Nurturing talent...promoting excellence

मौलिक विज्ञान प्रकर्ष केन्द्र

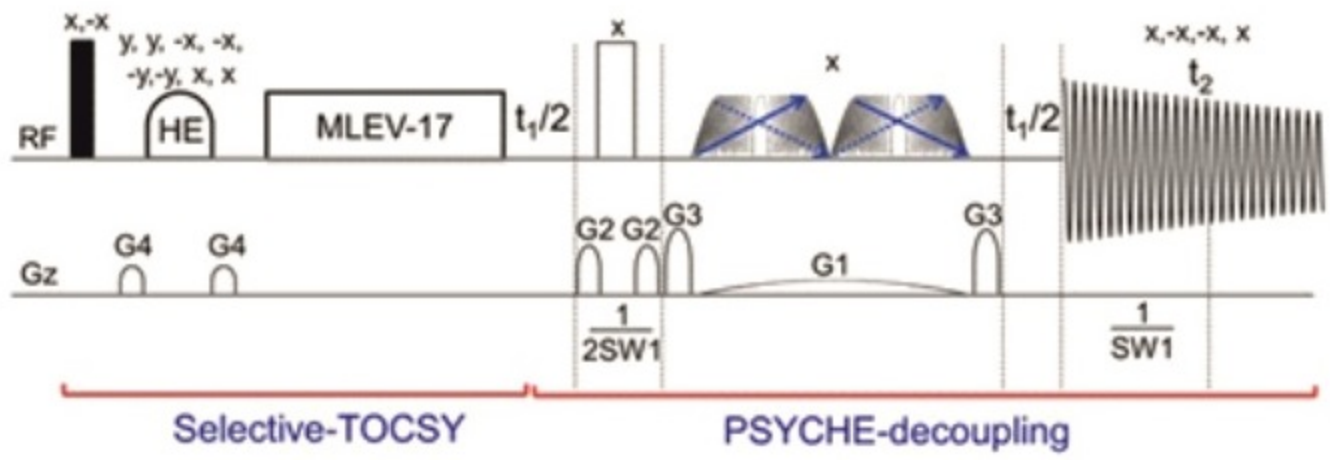
UM-DAE CEBS

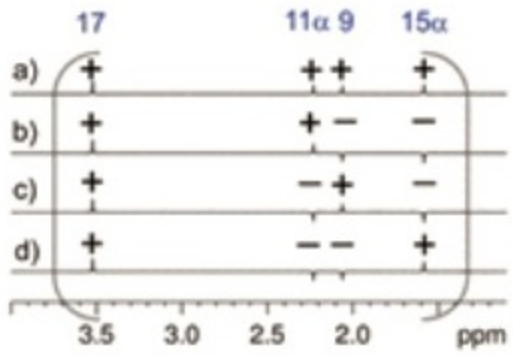
CENTRE FOR EXCELLENCE IN BASIC SCIENCES

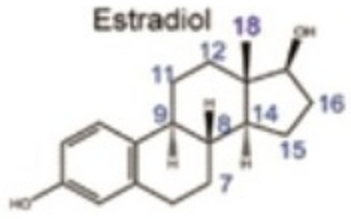
Health Centre Building, University of Mumbai, Kalina Campus, Mumbai - 400 098

Phone: 91-22-26524983 | Fax: 91-22-26524982

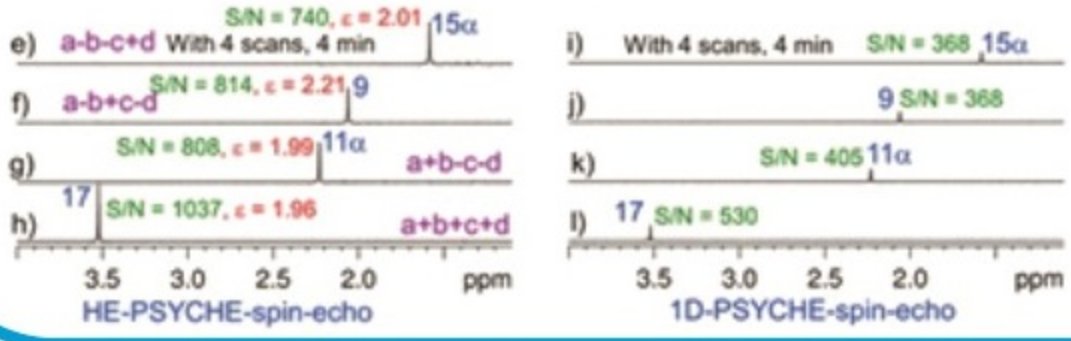
Hadamard-homodecoupling NMR methods: Improved efficacy in detecting long range TOCSY correlations







Application of H_4 Hadamard matrix
a ~2 fold sensitivity enhancement is observed



VMR Kakita, RV Hosur, **2016**, *chemphyschem-2*

Annual Report (April 2015 - March 2016)

University of Mumbai

Nurturing talent...promoting excellence

मौलिक विज्ञान प्रकर्ष केन्द्र

UM-DAE CEBS

Annual Report
(April 2015- March 2016)

University of Mumbai (UM) – Department of Atomic Energy (DAE)
Centre for Excellence in Basic Sciences (CEBS)

Director's Message

The University of Mumbai & Department of Atomic Energy (UM-DAE) Centre for Excellence in Basic Sciences (CEBS) has had yet another successful year, thus completing nine years of its existence, on the campus of the University of Mumbai at Kalina.

This year, the fifth batch of students graduated through the Integrated five year M. Sc programme of the Centre. It is very satisfying to mention that almost all the students who have passed out from CEBS, till now are currently pursuing their Ph.D. in prestigious institutions. The number of students getting admitted to CEBS is increasing progressively, and today it stands at 45 plus 2 from J&K per year. The Centre has been gaining in popularity across the country, as can be seen from the fact that, the number of students registering for its entrance test, namely, the National Entrance Screening Test (NEST), which is conducted jointly by CEBS and NISER-Bhubaneshwar, a sister institution of DAE with similar mandate, has increased from 3300 in the first year to more than 60,000 in the last year.

CEBS regularly organizes workshops, seminars, public lectures, refreshers course etc, and sometimes, jointly with the University of Mumbai. It has also started students exchange programmes with other institutions. Our interaction with York University is progressing very well and this year one student went to York to carry out the ninth semester project in the Chemistry stream. Likewise, students are also going to other institutions in the world for their Projects.

One of the hallmarks of CEBS is its Visitors' programme. We have been able attract eminent scientists from Cambridge to spend extended periods of time at CEBS carrying out collaborative research and also teaching our students at the same time.

CEBS has established modest research facilities for its core faculty. In addition to carrying out research at CEBS, the faculty members also collaborate with scientists in other research institutions and gain access to major equipment. Students from institutes across India come to CEBS to carry out semester-long projects under the guidance of our core faculty and to avail of the laboratory facilities here. The faculty at CEBS have been able to produce excellent research publications in reputed international journals. The productivity has been increasing steadily and during the last year 56 papers have been published in reputed International Journals. The faculty members have successfully secured grants for their research projects from external funding agencies such as DST, DBT, BRNS. etc.

The students at CEBS have initiated various academic and social activities such as Jigyaasa, Ragnarock, sports competitions, etc which have attracted students from other colleges in the city. The construction work of the permanent buildings of CEBS has been completed and

students have been allotted hostel accommodation in the new CEBS hostels with effect from August 2014. The Guest House has become fully functional and is getting occupied through-out the year.

A major achievement during the last year was the award of 'Grant-in-Aid under DAE' status to CEBS by the Union Cabinet. This, in one sense marks the end of 'Project Mode' for CEBS and entitles it to receive regular grants from DAE for its smooth functioning. Efforts are underway to get CEBS registered as a Society under 'Society Registration Act 1860'.

This document lists all the activities and accomplishments of the Centre during the last one year and it is satisfying to note that CEBS has lived up to the dreams of its creators. It has successfully established itself as a brand institution for teaching and research in the area of Basic Sciences. The idea behind setting up an institution like CEBS has received positive attention from other educational institutions across the country. A few universities in India have been in touch with the Faculty members of CEBS to seek guidance to set up similar institutions in their state universities.

I am thankful to the Brochure Committee for preparing this document.

R. V. Hosur
Director

Contents

Governing Council and Academic Board of the Centre

1. Governing Council and Academic Board of the Centre

Governing Council of the Centre

CEBS is managed by a Governing Council consisting of the following members:

Dr. Sekhar Basu Secretary to the Government of India Department of Atomic Energy, and Chairman, Atomic Energy Commission Anushakti Bhavan, C. S. M. Marg Mumbai – 400 001	Chairperson
Dr. Sanjay Deshmukh Vice - Chancellor University of Mumbai Fort Campus, Mumbai – 400 032	Co-Chairperson
Shri. K. N. Vyas Director Bhabha Atomic Research Centre Trombay, Mumbai – 400 085	Member
Dr. Sandip P. Trivedi Director Tata Institute of Fundamental Research Homi Bhabha Road Mumbai – 400 005	Member
Dr. Devang Khakhar Director Indian Institute of Technology, Bombay Powai, Mumbai – 400 076	Member
Pro Vice Chancellor University of Mumbai Fort Campus, Mumbai – 400 032	Member
Joint Secretary (R&D) Department of Atomic Energy Anushakti Bhavan, C.S.M. Marg Mumbai – 400 001	Member
Prof. S. K. Joshi Room No. 250 National Physical Laboratory Dr. K.S. Krishnan Road, New Delhi - 110 012	Member

Prof. R. V. Hosur — Member Secretary
Director, UM-DAE CEBS
University of Mumbai
Kalina Campus, Mumbai – 400 098

Academic Board of the Centre

The academic activities of the Centre are designed and overseen by the Academic Board of the Centre whose current members are:

Prof. S. M. Chitre — Chairperson
Emeritus Professor
UM-DAE CEBS
University of Mumbai
Kalina Campus, Mumbai – 400 098

Prof. J. V. Narlikar — Member
Formerly Inter-University Centre for
Astronomy and Astrophysics (IUCAA)
Post Bag 4, Ganeshkhind
Pune University Campus, Pune - 411 007

Prof. Arvind Kumar — Member
Homi Bhabha Centre for Science Education
V. N. Purav Marg, Mankhurd
Mumbai – 400 088

Prof. M. S. Raghunathan — Member
National Centre for Mathematics
Indian Institute of Technology – Bombay
Powai, Mumbai – 400 076

Prof. J. Maharana — Member
Institute of Physics
Sachivalaya Marg
Bhubaneshwar, Orissa - 751 005

Dr. Swapan Ghosh — Member
Head, Theoretical Chemistry Section
Bhabha Atomic Research Centre
Trombay, Mumbai – 400 085

Prof. Dipan Kumar Ghosh — Member
Indian Institute of Technology – Bombay
Powai, Mumbai – 400 076

Prof. N. Mukunda — Member
Centre for High Energy Physics
Indian Institute of Science
Bangalore – 560 012

Prof. K. N. Ganesh — Member
Director
Indian Institute of Science
Education and Research (IISER)
Dr. Homi Bhabha Road
Pashan, Pune – 411 008

Prof. R. R. Puri — Member
Indian Institute of Technology – Gandhinagar
B103, Sukun Chandkedha
S. G. Road, Ahmedabad – 382 424

Prof. G. D. Yadav — Member
Vice Chancellor
Institute of Chemical Technology
Mumbai – 400 019

Prof. N. Sathyamurthy — Member
Director
Indian Institute of Science Education and
Research (IISER) Mohali,
MGSIPA Complex, Sector 26
Chandigarh – 160 019

Prof. A. M. Narsale — Member
UM-DAE CEBS
University of Mumbai
Kalina Campus, Mumbai – 400 098

Prof. Deepak Dhar — Member
Department of Theoretical Physics
Tata Institute of Fundamental Research
Homi Bhabha Road, Colaba
Mumbai - 400 005

Dr. S. K. Apte — Member
Bio-Medical Group and Head
Molecular Biology Division
Bhabha Atomic Research Centre
Trombay, Mumbai - 400 085

Prof. M. K. Pejavar
Dean Science Faculty
University of Mumbai
Fort Campus, Mumbai – 400 032

Member

Prof. R. V. Hosur
Director
UM-DAE CEBS
University of Mumbai
Kalina Campus, Mumbai – 400 098

Member - Secretary

Faculty

2. Faculty

2.1 Core Faculty

DEPARTMENT OF BIOLOGY		
Name of the faculty	**Designation**	**Courses taught in the Academic Year (2015-2016)**
Prof. Jacinta D'Souza	Associate Professor	Biology I (B 101) Biology II (B 201) Biology Laboratory (BL 201) Chemistry-Biology Laboratory (CBL 401)
Dr. Manu Lopus	Reader 'F'	Cell Biology –I (B 301) Cell Biology II (B 502) Animal Physiology (B 602)
Dr. V. L. Sirisha	Assistant Professor	Biology Laboratory (BL 101, BL 201) Biotechnology-II (B804)
Dr. Dolly Khona	Research Associate - I	Biology Laboratory (BL 701, BL 801)
Dr. Patricia Pinto	Research Associate - I	-
Dr. Sanith C.	Research Associate - I	-
Dr. Vishal Singh Chaudhary	Research Associate - I	-
DEPARTMENT OF CHEMISTRY		
Name of the faculty	**Designation**	**Courses taught in the Academic Year (2015-2016)**
Prof. Neeraj Agarwal	Associate Professor	Chemistry Laboratory (CL 101, CL 201) Chemistry-Biology Laboratory (CBL 301) Analytical Chemistry (CB 501) Advanced Chemistry Laboratory (CL 701, CL 801)
Dr. Basir Ahmad	UGC Assistant Professor	Biochemistry-I (CB 302) Biophysical Chemistry (CB 601) Advanced Chemistry Laboratory (CL 701, CL 801) Physical Biology (CE 1002)
Dr. Mahendra Patil	Assistant Professor	Organic Chemistry I – (CB 303) Chemistry-Biology Laboratory (CBL 401)

		Advanced Chemistry Laboratory (CL 701)
Dr. Sinjan Choudhury	Assistant Professor	Advanced Chemistry Laboratory (CL 801) Biophysical Chemistry (CB 601) Chemistry-Biology Laboratory (CBL 301)
Dr. Avinash Kale	Visiting Assistant Professor	Biophysical Chemistry (CB 601) Group Theory (C 401)
Dr. Manish Patil	Research Associate-I	Chemistry-Biology Laboratory (CBL 401) Advanced Chemistry Laboratory (CL 701)
Dr. Rani Parvathy	Research Associate-I	Chemistry-Biology Laboratory (CBL 301)
Dr. Anushree Bhattacharya	Research Associate-I	-
Dr. Veera Mohana Rao	Research Associate-I	-
Dr. Vaibhav Kumar Shukla	Research Associate-I	-
DEPARTMENT OF MATHEMATICS		
Name of the faculty	**Designation**	**Courses taught in the Academic Year (2015-2016)**
Prof. Balwant Singh	Senior Scientist	Commutative Algebra (M 702) Advanced Commutative Algebra and Applications (ME 1005)
Dr. Shameek Paul	Research Associate - II	Foundations (M 301) Algebraic Topology (M 803)
Dr. Swagata Sarkar	Research Associate –I	Differential Topology (M 804) Graph Theory (M 504)
DEPARTMENT OF PHYSICS		
Name of the faculty	**Designation**	**Courses taught in the Academic Year (2015-2016)**
Prof. S. M. Chitre	Chairperson Academic Board & Emeritus Professor	Fluid Mechanics (P 704) Astronomy and Astrophysics (P 801)
Prof. R. Nagarajan	Emeritus Professor	Physics Laboratory (PL 101, PL 201, PL 601) Electronics and Instrumentation (G

		201, GL 201)
Prof. S. C. Phatak	Senior Scientist	Computer Basics (G 101) Computer Laboratory (GL 101)
Prof. A. K. Raina	Senior Scientist	Mathematical Physics II (P 401) Fluid Mechanics (P 701)
Prof. Vijay Singh	Raja Ramanna Fellow	Physics – I (P 101) Physics - II (P 201)
Prof. Sujit Tandel	UGC Associate Professor	Statistical Techniques and Applications (G 401) Nuclear Physics - I (P 601) Advanced Physics Laboratory (PL 701)
Prof. Ameeya Bhagwat	Associate Professor	Special Functions &Application (PM 601) Numerical Analysis (PM 501) Numerical Methods Laboratory (PML 501)
Dr. Gargi Shaw	Reader 'F'	Physics Laboratory (PL 301, PL 401) Astronomy and Astrophysics (P 801)
Dr. Sangita Bose	Reader 'F'	Condensed Matter Physics - I (P 602) Condensed Matter Physics - II (P 803) Advance Physics Laboratory (PL 701)
Dr. Ananda Hota	UGC Assistant Professor	Astronomy and Astrophysics (P 801)
Dr. Uma Divakaran	UGC Assistant Professor	Physics –I (P 101) Condensed Matter Physics - I (P 602)
Dr. M. Hemalatha	Assistant Professor	Nuclear Physics - I (P 601) Advance Physics Laboratory (PL 701) Reactor Physics and Radiation Sciences (P 704)
Dr. Bhaskar Khubchandani	Assistant Professor	Physics II (P201) Computational Laboratory and Numerical Methods (GL 401)
Dr. Manojendu Choudhury	Assistant Professor	Computer Basics (G 101) Computer Laboratory (GL 101) Statistical Techniques and Applications (G 401) Numerical Analysis (PM 501) Numerical Methods Laboratory

		(PML 501) Experimental Advanced Astronomy and Astrophysics (PL 801)
Dr. P. Brijesh	Assistant Professor	Physics Laboratory (PL 101) Mathematics II (M 201) Waves and Oscillations (P 304)
Dr. Bhooshan Paradkar	Assistant Professor	Classical Mechanics (P 302) Plasma Physics (PE 1014) Fluid Mechanics (P 701)
Dr. Kaushik Sengupta	Visiting Scientist - II	Physics Laboratory (PL 501, PL 601)
Dr. Sanjeev Kumar	Visiting Scientist - I	Physics Laboratory (PL 501, PL 601)
Dr. Neelam Upadhyay	Visiting Scientist -I	Mathematics –I Mathematics II (M 201)
Dr. Jayashree Roy	Research Associate - I	Experimental Advanced Astronomy and Astrophysics (PL 801)
Dr. Sushil Samant	Research Associate - I	Computer Basics (G 101) Computer Laboratory (GL 101)
Dr. Dinesh Negi	Research Associate - I	-
Dr. Shobha Surve	Research Associate - I	-

2.2 DBT, DST, UGC Scientists

Name of the faculty	Affiliation	Stream	Courses taught in the Academic Year (2015-2016)
Dr. Subhojit Sen	Ramalingaswami Fellow	Biology	Biology Laboratory (BL 601, BL 701) Cancer Biology (BE 1005)
Dr. Ishita Mehta	DST Inspire Faculty	Biology	Biology- I (B 101) Biology Laboratory (BL 301) Chemistry Biology Laboratory(CBL 401) Biology Laboratory (B 601)
Dr. Siddhesh Ghag	DST Inspire Faculty	Biology	-
Dr. Prachi Chandrachud	Dr. D. C. Kothari Fellow	Physics	-
Dr. Tripti Bameta	DST Inspire Faculty	Physics	Mathematical Physics –II (M 401)
Dr. Sanved Kolekar	DST Inspire Faculty	Physics	Mathematics – I (M 100) General Relativity and Cosmology (PE 1004)
Dr. Alpa Dashora	DST Inspire Faculty	Physics	Physics Laboratory (PL 101, PL 201) Physics-II (P 201)

2.3 Adjunct Faculty

Name of the faculty	Affiliation	Courses taught in the Academic Year (2015-2016)
Prof. H. C. Pradhan	Raja Ramanna Fellow Bhabha Atomic Research Centre (BARC), Mumbai	Ethics in Science and Intellectual Property Rights (H601) History and Philosophy of Science (H 302)
Prof. S. Kailas	Raja Ramanna Fellow Bhabha Atomic Research Centre (BARC), Mumbai	Reactor Physics and Radiation Sciences (P 704)
Dr. Swapan Ghosh	Bhabha Atomic Research Centre (BARC), Mumbai	Chemistry - II (C 201) Chemical Kinetics and Reaction Dynamics (PCB 401) Group Theory (C 401) Computational Chemistry (C 804) Mathematics- III (CB 301)
Dr. Srinivas Krishnagopal	Bhabha Atomic Research Centre (BARC), Mumbai	Classical Mechanics (P 302) Accelerator Physics and Applications (P 802)
Prof. H. M. Antia	Tata Institute of Fundamental Research (TIFR) Mumbai	-
Dr. Sudhir R. Jain	Bhabha Atomic Research Centre (BARC), Mumbai	Waves and Oscillations (P 304) Fluid Mechanics (P 701) Dynamical Systems (PE 1002)
Prof. Lokesh Tribedi	Tata Institute of Fundamental Research (TIFR) Mumbai	-
Prof. C.S. Rajan	Tata Institute of Fundamental Research (TIFR) Mumbai	Algebraic Number Theory (M802)
Prof. Sreerup Raychaudhuri	Tata Institute of Fundamental Research (TIFR) Mumbai	-
Dr. D.K. Palit	Bhabha Atomic Research Centre (BARC), Mumbai	Introductory Spectroscopy (CB 401) Photochemistry (C 701)
Prof. G. Ravindrakumar	Tata Institute of Fundamental Research (TIFR) Mumbai	Quantum Optics (PE 1013)
Prof. Raju V. Ramanujan	School of Materials Science and Engineering, Singapore	-

Prof. Narasimhan Chari	D.J. Sanghvi College	Partial Differential Equations (M 704) Computational Mathematics – III (M 805)

2.4 Distinguished Guest Faculty

Name of the faculty	Affiliation	Stream	Courses taught in the Academic Year (2015-2016)
Prof. S. S. Jha	*Formerly* Tata Institute of Fundamental Research (TIFR) Mumbai	Physics	Quantum Mechanics –I (P402)
Prof. P.C. Agrawal	*Formerly* Tata Institute of Fundamental Research (TIFR) Mumbai	Physics	Experimental Advanced Astronomy and Astrophysics (PL 801)
Prof. Chandrashekhar Khare	University of California (Los Angeles)	Mathematics	-
Prof. Shrinivas Kulkarni	California Institute of Technology (Caltech)	Physics	-

2.5 Visiting Faculty

BIOLOGY STREAM		
Name of the faculty	**Affiliation**	**Courses taught in CEBS Academic Year (2015-2016)**
Dr. Aparna Kotekar	iGenetic Diagnostics Pvt Ltd	Molecular Biology (B 401) Biotechnology –I (B 701)
Dr. Bhaskar Saha	St. Xaviers College, Mumbai	Animal Physiology (B 602) Neurobiology (BE 1004) Developmental Biology (B 703)
Dr. Deepak Modi	National Institute of Research in Reproductive Health, (NIRRH), Mumbai	Cell Biology – II (B 502)
Dr. Devashish Rath	Bhabha Atomic Research Centre (BARC), Mumbai	Bioinformatics (B 803)

Dr. Fatema Bhinderwala	Sophia College, Mumbai	Biology Laboratory (BL 801) Neurobiology (B 802)
Dr. Girish Maru	Tata Memorial Centre, Mumbai	Cancer Biology (BE 1005)
Dr. Gracy Rosario	Global Pathways Institute	Biology Laboratory (BL 701) Developmental Biology (B 703)
Dr. Jayashree Sainis	*Formerly* Bhabha Atomic Research Centre (BARC), Mumbai	Plant Physiology (B 603)
Dr. Leon Pareira	Freelancer	Biotechnology (B 804) Biodiversity (B 503)
Prof. M. M Johri	*Formerly* Tata Institute of Fundamental Research (TIFR), Mumbai	Plant Physiology (B 603)
Dr. Mahesh Subramanian	Bhabha Atomic Research Centre (BARC), Mumbai	Biochemistry I (CB 302) Biochemistry – II (CB 402)
Dr. Mandar Karkhanis	South Indian Welfare Society College	Microbiology (B 604) Genetics and Biostatistics (B 501)
Dr. Muktikanta Ray	Bhabha Atomic Research Centre (BARC), Mumbai	Bioinformatics (B 803)
Dr. N. V. Thakkar	*Formarly* Institute of Science	Organometallics & Bio-Inorganic Chemistry (C 703)
Prof. Paike Bhatt	Indian Institute of Technology, Mumbai	Metabolism (BE 1002)
Dr. Radhika Tendulkar	St Xavier's College, Mumbai	Neurobiology (BE 1004)
Dr. Rajendra Shinde	St Xavier's College, Mumbai	Biodiversity (B 503)
Dr. S. K. Apte	*Formerly* Bhabha Atomic Research Centre (BARC), Mumbai	Biology II (B201)
Prof. S. Sivakami	*Formerly* University of Mumbai	Biochemistry II (CB 402)
Dr. Sandeepan Mukherjee	Haffkine Institute , Mumbai	Virology (B801)
Dr. Shatrupa Sinha	Tata Institute of Fundamental Research (TIFR), Mumbai	Cancer Biology (BE 1005) Bioimaging (B 704)
Dr. Shreyasi Thakur	Tata Institute of Fundamental Research (TIFR), Mumbai	Bioimaging (B 704)
Dr. Vainav Patel	National Institute of Research in Reproductive Health, (NIRRH), Mumbai	Immunology (B 601) Immunology- II (B 702)

CHEMISTRY STREAM		
Name of the faculty	**Affiliation**	**Courses taught in CEBS Academic Year (2015-2016)**
Dr. C G S Pillai	*Formerly* Bhabha Atomic Research Centre (BARC), Mumbai	Chemistry of Materials (C 801)
Prof. Evans Coutinho	Bombay College of Pharmacy, Mumbai	Chemistry- I (C 101), Molecular Modeling and Drug Design (BE 1001)
Dr. Gail Carneiro	Sophia College	Organic Chemistry-I (CB 303)
Dr. Gomati Sridhar	KVS Menon College	Organic Chemistry – I (CB 303), Organic Chemistry –IV (C 702)
Dr. Kathi Sudarshan	Bhabha Atomic Research Centre (BARC), Mumbai	Nuclear Chemistry (CE 1001)
Dr. KRS Chandrakumar	Bhabha Atomic Research Centre (BARC), Mumbai	Macro and Supra-molecular Chemistry (C 802) Computational Chemistry (C 804)
Dr. Lakshamy Ravishankar	V.G.Vaze College of Arts, Science & Commerce	Organic Chemistry –IV (C702)
Prof. M. Sudarsanam	*Formerly* University of Mumbai	Chemistry Laboratory (CL 101, , CL 201) Analytical Chemistry (CB 501)
Dr. P. A. Hassan	Bhabha Atomic Research Centre (BARC), Mumbai	Macro and Supra-molecular Chemistry (C 802)
Dr. R.K. Vatsa	Bhabha Atomic Research Centre (BARC), Mumbai	Chemical Kinetics and Reaction Dynamics (PCB 401)
Dr. Rahul Tripathi	Bhabha Atomic Research Centre (BARC), Mumbai	Nuclear Chemistry (CE 1001)
Dr. S. K. Kulshreshtha	Formerly Bhabha Atomic Research Centre (BARC), Mumbai	Inorganic Chemistry – I (C 301)
Dr. Sudha Srivastava	Tata Institute of Fundamental Research (TIFR), Mumbai	Introductory Spectroscopy (CB 401)
Dr. Sunil K. Ghosh	Bhabha Atomic Research Centre (BARC), Mumbai	Physical Organic Chemistry (C 704)
Dr. Tanuja Parulekar	SIWS College	Organic Chemistry – I (CB 303),
Dr. Vinayak Rane	Tata Institute of Fundamental Research (TIFR), Mumbai	Quantum Chemistry (BE 1006)

MATHEMATICS STREAM		
Name of the faculty	**Affiliation**	**Courses taught in CEBS Academic Year (2015-2016)**
Prof. Ajit Kumar	Institute of Chemical Technology (ICT), Mumbai	Computational Mathematics -I (M 305), Computational Mathematics II (M 405, M605)
Prof. Alladi Subramanyam	Indian Institute of Technology (IIT-B), Mumbai	Stochastic Analysis (M 703) Probability Theory (M 605)
Prof. Amitava Bhattacharya	Tata Institute of Fundamental Research, Mumbai	Combinatory and Enumeration (ME 1002)
Prof. Ananth Hariharan	Indian Institute of Technology (IIT-B), Mumbai	Algebra II (M 402) Algebra I (M 303)
Dr. Aniket Sule	Homi Bhabha Centre for Science Education (HBCSE), Mumbai	Mathematics I & II (M 100, 200)
Dr. Anshu Gupta	IUCAA, Pune	Differential Geometry and Applications (M 603)
Prof. Inder K. Rana	Indian Institute of Technology (IIT-B), Mumbai	Analysis II (M 401), Analysis III (M501)
Dr. Joseph Amalnathan	Bhabha Atomic Research Centre (BARC), Mumbai	Mathematics I (M 101)
Prof. Jyotsa Dani	*Formerly,* St. Xavier College	Elementary Number Theory (M 403), Analysis I (M302)
Dr. Kiran Kolwankar	R. J. College, Ghatkopar	Differential Equations and Dynamic Systems (M 604)
Prof. M. G. Nadkarni	University of Mumbai	Introduction to Ergodic Theory (ME 1001)
Prof. Mahadeo Bakre	Formerly University of Mumbai	Fourier Analysis (M 801) Functional Analysis (M 701)
Prof. Parvati Shastri	Indian Institute of Technology (IIT-B), Mumbai	Algebra –I V(M 602), Algebra –III (M 502)
Dr. Prithwijit De	Homi Bhabha Centre for Science Education (HBCSE), Mumbai	Graph Theory (M 504)
Prof. R. C. Cowsik	Formerly University of Mumbai	Topology I (M404) Topology – II (M 503)
Prof. R. M. Pawale	University of Mumbai	Discrete Mathematics (M 304)
Dr. Ravi Aithal	University of Mumbai	Analysis –IV (M 601)
Dr. Richard D'Souza	Bhabha Atomic Research Centre (BARC), Mumbai	Mathematics II (M 201) Atomic & Molecular Physics (P 503)
Prof. S. Baskar	Indian Institute of Technology (IIT-B), Mumbai	Advanced Numerical Techniques (ME 1003)

