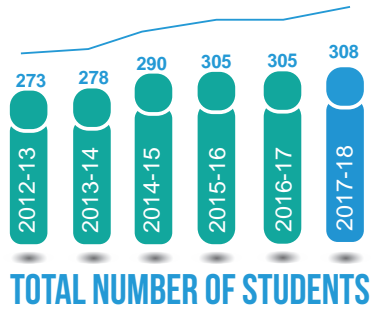
Shikha Dhiman
Ekashmi Rathore

ACADEMIC ACTIVITIES

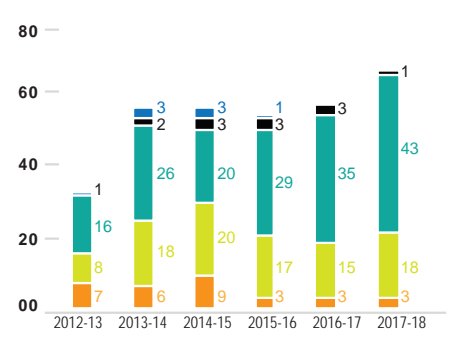
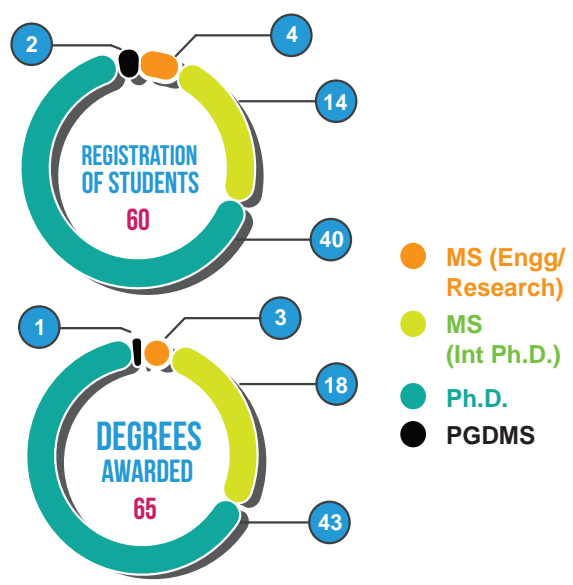
2017-2018



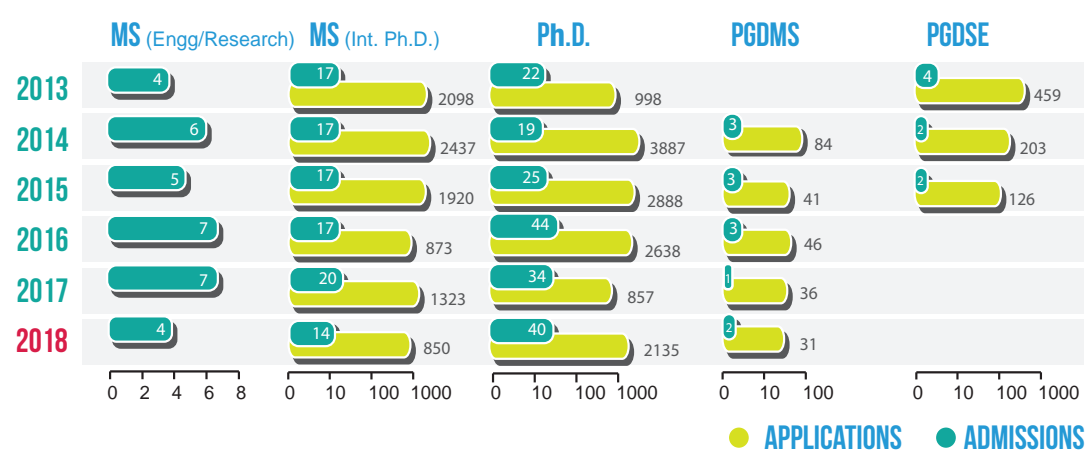
ADMISSIONS



2017-2018



NUMBER OF APPLICATIONS AND ADMISSIONS IN PAST 5 YEARS



RESEARCH & DEVELOPMENT

Research and development is the cornerstone of JNCASR's mission objectives. We have accounted several important discoveries and innovations over the years that have put us on the map, nationally as well as internationally. The Centre's interdisciplinary approach to research has resulted in close to 300 publications in the past year and almost 30 patents being filed. Our accomplishments have consistently made news in the scientific community and in the media for their direct social relevance. Several of our scientific inventions and results have been covered by Indian newspapers locally and nationally. In the following section we describe in detail the progress made in 2017-18 by each of our 9 research units namely, Chemistry and Physics of Materials Unit, Evolutionary and Integrative Biology Unit, Engineering Mechanics Unit, Geodynamics Unit, Molecular Biology and Genetics Unit, New Chemistry Unit, Neuroscience Unit, Theoretical Sciences Unit and International Centre for Materials Science.

SECTION - 03



Areas of Research

- Computational molecular science
- Programmable molecular materials in imaging and diagnostics
- Raman, brillouin spectroscopy and high pressure research
- Nanomaterials and catalysis
- Nanomaterials, nanofabrication and devices
- Functional organic/organic-inorganic hybrid materials
- Organic electronics, photovoltaics, device physics and bio-electronics
- Chemistry of materials
- Magnetism, superconductivity and multiferroicity

CPMU or Chemistry and Physics of Materials, was one of the first major research units established at JNCASR. With a novel inter-disciplinary approach to Materials Science, the Unit has made many groundbreaking discoveries ever since. 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. Notably, in December 2017 there was an international review of JNC's Materials Science Program, in which CPMU plays a key role. The review committee were in praise of the considerable progress clocked by the programme overall. CPMU's contribution was especially lauded. The body had a few suggestions to enhance CPMU's visibility on the international platform. Based on those inputs an umbrella body was created exclusively for Materials Science at JNC called the "School of Advance Materials (SAMat)". SAMat will be coordinated by the Chairs of the CPMU, ICMS, NCU and TSU.

RESEARCH HIGHLIGHTS

1. Observation of a series of topological transitions of insulator TiTe_2 before undergoing a phase transition under pressure; band inversion of insulator InTe_2 without parity change, the first such experimentally recorded observation of its kind (by **Chandrabhas Narayana**).
2. A detailed study on the industrially important process of separation and purification of ethylene from an acetylene/ethylene mixture in the presence of a metal organic framework (MOF) to show that effluent gas CO_2 uptake was significantly promoted by introducing specialised MOFs in the reaction (by **S. Balasubramanian**).
3. Discovery of a nano-array of super-packed bendable organic transistors, a billion to a sq.cm, for next-generation flexible electronic devices (by **K.S. Narayan**).
4. Design and fabrication of an innovative DNA-based super-resolution imaging technique with high multiplexing power for better in situ cytoskeleton network mapping over and above conventional super-resolution microscopy technique. The novel technique has been used to bring to light the molecular and structural basis of cytoskeleton alteration during aging (by **Sarit S. Agasti**).
5. A new family of polar magnetic oxides, $R\text{FeWO}_6$ ($R = \text{Dy, Eu, Tb and Y}$), which exhibit magneto electric properties has been discovered. (by **A. Sundaresan**).
6. Addressing future sustainable energy needs through efficient electrocatalysts with potential applications in metal-air batteries, water splitting and fuel cells to replace/reduce usage of precious metal-based catalysts (by **M. Eswaramoorthy**).
7. Synthesis of low-cost metal-free organic conjugated microporous polymers (CMPs) that show appreciable electro-chemical oxygen reduction activity (ORR) without any post-synthetic modification (by **Tapas Kumar Maji**).

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Light Scattering Laboratory

Chandrabhas Narayana, Ph.D., F N A Sc
Professor & Chair

We have continued our work on finding new topological transition materials under pressure. Our experimental data from Raman spectroscopy, resistivity and X-ray diffraction studies backed by sound theoretical mapping has unequivocally established topological transition in materials under pressure. TiTe_2 shows a series of topological transitions before undergoing a phase transition. This is the first time a material has shown such an exotic transformation. InTe_2 on the other hand showed a band inversion without parity change, which is also a first for any material. The work has potential applications in future insulator design. We have also successfully miniaturized a Raman spectrometer for diagnostic application. The current status of the project is at the development stage with a possible assay for detection of DNA/RNA without PCR amplification being one of our objectives. This apart we are also exploring Raman spectroscopy applications for studying exosomes for disease management. The group is involved in developing a High Pressure X-ray diffraction facility in KEK, Photon Factory, Tsukuba, Japan for Indian users which will be commissioned in July 2018.

Molecular Simulation Laboratory

S. Balasubramanian, Ph.D., F A Sc
Professor

We investigated supramolecular self-assembly of amino ester-based benzene-1,3,5-tricarbonylamides using MD simulations. The growth of such polymers were shown to crucially depend on the nature of the functional group. Density functional theory calculations of a metal organic framework (MOF) solid demonstrated the microscopic mechanisms involved in the separation and purification of ethylene from an acetylene/ethylene mixture, which is an industrially important process. The fluxionality of ligands in porous MOF solids were found to affect the gas uptake. This was extensively studied in a TKL MOF system which appears to take up an abundant amount of carbon dioxide. Sulfur dioxide, an acidic gas too needs to be sequestered and stored, just as CO_2 . The role of anion functionalization by room temperature ionic liquids in the uptake of SO_2 was studied using

gas phase quantum chemical calculations and MD simulations. It is shown that multiple site interactions of SO_2 with anions is conducive for its uptake. The role of chromophore rotational symmetry on helical handedness reversal of a supramolecular polymer upon electric field direction reversal was investigated using MD simulations. The observations enable us to draw general conclusions on the relationship between electric field-induced chiral enhancement and symmetry in polymers.

Molecular Electronics Lab

K S Narayan, Ph.D., F N A Sc, F A Sc
Professor and Dean, Research and Development

The molecular electronics laboratory at JNCASR is building a portfolio of different devices in the area of organic electronics. We have developed a nano-array with one billion transistors in 1 sq. cm area. Though tiny, these transistors provide higher output current in comparison to conventional organic field transistors used in organic light emitting diodes. As the new device is not rigid and uses organic semiconductor inks, it can also be used in flexible displays and sensor technology.

We call these vertical organic transistors Organic Nano-Triode Array. At 100 nm, each transistor in the circuit measures 500 times thinner than the human hair and it is half a micron in height. We made it in the lab using a simple templating technique. In the regular organic field effect transistor, there will be 5-10 transistors in 1 sq. cm area. But in our case, about one billion transistors can be packed into the same area. The cost per transistor is drastically scaled down with this procedure.

We carried out two types of measurements to study the capacity of the nano-array. The first one is the typical transistor measurement of the entire array. The second set of measurements involved studying each pore of the array and demonstrating its transistor action. The conclusion was that the new transistor can be turned-ON to the high conducting state with a very low voltage, even less than 3 V.

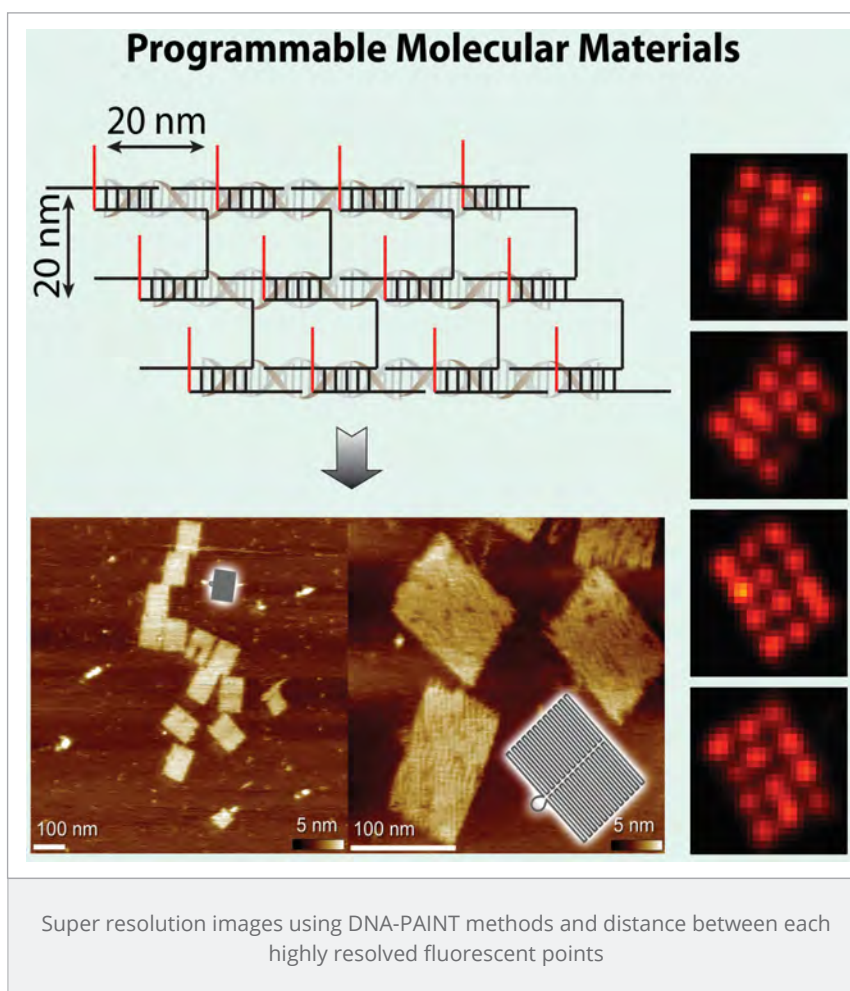
Further design and development is needed to fully address these vertical transistors as functional blocks to build circuits.

Molecular Design Lab and Nanoscopic Lab and Biomolecular Lab

Sarit S Agasti, Ph.D.
Faculty Fellow

Super-resolution microscopy is a powerful tool for exploring the cytoskeleton. Although it has met remarkable success in revealing structural details, the number of distinct molecular species that can be visualized simultaneously by this technique is limited by the spectral overlap between fluorophores. Our DNA based super-resolution imaging technique enhances visualisation of in situ cytoskeleton network mapping while also having high multiplexing power. We accomplished the necessary fluorescence ON/OFF switching for localization-based super-resolution microscopy by using transient DNA hybridization between docking strand and imager strand. We then demonstrated that DNA origami platform could be used to mimic the nanoscopic structural organization of biomolecules for super-resolution imaging performance. This imaging platform has an intrinsically scalable multiplexing ability. As the imager strand only interacts transiently with the target, orthogonal imager strands can be

sequentially applied to achieve unlimited multiplexing using a single dye and a single laser source. We explored the molecular and structural basis of cytoskeleton alteration during aging with this.



Superconductivity and Magnetism Lab

A. Sundaresan, Ph.D.
Professor

The work on the discovery of a new family of polar magnetic oxides, $R\text{FeWO}_6$ ($R = \text{Dy}, \text{Eu}, \text{Tb}$ and Y) exhibiting magnetoelectric properties has been published. Magnetization reversal phenomenon in YVO_3 has been suggested to arise from two competing magnetic phases at phase coexistence. Crystal structure, optical and magnetic properties of a single crystal of new organic-inorganic hybrid

$(\text{C}_2\text{H}_5\text{NH}_3)_2\text{CoCl}_4$ have been investigated. It undergoes a first order phase transition at 234/241 K (cooling/heating) to a noncentrosymmetric but nonpolar orthorhombic ($P2_12_12_1$) structure via rearrangement of both cations and anions. At low temperatures, it shows a large change in entropy $\sim 16\text{ J Kg}^{-1} \text{ K}^{-1}$ at 2.5 K under 7 T magnetic field. Magnetostructural coupling and magnetic dielectric effects have been investigated in new A-site ordered spinel $\text{LiFeCr}_4\text{O}_8$. Multiferroic properties have been investigated for the first in a B-site magnetic spinel GeCu_2O_4 .

Nanomaterials and Catalysis Laboratory

M. Eswaramoorthy, Ph.D.

Professor

Our research group has been exploring various aspects of nanomaterials focusing on their applications in heterogeneous catalysis, electrocatalysis, gas separation etc. Fuel efficiency and industrial effluent gas processing are some of the areas where our research can find applications. We have developed some low-cost, effective and efficient electrocatalysts for oxygen reduction reaction (ORR), hydrogen

evolution reaction and oxygen evolution reaction (OER), which when used in metal-air batteries, water splitting and fuel cells can replace or reduce the usage of precious metal based catalysts. Recently, we have also developed graphene and MoS₂ based membranes for the efficient separation of industrially important gas mixtures such as H₂ and CO₂.

We have also used various covalent, dynamic covalent and supramolecular approaches to alter the pore properties of mesoporous silica channels to tailor mass transport mimicking biological channels.

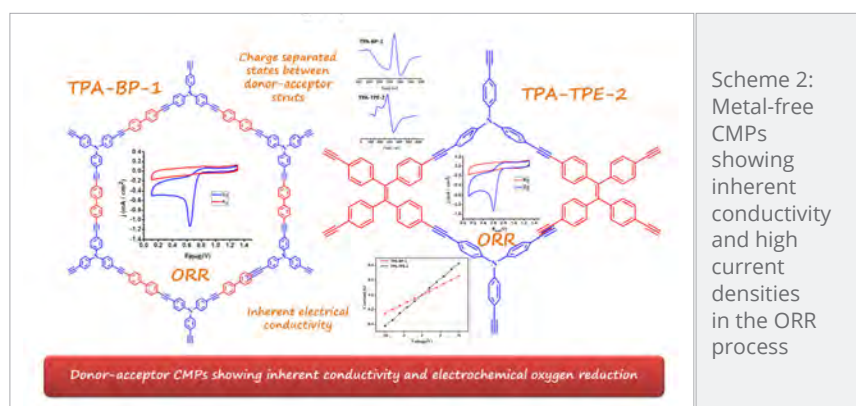
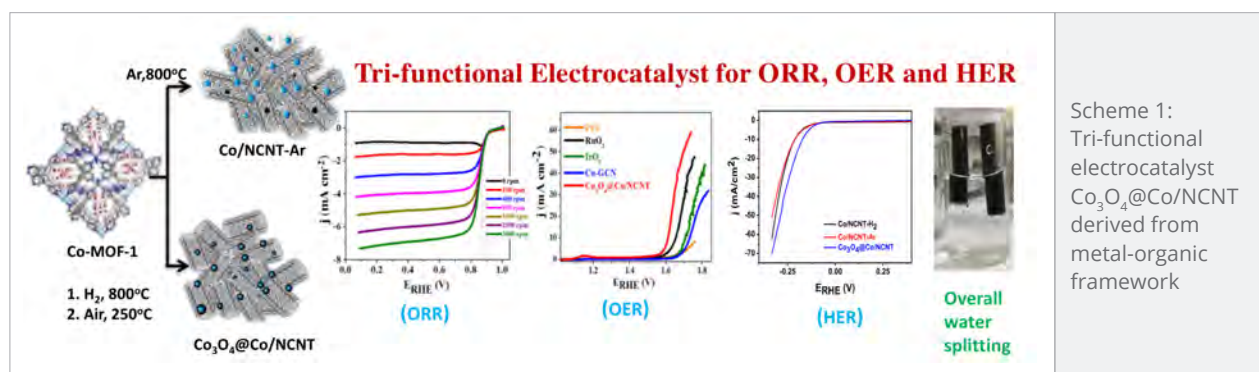
Molecular Materials Laboratory

Tapas Kumar Maji, Ph.D., F A Sc

Professor

We have shown that Co₃O₄@Co/NCNT nanostructures can be derived by pyrolyzing a dicyanamide based metal-organic framework (MOF) which can be used as efficient tri-functional catalysts in the oxygen reduction reaction (ORR), hydrogen evolution reaction and the oxygen evolution reaction (OER) involved in water splitting. (**Scheme 1**). Similarly, nanoporous carbons and nitrogen doped carbon nanodots were also synthesized from anionic MOFs to show activity in the ORR process. Further, we have devised a new method to synthesize metal-free porous organic

systems that show appreciable electro-chemical oxygen reduction activity without any post-synthetic modification. It involves the covalent coupling of donor-acceptor organic nodes and spacers to form conjugated microporous polymers (CMPs). The continuous charge separation induced via the covalent linkages, generates facile strut-to-strut charge transfer essential for electron transport in the electrodes. The porous structure also allows facile O₂ diffusion into the reactive sites leading to a high current density and low overpotential in these purely organic systems. So far we have synthesized four such CMPs which show metal-free activity with over-potentials as low as 150 mV (**Scheme 2**). We have further incorporated Co nanoparticles in these systems to realize 80 mV over-potentials thus demonstrating their promise as next-generation low-cost ORR catalysts. Cobalt nanoparticle



incorporated covalent-organic frameworks (COFs) and CMPs are also being used as water oxidation catalysts in our lab. These have shown activity as oxygen evolution catalysts with low over-potentials of 340 mV and high current densities. The porous organic materials are also being investigated as hydrogen evolution catalysts and as energy storage devices.

UNIT MEMBERS

Chair

Chandrabhas Narayana, Ph.D., F N A Sc, F R Sc, F A Sc

Professors

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

Shivaprasad S M, Ph.D. (On Lien W.E.F 11.08.2017),
(jointly with ICMS)

Kulkarni G U, Ph.D., F A Sc (On Lien W.E.F 21.4.2015)

Balasubramanian S, Ph.D., F A Sc

Chandrabhas Narayana, Ph.D., F N A Sc, F R Sc, F A Sc

Sundaresan A, Ph.D.

Eswaramoorthy Muthusamy, Ph.D.

Tapas Kumar Maji, Ph.D., F A Sc

Associate Professors

Ranjan Datta, Ph.D. (jointly with ICMS)

Rajesh Ganapathy, Ph.D. (jointly with ICMS)

Sridhar Rajaram, Ph.D. (jointly with ICMS)

Faculty Fellows

Sarit S Agasti, Ph.D. (jointly with NCU)

Bivas Saha, Ph.D. (jointly with ICMS)

Research Students

Gurshidali P, Abhishek Kumar, Swaraja Servottam, Anjali Gaur, Dheemahi, Brijesh, Ashutosh Kumar Singh, Shivani Grover, Tarandeep Singh, Nijita Mathew, Raagya Arora, Pragya Arora, Shashank Chaturvedi, Sukanya Das, Janaky S, Niloyendu Roy, Rajendra Singh, Lakshay Dheer, Narendra Kumar, Anaranya Ghorai, Pavitra Nityanand Shanbhag, Anirudha Mirmira, Srimayee Mukherji, Nikita Gupta, Abhiroop Lahiri, Shantanu Aggarwal, Sohini Bhattacharyya, Uttam Gupta, Suchitra, Raaghesh A.V, Sonu K.P, Abhijit Sen, Chandan De, Sisir Maity, Ankush Kumar, Purohit Sumukh Anil, Sudarshan Behera, Mrinal Boro, Swarnamayee Mishra, Shalu Rani, Surishi Vashishth, Divya, Sanchita Karmakar, Arunava Saha, Navneet Singh, Parul Verma, Abdul Azeez H, Subhajit Laha, Momin Ahamed, Kompella V K Srinath, Avula Venkata Siva Nikhil, Soumita Chakraborty, Nimish D, Sharona Thomas Horta, Usha Manjunath Bhat, Ravi Shankar P N, Yanda Premakumar, Manodeep Mondal, Divya C, Rajendra Kumar, Shivaram B Kubakaddi, Ganesh N, C S Deepak, Meenkshi Pahwa, Priyanka Jain,

Korlepara Divya Bharathi, Badri Vishal, Abhijit Chatterjee, Sudip Das, Chaitali Sow, Bharath B, V. Rajaji, Syamantak Roy, Dheeraj Kumar Singh, Papri Sutar, Swathi, Sanjay Kumar Nayak, Sreedhara M.B, A.Z. Ashar

Sr. Technical Officers

Sreenath V, BE

Srinivas S, BE

Research Scientist B

Anoop S, Suresh J

Technical Assistant

N R Selvi

Research Associates

Debabrata Samanta, Suman Banerjee, Chayanika Das

Research Associates (P)

Prashant Kumar, A Z Ashar

SERB National PDF

Kamali Kesavan, Shivanna M, Ashish Singh, Sandra Dias, Subarna Dey, Chandraiah M Darsi Rambabu, Mehraj Ud Din Sheikh

Post Doctoral Fellow

Shivani Sharma

Junior Research Fellows

Sanchayita Mukhopadhyay, Manideepa Dhar (jointly with NCU)

R&D Assistants

Anangi Brahmaiah, Shashidhara Pura (jointly with NCU), Soumya C (jointly with NCU), G. Aditya Kumar, Anil Krishna Konduri, Subrahmanya T M, Monica Swetha Bosco (jointly with NCU)

Awards / Membership / Fellowships / Sponsored Projects / Academics / Publications

AWARDS RECEIVED BY FACULTIES

C.N.R. RAO

- First Asian to receive the Materials Research Society's highest honor - the Von Hippel Award presented in Boston on November 29, 2017
- Wockhardt Research Prize
- Hon. Doctorate of IIT, Guwahati
- Hon. Doctorate of University of Guwahati

SARIT AGASTI

SERB Early Career Award and
DAE-Young Scientist Award

AWARD RECEIVED BY STUDENT

RADHA BOYA

(JNCASR Alumnus) for being selected to the MIT
technology review innovators of 2017

MEMBERSHIP

TAPAS KUMAR MAJI

Editorial Board Member for five years for an Inorganic
Chemistry Journal named Inorganica Chimica Acta,
published by Elsevier.

FELLOWSHIPS

CHANDRABHAS NARAYANA

Fellow of the Indian Academy of Sciences

TAPAS KUMAR MAJI

Fellow of the Indian Academy of Sciences

SARIT AGASTI

Wellcome Trust Intermediate Fellowship

SPONSORED PROJECTS

13 New Projects ₹ 4,12,85,536
33 Ongoing Projects ₹ 27,00,93,057

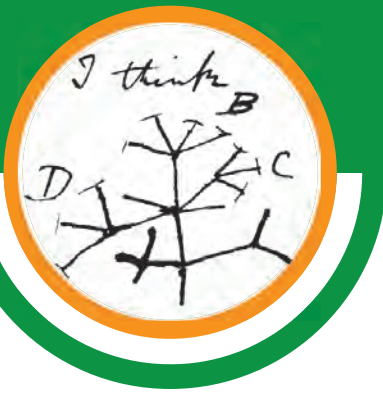
PUBLICATIONS

70 Journal Articles
2 Book Chapters

ACADEMICS

15 Students Admitted
22 Graduated

EVOLUTIONARY AND INTEGRATIVE BIOLOGY UNIT (EIBU)



Areas of Research

- Population Ecology
- Behavioural Ecology
- Phylogeography
- Evolutionary Genetics

Biological systems are structurally hierarchical, but functionality in biological systems needs to be interpreted and understood in an ecological and evolutionary context. The Unit (previously Evolutionary and Organismal Biology Unit) focuses on fundamental questions in whole-organism biology with a strong underpinning of evolutionary explanation. In this unit, theoretical analysis is combined with laboratory experiments and/or field observations to (a) understand the interplay of the evolution of life-histories and competitive ability, and its effects on population dynamics, (b) evaluate how the interplay of ecological factors, behavioural factors, and genetic factors affects social organization, and (c) re-conceptualize the core of evolutionary theory by reinterpreting basic phenomena like fitness and heredity, to analyse adaptive evolutionary dynamics under genic and non-genic inheritance. EOBU students (of late Prof. V.K. Sharma) have been assigned to Prof. Sheeba Vasu, Neuroscience Unit, upon her request. Their research will appear under NSU.

RESEARCH HIGHLIGHTS

1. Individual based model of fruitfly population dynamics that, for the first time, explains experimental data from multiple populations and environments.
2. Examination of the role of natural and sexual selection in the evolution of partial reproductive isolation in fruitfly populations with reduced sexual conflict.
3. First elucidation of female social structure of Asian elephants in India, showing individual-based to flexibly-nested fission-fusion dynamics, unlike that in African savannah elephants.
4. First demonstration of group size constraining female Asian elephant associations.
5. Comprehensive repudiation of claims that niche construction occupies a logical status in evolutionary explanation, on par with natural selection.

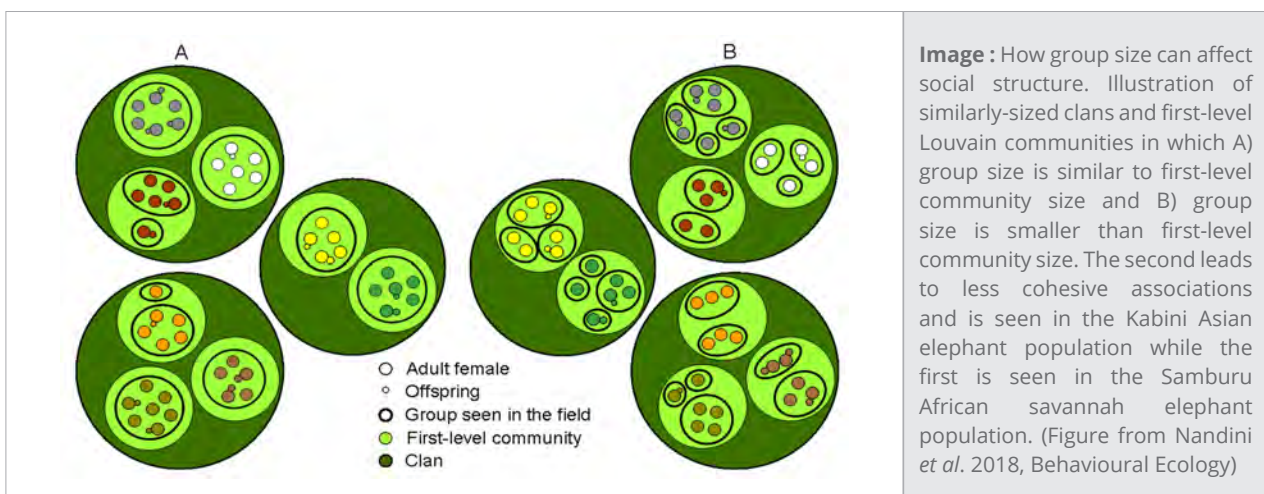


Image : How group size can affect social structure. Illustration of similarly-sized clans and first-level Louvain communities in which A) group size is similar to first-level community size and B) group size is smaller than first-level community size. The second leads to less cohesive associations and is seen in the Kabini Asian elephant population while the first is seen in the Samburu African savannah elephant population. (Figure from Nandini *et al.* 2018, Behavioural Ecology)

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Amitabh Joshi, Ph.D.

Professor

We developed an individual-based model of the dynamics of fruitfly populations which captures most details of the population dynamics, including time series summary statistics, stability measures and population size distributions. The model works for populations with different trait combinations under a variety of food regimes. This is the best functioning fruitfly dynamics model yet, and the first major advance in modelling fruitfly population dynamics since LD Mueller's 1988 model. This model also provided novel insights into the impact of interaction of food availability and life-history on population dynamics and pest control strategies (collaboration with

Prof. S. Dey, IISER Pune). We showed that different ecological contexts of crowding can favour the evolution of hard-wired versus plastic feeding rate responses. We also show the evolution of lower sexual conflict in rapidly developing populations due to interplay of breeding ecology and body size reduction, with the latter dominating. As a part of the collaborative Foundations of Genetics and Evolution Group, we showed that the logical status of niche construction was less central to evolutionary theory than that of natural selection. We also suggest that transmission fidelity can greatly affect evolutionary outcomes of culturally inherited mate preference for genetic traits.

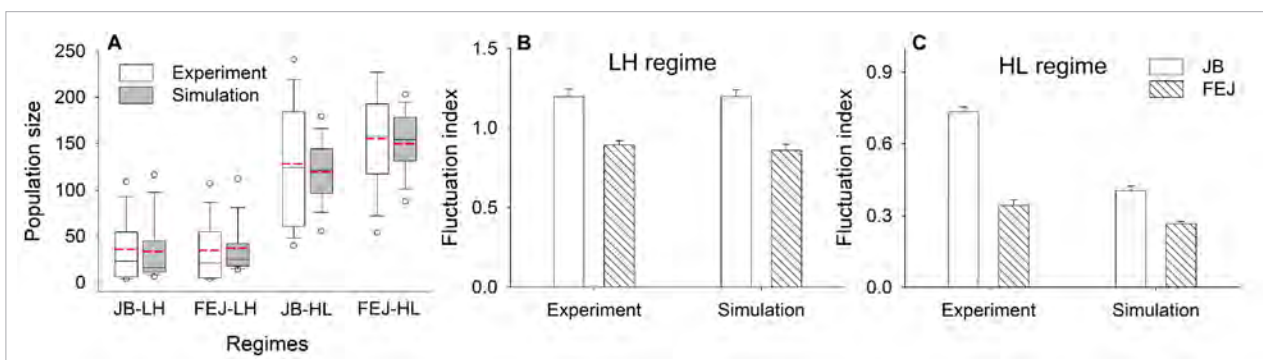


Image 1: Validating the ABM model of *Drosophila* population dynamics with populations selected for rapid development (FEJ) and their ancestral controls (JB). The model captures the dynamics of these two sets of populations with very different life-histories and demographic parameters extremely well. (A) Descriptive statistics of the population size distributions of experimental and simulated JB and FEJ populations. Red dashed lines: means, thin black lines: medians, edges of the boxes: 25th and 75th percentiles, whiskers: 10th and 90th percentiles and the circles outside: 5th and 95th percentiles of the distributions. White boxes represent experimental data while grey shaded boxes denote simulated time-series. Average (\pm SEM) FI of JB and FEJ populations corresponding to the experimental and simulated time-series under (B) LH and (C) HL regimes. Experimental data shows that in both the regimes, FEJs have lower FI than the JB, as predicted by the model (figure from S. Tung *et al.* BioRxiv, Doi: <https://doi.org/10.1101/138446>).

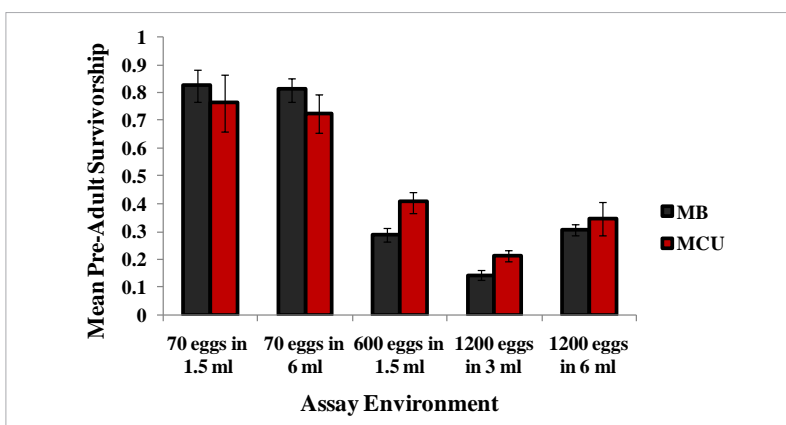


Image 2: The ecological context of crowding can affect fitness in crowded cultures of fruitflies. Note the lower pre-adult viability in both crowding adapted (MCU) and control (MB) populations in two treatments with exactly the same egg density (600 eggs per 1.5 mL food and 1200 eggs per 3 mL food). Crowding adapted MCU populations show higher viability than their ancestral controls in the three crowded treatments, but not in the two uncrowded treatments using only 70 eggs per vial.

T.N.C. Vidya, Ph.D.

Chair & Associate Professor

Our lab studies the social structure of female and male Asian elephants in Nagarahole and Bandipur National Parks. This is the only long-term study of Asian elephants in India that monitors a large number of individually identified elephants. By performing analysis of long-term data and comparison with other elephant populations, we showed how female elephant society is structured. In contrast to African savannah elephant female society which shows a strictly (hierarchically)-nested fission-fusion society, the Asian elephant females in Kabini showed

individual-based to flexibly-nested fission-fusion dynamics. We found that apparently different social structures in related species might have underlying similarities, which are obscured by differences in average group size. This study has implications for the study of social structure in other sets of closely related species. We found that despite constraints in group size, females interacted with their clan-mates rather than forming small, fixed groups, which suggests that there may be benefits from interacting more widely within the clan. The nature of these benefits, as well as competition amongst females, is being studied. There was no seasonality in associations at the level of clans. Social interaction amongst adult males is also being studied.

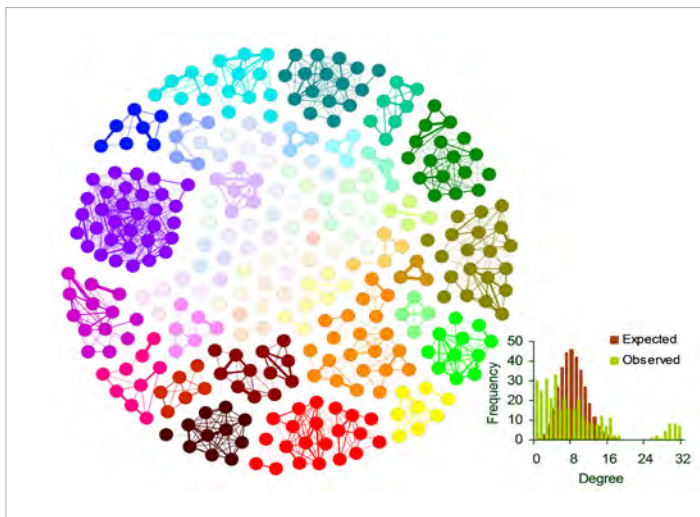


Image 3: Female social network based on 330 females. Each node here is a female and the edges between the nodes indicate nonzero association index (AI) between females (edge thickness is proportional to AI). Nodes are coloured based on modularity classes: nodes of the same colour are called a clan. The expected (Poisson) and observed degree distributions based on this social network are shown. Most of the solitary nodes towards the centre are females that were seen only once or a few times, whose clans have not yet been recovered. (Figure from Nandini *et al.* 2018, Behavioural Ecology)

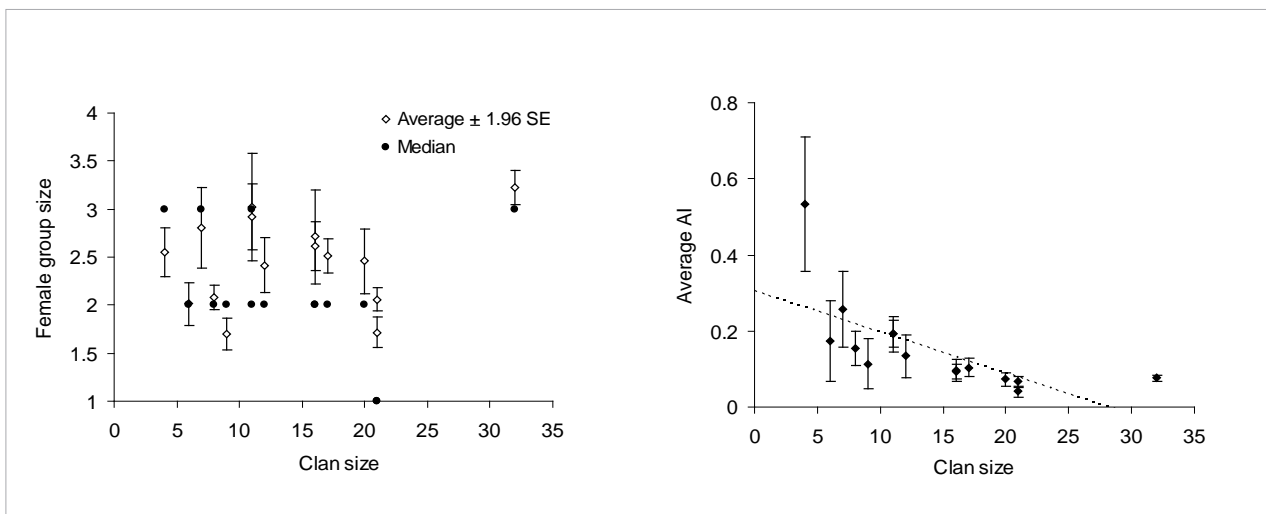


Image 4: a) Average \pm 1.96 SE and median group sizes and b) average \pm 1.96 SE association index (AI) plotted against clan size for 15 focal clans. There is no increase in group size with increasing clan size (a), indicating a constraint on group size. Therefore, the average AI decreases in clans of larger size (b), as it becomes difficult for females of larger clans to associate with one another given restricted group sizes. (Figure from Nandini *et al.* 2017, Animal Behaviour).