Prof. S. Krishnan	Indian Institute of Technology (IIT-B), Mumbai	Representation Theory of Finite Groups (M 705)
Dr. Swapnil Jawkar	Homi Bhabha Centre for Science Education (HBCSE), Mumbai	Mathematics I & II (M 100, 200)
PHYSICS STREAM		
Name of the faculty	**Affiliation**	**Courses taught in CEBS Academic Year (2015-2016)**
Prof. Achanta Venugopal	Tata Institute of Fundamental Research, Mumbai	Condensed Matter Physics –II (P 803)
Dr. Anwesh Majumdar	Homi Bhabha Centre for Science Education (HBCSE), Mumbai	Electromagnetism (P 303)
Prof. Arvind Kumar	*Formerly* Homi Bhabha Centre for Science Education (HBCSE), Mumbai	Quantum Mechanics II (P 601), Quantum Mechanics III (P 702)
Dr. D. Biswas	Bhabha Atomic Research Centre (BARC), Mumbai	Non-Linear Dynamics and Chaos (P 605, P703)
Prof. D. C. Kothari	University of Mumbai	Nanotechnology (PE 1011)
Prof. Dipan Ghosh	Indian Institute of Technology (IIT-B), Mumbai	Quantum Computing & Information (PE 1007) Classical Mechanics- II (P502)
Prof. G. Mukhopadhaya	Indian Institute of Technology, Mumbai	Classical Electrodynamics (P604)
Prof. Kailash Rustagi	Indian Institute of Technology, Mumbai	Electrodynamics (P 804)
Dr. Karthik Subbu	Mithibhai College	Applied Electronics Laboratory (GL 301)
Dr. Kartik Patel	Bhabha Atomic Research Centre (BARC), Mumbai	Computational Electrodynamics (PE 1010)
Prof. Manohar Nyayate	B. N. Bandodkar College, Thane	Physics Laboratory (PL 501, PL 601)
Prof. Nilamani Mathur	Tata Institute of Fundamental Research, Mumbai	Particle Physics (PE 1001)
Prof. P. Shashidhran	Vertak College	Applied Electronics Laboratory (GL 301)
Dr. Praveen Pathak	Homi Bhabha Centre for Science Education (HBCSE), Mumbai	Physics I (P 101) Physics II (P201) Electromagnetism (P 303),
Prof. Rajan Chitalay	Mithibai College, Vile Parle	Electronics and Instrumentation (G201)
Prof. S. H. Patil	Indian Institute of Technology (IIT-B), Mumbai	Statistical Mechanics –I (P403) Mathematical Physics-I (P 301),
Dr. S. K. Singh	Bhabha Atomic Research	Reactor Physics and Radiation

	Centre (BARC), Mumbai	Sciences (P 704)
Dr. Tushima Basak	Mithibai College, Vile Parle	Physics Laboratory (PL 301, PL 401)
Dr. Wendrich Soars	Vikash College	Physics Laboratory (PL 101) Applied Electronics Laboratory (GL 301)
General subjects etc.		
Name of the faculty	**Affiliation**	**Courses taught in CEBS Academic Year (2015-2016)**
Prof. Nilufer Bharucha	*Formerly* University of Mumbai	Communication Skills (H 101, H 201) World Literature-II (H 401)
Prof. Sridhar Rajeswaran	University of Mumbai	Communication Skills (H 101, H 201) World Literature-II (H 401)
Dr. N. S. Basavaiya	Bhabha Atomic Research Centre (BARC), Mumbai	Earth Science and Energy & Environmental Sciences (G 501)
Dr. S. K. Arora	Bhabha Atomic Research Centre (BARC), Mumbai	Earth Science and Energy & Environmental Sciences (G 501)
Prof. G. Nagarjuna	Homi Bhabha Centre for Science Education (HBCSE), Mumbai	History and Philosophy of Science (H 302)

Administration and Support

3.1 Administration

Name of Staff	Designation
Mr. K. P. Balakrishnan	Registrar
Dr. Jayant Kayarkar	Consultant (Admin & Accounts)
Mr. Kishore Menon	Advisor
Mr. B. L. Bhargava	Consultant (Building & Construction)
Mr. Milind Ashrit	Consultant (Finance)
Mr. Deepak P Hate	Consultant (Purchase)
Ms. Swati V. Kolekar	Office Superintendent (Admin)
Ms. Vaishali M. Kedar	Office Superintendent (Admin)
Ms. Rupali Shringare	Office Superintendent (Finance)
Ms. Neha Dandekar	Office Superintendent (Finance)
Mr. Prashant Gurav	Systems Assistant
Ms. Veena Naik	Office Assistant (Purchase & Store)
Mr. Nitesh Kadam	Hostel Assistant
Ms. Divya Sukumaran	Office Assistant (Multi Skill)
Ms. Vaibhavi Nerurkar	Office Assistant (Finance)
Mr. Amit Shetkar	Library Attendant
Mr. Maruti Khot	Office Attendant
Mr. Tushar Bandkar	Technician (Electrical)

3.2 Support

Laboratory Attendants

Mr. Ram M. Soure	Physics
Mr. Dinesh B. Desai	Physics
Mr. Santosh Sood	Biology
Ms. Rupesh Kamtekar	Chemistry
Mr. Abhay Bakalkar	Nuclear Physics & Computer
Mr. Harish Hira Singh	Biology
Mr. Rahul Shinde	Biology
Mr. Abhijit Ghag	Chemistry

Scientific Assistants

Mr. Kanak Gawde	Biology
Ms. Sonali Shiriskar	Chemistry
Mr. Ajayweer Gautam	Biology
Mr. Nikhil Kadlag	Biology

Senior Research Fellow (SRF)

Mr. Venkataramana G. Rao	Biology

Junior Research Fellow (JRF)

Mr. Namrata Maladkar	Physics
Mr. S. Gholam Wahid	Physics
Mr. Plawan Das	Mathematics
Ms. Swati Dixit	Chemistry
Ms. Poulomi Roy	Physics
Mr. Devesh Kumar	Physics

Senior Project Assistant (SPA)

Ms. Marilyn Sequeira	Biology

Junior Project Assistant (JPA)

Ms. Pradnya G. Parab	Physics
Mr. Domnic Colvin	Chemistry
Ms. Samridhi Phatak	Chemistry
Mr. Snehal Kaginkar	Biology
Ms. Tejashree Mahaddalkar	Biology
Ms. Pooja Potadar	Biology
Ms. Prabhjyot Bhui	Physics
Ms. Neha Vispute	Chemistry
Ms. Shreyada Save	Chemistry
Ms. Anuradha Kharde	Chemistry
Ms. Katherine Rawlins	Physics

Students

4. Students

4.1 Student intake

The intake of students is based on the nation-level entrance test, called the National Entrance Screening Test (NEST), that is held in several Centres all over India. Students who have passed their 12th standard or equivalent examination from any board in India are eligible to enroll for the test. This year, the test was conducted in 99 centres all over India.

National Entrance Screening Test (NEST)

Year	No. of Students enrolled for the NEST	No. of Students appeared for the NEST	No. of students selected in CEBS
2007	~5600	~3300	21
2008	~8200	~7000	11
2009	14105	12036	25
2010	16686	9453	30
2011	14500	9691	36
2012	15099	10775	35
2013	24543	19436	30
2014	45519	29645	35
2015	46615	30823	40

4.2 Students admitted in the academic year 2015-16

Sr. No.	M/F	Name of the Student	State of Origin
1	F	Ms. Akansha Shah	Uttar Pradesh
2	F	Ms. Amrita P.	Tamil Nadu
3	M	Mr. Apurva Singh	Uttar Pradesh
4	M	Mr. Arindam Ghosh	West Bengal
5	M	Mr. Arujash Mohanty	Orissa
6	M	Mr. Atthaluri Shashank	Telangana
7	M	Mr. Chanderpal	Haryana

Sr. No.	M/F	Name of the Student	State of Origin
8	F	Ms. Chhavi Bansal	Maharashtra
9	F	Ms. Chitra Murmu	Madhya Pradesh
10	M	Mr. Fawaz Abdul Latheef P K	Kerala
11	M	Mr. Gaurav Singh	Uttar Pradesh
12	F	Ms. Helly Chetan Jadav	Gujarat
13	M	Mr. Ishan J. Varma	Gujarat
14	M	Mr. K. Gnana Maheswar	Andhra Pradesh
15	M	Mr. Lakshya Gupta	Rajasthan
16	M	Mr. Manu T	Kerala
17	F	Ms. Mausam Rana	Himachal Pradesh
18	M	Mr. Mohammed Nisham	Kerala
19	F	Ms. Neha Srivastava	Uttar Pradesh
20	M	Mr. Nikhil Vishwanath Belure	Maharashtra
21	M	Mr. Nizam Ahmad	Uttar Pradesh
22	M	Mr. Palemokota Maithresh	Telangana
23	M	Mr. Prabhu Prasad Swain	Orissa
24	M	Mr. Pushpendra Yadav	Uttar Pradesh
25	M	Mr. Rakesh Kumar Saini	Rajasthan
26	M	Mr. Raman Rishi	Jharkand
27	M	Mr. Ramchandra Saha	West Bengal
28	M	Mr. Remulla Sujith	Karnataka
29	M	Mr. Rishabh Nain	Uttar Pradesh
30	F	Ms. S. Dhanlakshmi	Tamil Nadu
31	M	Mr. Saurav Kumar	Bihar
32	M	Mr. Shubham Gupta	Jammu & Kashmir
33	M	Mr. Sparsh Gupta	Rajasthan
34	F	Ms. Srishti Priya	Jharkand
35	F	Ms. Sukriti Santra	West Bengal
36	M	Mr. Vaibhav Varma	Chandigarh
37	M	Mr. Vibhu Vaibhav	Jharkand
38	M	Mr. Vishal Gupta	Maharashtra
39	M	Mr. Vivek Vishwanath Adole	Maharashtra
40	M	Mr. Yash Bajpai	Chandigarh

State wise distribution students admitted in the year 2015-16:

State of origin	No. of students admitted
Andhra Pradesh	01
Bihar	01
Chandigarh	02
Gujarat	02
Harayana	01
Himachal Pradesh	01
Jammu & Kashmir	01
Jharkand	03
Karnataka	01
Kerala	03
Madhya Pradesh	01
Maharashtra	04
Orissa	02
Rajasthan	03
Tamil Nadu	02
Telangana	02
Uttar Pradesh	07
West Bengal	03
Total	**40**

4.3 Achievements of students

- **Asian Science Camp**

The Ninth Asian Science Camp-2015 was held at Thailand during August 02-08, 2015.

1. Mr. Swapnil Shankar
2. Mr. Anton

- **Aptitude Test in Chemistry**

Ms. Karunya Dhevi has got 2nd place in the Aptitute test in Chemistry conducted by the Indian chemical society

4.4 Students placements who graduated in the year 2016:

Sr.no	Name of the Student	Offer accepted from
1.	Mr. Ajay C. J.	EPFL- Lausanne, Switzerland, Rochester University and University of Texas, Austin, USA
2.	Mr. Prashant Kumar Chauhan	Graduate Fellow at Johns Hopkins University, USA
3.	Mr. Swami Vivekanandji Chaurasia	Ph. D. Theoretical Physics Inst, Germany
4.	Mr. Kishen Balwant Priyadarshi	Information not available
5.	Mr. Krishnadev N.	Information not available
6.	Mr. Ayush Kumar Mandwal	Ph. D. at University of Calgary, Canada
7.	Mr. Bhishek Manek	Ph. D. at University of California, Santa Cruz, USA,
8.	Mr. Somendu Kumar Maurya	Ph.D. University of Waterloo, Canada
9.	Mr. Anurag Patel	JPA at CEBS
10.	Mr. Mohammad Saifullah	Project Trainee @ BARC
11.	Mr. Saket Suman	JPA at CEBS
12.	Ms. Phalguni Shah	Ph. D. at Department of Physics and Astronomy, Northwestern University
13.	Mr. Ankush Singhal	Ph. D. at Max Planck Institute of Colloids and Interfaces
14.	Mr. Abhijith R. Varma	-
15.	Mr. Benny Joji K.	Information not available
16.	Mr. Ashok Choudhary	Information not available
17.	Ms. Divya	Information not available
18.	Mr. Karan S. Khathuria	Ph. D. at Universität Zürich, Switzerland
19.	Mr. Vishal Padwal	Northwestern University, USA
20.	Mr. Praneel Samanta	JPA at CEBS
21.	Mr. Anil Kumar	JPA at CEBS
22.	Ms. Sumalata Sonavane	JPA at CEBS
23.	Mr. Tinku Kumar	Information not available
24.	Mr. Akshay Malwade	Ph. D. The Institut Pasteur, Paris, France
25.	Ms. Neha Mohanpuria	Ph. D. Gustave Roussy, France
26.	Ms. Anushree Ray	JPA at CEBS
27.	Mr. Kasuba Krishna Chaitanya	Visiting scientist at EMBL Germany

4.5 M.Sc. dissertation projects done by final year students:

Sr.No.	Name of the Student	Guide	Brief Title
Biology			
1.	Chaitanya Krishna Kasuba	Dr. Ch. Mohan Rao (CCMB)	Interaction of alphaB-crystallin and its phosphorylation mimicking mutants with other proteins in the context of human disease"
2.	Akshay Malwade	Dr. Brian Ingalls (University of Waterloo)	Mathematical Modelling of Quantitative Assay for Bacterial Conjugation"
3.	Anushree Ray	Dr. Anindya Ghosh Roy (NBRC)	Post translational modifications in tubulins of neuronal cells"
4.	Neha Mohanpuria	Dr. Guillaume Montagnac (Gustave Roussy Institute)	Analysis of aTAT1 diffusion in the lumen of microtubules
Chemistry			
5.	Mr. Tinku Kumar	Dr. Vinayak Rane (TIFR)	Photophysical quenching of pyrene by tempo radical : preliminary results
6.	Ms. Sumalata Sonawane	Dr. Shachi Gosavi from National Center for Biological Sciences (NCBS), Bangalore	Understanding the unusual florescence change in C-terminal domain of MK0293
7.	Mr. Anil Kumar	Prof. P M Dongre Head,Dept. Of Biophysics University of Mumbai	A model for the formation of protofibrils of a multidomain protein under native-like condition.
Mathematics			
8.	Mr. Karan Khathuria	Prof. Amitava Bhattacharya (TIFR)	Polyhedral combinatorics
9.	Ms. Divya	Prof. C. S. Rajan (TIFR)	The arithmetic of ellipptic curves and modular forms
10.	Mr. Joji Benny	Prof. A. J. Parameswaran (TIFR)	Differential topology
11.	Mr. Ashok Chaudhary	Prof. S Baskar (IIT-B)	ENO methods for Hamilton Jacobi equations
12.	Mr. Vishal Padwal	Prof. Narasimhan Chari (D. J. Sanghavi College)	Characterizations of regular local rings

Physics			
13.	Mr. Ankush Singhal	Dr. Swapan Ghosh (BARC)	Electronics Structure of Two-Dimensional Carbon-based Nanostructures: A Computational Investigation
14.	Mr. Swami Vivekanandaji Chaurasia	Dr. P. Ajith (ICTS) and Prof. M Hannam (cardif University)	Gaug Dynamics in Numerail Relativity
15.	Mr. Somendu Maurya	Prof. Achanta Venugopal (TIFR)	Photonic and Plasmonic Nanostructures for Ligh-Matter Interaction
16.	Mr. Phalguni Shah	Prof. Deepak Dhar (TIFR)	Propartionate growth in sandplie model
17.	Mr. Saket Suman	Prof. Sujit Tandel (CEBS)	Nanosecond Lifetime measurement technique for nuclear excited states
18.	Mr. Mohammad Saifullah	Dr. Prashant Shukla (BARC)	Cold Nuclear Matter Effects in production of Heavy Quarks
19.	Mr. Ajay C. J.	Dr. Srinivas Krishnagopal (BARC, CEBS)	Theory of Wavebreaking and Injection in Density Trasition Scheme in Laser Wakefield Acceleration
20.	Mr. Abhijith Varma	Shravan Hanasoge	Wave Propagation in the Presence of Magnetic Field
21.	Mr. Bhishek Manek	Prof. S. M. Chitre (CEBS) and Dr. Bhooshan Paradkar (CEBS)	Meridional Circulation in the Sun
22.	Mr. Anurag Patel	Dr. M. Hemalatha (CEBS and Dr. S. Kailas (BARC, CEBS)	Excitation function of (p.n) reaction on Zn isotopes
23.	Mr. Ayush Kumar Madwal	Dr. Sudhir Jain (BARC, CEBS)	Classical and Quantum double pendulum

4.6 Ph. D. Programme

The following CEBS students are registered for their Ph.D from University of Mumbai. Since Ph.D. Programme not formally approved at CEBS, the students are registered with Faculty member of University of Mumbai, but their research work is carried out at CEBS under the guidance of a CEBS Faculty member. It is hoped that this program, together with other academic programs, will start soon.

Name of the student	Guide in CEBS	Guide under whom registered
Ms Dolly Khona (PhD awarded)	Prof. Jacinta D'Souza	Prof. Manjushree Deodhar
Mr Venkataraman Rao (Thesis submitted)	Prof. Jacinta D'Souza	Prof. P. M. Dongre
Ms Pradnya Parab	Dr. Sangita Bose	Under process
Mr S. Gholam Wahid	Prof. Sujit Tandel	Under process

Awards and Honors and other Recognition

5. Awards and Honors

R.V. Hosur

- Distinguished IIT Alumnus Award of IIT Bombay, Mumbai.
- Elected to the ISMAR Council

Sinjan Choudhary

- "Professor Shantilal Oswal Young Scientist Award" in recognition of the research work in Thermodynamics and Bioenergetics, awarded by Indian Thermodynamics Society, Punjab University, Chandigarh

Sangita Bose

- Young Achievers Award, 2015 in Solid State Physics given by DAE-SSPS.

5.1 Other recognition like travel award, memberships of committees, societies etc.

Manu Lopus

- Guest Editor, Current Topics in Medicinal Chemistry
- Travel award from the Centre for International Co-operation in Science (CICS), Chennai, to attend 20th World Congress on Advances in Oncology and 18th International Symposium on Molecular Medicine, Athens, Greece.

Sinjan Choudhary

- Life membership of Indian Thermodynamics Society, India.

Ameeya Bhagwat

- Member of Organising Committee for the annual DAE-BRNS Nuclear Physics Symposium.

Gargi Shaw

- One of the Judges for National Science Seminar, 2015 (National Science Centre, Delhi)
- One of the Judges for the Western India Science Fair, 2016 (Nehru Science Centre, Mumbai)
- One of the judges for the **Elocution competition on the topic "Innovate and Cherish" for school students at Nehru Science Centre, 2016**

M. Hemalatha

- Member, Steering Committee, National Assessment and Accreditation Council *(*NAAC*),* University of Mumbai.
- Member, Indian Laser Association.

Neelam Upadhyay

- Received funding approval for the project titled "Identication of resonances in reactions of astrophysical interest" by Science and Engineering Research Board (SERB) under Start up Research Grant (Young Scientist) scheme.

Sangita Bose

- International Travel grant from the Department of Science and Technology, (Full air-fare) to attend the workshop on "Superconductivity at the verge" in Leiden, Netherlands, 2015.
- Continued as a member of Board of Studies (BOS) for physics department of St. Xavier's College, Mumbai.

Sujit Tandel

- Member of Syllabus Committee of Department of Physics, University of Mumbai

Sushil Samant

- Acted as referee for international journals such as Physics of plasmas and Plasma physics and Controlled Fusion.

Research Activities

6.1 Research Activities of Department of Biology

Jacinta D'Souza:

Identification, Isolation and Characterization of Multiprotein Complexes

Proteins are the cellular workhorses that rarely function alone. A **Multiprotein Complex (MPC)** is a cluster of two/more associated polypeptides, forming a quaternary structure linked by non-covalent interactions. MPCs form the cornerstone of most biological processes and together perform a vast array of biological functions. They are broadly classified as stable and transient. This laboratory has successfully established two platforms to address the cellular function of both a stable and transient MPCs using the biflagellated, unicellular alga *Chlamydomonas reinhardtii*.

Identification and isolation of stable FAP174-AKAP240 complex from the flagellum:

Flagella/cilia are fine thread-like organelles of motility protruding from several cells. Although the mechanistic details of motility remain elusive, the dynein-driven motility is regulated by various kinases and phosphatases. A-kinase anchoring proteins (AKAPs) are scaffolds that tether several signalling proteins. AKAPs possess a domain that *in vitro* interacts with the regulatory subunits (RI and RII) present in the cAMP-dependent protein kinase (PKA) holoenzyme. These subunits conventionally harbour contiguous stretches of a.a. residues that reveal the presence of the Dimerization Docking (D/D) domain, Catalytic interface domain and cAMP-Binding domain. Based on their RII-binding property, the *C. reinhardtii* flagella show the presence of two AKAPs (AKAP97 or RSP3 and AKAP240). Interestingly, AKAP97 binds *in vivo* to two RII-like proteins (RSP7 and RSP11) that contain only the D/D domain.

This study has found a *Chlamydomonas* Flagellar Associated Protein (FAP174) orthologous to MYCBP-1, a protein that binds to organellar AKAPs and Myc onco-protein. An *in silico* analysis showed that the N-terminus of FAP174 is similar to those RII domain-containing proteins that have binding affinities to AKAPs. Binding of FAP174 was tested with the AKAP97/RSP3 using *in vitro* pull-down assays; however, this binding was rather weak with AKAP97/RSP3. Using Western blotting and immunofluorescence approach, FAP174 protein was shown to localize to the central pair of the axoneme. Overlay assays showed that it binds to AKAP240 previously identified in the C2 portion of the central pair apparatus. It appears that the flagella of *C. reinhardtii* contain proteins that bind to AKAPs and except for the D/D domain, lack the conventional a.a. stretches of PKA regulatory subunits (RSP7 and RSP11); and, FAP174 is added to this growing list (*Venkatramanan G. Rao, Ruhi B. Sarafdar, Twinkle S. Chowdhury, Priyanka Sivadas, Pinfen Yang and Jacinta S. D'Souza*).

TheFAP174 D/D domain viz. C46 and its neighbouring residues in FAP174 seem to be a plausible interactor of AKAP. More importantly, the D/D domain is under the control of a motif consisting of VLVs that stretches from the 21st to 27th positions in the protein. Computer-assisted prediction of the secondary structure revealed that FAP174 WT is made

of α-helices, and the two VLV stretches are part of these. The role of the VLV stretches in dimerization of the recombinant WT and three variants, FAP174VLV21-23AAA, FAP174VLV25-27AAA, and FAP174C46A was evident by CD, FT-IR, and micro-Raman spectroscopy. While the mutations showed no effect on the secondary structure as well as on the predicted tertiary structure of the proteins, mapping the interaction networks exposed the hidden role that the VLVs have on the dimerization propensity of C46 (*Venkatramanan G. Rao, Yogesh Ashtkar, Elvis Martis, Evans Coutinho, Holger Gohlke, Santhosh Chidangil and JS D'Souza*).

Identification of aberrant Multiprotein complexes in flagellar mutants:

Genetic analysis of flagellar length control has revealed a number of genes involved in flagellar length determination. The long-flagella mutants (*lf1*, *lf2*, *lf3* and *lf4*) of *C. reinhardtii* are defective in proteins that lead to the assembly of abnormally long flagella. In a previous study, these mutants were characterized for their waveform patterns, swimming speed, beat frequencies and correlated these with their flagellar lengths. An anomaly in this correlation was detected and the underlying molecular significance is now being explored. The diverse inner dynein isoforms are one of the flagellar motors that convert the chemical energy of ATP into the mechanical energy of motility. The presence of these isoforms in the *lf* mutants was probed; and compared with the wild-type. The ratio of the dynein isoform, DHC11 in the *lf* mutants was scored as defective (*Marilyn P. Sequeira, Sapna Sinha, Mustafa Motiwala, Venkatramanan G. Rao, Toshiki Yagi, and JS D'Souza*).

Identification of transient protein complexes involved in the stress-induced physiology of Chlamydomonas reinhardtii: a question of survival versus death

This study showed that the vegetative cells of *C. reinhardtii* respond differentially to abiotic stress. Cells exposed to NaCl adopt a survival strategy and form palmelloids. The hallmarks of palmelloidy have been established by evaluating the lipid, starch and exopolysaccharide content of these cells and the spent medium reveals strong connection with cell wall proteins in the formation of palmelloidy (*Dolly K. Khona, Kanak Gawde, Erik Hom and Jacinta S. D'Souza*). On the other hand, cells exposed to H_2O_2, Menadione, Sorbitol and KCl have resulted in classical PCD; characterized by the morphological, physiological, biochemical, and molecular hallmarks (*Sirisha VL, Kanak Gawde, Mahuya Sinha, Seema Shirolikar and JS D'Souza*).

This leads to the crucial question of stress-induced survival and death in *C. reinhardtii*. In order to dissect this phenomenon, three molecules have been selected: (1) a Caspase-3-like protein (CrMC2) that might play a role in the stress-induced PCD process; and, its molecular complex is being identified (*Kasuba Chaitanya K. and Jacinta S. D'Souza*). (2) a GSK3β protein that might play a decisive role in leading the cells to a necrotic or an apoptotic type of cell death upon exposure to stress (*Sirisha VL, Prasad C. Kalamkar and Jacinta S. D'Souza*) (3) a survival protein, BolA whose expression increases under surviving conditions and decreases with death-inducing conditions. In order to identify the molecular

complex of CrBolA protein; the several GRX's from *C. reinhardtii* have been cloned, individually expressed in *E. coli* and purified for conducting a one-to-one interaction study (*Dolly K. Khona, Pratik K. Mandal, Maryam Khan and Jacinta S. D'Souza*).

Collaborative work:

Preparation of Ag and Au nanoparticles and their applications: Ag and Au nanoparticles have been prepared using two novel methods and these are being explored for their applications (*Sourabh Mehta, H. Muthurajan, and JS D'Souza*).

Optical control of filamentation-induced damage to DNA by intense, ultrashort, near-infrared laser pulses: This study reports the damage to DNA in an aqueous medium induced by ultrashort pulses of intense light of 800 nm wavelength. Focusing of such pulses, using lenses of various focal lengths, induces plasma formation within the aqueous medium. Such plasma can have a spatial extent that is far in excess of the Rayleigh range. In the case of water, the resulting ionization and dissociation gives rise to in situ generation of low-energy electrons and OH-radicals. Interactions of these with plasmid DNA produce nicks in the DNA backbone: single strand breaks (SSBs) are induced as are, at higher intensities, double strand breaks (DSBs). Systematic quantification of SSBs and DSBs at different values of incident laser energy and under different external focusing conditions reveals that damage occurs in two distinct regimes. Numerical aperture is the experimental handle that delineates the two regimes, permitting simple optical control over the extent of DNA damage (*AK Dharmadhikari, JA Dharmadhikari, Kasuba Chaitanya K, Harish Bharambe, JS D'Souza and D. Mathur*).

Characterizing molecular components and regulation of excision repair in *Chlamydomonas reinhardtii*: *C. reinhardtii* exhibits diurnal variations in UV sensitivity, a largely conserved phenotype amongst photosynthetic organisms and such variations, at least partially, originate because of modulations in DNA repair efficiency by photosynthetic apparatus. It is capable of excision repair and homologous recombination. Regulation of DNA repair by photosynthetic activity, repair activities despite absence of certain key proteins, extremely low HR frequency and aggressive foreign DNA inactivation are some of the features that remain elusive. Despite being a good candidate for DNA repair studies, the system has shown relatively less progress in understanding and defining the molecular machinery largely due to difficulties in targeted gene inactivation or silencing and overexpressing transgenes. The current study has created a method to prepare Nucleotide excision repair proficient extracts from *C. reinhardtii*. Using the same assay condition and pull-down approaches with immobilized DNA, it is possible to achieve few interesting goals. Firstly, it provides a much cleaner platform to isolate participating proteins. Secondly, it would be possible to learn if *C. reinhardtii* is capable of transcription-coupled repair, in which a stalled RNA pol recruits repair machinery. Thirdly, comparing pull down proteins from wild type vs repair mutants (already available and mostly uncharacterized) provides an opportunity to identify their genetic lesions, making them a robust tool for further studies. And lastly, knowing the repair proteome paves the way to understanding its regulation by

photosynthetic activity. They have prepared and validated NER active extracts. And, have also prepared biotin end-labelled DNA, which will be immobilized on streptavidin coated beads. Currently, they are standardizing the immobilization of DNA substrate with streptavidin coated magnetic beads and also standardizing crosslinking parameters for DNA-protein crosslinking using formaldehyde and methylene blue. Crosslinking is important to preserve weak interaction for further analysis. The plan is to pull down samples and send them for I-TRAQ analysis for comparison of proteome between UV damaged and undamaged DNA (*Vishalsingh Chaudhari, Jacinta S. D'Souza and B. J. Rao*).

Manu Lopus

Structural investigations into the binding mode of a novel noscapine analogue, 9-(4-vinylphenyl) noscapine, with tubulin by biochemical analyses and molecular dynamic simulations

Drug resistance associated with β_{III} tubulin isotype often poses a challenge to tubulin-targeted cancer chemotherapy. To identify effective therapeutics to address this problem, Dr. Lopus's laboratory (Experimental Cancer Therapeutics and Chemical Biology Lab) investigated the tubulin-binding interactions of 9-(4-vinylphenyl) noscapine (VinPhe-Nos), a potent analogue of noscapine with higher antiproliferative efficacy against multiple cancer cell lines than noscapine. In the current study, VinPhe-Nos showed six-times lower half-maximal inhibitory concentration (IC_{50}) for MDA-MB-231 cell viability than noscapine. The noscapinoid perturbed the secondary structure of tubulin, altered its surface configurations, and enhanced colchicine binding to tubulin, without altering microtubule polymer mass. To test its binding affinities to tubulin isotypes, they docked VinPhe-Nos onto the binding pocket on all known βtubulin isotypes using a Glide XP-program. VinPhe-Nos showed the lowest binding score of -7.905 kcal/mol with $\alpha\beta_{III}$ tubulin, compared to the other isotypes. Molecular dynamic simulation studies revealed that β_{III} tubulin used the largest number of hydrogen bonds (five) for its binding interaction with VinPhe-Nos. In addition, the lowest predictive binding energy (-98.397 kcal/mol) of VinPhe-Nos with β_{III} tubulin compared to other isotypes substantiate that VinPhe-Nos preferentially targetsβ_{III} tubulin. Their findings suggest that VinPhe-Nos may be explored for the treatment of β_{III} tubulin–overexpressing neoplasms.

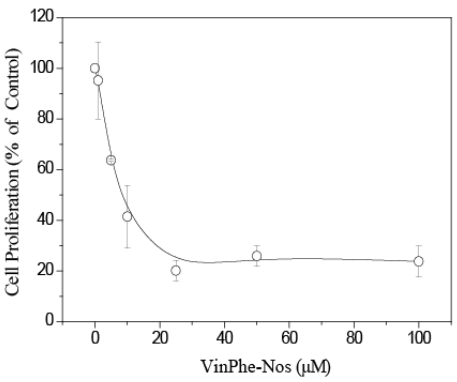
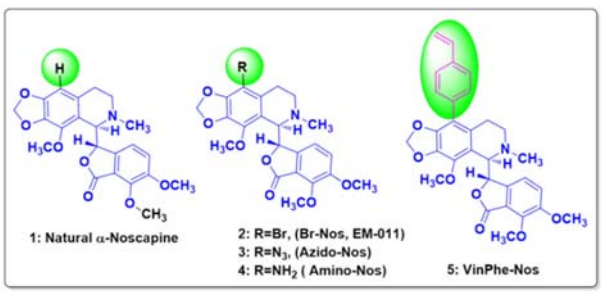


Figure 1.1.1 Left. Inhibition of TNBC cell proliferation by VinPhe-Nos. Below. Development of VinPhe-Nos



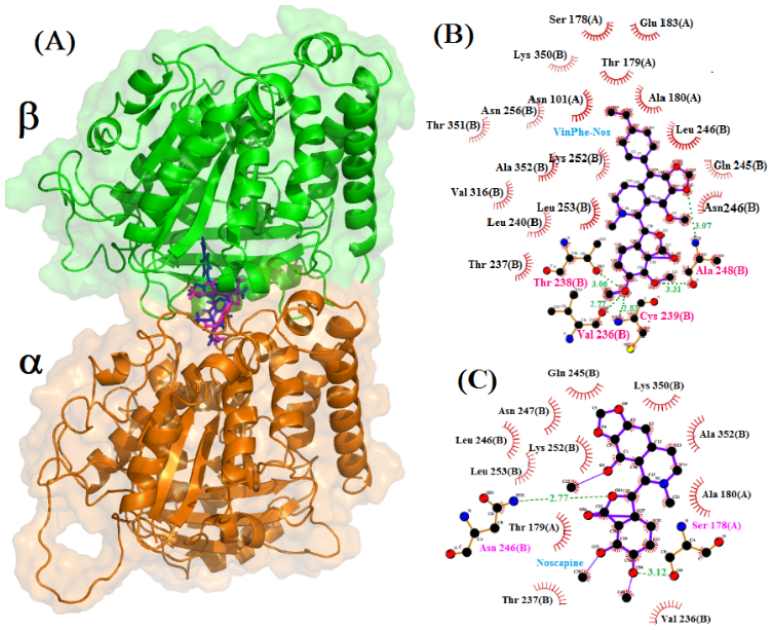


Figure 1.1.2. Comparison of binding mode of VinPhe-Nos and noscapine with beta III tubulin isotypes

(Collaborators, in house staff, and students: Ms. Tejashree Mahaddalkar, CEBS, Prof. Pradeep Naik, Guru Ghasidas Central University, Dr. Srinivas Kantevari IICT, Hyderabad, and Dr. Sinjan Choudhary, CEBS)

Subtle alteration of microtubule assembly dynamics and disruption of mitochondrial network integrity as anticancer strategy

In this work, a novel anticancer therapeutic strategy was investigated. Using known antitubulin ligands that mildly affect the structural integrity and assembly dynamics of tubulin, Dr. Lopus's group examined if by subtly disrupting microtubule dynamics, cancer cell proliferation can be inhibited. Using confocal imaging of drug-treated, pDsRed2-mito vector-transfected cells, they found that such treatment with a mild tubulin poison, Br-TMB-Nos can induce substantial fragmentation of cellular mitochondrial network. GFP-Light Chain protein 3 (GFP-LC3)-expressing cancer cells showed a robust induction of autophagy in drug-treated cells, demonstrating the cellular stress response against the drug. Since the majority of microtubule-targeted drug produce severe side effects due to their propensity to grossly damage microtubules of normal cells as well, the Group's findings provide a potential alternative with the use of milder antitubulin agents. Currently, the laboratory is investigating whether the mitochondrial fragmentation can be selectively induced in cancer cells to further reduce undesirable side effects.

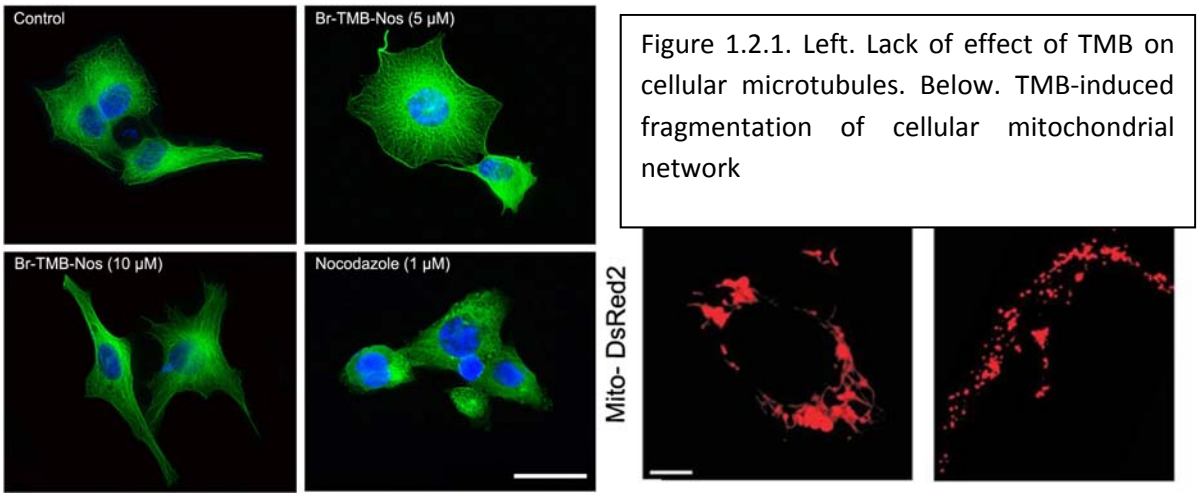


Figure 1.2.1. Left. Lack of effect of TMB on cellular microtubules. Below. TMB-induced fragmentation of cellular mitochondrial network

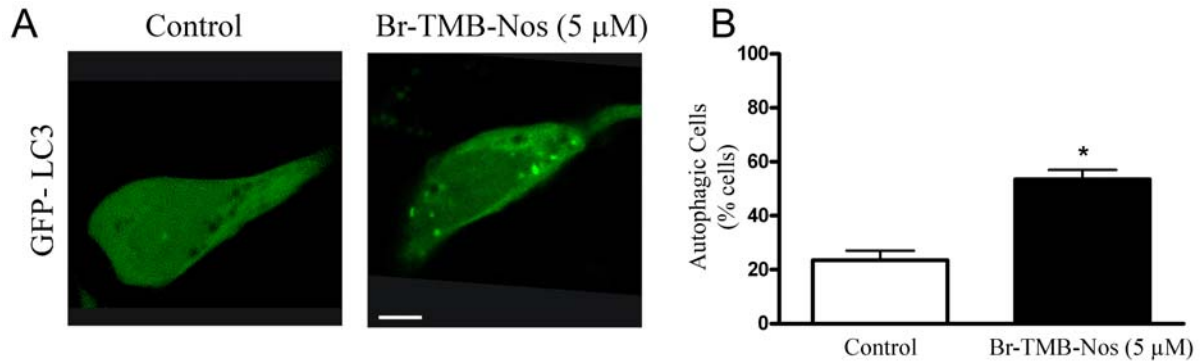


Figure 1.2.2. Formation of autophagosomes in drug-treated cells

(Collaborators, in-house staff, and students: Dr. Sanith C, CEBS, Prof. Joaquin Jordan, University of La-Mancha, Spain, Dr. Srinivas Kantevari IICT, Hyderabad, and Ms. Neha Mohanpuria, CEBS student)

Biochemical characterization of gold nanoparticles (GNPs) alone and GNPs coated with anticancer drugs for their molecular mechanism of action

Gold nano particles (GNPs) have been emerging as potential anticancer agents. However, little is known about the molecular mechanism of action of peptide-coated gold nanoparticles. In collaboration with Dr. H. Muthurajan's group at the National Centre for Nanoscience and Nanotechnology, University of Mumbai, Dr. Lopus's laboratory began a new study on the tubulin-targeted anticancer mechanism of action of novel peptide-stabilized nanoparticles. Their preliminary findings confirm the moderate-affinity binding of GNPs to tubulin. After completing biophysical and biochemical examination of the GNPs with tubulin, the lab plans to focus on elucidating the inner working of the nanoparticles (alone or as drug conjugants) in multiple animal cells including cancer cells and normal cells. The researchers aim to understand the signaling pathways that are inhibited/activated/altered by the gold nanoparticles. Collaborator(s): Dr. H. Muthurajan, National Center for Nanosciences and Nanotechnology, University of Mumbai.

Differential regulation of epithelial to mesenchymal transition in cancer cells following microtubule disruption.

This study, initiated by CEBS student Mr. Abhishek Howlader as part of his M.Sc. project, investigates the potential roles of microtubules in promoting and inhibiting epithelial to mesenchymal transition (EMT) in cancer cells. One of the driving forces of cancer metastasis is EMT, and the lab has been investigating how microtubule disruption alters EMT in triple-negative breast cancer cells. Preliminary data indicate that disruption of microtubule network by drugs such as indibulin, although inhibit cell migration, does not accomplish this through alterations in classic EMT markers such as E-cadherin and vimentin. Current work therefore focuses on identifying novel players that take part in the EMT induction/inhibition in presence of antitubulin ligands. CEBS student and staff involved: Mr. Abhishek Howlader, Dr. Sanith C (CEBS).

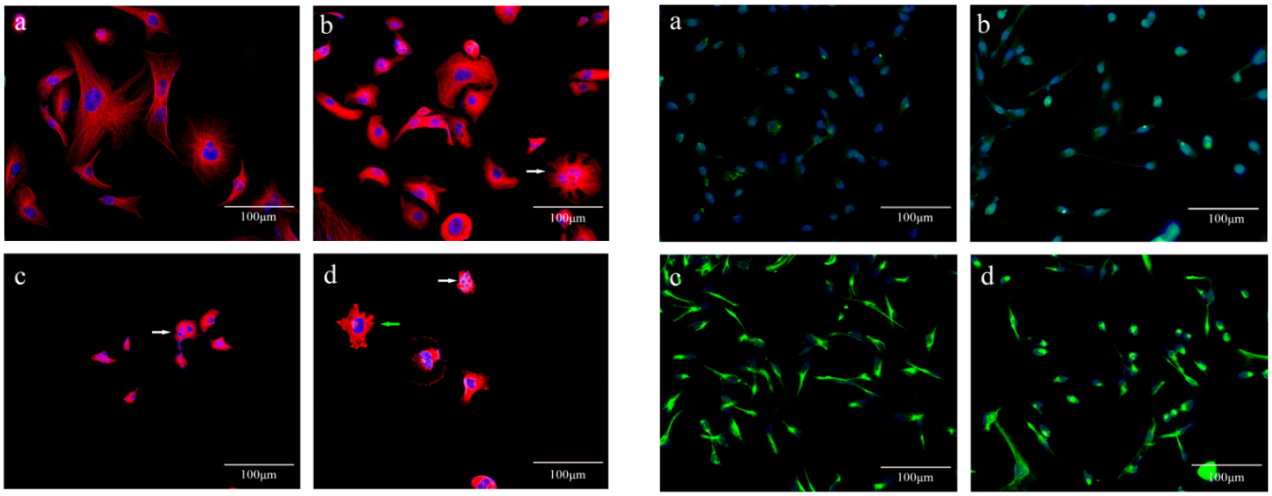


Figure 1.4.1 (Right). Disruption of cellular microtubules (red) by antitubulin ligand, indibulin (a, control; b, 50 nM Ind; c, 100 nM Ind; d, 1 μM nocodazole. Left: Lack of involvement of E-cadherin and vimentin in drug-treated microtubules. , a. Control cell stained for E-cadherin; b. Drug-treated cell stained for E-cadherin; c. Control cell stained for vimentin; d. Drug-treated cell stained for Vimentin

Antiproliferative mechanism of action of KS-Pyridyl-3-Boronic Acid against pancreatic cancer cells

This work, started by CEBS student Mr. Swagat Pradhan as part of his M.Sc. project, investigates the structural mechanisms with which a very potent drug molecule, KS-Pyridyl-3-Boronic Acid (KSPBA) inhibit proliferation of an aggressive, pancreatic tumour cell line, Panc-1. Preliminary data indicate that the drug exerts its effects through perturbation of the structural integrity of tubulin. The experiments are being repeated to confirm the findings. In addition, potential signaling molecules involved in the drug-induced inhibition of cell proliferation are being examined.

(Collaborators, in-house staff, and students : Dr. Srinivas Kantevari, IICT, Hyderabad. Ms. Tejashree Mahaddalkar, CEBS, Mr. Swagat Pradhan, CEBS student)

Sanith C.

Biological evaluation of novel analogues of noscapine for their anticancer potential

Noscapine is benzylisoquinoline alkaloid isolated from the plants of *Papaveraceae* family. Noscapines were previously used as a cough suppressant. After the discovery of the antitumor potential of noscapine, a number of noscapine derivatives, called noscapinoids have been rationally designed and synthesized to increase its cytotoxic/antiproliferative potency and tumour-specificity. Noscapinoids are found to be relatively harmless to cells and tissues. In this study, they rationally designed and synthesized, 37 new analogues/derivatives of noscapine and evaluated their antiproliferative potential against triple negative breast cancer cell line, MDA-MB-231. From the antiproliferative assay, it was found that three new noscapine derivatives, here named as compound 2 ($C_{24}H_{23}NO_7$), 20 ($C_{31}H_{27}N_50_7$) and 28 ($C_{29}H_{27}N_5O_7$) were most potent against MDA-MB-231 cell line. At 10 µM concentration, compound 2, 20 and 28 inhibited the proliferation of breast cancer cells by 70%, 84, and 66% respectively. Further research is going on to find how these new potential analogues of noscapines bind to tubulin and how they act on the breast cancer cell line.

[Researchers: *Dr. Sanith C, Dr. Manu Lopus* (PI), *Dr. Srinivas Kantevari* (Organic Chemistry Division-II (CPC Division), CSIR-Indian Institute of Chemical Technology, Hyderabad)]

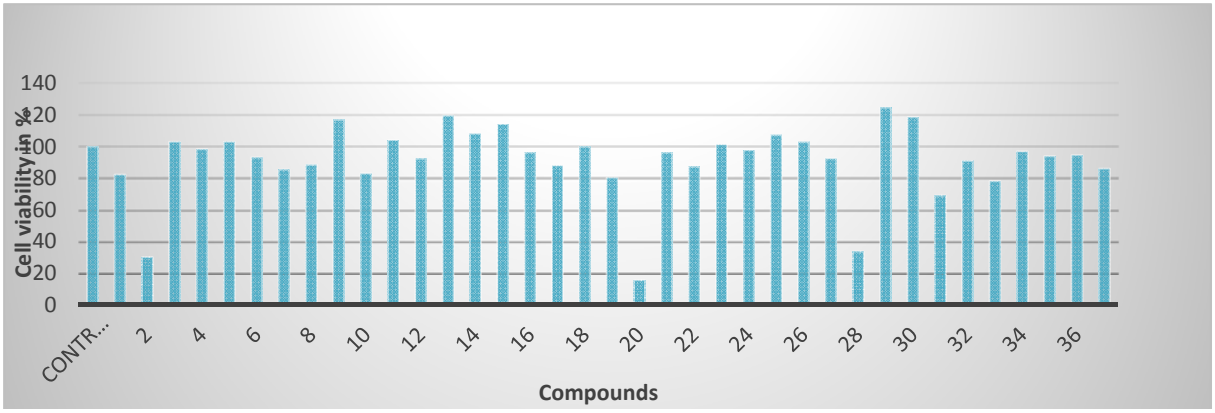


Figure 1: Screening of antiproliferative property of 37 novel noscapine derivatives against MDA-MB-231 cell line. MDA-MB-231 cells at a density of 50000 cells/mL were treated with 37 compounds at a concentration of 10 µM for 72 h. After incubation viability was examined using trypan blue dye exclusion method.

Mechanisms of epithelial to mesenchymal transition following perturbation of microtubule assembly dynamics.

Metastasis is the spread of cancer from its origin to another part of the body which is the prime cause of cancer-related mortality. In most of the cancer cases, epithelial cells will lose their inherent properties and will transform and gain more invasive or migratory properties of mesenchymal cells. In this research, they are investigating the roles of microtubule in epithelial to mesenchymal transition (EMT) of cancer cells. For the present study, the synthetic microtubule inhibitor Indibulin (N-[pyridin-4-yl]-[1-(4-chlorbenzyl)-indol-3-yl]-glyoxyl-amid) is used as a microtubule destabilizer to understand the role of microtubules in EMT. The remarkable feature of indibulin is that, it was found to be less toxic to neuronal cells, as per past studies. Indibulin can distinguish neuronal and non-neuronal cells due to the difference in microtubule post-translational modification. There are specific markers to detect EMT in cells, in which E-cadherin and vimentin are most common. E-cadherin, which involved in cell-cell adhesion, is expressed more in epithelial cells and less in mesenchymal cells. Similar way vimentin, an intermediate filament protein, is expressed more in mesenchymal cells and less in epithelial cells.

In this study, using a very invasive and migratory triple-negative breast cancer cell line MDA-MB-231, it was seen that indibulin inhibits the proliferation of this cell line with an IC_{50} of 53 nM (Figure 2). Indibulin at 50 and 100 nM deformed the microtubule network structure in MDA-MB-231 cells and oriented the microtubules near to the nucleus (Figure 3). At lower concentrations, indibulin has shown to be inhibiting the migratory property of MDA-MB-231 cells without killing them. Therefore, a lower concentration of indibulin was used to check whether it is altering any mesenchymal property of MDA-MB 231. E-cadherin and vimentin was used as a marker to detect EMT and found that there is no change in the expression levels of these two proteins after treating the cells with microtubule destabilizer indibulin. Since EMT has many other marker proteins, change in any other marker protein may also lead mesenchymal to epithelial transition and anti-migratory property of indibulin. Or it may be also possible that the anti-migratory property of indibulin does not have any involvement with EMT. Further experiments are ongoing to understand the role of microtubule in EMT.

(Researchers: Dr. Sanith C, Mr. Abhishek Howlader, TejashreeMahaddalkar, Dr. Manu Lopus (PI), Srinivas Kantevari)

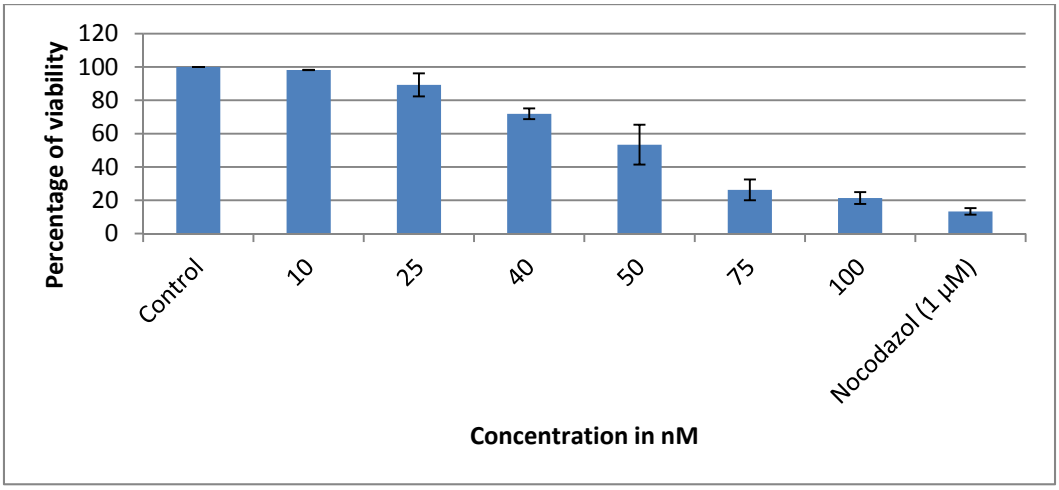


Figure 2: Antiproliferative effect of Indibulin against MDA-MB-231 cell lines. MDA-MB-231 cells at a density of 50000 cells/mL were treated with indibulin at various concentrations for 72 h. One µM nocodazole was used as positive control. After treatment, the cell viability was assessed using trypan blue dye-exclusion method. The results show that indibulin inhibits the cell viability in a concentration dependent manner and exhibited an antiproliferative IC_{50} of 53 nM against MDA-MB-231 cell line.

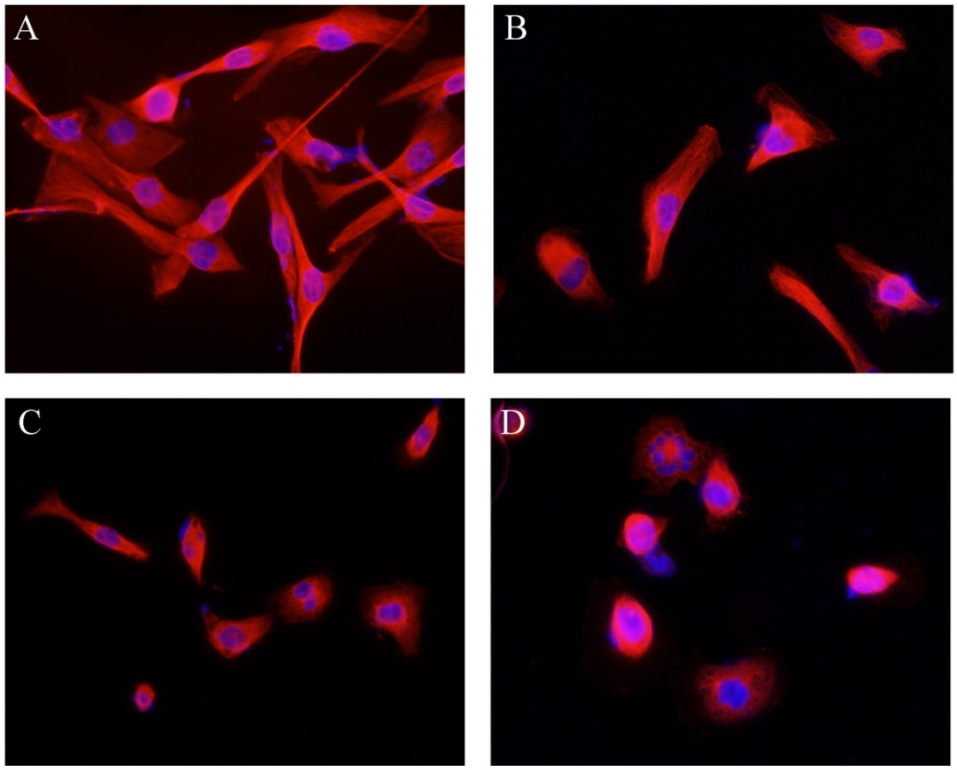


Figure 3: Microtubule staining: A) Control B) Indibulin (50 nM) C) Indibulin (100 nM) D) Nocodazole (1 µM). MDA-MB-231 cells were treated with 50 and 100 nM Indibulin for 24 h and

immunofluorescence stained with anti-alpha tubulin antibody. Microtubules are shown in red; nuclei are shown in blue.

Subhojit Sen

Epigenetic Mechanisms of Cancer

The group studies the molecular basis of 'Epigenetic phenomenon' and how that applies to disorders/diseases as well as normal development and behaviour. The current focus of the lab lies in drawing parallels between cancer epigenetics and the unicellular algal model system Chlamydomonas reinhardtii,exploiting DNA methylation. Using an Epigenetic assay that probes for a major hallmark of epigenetic change earlier identified by us to occur in mammalian cancer cells, namely spread of silencing mediated by Histone modifications (H3K4me2/3, K27me2/3, K9me2/3) and epigenetic players such as Polycomb mediated silencing (PRC2/4) and DNA methylation[1].

The Epigenetic Assay:

Using a dual reporter, we developed transgenic clones that track multiple pathways of epigenetic spread to report variegation of a drug resistance phenotype, Pm^R (paromomycin resistance, Fig 1). A DNA methylation inhibitor, Decitabine (DAC), was used to show proof of principle that these clones respond to well established epigenetic cancer drugs[2-5] (Fig 1), thereby validating the screen as a platform to study cancer epigenetics via reporter gene expression (by Snehal Kaginkar). New designs of tubulin based inducible promoters of gene expression are currently been constructed and tested for similar outputs (by Pooja Potdar). In toto, both designs has helped us query DNA based mechanisms of epigenetic spread and help classify responsive clones into well-known pathways/models using known drugs.

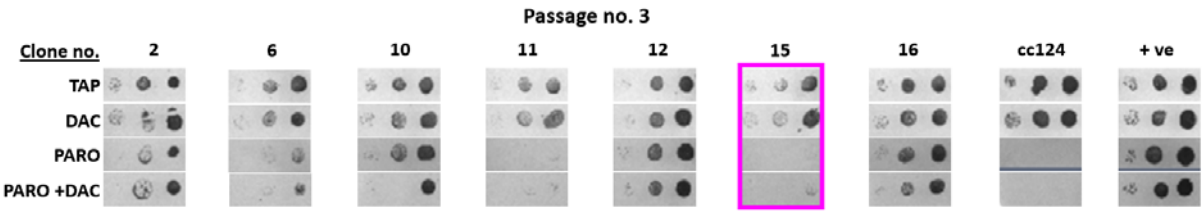


Figure 1: Spot assay for scoring the Epigenetic Phenotype – a comparison of the two controls TAP and DAC against the same populations grown on test plates Paro and Paro+DAC. Clone 6,10 and 15 are responsive.

Screening of natural compounds for epigenetically active mechanisms:

Sodium Butyrate (histone acetylation) and Decitabine (DNA methylation[6]) were used comparative classification of three plant derived compounds (namely curcumin, quercetin, cinnamic acid) into specific modes of action, based on their epigenetic response. The

gradient plate assay identified a collective range of phenotypes of transgenic Pm^R clones, i.e. some were silenced at high doses of curcumin while both cinnamic acid and sodium butyrate showed effects at lower doses (Fig 2). The likelihood that the latter two drugs probably acted in a similar pathway, likely by inhibition of histone deacetylases (HDACs) is to be tested. (by John James, Upnishad Sharma and Snehal Kaginkar [2-5]).