UNIT MEMBERS

Chair & Associate Professor

T N C Vidya, Ph.D.

Professor

Amitabh Joshi, Ph.D., F A Sc, F N A Sc, F N A

Research Students

Kulkarni Rutvij Kaustubh, Srikant
 Venkitachalam, Manan Gupta, Abhilash
 Lakshman, Manaswini Sarangi, Avani Mital,
 Sheetal Potdar, Ms Kuwar Aishwarya,
 Satyabrata Nayak, Revathe T, Neha Pandey,

Singh Viveka Jagdish, Manishi Srivastava, Anuj
 Menon, Hansraj Gautam, Keerthipriya. P,
 Pavitra Prakash

Research Associates

Nandini R Shetty, Joy Bose

R&D Assistants

Ankana Sanyal, Pratyusha Chakraborty,
 Ramesh M. K., Sajith V.S.

Awards / Sponsored Projects / Academics / Publications

AWARDS RECEIVED BY FACULTIES

AMITABH JOSHI
 Selected for the Prof. Har Swarup Memorial Lecture
 Award of INSA, 2017

T.N.C. VIDYA
 Prof. CNR Rao Oration Award, JNCASR

ACADEMICS

2 Students Admitted
5 Graduated

AWARD RECEIVED BY STUDENT

NANDINI R. SHETTY
 Best Ph.D. Thesis Award (Biological Sciences),
 JNCASR

SPONSORED PROJECT

1 Ongoing Project ₹ 28,00,000

PUBLICATIONS

11 Journal Articles
1 Book Chapter
1 Abstract
1 Newspaper Article
1 Discussion Forum Post



ENGINEERING MECHANICS UNIT (EMU)

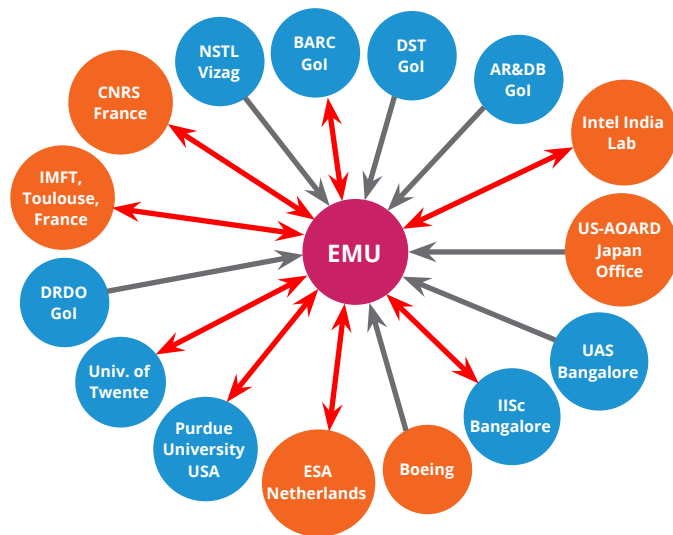
Areas of Research

- 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 nonequilibrium suspensions
- Flow under micro-gravity conditions

The Engineering Mechanics Unit has been pursuing research on a range of topics related to transport processes in simple and complex fluids over a range of length and time scales. Research endeavours encompass both fundamental concepts and application-oriented scenarios, and as shown in figure below, have led to connections, both research-based and funding-based, with leading institutions in India and around the world.

The research problems currently being investigated by the Unit are aerodynamics, complex fluids and rheology, flow and interfacial stability, and computational science.

In the past year, applications-oriented research has focused on both water and energy related issues. Fundamental research has been carried out on the flow of complex fluids that include dilute polymer solutions, emulsions, and suspensions of swimming microorganisms. Under method development the Unit has performed efficient large-scale computations of turbulent flow past bodies, with an analysis of the coherent structures as a function of both geometry and compressibility.



Research Funding & Collaborations

RESEARCH HIGHLIGHTS

1. Tie-up with the Bangalore international airport for investigations into nocturnal boundary layer processes towards prediction of Radiation fog (by **K.R. Sreenivas**).
2. Initiating the development of an energy and water efficient aeroponics chamber (by **K.R. Sreenivas**).
3. Discovery of a linear instability in viscoelastic pipe flow (by **Ganesh Subramanian**).
4. Discovery of a shear-concentration banding instability in active suspensions (by **Ganesh Subramanian**).
5. Development of an in-house code to solve for turbulent flow past turbine blades (by **Roddam Narasimha**).

RESEARCH ACTIVITIES AND ACHIEVEMENTS

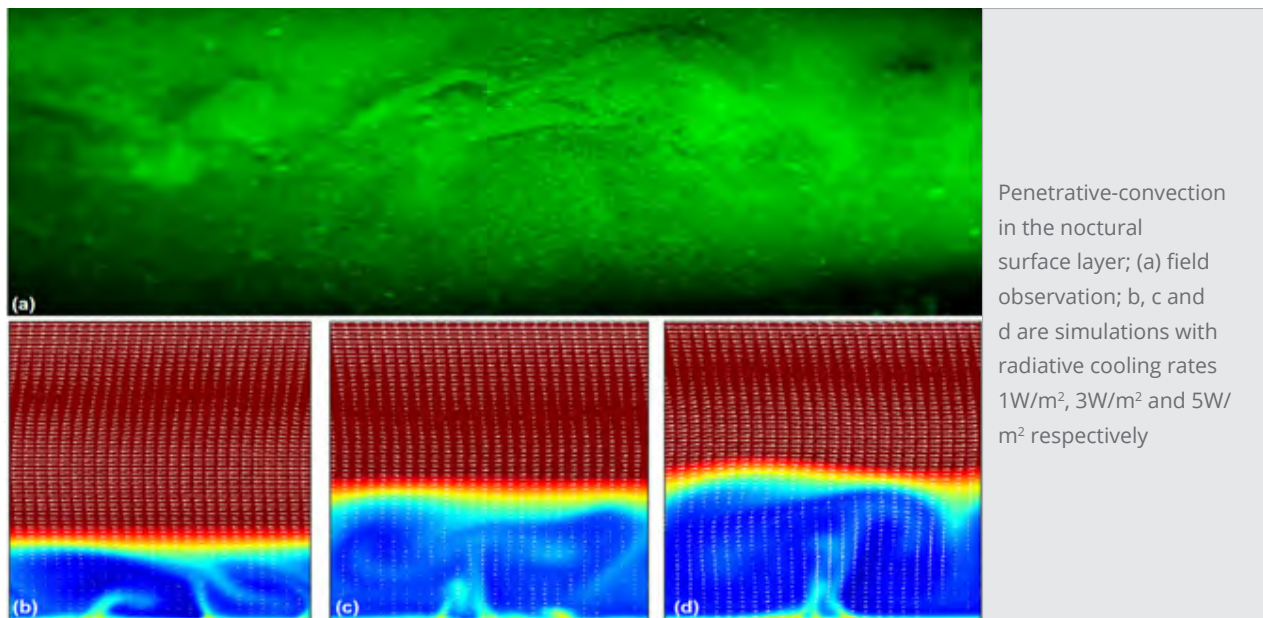
K.R. Sreenivas, Ph.D.

Professor, Chair

Radiation fog activity has been identified as an emerging and important issue in airport management. In this regard, our group has established a collaboration with the Bangalore International Airport Limited (BIAL) by establishing an observation station next to the runway for monitoring various parameters that impact fog formation. BIAL has expressed its interest in partnering with JNCASR by committing substantial funding for starting a new program to study transport processes in nocturnal atmospheric boundary layer, 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.

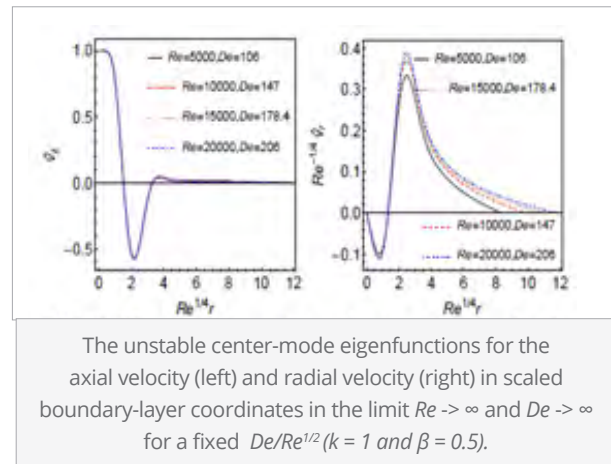
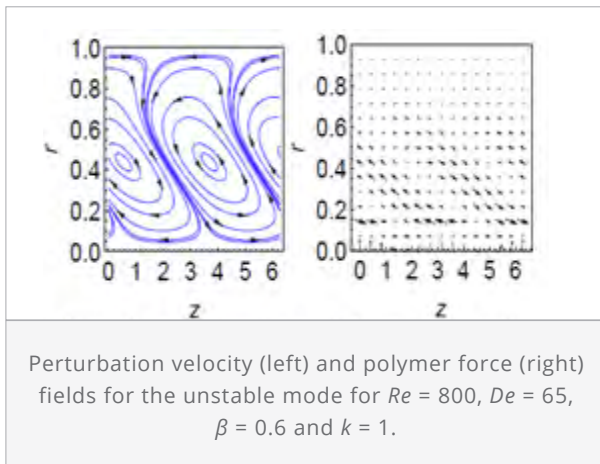


Ganesh Subramanian, Ph.D.

Professor

Research efforts, in collaboration with Prof. V. Shankar's group at IIT Kanpur, have led to the discovery of a new linear instability for pipe flow of a viscoelastic fluid. Newtonian pipe flow is known to be linearly stable, and this is therefore the first discovery of a linear instability in pipe flow since Reynold's

pioneering experiments demonstrating the transition to turbulence more than a hundred and twenty years ago. The discovery has fundamental implications for flow transitions of rectilinear shearing flows of viscoelastic fluids, and could profoundly change our current understanding of turbulent drag reduction.



Ongoing research efforts also involve the development of a novel methodology to estimate the convective rate of transport of heat or mass from droplets in topologically non-trivial ambient flows, a fundamental problem underlying a host of scenarios that include separation processes such as liquid-liquid extraction, spray drying emissions from internal combustion engines, growth of cloud condensation nuclei etc.

Ongoing research on the dynamics and rheology of bacterial suspensions has led to the identification of

a novel shear-induced banding instability in these systems, whereby the homogeneous sheared state becomes susceptible to instabilities under layering perturbations.

We have also started developing a new analytical framework, based on the fluctuation run-and-tumble equation, that will be used to analyse the role of non-equilibrium fluctuations in bacterial suspensions.

Santosh Ansumali, Ph.D.

Associate Professor

For Computational Fluid Dynamics (CFD), simulation of turbulent flows continues to remain a challenge. This is especially true if we need to simulate transient (rather than steady-state) 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 which incorporate the effect of small scales on the large eddies. Lattice Boltzmann algorithms for simulating fluid flow have become popular alternatives to traditional methods for directly solving the Navier-Stokes equations due to their ease of implementation and linear scalability across massively parallel computing environments. However, 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 (ELBM), that involves an additional demand that the entropy of the system decrease across each step of evolution. In the absence of an exact solution, ELBM uses iterative methods involving computationally expensive mathematical functions to obtain a numerical solution. Instead of demanding equality of entropy, we have shifted to demanding an inequality based essentially on the second law of thermodynamics - entropy should not decrease. In doing so, the problem has been recast to a search for solutions satisfying a non-linear inequality. We find 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 formulate an algorithm which 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 a demonstration of the prowess of the new algorithm, we have performed transient simulations of air flow past a benchmark

airfoil for angles of attack around the stall angle on a tera-scale computing cluster. The simulations have an 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, in the near future.

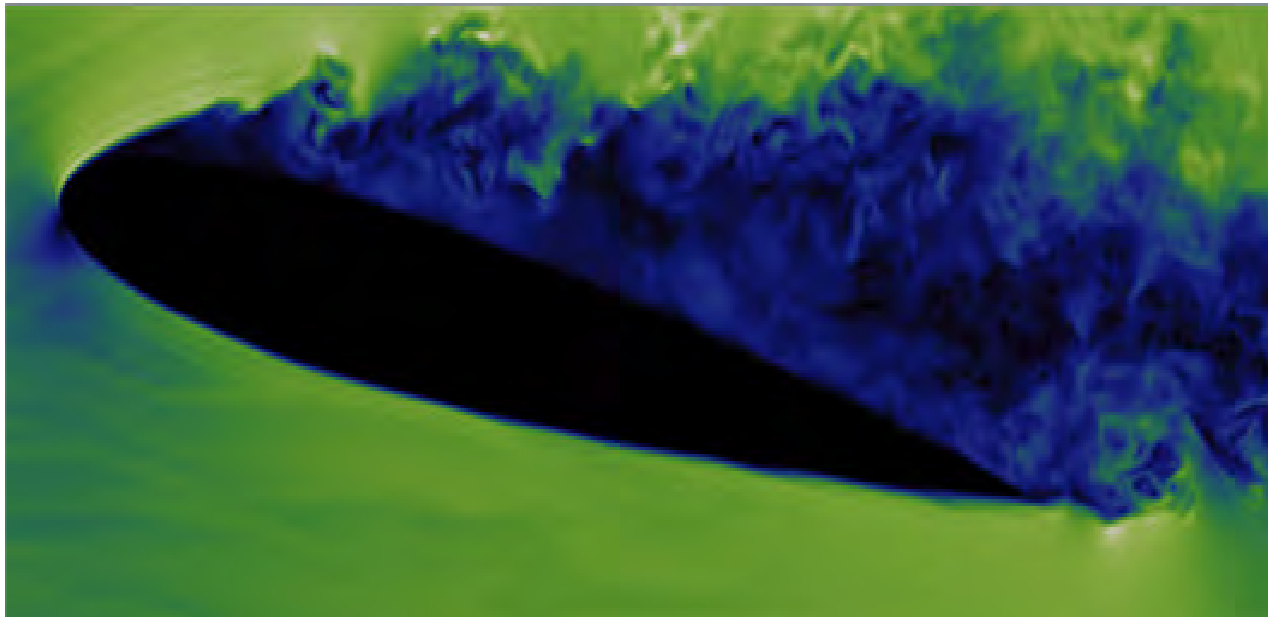
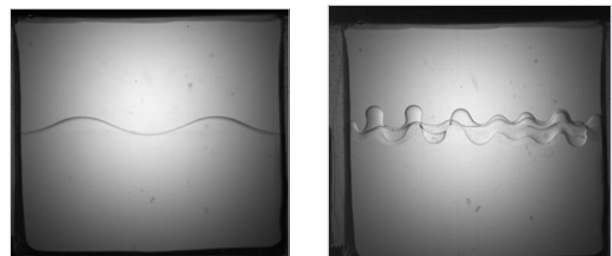


Fig: Visualization of NACA0012 airfoil in stall at an angle of attack 12° and Reynolds number 5×10^4 .

Diwakar S. Venkatesan, Ph.D.

Faculty Fellow

We have been involved in parabolic flight experimentation for the characterization of the 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 counter-intuitive stabilization that can result from a reduction in interfacial tension.



Evolving interface in normal gravity and micro-gravity conditions

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

Honorary Faculty

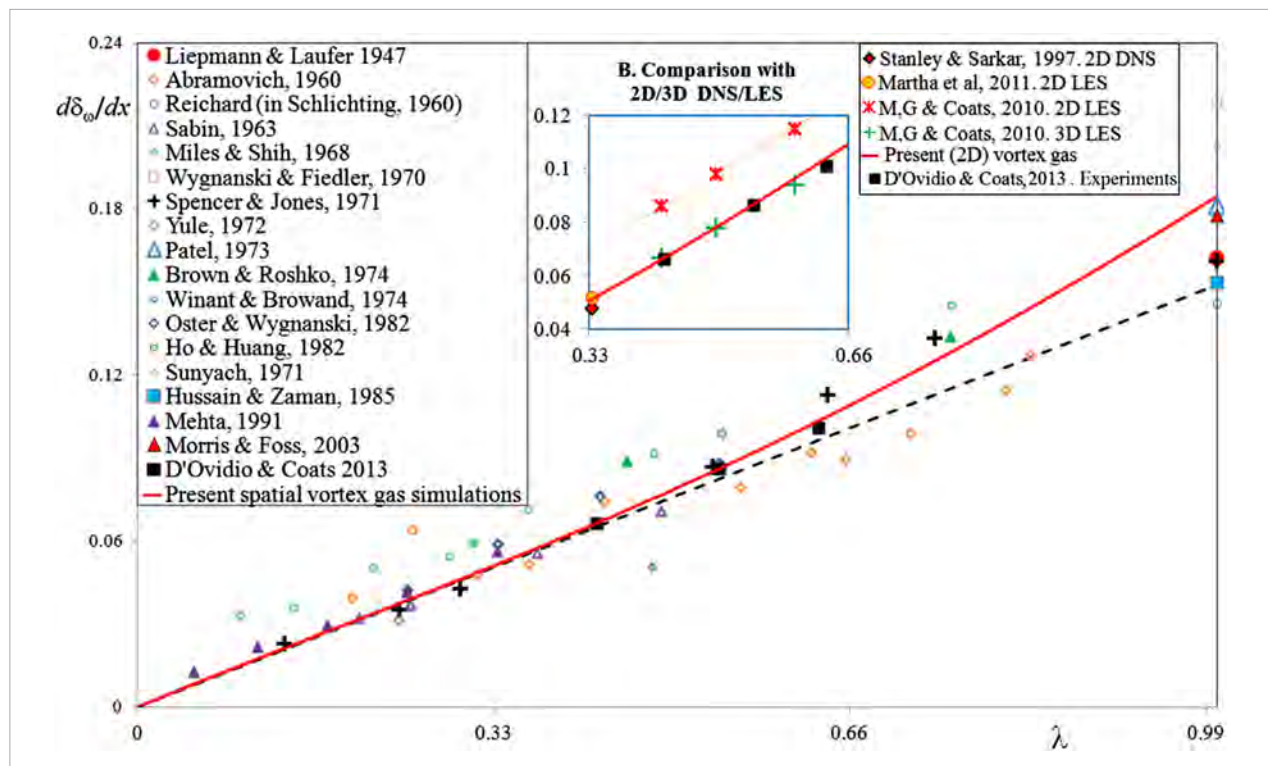
Research carried out in my group covers 3 areas: fluid dynamics of clouds studied through laboratory experiments as well as computer simulations; a vortex gas model for 2D turbulent free shear layers; and direct numerical simulation (DNS) of complex flow past gas turbine blades.

It has been demonstrated that a vortex gas (point-vortex) model for a spatially evolving 2D turbulent free shear flow yields a universal growth rate that is in surprisingly close agreement with data from high Reynolds number experiments (see Figure). This agreement is significant because the model is minimal. It appeals only to one dynamical principle (Kelvin's theorem), and uses only one mathematical tool (the Biot-Savart relation). Furthermore the model is very easy to code. The regime of universal growth rate at each velocity ratio across the layer is independent of initial conditions; the number of vortices and the

size of an averaging ensemble can be optimized for minimizing computer time.

A major achievement over the last two years has been the completion of three related projects on gas turbine blades, two of them for Gas Turbine Research Establishment (GTRE), under DRDO in Bangalore and the third for Advanced Numerical Research & Analysis Group (ANURAG), also under DRDO, Hyderabad. The projects involved DNS investigations on a widely studied low-pressure turbine (LPT) blade T106A. The computer code for DNS studies of T106A using the in-house developed ANUROOP has been validated providing valuable clues on the underlying physics of the different types of complex flows on the blade. High resolution ANURAG runs show a simpler flow structure, and a large effect of blade surface curvature on the flow.

It has been demonstrated that use of Graphics Processing Units/GPUs (along with CPUs) can yield large gains in computing time and performance.



Self-preservation spread rate of a turbulent free-shear layer by vortex-gas simulations as a function of velocity-ratio parameter λ (full red line shown as a smooth fit over data points for 9 values of λ), compared with temporal vortex gas (the dashed line), experiments (points) and (in inset B) 2D and 3D LES and 2D DNS studies. (Physics of Fluids, 29, 020708, 2017)

UNIT MEMBERS

<p>Chair Sreenivas K R, Ph.D.</p> <p>Professors Sreenivas K R, Ph.D. Meheboob Alam, Ph.D. Ganesh Subramanian, Ph.D.</p> <p>Associate Professor Santosh Ansumali, Ph.D.</p> <p>Faculty Fellow Diwakar Seyyanur Venkatesan, Ph.D.</p> <p>Senior Professor (Honorary Professor) R Narasimha, Ph.D., F A Sc., FNA, F.T.W.A.S, F.R.S.</p> <p>Research Students Saifuddin, Akanksha Bohra, Tanumoy Dhar, Nishant Soni, Swastik Hegde, Prashanth Ramesh, Pulkit Kumar Dubey, Albin Prince John, Biswadeep Roy, Mohammad Atif, Mayank Toprani, Aghor Pratik Prashant, Samarth Agrawal, Akshaysingh Bhawarsingh Shekhawat, Bangar Sarika Shivaji, Piyush Garg, Shaurya Kaushal,</p>	<p>Arun Kumar Varanasi, Prateek Anand, Praveen Kumar K, Mohammad Raifuddin, Mahan Raj Banerjee, Sankalp Nambiar, Rama krishna Rongali, Sunil V Bharadwaj, Shashank H J, Vybhav G R, K. Siddharth</p> <p>Research Associates Maruthi N H, Saikat Saha, S Ravi Chandran, Dhiraj Kumar Singh, Deepak Govind Madival, Kishore Singh Patel, Ramakrishna Rongali, Aneesh Prabhakar</p> <p>Research Associate (P) Sunil Bharadwaj SERB National PDF Nandu Gopan, Lakshminarasimharao</p> <p>SERB Young Scientist Fellow Shailendra Kumar Singh</p> <p>R & D Assistants Sohini Ganguly, Sankalp Radhakrishnan Nambiar, Rhoheth Radhakrishnan, Pravesh Shukla</p>
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Awards / Sponsored Projects / Academics / Publications

<div style="border: 1px solid #e91e63; border-radius: 15px; padding: 5px; background-color: #fce4ec; margin-bottom: 10px;"> <p style="text-align: center; background-color: #e91e63; color: white; padding: 5px; border-radius: 10px;">AWARD RECEIVED BY FACULTY</p> <p style="text-align: center; color: #e91e63; font-weight: bold; margin: 5px 0;">RODDAM NARASIMHA</p> <p style="text-align: center; font-size: small; color: #000080;">Distinguished Alumnus Award in the Centenary Global Alumni Meet of the University of Mysore Alumni Association (6 February 2016)</p> </div> <div style="border: 1px solid #e91e63; border-radius: 15px; padding: 5px; background-color: #fce4ec;"> <p style="text-align: center; background-color: #e91e63; color: white; padding: 5px; border-radius: 10px;">ACADEMICS</p> <p style="text-align: right; color: #e91e63; font-weight: bold; margin: 5px 0;">5 Students Admitted 3 Graduated</p> </div>	<div style="border: 1px solid #e91e63; border-radius: 15px; padding: 5px; background-color: #fce4ec; margin-bottom: 10px;"> <p style="text-align: center; background-color: #e91e63; color: white; padding: 5px; border-radius: 10px;">AWARDS RECEIVED BY STUDENTS</p> <p style="text-align: center; color: #e91e63; font-weight: bold; margin: 5px 0;">NAVANEETH K. M.</p> <p style="text-align: center; font-size: small; color: #000080;">Roddam Family Award (Best Thesis for Ph.D.), JNCASR</p> <p style="text-align: center; color: #e91e63; font-weight: bold; margin: 5px 0;">NAKUL PANDE</p> <p style="text-align: center; font-size: small; color: #000080;">Roddam Family Award (Best Thesis for M.S. (Engg.)), JNCASR</p> </div> <div style="border: 1px solid #e91e63; border-radius: 15px; padding: 5px; background-color: #fce4ec; margin-bottom: 10px;"> <p style="text-align: center; background-color: #e91e63; color: white; padding: 5px; border-radius: 10px;">SPONSORED PROJECTS</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; color: #e91e63; font-weight: bold;">5 New Projects</td> <td style="width: 50%; color: #e91e63; font-weight: bold;">₹ 16,25,570</td> </tr> <tr> <td style="color: #e91e63; font-weight: bold;">8 Ongoing Projects</td> <td style="color: #e91e63; font-weight: bold;">₹ 80,41,978</td> </tr> </table> </div> <div style="border: 1px solid #e91e63; border-radius: 15px; padding: 5px; background-color: #fce4ec;"> <p style="text-align: center; background-color: #e91e63; color: white; padding: 5px; border-radius: 10px;">PUBLICATIONS</p> <p style="color: #e91e63; font-weight: bold; margin: 5px 0;">12 Journal Articles 5 Conference Papers</p> </div>	5 New Projects	₹ 16,25,570	8 Ongoing Projects	₹ 80,41,978
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8 Ongoing Projects	₹ 80,41,978				



GEODYNAMICS UNIT (GDU)

Areas of Research

- Tectonics and earthquake generation processes along the Himalaya
- Neotectonics and seismicity of the continental interiors
- Seismogenesis of the Himalayan earthquakes
- Tsunami hazard assessment along the western and eastern coasts of India
- Reconstruction of the late Quaternary climatic changes in the central Himalaya

One of the primary goals of the Unit is to characterize the main thrust belts in the 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. During the period 2017-2018, seismotectonics of the Himalaya held the focus. The locations, ruptures, and sizes of the earthquakes during the latter half (1803 and 1833 CE) of the millennium are well documented, but ambiguities still exist about the first half of the last millennium (1255, 1344, and 1505 CE). Seismological and geological tools were used to investigate the earthquake mechanisms of the Himalayan arc and its contiguous regions. The tsunami hazard areas of the Indian Coasts and climate evolution in the Himalayan region using various geological proxies were also investigated. Books on interesting geodynamic topics were also prepared by some unit members.

RESEARCH HIGHLIGHTS

1. A book was authored by **K.S. Valdiya** and **Jaishri Sanwal** titled "Neotectonism in the Indian subcontinent", published by Elsevier.
2. The long-term behaviour of earthquake source zones of India was studied by **C.P. Rajendran** and his team. Constraining the seismogenesis of the Himalayan earthquakes was the main focus of their work.

RESEARCH ACTIVITIES AND ACHIEVEMENTS

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

Honorary Professor and Chair

We identified belts where sudden and swift geological phenomena may occur. Our studies are focused on vulnerable regions, such as the central sector of the Himalayan arc (Kumaun in the Uttarakhand), 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, field work, and atypical behaviours of rivers and streams towards tectonic movements. Prof. K.S. Valdiya and Jaishri Sanwal (co-authors) also published a book describing various tectonic-geomorphological units of the Indian subcontinent and chronicles the structural and physiographic changes resulting from movements on active faults. The book identifies areas and belts that are affected by geological hazards resulting from neotectonic activities and provides information on neotectonic movements and consequent modification of landscape and drainage systems.

C.P. Rajendran, Ph.D.

Senior Associate

We investigated if any known historical earthquakes (e.g. the 1803 event sourced near Uttarkashi) ruptured

the Main Frontal Thrust (MFT) near the foothills of the Himalaya. Geological studies in a site south of Nainital in the Kumaun Himalaya suggested a single episode of a low-angle displacement at this site possibly after 1266 CE and before 1636 CE (**Fig 1**). These new

observations from the trench sections across the MFT, however, support the assumption that the 1803 earthquake did not rupture the MFT (Fig. 1). We infer that although there was a décollement in the MHT (Main Himalayan Thrust- the detachment surface under the Himalaya- see Fig. 2), the 1803 rupture might have been accommodated midway on some of the hinterland structures, short of reaching the MFT and was comparable to a suite of blind thrust earthquakes (Mw ~7.5) like the 1905 Kangra and the recent 2015 Gorkha (Nepal) earthquakes. We also developed new source models for the 1991 Uttarkashi (Mw ~6.7) and the 1999 Chamoli (Mw ~6.5), the only moderate earthquakes in the post-broadband instrumentation era in the Garhwal Himalaya. We established that these earthquakes originated on the flat on the MHT and had a southwest direction, similar to the Mw ~7.3, May 12, 2015 Nepal earthquake. Also, the historical 1803 Uttarkashi earthquake (Mw ~7.5) originated in the MHT. Although the rupture propagated to the south, it did not rupture the Main Frontal fault (MFT, as shown in Fig. 2). These studies were funded by the Ministry of Earth Sciences. Along with our collaborators in IISc, we prepared a review examining the seismic source behavior of all the important earthquakes recorded along the Himalayan arc for the Earth-Science Reviews (ESR) (Fig. 3).

We also identified potential study sites and evaluated the tsunami risk on the eastern seaboard of India (funded by Board of Research in Nuclear Sciences, BRNS). Another initiative was our study on "Tsunami

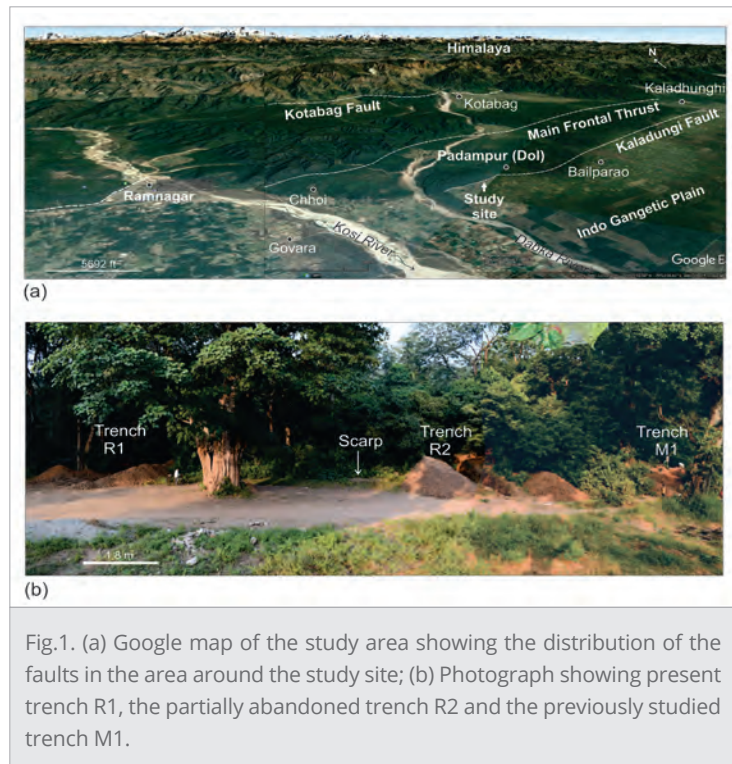


Fig.1. (a) Google map of the study area showing the distribution of the faults in the area around the study site; (b) Photograph showing present trench R1, the partially abandoned trench R2 and the previously studied trench M1.

risk for the Western Indian Ocean: Steps toward the integration of science into policy and practice" funded by Natural Environment Research Council, Global Research Fund, United Kingdom.

Under our paleo-climate studies we also reconstructed the late Quaternary climatic changes using an exposed fluvio-lacustrine section near Dwarahat Village, Kumaun Central Himalaya (Fig. 4). Using stable carbon isotopes ($\delta^{13}C$), we suggest two major episodes of climatic events of middle Pleistocene to early-mid Holocene, corresponding with the Last Glacial maxima (LGM) and Older Dryas (YD). We established the chronology using AMS radiocarbon ages (Fig. 5). The values of carbon isotopes varied between -23‰ to -14‰, marking the shift in vegetation pattern throughout the profile (Fig. 5). The lower part of the profile was dominated by C₃ type vegetation, indicating warm and moist conditions. The initial onset of cold and arid period is evident by a gradual shift in the vegetation pattern from C₃ to C₄ kind of plants. Eventually, the value of $\delta^{13}C$ decreases during this time confirming a prolonged phase of cold and arid climate with strengthening of winter westerlies. This cold period dated at ~19,000 yrs BP may correspond with global cold

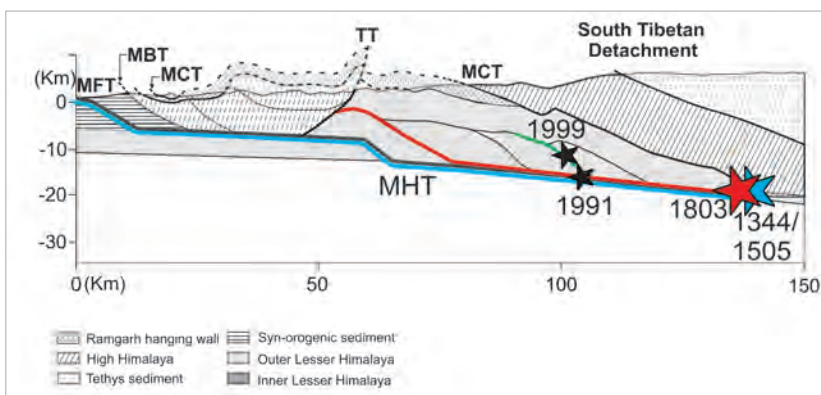


Fig. 2. A generalized cross section of the central Himalaya showing the possible rupture extent of the large 1803 earthquake (Mw ~7.5). The rupture propagates south through the décollement and accommodates in the hinterland structures (Rajendran *et al.*, 2018 and reference therein; see publication list).

event LGM. We show that this phase, observed at 200 cm above the base, gradually emerges into a warm and moist climate, marking the end of glacial period. Increasing trend in C_3 plants indicates that the Indian

Summer Monsoon (ISM) intensified during this period. This short, yet prominent warm spike is probably related to the oscillation of Bølling-Allerød interstadial around ~ 15,000 yr BP.

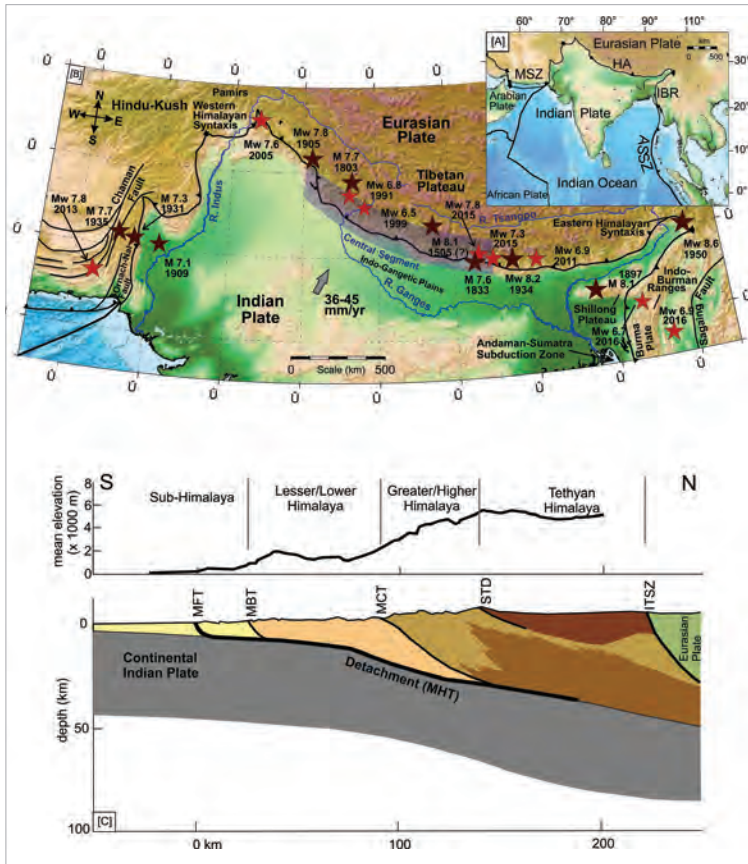


Fig. 3. a. India-Eurasia plate boundary showing Makran Subduction Zone (MSZ), Himalayan Arc (HA), Indo-Burman Ranges (IBR), and Andaman-Sumatra Subduction Zone (ASSZ). b. Map showing significant earthquakes in the Himalaya and its contiguous areas. Red stars: Modern-day events (Mw ≥ 6.5). Brown stars: Historic earthquakes (M ≥ 7). Thick black line with triangles shows the convergent plate boundary. Black lines: Major fault systems. c. Generalized cross section of the central Himalaya, showing the Main Central Thrust (MCT), the Main Boundary Thrust (MBT), the Main Frontal Thrust (MFT), the South Tibetan Detachment (STD), and the Indo-Tsangpo Suture Zone (ITSZ). Detachment plane coincides with the Main Himalayan Thrust (MHT) (Rajendran, K. *et al.*, 2017 and references therein; see publication list).