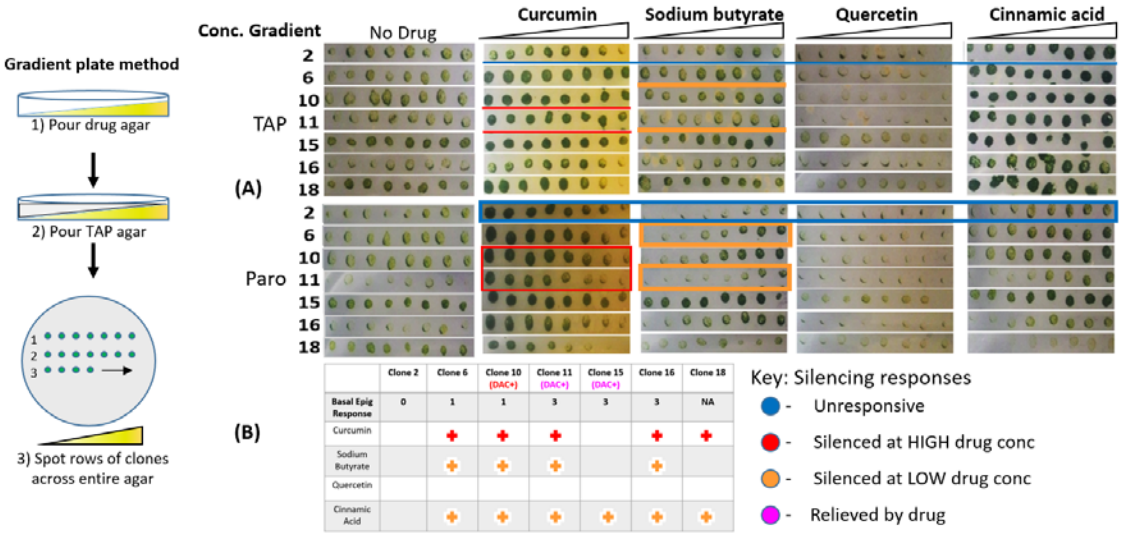


Fig 2: Gradient plate assay to test epigenetic responses of clones against different plant derived compounds. The Epigenetic phenotype on PARO can be deciphered as a response in comparison to control – TAP. Results are summarised in the table below.

Molecular Epigenetic Assays to map nucleosomes:

Although Micrococcal Nuclease based probing of chromatin (MNase assays) is widely used in mammalian, drosophila and yeast systems, the presence of the cell wall has largely impaired analysis of chromatin in Chlamydomonas. We have successfully designed a quick method, whereby we can introduce MNase into the cells by mechanical abrasion of the cell wall to allow access to chromatin in vivo. We obtained successful MNase ladders in Chlamy and are currently using these to map differential states of gene expression vis-à-vis chromatin compaction at the promoter i.e. euchromatin v/s heterochromatin. (Nicole D'Souza, Pooja Potdar and Anirudha Pillai)

Analysis of PRC2 and DNA methylation – an evolutionary perspective:

Using extensive comparative genomics and cross-analysing structural/functional conservation data we have identified key genes in Chlamydomonas in epigenetic pathways[7-8]. We propose to develop an evolutionary understanding of the interaction of DNA methylation vis-à-vis histone methylation by the PRC2 complex, and its connections with evolution of multicellularity (by John James, Pooja Potdar, and Patricia Pinto).

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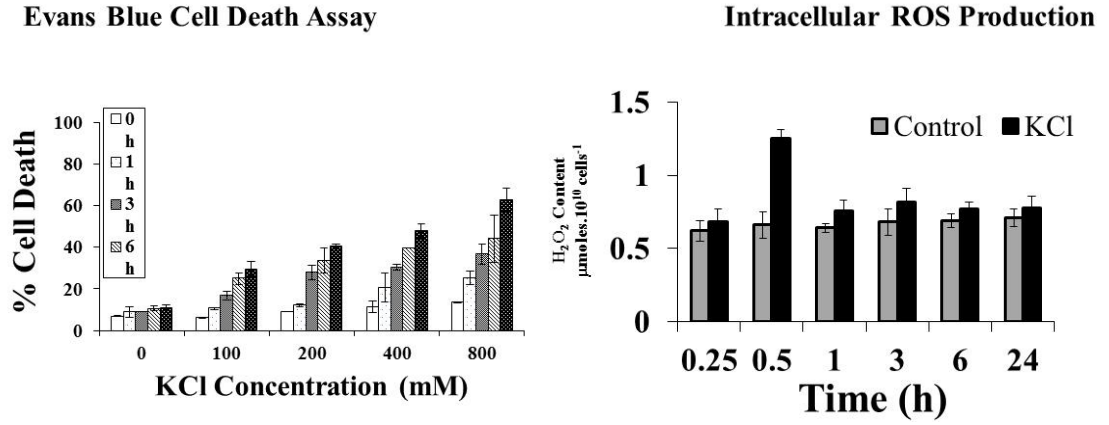
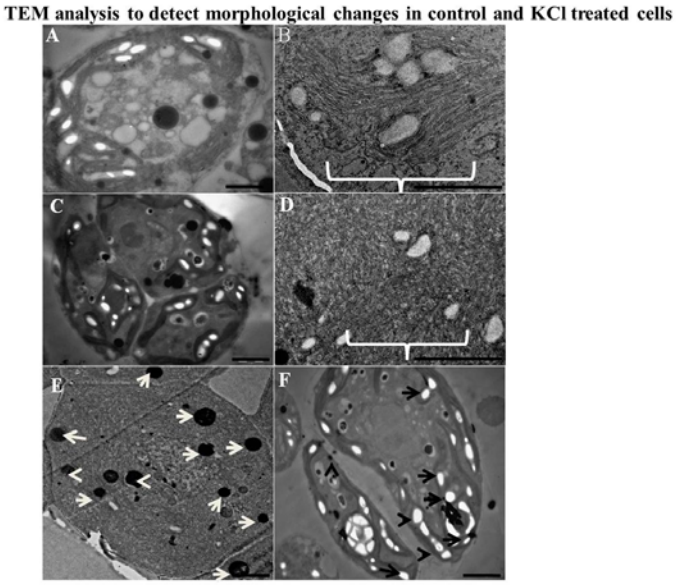
V. L. Sirisha

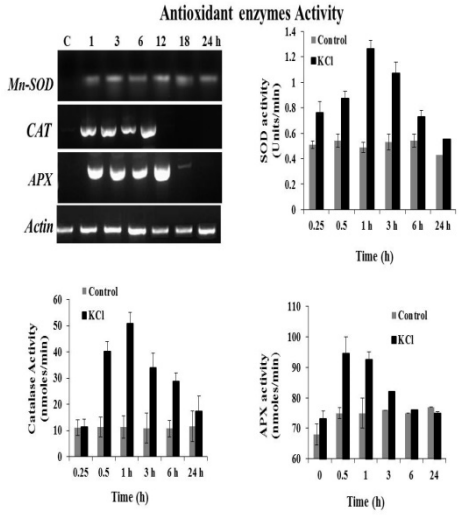
Potassium chloride induces caspase-independent mode of programmed cell death in *Chlamydomonas reinhardtii:*

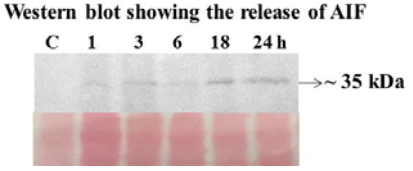
Programmed cell death (PCD) plays an important role in mediating adaptation responses under adverse conditions such as high salinity. In order to understand the molecular mechanism of adaptation of algal cells to salt, the fresh water alga *Chlamydomonas reinhardtii* was challenged with 200 mMKCl. In the present study, vegetative cells of *Chlamydomonas reinhardtii* undergo cell death when exposed to 200 mMKCl; this death being dose-dependent with 100-800 mMKCl causing 16-64% cell death. Within half an hour of KCl exposure, a ~1.9-fold rise in the intracellular H_2O_2 content followed a subsequent increase in the antioxidant enzyme (SOD, CAT and APX) activities and their transcript levels were observed. Furthermore, apoptotic hallmarks such as disruption

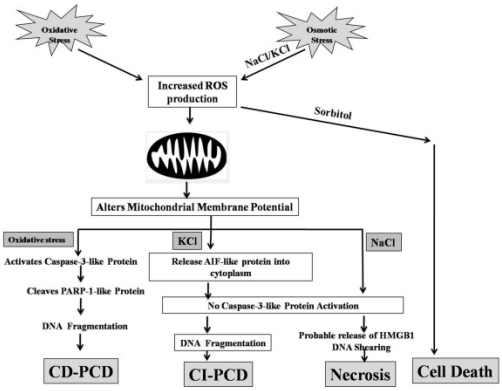
of mitochondrial membrane potential, DNA nicks, AIF release into the cytoplasm and genomic DNA fragmentation were observed. Interestingly, KCl stress did not stimulate caspase-3-like protease activity. Additionally, cells undergoing PCD showed characteristic shrinkage with an accumulation of lipids and vacuoles, along with degraded chloroplast. These results illustrate that KCl induces ROS production that leads to AIF release from mitochondria, causing a caspase-independent cell death in *Chlamydomonas reinhardtii*.











Dual role of GSk3β during apoptosis and necrosis in Chlamydomonas reinhardtii

The signalling of Glycogen Synthase Kinase-3β (GSK-3β) has been implicated in stress-induced apoptosis. It has the perplexing capacity to either increase or decrease the apoptotic threshold. However, the pro-apoptotic and anti-necrotic role of GSK-3β was not clear. In the present study, we show the paradoxical involvement of GSK-3β in oxidative stress induced apoptosis and osmotic stress induced necrotic-like cell death pathways in *C. reinhardtii*. In this study we found that apoptotic events were abolished by GSK-3β inhibitors like lithium chloride, where there is reduced cell death and laddering upon oxidative stress. On the other hand inhibitors of GSK-3β potentiate increased cell death and DNA shearing in case of osmotic stress. Studies of this eccentric ability of GSK-3β to oppositely influence two types of cell death signalling have shed light on important regulatory mechanisms in apoptosis and necrosis. This will provide the foundation for designing the rational use of GSK-3β inhibitors for therapeutic interventions.

6.2 Research activities of Department of Chemical Sciences

Anusri Bhattacharya

Deciphering the structure of centromeric protein Scm3 and its role in regulating the assembly of centromeric nucleosome through NMR spectroscopic studies

Scm3 has been known to play a regulatory role in the assembly of the centromeric nucleosome in *S. cerevisiae.* It acts as a chaperone to the histone variant, Cse4 in yeast and assists in its migration to the nucleosome to form a functional inner kinetochore. Although, Scm3 is the Cse4 specific chaperone in yeast, the mechanism of interaction of Scm3 and Cse4 as well as the interacting residues of the two proteins are not clear. The present study aims to decipher the structure of full length Scm3 and the residues of Cse4 involved in the interaction through NMR spectroscopy. The expression of Scm3 was standardized to obtain very high yield and the pure protein was isolated by column refolding procedure and the molecular weight was confirmed by MALDI .The emission maxima of the intrinsic tryptophan fluoresescence of Scm3 at around 345 nm, indicated that Scm3 might be intrinsically disordered and FTIR spectra indicated a high percentage of random coil (Fig. 1).

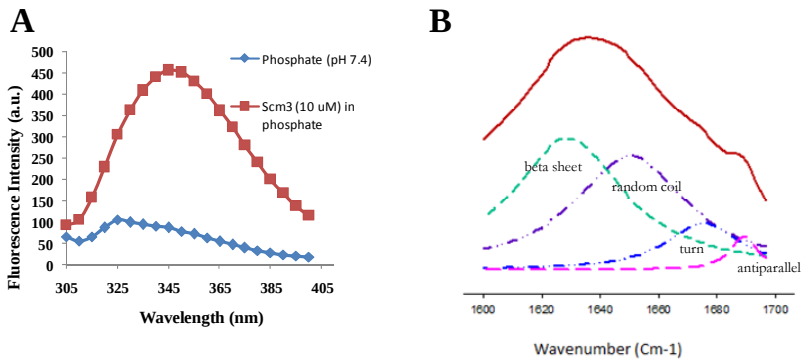


Fig 1. Tryptophan fluorescence and FTIR spectra of Scm3

NMR data: The HSQC spectra of ^{15}N-Scm3 was recorded at three temperatures for optimisations (Fig.2). The spectra corresponding to 283K indicated the maximum number of peaks and so this temperature was chosen for recording of most of the 2-D and 3-D NMR experiments. The HSQC spectra also indicated the protein to be intrinsically disordered in nature. Backbone assignment of Scm3 protein is in progress to resolve the structure of the protein.

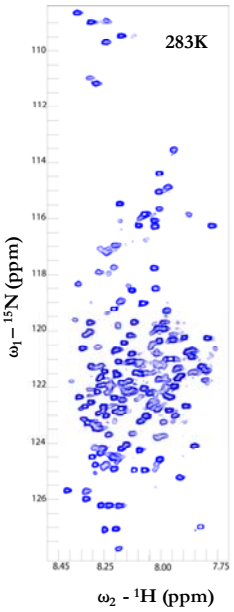


Fig 2. HSQC spectra of Scm3 at different temperatures

The NMR studies will be helpful in deciphering the structure of full length Scm3 and will provide an understanding of the key residues of Scm3 involved in interaction with Cse4.

(Collaborators: Prof. Ashutosh Kumar, Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay).

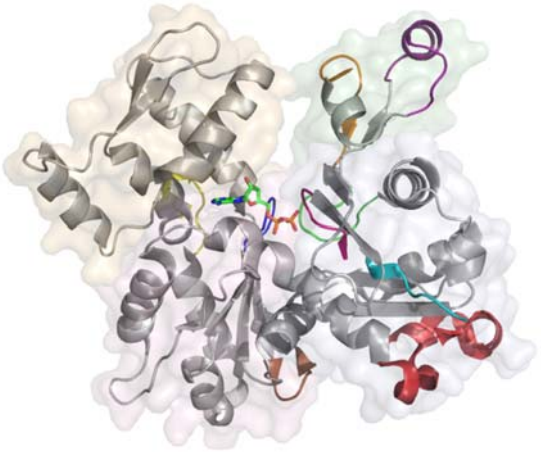
Studying the domain specific interaction of CENP variant Cse4 with its chaperonic partner Scm3 through time resolved fluorescence studies

The integral chromatin protein, Scm3 has been known to interact directly with Cse4 through its histone fold domain. Although, the affinity of interaction of Scm3 and Cse4 has been resolved, not much is known about the mode of interaction of the two proteins as well as the role of individual domains of Cse4 in Scm3 binding. Therefore, the objective of the study is to decipher the changes in the microenvironment of trpytophan residue when the two proteins react through time-resolved fluorescence spectroscopic studies.

The life-time calculation and anisotropy values of both full length Scm3 (native state) and full length Cse4 (in 8M Urea, 5M Urea and 0M Urea) were calculated individually. Though, the anisotropy values of Scm3 were in the acceptable range, good fit could not be obtained for the denatured Cse4 protein. The large variation in the anisotropy values was attributed to the presence of two tryptophan residues of Cse4 in two different micro-environments (one at the N-terminal domain and the other at the C-terminal domain). Therefore, site-directed mutants were designed incorporating only one tryptophan residue in the protein sequences of both Cse4 and Scm3. In addition, the N-terminal and C-terminal constructs of Cse4 were also cloned to study the domain specific interaction with Scm3. The mutants were confirmed by sequencing, the proteins were isolated and the time resolved fluorescence studies are in progress for the various Scm3 and Cse4 constructs.The fluorescence anisotropic studies of the mutated Scm3 proteins and its interacting partner Cse4 will provide an understanding on the site-specific microenvironment (local and global) of the tryptophan residue when the two proteins react. The data will further indicate the structural heterogeneity as well as the conformational flexibility of the individual domains of Cse4 on interacting with Scm3. The study will elucidate the association kinetics of Scm3 and Cse4 at the individual residue levels; thereby showing the role of Scm3 in assisting in the assembly of centromeric nucleosome.

(Collaborators : Prof. Ashutosh Kumar, Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay and Prof. G. Krishnamoorthy, Department of Chemistry, TIFR, Mumbai).

Avinash Kale



Understanding Actin polymerization dynamics/regulation in Apicomplexans

The milestones achieved:

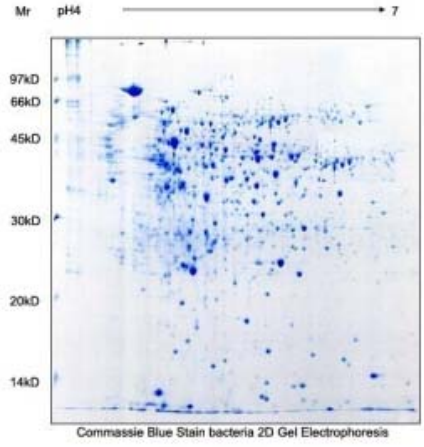
- Purification for actin from Bovine muscle is optimized.
- Currently they are working towards understanding the polymerization process for Actin using Biophysical techniques.
- Currently working on a manuscript of a review article titled: “Actin regulation in

Apicomplexan: the structural, functional, and evolution story so far".

- Currently collaborating with Dr. Supreet Saini (IIT, Bombay) to prepare a mathematical model to understand the actin regulation in Apicomplexan (Plasmodium falciparum).
- Currently work is in progress to test the effects of small compound and to set up co-crystallization at IIT, Bombay. I am collaborating with Dr. Prasenjit Bhaumik on this project. Trials so far has yielded crystals for five different complexes.
- Above figure is generated using pdb structure 3U4L.

Isolation and identification of the novel bacterium having mosquito larvae-cidal activity

The milestones achieved:

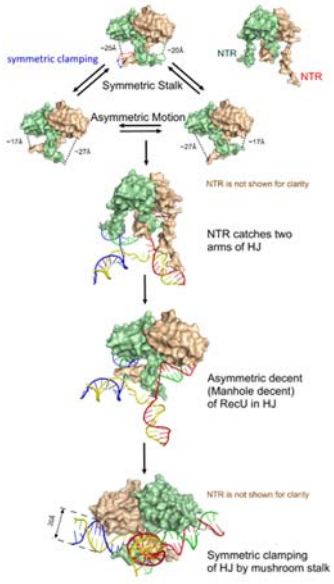


Commassie Blue Stain bacteria 2D Gel Electrophoresis

- Mosquito breeding facility has been successfully developed at Haffkine Institute.
- Ethical clearance for the project has been obtained.
- About 300 bacterial isolates have been collected from different locations of Mumbai and its suburban areas.
- High throughput screening is in process to test the larvae-cidal activity of these strains. We had observed differential toxicity for nine of the strains against culex larvae.
- They had optimized the work on differential proteomics at Haffkines to understand the differential toxicity of the bacterial strains.
- They are also working towards the structure analysis of the recombinant Binary toxin, BinA and initial crystals are obtained for BinA. We are in the process of optimizing the crystals for data collection.

Structural studies of Holliday Junction resolvase, RecU from B. subtilis

This project is in collaboration with Dr. John Rafferty from University of Sheffiled, United Kingdom. We had solved the 3.2A crystal structure of a protein-DNA complex. Currently we are working towards the Small Angle X-ray Scattering (SAXS) and fluorescence data to understand the flexibility of the protein. Also we are working towards molecular dynamic simulations (on super computer ParamYuva-II) to better understand the interaction of RecU with Holliday junction. The manuscript on this subject is currently under revision in Nucleic Acid Research (NAR).



Basir Ahmad

Multi-angle and multidisciplinary attack on Late-life diseases

The major goal of Dr Basir's research is to understand the molecular mechanism of formation, inhibition and disintegration of protein aggregates. Protein aggregation is the process by which proteins misfold, stick to each other and form fibrillar and/or amorphous aggregated species. The formation of proteins aggregates is associated with a spectrum of human diseases of dramatic social impact such as Alzheimer's and Parkinson's diseases, type 2 diabetes, cataract, cystic fibrosis and many others amyloidoses. The aggregation inhibition study deals with the cessationof the process of the aggregation, whereas, the disintegration study deals with dissociation of pre-formed aggregates into monomers and or non-toxic oligomers.He uses natural, semi-synthetic and synthetic small molecules for inhibition and disintegration studies. Knowledge gained from his investigations may help

1) To elucidate the physicochemical features of protein folding
2) To understand molecular and biochemical basis of aggregation based diseases
3) To develop drugs to prevent the progression of aggregation disease and cure the pre-existing disease.

He thinks that a molecule that is capable of both preventing conversion of native protein into aggregate and disintegrating pre-formed aggregates into monomer would be an ideal drug candidate for treating aggregation based disease. He employs a broad range of biophysical and imaging methods, including UV/Visible spectrophotometry, fluorescence, circular dichroism, TEM etc. for the in vitro studies.

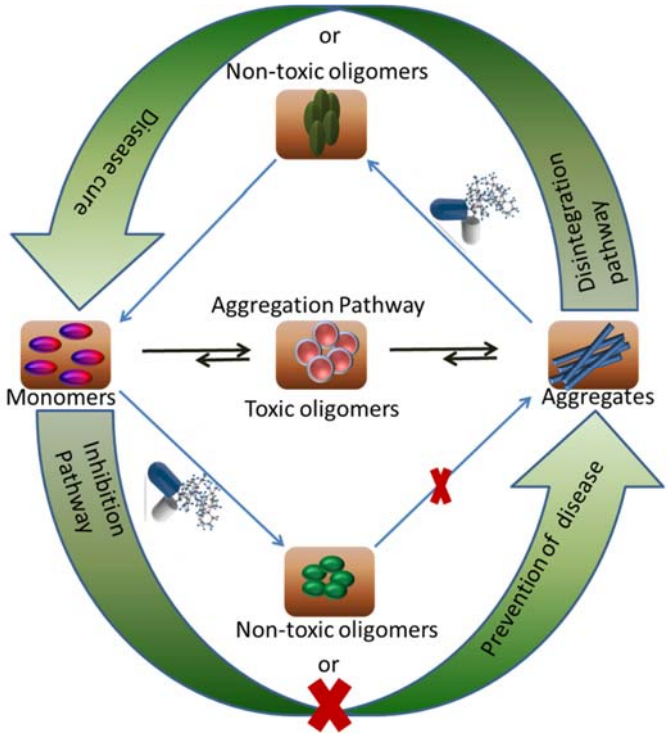


Fig.1.Therapeutic strategies of Dr Basir's Lab for protein aggregation diseases.

Projects completed

Curcumin promotes fibril formation in F isomer of human serum albumin via amorphous aggregation

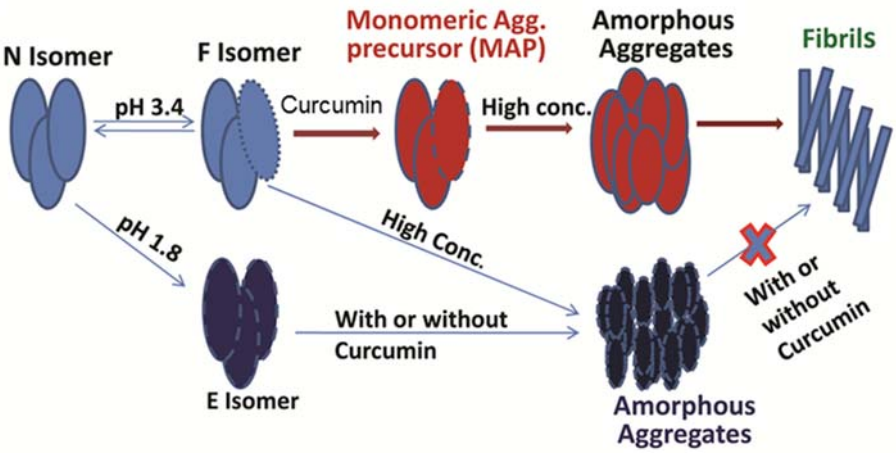


Fig 2. Schematic representation showing the effect of curcumin on the aggregation pathway of F and E isomers of HSA.

In this study, they have shown that curcumin, a well-known inhibitor of amyloid fibril formation can induce the fibrillation of F isomer of HSA. Transmission electron microscopy (TEM), 90° light scattering (RLS), thioflavine T (ThT) and Congo red (CR) binding studies demonstrated that both F (pH 3.4) and E (pH 1.8) isomers of human serum albumin (HSA) in the absence and presence of curcumin initially converted into amorphous aggregates. Interestingly, only the sample containing F isomer preincubated with curcumin formed fibrils on incubation for longer period. We also found that curcumin strongly bind to the F isomer, alter its secondary, tertiary structures and thermal stability. We conclude that the conversion of intermediate states into amorphous aggregate to fibrils is dictated by its conformation. This study provides unique insights into ligand-controlled HSA aggregation pathway and should provide a useful model system to study both amorphous and the fibrillar aggregation of multidomain proteins.

(Students involved : Nivin Mothi (CEBS), Shivani A. Muthu (JPA, CEBS)),
(Collaborator: Dr. Avinash Kale(CEBS)).

Physical basis for the ofloxacin-induced acceleration of lysozyme aggregation and polymorphism in amyloid fibrils

Aggregation of globular proteins is an intractable problem, which generally originates from partially folded structures. The partially folded structures first collapse non-specifically and then reorganize into amyloid-like fibrils via one or more oligomeric intermediates. The fibrils and their on/off pathway intermediates may be toxic to cells and form toxic deposits in different human organs. To understand the basis of origins of the aggregation diseases, it is vital to study in details the conformational properties of the amyloidogenic partially folded structures of the protein. In this work, we examined the

effects of ofloxacin, a synthetic fluoroquinolone compound on the fibrillar aggregation of hen egg-white lysozyme.Using two aggregation conditions (4M GuHCl at pH 7.0 and 37 °C; and pH 1.7 at 65 °C) and a number of biophysical techniques, we illustrate that ofloxacin accelerates fibril formation of lysozyme by binding to partially folded structures and modulating their secondary, tertiary structures and surface hydrophobicity. We also demonstrate that Ofloxacin-induced fibrils show polymorphism of morphology, tinctorial properties and hydrophobic surface exposure. This study will assist in understanding the determinant of fibril formation and it also indicates that caution should be exercised in the use of ofloxacin in patients susceptible to various aggregation diseases.

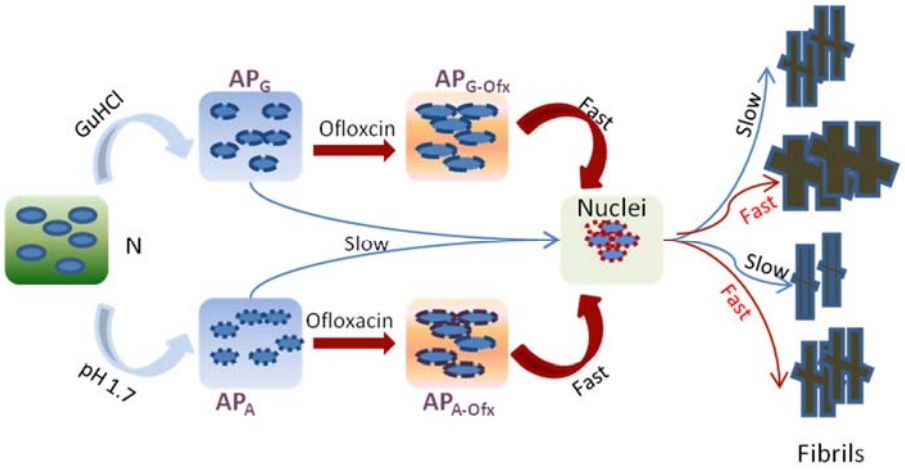


Fig 3. The effect of ofloxacin on GuHCl-induced and acidic pH-induced fibrillation pathway of lysozyme. Red and blue arrows showed fibrillation pathways with and without ofloxacin, respectively.

(CEBS Students and in-house staff involved: Shivani A. Muthu, Nivin Mothi, Sonali M. Shiriskar, Anil Kumar).

(Collaborator: Dr. Raghuvir R. S. Pissurlenkar, Goa College of Pharmacy, Panaji, Goa).

Effects of Mutations on the Reconfiguration Rate of α-Synuclein:

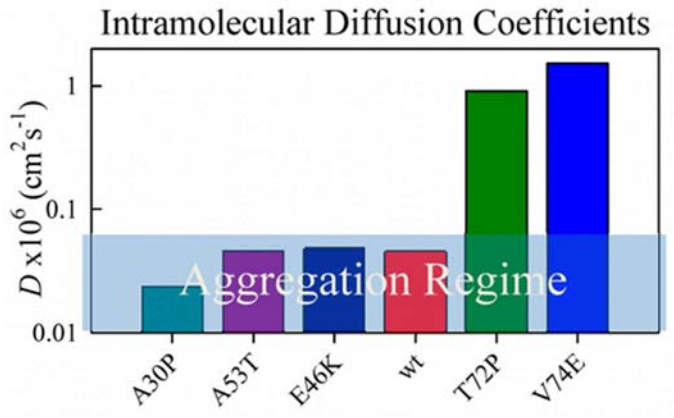


Fig 4. Intramolecular diffusion coefficients of aggregation promoting and aggregation inhibiting mutation of alpha-synuclein

It is still poorly understood why α-synuclein, the intrinsically disordered protein involved in Parkinson's and other neurodegenerative diseases, is so prone to aggregation. Recent work has shown a correlation between the aggregation rate and the rate of diffusional reconfiguration by varying temperature and pH. Here we examine the effects of several point mutations in the sequence on the conformational ensemble and reconfiguration rate. We find that at lower temperatures the PD causing aggregation enhancing mutations slow down and aggregation reducing mutations drastically speed up intramolecular diffusion, as compared to the wild type sequence. However, at higher temperatures, one of three familial mutations that enhance aggregation slows intramolecular diffusion while non-natural mutations that inhibit aggregation speed up intramolecular diffusion. These results support the hypothesis that the first step of aggregation is kinetically controlled by reconfiguration in which the protein chain cannot reconfigure rapidly enough to escape oligomerization. Finally we provide physical and chemical insights into why small point mutations cause these dramatic changes in the conformational ensemble and dynamics.

(Collaborator: Prof. Lisa J. Lapidus, Michigan State University, USA).