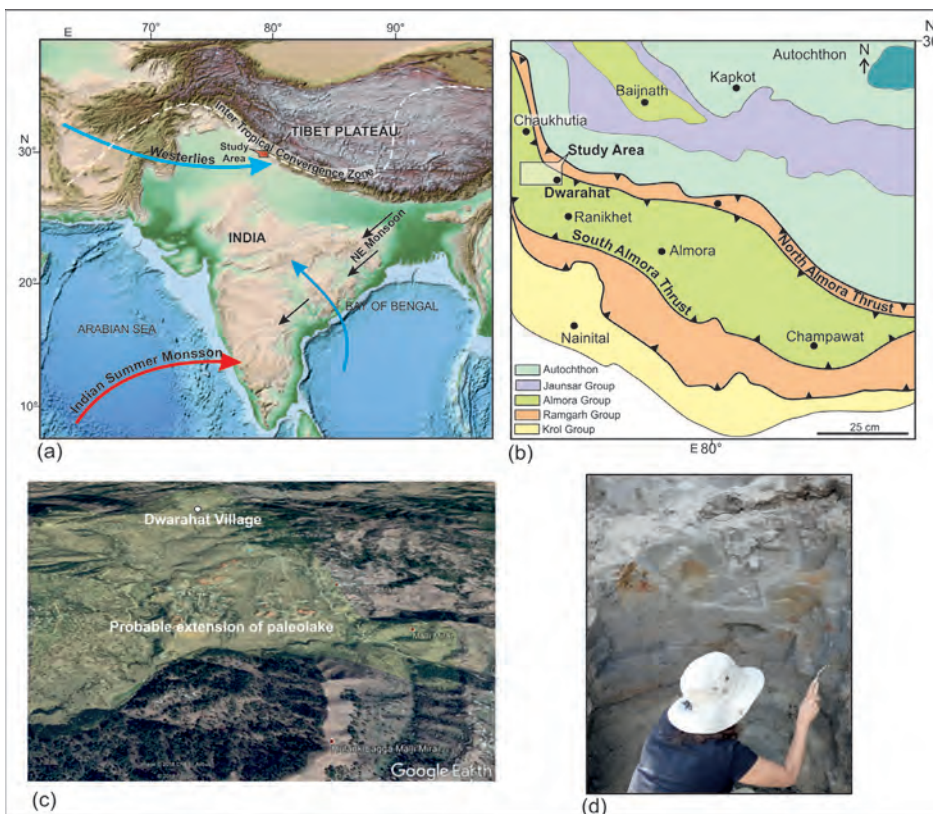


Fig. 4. (a) Map shows the location of study area (Dwarahat paleolake) with trend of different monsoon system (ISM, EASM and WDs); (b) Geological map of the study area; (c) Google image showing the extent of the paleolake in Dwarahat; (d) A field exposure of paleolacustrine deposit.

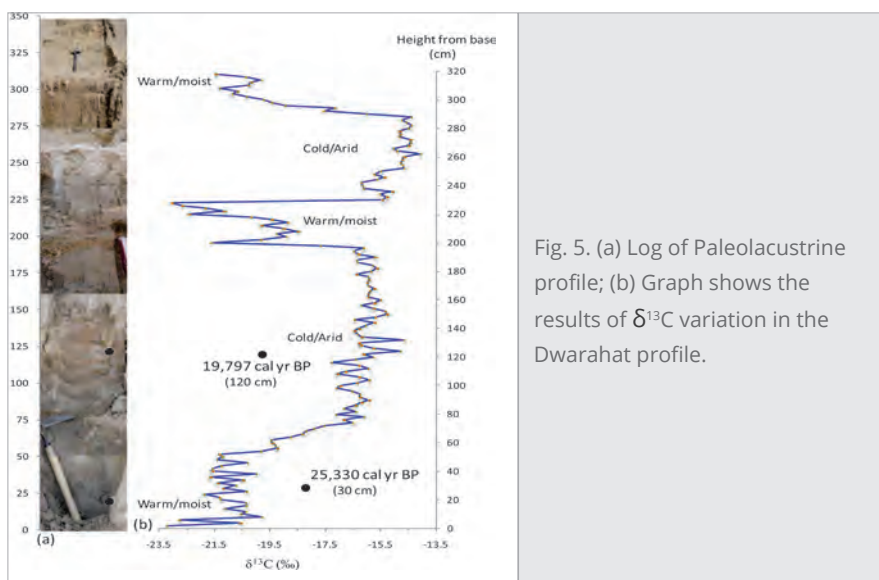


Fig. 5. (a) Log of Paleolacustrine profile; (b) Graph shows the results of $\delta^{13}\text{C}$ variation in the Dwarahat profile.

UNIT MEMBERS

Honorary Professor & Chair

K. S. Valdiya, Ph.D., FA Sc, FNA, FNA Sc, FTWAS

Sr. Associate

C. P. Rajendran, Ph.D.

Research Scientist

Jaishri Sanwal Bhatt, Ph.D.

Research Associates

Anandasabari

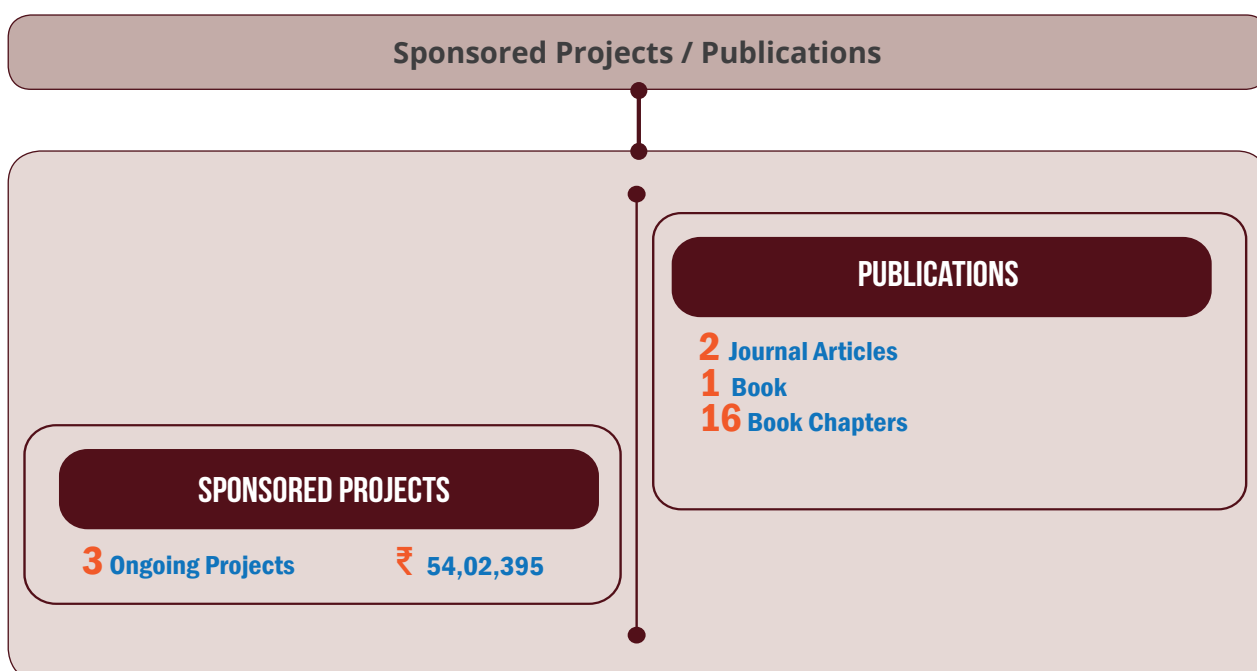
Revathy M. Parameswaran

Post-doctoral Fellow

Thulasi Raman Natarajan

Research Assistant

M. Suresh Kumar



THE INTERNATIONAL CENTRE FOR MATERIALS (ICMS)



Areas of Research

- Solid state and structural chemistry
- Heteroepitaxial growth and formation of selfassembled nanostructures
- Aberration corrected high resolution transmission electron microscope
- Semiconductor nano-structures
- Soft condensed matter physics
- Organic-Inorganic Hybrid Materials
- Physics and Chemistry of Nanomaterials

The International Centre for Materials Science (ICMS) at the Jawaharlal Nehru Centre for Advanced Scientific Research, is devoted to carry out high impact interdisciplinary research, promote collaborations, personnel exchange, organize discussions and meetings, and promote education in advanced materials science. ICMS was dedicated to the nation by the then Prime Minister of India, Dr. Manmohan Singh on December 03, 2008. The Centre is financially supported by the Department of Science and Technology (DST), Government of India and directed by Prof. C.N.R. Rao, F.R.S.

A Memorandum of Understanding with Ras-al-Khaimah Centre for Advanced Materials (RAK-CAM) was signed on December 3, 2011 between Prof. A. K. Cheetham, F.R.S., Chairman, Scientific Advisory Board of RAK-CAM and Prof. M.R.S. Rao, President, JNCASR. The support provided by RAK-CAM has been used to establish the Sheikh Saqr Laboratory (SSL) in ICMS and to support various activities, lectures and Fellowships.

The Centre has established several collaborations and has signed Memorandum of Understanding with leading international research institutions such as Weizmann, SISSA, RMIT –Australia, Waterloo Canada, University of Manchester under which there are constant exchanges of students and researchers along with frequent technical meetings and workshops. The centre is a member of several international fora like EICOON, WMRIF and IUSSTF.

ICMS supports PhD and MS degree programmes, short-term visitors and offers post-graduate diploma in materials science. It offers Senior and Junior Fellowships under RAK-CAM programme and also short-term visiting programmes. The students admitted by JNCASR under PhD and MS programmes also get an opportunity to use the state of the art facility, attend national/international conferences, meetings and visit other universities under various collaborative and exchange programmes.

RESEARCH HIGHLIGHTS

The International Centre for Materials Science (ICMS) has emerged as one of the leading facilities in the country for high impact interdisciplinary research. The excellence of the faculty and students has created a progressive environment. The various research fellowship programmes and the post-graduate diploma programme have been progressing as envisaged. The infrastructure and research facility has grown steadily. The high-performance computing facility and the H₂O splitting laboratory are fully set up and operating. The ongoing research programs are Chemistry of Materials, Surface physics Soft Condensed Matter, Low-dimensional materials and other aspects of Materials Science. In addition to carrying out innovative research, ICMS has also organized seminars, schools and conferences both in JNCASR and outside. ICMS has also financially supported conferences and workshops.

RESEARCH ACTIVITIES AND ACHIEVEMENTS

C.N.R. Rao, Ph.D., F.R.S., Hon. F.R.S.C., Hon. F. Inst. P.

Director

A major effort in my laboratory is to reduce H_2O and CO_2 photochemically, or photoelectrochemically. Two-dimensional materials such as phosphorene and MoS_2 continue to be of great interest. In recent months, we have tried to prepare and characterize oxides and sulfides with aliovalent anion substitution to obtain new materials such as Zn_2NF and TiNF .

Three major themes of our group are (1) Fabricating efficient electrode for solar driven water splitting to produce hydrogen as a green fuel achieved by the

sequential galvanostatic and potentiostatic pulses in the electrodeposition of Ni on graphite rod to produce $\text{Ni}/\text{Ni}(\text{OH})_2/\text{graphite}$ interfaces. (2) Synthesis of heterostructures by the vertical stacking of layered materials to modulate the functional properties of 2D materials. (3) Employing the complete substitution of S from CdS by the aliovalent anions (P^{3-}) and (X) to obtain a family of semiconductor compound having formula $\text{Cd}_4\text{P}_2\text{X}_3$ (X= Cl, Br, and I) which showed artificial photosynthesis in pure water.

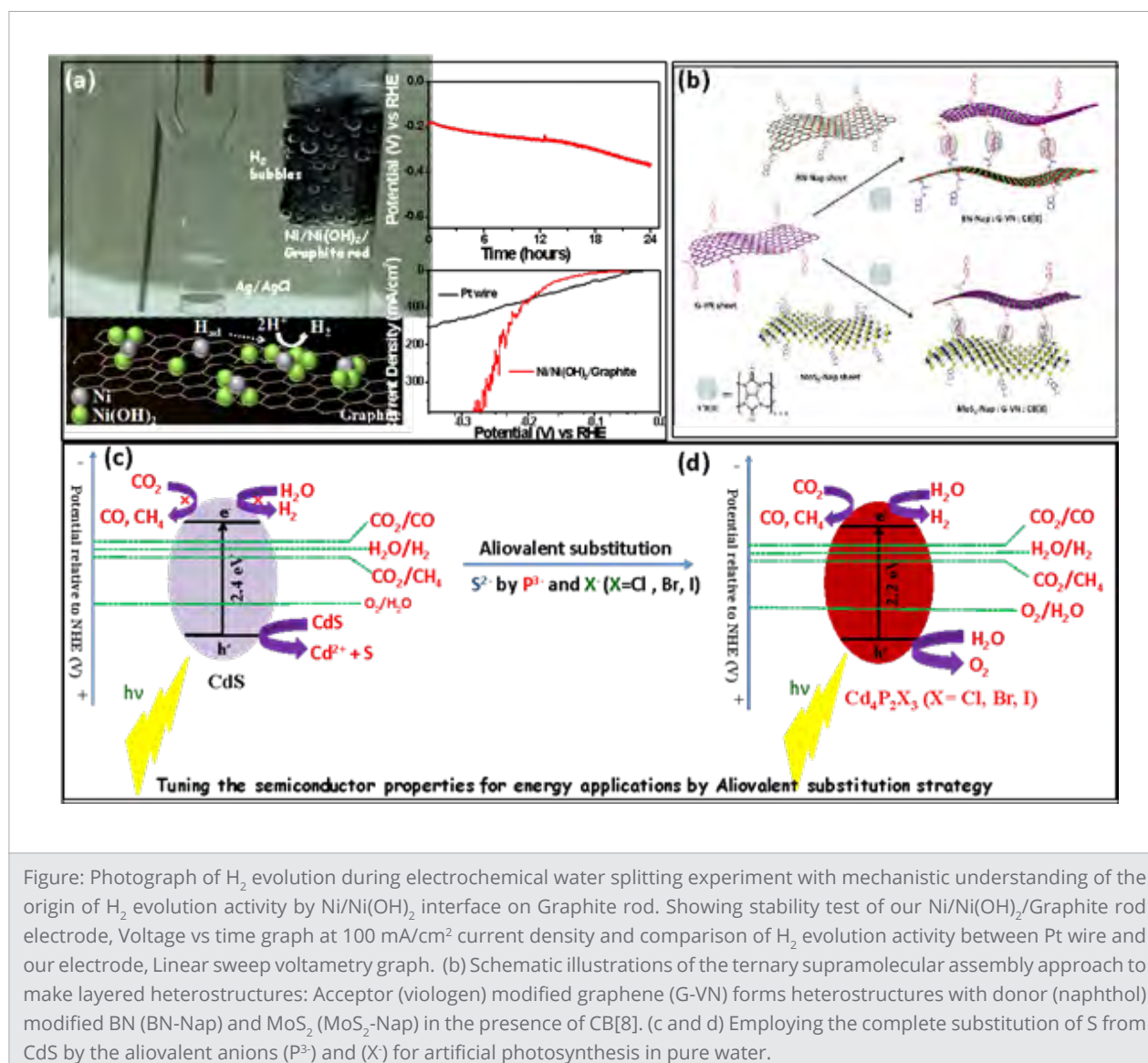


Figure: Photograph of H_2 evolution during electrochemical water splitting experiment with mechanistic understanding of the origin of H_2 evolution activity by $\text{Ni}/\text{Ni}(\text{OH})_2$ interface on Graphite rod. Showing stability test of our $\text{Ni}/\text{Ni}(\text{OH})_2/\text{Graphite}$ rod electrode, Voltage vs time graph at $100 \text{ mA}/\text{cm}^2$ current density and comparison of H_2 evolution activity between Pt wire and our electrode, Linear sweep voltammetry graph. (b) Schematic illustrations of the ternary supramolecular assembly approach to make layered heterostructures: Acceptor (viologen) modified graphene (G-VN) forms heterostructures with donor (naphthol) modified BN (BN-Nap) and MoS_2 (MoS_2 -Nap) in the presence of CB[8]. (c and d) Employing the complete substitution of S from CdS by the aliovalent anions (P^{3-}) and (X) for artificial photosynthesis in pure water.

S.M. Shivaprasad, Ph.D.*Professor* (jointly with CPMU), (On Lien W.E.F 11.08.2017)

A novel route to achieve two-dimensional (2D) carrier confinement in a wedge-shaped wall structure made of a polar semiconductor has been demonstrated theoretically. A recent experimental finding of very high electron mobility in wedge shaped GaN nanowall networks has been analyzed in the light of this theoretical reckoning. We have also demonstrated that nanostructuring of GaN thin films significantly enhances the band-edge emission, due to structural and geometrical effects. On another front, a kinetically controlled two-step growth process for the formation of an array of dislocation free high mobility InN nanorods (NRs) on GaN nanowall network (NWN) by Molecular Beam Epitaxy is demonstrated here. We have also reported a systematic study of the nitridation of the Si (111) surface by nitrogen plasma exposure.

Ranjan Datta, Ph.D.*Associate Professor*

We have developed a soft technique at atomic plane resolution for magnetic characterization by HREELS. We have also studied the epitaxial growth of TMDs (MoS_2 , WS_2) and their heterostructure with BN by PLD. We have also investigated alloys of TMDs (MoS_2 , WS_2) and ReS_2 .

Rajesh Ganapathy, Ph.D.*Associate Professor*

Research in the Soft Matter Lab focused on three key research themes namely (1) stochastic thermodynamics, (2) glass transition and (3) colloidal self-assembly. As a part of a collaborative effort, we have designed and implemented a microscopic heat engine that is powered by bacterial activity. On the glass transition front, we have devised new analysis techniques that allow us to distinguish between competing mechanisms of glass formation. On the colloidal self-assembly front, we have developed special surfaces that not only aid in deciding the symmetry of the growing crystallites, but also in directing particles to specific sites prior to nucleation.

Sridhar Rajaram, Ph.D.*Associate Professor*

The stereo regularity of a polymer plays a role in determining the physical properties like T_g , T_m , and degradation stability. Poly (α -aryl glycolic acids) are expected to have superior physical properties in comparison to polymers made from other α -hydroxy acids. Polymerization of enantiopure mandelic acid into an isotactic polymer has been accomplished recently. Apart from mandelic acid, other α -aryl glycolic acids are not readily available as pure enantiomers. Therefore, we have initiated a dynamic kinetic resolution approach for the synthesis of isotactic poly (α -aryl glycolic acids) from racemic monomers. Stereo-control in the propagation step has been studied using dimerization as a model reaction. We have achieved excellent selectivity in this reaction and currently, we are expanding this to polymerization. We have developed a dendritic Raman marker for early detection of HIV-infection. We have shown that dendritic Raman markers show a ten-fold increase in signal intensity. In another project, we have developed an enantioselective synthesis of diamino phosphonates.

Ranjani Viswanatha, Ph.D.*Associate Professor* (jointly with NCU)

We have been working extensively on doping transition metals into quantum dots and using them as nanosensors to probe the electronic structure of the host quantum dots. We have worked on doping of magnetic ions into CdS nanocrystals and studied its corresponding magnetism. We have studied the magnetism arising out of the interface of magnetic/non-magnetic materials giving rise to an exchange bias at the interface using EXAFS as a tool.

Secondly, we have worked on the mechanism of Mn emission and uncovered an important long-standing puzzle regarding the Mn emission using transient absorption and clever modification of the host material to increase the lifetime of the transient species that has so far been elusive. We have also synthesized air stable Sn doped perovskite materials with excellent optical properties. We have also tried to understand a lot of unsolved problems in the high-performance perovskites using EXAFS as a tool in undoped, Sn or Mn doped perovskite materials.

Premkumar Senguttuvan, Ph.D.

Faculty Fellow

During this period, our research has been focused on two class of electrode materials. 1) NASICON cathodes; and 2) Tin and antimony based alloy anodes for Na-ion batteries.

Vanadium based NASICON cathodes have been demonstrated to have stellar cycling performance in Na-ion batteries. Furthermore, to improve the capacity, we have synthesized a series of $\text{Na}_{3+x}\text{VM}'(\text{PO}_4)_3$ (M' is a 1st and 2nd row transition metal ion) compounds. Detailed XRD and XAFS studies have yielded more insights into different molecular arrangements of MO_6 and PO_4 units depending upon the nature and concentration of M' in the structure, which can also be corroborated with the different electrochemical redox voltages. Other complementary experiments are underway to obtain a comprehensive view on the structural and electrochemical properties of NASICON compounds.

Bivas Saha, Ph.D.

Faculty Fellow

In the Heterogeneous Integration Research Group, we have worked at the intersection between materials science and applied physics, and employed

a combination of experimental and theoretical approaches to drastically improve energy conversion efficiency in solid-state electronic and optoelectronic devices, as well as develop energy efficient low power electronic switches. Our Group strived to:

1. Maximize energy conversion efficiency in thermoelectric, plasmonic, and solar-to-electrical energy conversion devices by developing novel heterostructure and thin film based materials and metamaterials.
2. Minimize energy required for logic switches in digital applications by developing artificially structured materials and devices.

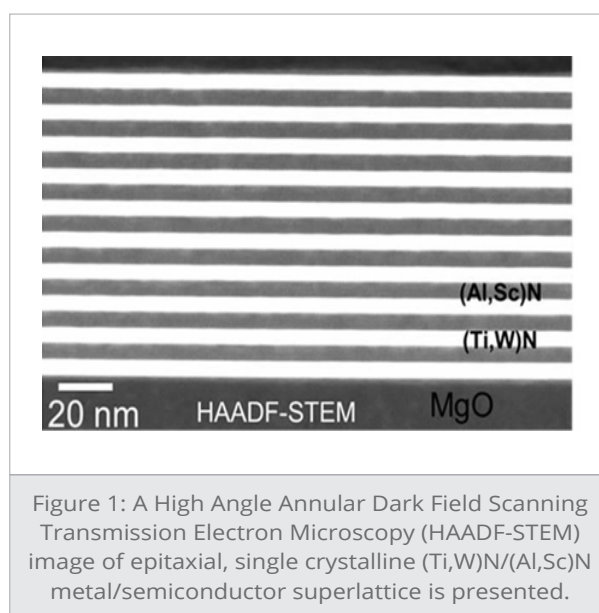


Figure 1: A High Angle Annular Dark Field Scanning Transmission Electron Microscopy (HAADF-STEM) image of epitaxial, single crystalline (Ti,W)N/(Al,Sc)N metal/semiconductor superlattice is presented.

Sheikh Saqr Laboratory

The International Centre for Materials Science had established a close collaboration with the Ras-Al-Khaima Centre for Advanced Scientific Research (RAK-CAM) in 2007. The ties were further strengthened by signing of a Memorandum of Understanding in December 2011, to establish the Sheikh Saqr Laboratory (SSL) at the ICMS of JNCASR, Bangalore. The SSL in the new CCMS building was inaugurated by His Highness Sheikh Saud Bin Saqr Al Qasimi in 2013.

The SSL infrastructure and research facility has grown steadily since 2013. The SSL and ICMS research

facilities together have fulfilled the objective as the country's leading research-initiative. The new CCMS building and the SSL laboratories won the NDTV - Design and Architecture Award under the Institutional Architecture Design of the Year for Education-2014.

The SSL is headed by Prof. C.N.R. Rao, Director, ICMS. Prof. Anthony K. Cheetham, Chairman of RAK-CAM's Scientific Advisory Board, and the faculty of ICMS and others working in materials science at JNCASR are associated with SSL. The grant also supports research associates, technical assistants and R&D assistants.

RAK-CAM - Sheikh Saqr Fellowships

This programme was initiated in January 2008 with the support of grants from RAK-CAM and SSL to motivate senior and junior scientists in materials science. The grants from RAK-CAM have been used not only

to purchase equipment and chemicals, but also to support the research of young researchers and senior scientists. This fellowship programme has been very successful.

UNIT MEMBERS

Director

C N R Rao, F.R.S., Hon. F.R.S.C., Hon. F. Inst. P.

Professor

Shivaprasad S M, Ph.D., (jointly with CPMU)
(On Lien W.E.F 11.08.2017)

Associate Professors

Ranjan Datta, Ph.D.
Rajesh Ganapathy, Ph.D.
Sridhar Rajaram, Ph.D.
Ranjani Viswanatha, Ph.D.

Faculty Fellows

Premkumar Senguttuvan, Ph.D.
(jointly with NCU)
Bivas Saha, Ph.D.
(jointly with CPMU)

Research Students

(PG Diploma in Materials Science)

Himani
Rohit

Sr. Research Officer

Jay Ghatak

Technical Assistant (Inst.)

Mahesh J.I.

Sr. Steno GR. I

Sudha J

Research Associates

K Manjunath
Manjodh Kaur

Research Associate (P)

M B Sreedhara

SERB National PDF

Shashidhara

Women Scientist Scheme A

Saraswathi C

SERB National PDF

Mokurala Krishnaiah

Junior Research Fellow

Goutam P

Technical Assistant

Prajwal D J

R & D Assistants

Jagadish T
Vinayak Pattar
Pramod Kumar
Bidesh Biswas

Awards / Appointment / Sponsored Projects / Fellowships / Academics / Publications

AWARDS RECEIVED BY FACULTIES

C.N.R. RAO

- First Asian to receive the Materials Research Society's Highest Honor - the Von Hippel Award presented in Boston on November 29, 2017
- Wockhardt Research Prize
- Hon. Doctorate of IIT, Guwahati
- Hon. Doctorate of University of Guwahati

RANJAN DATTA
MRSI Medal 2018

RANJANI VISWANATHA
MRSI Medal 2018

S. M. SHIVAPRASAD
Distinguished Lectureship Award

BIVAS SAHA
Research Initiation Award from Stint, Sweden

FELLOWSHIPS

SHEIKH SAQR RAK CAM SENIOR FELLOW
SWAPAN PATI, UMESH V. WAGHMARE

SHEIKH SAQR CAREER AWARD FELLOWS
M. ESWARAMOORTY, JAYANTA HALDAR

SHEIKH SAQR STUDENT FELLOWS
MANJEET CHETRI, UTTAM GUPTA

APPOINTMENT

S. M. SHIVAPRASAD
Director of Higher Education Academy, Dharwad

SPONSORED PROJECTS

4 New Projects	₹ 3,45,32,373
7 Ongoing Projects	₹ 8,66,00,000

ACADEMICS

2 Students Admitted
1 Graduated

AWARD RECEIVED BY STUDENT

CHANDAN KUMAR
Best Ph.D. Thesis Award (Physical Sciences)

PUBLICATIONS

43 Journal Articles
1 Book Chapter



Areas of Research

- 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 Regulation in Humans with Special Emphasis on Diseases

The laboratories of Molecular Biology and Genetics Unit have been academically quite active and productive during 2016–2017. A total of 56 peer-reviewed publications have been published during the past academic year. There have been 14 colloquia, and nine theses have been defended; 13 students joined the Ph.D. program and 15 students joined the MS-PhD and Integrated Ph.D. program last year. The contributions of several faculty members were recognized in the form of awards and memberships of professional bodies. Several guest lectures and six conferences in and outside JNCASR were organised, many national and international conferences were attended by the faculty. Many national and international conferences were attended by students to make oral or poster presentations. The faculty members participated as experts to review project proposals, and were awarded grants from national and international funding agencies. Thus, the past year has been quite vibrant and dynamic for the Unit.

RESEARCH HIGHLIGHTS

1. Autophagy inducing molecules that could clear α -synuclein aggregates *in vitro* and *in vivo* were discovered. Also, HTS-compatible luciferase based assay was used in yeast to identify new small molecules which could modulate autophagy (by **Ravi Manjithaya**).
2. Centromeres of *Candida tropicalis* were identified and centrosomes were found to be retrotransposon-rich structures. A direct link was further shown between RNAi and evolution of centrosomes, as loss of RNAi led to shorter centrosomes due to truncation of retrotransposons (by **Kaustuv Sanyal**).
3. Chemical biology and fundamental biology techniques were used to study the epigenetic regulation of gene expression during differentiation and disease. The role of acetylation, arginine methylation, histone shuffle, and non-histone chromatin proteins in gene expression during cancer and neurodegenerative disorders was probed (by **Tapas K. Kundu**).
4. Cell and molecular biology approaches, mouse “knockout” analysis, and transcriptome analysis were used to show that Rudhira, a cytoskeletal protein, positively regulates TGF β signaling and is essential for cardiac development and vascular patterning in mice (by **Maneesha Inamdar**).
5. A large number of promoter-variant viral strains were shown to emerge in the recent years. These variants were divided in to two categories and these variations were found to be unique to only the subtype-C of HIV-1 (by **Ranga Udaykumar**).

6. The genetic basis for the high incidence of hearing impairment in the village of Dhadkai in Jammu & Kashmir (India) was studied. Recessive mutations in at least three genes which caused hearing loss were investigated: *OTOF* (p.R708X), *SLC26A4*(p.Y556X), and *CLDN14* (p.V85D); the mutation p.R708X was determined as the major cause of this loss (by **Anuranjan Anand**).
7. Genetic and chemical biology approaches were used to characterise and show the essentiality of fumarate hydratase (FH) in *P. falciparum* (Pf). The structure of the PFFH homolog was solved from *Methanocaldococcus janaschii*, and this is the first structure to be solved in this family of nucleotidases. Pf AMP deaminase (AMPD) was also characterised using a genetic complementation approach (by **Hemalatha Balaram**).
8. A paper was published where for the first time a novel K-10 insertion in *pvcrt-o* gene of *Plasmodium vivax* isolated from an endemic region has been reported. In another study performed in collaboration, FASII inhibition was shown by triclosan, an antibacterial and antifungal agent, to prevent cytokinesis in the apicomplexan parasite *Toxoplasma gondii* tachyzoites (by **Namita Surolia**).
9. mrhl lncRNA, which binds to the promoter and regulates Sox8 gene expression which in turn regulates the expression of meiotic specific genes was discovered. hmrhl RNA was found to be differentially expressed in different cancers. A new lncRNA, *LOC284454*, that targets the focal adhesion pathway was discovered to be highly downregulated in breast cancer (by **M.R.S. Rao**).

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Autophagy Laboratory

Ravi Manjithaya, Ph.D. (jointly with NSU)
Associate Professor

The focus of our lab has been to investigate novel tools and probes using genetic and pharmacological approaches to study the process of autophagy and understand its relevance in diseases. We discovered several autophagy inducers that cleared α -synuclein aggregates and rescued cells from 'aggregate toxicity' (neuroprotective) in yeast (Rajashekhar *et al*, Scientific Reports, 2015), human cell lines, and in a preclinical transgenic mouse model of Parkinson's disease (Suresh *et al*, Autophagy, 2017). We developed and implemented a novel, sensitive HTS-compatible luciferase based assay in yeast *Saccharomyces cerevisiae* to monitor autophagic flux in real time (Mishra *et al*, BB Reports 2017). We used this assay to screen many small molecule libraries and identified several modulators of autophagy (Rajashekhar *et al*, ChemPlusChem 2014). These small molecules also regulate similar stages of autophagy flux in higher eukaryotes, including mammalian and plant cells showing the conserved nature of autophagy across kingdoms (Mishra *et al*, Autophagy, 2017). We are currently expanding our research by looking at other

disease models where autophagy has been implicated, such as xenophagy model for Listeria, Huntington's mouse model for studying neurodegeneration, and cancer models.

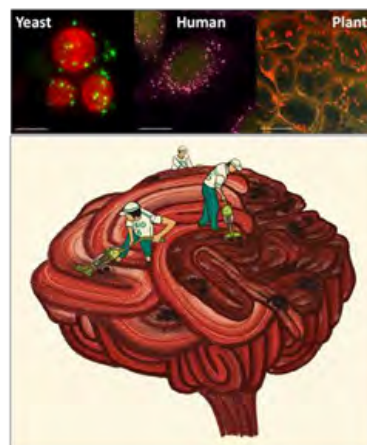


Figure: Neurodegenerative disorders, such as Parkinson's are characterized by toxic protein aggregates (Lewy Bodies) that eventually kill brain cells. Inducing autophagy, the selective autophagy process designed to clear such clumps, is neuroprotective. Small molecule inducers of autophagy, such as 6-Bio may have therapeutic potential to treat similar neurodegenerative diseases.

Molecular Mycology Laboratory

Kaustuv Sanyal, Ph.D., F A Sc, F N A Sc
Professor

To understand the process of centromere evolution and its impact on genome evolution and speciation in fungi, we studied centromeres of many human pathogenic fungi, including *Candida albicans*, *Candida tropicalis* (Ascomycota), and several species of *Cryptococcus* and *Malassezia* (Basidiomycota). We made significant discoveries during 2016–2018. In 2016, we identified centromeres of a human fungal pathogen *Candida tropicalis* (Chatterjee *et al.*, 2016, PLOS Genetics). We showed that centromeres in *C. tropicalis* significantly diverged from its closely related *Candida* species but resembled a distantly related fission yeast. In another study performed in a long-term collaboration with a group in Duke University Medical Center, we showed that the transition from tetra-polar mating system in non-pathogenic *Cryptococcus* species to bipolar mating system in pathogenic *Cryptococcus* species occurs by centromere-mediated recombination of two chromosomes carrying MAT loci in the non-pathogenic strain (Sheng, Yadav *et al.*, 2017, PLOS Biology). More recently, in another collaborative effort with the same group in Duke University, we discovered centromeres are retrotransposon-rich structures. We further show that loss of RNAi leads to shorter centromeres due to truncated retrotransposons, thus showing a direct link between RNAi and evolution of centromere structure (Yadav *et al.*, 2018, PNAS). Our current goal is to decipher the mechanism(s) by which factors, such as pericentric repeats, DNA methylation, histone methylation, and RNAi regulate centromere function.

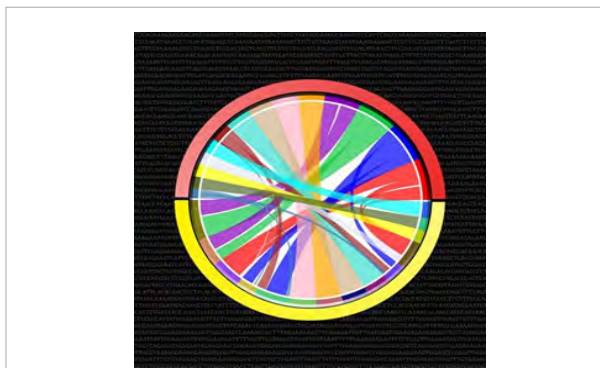


Figure: The circos diagram depicting a chromosome-wide comparison between genomes of two closely related pathogenic species (shown in red and yellow half-circles) of the *Cryptococcus* species. In a recent paper published in PNAS (2018), Yadav *et al.* show that RNAi plays a significant role in maintaining long, retrotransposon-rich sequences at the centromere. The loss of RNAi triggers a cascade of events leading to evolution of shorter centromeres.

Transcription and Disease Laboratory

Tapas Kumar Kundu, Ph.D., F A Sc, F N A Sc, F N A
(jointly with NSU)
Professor

We work on the epigenetic regulation of gene expression during differentiation and disease. The primary focus of the lab is to understand the role of histone acetylation, arginine methylation, histone shuffle, and non-histone chromatin proteins in gene expression during cancer and neurodegenerative disorders.

We use chemical biology tools, in addition to fundamental biological techniques, to address these questions. Recently we showed that total knockout of the highly abundant multifunctional non-histone chromatin protein PC4 is embryonic lethal. Although the brain specific conditional knockout mice survived, they had significant defects in memory extinction.

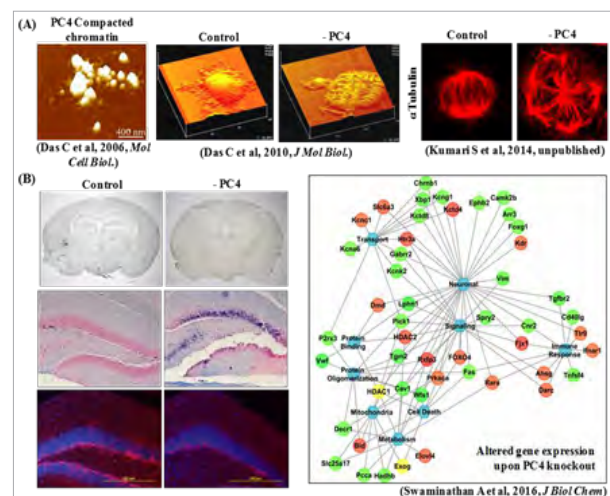


Figure: Chromatin protein PC4 and its role in (A) genome organization and (B) neural development and differentiation

Vascular Biology Laboratory

Maneesha Inamdar, Ph.D., F A Sc, F N A Sc
Professor

We target mechanisms that orchestrate hematopoiesis, vascular and cardiac development using stem cells and animal models. Specifically, we focus on conserved proteins and processes that regulate ubiquitous cellular function in a tissue-specific manner. In the last couple of years, we have identified novel metabolic regulators that maintain the stem cell state and regulate differentiation in human

pluripotent stem cells. We showed that oxidative phosphorylation has key role in determining cell fate. We identified non-genetic methods to modulate mesenchymal stromal cell response to the pro-inflammatory secretome in cardiac repair. We also identified key cytoskeletal regulators of cardiovascular development and function. We showed that Rudhira/BCAS3, a cytoskeletal protein primarily expressed in the developing mammalian vasculature and during

adult neo-angiogenesis, reorganizes cytoskeletal elements for directed cell migration. Using cell and molecular biology approaches, mouse “knockout” analysis and transcriptome analysis, we showed that Rudhira is essential for cardiac development and vascular patterning and it achieves this by positively regulating TGFβ signaling. We will further characterize the function of this protein family to maintain blood stem cell homeostasis.

HIV-AIDS Laboratory

Ranga Udaykumar, Ph.D.

Chair & Professor

The attention of the laboratory has recently shifted to viral transcriptional silence. Breaking transcriptional silence is critical to effectively manage diseases and develop vaccines. In a study performed in collaboration with four institutes spanning 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 show that such variations appear to be unique to only subtype-C of HIV-1. We are currently performing experiments to see how viral latency and reservoirs are affected in these infections. In future studies, we will examine the effect of sequence duplications in the viral promoter and Gag-p6 on viral replication fitness, drug resistance, and evolution. We also plan to examine the subtype-specific properties of reverse transcriptase.

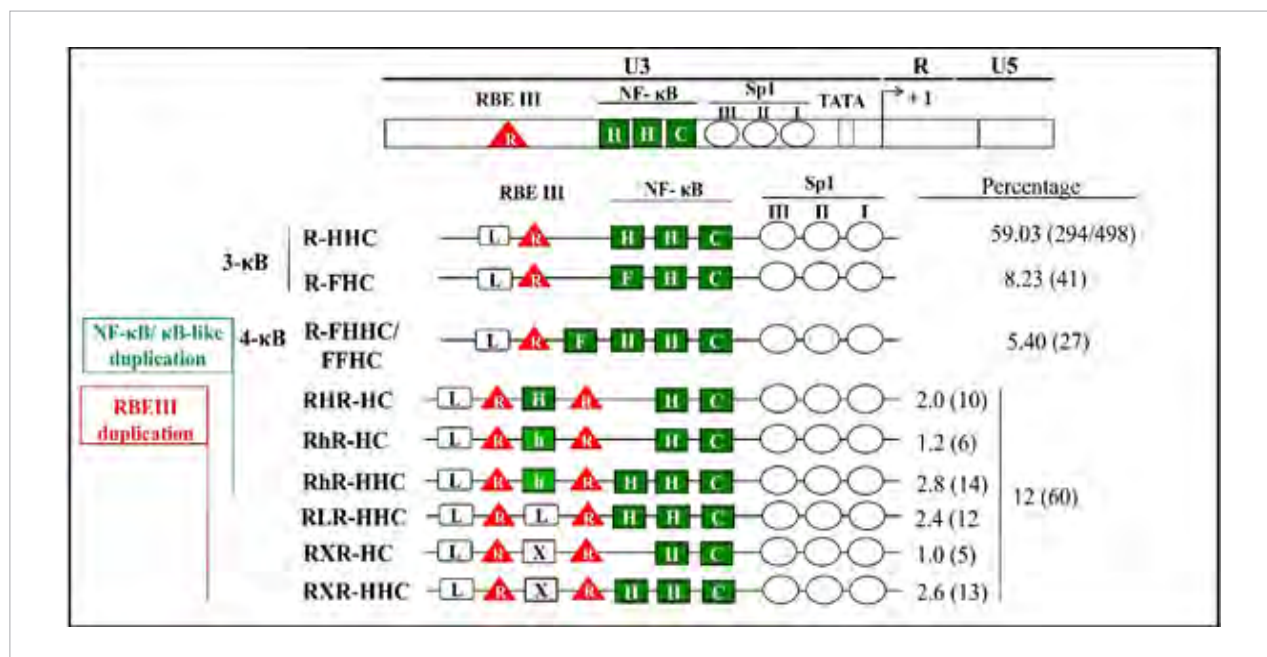


Figure: A large number of promoter-variant viral strains have been emerging only in HIV-1 subtype-C (Bhange D *et al*, unpublished). The green squares and red triangles represent the NF-κB and RBEIII motifs in the HIV-1 promoter, respectively. The variations may be classified broadly into three categories based on only NF-κB motif duplication or variation, only RBEIII duplication, and coduplication of both NF-κB and RBEIII motifs. Efforts are presently in progress in our laboratory to understand the significance of this enormous genetic variation for viral evolution, pathogenicity, and viral latency. The work is a collaborative effort of JNCASR and four other clinic institutes of India (All India Institute of Medical Sciences, New Delhi; National AIDS Research Institute, Pune; St. John’s Hospital, Bangalore; and YRG CARE, Chennai).

Human Genetics Laboratory

Anuranjan Anand, Ph.D., F A Sc, F N A, F N A Sc
Professor

Mutations in OTOF, CLDN14, and SLC26A4 are the major cause of hearing impairment in Dhadkai village, Jammu and Kashmir (India). In the previous year, we completed a study to identify the genetic basis for the high incidence of hearing impairment in the Dhadkai village. In a two-step approach to identify the causative mutations, we carried out a whole-genome-based analysis of an extended family of 45 members, which included 23 affected and 22 unaffected members. Additionally, a number of known genes causing vulnerability to deafness, including Cx26, SLC26A4, CLDN14, TMPRSS3, TMC1, TMIE, and USH1C were analyzed in seven smaller families with hearing impairment.

In the 45-member extended family, the critical chromosomal region was mapped to 2p24-p22. The c.2122C>T (p.R708X) mutation in OTOF in 2p24-p22

was identified to be the causal change. Among seven small families unrelated to the 45-member extended family, hearing loss was attributed to p.R708X in OTOF in three and to p.V85D in CLDN14 in one family. We also identified a new mutation, c.1668T>A (p.Y556X) SLC26A4 in two families. We could not identify the causative change in one of the seven small families. These results suggest a considerable genetic heterogeneity in the causation of hearing loss in Dhadkai population. We observed recessive mutations in at least three genes causing hearing loss: OTOF (p.R708X), SLC26A4(p.Y556X), and CLDN14 (p.V85D). Our study shows that mutation p.R708X is the major cause of hearing impairment in Dhadkai (Figure, below). In the coming years, we will try to (i) define the causes of hereditary hearing loss in all affected families in Dhadkai, (ii) identify the heterozygous carriers for the causative mutations identified among the village population, and (iii) implement a specially designed genetic counseling protocol for the high-risk families based the outcome of the genetic studies.

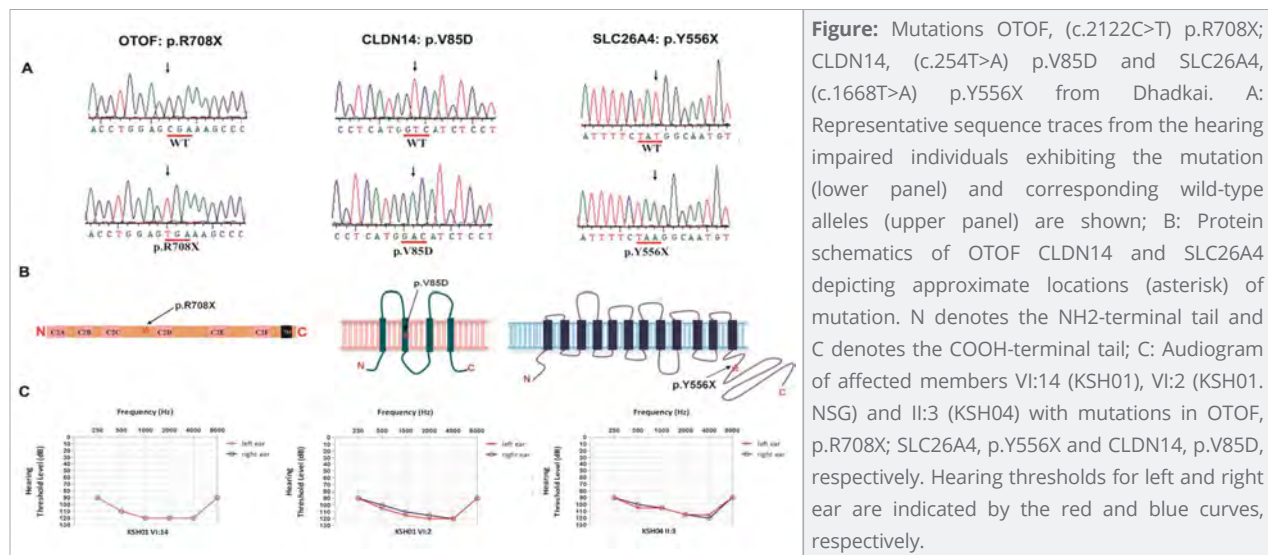


Figure: Mutations OTOF, (c.2122C>T) p.R708X; CLDN14, (c.254T>A) p.V85D and SLC26A4, (c.1668T>A) p.Y556X from Dhadkai. A: Representative sequence traces from the hearing impaired individuals exhibiting the mutation (lower panel) and corresponding wild-type alleles (upper panel) are shown; B: Protein schematics of OTOF CLDN14 and SLC26A4 depicting approximate locations (asterisk) of mutation. N denotes the NH2-terminal tail and C denotes the COOH-terminal tail; C: Audiogram of affected members VI:14 (KSH01), VI:2 (KSH01.NSG) and II:3 (KSH04) with mutations in OTOF, p.R708X; SLC26A4, p.Y556X and CLDN14, p.V85D, respectively. Hearing thresholds for left and right ear are indicated by the red and blue curves, respectively.

Molecular Parasitology and Protein Engineering Laboratory

Hemalatha Balaram, Ph.D., F A Sc, F N A Sc
Professor

Our group focuses on two major themes: physiological relevance of genes involved in purine and energy metabolism and structure-function analysis of these enzymes to develop inhibitors. We characterized

P. falciparum (Pf) fumarate hydratase (FH) and showed that this gene is essential to *Plasmodium* using genetic and chemical biology approaches. We also solved the structure of the PfFH homolog from *Methanocaldococcus janaschii* which forms the basis to understand catalysis by the 4Fe-4S cluster containing FHs. PfISN1 is the first structure to be solved in this family of nucleotidases. We characterized Pf AMP deaminase (AMPD) using a genetic complementation approach which threw light on key residues involved in catalysis.

We further established the biochemical function of a putative phosphoglycolate phosphatase and showed it to be essential for the asexual stages of *P. falciparum* using reverse genetics. Another aspect being pursued is structure-function analysis of enzymes involved in GMP synthesis. The structure of MjATPPase complexed to the substrate XMP provides a framework to understand ligand binding and catalysis through mutagenesis.

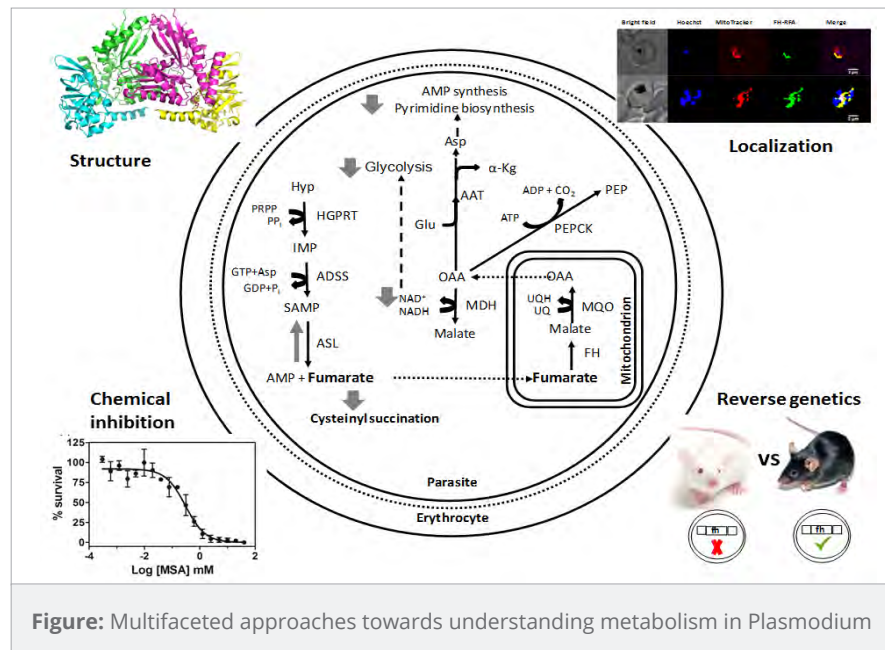


Figure: Multifaceted approaches towards understanding metabolism in Plasmodium

Molecular Parasitology Laboratory

Namita Surolia, Ph.D., F A Sc, F N A Sc
Professor

Our group reported a novel K-10 insertion in *pvcr-t-o* gene of *Plasmodium vivax* isolates from a malaria endemic region. This is the first report from India to show mutation in *pvcr-t-o*. The prevalence of SNPs in *P.vivax* ortholog of *P. falciparum chloroquine* resistant gene (*pvcr-t-o*) indicates that the parasite may have acquired CQ resistance in the area. Monitoring of drug resistant markers and therapeutic efficacy studies are desirable to manage and administer antimalarial drugs (Shiny Joy *et al*, 2018:Malar J;17:40).

In a collaborative research with the Brazilian group, we also established that FASII inhibition by triclosan, an antibacterial and antifungal agent, prevented cytokinesis in another apicomplexan parasite *Toxoplasma gondii tachyzoites*. This led to bound daughter cells and incomplete pellicle formation. This study also provided evidence to show that FASII is essential to generate lipid substrates required for final step of parasite division (Martins-Duarte ES *et al*, J Cell Sciences, 2016).

Chromatin Biology Laboratory

M.R.S. Rao, Ph.D., F A Sc, F N A, F N A Sc, FTWAS
Honorary Professor

Long non-coding RNAs are important regulators of several biological processes, such as spermatogenesis.

We showed that *mrhl* lncRNA, discovered in our laboratory, binds to the promoter and regulates Sox8 gene expression which in turn regulates the expression of meiotic specific genes. We also identified the human homologue of *mrhl* RNA which is syntenically conserved with partial sequence similarity.

Mrhl RNA is expressed in neuronal progenitor cells in E14.5 mouse brain and also during retinoic acid (RA) induced differentiation of mouse ES cells. The *hmrhl* RNA (human *mrhl*) is differentially expressed in different cancers. DDX5/p68 RNA helicase protein, involved in splicing of precursor mRNAs, also interacts with lncRNAs, such as SRA and *mrhl* to modulate gene expression. We identified a new lncRNA LOC284454 which also contains miR23a-27a-24-2 micro RNA cluster, interacts with p68 protein, and is highly downregulated in breast cancer. One of the targets of this lncRNA is the focal adhesion pathway which plays an important role in cell migration. ASCL1 is a basic Helix-Loop-Helix transcription factor which is involved in various cellular processes like neuronal development and signaling pathways. We have done a detailed system analysis of the transcriptome profile and identified distinct and common functional networks governed by ASCL1 in glioma and small cell lung cancer. In the coming years, we will analyze the molecular mechanisms of *mrhl* RNA mediated regulation of Sox8 gene expression during meiotic commitment of spermatogonial cells. We will also study the targets of *hmrhl* RNA in erythroleukemic cells and its role in cancer pathobiology.

UNIT MEMBERS

Chair

Ranga Udaykumar, Ph.D.

Professors

Hemalatha Balaram, Ph.D., F A Sc, F N A Sc

Namita Surolia, Ph.D., F A Sc, F N A Sc

Anuranjan Anand, Ph.D., F A Sc, F N A, F N A Sc

Ranga Udaykumar, Ph.D.

Maneesha S Inamdar, Ph.D., F A Sc, F N A Sc

Kaustuv Sanyal, Ph.D., F A Sc, F N A Sc

Tapas Kumar Kundu, Ph.D., F A Sc, F N A Sc, F N A
(jointly with NSU)

Associate Professor

Ravi Manjithaya, Ph.D. (jointly with NSU)

Honorary Professor

MRS Rao, Ph.D., F A Sc, F N A, F N A Sc, FTWAS

Research Students

Akshaya C Nambiar, Rahul Madaan, Padmalaya, Jyotsna Karan, Dongre Prathamesh Rajesh, Sharma Pragya Niraj, Ranabir Chakraborty, Shubham Singh, Ankit Sharma, Kuladeep Das, Saheli Roy, Rashi Aggarwal, Irine Maria Abraham, Chhavi Saini, Tirath Raj Dwivedi, Bornika Roy, Anjali Amrapali Vishwanath, Polisetty V S Satya Dev, Anindita Pal, Swati Keshri, Akash Kumar Singh, Bhavana Kayyar, Veena A, Priya Jaitly, Pallabi Mustafi, Siddharth Singh, Arpitha A Suryavanshi, Somya Vats, Saloni Sinha, Pooja Barak, Lakshmeesha K N, S Sundar Ram, Shreyas Sridhar, S. N. Suresh, Sunaina Singh Rajput, Lakshmi Sreekumar, Shveta Jaishankar, T. Lakshmi Prasoon, Anusha Chandrashekarmath, Monica Upadhyay, Ragini Agrawal, Kamat Kajal Murli, Cuckoo Teresa Jetto, Yengkhom Roja Devi, Anushka Chakravorty, Resmi Ravi, Smitha A S, Sreshtha Pal, Rajarshi Batabyal,

Preeti Jindal, Priya Brahma, Nivedita Pandey, Moumita Basu, Sambhavi Puri, Ananya Ray, Bhange Disha Ramesh, Aditya Bhattacharya, Asutosh B R, Shrilaxmi V. Joshi, Arindam Ray, Arun Panchapakesan, Iyer Aditya Mahadevan, Suchismita Dey, Dongre Aparna Vilas Pushpalata, Rima Singha, Wulligundam Praveen, Krishnendu Guin, Barve Gaurav Ramanand, Palak Agrawal, Debosree Pal, Arnab Bose, Divyesh Joshi, Sweta Sikder, Sutanuka Chakraborty, Santosh S, Neha Varshney, Shalini Roy Choudhury, Shukla Arpit Prakashkumar, Malini Menon, Deeti K Shetty

Sr. Technical Officer (Veterinary)

Prakash R G, B V Sc & A.H.

DST-Inspire Research Associate

Rajni Garg (MCB, IISc.)

DBT-Research Associate-III

V Shalini

Research Associates-II

Arun Renganathan, Sarmistha Halder Sinha

Research Associates

Stephanie Roshni Kaypee, Amit Kumar Behera Ram Murthy A, Sourav Chatterjee

Research Associates (P)

Neha Varshney, Sweta Sikder, Chandreyee Datta (MCB, IISc.), Malini Menon

Senior Research Fellows

Shalini Roy Choudhury, Diana Rodrigues

Awards / Membership / Sponsored Projects / Academics / Publications

AWARDS RECEIVED BY FACULTIES

HEMALATHA BALARAM

Dr. Raja Ramanna State Award 2015-16
from Government of Karnataka

TAPAS KUMAR KUNDU

Banga Ratna, 2018
(Prestigious Civilian Award of Govt. of West Bengal)

FELLOWSHIPS

KAUSTUV SANYAL

- DBT Tata Innovation Fellowship for the year 2016-17
- Fellow, Indian National Academy of Sciences, New Delhi
- Fellow, Indian Academy of Sciences, Bangalore

HEMALATHA BALARAM

- Fellow, Indian National Science Academy

MANEESHA INAMDAR

- Fellow, Indian Academy of Sciences
- Fellow, Indian National Science Academy

ACADEMICS

14 Students Submitted
12 Graduated

SPONSORED PROJECTS

15 New projects ₹ 3,11,75,958
33 Ongoing projects ₹ 4,29,97,666

MEMBERSHIPS / APPOINTMENTS

M.R.S. RAO

- Member of the Governing Body of CSIR
- Chairman, DBT Task Force on Human Genetics & Genomics
- Chairman, Ramalingaswamy Fellowship Selection Committee, DBT
- Member, International Review Committee of Spanish Government to review Spanish Research Institutes

TAPAS KUMAR KUNDU

- Lifetime Distinguished Professorship of University of Mysore
- President, Chemical Biology Society, India

MANEESHA INAMDAR

- Member, JAX Regional Council of the Jackson Laboratories, Bar Harbor, Maine, USA

PUBLICATIONS

25 Journal Articles
2 Conference Papers
3 Book Chapters



NEW CHEMISTRY UNIT (NCU)

The New Chemistry Unit is a relatively new Unit at JNC. Currently, the Unit has a few core faculty members and Prof. C.N.R Rao as Chairman. Several faculty members from other Units of the Centre are also associated with NCU. Different aspects of chemical science and areas at the interface of chemical biology, chemical science and materials science are most actively pursued in the Unit.

The students were admitted for the Ph.D degree programme as well as integrated Ph.D. in Chemical Sciences. The students for integrated MS-PhD programme in Chemical Sciences were admitted through project-oriented chemical education (POCE). The students admitted for these programmes underwent extensive coursework and research training before continuing dissertation work.

Areas of Research

- Artificial photosynthesis
- Molecular probes
- Antimicrobial hydrogels
- Structure of quantum dots
- Thermoelectric materials
- Organic and supramolecular synthesis
- Integrated technologies via thermochemical methods

RESEARCH HIGHLIGHTS

1. Employing the complete substitution of S from CdS by the aliovalent anions (P^{3-}) and (X), a family of semiconductor compounds, $Cd_4P_2X_3$ (X= Cl, Br, and I) were obtained which showed artificial photosynthesis in pure water unlike CdS where the use of sacrificial electron donors is indispensable (by **C.N.R. Rao**).
2. Hybrid peptoids and small molecule-based molecular tools were developed to clear toxic plaques in the brain through the natural cellular process. This can address issues related to incurable neurodegenerative diseases, such as Alzheimer's (AD) and Parkinson diseases (PD) (by **T. Govindaraju**).
3. Supramolecular polymerization of an adenosine triphosphate (ATP) receptive molecule, OPV-DPA was achieved by activating its thermodynamic dormant state. Supramolecular polymerization similar to actin filaments was demonstrated using an ATP fuel-driven strategy. Also, transient self-assembly, another feature of actin filaments was shown by coupling it to phosphatase enzyme (by **Subi Jacob George**).
4. Antimicrobial hydrogels (both preformed and injectable) were developed as an effective strategy to treat infections. Important properties of these antimicrobial hydrogels include long term antimicrobial activity and sustained release of loaded antimicrobial agents, which make them immensely useful to cure infections. Subcutaneous implantation of the injectable gel (vancomycin-loaded) was capable of killing MRSA upon direct introduction of MRSA into the gel as well as when introduced at a distal site away from the gel in mice model (by **Jayanta Haldar**).
5. Copper doping was used to study the electronic structure of complex heterostructure quantum dots. Transition metals were doped into quantum dots and used as nanosensors to probe the electronic structure of the host quantum dots. CdS nanocrystals

- doped with magnetic ions and its magnetic properties were studied. Using EXAFS as a tool, the magnetism arising out of the interface of magnetic/non-magnetic materials that gives rise to exchange bias at the interface was also investigated (by **Ranjani Vishwanatha**).
6. Integrated Technologies to convert anthropogenic CO₂ to MeOH & other value-added chemicals via thermochemical route were developed (by **Sebastian C. Peter**).
7. GeTe and its derivatives constitute potential Pb-free thermoelectric materials. The main constraint in optimizing its thermoelectric performance is its high lattice thermal conductivity (κ_{Lat}). To address this problem, a low κ_{Lat} (~ 0.7 W/mK) and significantly high thermoelectric figure of merit ($ZT = 2.1$ at 630 K) in a Sb doped pseudoternary (GeTe)_{1-2x}(GeSe)_x(GeS)_x system was demonstrated (by **Kanishka Biswas**).

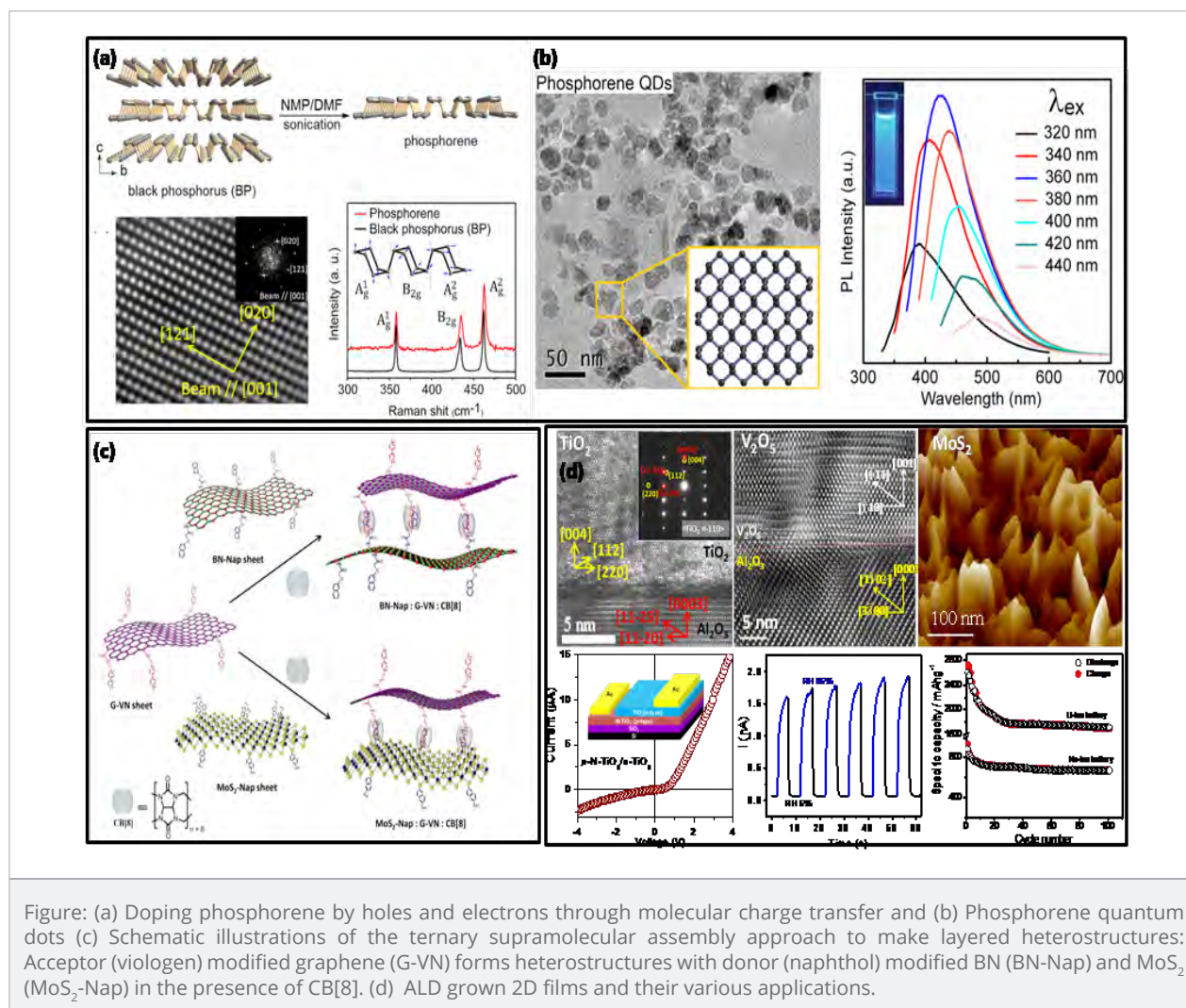
RESEARCH ACTIVITIES AND ACHIEVEMENTS

C N R Rao, Ph.D., D Sc, Sc D (hc), D Sc (hc), LLD (hc), D Litt (hc), Dr Eng (hc), F A Sc, F N A, F R S, F TWAS, Hon. F R S (C), Hon F. Inst P., Hon. F R S C.

Senior Professor and Chair

Stacked 2D materials exhibit unique optical, electrical and thermal properties due to synergistic effects and

tunable composition of the individual components. In this regard, the first successful noncovalent synthesis of heterostructure assemblies of layered 2D sheets has been made. Furthermore, this approach is being extended for the formation of molecular adducts with organic molecules to investigate the properties of 2D-molecular adducts. We have also grown epitaxial films of oxides, sulphides and nitrides namely of



anatase TiO_2 , V_2O_5 and MoS_2 on c-sapphire using ALD technique and used them for applications like humidity sensing and electrochemical performances in Na and Li ion batteries. We have also investigated photochemical reduction of H_2O and CO_2 with a new family of catalysts of the formula $\text{Cd}_4\text{P}_2\text{X}_3$ (X= Cl, Br, I), obtained by the complete aliovalent substitution of the sulphide ions in CdS by P and X (X= Cl, Br, I). Unlike CdS, the $\text{Cd}_4\text{P}_2\text{X}_3$ compounds exhibit hydrogen evolution and CO_2 reduction from water even in the absence of a sacrificial agent or cocatalyst. Use of N_{ix}P_y as the cocatalyst, enhances hydrogen evolution,

reaching 3870 (apparent quantum yield, AQY=4.11) and 9258 (AQY=9.83) $\mu\text{mol h}^{-1}\text{g}^{-1}$ respectively under artificial and natural sunlight irradiation in case of $\text{Cd}_4\text{P}_2\text{Br}_3/\text{N}_{ix}\text{P}_y$. We further studied the chemical doping of phosphorene by electron donor and acceptors. Both acceptors and donors interact with phosphorene by charge-transfer, with the acceptors having more marked effects. In this direction, we prepared the blue emitting phosphorene quantum dots by liquid phase exfoliation of black phosphorus. The average particle sizes of PQDs decrease from 5.0 to 1.0 nm on increasing the sonicator power from 150 to 225 W.

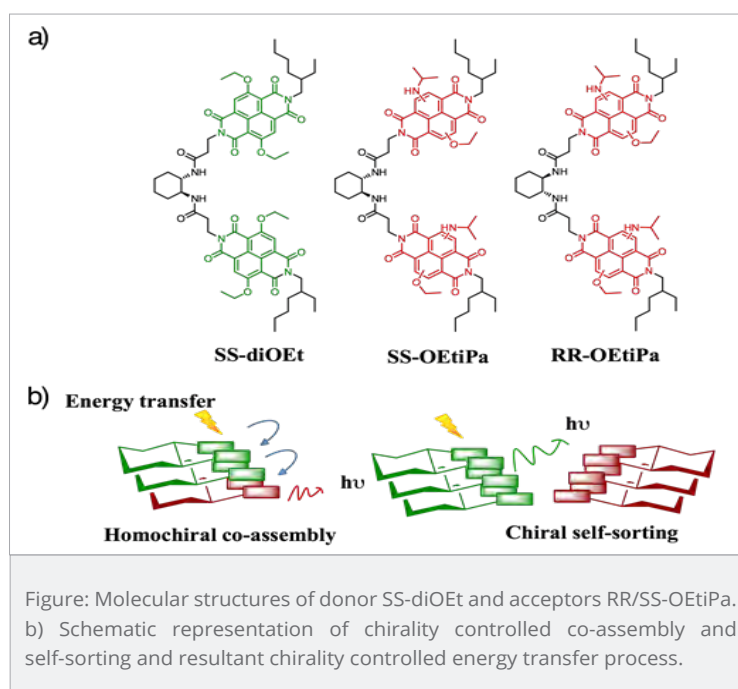
T Govindaraju, Ph.D.
Associate Professor

Our research interest in general 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. During the reporting period, our major research 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. Hybrid peptoids and small molecule based molecular tools have been developed in our laboratory, which are 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.

Subi Jacob George, Ph.D.
Associate Professor

During 2017-2018, we explored the amazing self-organization property present in most biological systems. These systems also exhibit remarkable spatio-temporal control over their self-assembly and systemic functionality. The complexity of the underlying supramolecular organisation can be understood in the context of the material applications within the system such as development of novel, functional organic and hybrid materials to control a certain function. In our approach for a bio-inspired self-assembling structure with spatio-temporal control, we targeted chemical fuel such as ATP driven living supramolecular



polymerisation to precisely control the length and dispersity of supramolecular polymers and aimed to get supramolecular, block co-polymers to control the associated novel functions. We also designed

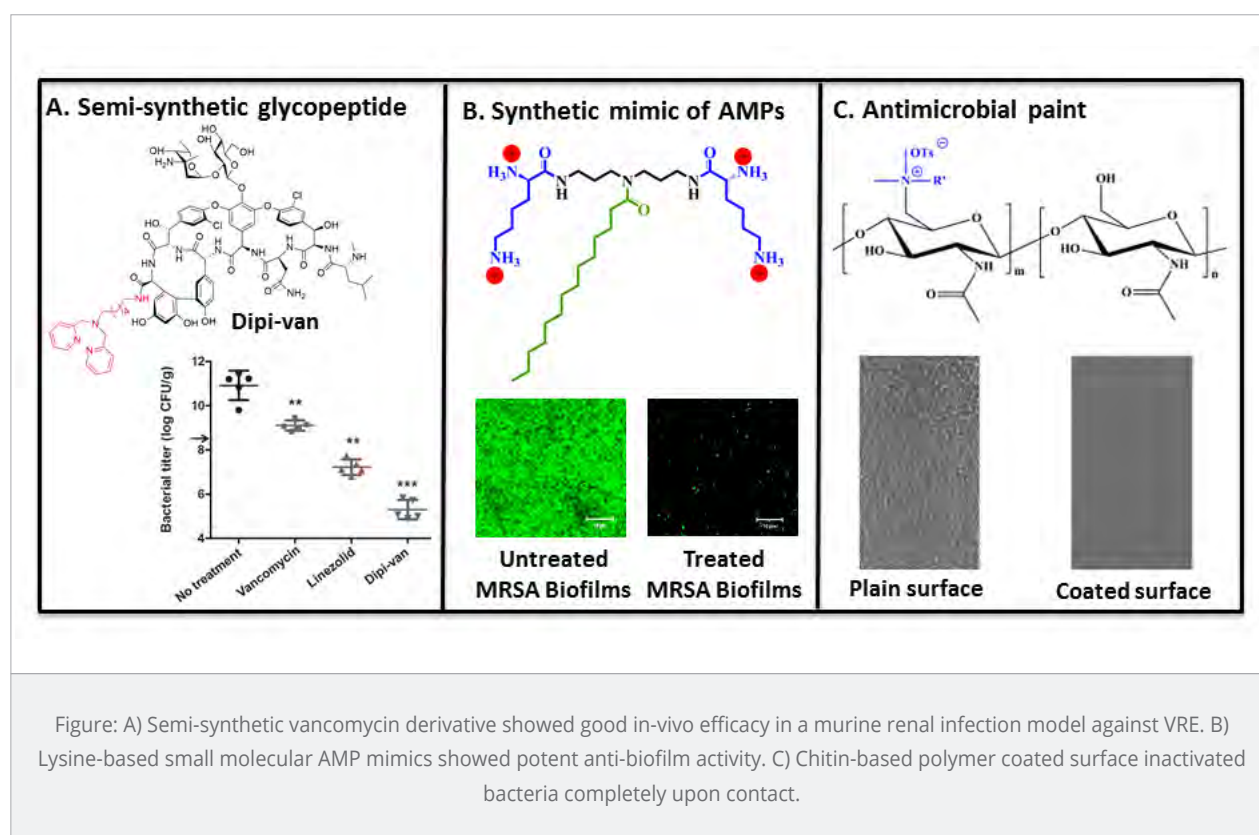
chirality driven self-sorted supramolecular stacks to control energy transfer characteristics and observed stereoselective supramolecular organisation.

Jayanta Haldar, Ph.D.
Associate Professor

Our research integrates organic chemistry and material science with biology to combat infectious diseases. Membrane-active molecules are developed to add teeth to obsolete antibiotics (such as tetracycline, rifampicin, erythromycin, etc.) in combating multi-drug resistant Gram-negative bacteria and their biofilms. The combined formulation has shown potent efficacy in in-vivo mice models with burn-wounds and surgical site infections.

In a major research development in the fight against antimicrobial resistance, the Haldar lab has devised various strategies such as enhancing binding constant, adding more steps to the action mechanism of vancomycin to develop semi-synthetic vancomycin derivatives that have successfully deactivated vancomycin-resistant bacteria both *in-vitro* and *in-vivo*.

The lab has also developed synthetic polymeric compounds that could potentially be used for mass-scale disinfection in hospitals and epidemic zones. These are small molecular and polymeric mimics of antimicrobial peptides (AMPs) that display antimicrobial activity against bacteria, fungi, parasite and Ebola virus. These synthetic antimicrobial compounds could also tackle difficult-to-treat biofilm associated infections. These water-insoluble polymeric coatings were engineered from synthetic and natural polymers and can be painted onto surfaces such as hospital walls, floors, operating equipment and implantable devices. These antimicrobial paints could deactivate microbes upon contact and also prevent biofilm formation.



Sridhar Rajaram, Ph.D. (jointly with ICMS, and CPMU)
Associate Professor

The stereoregularity of a polymer plays an important role in determining its physical properties like T_g, T_m, and degradation stability. Poly (α-aryl glycolic acids) are expected to have superior physical properties in comparison to polymers made from other α-hydroxy acids. Enantio pure mandelic acid has recently been polymerised into an isotactic polymer. Apart from mandelic acid, however, other α-aryl glycolic acids are not readily available as pure enantiomers. Therefore, we have initiated a dynamic kinetic

resolution approach for the synthesis of isotactic poly (α-aryl glycolic acids) from racemic monomers. Stereo-control in the propagation step has been studied using dimerization as a model reaction. We have achieved excellent selectivity in this reaction and currently, we are expanding this to polymerization. In a separate project we have developed dendritic Raman markers for early detection of HIV-infection. We have shown that dendritic Raman markers show a ten-fold increase in signal intensity. We have also developed an enantioselective synthesis of diaminophosphonates.

Sebastian C. Peter, Ph.D.
Associate Professor

Two most imminent scientific and technological problems that the mankind is facing in the 21st century, is that of energy and climate. Our group is trying to address both these issues in a “one stone two bird approach” by converting CO₂ thermochemically to chemicals and greener fuels. The integrated CO₂ conversion technology is in the developmental stage for commercialisation where the team is capturing

CO₂ from industrial flue stream and converting it to products of industrial importance. The end to end technology comprises innovations in catalyst synthesis, reactor designs, hydrogen generation and product purification. During the course of technology development, our startup company, Breathe, is running for the 20M USD NRG-COSIA Carbon XPRIZE competition to mitigate climate change. We are already tied up with companies like TATA Power, Novomer, CCS, SHELL to scale the technology commercially.

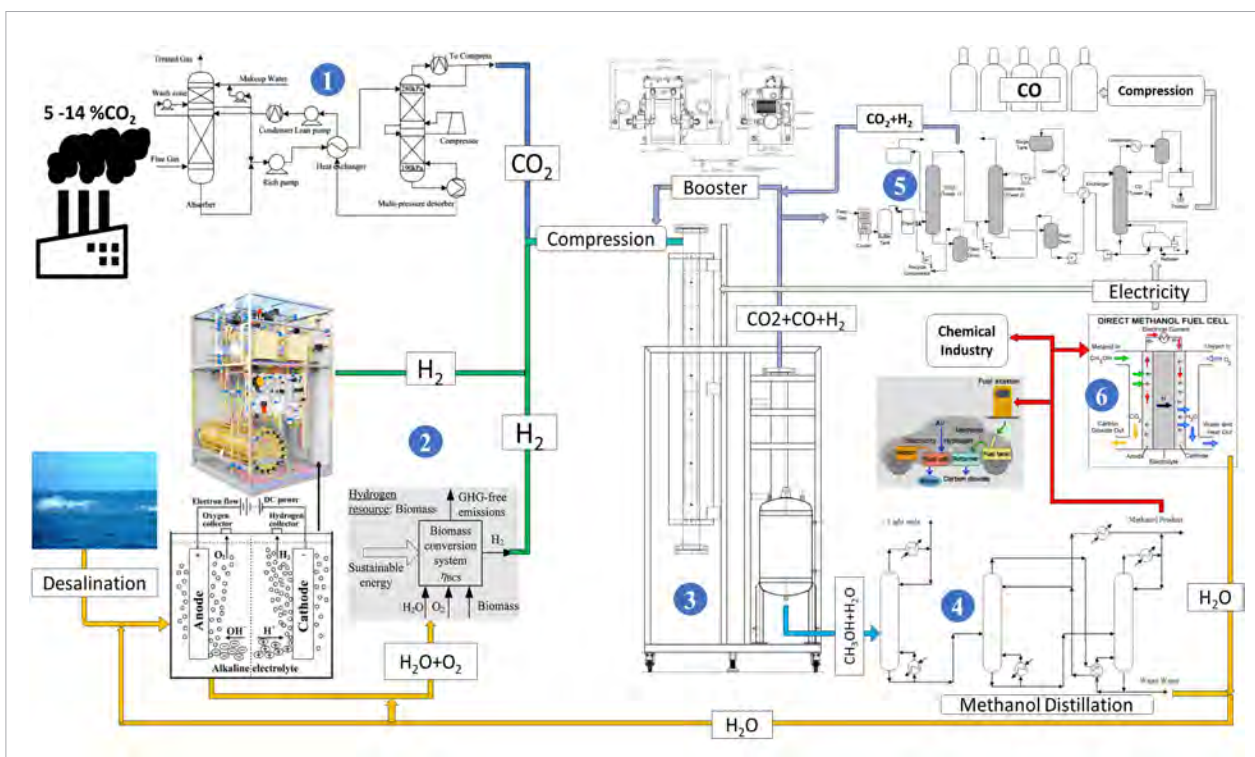


Figure: Overview of the integrated technology consisting of 6 major plug-in units: (1) CO₂ capture from flue stream, (2) H₂ generation from either electrolysis of alkaline water or from biomass, (3) carbon conversion unit for methanol and CO production, (4) Methanol distillation unit, (5) CO purification unit and (6) Use of methanol in fuel cell to generate electricity, CO₂, water, and use of methanol in chemical industry and as transportation fuel.