Kinetic parameters of lysozyme fibrillation are controlled by structure of partially folded intermediate states

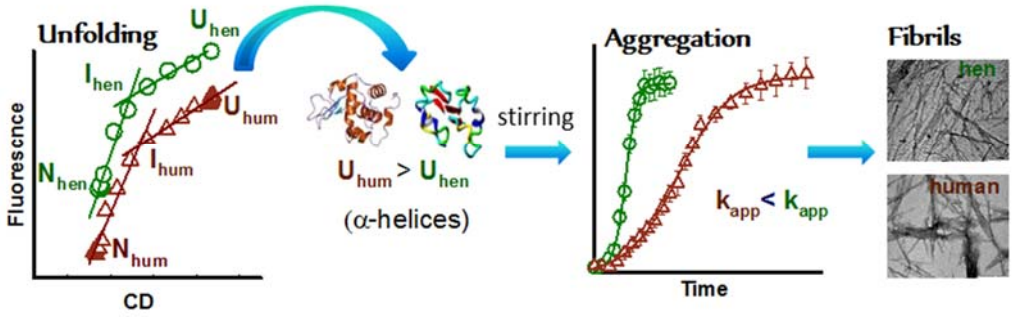


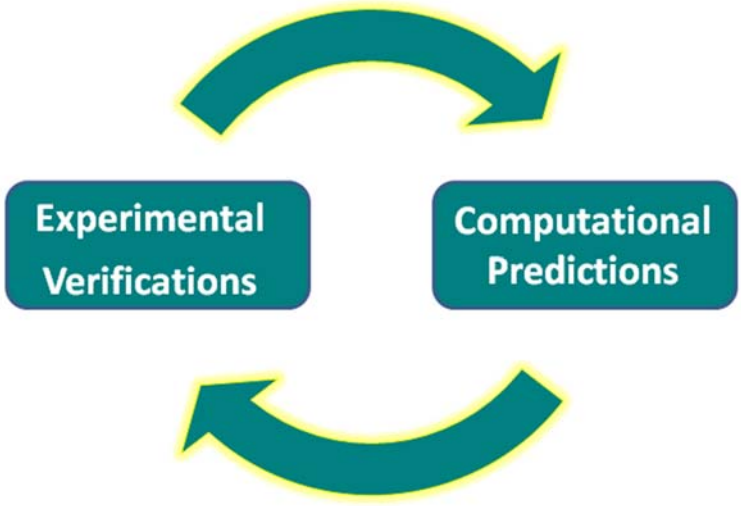
Fig 5. Model of temperature-induced unfolding and aggregation of hen and human lysozyme

Human lysozyme is homologous in three-dimensional structure to hen lysozyme and later is commonly used to understand folding and amyloid aggregation pathway of the former. The fibrillation of the two proteins is known to occur via partial unfolding. A work dedicated to comparing the aggregation-prone conformations and their sequent conversion into amyloid-like fibrils in an identical condition is not available. This has provided an opportunity to compare the fibrillation behaviors of the two homologous proteins under identical solution condition. In this work, we have shown that the temperature-induced unfolding of the two proteins at pH 1.5 occurred via a three states process. We found that temperature-unfolded states of the two proteins differ in contents of residual secondary and tertiary structures. The temperature-unfolded states of both proteins rapidly converted into well-defined amyloid-like fibrils on stirring at 230 RPM. We further observed that the

kinetic parameters, lag time (t_{lag}) and apparent rate constant (k_{app}) of aggregation of hen lysozyme were markedly enhanced than human lysozyme. Amyloid fibrils formed by the two proteins only slightly differ in their morphology and Tinctorial properties. Therefore, on the basis of our in vitro aggregation and in silico aggregation and α-helical propensities prediction studies, we concluded that the major determinant of acceleration of aggregation of hen lysozyme is the stabilization of amyloidogenic native α-helices in highly dynamics partially-folded state. Comparison of aggregation-prone conformations and their aggregation kinetics parameters also with other protein systems can serve as a useful model to understand the factors promoting amyloid aggregation.
(CEBS Students involved: Ankur, Neha Vispute, Vaibhav Kumar Shukla).

Mahendra Patil

Dr. Patil's research group combines elements of computational chemistry and organic synthesis to device new catalytic strategies for organic conversions. Detailed mechanistic investigations of reactions play a crucial role in method development forthe organic conversions. Dr. Patil's group employs a suite of computational approaches to investigate the mechanism of catalytic conversions, and to identify the factors which control the selectivity of the reaction. Insights obtained through computational investigationsare used to develop new synthetic methodologies with the particular emphasis on creating novel concepts in catalysis.

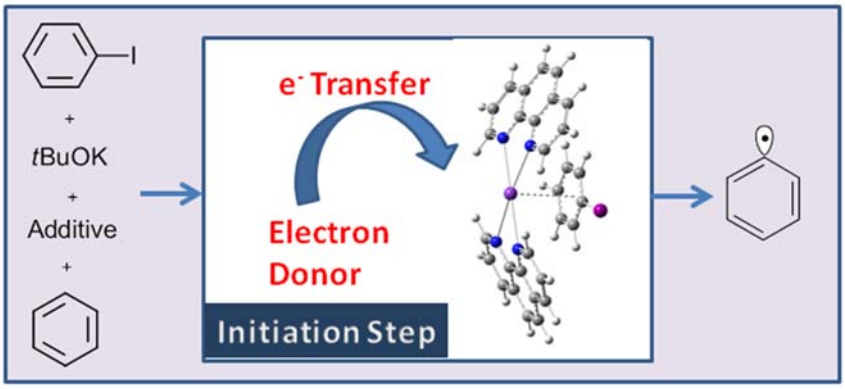


Key research areas: Chemical Catalysis: Organocatalysis, Transition metal catalysis

The major focus of research program is to understand the mechanism and reactivity of organic reactions using computational and experimental tools with a specific emphasis on asymmetric conversions. Asymmetric catalysis represents a highly dynamic area in organic chemistry. The field of asymmetric catalysis has played a crucial role in producing enantiomerically pure compounds for pharmaceutical, agrochemical, and industrial applications. Despite significant advances in asymmetric catalysis, the development of new

catalytic systems for the asymmetric transformations has always remained a challenging objective to the organic chemists. Notably, current practices in the catalyst discovery often rely on the expensive and serendipitous optimization of reaction conditions. Application of computational approaches for the discovery of new catalysts can be useful in reducing experimental efforts in environment-benign manner. The mechanistic and structural insights provided by computational investigations may help in rational designing of catalyst prior to experimental endeavors. The aim of Dr. Patil's research is to develop new catalysts or catalytic strategies for the organic reactions using combinations of computational and experimental approaches.

Recent Publication: J. Org. Chem.2016**,** 81, 632–639.



Neeraj Agarwal

Emissive 1,8-Diaryl Anthracene Derivatives and their nano/macro stuctures:

A new route for the synthesis of 1,8 Diaryl-anthracene derivatives was developed to access the 1,8 diaryl anthracene derivatives in the good yields. Detailed photophysical and electrochemical studies show that these anthracene derivatives emit in the blue region with a narrow FWHM and provide a high quantum yield (upto 75%). The HOMO and LUMO energy levels of these compounds are in the range of -5.62 to 5.71 and 2.68 to 2.79 eV, respectively. Furthermore, one of these new anthracene derivative was used for the surfactant assisted self assembling process to obtain the micro/nano structures. Formation of microplates in the polyvinylpyrrolidone (PVP) and nonowires with an average diameter of ~290 nm in the cetyl trimethylammonium bromide (CTAB) were observed. It was also noticed that the emission intensity was retained even in the nano assemblies. The DFT calculations suggest that multiple hydrogen bonding interactions are possible between two interacting monomers. The blue emitting properties, compatible HOMO and LUMO energy levels, highly blue emitting micro/nano assemblies of these compounds makes them suitable material for OLED.

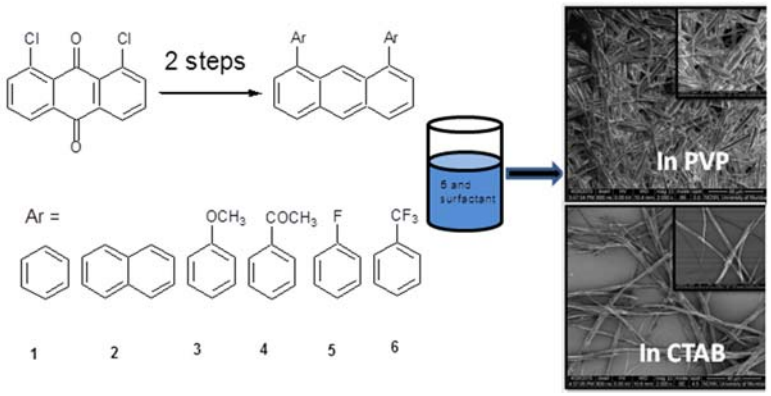


Figure 1: Anthracene derivatives and their morphological studies
(Work carried out by: Neeraj Agarwal, Manish Patil and Mahendra Patil)

Acridone based materials for hole transport applications:

A series of new donor-acceptor molecules based on acridone-amine containing four aryl substituted 2,7-diaminoacridones**(1-4)** and morphololine substituted acridone compounds **(5)** were synthesized in good yields using palladium catalysed Buchwald-Hartwig C-N amination. Their absorption, photoluminescence and electrochemical properties were investigated in solution and in thin films. Photophysical properties were found to be affected by electron donating capability of substituents on diaryl amines. Absorption studies showed an intramolecular charge transfer transitions (ICT) in a range of 447-479 nm. These acridone amine derivatives emit in green region (500-527 nm). Reversible oxidation wave were observed for compounds **1-5** in cyclic voltammetry. The HOMO (-4.95 to -5.11 eV) and LUMO (-2.36 to -2.56 eV) energy levels of **1-5** were calculated. The E_{HOMO} for compounds **1-5** are similar with the most widely used hole transporting materials **NPD**, **TPD** and **spiro-OMe-TAD**. Hence we believe that these compounds are having potential to be used as hole transporting materials in optoelectronic devices.

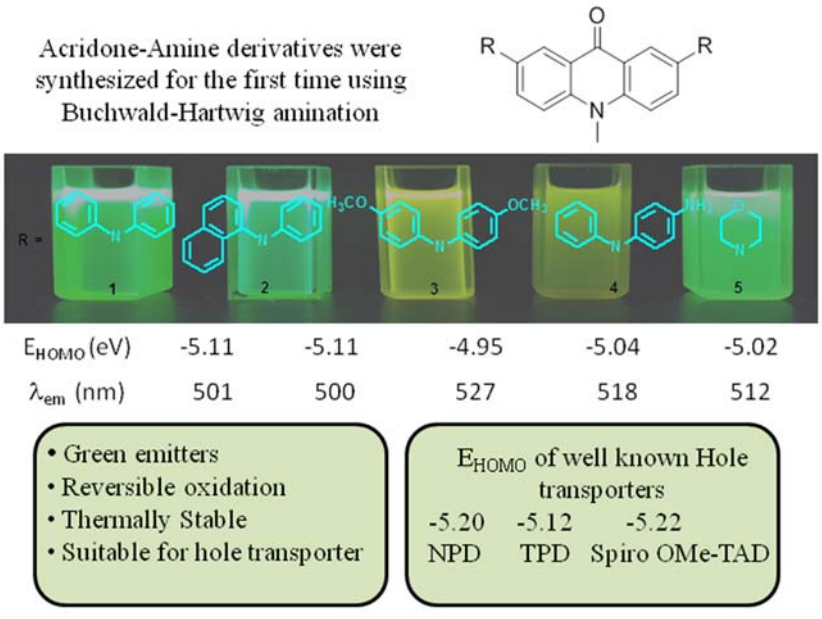


Figure 2: Acridone derivatives for hole transport materials

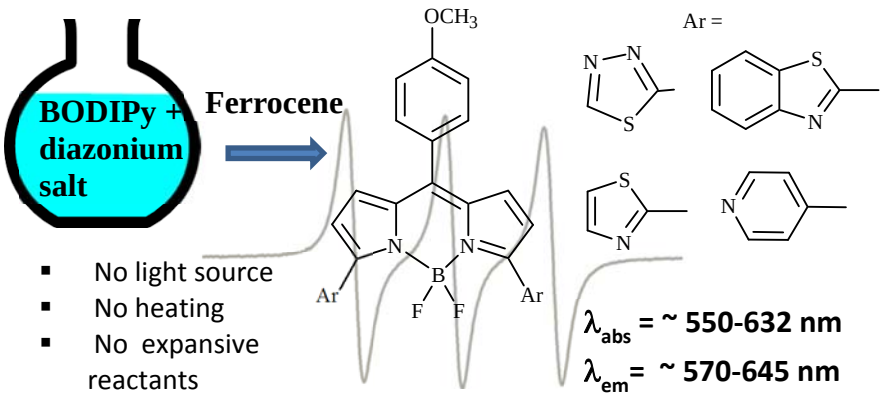
(Work carried out by: Bharat Sharma (Sudent, MU) and Azam Shaikh (Sudent, MU) Neeraj Agarwal (CEBS), and Rajesh Kamble (MU)

New BODIPY derivatives for biological applications: Mono and di-pyrrolyl-4,4'-difluoro-8-(aryl)-4-bora-3a,4a-diaza-s-indacene (BODIPy) (**1-4**) were synthesized. For this reaction no catalyst was used for C-C coupling. Pyrrole substitution on 3- or 3,5- positions caused large bathochromic shifts (up to ~150 nm) in absorption and fluorescence maxima in comparison to classical BODIPy. Detailed photophysical studies of these BODIPY showed interesting properties. Charge transfer was observed in mono pyrrole substituted BODIPYs. Lippert-Mataga equation ann DFT calculations were used to calculate the ground and excited state dipole moments of these BODIPYs.

(Work carried out by: Karthika K Jairaj (Student, CEBS), Akanksha Nimesh (summer student from IITK), Sanoj (Student, CEBS) and Neeraj Agarwal (CEBS)

Ferrocene catalysed heteroarylation of BODIPy and reaction mechanism studies by EPR and DFT methods: Mono and di heteroaryl BODIPy derivatives (**1-8**) were obtained in a cost-effective way. This method gives easy access to 4-pyridyl substituted BODIPy (**7-8**) which are useful to synthesize water soluble derivatives for biological applications. Reaction pathway for this reaction was studied by carrying out the spin cross-over experiments using electron paramagnetic resonance (EPR) technique. A strong signal in EPR was obtained in the presence of ferrocene and heteroaryldiazonium salt which indicates the formation of radicals during the initial steps of reaction. In addition, we have also performed the computational investigations on different steps of reaction to elucidate the role of ferrocene as a radical initiator in this reaction.

(Work carried out by: Swati Dixit (JPA, CEBS), Mahendra Patil, CEBS and Neeraj Agarwal, CEBS)



Spin cross-over experiment using EPR and DFT calculations show the radical formation

R. V. Hosur

Novel multidimensional NMR pulse sequences have been developed for rapid acquisition of multidimensional NMR data in small molecules and proteins alike. These rely on use of dual receivers, non-uniform sampling schemes and appropriate data manipulation. Structural insights have been derived in the case Cyclophillin of yeast (CPR3). The influence of some osmolytes on the fibrillation process of proteins has been investigated. The effects of selected herbal preparations on the dissolution and inhibition protein fibrillation has been investigated. These have therapeutic implications.

NMR pulse sequences

Non uniform sampling in combination with homo-nuclear broadband decoupling along indirect dimension, and indirect covariance processing has been used to record ultra-high resolution two-dimensional TOCSY spectra in less than half an hour, for typical sample concentrations in mM range. TOCSY correlations belonging to protons separated by as little as ~ 2 Hz could be distinctly discerned. Utility of the technique for very low concentrations has been demonstrated (Veera Mohan Rao Kakita and R. V. Hosur).

Solution Structure of CPR3

Cyclophilins regulate protein folding, transport and signalling through catalysis of proline isomerization, and are ubiquitously expressed in both prokaryotes and eukaryotes. Cpr3 is the yeast mitochondrial cyclophilin and it is structurally and biophysically uncharacterized so far. Yeast cyclophilin gene cpr3 is essential for the lactate metabolism. Here, we report ^{1}H, ^{13}C, and ^{15}N chemical shift assignments of Cpr3 protein determined by various 2D and 3D heteronuclear NMR experiments at pH 6.5, and temperature 298 K. The structural fold of Cpr3 is seen to be comprised of eight β strands corresponding to stretches of residues, K23-V30 (β1), G36-L42 (β2), R73-I75 (β3), M79-Q81 (β4), G114-S118 (β5), F130-I132 (β6), H144-V150 (β7) and E173-E181 (β8) and three helical regions corresponding to residues K49-T59 (α1), P138-L140 (α2), and M154-S162 (α3) (Vaibhav Kumar Shukla, Jai Shankar Singh, Dipesh Trivedi, Ramakrishna V. Hosur, Ashutosh Kumar).

Kinetics of Protein Aggregation

We have studied here using a number of biophysical tools the effects of osmolytes, betaine, citrulline, proline and sorbitol which differ significantly in terms of their physical characteristics such as, charge distribution, polarity, H-bonding abilities etc, on the fibrillation of insulin. Among these, betaine, citrulline, and proline are very effective in decreasing the extent of fibrillation. Proline also causes a substantial delay in the onset of fibrillation in the concentration range (50-250 mM) whereas such an effect is seen for citrulline only at 250 mM, and in case of betaine this effect is not seen at all in the whole concentration range. The enthalpies of interaction at various stages of fibrillation process have suggested that the preferential exclusion of the osmolyte and its polar interaction with the protein are important in inhibition. The results indicate that the osmolytes are most

effective when added prior to the elongation stage of fibrillation. These observations have significant biological implications, since insulin fibrillation is known to cause injection amyloidosis and our data may help in designing lead drug molecules and development of potential therapeutic strategies (Sinjan Choudhary, Nand Kishore and R. V. Hosur).

Sinjan Choudhury

Inhibition of insulin fibrillation by osmolytes: Mechanistic Insights

Understanding the mechanism of protein aggregation and its prevention is the basis of therapeutic strategies for amyloidosis. A combination of calorimetry, spectroscopy and microscopy has been used to understand the nature of interactions of osmolytestrehalose, citrulline, proline, sorbitol and betaine with the protein at different stages of the fibrilization of bovine pancreatic insulin. Based on ThT fluorescence emission intensities and microscopic images, the nucleation, elongation, and saturation phases of the fibrilization have been identified.

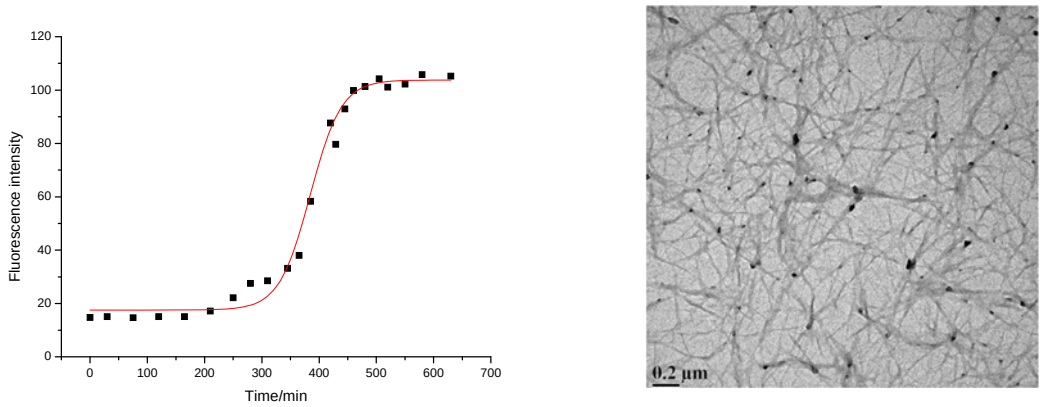


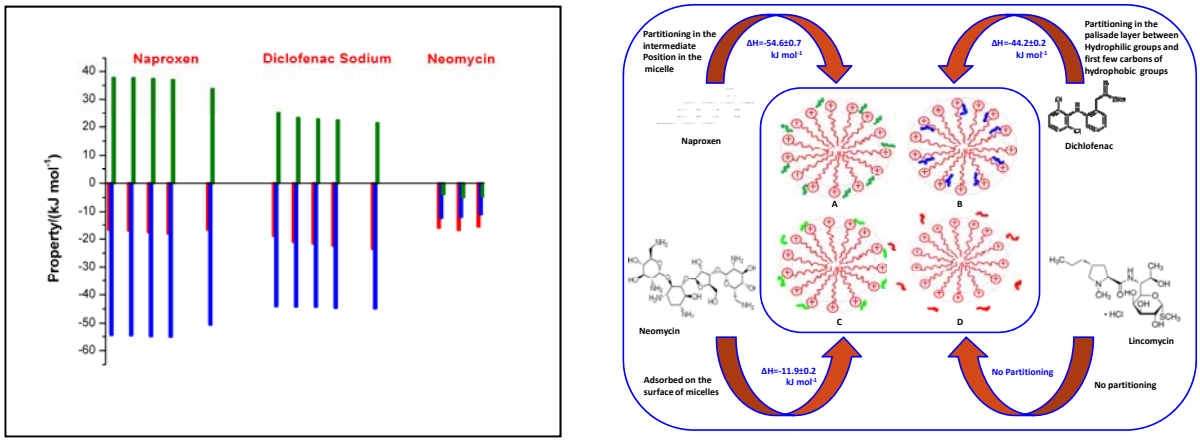
Figure 1: Thioflavin T binding assay and transmission electron microscopy shows the formation of insulin fibrils.

Among these, betaine, citrulline, and proline are very effective in decreasing the extent of fibrillation. Proline alsocauses a substantial delay in the onset of fibrillation in the concentration range (50–250 mM) whereassuch an effect is seen for citrulline only at 250 mM, and in case of betaine this effect is not seen atall in the whole concentration range. The enthalpies of interaction at various stages of fibrillationprocess have suggested that the preferential exclusion of the osmolyte and its polar interactionwith the protein are important in inhibition. The results indicate that the osmolytes are mosteffective when added prior to the elongation stage of fibrillation. These observations have significantbiological implications, since insulin fibrillation is known to cause injection amyloidosis and our datamay help in designing lead drug molecules and development of potential therapeutic strategies.

(Collaborators : Prof. R.V. Hosur, CEBS and Prof. Nand Kishore, IIT Bombay)

Thermodynamic insights into drug-surfactant interactions: isothermal titration calorimetry of the interactions of naporxen, diclofenac sodium, neomycin, and lincomycin with hexadecytrimethylammonium bromide

Identification of the strength and nature of interaction of drugs with the micellar assemblies in terms of partitioning constant, enthalpy, entropy, and stoichiometry is essential for the design of novel drugs as well as modification or choice of transport vehicles for target oriented drug delivery. Tunability of the size of micelles and modification of the functional groups on drugs are key factors which can direct the latter specifically to tumour and inflammatory tissues where permeability is more. In this work, non steroidal anti-inflammatory drugs naproxen, and diclofenac sodium, and antibiotic drugs neomycin and lincomycin have been chosen.An ultra sensitive isothermal titration calorimetry has been employed to determine partitioning constant, enthalpy of partitioning, entropy of partitioning and the number of drug molecules partitioning per micelle of the surfactant. The partitioning of diclofenac sodium into the HTAB micelles is observed to be stronger than naproxen. It is further observed that the number of moles of diclofenac sodium partitioning per mole of the under the studied temperature range is also higher than that observed in the case of naproxen.The partitioning of neomycin in the HTAB micelles is observed to be weaker than naproxen and diclofenac sodium whereas titrations of lincomycin with HTAB micelles did not show any binding/partitioning pattern in the entire studied range of 293.15 K to 318.15 K. Precise isothermal titration calorimetric measurements have provided the values of partitioning constant, enthalpy and entropy changes along with the mechanism of partitioning process of naproxen, diclofenac sodium, neomycin and lincomycin in hexadecyltrimethylammonium bromide micelles(Fig 2A). Based on these results, a scheme for association/partitioning of drugs in the micelles of HTAB is suggested (Fig. 2B). In this scheme, naproxen molecules are shown to be interacting only at the surface of the micelles and diclofenac sodium molecules are able to partition into the palisade layer of the micelles to a small extent, though ionic interactions at the surface dominate. Neomycin molecules do not partition but interact weakly with the positively charged surface of HTAB micelles. Lincomycin is not able to interact significantly even with the surface of the micelles.



(A) (B)

Figure2:(A) The change in standard Gibbs free energy (ΔG^o, —), enthalpy (ΔH^o, —) and entropy (expressed as -TΔS, —) accompanying the partitioning of naproxen, diclofenac sodium, and neomycin in HTAB micelles at T = 298.15 K. (B) Scheme describing the mode of partitioning/interaction of naproxen, diclofenac sodium, neomycin and lincomycin with the HTAB micelles

The future of such studies lies in understanding the interaction of a variety of drugs with different drug delivery vehicles quantitatively in order to gain insights into the functional groups responsible for interaction/partitioning, and hence deriving guidelines for target oriented synthesis of new drugs.

(Collaborator: Prof. Nand Kishore, IIT Bombay).

Synergistic inhibition of protein fibrillation by Triphala and Guggulaqueous extracts

Ayurveda is one of the oldest system of medicines and is based on the natural products for the treatment of a variety of diseases. This system of medicine mainly emphasizesadopting therapeutic measures which vitalize and rejuvenate the body. Many polyherbal formulations have been found very effective for the treatment of cancer, cardiovascular disorders, ophthalmic problems, liver dysfunction and many other diseases.

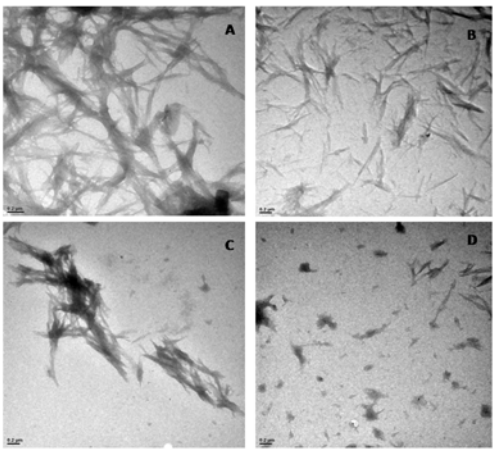


Figure 3: Transmission electron microscopic images (TEM) of lysozyme fibrils after 36 hr of incubation (A) in absence, and in presence of (B) 0.5 mg/ml of triphala, (C) 0.5 mg/ml of guggul, and (D) mixture of 0.5 mg/ml of triphala and guggul.

Triphala and guggul are ancient and long-established polyherbal medicines from ayurveda, well known for their anti-inflammatory, anticarcinogenic, antiapoptopic and many other beneficial properties. In this project the anti-amyloidogenic properties of these ayurvedic medicines have been studied using a combination of spectroscopy and microscopy. Both triphala and guggulare seen to inhibit lysozyme fibrillation; triphala is more effective in preventing fibrillation than guggul as shown by ThT fluorescence binding assay.

Further, interestingly, a significant synergy was observed in the actions of these two ayurvedic herbal medicines. The efficacy of inhibition of fibrillation in the presence of triphala and guggul together was almost similar to that seen with triphala alone. This observation in conjunction with NMR data, which showed strong peaks in identical spectral regions suggesting presence similar functional groups in the two preparations, seems to suggest, (i) direct binding of the functional groups with the protein is responsible for inhibition of fibrillation, and (ii)triphala and guggul extracts either bind competitively to the same sites on lysozyme, or there is an allosteric effect wherein binding of triphala reduces the efficacy of guggul binding. These observations throw valuable light, by extrapolation, on how particular ayurvedic preparations could be effective against a multitude of diseases.The current work has significant therapeutic implications and will provide directions to the developments of new generation phytopharmaceuticals which can be used alone or with other phytomedicine or in combination with any other kinds of drugs.
(Name of student involved: Ms. Shreyada N Save, CEBS)

Inhibition of protein fibrillation by chemical chaperones: Synergistic Effects

Protein aggregation and accumulation of aggregated proteins are responsible for various diseases which have been collectively named as protein conformational disorders (PCDs). Osmolytes are small organic molecules and promote protein folding, enhance protein stability and hence they are also known as chemical chaperones. The synergistic effects of chemical chaperons proline and sorbitol on prevention of fibrillation in bovine pancreatic insulin and hen egg white lysozyme has been examined. A combination of fluorescence spectrophotometer, transmission electron microscopy and isothermal titration calorimetry has been used to understand the structural morphology and mode of interaction of the osmolytes with the proteins at different stages of fibrillation. The present work focuses on understanding the possible synergy of proline and sorbitol on protein fibrillation by using spectroscopic, microscopic and calorimetric techniques. Interestingly, a significant synergy between the effects of proline and sorbitol has been obereved. It is conceivable that such effects would be observed for many different osmolyte combinations.

Such a phenomenon would have important implications for combination therapy with different types of drugs.