Ranjani Viswanatha, Ph.D. (jointly with ICMS)
Associate Professor

We have solved an important, long-standing puzzle in Mn emission using transient absorption and clever modification of the host material to increase the lifetime of the transient species. We have also synthesized air stable Sn doped perovskite materials

with excellent optical properties and are trying to understand a lot of unresolved questions in undoped or Sn/Mn doped high-performance perovskites using EXAFS as a probe.

Kanishka Biswas, Ph.D.
Faculty Fellow

We have designed a novel material AgCuTe with an ultralow κ_{Lat} through soft phonon modes and optical-acoustic phonon coupling in the room temperature hexagonal phase of AgCuTe, in which the dynamic disorder of Ag/Cu cations leads to reduced phonon frequencies and low mean free paths in the high-temperature rocksalt phase. A high figure-of-merit, zT of 1.6 is achieved at 670 K in p-type AgCuTe (*Angew. Chem. Int. Ed.*, 2018, doi: 10.1002/anie.201801491).

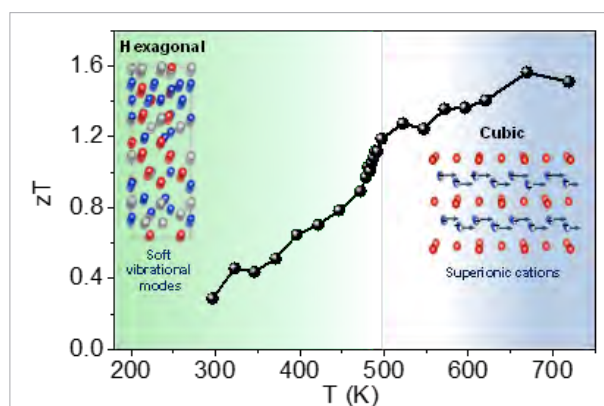


Figure 1. Temperature dependent thermoelectric figure of merit (zT) of the p-type AgCuTe (*Angew. Chem. Int. Ed.*, 2018, doi: 10.1002/anie.201801491).

We demonstrated a facile room temperature, solvent-free, general, and scalable all-solid-state mechanochemical synthesis for different inorganic perovskite type halides, with versatile structural connectivity in three (3D), two (2D), and zero (0D) dimensions. 3D CsPbBr₃, 2D CsPb₂Br₅, 0D Cs₄PbBr₆, 3D CsPbCl₃, 2D CsPb₂Cl₅, 0D Cs₄PbCl₆, 3D CsPbI₃, and 3D RbPbI₃ have all been synthesized by this method, materialized through an inorganic retrosynthetic approach (*Chem. Eur. J.*, 2018, 24, 1811–1815).

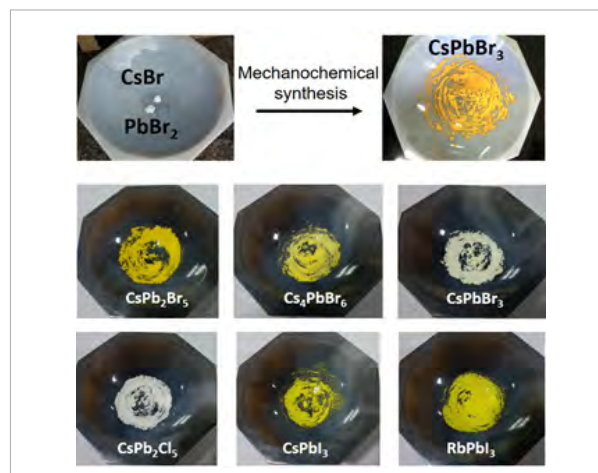


Figure 2. All solid state mechanochemical synthesis of CsPbBr₃ from CsBr and PbBr₂ with physical appearance of as synthesized CsPb₂Br₅, Cs₄PbBr₆, CsPbBr₃, CsPb₂Cl₅, CsPbI₃, and RbPbI₃, synthesized via same procedure (*Chem. Eur. J.*, 2018, 24, 1811–1815).

We synthesized two-dimensional few-layer nanosheets of intergrowth Sn_mBi_{2n}Te_{3n+m} compounds which are TIs in bulk, by solution phase synthesis. These few-layered materials exhibit a semiconducting band gap, with exotic electronic transport properties. (*Angew. Chem. Int. Ed.*, 2017, 56, 14561–14566).

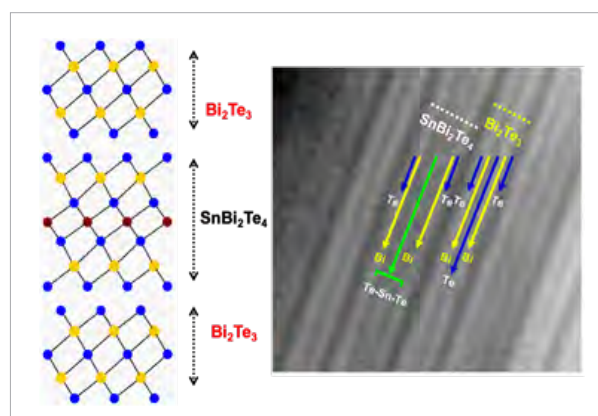


Figure 3. 2D nanosheets of van der Waals heterostructure derived from (SnTe)_m(Bi₂Te₃)_n homologous intergrowth family (*Angew. Chem. Int. Ed.*, 2017, 56, 14561–14566).

We have developed novel, layered metal chalco-phosphates for ion exchange and intercalation reactions, which we are using for heavy metal and nuclear waste sequestration from water (*Chem. Eur. J.*, 2017, 23, 11085-11092).

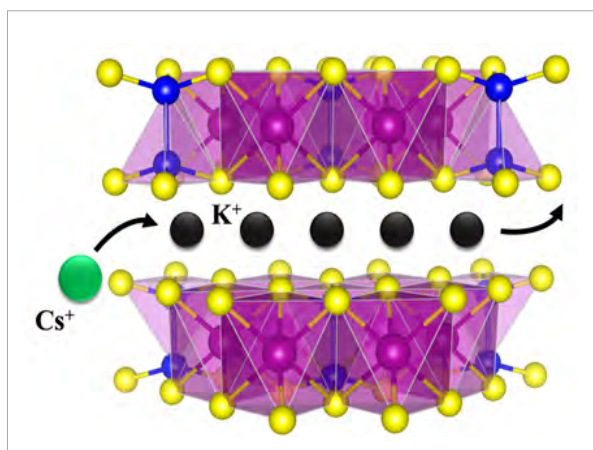


Figure 4: Use of KMPS-1. (Mn, purple; P, blue; S, yellow; K, black) for heavy metal / radionuclide waste capturing, coming from different sources (*Chem. Eur. J.*, 2017, 23, 11085-11092).

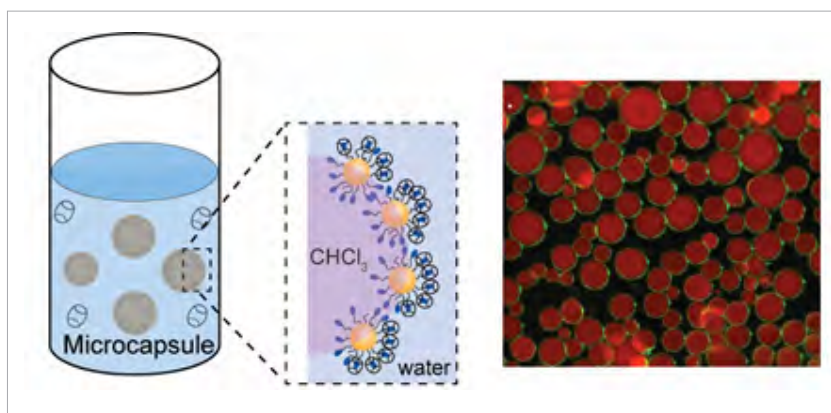
Sarit S Agasti, Ph.D.

(jointly with CPMU)

Faculty Fellow

Single cell analysis is gaining increasing importance in basic biological research since measurement at single-cell level provides valuable insights into tumor heterogeneity. However, it is technologically challenging to isolate a single cell as well as characterize its response to a given

therapeutic agent. We have recently fabricated stable and biocompatible nanoparticle stabilized microcapsules using catalyst free bioorthogonal click chemistry tools. These capsules have optimal size and required functionality to benefit encapsulation of single cell. Additionally, we have adopted microfluidics technology for the high throughput generation of controlled and uniform sized microcapsules to enhance the method's efficiency. The capsule surface when decorated with gold nanoparticles provides a Surface Enhanced Raman Scattering (SERS) based molecular analysis platform. We plan to utilize the single cell encapsulation ability of the microcapsules along with the single molecule sensitivity of SERS based technique to analyze and profile cancer cell drug response.



Premkumar Senguttuvan, Ph.D.

(jointly with ICMS)

Faculty Fellow

During this time, our research has focused on two classes of electrode materials. 1) NASICON cathodes & 2) Tin and antimony based alloy anodes for Na-ion batteries.

The stellar cycling performance of Vanadium based NASICON cathodes in Na-ion batteries is a known fact. To improve the battery capacity further, we have synthesized a series of $\text{Na}_3+x\text{VM}'(\text{PO}_4)_3$ (M' are the 1st and 2nd row transition metal ions) compounds. Detailed XRD and XAFS studies have shown greater

insight into different molecular arrangements of MO_6 and PO_4 units depending upon the nature and concentration of M' in the structure, which can also be correlated to the different electrochemical redox voltages. Other complementary experiments are underway to obtain a comprehensive view on the structural and electrochemical properties of NASICON compounds.

We have also synthesised micro and nanoscale tin and tin oxide negative electrodes through solution and solid-state synthesis routes. We are currently at the stage of their preliminary electrochemical characterisation.

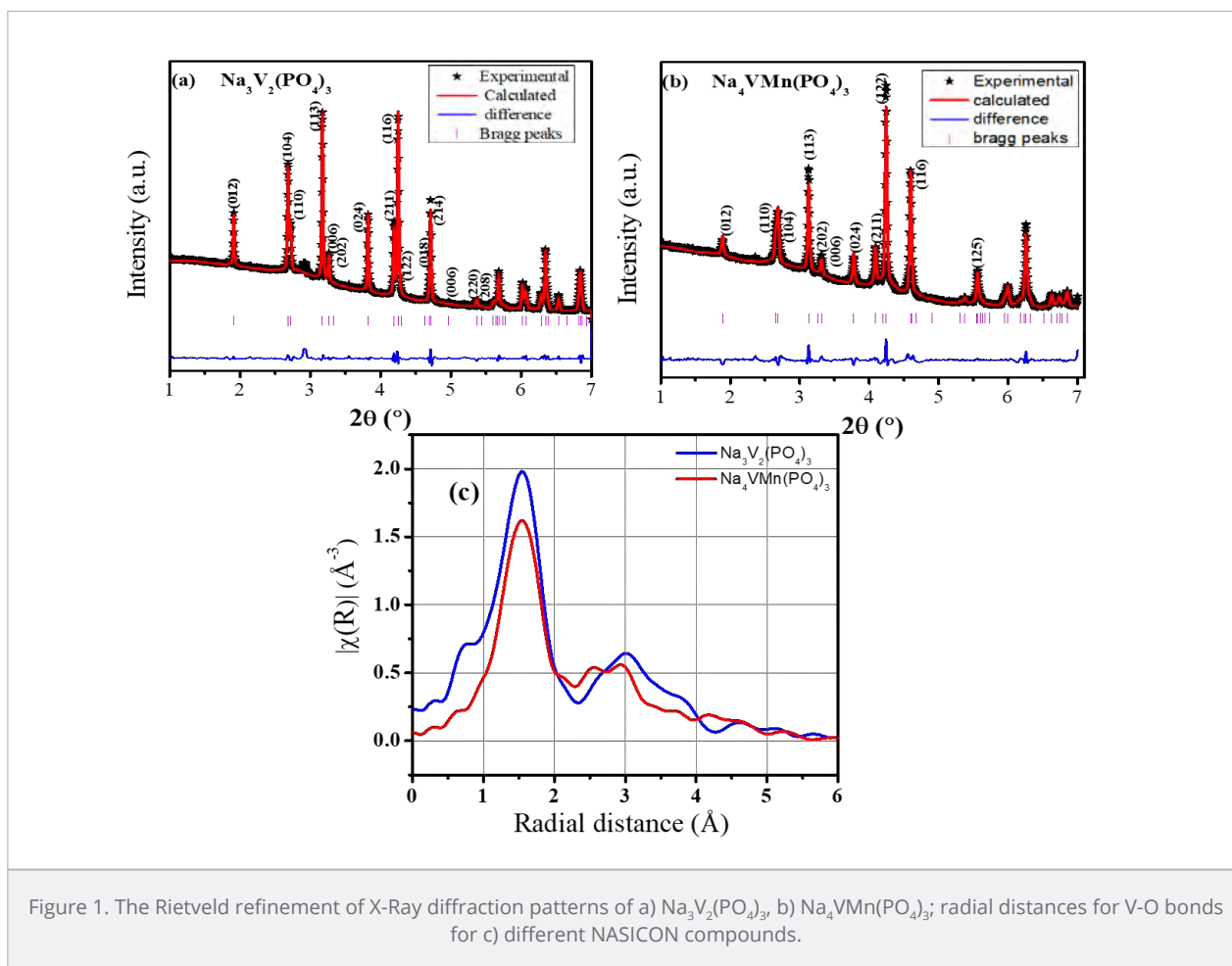
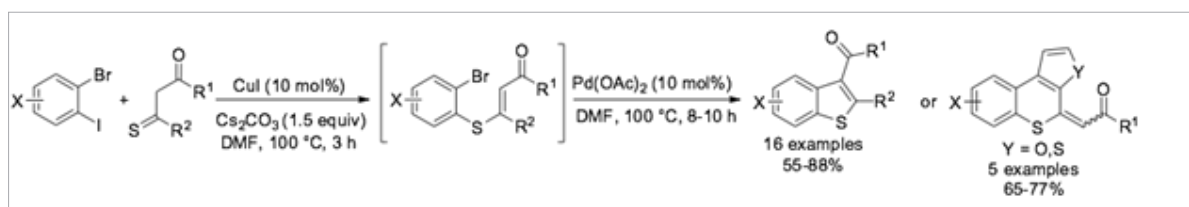


Figure 1. The Rietveld refinement of X-Ray diffraction patterns of a) $\text{Na}_3\text{V}_2(\text{PO}_4)_3$, b) $\text{Na}_4\text{VMn}(\text{PO}_4)_3$; radial distances for V-O bonds for c) different NASICON compounds.

H. Ila, Ph.D., F N A, F A Sc
Honorary Professor

Synthesis of Substituted Benzo[*b*]thiophenes

Substituted benzo[*b*]thiophenes represent an important class of heterocycles displaying a broad range of biological activity and serving as useful heterocyclic cores to a host of marketed drugs. They are also important structural components in development of optoelectronic materials. In continuation of our earlier studies towards development of new synthetic methodologies for substituted benzo[*b*]thiophenes via copper catalyzed intramolecular cross-coupling (Ila, H. *et al J. Org. Chem.* 2015, 80, 2884) and intramolecular C-H functionalization/ C-S bond formation (Ila, H. *et al Chem. Eur. J.* 2015, 21, 17116), we have now newly developed one-pot synthetic methods that are also metal-free in some cases.



Synthesis of Substituted Benzo[*b*]thiophenes via sequential One-Pot, Copper-Catalyzed Intermolecular C-S Bond Formation and Palladium-Catalyzed Intramolecular Arene-Alkene Coupling of Bis(het)aryl/alkyl-1,3-monothiodiketones and *o*-Bromiodoarenes.

UNIT MEMBERS

Senior Professor & Chair

C N R Rao, Ph.D., D Sc, Sc D (hc), D Sc (hc), LLD (hc), D Litt (hc), Dr Eng (hc), F A Sc, F N A, F R S, F TWAS, Hon. F R S (C), Hon F. Inst P., Hon. F R S C.

Associate Professors

Subi Jacob George, Ph.D.
Govindaraju T, Ph.D.
Jayanta Haldar, Ph.D.
Sebastian Chirambatte Peter, Ph.D.
Ranjani Viswanatha, Ph.D. (jointly with ICMS)
Sridhar Rajaram, Ph.D. (jointly with ICMS & CPMU)

Faculty Fellows

Kanishka Biswas, Ph.D.
Sarit S Agasti, Ph.D. (jointly with CPMU)
Premkumar Senguttuvan, Ph.D. (jointly with ICMS)

Honorary Professor

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

Research Students

Reetendra Singh, Sudip Mukherjee, Aditi Chiring, Geetika Dhandra, Sushmita Chandra, Amit, Harshit Arora, Santu Sinha, Manswee Barua, Satyajit Pal, Sreyan Ghosh, Madhulika Mazumder, Ekashmi Rathore, Shikha Dhiman, Suchi Smita Biswas, Mahima Makkar, Paramita Sarkar, Saurav Chandra Sarma, Ananya Banik, Ananya Mishra, Yelisetty Venkata Suseela, Krishnendu Jalani, Mohini Mohan Konai, K. Rajasekhar, Navin Kumar Singh, Paribesh Acharyya, Debabrata Bagchi, Robi Sankar Patra, Mary Antony P, Madhu R, Ahuja Vinita Ashok Kumar, Risov Das, Saptarshi Chakraborty, Souvik Sarkar, Rajib Dey, Swadhin Garain, Moinak Dutta, Payel Mondal, Subham Ghosh, Yogendra Kumar, Mohd Monis Ayyub, Biswanath Maity, Sumon Pratihar, Arka Som, Arjun C H, Brinta Bhattacharjee, Debasis Ghosh, Pradeep K R, Anusha S Avadhani, Shreya Sarkar, Manisha

Samanta, Ranjan Sasmal, Sourav Samanta, Swagatam Barman, Aritra Sarkar, Ramesh M S, Suman Kuila, Subhajit Roychowdhury, Anand Kumar Roy, Shubhajit Das, Manjeet Chhetri, Soumyabrata Roy, Anand Acharya

Research Associates

A R Rajamani, M Kanagaraj, Subba Reddy Marri, Sandip Samaddar, Debajyoti Basak, Nilanjana Das Saha, Chenikkayala Balachandra, Shidaling Mattepanavar, K Rajasekhar, Nabadyuti Barman, Shadab Alam, S. Dasaradha Ramarao, Rita Ghosh

Research Associate (P)

Tanmoy Ghosh

Research Associates - III

Bappaditya Roy, Arpita Paikar

SERB National Post-doctoral Fellows

Sreenivasulu Bandi, Iniyavan P, G.L.Balaji, Kaman Sharma, Pardhasaradhi Satha

SERB Fast Track Young Scientist Fellow

Vibha Gautam

Junior Research Fellow

Kathakali De

R&D Assistants

Kaja Sai Manoj, Shradhya Sarkar, Utsav Kumar Dey, Jithu Raj, Madhav Govind Nayak, Soumya C (jointly with CPMU), Monica Swetha Bosco (jointly with CPMU), Krishnendu Maji, Devanshi Shah, Jaiminkumar Narmadashankar Bhatt

Technical Assistant (Inst)

Shivakumar K.M.

Awards / Fellowships / Sponsored Projects / Academics / Publications

AWARDS RECEIVED BY FACULTIES

C.N.R. RAO

- First Asian to receive the Materials Research Society's highest honor - the Von Hippel Award presented in Boston on November 29, 2017
- Wockhardt Research Prize
- Hon. Doctorate of IIT, Guwahati

T. GOVINDARAJU

- Young scientist award (2017), Indian peptide society
- MRSI Medal (2017), Materials Research Society of India

JAYANTA HALDAR

- CRSI Bronze Medal 2018

KANISHKA BISWAS

- Young Scientist Wiley Award by International Union of Materials Research Societies in IUMRS-ICAM 2017 in Japan
- Profile selected in "New Frontier in Indian Research" by Royal Society of Chemistry (RSC), UK

SARIT AGASTI

- SERB Early Career Award
- DAE Young Scientist Award (YSRA), DAE-BRNS, 2017

SEBASTIAN C. PETER

- Leading the team which qualified as semi-finalist of NRG COSIA Carbon XPrize

PREMKUMAR SENGUTTUVAN

- DST-Early Career Research Award, 2017-2019

FELLOWSHIPS

SUBI J. GEORGE

DST Swarna Jayanti Fellowship in Chemical Sciences for the year 2017

SARIT AGASTI

Wellcome Trust Intermediate Fellowship

AWARDS RECEIVED BY STUDENTS

EKASHMI RATHORE

(Ph.D. Student, NCU) wins the Falling Walls Lab India 2017 - New Delhi

AMIT

Babu Matru Prasad Scholarship (Best Ph.D. Thesis Award)

PARAMITA SARKAR

Smt & Sri Babu Narayanaswamy Prize (Best M.S.Thesis Award)

SPONSORED PROJECTS

16 New Projects ₹ 4,85,91,883
7 Ongoing Projects ₹ 8,66,00,000

PUBLICATIONS

94 Journal Articles
2 Book Chapters

ACADEMICS

14 Students Admitted
14 Graduated



NEUROSCIENCE UNIT (NSU)

Areas of Research

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

*The Neuroscience Unit addresses clinically relevant neurological phenotypes as well as normal neurobiological phenomena in model organisms, *Drosophila*, mice, and human patients. Molecular and network-level underpinnings of circadian rhythms, intellectual disabilities, and seizure disorders form the main underpinnings of the unit. Several collaborative projects are underway between members of the Unit and other scientists within the Centre as well as with clinicians and researchers in NIMHANS, IISc, NCBS and other national and international organisations. The student and faculty members of the Unit also engage in Neuroscience discussions through seminars and journal clubs. InSearch 2018, a one day Symposium on Insects in Research, was conducted by the Unit to celebrate the award of the Nobel Prize in Physiology and Medicine to the discovery of the molecular mechanisms underlying circadian clocks in fruitfly *Drosophila melanogaster*. This was attended by Undergraduate and Master's students and teachers from across the city and outside.*

RESEARCH HIGHLIGHTS

1. In a mouse model of a subtype of Autism Spectrum Disorders, Syngap1-/-+, Chloride co-transporters were suggested to be major determinants of synapse dysfunction in hippocampal neurons.
2. Syngap1 was shown to be expressed in astrocytes for the first time and a heterozygous mutation was shown to affect astrocyte branching patterns.
3. A collaboration between members of the unit has resulted in the demonstration of a small molecule modulator of autophagy being able to reduce the toxic effects of a-synuclein in a mouse model of neurodegenerative disease.
4. Unidirectional communication between the circadian pacemaker and the sleep homeostat was shown for the first time in fruit flies, a rapidly emerging model for sleep research. Sleep deprivation was demonstrated to result in reduced reproductive output in female fruitflies.
5. Selection for highly accurate circadian clocks in fruitfly populations was found to be accompanied by increased circadian light sensitivity as well as better temperature compensation.

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Human Genetics Laboratory

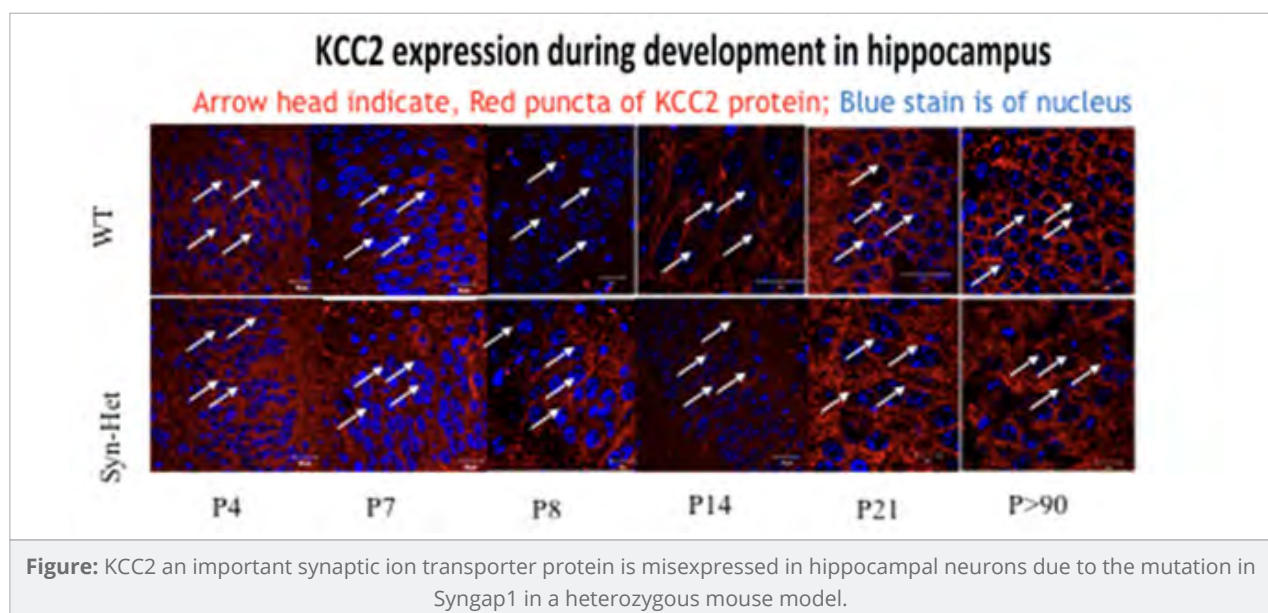
Anuranjan Anand, Ph.D., F A Sc, F N A, F N A Sc
Professor & Chair

We look at genetic and cell biology of CASR, a causative gene for juvenile myoclonic epilepsy. Juvenile myoclonic epilepsy (JME) accounts for 20% of all human epilepsies and has genetic basis in its etiology (Thomas and Berkovic, Nat Rev Neurol 2014). We identified a novel genetic locus, EIG8 for JME (Kapoor et al, Ann Neurol 2008). To isolate the causative gene at EIG8, we conducted genetic studies which revealed six mutations in CASR present exclusively in JME patients. CASR encodes a G-protein coupled receptor that senses extracellular calcium levels (Brown et al, Nature 1993). The six mutations identified are rare and misread alleles which alter conserved CASR residues. We carried out functional studies employing MAPK (mitogen-activated protein kinase) assay for the CASR mutations identified. In the MAPK assay, across different Ca^{2+} concentrations, the signalling activity of CASR followed a sigmoidal dose-response curve, with exponentially increasing activity of Ca^{2+} . This suggested that the G-protein receptors have enhanced responsiveness to the Ca^{2+} . The alleles they consequently activate affect the CASR-regulated neuronal functions. We believe that the function of CASR in the brain is crucial to maintain normal neuronal excitability, and CASR is a potential therapeutic target in epilepsies.

Neurophysiology Laboratory

James Chelliah, Ph.D.
Faculty Fellow

A cardinal feature of the human brain development is that sensory, cognitive and emotional experiences shape synapses, neural-circuit development, memory formation and recall of stored memories. Several studies have shown that these features are altered in intellectual disability (ID) and Autism Spectrum Disorder (ASD). De novo heterozygous mutations in the gene that encodes for synaptic RasGAP, Syngap1, has been shown to cause ID and increase the risk for developing ASD in young children. In our laboratory, we are trying to understand how a dysfunctional SYNGAP1 affects function and development of Cl^- channels, astrocytes, and also its interaction with other proteins such as the Fragile X mental retardation protein. Our preliminary results suggest that Syngap1-/+ alters the expression and function of K^+Cl^- transporter, and astrocytes during development. Further, SYNGAP1 expression is regulated by a FMRP during development, which could be a potential therapeutic target in future. We have collaborative projects with faculty members from IISc., NCBS, and University of Central Lancashire, UK. Dr. Milos, my collaborator in the UK, and I have started a project looking at the altered expression and function of SUMOylation and kainate receptors in Syngap1-/+ mice.



Behavioral Neurogenetics Laboratory and Chronobiology Laboratory

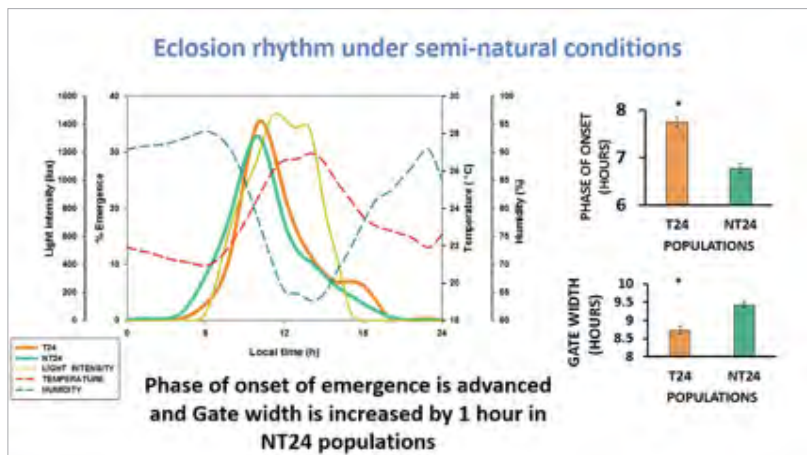
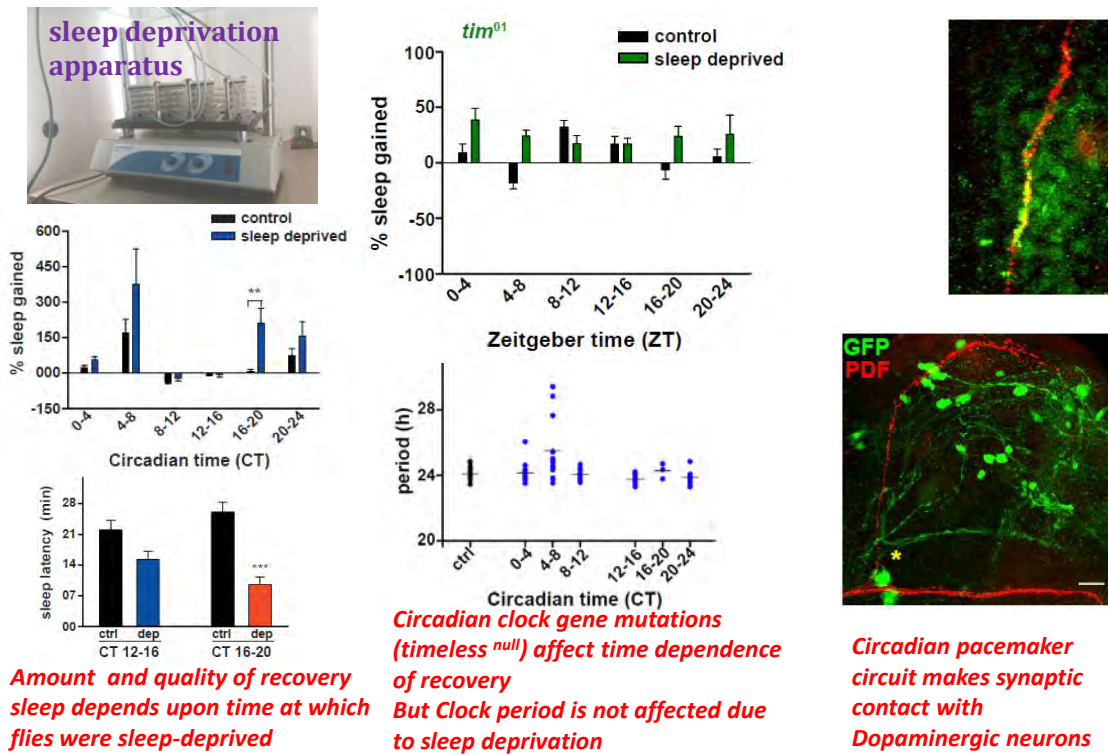
Sheeba Vasu, Ph.D.
Associate Professor

We have demonstrated communication between *Drosophila circadian* pacemaker circuit and the sleep homeostat, to further explore the aspects of sleep recovery affected by the circadian clock. We uncover that mutations in the circadian clock also impact the time-of-day dependence of the sleep homeostat. We demonstrate that Dopaminergic neurons lie downstream of the circadian pacemaker, thus affecting sleep control centres. We show that one of

the adaptive values for the evolution of sleep stems from its ability to ensure higher reproductive output in female flies (Potdar *et al.*, J 2018; Experimental Biology).

We examined various aspects of circadian rhythm biology ranging from examining various circadian clock properties and their inter-relationships, the genetic correlations underlying phasing of rhythms or chronotypes, the role of canonical clock genes on rhythmic oviposition – an important fitness trait – and also studied how exposure to natural cycles of light, temperature and humidity may, over generations, shape the evolution of circadian clocks in fruitflies. We

Demonstration of a uni-directional route of communication from circadian clock to sleep homeostat in fruitflies



showed that ambient temperature can influence the divergence of circadian chronotypes to varying extents and that 'late or evening' chronotypes are more readily affected by temperature cycles. Whole-genome sequencing of divergent chronotypes have begun to yield insights into the underlying genetic phenomena. In contrast to the literature we show that fast and slow running clocks do not respectively exhibit greater advances and delays

in the phase-response characteristics. There are exceptions though. The role of certain canonical circadian clock genes in oviposition rhythm seems to be largely based on the need to maintain a certain speed while others influence the ability of the rhythm to phase itself correctly to cyclic time cues. Populations of flies that have been reared under semi-natural conditions evolve an earlier phase of their adult-emergence rhythm and a significantly looser gating of this behaviour. We also find that gap junction genes

Innexin 1, 2 and 4 play a role in determining the speed of the Drosophila circadian clock and its ability to appropriately phase activity in the presence of light/dark cycles.

We also discover that in the context of pathogenic forms of the human Huntingtin protein, autophagy and heat-shock pathways can synergistically counter toxic aggregates. This was studied in a Drosophila model.

UNIT MEMBERS

Professor & Chair

Anuranjan Anand, Ph.D., F A Sc, F N A, F N A Sc

Adjunct Faculty Members

M R S Rao, Ph.D., F A Sc, F N A, F N A Sc, FTNAS, FTWAS
(Honorary Professor)

Tapas K Kundu, Ph.D., F A Sc, F N A, F N A Sc
(On leave to CDRI, Lucknow)

Ravi Manjithaya, Ph.D

Associate Professor

Sheeba Vasu, Ph.D

Faculty Fellow

James Premdoss Clement Chelliah, Ph.D

Research Students

Arijit Ghosh, Vijay Kumar M J, Dani Chitrang
Kamal, Abhik Paul, Iyer Aishwarya Ramakrishnan,
Vijaya Verma, Iyengar Aishwariya Prasan

Awards / Memberships / Sponsored Projects / Publications

MEMBERSHIP

M.R.S. RAO

Member of the Governing Body of CSIR

SPONSORED PROJECTS

1 New Project	₹ 9,60,000
6 Ongoing Projects	₹ 1,04,44,335

PUBLICATIONS

8 Journal Articles
3 Book Chapters

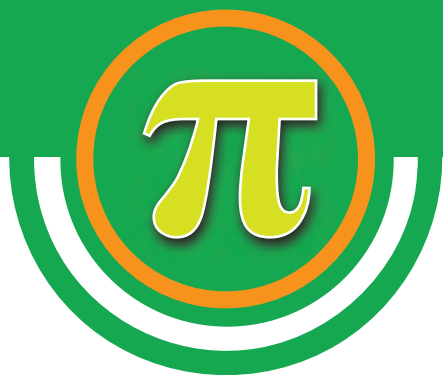
AWARD RECEIVED BY STUDENTS

VIJAYA VERMA

Ph.D. Student, NSU, was awarded the best poster at 16th Molecular cellular and Cognition Society conference held at National University of Singapore from 1-3 August 2017.

NIKHIL KL (JNCASR Alumnus)

(Research Supervisor: Late Prof. Vijay K. Sharma) received Humboldt Fellowship for Postdoctoral Researchers, presently working in Universitätsmedizin Berlin.



THEORETICAL SCIENCE UNIT (TSU)

At the Theoretical Sciences Unit, we aim to understand, explain and address the underlying physics that governs the world we see around us. We apply an interdisciplinary approach to problems in very diverse areas such as evolutionary biology and materials sciences to predict and identify new phenomena and circumstances that modify observed patterns in nature whether that be 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. In the past year our research has encompassed these areas - theory of catalysis for energy and environment; 2 dimensional materials defects, surface reconstructions, self-assembly; thermoelectrics and magnetoelectrics; drug molecule and biological membrane interactions; jamming, self-organization, void space, cluster growth and evaluations; method development at various energy and length scales.

Areas of Research

- Theory and simulations of materials
- Statistical physics of systems at and away from equilibrium
- Nonequilibrium phenomena in physics and biology
- Computational nanoscience
- Advanced quantum theory: from molecules to materials
- Computational studies of protein-protein interactions
- Phase transformations and dynamics of soft matter
- Non-commutative probability and geometry: mathematics of quantum mechanics
- Correlated electron systems and organic electronics
- Computational insights into evolutionary dynamics

RESEARCH HIGHLIGHTS

1. Ultra-low thermal conductivity observed in halide thermo electrics has been explained and the mechanism of their high thermo electric performance has been computationally understood (by **Umesh Waghmare**).
2. Computational studies of Anderson localization of phonons in an exact manner have been performed (by **N. S. Vidhyadhiraja**).
3. Chemically modified carbon nanotubes have been modelled for potential use as a sensor and trap for hazardous insecticides (by **Swapan K. Pati**).
4. Simple descriptors have been identified to explain structures of a system comprising of various self-assembled organic molecules and a simulated host surface (by **Shobhana Narasimhan**).
5. It has been shown that evolution can be significantly sped up when the phenotypic trait in question is controlled by hundreds of genes of small effects (by **Kavita Jain**).
6. Clustering phenomenon involving an energy decay and cluster growth in inelastic granular matters have been numerically studied (by **Subir K. Das**).
7. Self-organization studies on shear-jammed granular particles show a clear increase in underlying organisation under shear even when they are frictionless. Jamming transition in the system is dependent on the average number of particles in contact with each other (by **Srikanth Sastry**).
8. Simulations have been carried out to study interactions between bacterial cell membranes and small drug molecules that show potential antibiotic properties (by **Meher K. Prakash**).

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Swapan Pati, Ph.D., F A Sc, F N A Sc, F T W A S

Professor & Chair

We have studied mechanistic insights into hydrogen activation by frustrated Lewis pairs. We have studied in detail, the structural and magneto-electronic properties of various point defects in MXenes by using first principle methods. Our computational studies on chemically modified carbon nanotubes have shown that they can trap and sense various hazardous insecticides. We have shown using a first principles study that a new 2D material, alpha lead oxide (α -PbO) shows visible light sensitivity. We have identified a high-performance cobalt-based Metal-Organic Framework to catalyse oxygen reduction reaction.

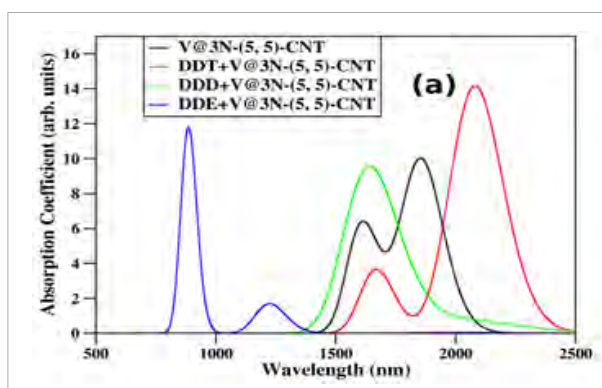


Fig: Optical absorption spectra of (5,5) Carbon Nanotube (CNT) and DDT, DDD and DDE absorbed CNT.

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

Professor

Theory of catalysis for energy and environment:

We identified the electronic and structural descriptors of the catalytic activity of borocarbonitrides in oxygen reduction reaction. We showed how oxide heterostructures can be effective in photo-electro-catalysis of water splitting reaction using solar energy.

Superconductivity: We explained experimental observation of superconductivity in nano-clusters of Ta well below the sizes set by Anderson criterion, based on enhanced electron-phonon coupling due to strain at nano-scales.

2-dimensional materials: We determined the precise nature of the electronic structure of 1T form of 2-dimensional MoS_2 as synthesized chemically, and explained experimental observations. We studied pressure dependent properties of MoTe_2 and black phosphorus.

Thermoelectrics: We explained ultra-low thermal conductivity observed in halide thermoelectrics, and derived insights into mechanisms of their high thermoelectric performances.

Method Development: We developed phonon spectral formulation of the atomistic Green's function methods and used it to determine interfacial thermal conductance that involves coupled electronic and phonon degrees of freedom. We also developed an automated procedure based on machine learning to expedite discovery of functional materials starting from large databases.

Srikanth Sastry, Ph.D., F A Sc, F N A Sc, F N A

Professor

In 2017-18 we have carried out research in the areas of (i) shear jamming in granular matter, (ii) the yielding transition in amorphous solids, (iii) complex dynamics in glass forming liquids.

Extensive computer simulations and numerical calculations have shown that the self-organization necessary for shear jamming occurs even for frictionless particles, and that jamming occurs at a precisely defined state at which the mean contact number of particles reaches a value of $D + 1$, D being the spatial dimension. A percolation transition of stressed regions takes place, establishing new connections with rigidity studies in covalent glasses.

Yielding, or mechanical failure in glasses has been probed with a cyclic deformation protocol, called cyclic strain or CS. It has been shown that yielding emerges as a sharply defined transition under such a protocol, sharper than an ordinary deformation uniform in time. Under CS the glass is found to become plastic with a series of localised irreversible deformations called

plastic rearrangement events occurring within the system until there is a transition from localized yield to one that is system spanning. This phenomenon involves a discontinuous percolation transition. (Fig.1)

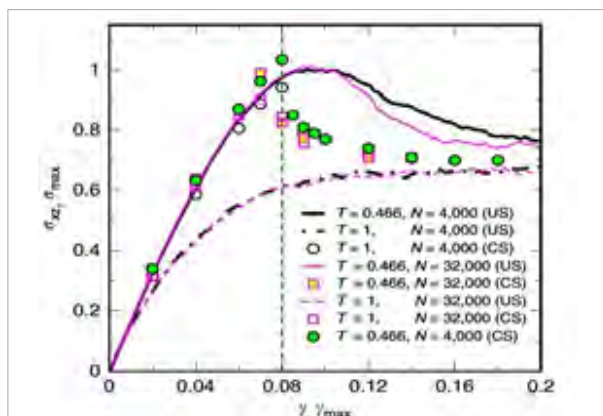


Figure 1: Averaged stress-strain curves for uniform strain (US) are shown as lines—thick (black) for $N = 4,000$ and thin (magenta) for $N = 32,000$ while solid and dashed lines represent $T = 0.466$ and $T = 1$, respectively. Maximum stress σ_{\max} versus γ_{\max} are shown for cyclic strain (CS) (circle and square denote $N = 4,000$ and $32,000$, respectively, with filled and open symbols corresponding to glasses from $T = 0.466$ and $T = 1$). The vertical line at $\gamma_{\max} = 0.08$ indicates the sharp yielding transition seen.

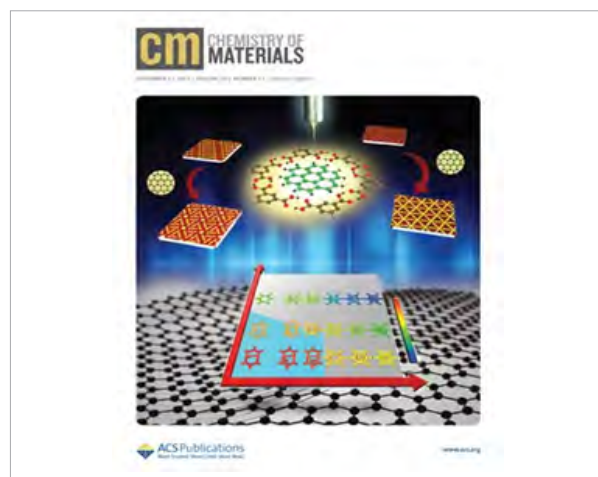
Analysing the dynamics of glass forming liquids, it has been shown that the Adam-Gibbs relation applies to diffusion, and not viscosity, and this observation has been employed in the analysis of the violation of the Stokes-Einstein relation.

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

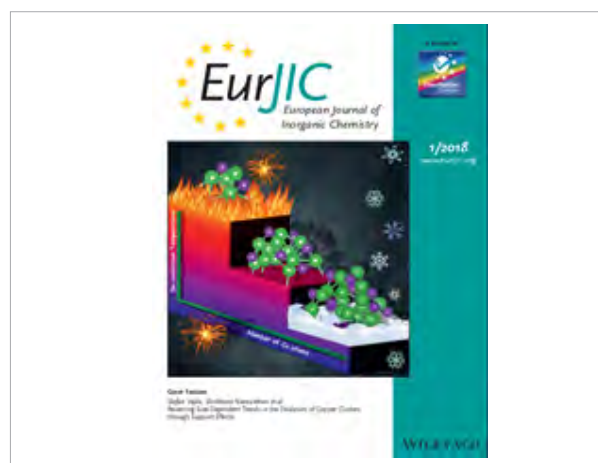
Professor

For the first time, simple descriptors were identified that can be used to predict the geometry of host-guest architectures of a system of self-assembled organic molecules on surfaces. These descriptors can be evaluated at zero computational cost, as they depend only on the geometry and formula of the isolated molecules in the gas phase.

P. Zalake *et al.*, *Chemistry of Materials* 29, 7170 (2017).



It was shown that the oxidation state of small copper nanoparticles can be tuned by appropriately choosing the support that they are deposited on. Our computation shows that the sensitivity to particle-size of the temperature at which the nanoparticle clusters reduce from oxidised to metallic phase gets reversed on using a hydrolysed alumina support instead of a standard gas phase. This is important because Cu nanoparticles are used as catalysts for several industrially important reactions, for some of which it is better for the clusters to be elemental, while for others a certain degree of oxidation is preferable.



N. S. Vidhyadhiraja, Ph.D.

Associate Professor

(1) **Phonon Localisation:** The study of phonon localization initiated last year has resulted in one publication where we have presented a new computational technique that can capture the Anderson localization of phonons in an exact way.

(2) **Quantum criticality with interactions and disorder:** In a manuscript under review, we have presented the first evidence for disorder driven quantum criticality in strongly correlated systems. Strong deviation from Landau damping is found, which is in accord with a whole range of ill-understood non-Fermi liquid phenomena in several materials.

Subir K Das, Ph.D.

Associate Professor

Our group broadly studies problems in the area of Statistical Mechanics. This year we have focused on problems related to nucleation, growth, aging and wetting in various condensed matter systems. Significant new understanding on the following topics has been obtained.

Kinetics of vapor-solid phase transition: Role of fractality in ballistic aggregation process has been computationally identified and understood via theoretical arguments.

Ordering in Ferromagnets: Aging properties in the framework of Ising model in three dimensions have been studied via Monte Carlo simulations at temperatures above and below the roughening transition temperature indicating the influence of the transition temperature on the phenomenon.

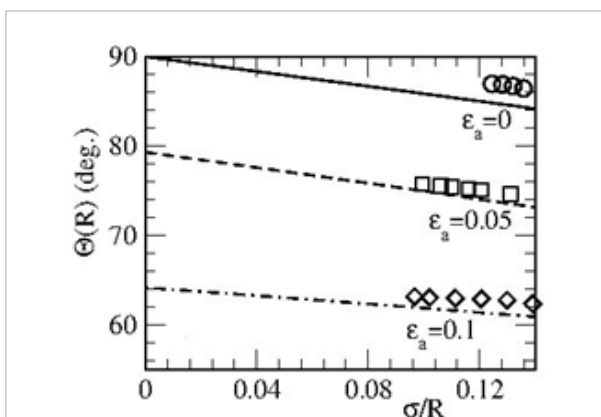


Fig: Variation of contact angle with radius of curvature in wetting phenomena, for various strengths of wall-particle interaction. The symbols are from Monte Carlo simulations. The lines represent predictions of a theory

Surface induced heterogeneous nucleation: Curvature dependence of contact angle and line tension for wall attached droplets has been studied via Monte Carlo Simulations.

Clustering phenomena in granular matter: Energy decay and cluster growth in various models of systems containing inelastic granular particles have been studied via molecular dynamic simulations.

Kavita Jain, Ph.D.

Associate Professor

This group showed that greater the number of genes linked to a phenotypic trait, faster the evolution. Evolution can occur rapidly when a phenotype is controlled by hundreds of genes of small effect. The work has been included in the 'Genetics Highlights of May 2017'.

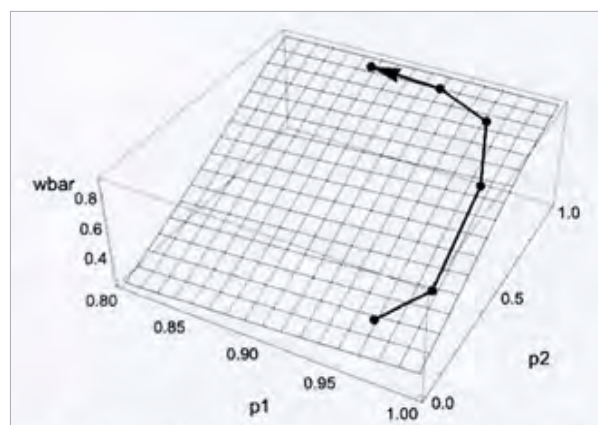


Fig: Evolution of allele frequencies on the adaptive landscape when a phenotypic trait is controlled by two loci. In the top (bottom) panel, both effects are smaller (larger) than the threshold effect.

Meher K Prakash, Ph.D.

Faculty Fellow

We have worked on a new class of amphiphilic small molecules that have the potential to replace conventional antibiotics. In general, antibiotics become ineffective as bacterial proteins undergo mutations and develop resistance to the drugs. Recently, a new

class of small cationic amphiphilic molecules have been developed that have been found to act as an alternative to conventional drugs, but the mechanism of their action is unknown. We have used advanced molecular dynamics simulations to investigate the interaction between two such potential drug molecules with prototypical bacterial and red blood cell membranes. The differences in charge separations and length of the alkyl chains of the small molecules lead to a differential selectivity between different types of membranes indicating differential affinity of bacteria and RBC towards the drug molecules.

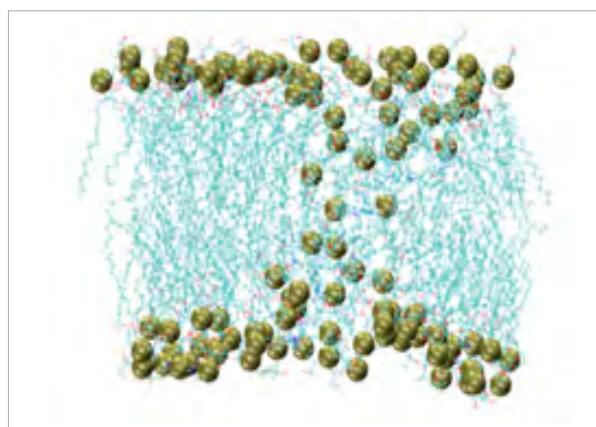


Fig: Understanding the mechanism of the drug molecules that can replace traditional antibiotics

UNIT MEMBERS

Chair

Swapan K Pati, Ph.D., F A Sc, F N A Sc, F T W A S

Senior Professor

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

Professors

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

Srikanth Sastry, Ph.D., F A Sc, F N A Sc, F N A

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

Swapan K Pati, Ph.D., F A Sc, F N A Sc, F T W A S

Associate Professors

Vidhyadhiraja N S, Ph.D.

Kavita Jain, Ph.D.

Subir Kumar Das, Ph.D.

Faculty Fellow

Meher K Prakash, Ph.D.

Research Students

Vinayak M Kulkarni, Nandana S K, Himanshu Joshi, Koyendrila Debnath, Sachin Kaushik, Ankit Kumar, Abhishek Kumar Adak, Pallavi Sarkar, Raju Kumar Biswas, Archana Devi, Arabinda Bera, Varghese Babu, Koyel Das,

Nalina V, Yagyik Goswami, Jyoti Dalal, Neha Bothra, Pallabi Das, Malay Ranjan Biswal, Dheeraj Kumar, Sourav Mondal, Meha Bhogra, Sruthi C K, Monoj Adhikari, Pawan Kumar, Rajdeep Banerjee, Debdipto Acharya, Sukanya Ghosh, Subhajit Paul, Wasim Raja Mondal, Alok Kumar Dixit, Kaushlendra Kumar

DST-Inspire Research Associate

Soumalya Joardar

SERB National Post-doctoral Fellow

V Sampath Kumar

Research Associates

K Navamani, Anuja Chanana, Swetarekha Ram, Matukumilli V D Prasad, Devina Sharma, Subhajit Paul

Research Associate - III

Srinivasa Rao Varanasi

Research Associates (P)

Rajneesh Kumar, Himangsu Bhaumik, Arunkumar Bupathy, Anushul Deep Singh Parmar, Sayani Chatterjee

R&D Assistants

Ganesh Kumar Nayak, Wasim Raja Mondal, Ayan Majumder

DST Post-doctoral Fellowship in Neuroscience & Technology

Sandhya Rai

Awards / Memberships / Sponsored Projects / Publications

AWARD RECEIVED BY FACULTY

UMESH V. WAGHMARE
G.D. Birla Award (2016)

ACADEMICS

8 Students Admitted
8 Graduated

PUBLICATIONS

64 Journal Articles
2 Book Chapters

MEMBERSHIP

K.B. SINHA
(President of the "Association of Quantum Probability and Infinite Dimensional Analysis" (AQPIDA) since 2014)

SPONSORED PROJECTS

6 New Projects	₹ 1,56,73,369
13 Ongoing Projects	₹ 8,65,200

CSIR CENTRE OF EXCELLENCE IN CHEMISTRY (CSIR-COE)

In January 1991, the CSIR established person-based Centre of Excellence in Chemistry under CSIR's programme to build Centres of Excellence throughout the country. This was a landmark recognition of the research efforts in the field of Chemistry by JNCASR and has over the years provided further support to the member(s) connected with this Centre of Excellence.

Areas of Research: Various aspects of solid state and materials chemistry.

RESEARCH HIGHLIGHTS

- Supercapacitors based on borocarbonitrides and modified graphene were found to perform well.
- Solar thermochemical reduction of water and CO₂ to hydrogen and CO respectively, was carried out successfully.
- Functionalization of MoS₂ nanosheets by organic molecules was carried out.

UNIT MEMBERS

Linus Pauling Research Professor and Chair

C N R Rao, Ph.D., D Sc, Sc D (hc), D Sc (hc), LLD (hc), D Litt (hc), Dr Eng (hc), F A Sc, F N A, F R S, F TWAS, Hon. F R S (C), Hon F. Inst P., Hon. F R S C

Office Staff

Victor Sathish D.G. (Lab Helper)

Research Staff

Gopalakrishnan (Research Associate)

S. Rajesh (R&D Assistant)

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Graphene is one of the main areas of research in this centre. In 2017-18, synthesis of two to four-layer graphene was carried out by arc-discharge of graphite in a hydrogen atmosphere as well as under other conditions. Besides providing clean graphene surfaces, this method allows for doping with boron and nitrogen.

Inorganic analogues of graphene also constitute an important area of research. Various chemical methods have been developed for the synthesis of layered transition metal dichalcogenides which includes MoS₂, WS₂, MoSe₂, WSe₂, NbS₂ and NbSe₂. Their applications in IR detectors, gas sensors and polymer composites for their interesting mechanical, electrical and magnetic properties, have been studied. Micromechanical cleavage method has been used for obtaining single-layer graphene analogues of MoS₂, GaS and GaSe and their applications in transistors, detectors and sensors were studied. Functionalization of MoS₂ nanosheets and MoS₂ covalently bonded to nanosheets of other materials are being pursued.

High Surface area borocarbonitrides were synthesized from low cost starting materials like urea, boric

acid and activated charcoal. Graphene-like BxCyNz samples exhibit surface area in the range 1500-1900 m²/g, with large uptake values of CO₂ and shows good performance characteristics as supercapacitor electrodes and as ORR catalysts. Several other aspects of borocarbonitrides are being examined.

Photocatalytic water splitting using powder catalyst dispersed in water by simply shining light is one of the most energy effective and easiest ways to obtain H₂ and O₂. The unit is investigating possible generation of hydrogen by using semiconductor heterostructures and dyes through this method. Thermochemical decomposition of H₂O by perovskite oxide is another area of active exploration. Besides photochemical and thermochemical methods, photoelectrochemical means of splitting water is also being pursued.

Aliovalent anion substitution in metal oxides and sulfides causes major changes in their electronic properties and structure. Several oxides including ZnO and TiO₂ substituted by N and F and P, Cl substituted CdS and ZnS are being examined for this purpose. Substituted analogues of ZnO and CdS such as Zn₂NF and Cd₄P₂Cl₃ are also being investigated.

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

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

Areas of Research: Materials sciences, Glass, Other computation-intensive research areas.

RESEARCH HIGHLIGHTS

- Prediction of new topological insulators in 2D materials under zero strain.
- Identification of a simple descriptor for the HOMO-LUMO gap in phenylene-ethynylene molecules that depends only on the attachment sites of the molecule's alkoxy side chains.
- Microscopic interpretation of increased sulfur dioxide uptake via anion functionalization in room temperature ionic liquids.
- Study on the role of molecular dipole orientations and intermolecular interactions in a derivative of pyrene on its supramolecular self-assembly in solution that showed the relationship between electric field induced chiral enhancement in the molecule and its symmetry.
- Development of methods of analysis of thermal transport that have led to a better understanding of high performance thermoelectric materials.
- Uncovering the physics of lower size limit on the existence of superconducting order.
- Exploration of several aspects of topology in 2-dimensional materials with focus on their photo-electro catalytic properties.
- A new class of molecules are being developed by our experimental collaborators, which act as double-mimics - mimicking the acyl chains of lipids while also behaving like antimicrobial peptides in their action against membranes. The mechanism of their action, especially their selectivity against bacterial membranes is not clear. Using all-atom simulations combined with umbrella sampling, we could demonstrate how the charge interactions and the length of the acyl chains of the drug molecules contribute to the selective action against bacterial model membranes.
- Depending on the intrinsic and regular defect types, we have predicted that Ti_2XT_2 (where X is C/N and T = O/F/OH) MXene can undergo transition from metal to semiconductor or vice-versa and few defective ones can become magnetic too.
- Using in-house developed time-dependent adaptive Density-matrix renormalisation group, DMRG methods, in a dipolar Fermionic correlated ladder structure we found various exotic phases, including supersolid and spin-triplet ($S_z=0$) superfluid phases. We then examined their stability against hopping along rungs, spin-dependent hopping and three body dipolar interactions.
- Observation of yield in glasses occurring as a sharply defined transition, accompanied by shear banding, under cyclic deformation.
- Theoretical proof that the Adam-Gibbs relation, relating thermodynamics with dynamics in glass forming liquids, applies primarily to contexts of diffusion and not to viscosity.

UNIT MEMBERS

Faculty

Balasubramanian Sundaram
Shobhana Narasimhan
Srikanth Sastry
Swapan K Pati
Umesh V Waghmare
Meher K Prakash

Research Associate

Devina Sharma

Research Associate (P)

Anushul Deep Singh Parmar

Research Scientist B

Anoop S., Suresh J.

Helper

Basavaraj T.

INTELLECTUAL PROPERTY

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

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

During 2017-2018, 28 patent applications were filed (India-5, PCT-3, Canada-4, Europe-4, OAPI-2, Singapore-2, ARIPO-2, S. Africa-2, and USA-4) for inventions meeting territorial patentability criteria. The Centre has also obtained 7 (India-2, Australia-1, Canada-1, Korea-1 and USA-2) patent grants.

The Centre has so far filed 268 (India-83, PCT-52, Australia-5, Brazil-3, Canada-9, China-6, Europe-26, Hong Kong-2, Israel-1, Japan-8,

Korea-2, Singapore-3, S. Africa-5, S. Korea-3, USA-55, ARIPO-2, OAPI-2 and Vietnam-1) National Phase (i.e. foreign countries) and International Phase (i.e. PCT) Patent Applications and obtained 69 (India-12, Australia-3, Canada-1, China-4, Europe-8, Japan-4, Korea-2, S.Africa-2, S.Korea-1 and USA-32) patent grants, in addition to registering: Industrial Design-1, Copyright-1 and Trade Mark-1.

Copyright Registered

Copyright Registration Certificate has been issued (for Diary No. 12289/2016-CO/SW-9306/2017) on 10th August 2017 for computer software titled 'ANUROOP: A compressible DNS code to simulate and study flow over turbine blades' developed by Prof. Roddam Narasimha, Shri Suresh Madhusudan Deshpande and Shri Rajesh Ranjan.

Technology Transferred

During 2017-2018, the technology entitled 'Inhibition of Histone Acetyltransferases by CTK7A and Methods Thereof' developed by Prof. Tapas Kumar Kundu, Dr. Mohammed Arif, Dr. Kempegowda Mantelingu, and Dr. Gopinath Kodaganur Srinivasachar has been licensed to one company.

Patent Applications Filed (April 2017 - March 2018)

Indian Patent Applications

Inventors	Unit	Territory	Application Number	Date of Filing
Govindaraju Thimmaiah	NCU	India (Prov)	201741020511	12-06-2017
Chintamani Nagesa Ramachandra Rao, Claudia Felser, Catherine Ranjitha Rajamathi, Nitesh Kumar, Uttam Gupta	NCU & CPMU	India (Prov)	201811005625	14-02-2018
Sarit Sekhar Agasti, Ranjan Sasmal, Nilanjana Das Saha	NCU	India (Prov)	201741029226	17-08-2017
Tapas Kumar Maji, Syamantak Roy	CPMU	India (Prov)	201741040351	13-11-2017
Tapas Kumar Kundu, Muthusamy Eswaramoorthy, Rajkumar Banerjee, Chandra Kumar Elechelawar, Sarmistha Halder Sinha	MBGU & CPMU	India (Prov)	201841009113	13-03-2018

International Phase Patent Applications Filed Under PCT

Title of the Invention	Inventors	Unit	Territory	Application Number	Date of Filing
A polymer network, method for production, and uses Thereof	Jayanta Haldar, Jiaul Hoque	NCU	PCT	PCT/ IN2017/050311	28-07-2017
Shape tailored ordered PdCu ₃ nanoparticle surpassing the activity of state-of-the-art fuel cell catalyst	Sebastian Chirambatte Peter, Rajkumar Jana, Saurav Chandra Sarma	NCU	PCT	PCT/ IN2018/050167	26-03-2018
Palladium based selenides as highly stable and durable cathode materials In fuel cell for green energy production	Sebastian Chirambatte Peter, Saurav Chandra Sarma	NCU	PCT	PCT/ IN2018/050168	26-03-2018

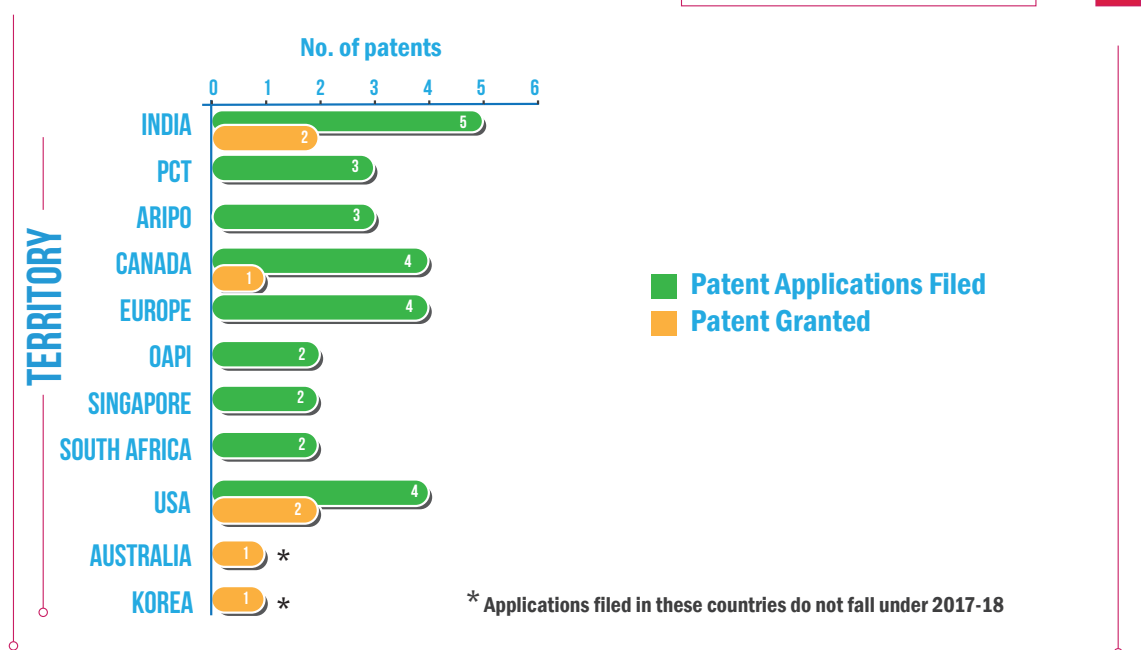
National Phase Patent Applications Filed under PCT

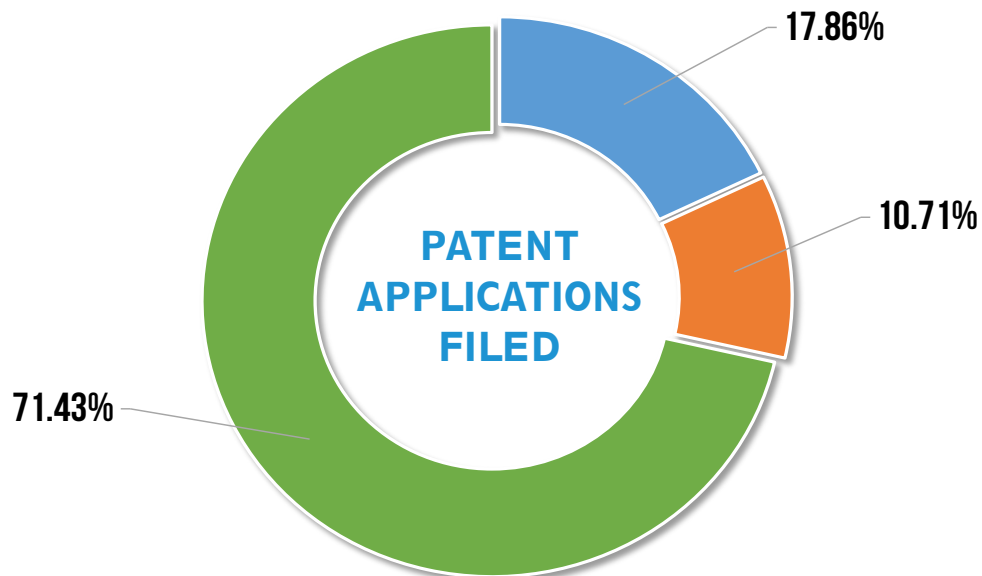
Title of the Invention	Inventors	Unit	Territory	Application Number	Date of Filing
Compounds as DNA probes, methods and applications thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy	NCU	ARIPO	Not Assigned	23-03-2018
			USA	15/755,175	26-02-2018
			S. Africa	2018/01947	23-03-2018
			Singapore	11201801522R	26-02-2018
			Canada	2,996,665	26-02-2018
			Europe	16770984.9	26-02-2018
			OAPI	Not Assigned	26-02-2018
Compounds as stimuli-responsive probes, methods and applications thereof	Govindaraju Thimmaiah, Nagarjun Narayanaswamy	NCU	ARIPO	Not Assigned	23-03-2018
			Canada	2,996,666	26-02-2018
			Europe	16770555.7	26-02-2018
			OAPI	Not Assigned	26-02-2018
			Singapore	11201801523S	26-02-2018
			S. Africa	2018/01948	23-03-2018
			USA	15/755,283	26-02-2018
Glycopeptides and uses thereof	Jayanta Haldar, Yarlagadda Venkateswarlu	NCU	Canada	2,972,276	23-06-2017
			Europe	15843087.6	26-06-2017
			USA	15/539777	26-06-2017
Glycopeptides conjugates and uses thereof	Jayanta Haldar, Yarlagadda Venkateswarlu	NCU	Canada	2,975,975	04-08-2017
			Europe	16718913.3	04-09-2017
			USA	15/549,086	04-08-2017

Patents Granted (April 2017 - March 2018)

Title of the Invention	Inventors	Unit	Territory	Patent Number	Granted on
A metal nanosponge and a process thereof	Eswaramoorthy Muthusamy, Saikrishna Katla	CPMU	India	282705	24-04-2017
Self assembly of naphthalene diimide derivatives and process thereof	Govindaraju Thimmaiah, Manjula Basavanna Avinash, Makam Pandeewar	NCU	India	293450	27-02-2018
Cationic antibacterial compound, composition, method and articles thereof	Jayanta Haldar, Yarlagadda Venkateswarlu, Akkapeddi Padma	NCU	Korea	10-1816228	02-01-2018
			Canada	2855753	22-08-2017
			USA	Notice of Allowance received on : 23-01-2018	Notice of Allowance received on : 23-01-2018
Antimicrobial compounds, their synthesis and applications thereof	Jayanta Haldar, Chandradhish Ghosh, Gautham Belagula Manjunath, Padma Akkapeddi	NCU	Australia	2013365769	02-03-2018
			USA	9,783,490 B2	10-10-2017

PATENTS 2017-2018





- INDIA - 5 APPLICATIONS
- INTERNATIONAL PHASE (PCT) - 3 APPLICATIONS
- NATIONAL PHASE (FOREIGN COUNTRIES) - 20 APPLICATIONS

TOTAL IPR OVER THE YEARS UNTIL 2018



UNIT MEMBERS

Dean, Research & Development

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

Technical Officer Gr. I

A.V. Nagarathnamma, M Sc

Technical Staff

Yadati Rajyalakshmi, B E

FACULTY PUBLICATIONS

PUBLICATIONS 2017*

9 Research Units

53 Faculties

277 Publications

2017*

277

TOTAL PUBLICATIONS



5.15

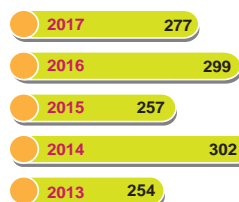
AVERAGE IMPACT FACTOR

246

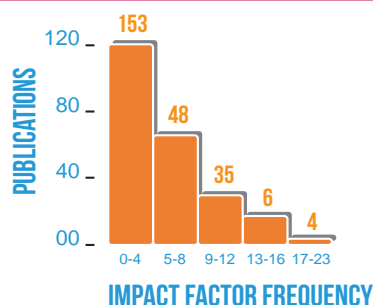
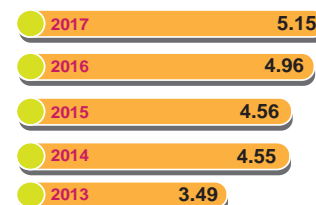
TOTAL JOURNAL ARTICLES IN IMPACT FACTOR JOURNALS

5-YEAR ANALYSIS

NUMBER OF PUBLICATIONS



AVERAGE IMPACT FACTOR OF PUBLICATIONS

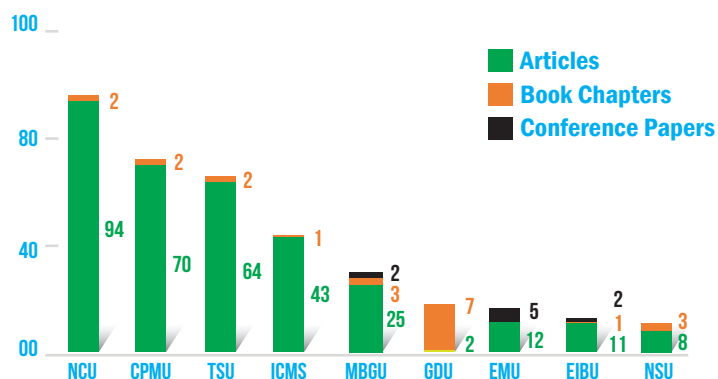


FREQUENCY DISTRIBUTION OF PUBLICATIONS WITH IMPACT FACTOR

* Publications in this report has been taken for the completed calendar year i.e., January - December 2017

PUBLICATIONS BY UNITS

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), Neuroscience Unit (NSU), New Chemistry Unit (NCU), and Theoretical Sciences Unit (TSU).



STARTUPS BY JNCASR FACULTY

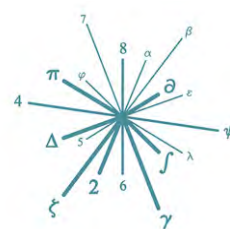
Commercialization of 'high risk-high potential' technologies by spinning them off from academia is one of the successful models, and hence being practised by many academic institutes across the globe. JNCASR, through its Technical Research Centre (TRC), is among very few Indian public-funded R&D institutes, which have taken this pioneering, but complex, initiative to escalate its technology commercialization efforts for the global markets. This is in line with Government of India's policies like Start-up India, Make-in-India, Digital India and alike. JNCASR

continues to scale-up its R&D commercialization activities through spin-offs systemically and systematically.

As part of such efforts, two start-up companies spun-off from JNCASR, namely Sankhyasutra Labs Pvt. Ltd. and VNIR Biotechnologies Pvt. Ltd., both created by JNCASR's faculty members and researchers. Sankhyasutra Labs is the first start-up created at JNCASR, and was cofounded by Prof. Santosh Ansumali, Engineering Mechanics Unit, JNCASR with support from JNCASR.

SANKHYASUTRA

Sankhyasutra claims to be the only company of its kind in India (if not in Asia), which provides high-end Computational Fluid Dynamics (CFD) and simulation solutions for complex product development problems with applications ranging from precision engineering to aerospace to defense to cement plants, to name a few. Within a short span of time, Sankhyasutra has made substantial progress in terms of garnering investments, building its core team (~15 employees are currently on-board with full time CEO and COO), securing orders from clients in the order of magnitude that is sufficing



Sankhya Sutra Labs

sustenance of the company at least for next few years, and building a robust sales pipeline for future business. Sankhyasutra is working to raise Series A investment to bolster its business expansion. JNCASR has providing all possible support to Sankhyasutra in its journey towards global commercialization of inventions developed at JNCASR.

VNIR BIOTECHNOLOGIES PVT LTD

Vnir Biotechnologies Pvt. Ltd. is the second spin-off company of JNCASR, co-founded by two of faculty members of JNCASR, Prof. T. Govindaraju, New Chemistry Unit and Dr. Meher Prakash,



Molecular Biophysics Group, JNCASR. Vnir is based on small fluorescence probes/ molecules, developed at JNCASR, with applications in biological imaging and diagnostics. The start-up company is set to commercialize about 6-10 NIR (near-infrared) fluorescence probes for addressing some of the unmet market needs such as reactive oxygen species detection, live cell imaging or safer alternatives for high throughput applications like real-time PCR. Also, Vnir has plans to develop point-of-care devices to diagnose communicable diseases like malaria

and non-communicable diseases like Alzheimer's. Vnir is already an incubatee of an accredited incubator at Bangalore, structured first few angel investments, designed and commenced beta marketing campaigns, hired its first set of employees, and made significant progress in other techno-commercial fronts as well. The start-up is currently busy in orchestrating activities like setting-up manufacturing facility, sales and distribution channels etc. JNCASR has been helping the confounders in all possible ways.

Two of JNCASR's start-ups have been selected as Karnataka's top 100 start-ups: Aimed to trigger the start-up ecosystem in the state to the next level, the Government of Karnataka announced shortlisted 100 start-up winners' list, out of 1700 applications it received under its large entrepreneurship platform, called ELEVATE 100

in August 2017. Breathe Applied Sciences Pvt. Ltd and Vnir Biotechnologies Pvt. Ltd – two of JNCASR supported start-ups based on JNCASR's inventions - have been selected among the top 100 start-ups of Karnataka, and received seed funds.



FELLOWSHIPS & OUTREACH

One of JNC's mandated roles is to increase scientific awareness and contribute to the quality of science education at the school and college levels in the country. The community attempts to do that through various outreach programmes and methods. These are conducted by a dedicated Unit, the Education Technology Unit, and under a full-fledged Fellowship and Extensions Programme. Both together constitute the Centre's outreach arm.

SECTION - 04

FELLOWSHIPS AND EXTENSION ACTIVITIES

JNCASR considers effective science outreach, education and awareness programmes to be an important component of its yearly activities. The Centre has dedicated programmes that cater to a very diverse audience, from school students and teachers, to scientists engaged in R&D in Central Universities and Laboratories across India. While the unit called the Education Technology Unit (ETU) conducts activities mainly for school students and teachers, the Centre's various fellowship and extension programmes constitute the other arm of its outreach. These programmes are aimed at promoting research amongst the country's youth and contributing to the quality of skilled manpower in the sciences.

The major highlights from the Fellowship and Extension programmes for the year 2017-18 are as follows:

Summer Research Fellowship Programme (SRFP)

The Summer Research Fellowship Programme or SRFP is a DST-sponsored two-month long fellowship typically awarded to an average of 50/60 meritorious undergraduate/Master's students from the science stream every year. It gives them the opportunity to work on a research project over the summer with one of JNC's faculty or other faculty from national institutes under the programme. The programme was instituted in 1990 and attracts around 2000 applications annually. In SRFP 2017, 1396 applications were received, of which 95 students availed the scholarship and received research oriented training in various areas of Physics, Chemistry, Biology or Engineering at institutes in Bangalore, and elsewhere in the country. The advertisement for SRFP 2017 is announced on the JNCASR website and is widely circulated amongst colleges across the country.