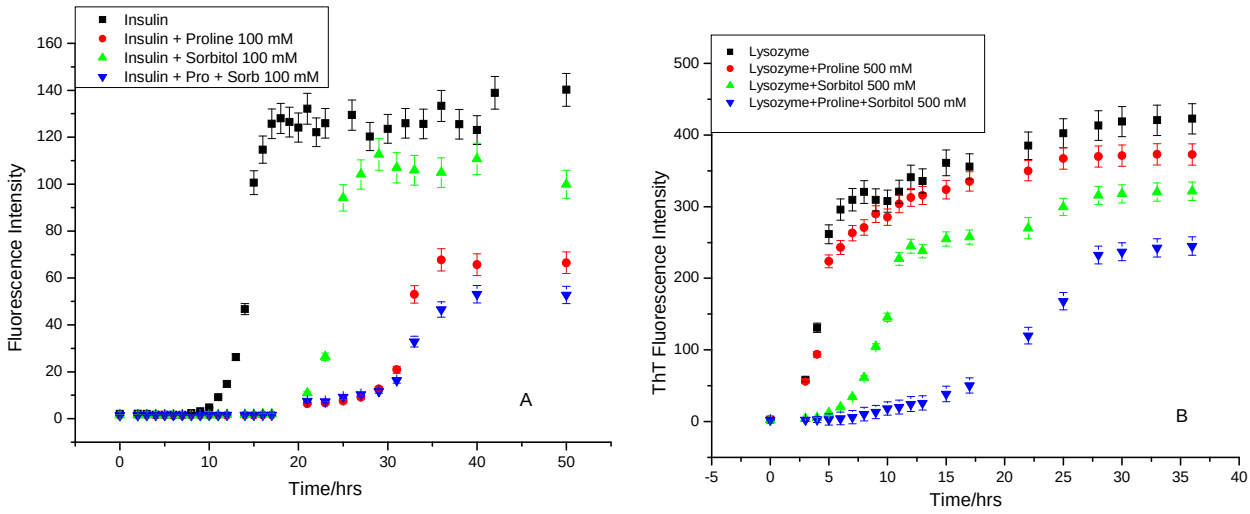


Figure 4: Kinetics of (A) insulin and(B) lysozyme fibrillation monitored by the binding of ThT with amyloid fibrils in presence of proline, sorbitol and their mixture.
(Collaborator: Prof. R.V. Hosur, CEBS and Prof. Nand Kishore, IIT Bombay)
(Student involved: Ms. Shreyada N Save)

6.3 Research activity of Department of Mathematics

Swagata Sarkar

Degree Problem:

In algebraic topology the degree problem involves calculating the possible Brouwer degrees of *(continuous)* maps between two spaces (of a certain kind) of the same dimension. My collaborators and I are trying to calculate the possible degrees of maps between spaces of the kind G/P, where G is a simple, complex, classical algebraic group and P is a maximal parabolic subgroup.

In the past year, we considered maps between two Isotropic Grassmannian of the same dimension and proved that given a map between two oriented Isotropic Grassmannians of the same dimension, either the two Grassmannians are the same or the degree of the map is zero.

Additionally, we proved that given any map between an oriented isotropic Grassmannian and an oriented real Grassmannian, the degree of the map has to be zero.
Details can be found in our paper :

S.Basu, S. Sarkar, *Degrees of maps between Isotropic Grassmann Manifolds.*

(Submitted for review in journal)

(arxiv: 1508.02143)Jo

The authors are also studying maps between other spaces of the form G/P, and trying to calculate degrees of maps between them.

Projective Stiefel Manifolds:

Her collaborators and they are trying to the calculate the rational cohomology algebra of the projective Stiefel manifold. They are trying to work out the possible graded algebra homomorphisms between the cohomology algebras of two projective Stiefel manifolds.

Homotopy type of function spaces:

Study of the homotopy type of function spaces is a well-established area and a lot of work is going on in this area. With my collaborators, I am trying to read topics in the theory of operads with a view towards applying the theory to the study of homotopy type of certain function spaces.

6.4 Research activity of Department of Physics

Accelerator, Laser and Plasma Simulation (ALPS) Laboratory

S. Samant, B. Paradkar, P. Brijesh, S. Krishnagopal

Proton Acceleration Using Laser-Plasma Interaction (LPI)

Radiation Pressure Acceleration (RPA) scheme is extensively investigated in recent LPI studies due to its potential to produce high quality, high charge proton beams. One of the major challenges for successful realization of this scheme is to control the energy spread of accelerated proton beams. Due to its critical importance, proton acceleration research activities in the ALPS Laboratory are focused on gaining detailed physics understanding of this issue. Using numerical simulations, it was demonstrated that electron heating inside the target is responsible for the energy-spread of proton beams. The mechanism of electron heating can be understood from Fig. 1.

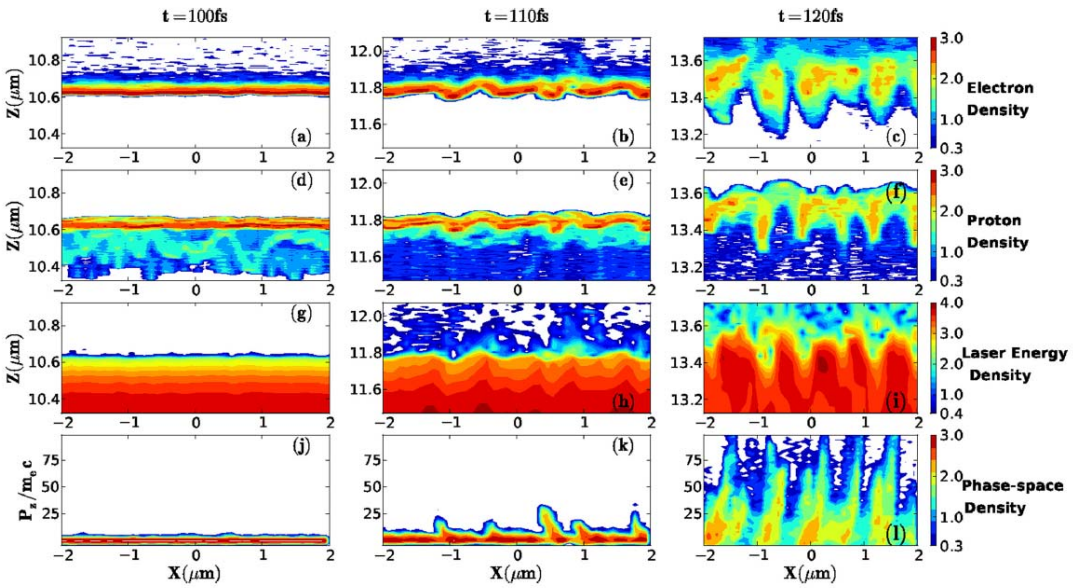


Fig. 1.

During the course of acceleration, transverse modulations are developed in electron and proton densities due to the growth of Rayleigh-Taylor instability (RTI) [see Fig. 1(a)-(f)]. Then the laser penetrates through these modulations as can be seen from Fig. 1(g)-(i). Finally, electrons oscillating in this laser field are ponderomotively scattered causing the heating of such electrons. Electron heating and hence proton energy spread was found to be lesser in the shorter pulse duration lasers due to restricted growth of RTI. A novel two-target assembly was also proposed to control the energy spread for the long pulse duration lasers. These results are published in Physical Review E93**,** 023203 (2016). Also, part of above figure was selected by PRE editors for its Kaleidoscope section.

Laser Wakefield Acceleration of Electrons

In laser wakefield acceleration of electrons, experiments have demonstrated the production of high brightness beams using a downward transition in the plasma density. The ALPS Laboratory has vigorously pursued the understanding of the underlying physics using computer simulations. We have shown how the downward density transition leads to controlled injection of electrons due to the reduction in the phase velocity of the wake. Figure 2a shows that injected electrons (in green) have a longitudinal velocity that is greater than the calculated phase velocity of the wake (blue line), whereas the unaccelerated electrons (in red) have a lesser velocity. We have introduced the concept of *transverse filtering*, which means the injection becomes more and more on-axis; to explain why the transverse emittance decreases as the scale length of the density transition is increased. Figure 2b shows that the faster accelerated electrons (in green) have a smaller transverse extent compared to slower non-injected electrons (in red). We have also shown how multiple upward density transitions can be exploited to control the acceleration process, resulting in a 1.2 GeV electron beam that is bright enough to drive a soft X-ray free-electron laser (FEL) at a wavelength of 4 nm.

Fig. 2(a)

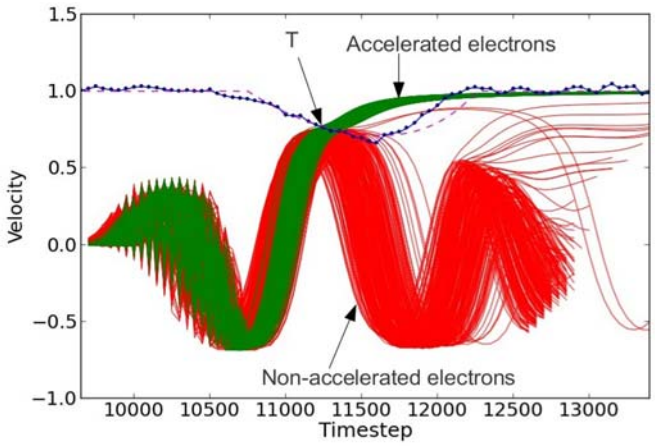
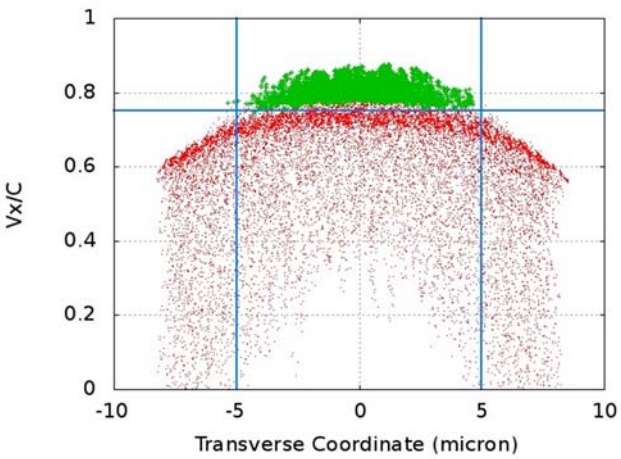


Fig. 2(b)



The ALPS Laboratory is also studying the utilization of higher-order laser modes in laser wakefield acceleration. Preliminary results show that it is possible to find optimal parameters that can sustain long-range propagation of a higher-order laser mode in plasma and generate a quasi-monoenergetic GeV ring electron beam, which could have interesting applications in proton collimation and positron acceleration.

Particle-in-Cell (PIC) Code Development

It is important to have indigenous computer codes available for the simulation of proton and electron acceleration in conventional as well as laser-plasma accelerators. To this end the ALPS Laboratory has developed a 2.5 dimensional, fully relativistic electromagnetic PIC code AGASTHII (Advanced General-purpose Accelerator Simulation Toolkit for High Intensity Interaction). This code solves the Maxwell equations on a Cartesian grid for the electric and magnetic fields. Particle species such as electrons or ions are moved using the Lorentz force obtained at the particle location due to the electromagnetic fields at the grid points. Beam transport in conventional accelerators can be performed either using matrices for the various accelerator elements, or by importing the electromagnetic fields. AGASTHII has been developed primarily to model beams in conventional and laser-plasma accelerators, but it can be used in other areas such as modelling of solar and ionospheric plasmas. It has been successfully benchmarked with theory and other PIC codes such as VORPAL and WARP. The code is developed in C^{++} in a fully object-oriented manner, so source code modification or addition of extra features can be done easily. The current version supports shared memory parallelization using OpenMP. In the future, we will be working on adding reduced dimensional modeling capability to the code and on parallelization of the code over distributed memory architecture using MPI. This work was done in collaboration with Abhishek Pathak (IADD, BARC).

Investigation of Solar Activity Cycle

The research on Astrophysical plasmas is being carried out in the ALPS Laboratory in collaboration with Professor S. M. Chitre. Currently ALPS is actively involved in investigating the problem of solar activity cycle with a view to understanding the underlying mechanism responsible for driving the magnetic activity cycle on the Sun. The primary objective of this study is to develop a single fluid magnetohydrodynamic (MHD) model for the solar convection zone, which will determine the characteristics of the global magnetic field as well the meridional circulation velocities consistent with the helioseismically measured solar angular velocity.

In the present model, the steady-state circulation velocities are first computed by balancing azimuthal angular momentum transport with the Reynolds stress, while the Maxwell stress in solar convection zone is presently neglected as a fist approximation. A stable numerical scheme is developed which serves to calculate the meridional velocity components from the accurate helioseismic measurements adopting a prescribed Reynolds stress prescription. It is proposed to use this formulation subsequently to infer the magnetic field and meridional velocity pattern using the seismically measured angular velocity variations. This study is being carried out in collaboration with Professor Douglas Gough of IoA, Cambridge and Professor H. M. Antia from TIFR, Mumbai.

Student research projects are an integral part of the ALPS Laboratory activities. Students who have worked with us include *C. J. Ajay, N. Krishnadev and Bhishek Manek* (CEBS) for their Masters Theses, *Sachin Prabhakar and Aswathi Sivan* (CEBS) for their 7th semester projects*, Sachin H. B*. (IISER, Kolkata) and *Jennifer Joseph* (Central University, Hyderabad) for their summer projects.

Alpa Dashora

Computational Condensed Matter Physics

Co–Ni–B nanocatalyst for efficient hydrogen evolution reaction in wide pH range (Theory and Experiments):

[Ref.: Appl. Catalysis B: Environ. 192, 126 (2016)]

Amorphous Co–Ni–B nanocatalyst with high electrocatalytic activity toward hydrogen evolution reaction (HER) in wide pH range was successfully synthesized. The content of Ni was varied by adjusting the molar ratio Ni/(Ni + Co) in Co–Ni–B from 10% to 50% to identify the most suitable composition for HER. Co-30Ni–B (with 30% Ni/(Ni + Co)) showed the highest catalytic activity and could reach a current density of 10 mA/cm2 at just 170 mV in pH 7 and 133 mV in pH 14. It also exhibited a Tafel slope value of 51 mV/dec in pH 7 suggesting Volmer-Heyrovsky reaction mechanism for HER. The role of each element in improving the activity was justified with results from XPS, XAS and DFT calculations. It was observed that the presence of Ni promotes higher electron density at Co active sites of Co–

Ni–B which in turn facilitates efficient reduction reaction to enhance HER rate. Co-30Ni–B could sustain 1000 cycles and prolonged hours of operation for about 40 h without losing activity making it an excellent low-cost electrocatalyst material.

To understand the charge transfer trend in pure and Ni doped Co–B clusters, density functional theory (DFT) based calculations using the Dmol3 code of Material Studio were performed. The crystal structure of Co_2B was built using experimental structural parameter. Co_2B compound accepts a tetragonal cell with space group I4/mcm having cell parameters a = b = 5.015 Å and c = 4.220 Å. The crystal structure thus built was geometry optimized and using this as a base structure, a 5 Å X 5 Å X 5 Å nanocluster was constructed. DFT formalism was implemented to perform geometry optimization of the Co_2B nanocluster which displayed random arrangement of Co and B atoms. Charge transfer was studied using the Mulliken charge analysis for pure and Ni doped Co–B clusters of size 5 Å x 5 Å x 5 Å. The PBE gradient corrected functional was used for exchange and correlation and the double numerical plus polarization (DNP) basis set was used. Spin unrestricted calculations were performed in order to obtain accurate results.

From the present calculations, the charge transfer in pure Co–B nanocluster was estimated from B to Co wherein the average charge on Co was calculated to be −0.0067 $e^-$and average charge on B atoms was +0.0195 e^-. To check the effect of Ni doping, 25% Ni doping was considered in Co–B cluster at various doping sites (Fig. 1). After Ni doping, the average charge obtained on Co atoms was −0.0098 e^- which is higher than that obtained with pure Co–B nanocluster. On the other hand, positive average charge is noted on Ni (+0.0121 e^-) and B (+0.01431 e^-) atoms. Thus, the addition of Ni increases the negative charge on Co atom in Co-25Ni–B cluster which again confirms the results obtained by XPS and XAS analysis.

The higher HER activity in Co–B is mainly attributed to the electron transfer from boron to d-band of Co. These Co active sites with higher electron density improve the electron donating ability of Co, thereby promoting HER. In Co–Ni–B, the presence of Ni causes boron enrichment on the surface which further activates these Co sites by providing excess electrons as confirmed by XPS, EXAFS, XANES and DFT calculations. This is the main reason of higher HER activity obtained for Co–Ni–B as compared to Co–B having similar morphology and surface area. By electron transfer, boron also protects the Co sites from oxidation and deactivation, thus offering high stability in extreme conditions. Considering the HER rates of Ni–B and Co–B, it seems that Co is more active in borides than Ni. Thus, as the Ni concentration increases, the cobalt sites are further activated by electron density, but after Ni= 30%, the Co sites are replaced by less active Ni sites causing reduction in HER activity.

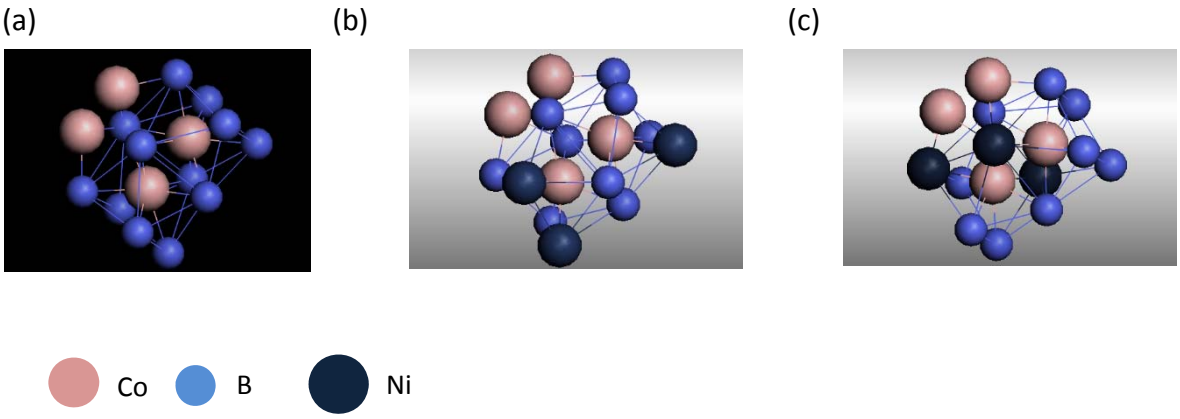


Fig. 1: Geometrically optimized nanoclusters of (a) pure Co-B and (b, c) Co-25Ni-B with Ni doping at different sites used for DFT calculations for charge transfer.

(Collaborators: Prof. D.C. Kothari, Department of Physics, University of Mumbai, Mumbai, Dr. Nainesh Patel, Department of Physics, University of Mumbai, Mumbai, Prof. Antonio Miotello, Dipartimento di Fisica, Università degli Studi di Trento, Italy).

Efficient Co-B-codoped TiO_2 photocatalyst for degradation of organic water pollutant under visible light (Theory and Experiments):

[Ref.: Appl. Catalysis B: Environ. **183**, 242 (2016)]

Lattice location of B in TiO_2 is tuned to determine its effect on the photocatalytic activity of Co-B codoped TiO_2. Sol–gel method was used to synthesize the samples. The concentrations of Co and B were first optimized by maximizing the photocatalytic activity for the mono-doped (Co or B)-TiO_2. In addition to the DFT calculations for discovering new energetic levels introduced in TiO_2bycodoping, various characterization techniques were used to determine the dopant lattice sites in $TiO_2$and interactions between them; and also determining their consequences on electronic, morphological, structural, and optical properties. At low concentration of B-doping (1 at.%), B occupies the interstitial site (B_{int}), but as the concentration increases (2 at.% and 3 at.%) B also occupies substitutional O position (B_{sub}) in addition to $B_{int}$to form TiO_2containing $B_{int+sub}$. Both these B-doped TiO_2showed improved photocatalytic activity attributed to effective charge separation obtained for TiO_2–B_{int}due to the formation of shallow energy level while higher visible light absorption is achieved with TiO_2–$B_{int+sub}$ owing to the presence of two deep energy levels in the band gap as confirmed by DFT calculations. In the case of Co doping, the band gap of TiO_2 is reduced but the recombination rates are always high and are caused by the formation of Co states in the band gap. For Co mono-doped TiO_2, the photocatalytic activity is low for all the concentrations considered, exceptfor very low concentration of Co (0.1 at.%). Two opposite effects were observed when small amount of Co (0.1 at.%) was

codoped with B_{int} or $B_{int+sub}$. In particular, the photocatalytic degradation rate of organicaqueous pollutants (p-nitrophenol and rhodamine B dye) reduces for TiO_2–Co–B_{int} whereas it is enhanced remarkably for TiO_2–Co–$B_{int+sub}$ as compared to (Co or B) monodoped (~2.1 times) and undoped (~7.8times) TiO_2. Higher photocatalytic activity observed in Co-doped TiO_2–$B_{int+sub}$ is discussed in terms of the interactions of Co with B at two different lattice positions in TiO_2 and the synergistic effect created by higher visible light absorption and the improved charge separation

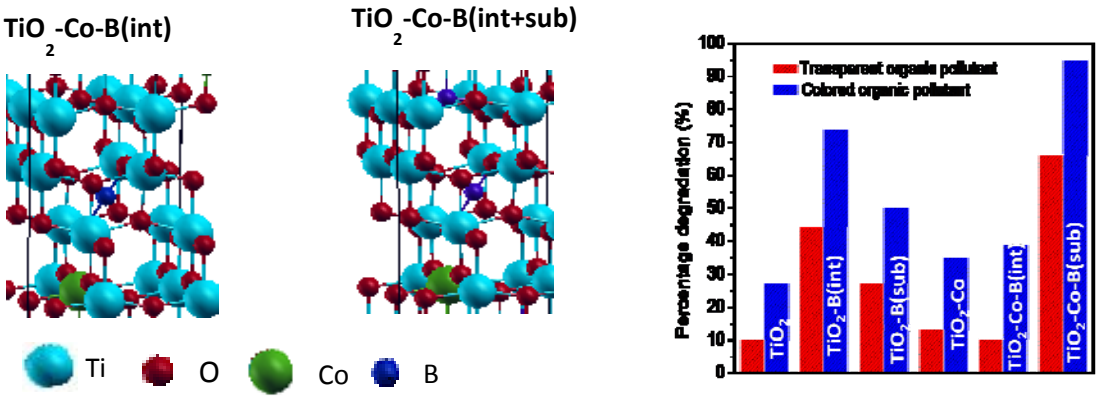


Fig. 2 Crystal structure of TiO_2-Co-B(int) and TiO_2-Co-B(int+sub) with rate of degradation.

(Collaborators: Prof. D.C. Kothari, Department of Physics, University of Mumbai, Mumbai, Dr. Nainesh Patel, Department of Physics, University of Mumbai, Mumbai, Prof. Antonio Miotello, Dipartimento di Fisica, Università degli Studi di Trento, Italy).

Ameeya Bhagwat

Working on the semi classical methods in nuclear physics. In particular, the Wigner – Kirkwood (WK) ħ expansion of the one body density matrix to calculate the smooth part of energy is being investigated. Conventionally, this is achieved by the well – known Strutinsky smoothing procedure. Strutinsky smoothing procedure runs into practical difficulties for finite potentials, since for carrying out the Strutinsky smoothing, one requires the discrete single particle spectrum, with cut – off well above (at least 3ħω, ħω being the major shell spacing) the Fermi energy. In a realistic potential, this condition is not met, since continuum may start within ~1ħω of Fermi energy. Standard practice is to discretise the continuum by diagonalising the Hamiltonian in a basis of optimal size. The WK approach, on the contrary, makes no explicit reference to the single particle spectrum, and achieves accurate smoothing of the total energy. Thus, WK approach is a good alternative to the conventional Strutinsky smoothing scheme. The expansion has been carried out up to the fourth order in ħ, for central potential as well as for spin orbit potential. This is a very challenging task. We

have developed the necessary framework, and the code for calculating the corrections up to the fourth order has been written and tested. The final goal of this project is to apply the WK smoothing to calculate the shell corrections and hence the nuclear masses, for all the nuclei from proton drip line to neutron drip line. Due to the fact that the WK approach does not use the single particle structure explicitly, it is expected that the present approach will be more reliable than the existing approaches to calculate the nuclear masses, especially for the neutron rich and the neutron deficient nuclei. The accurate calculation of nuclear masses has tremendous impact on a number of fields, for example, nuclear astrophysics, where, understanding of stellar synthesis of stable nuclides, as well as that of r – process requires masses of neutron rich nuclei up to a very high degree of precision. Most of these nuclei are experimentally inaccessible. Thus, the nuclear mass formulas are very much relevant for such investigations.

This model has been applied to the description of ground state binding energies of even – even spherical and deformed nuclei spanning the entire periodic table. The validity of the model in the extreme neutron rich and neutron deficient sectors has also been demonstrated. As an extension, an attempt is being made to accomplish a difficult task of describing the charge radii and binding energies of nuclei within the same mic – mac framework. The initial investigations have been proved to be successful. Recently, the model has been successfully applied to the spontaneous fission phenomenon of the superheavies.

(Collaborators : Prof. Ramon Wyss, KTH Stockholm, Sweden, Prof. Peter Schuck IPN Orsay, Franc), Prof. Xavier Viñas and Prof. Mario Centelles University of Barcelona, Spain).

The work on semi – classical treatment of the Gogny functional is in progress. The preliminary results are very promising, and are being readied for communication to a journal.

A simple formula for ground state nuclear masses based on the microscopic - macroscopic approach has been developed. Considering a set of 2353 nuclei with Z>8 and N>8, the formula yields an rms deviation of just 266 keV. The formula has a major advantage: it allows one to parameterise the fluctuating part of the ground state energy reliably. This result is very interesting and important, since the fluctuating part of the energy is related directly to the trace formula, which in turn encodes the interaction itself. Further investigations along these lines are in progress.

The investigation of alpha decay properties of proton rich nuclei in the Sn region and alpha and cluster decay phenomena in the heavy and superheavy region are in progress. The Q values, necessary for evaluation of the half lives, are taken from the model developed (see ‘c’), whereas the decay widths are calculated explicitly by solving the Schrödinger equation suitably. This work is being undertaken in collaboration with Prof. Roberto J. Liotta of KTH, Stockholm.

The important problem of contribution of non – local effects in the optical model, particularly for loosely bound projectiles at low energies are being investigated. The

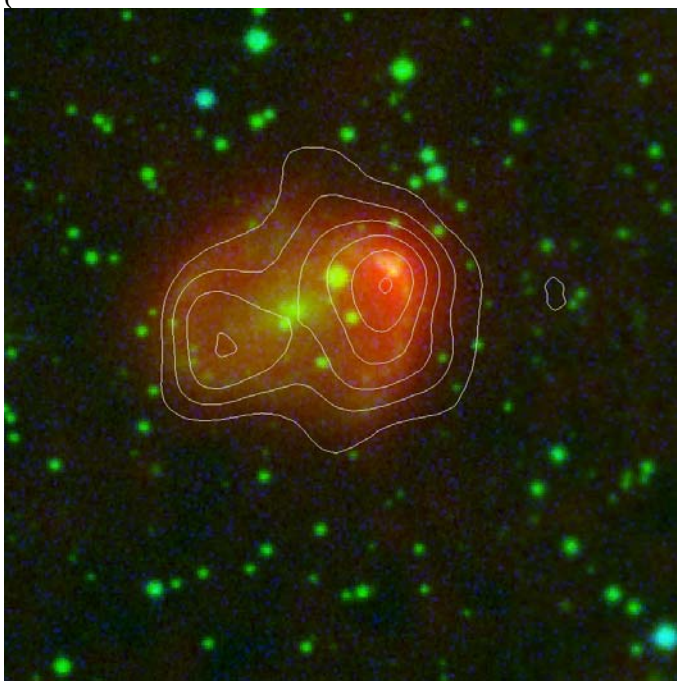
necessary formalism has been developed, and at present they are in the process of validation of the formalism.

(Collaborators : Dr. Neelam Upadhyay and Prof. B. K. Jain).

Ananda Hota

Digging deeper in to Black Hole-Galaxy co-evolution using GMRT telescope

After the discovery of the exotic galaxy Speca (Hota et al. 2011) several groups of astronomers all over the world have attempted discovering more Speca-like objects to understand the reason why they are so rare. Nearly half a dozen such galaxies have been discovered till date. The very existence of these odd-ball spiral galaxies hosting large spinning supermassive black holes and launching million light year size radio jets containing relativistic magnetised plasma, questions the traditional understanding of co-evolution of galaxies and black holes through merger and AGN-feedback. These galaxies hint to alternate processes of co-evolution and/or possibility that the rarity in the current Universe is a special or final condition of the general condition of frequent occurrence that existed in the early Universe. Recent studies with the GMRT have revealed possible relic radio lobes farther away than the active radio lobes from a spiral Seyfert galaxy named NGC4235 (Kharb, …, Hota 2016). As DAE-funded Giant Meterwave Radio Ttelescope (GMRT, located near Pune) is the largest radio telescope operating at low frequencies, it is the most powerful machine attracting scientists from all over the world who are interested to dig deeper in to the past of galaxy-black hole co-evolution in our Universe. How feedback processes from such radio jets affect the future of star formation in a galaxy is an important problem in astrophysics and GMRT can play a major role. Specially so, because the new sky survey, named TIFR GMRT Sky Survey(TGSS) is the most sensitive and highest angular resolution sky survey done so far at low radio frequencies to study the old radio plasma. More discoveries of Speca-like galaxies using TGSS and citizen-science approach can help a better understanding or black hole galaxy co-evolution in our Universe.



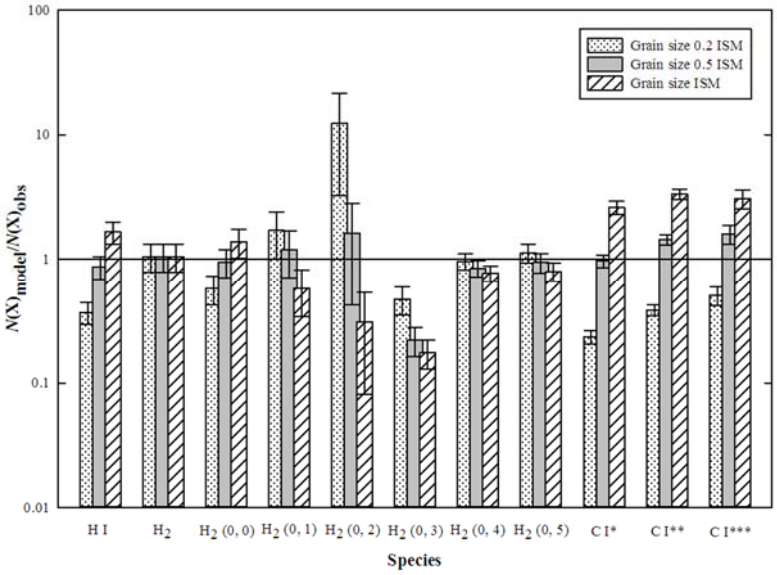
*A new-found spiral galaxy with possible radio bubbles. Radio emission from GMRT (TGSS ADR) is shown in contours and Green represents optical image (DSS). Red represents 22 micron emission from very cold (a few 100 degree Kelvin) micron-size dust-grains and PAH (*Polycyclic aromatic hydrocarbons*) seen with the WISE satellite telescope of NASA. Image made using NASA*

1. Hota, Ananda; Sirothia, S. K.; Ohyama, Youichi; Konar, C.; Kim, Suk; Rey, Soo-Chang; Saikia, D. J.; Croston, J. H.; Matsushita, Satoki 2011, MNRAS, 417, L36, 2. Kharb P., Srivastava S., Singh V., Gallimore J.F., Ishwara-Chandra C.H., Hota Ananda, 2016, MNRAS, 459, 1310 3. Hota Ananda, Konar Chiranjib, Vaddi Sravani, Dabhade Pratik, Nemani Lavanya et al. 2016 (astro-ph link coming soon)

Gargi Shaw

Physical conditions in high red-shift Damped Lyman alpha absorbers:

Damped Lyman α absorbers (DLAs) are neutral hydrogen clouds with H I column densities, N(H I) ≥ $10^{20.3}$ cm^{-2} and are seen along the line of sight of AGNs or GRBs. They trace the bulk of the neutral hydrogen at high redshift and are considered to be the progenitors of present-day disk galaxies. Dr. Gargi Shaw is mainly interested in those high-redshifted DLAs which shows H_2 and various other atomic and ionic lines. Molecular hydrogen forms on dust grains more efficiently. Using numerical simulations she and her group are trying to understand the dust grain properties at high red shift. They have inferred that the grain sizes in high redshift DALs are either smaller compared to the ISM type grains or fluffy grains exists there with more surface area.



The plot shows the ratio of model to observed column densities for H I, C I and H_2 for the DLA at zabs = 2.3377. Grain size is varied for the same model. The best-fitting model is clearly the one with grains of size 0.5 times the ISM grain size.

(Collaborator: Prof. R. Srianand, IUCAA, Pune),

(One PhD student Ms. Katherine Rawlins is involved in this project).

Physical conditions in CO enriched Novae:

Classical Novae arise in a close binary system where a white dwarf and a main sequence star, or a sub-giant or a red-giant star orbit each other. Due to their close proximity and the extreme gravity of the white dwarf, hydrogen from the companion star is drawn into an accretion disk and eventually deposited as a hydrogen layer on the surface of the white dwarf. With the accretion of more and more hydrogen the pressure and temperature at the bottom of this surface layer increase rapidly and at a point it triggers nuclear fusion reactions. These reactions rapidly convert the hydrogen into heavier elements creating a runaway thermonuclear reaction where the energy released by the hydrogen burning increases the temperature, which in turn drives up the rate of hydrogen burning. The energy released through this process ejects the majority of the unburnt hydrogen from the surface of the star in a shell of material moving at speeds of up to 1,500 km/s. This produces a bright but short-lived burst of light, called Nova. Though the environment is very harsh, dust and molecules (CN, CO, SiO, SiO_2, PAHs, H_2) in wind of classical novae are well observed. However, their formation is very poorly understood and not much simulation has been done in this area of research so far.

CO molecule has been detected in many Novae such V705 (Evans.et al. 1996), V496 Scuti (Ashish Raj et al. 2014), V2274 Cygni (Rudy et al. 2003), V2615 Ophiuchi (Das et al. 2009) and V5668Sgr (Banerjee et al. 2015). The observed CO column density ranges from $2x10^{17}$ to $8.5x10^{18}$ cm^{-2}. However, none of these novae show any evidence of H_2.

Dr. Gargi Shaw and her group is trying to address this problem with the spectral simulation code Cloudy (Ferland et al. 1998; 2013) and derive the physical conditions for such novae.

(Collaborator: Prof. Ramkrishna Das, S.N.Bose National Centre for Basic Sciences, Kolkata, WB),

(Student Involved: Mr. Ashish Koli).

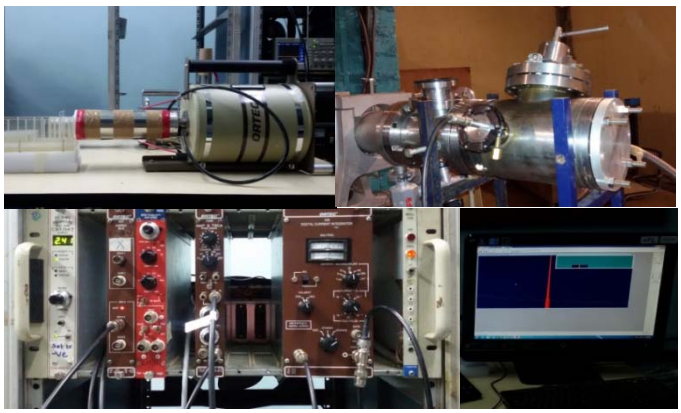
Low-mass X-ray binaries

Many microquasars and low-mass X-ray binaries (LMXBs) exhibit narrow absorption features identified with resonant absorption from Fe xxv and Fe xxvi and other abundant ions. In many well studied systems there is evidence for blue-shifts, indicating outflowing plasmas. Dr. Gargi Shaw is interested in modelling such environments.

(Collaborators: Prof. Sudip Bhattacharya,TIFR, Mumbai).

M. Hemalatha

Experimental Nuclear Physics: Proton-induced reactions on Se isotopes



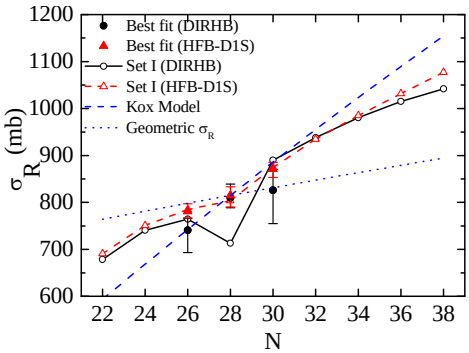
Management of long-lived nuclear waste is an important aspect for any sustainable nuclear energy programme. Several strategies are being explored for the transmutation of the long-lived fission products such as ^{79}Se. Neutrons, protons and photons are being considered as suitable probes for this program. Neutrons are not suitable for the transmutation of Se isotopes. It turns out that *p*-induced reactions in particularand low energy protons (about 20 MeV) are suitable for converting ^{79}Se to short-lived ^{79}Br while transmuting the other Se isotopes to either stable or short-lived Br isotopes.

While (p,n) data exist for stable Se isotopes over a limited energy range, there are no data for the radioactive ^{79}Se. Hence, the cross sections of the (p,n) reactions on ^{76,77,78,80,82}Se using natural Se targets using stacked-foil activation technique have been measured. Se deposited on Al targets have been irradiated with proton beam of energies from threshold to 18.5 MeV using 14 UD BARC-TIFR Pelletron accelerator facility at Mumbai. Since the half-lives of the isotopes are relatively long, radioactivity of the activation products was determined via off-line gamma-counting method using high resolution HPGe detectors. The excitation function for the ^{76,77,78,80,82}Se(p,n) obtained experimentally has been compared with statistical model codes Empire and Talys. With suitable adjustment of optical model and level density parameters, there is good agreement between experiment and calculated excitation function.

Team: M. Hemalatha, N. Maladkar, A. Patel, R. John, S. Kailas, S. G. Wahid, D. Negi, S.K.Tandel, BARC collaborators

Correlation between nuclear charge radii with reaction cross sections:

Investigation of the correlation between nuclear charge radii with reaction cross sections and utilizing this correlation in predicting the reactions cross sections are being carried out.



Smaller charge radii compared to neighboring isotopes are signature of magic numbers which arise due to the right number of protons or neutrons. While on the other extreme we have halo nuclei which have abnormally large radius. Observing the nuclear charge radii in isotopic chains, new shell gaps seems to appear or

traditional shell gaps are found to vanish. These features give insights in to the nuclear interactions. The behavior in nuclear charge radii and reaction cross sections have been investigated for Ti and Cr isotopic chains. Details about figure given in Hemalatha *et al*., Phy. Rev. C, 92, 024611 (2015) and EuropeanPhysicalJournal, 107,08006(2016).
Team: M. Hemalatha, N. Maladkar , S. Kailas

Neelam Upadhyay

Homogenizing Schrödinger equation with nonlocal interaction

Conventionally, optical potential model is used to study scattering process. The optical potentials used in these studies are local and energy-dependent. Recent works on (d,p)/(p,d) reactions [1,2] have shown that explicit inclusion of nonlocal effects significantly modify reaction observables. Such studies involve solving an integro-differential Schrödinger equation with nonlocal kernel. This kernel is constructed from nonlocal potential and normalized Gaussian form factor depending on the range of nonlocality for the nucleon-nucleus potential [3]. In the early sixties, an iterative procedure was proposed by Perey and Buck to solve such equation [3]. This involved approximating the nonlocal kernel by a local equivalent potential as an initial guess and subsequent improvisation through an iterative procedure.

So far this technique has been implemented for stable nuclei [1,2,3]. However, as one moves to unstable nuclei, it is not known if it is adequate to use local equivalent potential. Hence, a versatile method to homogenize the nonlocal Schrödinger equation was developed by the group that retains the effect of nonlocality without introducing any approximations. With the aim to understand how the new method compares with the Perey-Buck iterative scheme, a comparative study of neutron scattering off various systems as a function of energy was performed. Various observables like total and differential cross sections were calculated to quantify the accuracy of homogenization method.
(Collaborators : Dr. A. Bhagwat, CEBS and Dr. B. K. Jain)
Reference:

1. A. Deltuva, Phys. Rev. C79, 054603 (2009).
2. L. J. Titus & F. M. Nunes, Phys. Rev. C89, 034609 (2014).
3. F. Perey and B. Buck, Nucl. Phys. 32, 253 (1962).

Sangita Bose

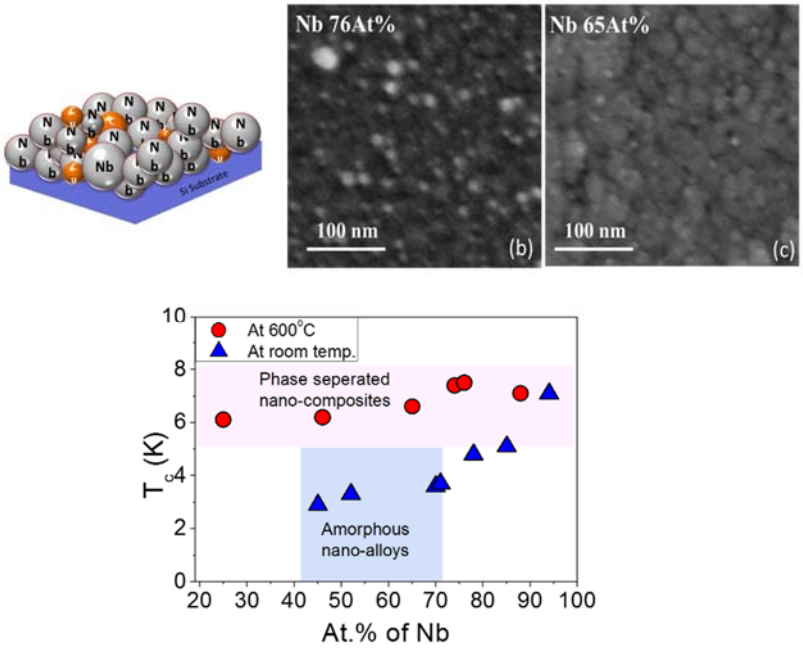
Superconductivity in Nb-Cu nano-composites and nano-alloys:

Superconductivity in granular media has been a recurring theme in the field of superconductivity for several decades. Early studies on granular superconductors indicated that depending on the degree of coupling between grains, the elementary excitations that eventually destroy superconductivity at a characteristic temperature, Tc, could be fundamentally different from those in clean homogeneous systems. From

phenomenological standpoint, the Tc of a superconductor is governed by the amplitude and phase excitations of the complex superconducting order parameter. Within the celebrated Bardeen Cooper Schrieffer (BCS) theory, Tc is given by the temperature at which the amplitude of the order parameter goes to zero and phase fluctuations play a negligible role. In granular systems where the superconducting grains are weakly coupled to each other through Josephson coupling, it has been suggested that superconductivity could be destroyed through phase fluctuations even when the amplitude of the order parameter remains finite. Nb-Cu nanocomposite films presents an interesting system to test the role of phase fluctuations on superconductivity. In addition, Nb-Cu which are immiscible in the bulk form, is known to form amorphous nanoalloys at certain concentration ratios of Nb:Cu. These nanoalloys have been reported to be superconducting previously. Hence, in these nanoalloys, structural and compositional disorder can have an important role to play in controlling the superconducting properties. Hence, Nb-Cu can form a single model system in which we can explore different regimes - from the crystalline two phase nanocomposites to an amorphous nanoalloy regime where the superconducting properties are controlled by dis-order.

A systematic study of the superconducting properties of Nb-Cu nanocomposite systems was done. The ratio of Nb:Cu was varied in the films by changing the relative DC power ratio during sputtering. One set of films were grown at 600^0C while the other set was grown at room temperature. For the former set, the films formed, phase separated nano-composites of FCC-Cu and BCC-Nb irrespective of the Cu content (see SEM image in figure below). The microstructure revealed the presence of small crystallites of Nb and Cu (see schematic of the film in figure below), with their sizes changing only slightly with decreasing Cu content. Interestingly, the superconducting transition temperature (T_c) of these nano-composites was observed to decrease from 8.0 to 6.0K for Cu concentrations between 100At%-Nb to 25At%-Nb. Other superconducting parameters like critical fields, critical currents and superconducting energy gap also decreased with increasing Cu concentration. In addition, in all films two resistive transitions was observed. Comparing the transition temperatures with the superconducting transition temperatures in nanoparticles of pure Nb with different particle size led to the conclusion that the higher transition is associated with the superconducting transition of individual Nb grains whereas the lower transition corresponds to the temperature where global phase coherence is established. *Our results underpined the importance of phase fluctuations on the superconducting properties of 3-dimensional superconductor/normal metal composites.*

For the second set of films, nano-alloys of Nb-Cu were formed as the Cu concentration was 70 At% thereby showing that solid solutions can be formed in a metastable state for systems which is otherwise thermodynamically unfavourable. These nano-alloys were also found to be superconducting with a T_c around 3.0±0.6 K (see figure). *The mechanism of superconductivity in these nano-alloys are currently under investigation.*



Collaborators: Dr. Pratap Raychaudhuri, Vivas Bagwe and Bhagyashree Chalke (TIFR) (Sample structural characterization by SEM, EDX and magnetic field measurements done at TIFR)

Students: Pradnya Parab, Prabhjyot Bhui (CEBS) (Growth and all low temperature measurements done at CEBS)

Post doc: Sanjeev Kumar (CEBS) (Involved in preliminary growth at CEBS).

R. Nagarajan

Studies of light scattering in ferrofluids (FF) are of importance in basic science and in application. Light (He-Ne 10 mW laser) scattering studies were carried out in dispersions of Fe_3O_4 nanoparticles (MNP) in water (PAA coated, hydrodynamic diameter D_h: 80 nm) and in hexane (Oleic acid coated, D_h: 40 nm). When light beam is focused into the hexane based FF (30 mg/ml), a self-diffraction pattern (SDP) is observed in the forward scattered beam (captured using a CCD camera), which is understood in terms of thermal lensing effect and consequent profile of nonlinear local index of refraction (n + Δn). Application of magnetic field perpendicular to the light beam results in a variation in the SDP due to a redistribution of MNPs, with a significant delay after the application of the field. Generation of magnetic field for desired duration and capturing the dynamics of SDP in this duration is carried out using an automated system. Analysis of the patterns with using image processing, indicates a change in Δn from $1.3 * 10^{-3}$ at 210 ms after the onset of the field, to $3.8 * 10^{-3}$ at 420 ms. This enables investigation of the dynamics of MNP in the medium. Particle image velocimetry (PIV) technique was used to visualize SDP dynamics.

Similar studies in the water based FF, did not show SDP, instead a vertical streak was

observed on application of the field. Non-formation of SDP is attributed to higher heat capacity of water and consequent reduction in thermal lensing effect. The vertical streak (observed by other workers also) is due to formation of chain like structures of MNP under the influence of magnetic field. In this case too, there is a specific time of evolution of the streak, which provides means of studying dynamics of chain formation. Experiments for such investigations are underway.

Principal investigator: S. Radha, UDP, UoM; Co-investigators: M. Shalini, Chintamani Pai, and Nooris Momin, UDP, UoM; H. Muthurajan, NCNNUM.

S. M. Chitre

Boussinesq Convective Modes:

The linear Boussinesq convective modes were studied for a rotating star with meridional circulation. The main thrust has been to derive the integral expressions for convective flux and the Reynolds stress which needs to be evaluated numerically, and which have been checked analytically in the absence of rotation and shear.

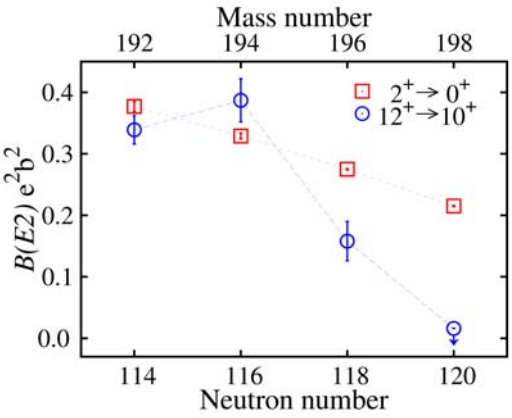
This expressions for the Reynolds stress is to be incorporated into the calculation in order to infer the magnetic field configuration and meridional circulation pattern that is consistent with the seismologically inferred angular velocity variations.

Collaboration : Prof. Douglas Gough, Dr. Bhooshan Paradkar (CEBS), Prof. H. M. Antia (TIFR) and Bhishek Manek (CEBS Student).

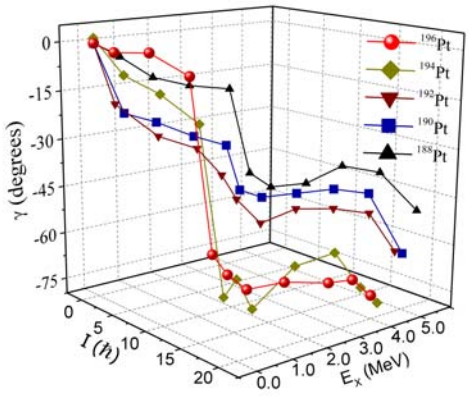
Sujit Tandel

Isomers and oblate rotation in neutron-rich Pt isotopes

Rotation-aligned isomeric states and associated oblate collective sequences are established in even-Pt isotopes. Reduced *E2* transition probabilities for the de-excitation of the 12^+ isomers indicate an abrupt and unexpected quenching of oblate collectivity around neutron number *N*=120. Structure and shape evolution at high spin in the heaviest stable isotopes is found to be markedly different from observations in the lighter ones.



Reduced *E2* transition probabilities in Pt isotopes



Shape evolution in Pt isotopes

Shape coexistence in As and Ge nuclei

Coexistence of prolate and oblate shapes and nucleon alignments have been studied in the nuclei 73As and 70Ge. Vibrational structures have also been identified.

High-resolution spectroscopy using a digital data acquisition system

High-resolution germanium and CdTe radiation detectors are being configured for use with a state-of-the-art, 500 MHz digital data acquisition system acquired using external grant funding. Additionally, fast timing measurements with BaF_2 scintillation detectors are being performed.

PhD students: S. Gholam Wahid, Poulomi Roy
Project students: Saket Suman, Sanchit Sablok, Ankit Kumawat
Research Associate: Dr. Dinesh Negi

Tripti Bameta

Transcriptional Interference: A tool for gene regulation:

In this work we performe theoretical studies of complex RNAP-tra c phe-nomena that are believed to play important regulatory roles in living cells. These phenomena arise from simultaneous transcription of two overlapping genes either on the same DNA template or two genes on the two adjacent single strands of a duplex (double-stranded) DNA. In the former case, traf-c is entirely uni-directional although RNAPs transcribing di erent genes polymerize two distinct species of RNA molecules by starting (and stopping) at di erent sites on the same template DNA strand. In contrast, in the latter case, RNAP tra c in the two adjacent \lanes" move in opposite di-rections transcribing the respective distinct genes. In both these situations the phomenon of suppressive in uence of one transcriptional process on the other is called transcriptional interference (TI).

In general, a RNAP at the initiation, elongation or termination stage of transcription of one gene can suppress the initiation, or elongation (or in-duce premature termi- nation) of that of the other gene by another RNAP. In other words, the stages of transcription of the two interfereing RNAPs de ne a distinct mode of interference. Di erent modes of interference have been assigned di erent names like \occlusion", \collision", \sitting duck in-terference", etc. Many pairs of interfering transcription processes are known to form a bistable switch: switching ON a high level of transcription of one of the two genes can switch OFF the other by its suppressive e ect and vice versa. Thus, the sense and anti- sense genes transcription itself makes a \self-regulatory" circuit .

For this system, we have developed a uni ed theoretical frame- work that, for a given relative orientation of two genes, captures all possible modes of TI. Using this theoretical model we have investigated the e ects of (i) ge-ometric parameters, like the relative orientation and spatial extent of the overlap of the two genes, and (ii) kinetic parameters, like the rates of ini-tiations, terminations, unhindered elongation as well as those of passing or premature detachments of RNAPs up on close encounter, etc. on (a) the spatio-temporal organization of the RNAPs, and (b) the overall rates of synthesis of full-length transcripts of both the genes. Our systematic and comprehensive theoretical analysis throws light on the mechanisms of vari-ous kinetic aspects of TI phenomena observed in di erent kingdoms of life (i.e., transcription by bacteriophage RNAP as well as by those of bacteria and higher organisms). More precisely, we have established the RNAP tra c conditions necessary for the switch-like regulation of two mutually interfering transcriptional processes. We have also demonstrated how deviations from these tra c conditions lead to various other types of outcome of TI.

This paper is under review in Physical Review E.

Correlation of Nucleosome organization with Transcrip-tion

Chromatin is a compact structure of DNA which consists of many nucleo-some. These nucleosomes bound to DNA in speci c pattern depending on the DNA sequence and

various other factors. Current `nucleosome sequenc-ing' experiments show variety of nucleosome patterns, some region with very precise nucleosome occupancy and some with relatively varying organisation. After each transcription most of the nucleosome are dislodged from the gene and after transcription these nucleosomes rebind DNA at precise location in very e cient manner. In this work, we give a model to study role of RNA polymerase on nuclesome organisation in gene region. This work is near completion.

Publications

Publications

7.1 Publications in peer reviewed Journals :

1. S. Gupta, N. Patel, R. Fernandes, R. Kadrekar, **Alpa Dashora**, A.K. Yadav, D. Bhattacharyya, S.N. Jha, A. Miotello, and D.C. Kothari
"Co-Ni-B nanocatalyst for efficient hydrogen evolution reaction in wide pH range"
Applied Catalysis B: Environmental 192, 126 (Impact Factor: 7.435).

2. R. Jaiswal, N. Patel, **Alpa Dashora**, R. Fernandes, M. Yadav, R. Edla, R.S. Varma, D.C. Kothari, B.L. Ahuja and A. Miotello
"Efficient Co-B-codoped TiO_2 photocatalyst for degradation of organic water pollutant under visible light"
Applied Catalysis B: Environmental 183, 242 (Impact Factor: 7.435).

3. J. P. Maharana, **A. Bhagwat** and Y. K. Gambhir
"Microscopic Investigations of α Emitters Close to the N=Z Line"
Phys. Rev. C 91, 047301.

4. **A. Bhagwat** and R. J. Liotta
"Consistent Description of Cluster Decay Phenomenon in Trans Actinide Nuclei"
Phys. Rev. C 92, 044312.

5. X. Viñas, **A. Bhagwat,** M. Centelles, P. Schuck and R. Wyss
"Applications to Nuclear Properties of the Microscopic-Macroscopic Model Based on Semiclassical Wigner-Kirkwood Method"
Phys. Scr. 90, 114001.

6. Y. K. Gambhir, **A. Bhagwat** and M. Gupta,
"The Highest Limiting Z in the Extended Periodic Table"
J. Phys. G: Nucl. Part. Phys. 42, 125105.

7. X. Viñas, **A. Bhagwat,** R. Castillo, M. Centelles and P. Schuck
"Gogny – Force Inspired Mass Formula within the Wigner – Kirkwood Averaging Scheme" *Acta Physica Polonica B (proceedings supplement) 8, 699.*

8. P. Kharb, S. Srivastava, V. Singh, J.F. Gallimore, C.H. Ishwara-Chandra, **Ananda Hota**
"A GMRT study of Seyfert galaxies NGC 4235 and NGC 4594: evidence of episodic activity?"
Monthly Notices of the Royal Astronomical Society, Volume 459, Issue 2, p.1310-1326.

9. **Mothi N., Muthu S., Kale A., Ahmad B**
"Curcumin promotes fibril formation in F Isomer of human serum albumin via amorphous aggregation".
Biophys Chem. 2015 Aug 15; 207:30-39.

10. **Muthu SA**, **Mothi N**, **Shiriskar SM**, Pissurlenkar RR, Kumar A, **Ahmad B**.
"Physical basis for the ofloxacin-induced acceleration of lysozyme aggregation and polymorphism in amyloid fibrils"
Arch Biochem Biophys. 2016 Feb 15;592:10-9.

11. Acharya S, Saha S, **Ahmad B**, Lapidus LJ.
"Effects of Mutations on the Reconfiguration Rate of α-Synuclein"
J Phys Chem B. 2015 Dec 17;119(50):15443-50.

12. **Ahmad B**, Muteeb G, Alam P, Varshney A, Zaidi N, Ishtikhar M, Badr G, Mahmoud MH, Khan RH.
"Thermal induced unfolding of human serum albumin isomers: assigning residual α helices to domain II"
Int J Biol Macromol. 2015 Apr;75:447-52.

13. G Desforges, **B.S. Paradkar**, M Hansson, TL Audet, J Ju, I Gallardo-González, B Aurand, P Lee, L Senje, A Persson, S Dobosz Dufrénoy, O Lundh, G Maynard, P Monot, JL Vay, C-G Wahlström, B Cros
"Analysis of electron injection in laser wakefield acceleration using betatron emission in capillary tubes"
SPIE Optics+Optoelectronics, 95140Z-95140Z-11.

14. **B. S. Paradkar** and **S. Krishnagopal**
"Electron heating in Radiation pressure driven proton acceleration with a circularly polarized laser"
Physics Review E 93, 023203.

15. **Dolly K. Khona**, Seema Shirolikar, Deodhar, Erik Hom, **D'Souza J. S**.
"NaCl-induced palmelloidy in the green chlorophyte, *Chlamydomonas reinhardtii*"
Algal Research, 16: 434-448.

16. **Sirisha V. L., Mahuya Sinha, Kanak Gawade** and **Jacinta S. D'Souza**
"KCl Induces PCD through a Mitochondrion-mediated Caspase-independent Pathway in *Chlamydomonas reinhardtii***"**
Phycologia, 55(4):378-392.

17. **Chaitanya Kasuba Krishna, Sirisha V. L.** and **Jacinta S. D'Souza**
"Physiological relevance of programmed cell death in unicellular algal systems - A review" *Algal Research 12: 126-133.*

18. **M. Hemalatha, N. Maladkar and S. Kailas**
"Prediction of reaction cross section for p-Cr"
European Physical Journal, 107, 08006.

19. R.G. Mane, P. Surendran, Sanjay Kumar, J.P. Nair, M.L. Yadav, **M. Hemalatha,** R.G. Thomas, K. Mahata, **S. Kailas**, and A.K. Gupta
"Verification of the sputter-generated 32SFn- (n=1-6) anions by accelerator mass spectrometry**"**
Nucl. Inst. Meth. B366, 13.

20. **M. Hemalatha, N. Maladkar and S. Kailas**
"Correlation between nuclear charge radii of Ti and reaction cross sections for p-Ti"
Phy. Rev. C, 92, 024611.

21. **S. Kailas**, ***M. Hemalatha***, and A. Saxena
"Nuclear Transmutation Strategies for Management of Long Lived Fission Products"
Pramana, 85, 517.

22. **Patil M.**
"Mechanistic Insights into the Initiation step of the Base Promoted Direct C–H Arylation of Benzene in the Presence of Additive"
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24. **Patil M.** Thiel, W.
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J. Comp. Chem. 2016, 37, 280–285. [Impact factor: 3.13].