Visiting Fellowship Programme

The Visiting Fellowship Programme is meant for faculty or R&D scientists from Central Universities and Laboratories in India. By this fellowship, scientists visit one of the Centre's units and are associated with a

particular faculty during a short period while pursuing research. 15 out of a total 17 candidates were selected for the Centre's Visiting Fellowship in 2017-18. They will be attached to faculty from the following units CPMU, EIBU, MBGU, NCU, NSU, and TSU

Project-oriented Chemistry Education (POCE) and Project-oriented Biology Education (POBE) programmes

The Centre's Project-oriented Chemistry Education (POCE) and Project-oriented Biology Education (POBE) programmes are for first-year undergraduate Chemistry and Biology students by which they visit JNC during summer over the course of three years while attending special lectures and taking part in laboratory projects. The programme aims to enhance the quality of science training they receive during their undergraduate years giving them more exposure to a research environment. Additionally, students who complete the programme with outstanding performance get an opportunity to pursue their M.S.-Ph.D. education at JNCASR following a successful interview. To expand the reach of POCE and POBE, the Centre advertises the programmes in many newspapers, on its website and also circulates it among colleges in small towns. This year 10 students out of 240 applicants were selected under POBE and 11 for POCE, out of 290. 10 students from POCE 2015-17 batch and 9 from POBE 2015-17 batch completed the programme successfully with Diplomas in Chemistry and Biology awarded to them at the end of their three years with JNC.

Student Buddy Programme

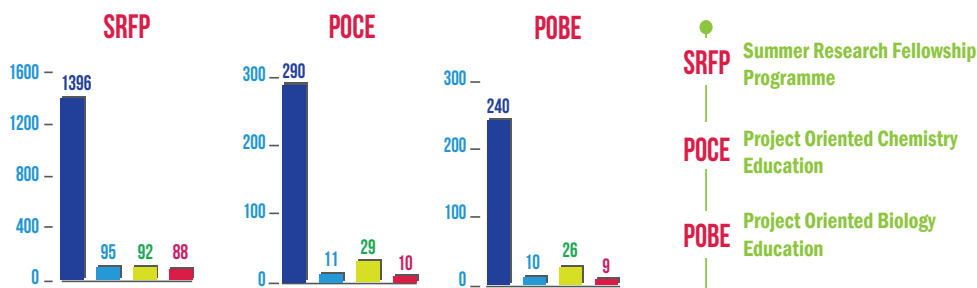
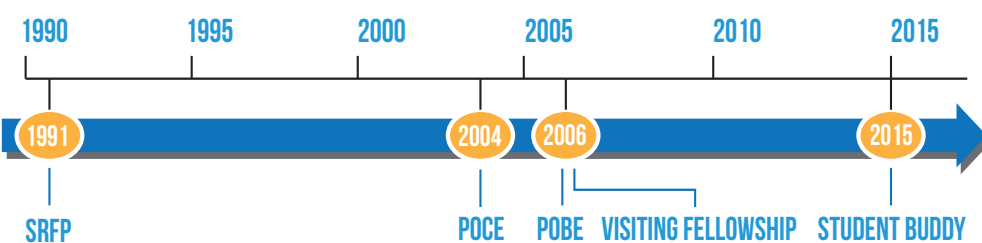
JNCASR also has day-long science orientation programmes meant for school students. The Centre has begun a novel Student Buddy Programme in 2015 by which high school students from Class XI & XII are paired with student researchers at JNC to expose them to life in research over a day. 101 students from JNV Belagavi, JNV Udupi, JNV Mundugod and KV MEG Bengaluru participated in the programme during the year 2017.

SCIENCE OUTREACH FELLOWSHIPS AND EXTENSION PROGRAMMES

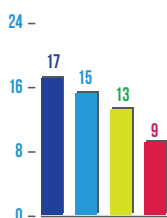
2017-2018

PROGRAMMES

TIME-LINE OF ESTABLISHMENT OF DIFFERENT PROGRAMMES



VISITING FELLOWSHIP PROGRAMME



STUDENT BUDDY



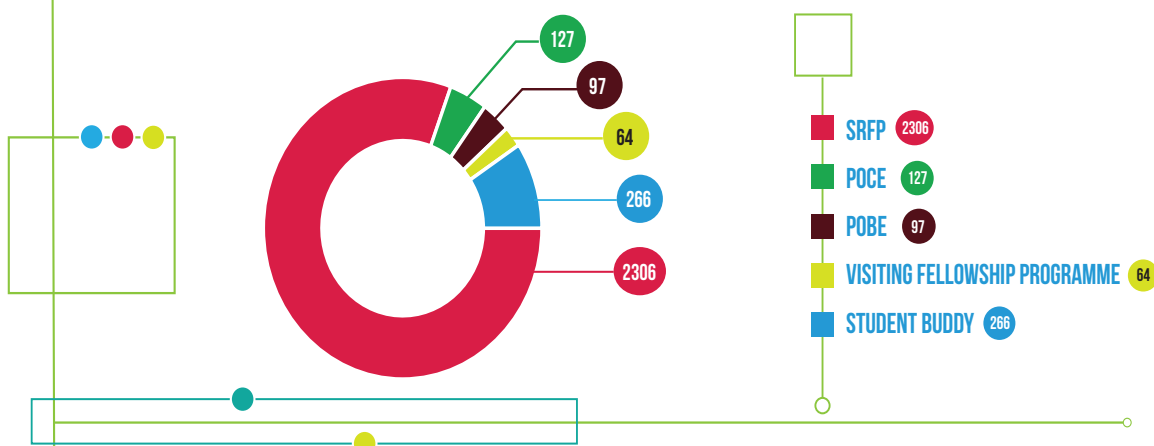
SRFP Summer Research Fellowship Programme

POCE Project Oriented Chemistry Education

POBE Project Oriented Biology Education

- No. of applications received
- No. of candidates offered
- No. of candidates participated
- No. of candidates completed

TOTAL CANDIDATES TRAINED FROM INCEPTION TILL MARCH 31, 2018



EDUCATION

TECHNOLOGY UNIT

This unit was set up in 1996. Since then, it has been working towards improving science education in schools and colleges by developing learning and teaching materials. It also conducts lecture programme/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 Teachers Award

The unit organised a teacher-students' programme on June 30, 2017, where teachers who have made significant contributions in teaching were awarded 'Outstanding Science Teachers' awards. Shri Channappa K.M. and Dr. Yogendra Kumar Kothari received the 2016 prize for Outstanding Science Teacher. These awards were sponsored by the CNR Rao Education Foundation.

Programme in Physics/Chemistry/Biology for Students

Between July 2017 and December 2017, the unit conducted two sessions each of the Programme in Physics for Students, Programme in Chemistry for Students, and Programme in Biology for Students. More than 400 students participated in each of these programmes.

Student Mentoring Programme

The Student Mentoring Programme was held twice at the CNR Rao Hall of Science between May 1-May 31, 2017 and 23 September – 30 October 2017. This programme was started in May 2016 and is organised by the CNR Rao Education Foundation in association with the CNR Rao Hall of Science and ETU. Each session consisted of two batches with 8 students (Class XI and XII) in each batch. Under this programme, a team of faculty and student volunteers at JNCASR interacted as mentors. The participants and their student mentors attended interactive sessions along with regular classes which spanned different science subjects. They also performed experiments and were given additional study material. This allows students to witness how research is performed in labs and prepares them for a career in science.

Chetana Programme

The programme was jointly organized by the CNR Rao Hall of Science, ETU, and the Department of Information Technology, Biotechnology and Science & Technology, Karnataka Govt. An initiative of Karnataka Govt. is focused towards girls who are SSC toppers and exposes them to the latest advances in science and technology. This initiative is aimed to encourage them to take up science as a career. During the 10-day workshop, the girl students attend lectures on Physics, Chemistry, Biology, and basics of computers. They also conduct experiments and visit different labs. Twenty-five students participated in the Chetana Winter School, which was conducted from December 15–22, 2017 at JNCASR.

Parikrma Festival of Science

The first Parikrma Science festival was organised by the unit in 2016-17 and was met with great success. In 2017-18, it was organized for a second time during January 4 and 5, 2018 at the CNR Rao Hall of Science, JNCASR. The festival was conducted by the CNR Rao Hall of Science and ETU in association with Parikrma – an NGO that educates street and slum children and runs multiple schools and a college for these children. The theme of the festival this year was 'Air', and it was attended by 150 students and 50 teachers from 50 different schools along with 30 guests, and 20 volunteers.

Science Outreach Programme

A science outreach programme was organised between May 6–8, 2017 by Himalayan Gram Vikas Samiti which was supported by CNR Rao Hall of Science. It was attended by 150 students (Class X, XII) and several faculty members of JNCASR participated, delivered lectures, and demonstrated experiments during this programme.

CNR Rao Education Foundation in association with School Chandan, Laxmeshwar, Gadag conducted another science outreach programme from February 28, 2018 to March 2, 2018. A total of 150 students (classes X and XI) and teachers attended and interacted with the JNCASR faculty during several lectures and demonstrations conducted as a part of this programme.

SCIENCE OUTREACH EDUCATION

2017-2018 TECHNOLOGY UNIT

10 PROGRAMMES ORGANIZED

1715 PARTICIPANTS

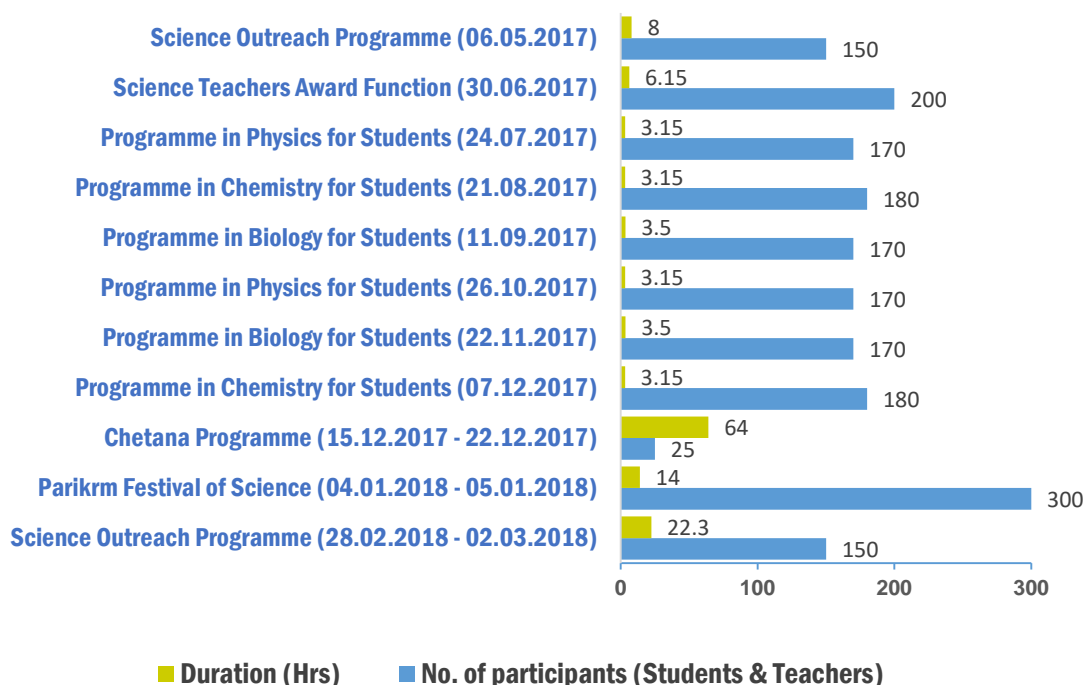
STUDENTS AND TEACHERS

VENUES

Himalayan Gram Vikas Samiti
Conference Hall, Gangolihat

Madan Mohan Malaviya Amphitheatre,
CNR Rao Hall of Science, JNCASR

PROGRAMMES



2017 THE STUDENT MENTORING PROGRAMME

8 Students/ Batch

Batch 1: May 1-May 31, 2017

Batch 2: September 23 - October 30, 2017

Venue: CNR Rao Hall of Science, JNCASR

Programme Sponsored by the CNR Rao Education Foundation

Organized by ETU and CNR Rao Hall of Science

Conducted by Faculty and Students of JNCASR

“

Fifty years is a very long period. The first 30–35 years – we could call this period as one when India equipped itself to face important problems. For example, we built institutions such as the IITs and the National Laboratories... We need much better infrastructure facilities and we must work on more difficult problems. Unfortunately, we have been used to working on problems that are somewhat repetitive. If we want to be at the cutting edge, we have to be innovators and originators

- Prof. CNR Rao

”

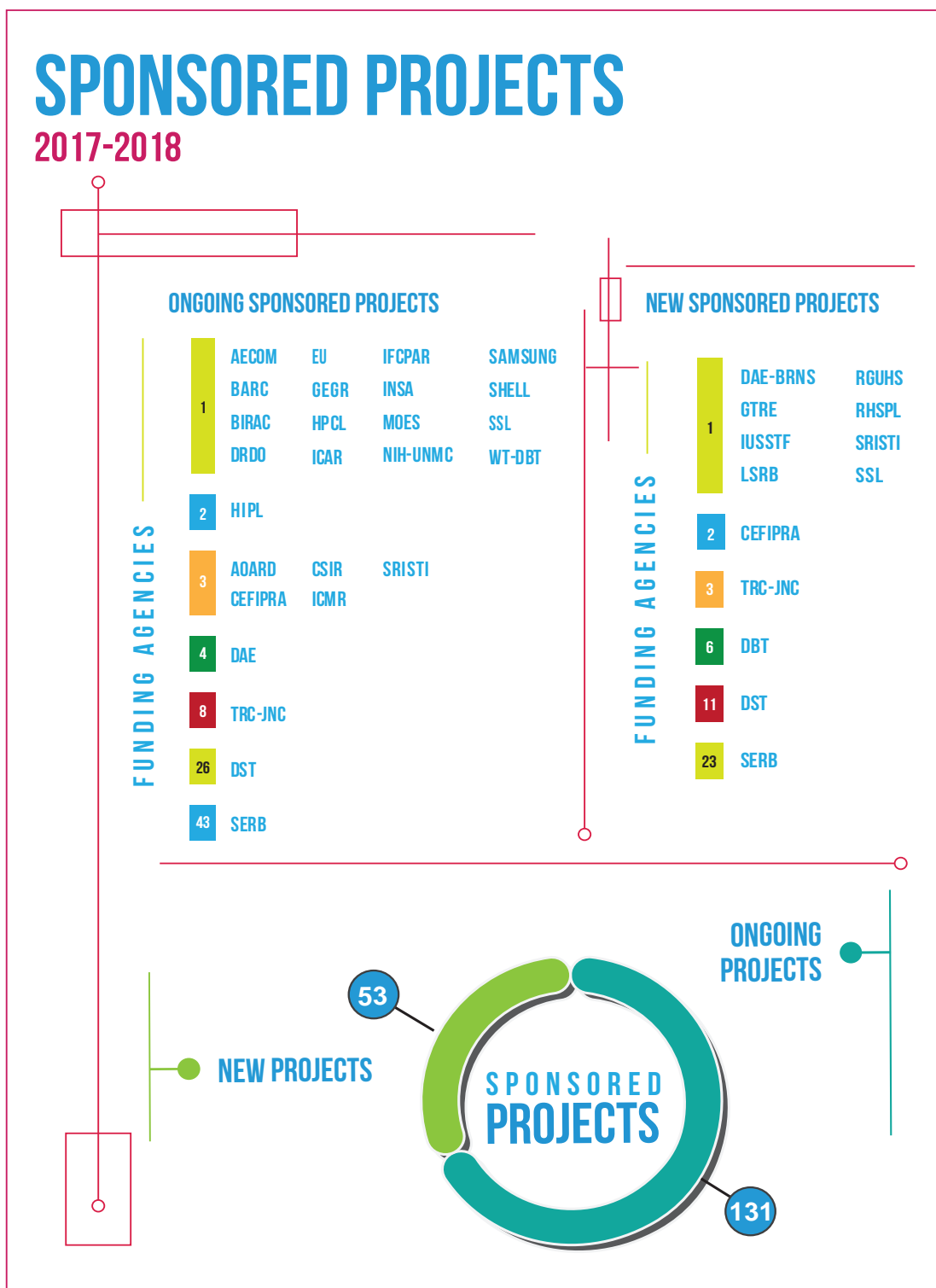
FUNDING & FACILITIES

World-class facilities and infrastructure are the backbone of the state-of-the-art research. Since its inception JNCASR has provided its scientists the latest in both, with constant upgradation of its facilities to keep up with the ever-diversifying research needs of the community.

SECTION - 05

SPONSORED PROJECTS

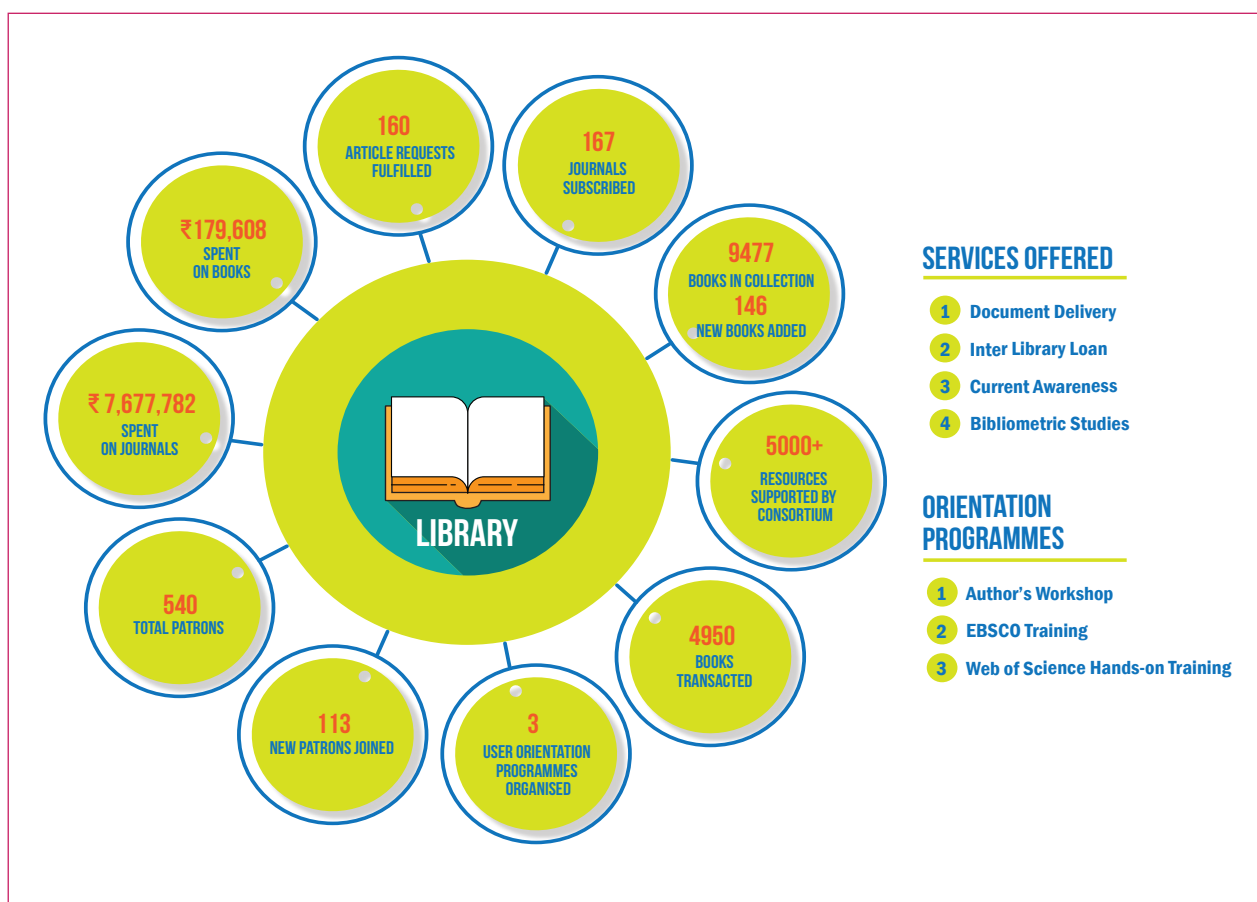
An important criterion of excellence for a research organisation is the number and amount of extra-mural funding in the form of sponsored projects the institute receives. JNCASR and its faculty members have been prolific in number of projects and the grant that they have received. In 2017-18, 53 new projects from industries, national as well as international funding bodies have started. Currently, there are 131 ongoing projects in various stages of their duration.





The JNCASR Library has a collection of 9477 books and access to 5000+ scientific journals. It is equipped with network scanners and copiers, Wi-Fi and Desktop PCs for browsing online journals and a library catalogue. During the past year multiple journal articles were procured on request from faculty and students under document delivery services from libraries abroad and from CSIR and

DST Institutions across the country or neighbouring libraries within the city. A total of 160 such article requests have been fulfilled through inter-library cooperation. During the year 2017-18, the library has added 146 books to its collection of which 11 are e-books. The Library currently subscribes to 167 journals of which 163 are online, and provides access to 5000 more through the National Knowledge Resource Consortium or the NKRC. It also carries subscriptions to the latest database and other online tools, such as Scopus, Web of Science, SciFinder & Cambridge Crystallographic Data Centre, Grammarly, to help the Centre's scientists access the most up-to-date information from the scientific community worldwide. It subscribes to the Derwent Innovation Index to enable better-informed patent searches before patent filing. Apart from providing these facilities, the Library also organises regular orientation programmes for its users. In 2017-18 three such programmes were held to train participants on writing skills, Web of Science and EBSCO usage.



STAFF MEMBERS

Sr Library-cum-Information Officer

Nabonita Guha

Library cum Information Assistant

Senthil Kumar N

Sr Library cum Information Assistants (Gr.I)

Nandakumari E, Nagesh Hadimani

Helper

Rajeeva J

COMPUTER LABORATORY (COMPLAB)

The Complab facility at JNCASR has undertaken the following projects during the period 2017 - 2018: network upgradation, JNCASR web page upgrade, mail migration to open source software, addition of storage space to the central storage facility, installation of secure and enhanced Wi-Fi connections across JNC campus and setting up of an enhanced network management system for improved network performance.

During the reporting period, the existing network in JNCASR campus has been upgraded with high speed Gigabit switches along with optical fiber cables which can give high speed Local Area Network (LAN)- up to 10Gbps- Intranet connectivity. Internet bandwidth has been increased from 330 Mbps to 450 Mbps using a combination of service providers, i.e., 100 Mbps from National Knowledge Network (NKN), 450 Mbps from Sify and 80 Mbps of RF from D-Voice. With this enhanced Internet bandwidth, each person on campus now has 10 Mbps Internet connectivity from throughout the campus. New storage space has been added to the existing 22 TB central storage facility. A new Veeam Deduplication software has also been installed in the facility to store more data. JNC mail has been migrated from the Network Edition paid ZIMBRA mail server to Open Source ZIMBRA mail server along with OS upgradation for unlimited account space. To increase connectivity through Wi-Fi, a high speed Wireless network with 802.11 b/g/n/ac has been installed. The Campus is currently covered with 70 Instant Access Points. Each Access Point is capable of giving 350Mbps to 500Mbps network connectivity with 802.11 b/g/n/ac thus improving Wi-Fi connectivity. Further, to secure the Wi-Fi connection, it has been fully configured with High-End security modules, and an authentication procedure via the Complab's centralized LDAP and CPPM Server has been put in place for Wi-Fi users and visitors. Towards improving

network performance and providing continuous network connectivity across campus, an efficient network management system has been set up that will ensure security and redundancy of servers and other interconnecting devices like core switch, firewall etc. All critical network components have been put on Active-Active redundancy mode. Progress have been made towards upgradation of the JNCASR website.

CompLab MEMBERS

Head, CompLab

Santosh Ansumali, Ph.D.

Consultants

Chandan N,
Udhaya Kumar S

Trainee

Sathish Kumar P

Onsite Engineers

Rajeev Ranjan
Vikas Mohan Bajpai

NEW RESEARCH FACILITIES

Chemistry and Physics of Materials Unit (CPMU)

X-Ray diffractometer; Gemini SEM 500; TPD Unit for Catalyst Evaluation, Gas Sampling Valve & Chromatography Data Acquisition Unit; Monowave 200 Microwave systems reactor; Reaction ion etching system.

Engineering Mechanics Unit (EMU)

IDTO Series camera motion PRO timing hub.

International Centre for Materials Science (ICMS)

Leica SP8 confocal laser scanning microscope; Shimadzu GCMS with digital probe.

Molecular Biology and Genetics Unit (MBGU)

Microscope system for automated digitization of specimens; Thermo fisher varioskan LUX multimode plate reader; Countess II FL Cellcounter; DV wide-held Fluorescence Microscope.

New Chemistry Unit (NCU)

Ultrafast Purification LCMS; DNA/LNA/RNA synthesizer; Agilent 1260 infinity preparative LC; DH3Rheometer with accessories; Agilent 490 Micro GC system; Battery test station & electrochemical workstation.

Technical Research Centre (TRC)

3D laser lithography system.



2017-18 has been an excellent period for JNCASR. With continued support from the Department of Science and Technology, the Centre looks forward to pursuing its mandate with greater vigour.

FINANCIAL STATEMENTS

Financial statements of the assessment year 2018-19 are presented in this section

SECTION - 06

AUDITOR'S REPORT

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

Report on the Financial Statements

We have audited the financial statements of "Jawaharlal Nehru Centre For Advanced Scientific Research" Jakkur, Bangalore 560 064, which comprise the Balance Sheet as at 31st March 2018, the Statement of Income & Expenditure Account, Receipts and Payments for the year then ended and a summary of significant accounting policies and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of the financial statements. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation of the financial statements that are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of the accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion on the financial statement.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the said accounts give the information required & give a true and fair view in conformity with the accounting principles in India.

- 1) In the case of the Balance Sheet, of the state of affairs of Jawaharlal Nehru Centre for Advanced Scientific Research, as at 31st March 2018.

- 2) In the case of Income & Expenditure Account, of the Excess of Expenditure over Income for the year ended on that date.

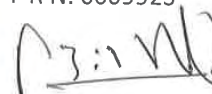
We further report that:

- a) The Balance Sheet & Income & Expenditure Account dealt with by this report, are in agreement with the books of Accounts.
- b) In our opinion, proper books of accounts as required 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 prepared in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India subject to the following observations:
- i) Non-Provisions of accrued liability in respect of leave encashment which is not conformity with the Accounting Standard 15 (Accounting for retirement benefits in the financial statements of Employees) issued by the Institute of Chartered Accountants of India.
- ii) The Institute has to regularize the contributions / grants received during the year from foreign funding agencies, as the registration granted to the institution under the provisions of Foreign Contribution Regulation Act, 2010 has been withdrawn w.e.f 19th June, 2015. The Foreign contributions received thereafter require approval from the authorities concerned.

Place: Bangalore
Date : 27.07.2018



For B R V GOUD & CO.,
Chartered Accountants
F R N. 000992S



(A B SHIVA SUBRAMANYAM)
PARTNER
M. No. 201108

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
BALANCE SHEET AS AT 31ST MARCH 2018**

Amount in Rs.

Description	Schedule No.	Current year 2017-18	Previous year 2016-17
Liabilities			
Capital/corpus fund	1	1,99,85,84,695	1,61,22,89,974
Reserves & surplus	2	1,38,11,636	7,51,02,333
Earmarked and endowment funds	3	1,19,70,19,351	1,18,20,81,261
Secured loans and borrowings	4	0	0
Unsecured loans and borrowings	5	0	0
Deferred credit liabilities	6	0	0
Current liabilities and provisions	7	14,96,93,452	9,48,29,252
Total		3,35,91,09,134	2,96,43,02,820
Assets			
Fixed assets	8	1,73,46,54,311	1,61,22,89,974
Investments-From earmarked/endowment funds	9	22,82,55,463	27,39,39,169
Investment - Others	10	12,08,79,200	7,25,00,000
Current assets, loans, advances etc.	11	1,27,53,20,160	1,00,55,73,677
Total		3,35,91,09,134	2,96,43,02,820
Significant accounting policies	24		
Contingent liabilities & notes on accounts	25		

Schedules 1 to 25 are integral part of accounts

**For Jawaharlal Nehru Centre for
Advanced Scientific Research**

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



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

Place : Bangalore
Date : 27/07/2018.

[Signature]
Sampad Patra
Accounts Officer

[Signature]
Prof. V. Nagaraja
President

[Signature]
Joydeep Deb
Administrative Officer

**JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2018**

Amount in Rs.

Description	Schedule No.	Current year 2017-18	Previous year 2016-17
Income			
Income from sales/services	12	0	0
Grants/subsidies	13	76,41,52,000	73,98,00,000
		76,41,52,000	73,98,00,000
Less: Fixed assets acquired during the year from DST core grant		21,68,63,612	14,51,97,219
		54,72,88,388	59,46,02,781
Fees/subscriptions	14	49,75,177	32,81,876
Income from investments	15	0	0
Income from royalty, publication, licence fee etc.	16	1,42,772	2,96,760
Interest earned	17	76,23,511	96,94,181
Other income	18	1,04,59,695	2,22,76,901
Increase/decrease in stocks	19	0	0
Total (A)		57,04,89,543	63,01,52,499
Expenditure			
Establishment expenses	20	39,67,78,829	32,00,05,896
Other administrative expenses etc.	21	23,49,64,714	23,54,99,813
Expenditure on grants, subsidies etc.	22	0	0
Interest & bank charges	23	9,950	16,592
Depreciation (Net total at the year end-Corresponding to sch.-8)		10,69,15,408	0
Total (B)		73,86,68,902	55,55,22,301
Balance being excess of income over expenditure (A-B)		-16,81,79,358	7,46,30,198
- Prior period expenses		26,747	14,00,237
Reserve & surplus - Balance brought forward		7,51,02,333	18,72,373
Balance being surplus/deficit carried to reserves and surpluses		-9,31,03,772	7,51,02,333
Significant accounting policies	24		
Contingent liabilities & notes on accounts	25		

Schedules 1 to 25 are integral part of accounts

**For Jawaharlal Nehru Centre for
Advanced Scientific Research**

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



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

Sampad Patra
Accounts Officer

Prof. V. Nagaraja
President

Joydeep Deb
Administrative Officer

Place : Bangalore
Date : 27/07/2018.

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2018

Description	2017-18 Amount in Rs.	2016-17 Amount in Rs.
SCHEDULE 1- Capital/Corpus Fund :		
A: Capital		
Balance as at the beginning of the year	1,61,22,89,974	1,56,74,11,558
Add : Fixed assets acquired during the year from core grant	21,68,63,612	14,51,97,219
Add : Fixed assets acquired during the year from other funds	1,24,16,134	0
Sub total	1,84,15,69,720	1,71,26,08,778
Less : Depreciation for the current year	10,69,15,408	10,03,18,804
Total (A)	1,73,46,54,311	1,61,22,89,974
B: Corpus fund		
Opening balance	22,81,50,335	19,93,71,034
Additions during the year	1,69,10,767	1,23,83,639
Funds-Income from investments made	1,84,49,337	1,60,94,996
Interest from savings bank - Endowment account	4,20,267	3,01,137
Sub total	26,39,30,707	22,81,50,806
Less : Funds-utilisation/expenditure incurred	323	471
Total (B)	26,39,30,384	22,81,50,335
Total (A+B)	1,99,85,84,695	1,84,04,40,309
SCHEDULE 2- Reserves and surpluses :		
General reserve:		
Surplus/deficit in income and expenditure account	-9,31,03,772	7,51,02,333
Capital reserve:		
Depreciation reserve	10,69,15,408	0
TOTAL	1,38,11,636	7,51,02,333



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2018

SCHEDULE 3- Earmarked and endowment funds:	FUND - WISE BREAK UP					TOTAL	
	Scheme Funds	Kiran Mazumdar-Shaw- MBSRL	Chemical Heritage Exposition	Endowment		2017-18	2016-17
				Others	Others		
A) Opening balance of the funds	87,23,67,255	0	0	8,15,63,672		95,39,30,926	62,23,25,439
B) Additions to the funds:							
i. Donations/grants	63,24,20,503	1,50,00,000	45,10,000	20,00,000		65,39,30,503	74,12,46,224
ii. Income from investment made on account of funds	7,56,61,755	0	0	49,71,303		8,06,33,058	6,53,86,822
iii. Others	40,86,387	0	0	0		40,86,387	78,76,424
Total (A+B)	1,58,45,35,900	1,50,00,000	45,10,000	8,85,34,974		1,69,25,80,874	1,43,68,34,910
C) Utilisation / expenditure towards objectives of funds							
i. Capital expenditure							
- Fixed assets	17,39,52,988	1,24,10,767	5,367	0		18,63,69,122	25,57,75,236
- Others	0	0	0	0		0	0
Total	17,39,52,988	1,24,10,767	5,367	0		18,63,69,122	25,57,75,236
i. Revenue expenditure.							
- Salaries, wages & allowances etc	8,28,58,589	0	0	0		8,28,58,589	5,85,42,183
- Other administrative expenses	22,29,64,568	0	0	33,69,244		22,63,33,812	16,85,86,565
Total	30,58,23,157	0	0	33,69,244		30,91,92,401	22,71,28,748
Total (C)	47,97,76,145	1,24,10,767	5,367	33,69,244		49,55,61,523	48,29,03,984
Net balance as at the year end (A + B - C)	1,10,47,59,755	25,89,233	45,04,633	8,51,65,730		1,19,70,19,351	95,39,30,926



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Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2018

Description		2017-18 Amount in Rs.	2016-17 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	2,78,67,188		
b. Others - EMD/security deposit	44,36,675	3,23,03,863	1,91,79,871
2. Advances received :		16,13,035	17,60,550
3. Statutory liabilities :		1,54,16,289	17,51,094
4. Other current liabilities:		3,88,11,749	6,92,50,478
Total (A)		8,81,44,936	9,19,41,993
B. Provisions			
7th pay commission arrears		5,82,07,135	0
Unpaid stipend/salary		33,41,381	28,87,259
Total (B)		6,15,48,516	28,87,259
Total (A+B)		14,96,93,452	9,48,29,252



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH , JAKKUR POST, JAKKUR, BANGALORE 560 064
Schedules forming part of the accounts for the year ended 31st march 2018

SCHEDULE B - FIXED ASSETS

DESCRIPTION	GROSS BLOCK				DEPRECIATION				NET BLOCK	
	Cost/Value as at beginning of the year 2017-18	Additions during the year 2017-18	Dedn. during the year 2017-18	Cost/value at the end of the year 2017-18	Depre. as at the beginning of the year 2016-17	Depre. during the year 2017-18	On Dedn. during the year 2017-18	Total upto the year end 2017-18	as at the Current year - end 2017-18	as at the Previous year - end 2016-17
Land :										
Free hold land	1,77,15,351	0	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	3,15,64,764	14,31,686	0	3,29,96,450	5,48,37,041	5,62,68,727
Hostel building	1,56,60,055	0	0	1,56,60,055	57,91,109	2,55,259	0	60,46,368	96,13,687	98,68,946
Advanced material research lab	2,59,30,339	0	0	2,59,30,339	59,01,613	4,22,665	0	63,24,278	1,96,08,061	2,00,28,726
Animal house	67,68,701	0	0	67,68,701	24,69,612	1,10,656	0	25,80,268	42,08,433	43,19,089
Staff housing	43,19,353	0	0	43,19,353	12,33,234	70,405	0	13,03,639	30,15,714	30,86,119
ETU building	30,91,348	0	0	30,91,348	6,60,518	50,389	0	7,10,907	23,80,441	24,30,830
Other buildings like extn. of hostel , college etc	1,18,83,626	0	0	1,18,83,626	23,74,811	1,93,703	0	25,68,514	93,15,112	95,08,815
Nano science lab	70,42,909	0	0	70,42,909	11,47,993	1,14,799	0	12,62,792	57,80,117	58,94,916
Engineering & mechanical lab	74,26,272	0	0	74,26,272	12,07,359	1,21,048	0	13,28,407	60,97,865	62,18,913
Dining hall & kitchen block	1,24,04,330	11,55,261	0	1,35,59,591	19,22,966	2,21,021	0	21,43,987	1,14,15,604	1,04,81,364
Hostel phase II	1,95,52,377	0	0	1,95,52,377	31,87,038	3,18,704	0	35,05,742	1,60,46,635	1,63,65,339
Lecture hall & academic block	96,36,712	0	0	96,36,712	15,53,180	1,57,078	0	17,10,258	79,26,454	80,83,532
Intl. centre for material sciences	5,01,48,316	0	0	5,01,48,316	73,79,622	8,17,418	0	81,97,040	4,19,51,276	4,27,68,694
International house	2,31,42,418	0	0	2,31,42,418	34,85,627	3,77,221	0	38,62,848	1,92,79,570	1,96,56,791
Hostel phase III	2,75,01,103	0	0	2,75,01,103	39,71,160	4,48,268	0	44,19,428	2,30,81,675	2,35,28,943
Prof. CNR Rao hall of science	1,03,33,669	0	0	1,03,33,669	14,95,331	1,68,439	0	16,63,770	86,69,899	88,38,338
Extension to HIV lab	10,16,085	0	0	10,16,085	1,49,059	16,562	0	1,65,621	8,50,464	8,67,026
Security office building	7,42,632	0	0	7,42,632	48,101	12,105	0	60,206	6,82,426	6,84,531
Radio activity - lab II	30,35,391	0	0	30,35,391	1,48,260	49,477	0	1,97,737	28,37,654	28,87,131
Sewage treatment building (STP)	2,91,699	0	0	2,91,699	47,547	4,755	0	52,302	2,39,397	2,44,152
Residential quarters - Adm. Officer	36,59,034	0	0	36,59,034	4,25,963	59,642	0	4,85,605	31,73,429	32,33,071
Child care centre	7,28,827	0	0	7,28,827	88,761	11,880	0	1,00,641	6,28,186	6,40,066
Extension to biology lab -2009	1,94,24,005	0	0	1,94,24,005	17,86,492	3,16,611	0	21,03,103	1,73,20,902	1,76,37,513
Animal house - Additional block	82,92,632	0	0	82,92,632	11,76,312	1,35,170	0	13,11,482	69,79,150	71,14,320
Hostel phase IV (62 rooms)	2,59,34,842	0	0	2,59,34,842	26,29,382	4,22,738	0	30,52,120	2,28,82,722	2,33,05,460
Extension to paulling building - Bio block	47,66,109	0	0	47,66,109	19,69,251	77,688	0	20,46,939	27,19,170	27,96,858
SCADA-DG room	2,40,660	0	0	2,40,660	19,614	3,923	0	23,537	2,17,123	2,21,046
President's residence	77,88,054	0	0	77,88,054	6,23,200	1,26,945	0	7,50,145	70,37,909	71,84,854
Visiting students hostel	3,39,82,070	0	0	3,39,82,070	27,39,476	5,53,908	0	32,93,384	3,06,88,686	3,12,42,584
Health centre	32,43,422	0	0	32,43,422	2,64,339	52,868	0	3,17,207	29,26,215	29,79,083
Nano institute-Shivanapura	37,09,242	0	0	37,09,242	3,02,304	60,461	0	3,62,765	33,46,477	34,05,338
Matri. science block - CCMS	5,54,31,961	0	0	5,54,31,961	40,39,750	9,03,541	0	49,43,301	5,04,88,660	5,13,92,201
Post doc housing- Srirampura	1,54,86,086	0	0	1,54,86,086	6,89,125	2,53,423	0	9,42,548	1,45,44,538	1,47,98,961
New auditorium	2,20,24,759	0	0	2,20,24,759	9,92,096	3,59,004	0	13,51,100	2,06,73,659	2,10,32,663
New auditorium phase II	1,03,500	4,86,12,612	0	4,87,16,112	1,687	7,94,073	0	7,95,760	4,79,20,352	1,01,813
EOBU lab block	2,09,11,646	0	0	2,09,11,646	14,75,788	3,40,860	0	18,16,648	1,90,94,998	1,94,35,858
Infrastructure facility- Road, street lights, partitions etc	9,88,28,587	77,84,225	0	10,66,12,812	1,53,07,094	17,37,789	0	1,70,44,883	8,95,67,929	8,35,21,493
Equipments :										
Plant/machinery/scientific equipments	93,01,65,128	8,46,62,664	3,500	1,01,48,24,292	34,92,69,499	4,82,04,154	0	39,74,73,653	61,73,50,639	58,08,95,629
Equipments carbon & nano materials	3,41,82,430	0	0	3,41,82,430	3,42,21,008	0	0	3,42,21,008	-38,578	0
Equipments physics & chemistry of matri.	98,78,095	0	0	98,78,095	96,08,402	2,69,692	0	98,78,094	1	2,69,693
Equipments cluster studies	26,87,514	0	0	26,87,514	24,10,151	1,27,657	0	25,37,808	1,49,706	1,77,363
Equipments advance technology lab	2,02,02,562	0	0	2,02,02,562	1,77,79,515	9,59,622	0	1,87,39,137	14,63,425	24,23,047
Equipment magnet	70,90,855	0	0	70,90,855	62,36,685	3,36,816	0	65,73,501	5,17,354	8,54,170
ICMS-lab equipment/ lab facilities	28,28,83,804	4,52,97,669	10,000	32,81,71,473	7,07,23,960	1,55,88,145	0	8,63,12,105	24,18,59,368	21,21,59,844
Vehicles	46,54,458	8,24,275	66,600	54,12,133	34,84,396	5,14,153	0	39,98,549	14,13,584	11,70,062
Furniture and fixtures	8,69,23,596	60,42,864	8,000	9,29,59,460	7,26,21,373	58,84,271	0	7,85,05,644	1,44,52,816	1,43,02,223
Office equipments	2,11,13,679	20,13,759	1,550	2,31,25,888	1,22,00,117	10,98,480	0	1,32,98,597	98,27,291	89,13,562
Computer/peripherals	7,93,75,185	48,63,704	0	8,42,38,889	8,30,19,977	0	0	8,30,19,977	12,18,912	-36,44,792
Electrical installations	11,27,36,560	0	0	11,27,36,560	1,55,20,832	18,37,639	0	1,73,58,471	9,53,80,089	9,72,17,728
Library books	2,89,62,165	1,63,266	0	2,91,25,431	1,56,81,567	13,83,458	0	1,70,65,025	1,20,60,406	1,32,80,598
Library Journals	18,76,47,997	77,24,982	0	19,53,72,979	7,04,18,828	92,80,217	0	7,96,99,045	11,56,73,934	11,72,29,189
Tubewells & water supply	2,46,912	0	0	2,46,912	55,232	4,057	0	59,289	1,89,623	1,93,880
Other fixed assets										
Intangible assets-Softwares	2,36,77,272	28,49,355	0	2,65,26,627	1,66,70,761	98,55,865	0	2,65,26,626	1	70,06,511
Capital work in progress										
Modern biomedical science research laboratory	0	1,24,10,767	0	1,24,10,767	0	0	0	0	1,24,10,767	0
Chemical heritage exposition	0	5,367	0	5,367	0	0	0	0	5,367	0
Basic infrastructure facilities - New campus - Chokkanalli	0	49,58,626	0	49,58,626	0	0	0	0	49,58,626	0
Total	2,50,24,83,827	22,93,69,396	89,650	2,73,17,63,573	89,01,93,853	10,69,15,408	0	99,71,09,261	1,73,46,54,311	1,61,22,89,974



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2018

Description	2017-18 Amount in Rs.	2016-17 Amount in Rs.
SCHEDULE 9- Investments - Earmarked/endowment funds		
Long term deposits		
Fixed deposits - Housing development finance corporation limited	8,77,05,500	8,77,05,500
Fixed deposits - Canara bank	3,50,00,000	5,34,67,000
Fixed deposits - State bank of india	1,00,49,963	7,72,66,669
Fixed deposits - PNB housing finance limited	3,25,00,000	1,75,00,000
Fixed deposits - Stock holding corporation of india	6,30,00,000	3,80,00,000
Total	22,82,55,463	27,39,39,169
SCHEDULE 10- Investments - Others		
Short term deposits	12,00,00,000	7,25,00,000
Others	8,79,200	0
Total	12,08,79,200	7,25,00,000
Schedule 11- Current assets, loans, advances etc.,		
Cash & bank balances (Schemes)		
Cash in hand	0	0
Cash at bank - Canara bank	1,28,37,801	47,53,917
Fixed deposits - Canara bank	12,00,00,000	28,80,75,432
Fixed deposits - Housing development finance corporation limited	22,00,00,000	0
Fixed deposits - State bank of india	0	19,59,991
Fixed deposits - PNB housing finance limited	64,76,01,317	29,25,00,000
Fixed deposits - Stock holding corporation of india	0	20,00,00,000
Sub total	1,00,04,39,118	78,72,89,340
Loans and advances (Schemes)		
Interest accrued on fixed deposits	3,18,21,171	2,34,18,513
TDS receivable	14,49,675	8,61,641
Receivables from centre	2,53,39,683	1,48,42,872
Receivables from various funding agencies	4,57,10,108	4,59,54,889
Sub total	10,43,20,637	8,50,77,914
Total of Schemes	1,10,47,59,755	87,23,67,255
Cash & bank balances		
Cash in hand - Grant account	0	12,425
Cash in hand - Endowment account	0	0
Cash at bank - Canara Bank - Grants account	63,09,733	5,59,91,316
Cash at bank - Canara Bank - Endowments account	68,64,183	61,37,974
Cash at bank - SBI	1,09,04,360	28,33,039
Cash at bank - HDFC	15,94,100	37,018
Sub total	2,56,72,376	6,50,11,773
Loans and advances		
Advances to staff	49,350	17,16,521
Deposits	18,27,929	6,87,259
Interest accrued on earmarked/endowment funds	1,28,55,584	1,24,06,114
Other advances & receivables	1,11,40,540	1,52,82,840
Receivables- CSIR, UGC, DBT, DST	1,48,90,105	1,83,09,720
Endowment account - Receivable from scheme account	1,50,00,000	1,00,00,000
Endowment account - Advance to supplier	33,110	25,600
Endowment account - Receivable from CPF account	8,46,13,346	1,32,000
Endowment account - Receivable from grant account	3,16,978	65,12,420
TDS receivable - Grant account	27,50,374	25,22,436
TDS receivable - Endowment account	13,71,714	5,60,731
Imprest balance	39,000	39,010
Sub total	14,48,88,029	6,81,94,650
Total of other than Schemes	17,05,60,405	13,32,06,423
Total	1,27,53,20,160	1,00,55,73,677



Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2018

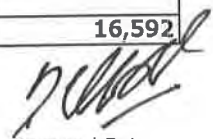
Description	2017-18 Amount in Rs.	2016-17 Amount in Rs.
SCHEDULE 12- Income from sales/services	0	0
SCHEDULE 13- Grants/subsidies :		
Grants - DST	76,41,52,000	73,98,00,000
Grants - From government agencies/travel grants etc.	0	0
Grants - From other institutes	0	0
Grants - Other international agencies	0	0
Total	76,41,52,000	73,98,00,000
SCHEDULE 14- Income from fee/subscriptions etc :		
Income from fee, subscriptions, medical contribution etc.	49,75,177	32,81,876
Total	49,75,177	32,81,876
SCHEDULE 15- Income from investments;	0	0
SCHEDULE 16- Royalty income, publication, licence fee etc:		
From royalty	0	0
Licence fee	1,42,772	2,96,760
Total	1,42,772	2,96,760
SCHEDULE 17- Interest earned:		
From term deposits	8,78,689	72,88,266
From SB accounts with nationalised banks	61,75,478	24,05,915
Interest earned - Others	5,69,344	0
Total	76,23,511	96,94,181
SCHEDULE 18- Other income:		
From visitors house, guest rooms, students residence etc.	75,33,657	70,85,058
CSIR fellowships, ICMS, SRFP reimbursement etc.	0	98,58,982
Prior year receipts	22,28,365	33,36,937
Other funds-cluster studies	0	39,541
Miscellaneous income	5,39,020	6,07,860
From others (tender fee & other fee collected)	40,000	0
Other receipts (Uncashed cheques reversed)	1,18,654	13,48,523
Total	1,04,59,695	2,22,76,901
SCHEDULE 19- Increase/decrease in stock:	0	0



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
Schedules forming part of the accounts for the year ended 31st march 2018

Description	As at 31.03.2018	As at 31.03.2017
SCHEDULE 20- Establishment expenses:		
Salaries & scholarship to students	27,60,39,593	23,43,09,167
Wages	8,52,81,342	5,61,05,877
Allowances (Medical reimbursements etc.,)	81,31,962	76,55,179
Bonus	0	7,87,512
Contribution to CPF	4,27,719	82,26,370
Contribution to new pension scheme	2,13,06,065	63,84,216
Contribution to group gratuity scheme	1,19,675	41,21,110
Leave encashment benefits	38,16,546	8,58,443
LTC	16,55,927	15,58,022
TOTAL	39,67,78,829	32,00,05,896
SCHEDULE 21- Other Administrative expenses		
Electricity & power	5,87,44,857	5,80,68,150
Water charges	56,33,397	60,37,638
Insurance	7,67,394	7,95,329
Repairs & maintenance	6,28,77,396	5,82,36,443
Rents, rates & taxes	7,79,014	12,69,232
Vehicles running & maintenance	61,32,453	65,07,546
Postage, telephone & communication	25,95,437	36,31,828
Printing, stationery, books	60,71,450	51,38,661
Travelling and conveyance	44,51,066	45,72,817
Expenses on seminars/workshops/discussion meetings	80,76,512	55,48,880
Membership & subscriptions	1,17,95,518	14,18,794
Professional charges	15,27,260	74,45,976
Laboratory consumables	4,06,38,869	4,17,54,638
Advertisement & publicity	35,62,260	14,13,375
Student residence, guest house, I house, etc	2,50,428	43,90,305
Statutory audit fee	95,200	70,000
POBE & POCE programme	9,31,044	9,51,859
Summer research fellowship & student programme	13,12,022	22,96,021
ICMS - Workshops, Schools etc.,	8,73,656	15,84,567
ICMS - Visitor programmes (National & international)	1,45,754	1,50,583
ICMS - Recurring expenses	1,77,03,729	1,18,58,171
ICMS - Scientists & supporting staff	0	1,23,59,000
TOTAL	23,49,64,714	23,54,99,813
SCHEDULE 22- Expenditure on grants, subsidies etc:	0	0
SCHEDULE 23- Interest and bank charges:	9,950	16,592


Sampad Patra
Accounts Officer



JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31ST MARCH 2018
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.



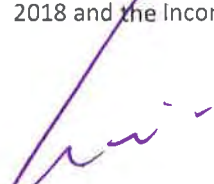
9. **Prior Period Items** : Prior period items, being any income or expense, which has arisen in the current period as a result of errors or omissions in the preparation of the financial statements of one or more prior periods, are recognized as and when they are noticed and are shown separately.


SCHEDULE 25: CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS


A. Contingent liability	2017-18 (Amount)	2016-17 (Amount)
1. Claims against the entity not acknowledged as debts	Nil	Nil
2. Letter of Credit outstanding	Nil	Nil

B. NOTES ON ACCOUNTS:

- The amount of Rs.76,41,52,000/- Indicated in Income and Expenditure Account Grants/subsidies Income includes Rs.15,08,59,000/- towards infrastructural support for which specific grants have been released by DST, GoI during the financial year.
- 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.
- Depreciation on fixed assets amounting to Rs. 10,69,15,408/- 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.
- 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.
- Schedules 1 to 25 are annexed to and form an integral part of the Balance Sheet as at 31st March 2018 and the Income and Expenditure Account for the year ended on that date.


Prof. V. Nagaraja
President

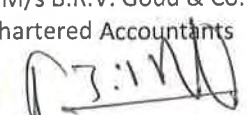

Joydeep Deb
Administrative Officer


Sampad Patra
Accounts Officer

Place : Bangalore
Date : 27/07/2018



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


[A.B. Shiva Subramanyam]
Partner

M.no.: 201108

**JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2018**

	2017-18	2016-17	PAYMENTS & CLOSING BALANCES	2017-18	2016-17	Amount in Rs.
I. Opening Balances & RECEIPTS			I. Expenses :			
- Cash in hand & imprest at Centre	51,435	1,60,650	- Establishment Expenses	38,94,26,281	39,31,16,323	
- Cash in hand & imprest at Scheme Fund	0	63,211	- Administrative Expenses	97,77,82,499	1,06,25,79,720	
Bank balances:			- Expenditure out of Endowments	31,66,158	37,86,069	
<i>In savings bank Accounts:</i>			Sub Total :	1,37,03,74,937	1,45,94,82,112	
- Canara Bank	6,21,29,290	2,83,86,649	II. Expenditure on Fixed assets and			
- Canara Bank - Scheme A/c	47,53,917	92,28,655	Capital Work-in-progress :			
- Union Bank of India	0	1,89,537	- Purchase of fixed assets	36,92,72,193	34,66,98,304	
- State Bank Of India	28,33,039	4,95,435				
- HDFC BANK	37,018	0	III. Refund of surplus money/loans	0	0	
In Deposit accounts :			IV. Finance charges(Bank charges)	20,054	0	
- At Canara Bank	5,34,67,000	5,69,67,000				
- At SBI	7,72,66,669	7,72,66,669	V. Other payments :			
- At HDFC Trust	8,77,05,500	0	- Earnest money deposit returned	0	0	
- At PNB	1,75,00,000	0	- Staff advances (Festival adv. etc.)	49,350	36,10,567	
- At SHC of India	3,80,00,000	0	- Other advances	63,17,26,913	86,72,889	
- At Canara Bank (Grant A/c)	7,25,00,000	10,67,05,500	- Security deposit returned	14,54,048	7,45,265	
- Fixed Deposit (Scheme A/c)	78,25,35,423	47,60,71,395	- TDS payments	2,87,40,442	2,71,06,185	
Sub Total :	1,19,87,79,292	75,55,34,701	- Professional tax	7,74,400	6,73,400	
			- Provident fund	2,32,04,221	2,19,45,946	
II. Grants Received :			- Advances to faculty	8,40,835	29,78,116	
- From DST-Grant in aid	76,41,52,000	73,98,00,000	- Payment to sundry creditors	18,38,914	1,48,72,616	
- Scheme Funds	99,64,96,141	1,12,88,86,104	- Advances to CPF Account	8,15,80,000	0	
- On behalf of endowments/corpus,others	2,15,10,000	62,40,049	Sub Total :	77,02,09,123	8,06,04,964	
			VI. Closing Balances :			
III. Income on Investments :			- Cash in hand & Imprest at centre	39,000	51,435	
<i>Interest on FD's :</i>			- Bank balances:			
- From earmarked/endowment funds	2,12,44,419	1,99,59,012	<i>In savings bank accounts at :</i>			
- From own funds	8,02,415	72,88,266	- Canara Bank	1,31,73,916	6,21,29,290	
- From Scheme Funds	3,06,73,530	2,40,83,342	- State Bank Of India	1,09,04,360	28,33,039	
Sub Total :	5,27,20,364	5,13,30,620	- HDFC BANK	15,94,100	37,018	
			- Canara Bank - Scheme A/c	1,28,37,801	47,53,917	
IV. Interest received on SB accounts :			Sub Total :	3,85,49,177	6,98,04,790	
- From grant in aid	61,75,478	24,05,915	Balance carried forward	2,54,84,25,484	1,95,65,90,100	
- From own funds	5,69,344	3,01,137				
- From Scheme Funds	33,95,516	26,84,703				
Sub Total :	1,01,40,338	53,91,755				
V. Other Income :						
- Collections from visitors, guest room etc	0	35,56,586				
- From fee, subscription etc	21,75,213	19,56,777				
- CSIR fellowships,UGC, DBT, SRFP	91,27,755	1,67,93,010				
- Overhead recoveries	1,00,00,000	1,00,13,500				
- From others	80,99,56,450	35,90,14,642				
Sub total :	83,12,59,418	39,13,34,515				
Balance carried forward	3,87,50,57,553	3,07,85,17,743				



**JAWAHARLAL CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
RECEIPTS AND PAYMENT ACCOUNT FOR THE YEAR ENDED 31ST MARCH 2018 (Contd...)**

	2017-18	2016-17	PAYMENTS & CLOSING BALANCES	Amount in Rs.
OPENING BALANCES & RECEIPTS				
Balance Brought Forward	3,87,50,57,553	3,07,85,17,743	Balance Brought Forward	1,95,65,90,100
VI. Other receipts :			<i>In deposit accounts at :</i>	
Income tax refunds	0	0	- At Canara Bank	5,34,67,000
From Sundry Creditors	0	0	- At SBI	7,72,66,669
Staff advances recovered	37,919	2,810	- At HDFC Trust	8,77,05,500
Settlement of advance to faculty	7,45,982	2,12,634	- At PNB	1,75,00,000
Earnest money received	0	0	- At SHC of India	3,80,00,000
Project funding received	69,437	1,24,453	- At Canara Bank (Grant A/c)	7,25,00,000
GSLI receipt	83,71,373	67,07,052	- Fixed Deposit (Scheme A/c)	78,25,35,423
Support to meetings				
Sub Total :	92,24,711	70,46,949	Sub Total :	1,12,89,74,592
TOTAL	3,88,42,82,264	3,08,55,64,692	TOTAL	3,08,55,64,692

For Jawaharlal Nehru Centre for Advanced Scientific Research

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



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

Place : Bangalore
Date : 27/07/2018.

Prof. A. Nagaraja
President

Joydeep Deb
Administrative Officer

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
CPF FUND STATEMENT OF AFFAIRS FOR THE YEAR ENDED 31ST MARCH 2018

Particulars	Amount in Rs.	Amount in Rs.	Particulars	Amount in Rs.
Contributory provident fund				
Subscription :			Investment of funds :	
Opening balance	9,09,84,299		Government of India 8 % Bonds (SHCIL)	4,95,00,000
Add : Subscriptions received during the year	73,82,808		Fixed Deposits at PNB housing finance	3,75,00,000
Advances repayments	14,67,287		Fixed Deposits at Canara bank	1,76,00,000
Interest on subscriptions	64,80,204		Fixed Deposit at HDFC	2,30,00,000
Sub total	10,63,14,598			12,76,00,000
Less : Advances / part finals granted	22,59,369		Cash at Bank :	
Less : Final settlement/adjustment	6,79,06,353		Canara Bank, SB A/C No. 0683101017513	8,58,95,698
Sub total	7,01,65,722			
Closing balance		3,61,48,876	TDS receivable :	
			Gol Bonds (2012-13) receivable	1,48,000
Contribution :			Gol Bonds (2014-15) receivable	1,48,000
Opening balance	5,79,51,867		Gol Bonds (2015-16) receivable	1,49,400
Add : Contribution during the year	24,93,396		Gol Bonds (2016-17) receivable	63,333
Interest on total contributions	39,86,720		Gol Bonds (2017-18) receivable	23,532
Sub total	6,44,31,983			5,32,265
Less : Final settlement/adjustment	3,85,46,867		Accrued interest :	
Closing balance		2,58,85,116	Accrued interest on deposits in Gol 8 % Bonds (SHCIL)	41,69,171
			Accrued interest on Deposits in PNB housing finance	42,33,654
Payable to Centre		12,217	Accrued interest on Deposits in Canara bank	30,96,712
Payable to NPS		8,35,03,143	Accrued interest on Deposits in HDFC	44,39,225
Payable to Corpus		8,46,13,346		1,59,38,762
Balance surplus/deficit (-)		-1,95,973		
Total		22,99,66,725	Total	22,99,66,725

For Jawaharlal Nehru Centre for Advanced Scientific Research

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



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

Place : Bangalore
Date : 27/07/2018.

Joydeep Deb
Administrative Officer

Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH
STATEMENT OF ENDOWMENT, CORPUS & OTHER FUNDS BALANCES AS ON 31/03/2018
(2017- 18)

Rs. in Lakhs

PARTICULARS	Principal	Opening	Additions	Interest	Interest		Expen-	Closing
	Endow.	balance	during	Received	Accrued	Total	diture	balance
	Fund	2017-18	2017-18	2017-18	2017-18	2017-18	2017-18	2017-18
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
ENDOWMENT CHAIRS								
Hindustan Lever Ltd. & Gharda Chemicals Chair	32.00	46.51	0.00	2.55	0.00	49.06	3.60	45.46
Astra Zeneca & IBM Chair	20.00	50.38	0.00	1.59	0.00	51.97	0.00	51.97
DAE - Dr.Vikram Sarabhai Chair	22.00	29.84	0.00	2.52	0.00	32.36	0.00	32.36
DRDO & CSIR Chair	30.00	70.58	0.00	2.39	0.00	72.97	3.60	69.37
Silver Jubilee Professorship -Prof. C.N.R. Rao	25.00	26.06	0.00	2.71	0.00	28.77	1.20	27.57
TOTAL- ENDOWMENT CHAIRS	129.00	223.37	0.00	11.76	0.00	235.13	8.40	226.73
RELIANCE INDUSTRIES								
Prof.Linus Pauling Professorship	84.34	101.14	0.00	6.89	0.00	108.03	10.48	97.55
OTHER ENDOWMENT FUNDS								
Contribution from Prof.CNR Rao	4.25	12.75	0.00	0.00	0.51	13.26	0.20	13.06
Shantha Seetharamaiah Award	1.00	3.56	0.00	0.00	0.12	3.68	0.13	3.55
Bapu Narayanaswamy Prize	1.00	2.77	0.00	0.00	0.12	2.89	0.06	2.83
Prof. Roddam Narasimha Prize	2.00	2.79	0.00	0.16	0.00	2.95	0.08	2.87
Prof. M.K.Chandrashekarana Fund	5.43	4.06	0.00	0.36	0.00	4.42	0.07	4.35
TOTAL - OTHER ENDOWMENT FUNDS	13.68	25.93	0.00	0.52	0.75	27.20	0.54	26.66
LECTURE SERIES								
Dr. A.V.Rama Rao Fund	31.00	32.00	0.00	1.17	0.00	33.17	2.03	31.14
ISRO-Dr. Satish Dhawan	14.00	20.33	0.00	1.11	0.00	21.44	0.02	21.42
DAE-Dr. Raja Ramanna	15.00	15.81	0.00	1.18	0.00	16.99	0.67	16.32
DBT-Prof. V Ramalingaswamy	7.00	12.63	0.00	0.55	0.00	13.18	0.82	12.36
TOTAL - LECTURE SERIES	67.00	80.77	0.00	4.01	0.00	84.78	3.54	81.24
C.N.R. RAO HALL OF SCIENCE FUND	170.00	185.01	20.00	12.47	3.70	221.18	9.60	211.58
MATERIALS RESEARCH FUND	149.06	199.41	0.00	4.36	5.25	209.02	1.12	207.90
JNC - CORPUS FUND	1,682.07	2281.51	169.11	114.43	74.26	2,639.31	0.01	2,639.30
GRAND TOTAL	2,295.15	3,097.14	189.11	154.44	83.96	3,524.65	33.69	3,490.96



Sampad Patra
Sampad Patra
Accounts Officer

JAWAHARLAL NEHRU CENTRE FOR ADVANCED SCIENTIFIC RESEARCH

Details of Scheme funds for the financial year 2017-18

Sl. No.	Code	Particular	Opening Balance		Additions to the Funds			Utilisation/Exp. towards objectives of funds			Closing Balance	
			Debit	Credit	Receipts	Recredits	Fixed Assets	Salaries	Oth. Admin. Exp.	Debit	Credit	
1	4213	DST/SA	36,30,285	0	0	0	0	0	0	0	36,30,285	0
2	5104	CSIR-COE/CNR	29,10,103	0	0	0	0	0	0	0	29,10,103	0
3	4425	NIH-UNMC/RUK	25,70,574	0	1,31,05,521	46,883	1,53,255	22,30,172	1,13,16,495	0	31,18,092	0
4	5105	DST-ICMS/CNR	24,28,431	0	0	0	0	0	0	0	24,28,431	0
5	4300	DBT/TKK	17,79,553	0	0	0	-4,59,542	0	5,82,398	0	19,02,409	0
6	4119	DBT/AA	17,17,113	0	0	0	0	0	0	0	17,17,113	0
7	4311	DST/RN	15,34,663	0	30,31,948	0	0	12,00,000	11,53,398	0	8,56,113	0
8	4206	ICPCNN/GUK	14,38,163	0	0	0	0	0	11,996	0	14,50,159	0
9	4203	DST/TNCV	13,32,342	0	0	0	0	0	0	0	13,32,342	0
10	4189	DBT/AA	12,32,132	0	0	0	0	0	0	0	12,32,132	0
11	4230	DBT/MI	11,00,593	0	11,71,654	0	0	0	1,00,000	0	28,939	0
12	4381	DRDO/RN	9,68,161	0	15,49,978	0	54,575	1,47,832	3,79,410	0	0	0
13	4220	IUSSTF/GUK	9,16,740	0	0	0	0	0	0	0	9,16,740	0
14	4292	SERB/AJ	8,86,286	0	28,14,828	0	0	3,00,000	5,15,771	0	0	11,12,771
15	4240	DST/TG	7,52,659	0	0	0	0	0	0	0	7,52,659	0
16	4298	LEOS-ISRO/NC	7,37,221	0	0	0	0	0	0	0	7,37,221	0
17	6003	CSIR-COE/CNR	7,30,129	0	83,00,000	0	0	7,07,982	13,90,297	0	0	54,71,592
18	4258	DST/AKM	7,05,565	0	0	0	0	0	0	0	7,05,565	0
19	4248	ICMR/RUK	6,67,842	0	0	0	0	0	0	0	6,67,842	0
20	4288	INTEL/RN	6,16,803	0	0	0	0	0	0	0	6,16,803	0
21	4242	NPOL/KRS	6,09,511	0	0	0	0	0	0	0	6,09,511	0
22	4274	DBT/KS	5,83,343	0	0	0	0	0	0	0	5,83,343	0
23	5101	DST/SAC-PM/CNR	5,73,994	0	0	0	0	0	0	0	5,73,994	0
24	4334	SERB/JC	5,66,001	0	24,867	33,993	0	27,048	59,387	0	5,93,576	0
25	4333	SERB/JG	4,83,351	0	0	0	0	0	0	0	4,83,351	0
26	4087	IJMM/CNR-OB	4,50,000	0	0	0	0	0	0	0	4,50,000	0



225	9044	CHANDRAIAH M	0	0	12,849	0	0	0	0	0	12,849	0	0	0	0
226	9045	LAXMINARASIMHAR	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
227	9046	SUBARNA DEV	0	0	13,333	0	0	0	0	0	0	0	0	0	13,333
228	9047	CHIRANJEEVI S V	0	0	13,225	0	0	0	0	0	13,225	0	0	0	0
229	9048	DARSI RAMBABU	0	0	12,903	0	0	0	0	0	0	0	0	0	12,903
230	9049	SANDRA DIAS	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
231	9050	RUCHIKA BHARADW	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
232	9051	ESWARAMOORTHY M	0	0	10,000	0	0	0	0	0	0	0	0	0	10,000
233	9052	SHRINKA SEN	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
234	9053	ASWATHY NARAYAN	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
235	9054	MAMTA NEGI	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
236	9055	MD.HASHIM REZA	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
237	9056	SHWETA PANCHAL	0	0	20,184	0	0	0	0	0	0	0	0	0	20,184
238	9057	SRIKANTH SASTRY	0	0	1,26,063	0	0	0	0	0	0	0	0	0	1,26,063
239	9058	PREMKUMAR SENGU	0	0	14,138	0	0	0	0	0	13,551	0	0	0	587
240	9059	G L BALAJI	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
241	9060	MEHRAJ UD DIN S	0	0	10,611	0	0	0	0	0	0	0	0	0	10,611
242	9061	KAMAN SHARMA	0	0	20,000	0	0	0	0	0	6,634	0	0	0	13,366
243	9062	MOKURALA KRISHN	0	0	10,166	0	0	0	0	0	0	0	0	0	10,166
244	9063	SUMAN YADAV	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
245	9064	SHASHIDHARA ACH	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
246	9065	SAMPATH KUMAR V	0	0	20,000	0	0	0	0	0	0	0	0	0	20,000
247	9066	NAMITA SUROLIA	0	0	16,000	0	0	0	0	0	15,305	0	0	0	695
248	9067	SREEDEVI P	0	0	20,000	0	0	0	0	0	20,000	0	0	0	0
249	4077	IT/KSN	0	0	0	335	0	0	0	0	0	0	0	0	335
250	4303	DST/SKP	0	0	0	600	0	0	0	0	600	0	0	0	0
251	4082	DRDO/KSN	0	0	0	887	0	0	0	0	0	0	0	0	887
252	4335	UKERI/UW	0	0	0	1,218	0	0	0	0	0	0	0	0	1,218
253	9016	SREENIVAS K R	0	0	5,900	1,325	0	0	0	0	0	0	0	0	7,225
254	4252	DST-JCB/TKK	0	0	19,04,271	1,338	0	0	0	0	16,45,157	39,548	0	0	0
255	4445	SERB/MI	0	0	18,00,000	1,419	0	0	0	0	2,02,052	0	0	0	15,99,367
256	9030	S.BANDI	0	0	20,000	1,425	0	0	0	0	10,315	0	0	0	11,110
257	4096	DST/SN	0	0	0	1,500	0	0	0	0	0	0	0	0	1,500



357	4442	SERB/A.SINGH	0	1,76,507	7,55,000	0	0	0	6,60,000	2,85,456	13,949	0
358	4147	UGC-CONTINGENCY	0	1,82,576	0	0	0	0	0	0	0	1,82,576
359	4437	SERB/SM	0	1,86,503	8,00,000	0	0	0	6,00,000	3,86,503	0	0
360	4435	SERB/PP	0	1,91,450	8,08,965	0	0	0	6,60,000	2,23,432	0	1,16,983
361	4401	SERB/KK	0	2,05,015	7,00,000	0	0	0	6,60,000	1,55,303	0	89,712
362	4176	DST/KRS	0	2,13,033	0	0	0	0	0	0	0	2,13,033
363	4159	DAE/AA	0	2,15,630	0	0	0	0	0	0	0	2,15,630
364	4338	DBT/MI	0	2,20,699	6,69,084	0	0	0	2,75,400	6,14,383	0	0
365	4044	INF/RR	0	2,20,968	0	0	0	0	0	0	0	2,20,968
366	4113	ICMR/AA	0	2,29,542	0	0	0	0	0	0	0	2,29,542
367	4171	DBT/NS	0	2,34,213	0	0	0	0	0	0	0	2,34,213
368	4308	HPCL/RM	0	2,39,309	0	0	0	0	0	0	0	2,39,309
369	4130	DAE/BRNS/CNR	0	2,41,551	0	0	0	0	0	0	0	2,41,551
370	4210	ICAR/TKK	0	2,48,986	0	0	0	0	0	0	0	2,48,986
371	4064	DST/CNR	0	2,61,088	0	0	0	0	0	0	0	2,61,088
372	4384	DBT/HB	0	2,65,259	10,63,315	0	0	0	1,62,581	3,57,403	0	8,08,590
373	4345	DBT/EM	0	2,67,860	3,14,357	0	0	0	2,37,145	3,31,460	0	13,612
374	4368	HPCL/KRS	0	2,81,235	17,078	0	0	0	0	5,95,756	2,97,443	0
375	4413	DBT/SSA	0	2,88,510	11,69,394	0	0	-1,59,457	4,90,000	4,64,752	0	6,62,609
376	4097	JNC/NS	0	3,00,492	0	0	0	0	0	0	0	3,00,492
377	4390	SERB/SKS	0	3,12,885	5,00,708	1,22,419	1,38,200	0	6,60,000	75,397	0	62,415
378	4411	INSA/RV	0	3,17,466	0	0	0	0	0	1,54,773	0	1,62,693
379	4276	DBT/TG	0	3,27,639	1,269	0	0	0	0	3,41,071	12,163	0
380	4396	TRC-JNC/KB	0	3,36,933	21,18,400	0	33,394	0	5,61,600	4,97,535	0	13,62,804
381	4071	DST/RUK	0	3,54,148	0	0	0	0	0	0	0	3,54,148
382	4142	IDS/RN	0	3,56,244	0	0	0	0	0	0	0	3,56,244
383	4367	SERB/VG	0	3,66,281	6,00,000	0	0	0	0	9,21,567	0	44,714
384	4410	SERB/NKK	0	3,91,404	7,75,464	0	0	0	5,81,429	3,00,000	0	2,85,439
385	4344	CSIR/SCP	0	3,93,824	3,37,200	0	0	0	5,47,611	2,15,181	31,768	0
386	4209	DST/SMD	0	4,01,722	0	0	0	0	0	0	0	4,01,722
387	4406	SERB/LG	0	4,02,827	7,00,093	0	52,367	0	6,60,000	4,05,067	14,514	0
388	4337	DBT/MRS	0	4,05,033	47,89,527	0	0	0	12,66,703	42,70,163	3,42,306	0
389	4403	SERB/VSM	0	4,20,330	6,42,549	0	0	0	3,85,000	4,89,301	4,000	1,88,578



423	4414	DST/VN	0	11,22,122	18,653	0	0	0	0	0	0	10,31,138	0	0	1,09,637
424	4432	DAE-BRNS/JH	0	11,50,000	29,686	6,18,028	9,33,028	0	0	0	0	1,03,251	0	0	7,61,435
425	4440	SERB/JH	0	11,56,161	10,45,619	0	10,36,000	1,40,400	0	0	0	5,09,365	0	0	5,16,015
426	4430	DST-RUS/AS	0	12,85,843	34,308	0	0	0	0	0	0	5,27,906	0	0	7,92,245
427	4374	DBT/HB	0	13,10,276	15,14,206	0	0	2,89,662	0	0	0	10,41,018	0	0	14,93,802
428	4238	VGST-SOP/	0	16,42,830	0	0	0	0	0	0	0	0	0	0	16,42,830
429	4342	SHELL/EM	0	18,05,344	0	0	0	0	0	0	0	5,47,631	0	0	12,57,713
430	4382	SERB/TKM	0	20,01,814	8,20,130	0	17,19,193	4,05,893	0	0	0	4,12,259	0	0	2,84,599
431	4336	IKST/UW	0	20,08,320	21,76,000	0	0	0	0	0	0	12,08,907	0	0	29,75,413
432	4072	DBT/KNG	0	20,33,705	0	0	0	0	0	0	0	0	0	0	20,33,705
433	4408	SERB/KB	0	20,90,009	6,69,504	0	5,01,820	4,77,013	0	0	0	4,57,238	0	0	13,23,442
434	4282	DBT/TKK-RUK	0	22,76,120	10,000	0	0	0	0	0	0	19,71,953	0	0	3,14,167
435	4424	SERB/SSA	0	23,97,253	58,967	0	14,81,600	9,06,777	0	0	0	5,91,387	0	0	3,83,233
436	4431	DAE-BRNS/CPR	0	25,19,550	1,77,839	67,500	9,00,000	0	0	0	0	9,21,085	0	0	37,027
437	4323	DBT/MI	0	30,57,148	70,087	0	0	5,14,016	0	0	0	22,41,534	0	0	3,71,685
438	4420	CEFIPRA/SCP	0	32,14,078	6,000	0	12,92,100	5,58,581	0	0	0	9,70,702	0	0	3,98,695
439	4350	BARC/MA	0	33,99,665	1,57,574	0	6,56,117	4,37,356	0	0	0	7,69,234	0	0	16,94,532
440	4407	DBT/TKK-EM	0	34,36,164	54,876	0	17,63,000	7,67,818	0	0	0	9,85,893	25,671	0	0
441	4140	DST/GUK	0	34,52,216	0	0	0	0	0	0	0	0	0	0	34,52,216
442	4324	EU/SKP/SJG	0	36,10,218	75,000	0	0	0	0	0	0	6,85,911	0	0	29,99,307
443	4426	TRC-JNC/TG	0	39,25,644	28,41,000	0	30,82,743	6,35,049	0	0	0	10,89,891	0	0	19,58,961
444	4416	TRC-JNC/KSN	0	39,60,000	10,92,000	0	59,058	0	0	0	0	44,479	0	0	49,48,463
445	4415	TRC-JNC/TKM	0	40,31,347	15,82,000	0	36,51,147	4,55,226	0	0	0	4,74,987	0	0	10,31,987
446	4358	DST/KB	0	41,13,452	86,913	0	0	0	0	0	0	22,88,225	0	0	19,12,140
447	4412	DST/SCP	0	41,49,175	87,445	24,29,430	46,85,479	3,27,258	0	0	0	2,91,855	0	0	13,61,458
448	4417	TRC-JNC/SCP	0	48,94,330	10,00,000	0	40,19,461	5,47,560	0	0	0	2,60,988	0	0	10,66,321
449	4385	DST-OVF/JNC	0	49,88,708	1,92,121	0	0	25,21,139	0	0	0	3,51,225	0	0	23,08,465
450	4294	DST/SB	0	67,86,037	78,29,273	0	11,37,724	27,69,510	0	0	0	15,94,310	0	0	91,13,766
451	4398	TRC-JNC/NC-RUK	0	78,31,368	25,60,000	0	16,26,664	6,09,100	0	0	0	12,00,435	0	0	69,55,169
452	4286	DST/GUK	0	79,12,917	2,26,682	0	2,85,134	15,13,953	0	0	0	5,55,962	0	0	57,84,550
453	4428	DST/SMS	0	1,06,05,240	8,79,47,281	0	2,43,57,323	24,38,300	0	0	0	63,44,275	0	0	6,54,12,623
454	4433	DST-SJF/RG	0	1,12,25,000	3,17,680	0	49,90,350	3,00,000	0	0	0	1,93,344	0	0	60,58,986
455	4427	DST-SJF/TG	0	1,49,96,982	5,25,094	0	10,06,319	0	0	0	18,35,366	0	0	1,26,80,391	



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