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"Synthesis of Highly Emissive 1,8-diaryl Anthracene Derivatives for Organic Light Emitting Devices: Substituent Effect on Fabrication of Micro/nanostructure"
RSC Adv., 2015, 5, 98447–98455. [Impact Factor: 3.84].

25. Wilson L, **Lopus M**, Miller HP, Azarenko O, Riffle S, Smith JA, Jordan MA
"Effects of eribulin on microtubule binding and dynamic instability are strengthened in the absence of the βIII tubulin isotype"
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26. **Lopus M**, Smiyun G, Miller H, Oroudjev E, Wilson L, Jordan MA
"Mechanism of action of ixabepilone and its interactions with the βIII-tubulin isotype"
Cancer Chemother Pharmacol, 76(5):1013-24.

27. **Lopus M**
"Advances in tubulin-targeted cancer chemotherapeutics"
Int J Mol Med 36, S8-S8 (Proceedings)

28. Bharat K. Sharma, Azam M. Shaikh, **Neeraj Agarwal** and Rajesh M. Kamble
"Synthesis, Photophysical and Electrochemical Studies of Acridone-Amine based Donor-Acceptors for Hole Transport Materials"
RSC Advances , 2016, 6, 17129-17137.

29. **Swati Dixit, Mahendra Patil** and **Neeraj Agarwal**
"Ferrocene catalysed heteroarylation of BODIPy and reaction mechanism studies by EPR and DFT methods"
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"Probing ultrafast dynamics in a solid-density plasma created by an intense femtosecond laser"
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"Contrasting levels of absorption of intense femtosecond laser pulses by solids"
Nature Scientific Reports, 5, 17870.

32. P. K. Singh, A. Adak, A. D. Lad, G. Chatterjee, **P. Brijesh** and G. Ravindra Kumar
"Controlling two plasmon decay instability in intense femtosecond laser driven plasmas"
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33. Jithender G. Reddy, Dinesh Kumar and **Ramakrishna V. Hosur**
"Novel (3,2)D- reduced dimensionality experiments and their automated analysis: Implications to high-throughput structural studies on proteins"
Magn. Reson. Chem., 53(2):79-87.

34. Pushpa Mishra, Sudarshan Rajgopal, Shobhona Sharma, **Ramakrishna V. Hosur**
"The C-terminal Domain of Eukaryotic Acidic Ribosomal P2 Protein is Intrinsically Disordered with conserved Structural Propensities"
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35. Pushpa Mishra and **Ramakrishna V. Hosur**
"Urea Dependent 15N NMR-Relaxation Studies on PfP2 Multimers Reveal that the C-Terminal Behaves like an Independent Intrinsically Disordered Peptide"
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"Ribosomal Protein P2 from apicomplexan parasite Toxoplasma gondii is intrinsically a molten globule".
Biophys Chem. 200-201, 27-33.

37. **Sinjan Choudhary**, Nand Kishore and **Ramakrishna V. Hosur**
"Inhibition of insulin fibrillation by osmolytes: Mechanistic Insights"
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38. Pushpa Mishra[1], **Sinjan Choudhary**[2], Sujoy Mukherjee [3], Disha Sengupta[4], Shobhona, Sharma[4] and **Ramakrishna V. Hosur**[1,2*]
"Molten globule nature of *Plasmodium falciparum* P2 homo-tetramer"
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J. Biomol. Struct. Dynam. May 2015,33 Suppl 1:98doi:10.1080/07391102.2015.1032785.

40. Debanjan Mukherjee[a], Pushpa Mishra[b], Mamata Joshi[b], Prasoon Kumar Thakur[c], **R.V. Hosur**[b], Gotam K. Jarori[a,]
"EWGWS insert in *Plasmodium falciparum* ookinete surface enolase is involved in binding of PWWP containing peptides: Implications to mosquito midgut invasion by the parasite"
Insect Biochemistry and Molecular Biology, 68, 13–22.

41. **Sinjan Choudhary**, PaurnimaTalele, Nand Kishore, Colloids Surf B
"Thermodynamic insights into drug-surfactant interactions : study of the interactions of naporxen, diclofenac sodium, neomycin, and lincomycin with hexadecytrimethylammonium bromide by using isothermal titrationcalorimetry" *Biointerfaces 132 (2015) 313-321.*

42. Anu A Thoppil, **Sinjan Choudhary**, Nand Kishore
"Competitive binding of anticancer drugs 5-fluorouracil and cyclophosphamide with serum"
Biochimica et Biophysica Acta 1860 (2016) 917–929.

43. **S.K. Tandel***, S.G. Wahid, P. Chowdhury, R.V. Janssens, M.P. Carpenter, T.L. Khoo, F.G. Kondev, T. Lauritsen, C.J. Lister, D. Seweryniak, S. Zhu*
"*Isomers and oblate rotation in Pt isotopes: Delineating the limit for collectivity at high spins"*
Physics Letters B 750 (2015) 225.

44. *S.G. Wahid,* **S.K. Tandel***, P. Chowdhury, R.V. Janssens, M.P. Carpenter, T.L. Khoo, F.G. Kondev, T. Lauritsen, C.J. Lister, D. Seweryniak, S. Zhu*
"Rotation-aligned isomer and oblate collectivity in ^{196}Pt*"*
Physical Review C 92 05432.

45. **S.K. Tandel**
"Isomers and oblate collectivity at high spin in neutron-rich Pt isotopes"
European Physical Journal Web of Conferences 107, 03005.

46. **S.K. Tandel**
"Spectroscopy of heavy fissionable nuclei"
Pramana – Journal of Physics DOI: 10.1007/s12043-015-1053.

47. M. Kumar Raju, P.V. Madhusudhana Rao, **S.K. Tandel**, P. Sugathan, R.P. Singh, S. Muralithar, T. Seshi Reddy, B.V. Thirumala Rao, Jie Meng, Shuangquan Zhang, Jian Li, Q.B. Chen, Bin Qi, R.K. Bhowmik
"High spin spectroscopy and shape coexistence in ^{73}As*"*
Physical Review C 92, 064234.

48. J. T. Matta, U. Garg, W. Li, S. Frauendorf, A. D. Ayangeakaa, D. Patel, K. W. Schlax, R. Palit, S. Saha, J. Sethi, T. Trivedi, S. S. Ghugre, R. Raut, A. K. Sinha, R. V. F. Janssens, S. Zhu, M. P. Carpenter, T. Lauritsen, D. Seweryniak, C. J. Chiara, F. G. Kondev, D. J. Hartley, C. M. Petrache, S. Mukhopadhyay, D. Vijaya Lakshmi, M. Kumar Raju, P. V.

Madhusudhana Rao, **S. K. Tande**l, S. Ray, F. Donau
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"Observation of gamma-band based on two-quasiparticle configuration in ^{70}Ge"
Physical Review C 93, 034317.

50. S. Biswas, R. Palit, A. Navin, M. Rejmund, A. Bisoi, M. Saha Sarkar, S. Sarkar, S. Bhattacharyya, D. C. Biswas, M. Caamano, M. P. Carpenter, D. Choudhury, E. Clement, L. S. Danu, O. Delaune, F. Farget, G. de France, S. S. Hota, B. Jacquot, A. Lemasson, S. Mukhopadhyay, V. Nanal, R.G. Pillay, S. Saha, J. Sethi, Purnima Singh, P.C. Srivastava and **S.K. Tandel**
"Structure of ^{132}Te : The two-particle and two-hole spectrum of ^{132}Sn"
Physical Review C 93, 034324 **.**

51. Deepika Choudhury, R. Palit, P. Singh, J. Sethi, S. Saha, S. Biswas, H. C. Jain, V. Nanal, R. G. Pillay, R. Donthi, S.K. Jadhav, B.S. Naidu, B. Maheshwari, A. K. Jain, S. C. Pancholi, R. P. Singh, S. Mukhopadhyay, D. C. Biswas, L. S. Danu, **S. K. Tandel**, L. Chaturvedi, K. Rojeeta Devi, Sukhjeet Singh
"Role of neutrons in the coexistence of magnetic and antimagnetic rotation bands in ^{107}Cd"
Physical Review C 91, 014318.

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"Finite Group Actions"
Journal of Indian Math Soc. (N. S.), Vol.83 Nos. 1-2 (2016),145-160. (aeXiv:1308.3092).

54. Amita Jain, Prakriti Sinha, Ankita Jain and **Sirisha L. Vavilala**
"Estimation of flavonoid content, polyphenolic content and antioxidant potential of different parts of *Abrus precatorius* (L.)"
International Journal of Pharmacy and Pharmaceutical Sciences. 7(8): 157-163.

55. **Uma Divakaran**, Shraddha Sharma and Amit Dutta
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Phys. Rev. E93 052199.

56. Sharddha Sharma, **Uma Divakaran**, A. Polkovnikov and Amit Dutta
"Show quenches in a quantum Ising chain; dynamical phase transitions and topology"
Phys. Rev. B 93, 144306.

57. Atanu Rajak and **Uma Divakaran**
"Effect of double local quenches on Loschmidt echo and entanglement entropy of a one-dimensional quantum system"
J. Stat. Mech. 043107.

7.2 Publications in Book:

1. B.L Ahuja and **Alpa Dashora**
"Compton Scattering"
In: Saleem Hashmi (editor-in-chief), Reference Module in Materials Science and Materials Engineering. Oxford: Elsevier; 2016. pp. 1-8. ISBN: 978-0-12-803581-8.

2. **V.L.Sirisha**, Ankita Jain and Amita Jain
"Enzyme Immobilization: an overview on methods, support material and applications of immobilized enzymes"
In: Kim S-K (Ed.) Marine Enzymes Biotechnology: Production and Industrial applications. Elsevier, U.S.A.

3. **V. L. Sirisha, Jacinta S. D'Souza**
"Polysaccharide based nanoparticles as drug delivery systems"
In: Kim S-K (Ed.) Marine Omics: Principles and Applications". CRC Press, USA.

4. **VL Sirisha and JS D'Souza**
"Algal polysaccharides and their biological applications"
Invited chapter for the book titled, 'Marine Algae Extracts: Processes, Products, and Applications', First Edition. Edited by Se-Kwon Kim and KatarzynaChojnacka. © 2015 Wiley-VCH Verlag GmbH & Co. KGaA. Published 2015 by Wiley-VCH Verlag GmbH & Co. KGaA. Chapter 26, pages: 411-453.

7.3 Publications in Conference proceedings:

1. S. Bhatt, K. Kumar, **Alpa Dashora** and B.L. Ahuja
"Electronic properties of Laves phase $ZrFe_2$ using Compton spectroscopy"
AIP Conference proceedings 1728, 020463.

2. **A. Bhagwat** and S. R. Jain
"Extreme Value Statistics of Ground State Nuclear Masses"
DAE – BRNS Symposium on Nuclear Physics, Sathya Sai University, Prasanthi Nilayam.

3. **M. Hemalatha, N. Maladkar and S. Kailas**
   "Prediction of reaction cross section for p-Cr"
   International Conference on Nuclear Structure and Related Topics, Dubna, Russia, 2015.

4. **Pradnya Parab, Prashant Chauhan and Sangita Bose**
   "Soft point contact spectroscopy to probe superconductor-normal metal junctions"
   AIP Conf. Proc. 1731, 130059.

5. **Pradnya Parab, Sanjeev Kumar, Prabhjyot Bhui**, Vivas Bagwe and **Sangita Bose**
   "Superconducting properties of Nb-Cu nano-composites and nano-alloys"
   AIP Conf. Proc. 1731, 130034.

7.4 Patents:

1. Patent filed at the 'The Patents Act 1970 (39 of 1970) & The Patents Rules, 2003 Provisional/Complete Specification (Section 10 and rule 13)'.
   Title of Invention: Process for Synthesis of Nanoparticles using tryptone as a reducing agent'.
   Authors of Invention: Mr. Saurabh Mehta, Dr. Muthurajan Harries and **Dr. D'Souza Jacinta Seraphina**. (588/MUM/2015)

2. Patent filed at the 'The Patents Act 1970 (39 of 1970) & The Patents Rules, 2003 Provisional/Complete Specification (Section 10 and rule 13)'.
   Title of Invention: Process for fabrication of Paper-based microfluidics.
   Authors of Invention: Mr. Saurabh Mehta, Dr. Muthurajan Harries and **Dr. D'Souza Jacinta Seraphina**. (2815/MUM/2015)

Conference, Invited talks, Lectures given outside and Collaboration of the faculty

8 Conference, Invited talks, Lectures given outside and Collaboration etc. of the faculty

8.1 Department of Biology

Jacinta D'Souza

Invited talks:

- 'Flagellar/Cilia – a scientific enigma' at Manipal College Pharmaceutical Sciences, Manipal University on August 04, 2015.
- 'Irreducible multiprotein complexes in cells' at the Orientation *cum* Selection camp of NIUS (Biology) 2015 held at the Homi Bhabha Centre for Science education (TIFR) on November 05, 2015.

Collaborations:

- Marquette University, USA : Prof. Pinfen Yang from on the project titled, 'FAP174: an RSP3 interacting protein from the green chlorophyte, Chlamydomonas reinhardtii'.
- Tata Institute of Fundamental Research, Mumbai : Prof. Deepak Mathur, Senior Professor on the project titled, 'Effect of in situ generated radicals and free electrons on plasmid DNA'.
- Department of Atomic and Molecular Physics, Manipal University : Dr. Santhosh Chidangil, HOD, on the project titled, 'Raman Spectroscopy of flagellar proteins'.
- Department of Biosciences and Bioengineering, IIT-B, Mumbai : Prof. Swati Patankar
- Department of Biological Sciences, TIFR : Prof. B. J. Rao, on the project tilted, 'Characterizing molecular components and regulation of excision repair in Chlamydomonas reinhardtii'.
- Centre for Nanosciences and Nanotechnology : Prof. Harries Muthurajan, on the project titled, 'Innovating procedures for making nanoparticles and paper-based fluidics systems'.

Manu Lopus

Invited talks:

- Tubulin-targeted cancer therapeutics at 20th World Congress on Advances in Oncology, Athens, Greece (October, 2015)

Session Chair:

- Chaired a session on Experimental Therapeutics at the 18th International Symposium on Molecular Medicine, Athens, Greece (October, 2015)

Presentations:

- Tejashree Mahaddalkar, Biochemical characterization of beta sitosterol as a tubulin binding agent at Annual meeting of the Society of Biological Chemists, Mumbai Chapter (August, 2015), NIRRH, Mumbai

Workshops:

- Sanith C, Fluorescence-activated cell sorting (FACS) workshop conducted by BD Bioscience and ACTREC, ACTREC, Navi Mumbai (March, 2016)
- Sanith C, Science Communication workshop organized by The Wellcome Trust/DBT India Alliance and NIRRH (ICMR) (May, 2016)

Collaborations:

- Department of Medical Sciences and Pharmacology, School of Medicine, University of Castilla-La Mancha, Spain : Prof. Joaquin Jordan, on Identification of novel mechanisms of cell death following drug assault, b. Standardization of three-dimensional cell culture using Cultrex 3D assay system.
- ACTREC, Mumbai : Dr. Milind Vaidya, on Standardization of three-dimensional cell culture using Cultrex 3D assay system.
- Indian Institute of Chemical Technology, Hyderabad : Dr. Srinivas Kantevari and
- Sambalpur University, Odisha : Prof. Pradeep Naik, on Synthesis and biological evaluation potent beta sitosterol derivatives.
- National Centre for Nanoscience & Nanotechnology, University of Mumbai : Dr. H. Muthurajan,. Biochemical and cellular characterization of casein-stabilized nanoparticles.
- Centre for Excellence in Basic Sciences : Prof. R.V. Hosur, Dr. Sinjan Choudhary, Dr. Basir Ahmed on Effect of Ayurvedic medicines and natural products on inhibition of protein aggregation.
- Centre for Excellence in Basic Sciences : Dr. Neeraj Agarwal on Cellular studies on photosensitizer compounds.

Subhojit Sen

Invited Talks:

- “Ambivalent nature of Bivalent nucleosomes: clues leading from 'Stemness' to Cancer”at International Conference on Genome Architecture and Cell Fate Regulation – 2014”, GACFR 2014 organised by Dr. J. Pongubala at Life Sciences, Hyderabad Central University, Dec 2014.
- “Tracking epigenetic memories from Stem cells to Cancer: a path paved by Bivalent Nucleosomes” at Society of Biological Chemists, India [SBC (I)] 2015 – Invited talk at National Institute for research in Reproductive Health.

Conferences participation

- Indian National Science Congress 2015 – at University of Mumbai.
- TIFR Annual Talks 2015 – TIFR, Mumbai
- Breast Cancer – an international perspective, 5th October 2015 at Sir H N Reliance Foundation Hospital, in collaboration with M. D. Anderson Cancer Centre, USA.

Posters Presentation:

- "Genome-wide positioning of Bivalent Nucleosomes"at ENCODE Meeting USA, 2015
- "Developing Chlamydomonas to test epigenetic effect of drugs and H3 tail modulations on DNA methylation."at SBC (I) Mumbai, India, 2015

Collaboration:

- Johns Hopkins USA Identifying Epigenetic : Dr. Stephen Baylin and Dr. E. Hariharan on "Mechanisms in Stem Cells and Cancer"

Sanith C.

Workshop

- Fluorescence-activated cell sorting (FACS) workshop conducted by BD Bioscience and ACTREC at ACTREC, Navi Mumbai on 10.03.2016

8.2 Department of Chemistry

Avinash Kale

Meeting:

- Invited as Panelist in the Panel discussion on protein purification problems and pitfalls session in the structural biology meeting for Mumbai and Pune region, held at IIT-Bombay in August 2015.

Lectures given outside CEBS:

- Involved in teaching "Bio Crystallography & Magnetic Resonance Techniques (course code PSBP302)" to semester III MSc Biophysics students for Department of Biophysics, Mumbai University.
- Involved in teaching "Elements of Bioinformatics & Chemoinformatics (Course code PSBP403)" to semester IV MSc Biophysics students for Department of Biophysics, Mumbai University.
- Involved in teaching "Bio Crystallography & Magnetic Resonance Techniques" course to St. Xavier's College.

Collaboration:

- Haffkine Institute, Mumbai : Dr. Abhay Chaudhary / Dr. Meera Ramya on Larvaecidal toxicity
- IIT, Bombay: Dr. Prasenjit Bhaumik on Larvaecidal toxicity
- SINP, Kolkata : Dr. Soumen Manna on Larvaecidal toxicity
- IIT, Bombay : Dr. Supreet Saini on Actin polymerization dynamics
- IGIB, New Delhi : Dr. Lipi Thukral on Actin polymerization dynamics / and resolvase
- IIT, Bombay : Dr. Sarath Chandra Dantu on Actin polymerization dynamics / and resolvase
- University of Sheffiled, United Kingdom: Dr. John B. Rafferty on Resolvase

- Centro Nacional de Biotecnologia–Consejo Superior de Investigaciones Cientificas, Campus Universidad, Autonoma de Madrid, Madrid, Spain : Dr. Sylvia Ayora on Resolvases

Anusri Bhattachrya

Conference:

- Attended Western Region Structural Biology Meet on 1st August, 2015 at IIT Bombay

Collaborators:

- Department of Biosciences and Bioengineering, IIT-B, Mumbai: Prof. Ashutosh Kumar on "Deciphering the structure of centromeric protein Scm3 and its role in regulating the assembly of centromeric nucleosome through NMR spectroscopic studies"
- Department of Chemistry, TIFR, Mumbai: Prof. G. Krishnamoorthy on "Studying the domain specific interaction of CENP variant Cse4 with its chaperonic partner Scm3 through time resolved fluorescence studies".

Basir Ahmad

Invited talks:

- "Application of fluorescence spectroscopy in biology" at National Science Day (Biophysics week), Department of Biophysics, University of Mumbai, March 1-3, 2016

Conference:

- Guest Editor for "Properties of Biological Macromolecules, Biologically Active Molecules, and Macromolecular Assemblies (PBMBAMMA)" at International Conference on Recent Trends in Engineering, Science and Technology – 2016, Hyderabad, India

Neeraj Agarwal

Invited talk

- "Ferrocene catalysed C-H arylation of BODIPy and its reaction mechanism studies" at International conference on recent advances in material sciences held at Department of Chemistry, Aligarh Muslim University, Aligarh on 29th March 2016.

Collaborations:

- Department of Chemistry, University of Mumbai, Mumbai : Prof. Rajesh Kamble.
- Colloids & Materials Chemistry Institute of Minerals & Materials Technology (CSIR), Acharya Vihar, Bhubaneswar: Dr. Yatendra Chaudhary.
- Department of Chemistry, **Aligarh Muslim University Aligarh** :Prof. Muneer Mohammad.

R. V. Hosur

Visits

- Visted USA for attending international conference on Biomolecular Stereodynamics, June 9-13, 2015

- Visited USA for giving lecture at Stanford, Berkeley, Washington, New York, San Diego, June 18-30, 2015

Invited talks:

- 'Molten Globule nature of P2 from Plasmodium falciparum and toxoplasma gondii, 19th conversation on Biomolecular Stereodynamics, Albany, USA, June 12, 2015
- 'Moving the Frontiers of Protein NMR' UC Berkeley, USA, June 15, 2015
- 'Advances in Protein NMR Methodologies', Stanford University, USA, June 17, 2015
- 'New developments in Protein NMR Methods' Scripps Clinic, San Diego, USA, June 19, 2015
- 'Some Advances in Protein NMR Methodologies', NIH, Bethesda, MD, USA, June 25, 2015
- 'Advances in Protein NMR' CCNY, NY, USA, June 29, 2015
- 'Moving the Frontiers of Protein NMR' IISc, Bangalore, July 16, 2015
- 'UM-DAE CEBS: A new Model for Basic Sciences Education and Research in India', IISER, Pune, July 22, 2015
- 'Evolution of NMR based Structural Biology', IIT-Bombay, Mumbai, Aug 1, 2015
- 'Science, Innovation and 'Development at Maker Mela, Somaiya college, Vidyavihar, Mumbai, October 11, 2015
- Enhancing speed, Enhancing Resolution, Controlling Protein Fibrillation and More', DCS annual talk, TIFR, November 5, 2015
- Structure, Dynamics, folding/unfolding of SUMO proteins; workshop on NMR spectroscopy at Mysore University, November 18, 2015
- Computational Methods in Structural Biology', MU Refresher course on Computational Methods in Basic Sciences, November 24, 2015
- 'Strengthening the University System in India', MU refresher Valedictory, Mumbai, November 28, 2015
- Structure, Dynamics, folding/unfolding of SUMO proteins, NCBS Bangalore, International symposium on sumo proteins January 27, 2016
- Some Recent Developments in Protein NMR; NMRS 2016 at IIT-Kharagpur, February 18, 2016

Rani Parvathy

Invited talk

- "Emphasis on education and technology" at National Science Day at SAIBA, Mumbai,

Conference:

- Attended National conference in Technology Vision 2035, TIFAC Mumbai, India

Collaboration:

- Centre for Excellence in Basic Sciences : Avinash Kale and
- Haffkin Institute, Mumbai : Sandeepan Mukerjee on " NMR metabolomics of BCG vaccine".

- Department of Biophysics , University of Mumbai, Mumbai : Prof. P. M. Dongare Co-wrote "NMR proposal"

Sinjan Choudhary

Invited talk:

- "Inhibition of insulin fibrillation by osmolytes: Mechanistic Insights" 10th National Conference on Thermodynamics of Pharmaceutical, Chemical and Biological Systems, University Institute of Pharmaceutical Sciences & Department of Chemistry, Panjab University, Chandigarh, November 20-21, 2015. (Award Lecture)

Collaborations :

- Centre for Excellence in Basic Sciences : Prof. R.V. Hosur, Dr.Basir Ahmed and Dr. Manu Lopus on "Effects of Ayurvedic medicines and natural products in inhibition of protein aggregation/fibrillation".
- Centre for Excellence in Basic Sciences : Dr. Manu Lopus on "Biophysical characterization of the interactions of novel designer drugs and natural products with tubulin".
- Department of Chemistry, IIT Bombay, Mumbai : Prof. Nand Kishore on "Effects of small molecules in inhibition of protein aggregation/fibrillation".
- Department of Chemistry, IIT Bombay, Mumbai : Prof. Nand Kishore on "Unravelling the binding thermodynamics of natural plant products with human serum albumin".

8.3 Department of Mathematics

Swagata Sarkar

Invited talks

- Degress of Maps between Isotropic Grassmannians, Invited speaker at the Conference in Topology and Dynamics, IISER , Bhopal, December , 2015

Conference

- Attended conference in Topology and Dynamics, IISER Bhopal, December 2015

Workshop

- ATM Workshop in Topology, ISI Kolkata, December , 2015
- Attended a series of talks in IIT-B on the Atiyah-Singer Index Theorem (Jan-April 2016)

Collaborations:

- Ramakishna Mission Vivekananda University, Belur, WB – Prof. Samik Basu
- Department of Mathematics, University of Haifa, Haifa, Israel: Dr. Shilpa Gondhali
- Department of Mathematics, IIT-B, Powai, Mumbai : Prof. Rekha Santhanam

8.4 Department of Physics

Alpa Dashora

Collaborations

- Department of Physics, University of Mumbai, Mumbai: Prof. D.C. Kothari and Dr. Nainesh Patel

and

- Dipartimento di Fisica, Università degli Studi di Trento, Italy: Prof. Antonio Miotello on "Study of new photocatalytic materials water splitting and H_2 production using first-principles study".
- Departmnet of Physics, M.L.S. University, Udaipur: Prof. B.L. Ahuja on "Study of charge and spin momnetum density and electronic propeties of materials using Compton spectroscopy and first-principles study"

Ameeya Bhagwat

Lecture given outside CEBS:

- Designed and taught a course on Mathematical Physics to M.Sc. - I students at ICT, Mumbai. This is part of the newly established M.Sc. programme in applied physics at ICT.
- Taught a unit on Particle Physics to M.Sc. Part – I students at the University Department of Physics, University of Mumbai.

Collaborations:

- KTH, Stockholm, Sweden: Prof. Ramon A. Wyss;
- University Of Barcelona, Spain: Prof. Xavier Vinas;
- University of Barcelona, Spain : Prof. Mario Centelles and
- IPN Orsay, France : Prof. Peter Schuck on "Semi-classical Description of Ground State Nuclear Masses and Fission Properties, and other related problems"
- KTH, Stockholm, Sweden: Prof. Ramon A. Wyss and Prof. Roberto J. Liotta on "Decay properties of Superheavy Nuclei as well as those of neutron deficient nuclei in Sn region"
- CEBS : Dr. Neelam Upadhyay and
- BARC : Prof. B. K. Jain on "Aspects of Non-locality in Low Energy Scattering Processes"
- IITB, Mumbai : Prof. Y. K. Gambhir and Dr. Mohini Gupta on "Structure Properties of Superheavy Nuclei".
- BARC : Prof. Sudhr Jain on "Quantum Fluctuations in Ground State Energies of Mesoscopic Systems".
- KTH, Stockholm : Prof. Bo Cederwall and
- TIFR, Mumbai : Dr. Rudrajyoti Palit on "DST–VR sponsored Indo – Swedish project: Nuclear Structure Near the Limits of Stability".

Ananda Hota

Invited talk:

- Attended the international conference "Extragalactic Relativistic jets: cause and Effect" 16-17 Oct 2015. This was organised by International Centre for Theoratical Ssciences of the Tata Institute of Fundamental Research, Bangalore, India.
- Participated in the Square Kilometre Array meeting at National Centre for Radio Astrophysics of the Tata Institute of Fundamental Research, Pune on 25 Jan 2016.

Lectures given outside CEBS:

- "NGC6764, NGC3801 and Speca: Effects of AGN-jets at kpc to Mpc scales, observed in low frequency radio to X-ray bands" was delivered at International Centre for Theoratical Sciences of the Tata Institute of Fundamental Research, Bangalore, India.

Bhooshan Paradkar

Invited Talks:

- Presented Physics colloquium at Bhabha Atomic Research Centre (BARC) on "Proton Acceleration using Intense Laser Plasma Interaction" (March 11, 2016)

Workshop attended:

- Participated and presented a poster at first Newton-Bhabha workshop on high field science held at Trivandrum (March 1-3, 2016).

Gargi Shaw

Invited talks:

- SNBNCSE (2015, 2016), IUCAA (2015), Foundation for Medical Research, Mumbai (2016).

Conferences attended:

- Jet triggering mechanisms in Black Holes (TIFR, 2016)

Lectures given outside CEBS:

- Taught Galactic and extra-galactic astronomy Course to the Department of Physics, University of Mumbai

Collaborations:

- IUCAA : Prof. R. Srianand on "Studying physical conditions of Damped Lyman alpha absorbers".
- SNBNCSE: Prof. Ramkrishna Das on "Studying physical conditions in various Novae" c) University of Kentucky : Prof. Gary Ferland on "Numerical simulation".
- TIFR : Prof. Sudip Bhattacharya on "Low mass X-ray binaries".

Manojendu Choudhury

Invited talks:

- Disc Jet Connection in Cygnus X-3 at International conference "Jet Triggering Mechanisms in Black Hole Source", held in TIFR, January 20-23, 2016

Conference:

- Timing & Spectroscopy: Wideband X-Ray Astronomy, held in TIFR Balloon Facility, Hyderabad, January 12-14, 2016.

M. Hemalatha

Conference:

- Attended International Conference on Nuclear Structure and Related Topics, Dubna, Russia, July 14-18, 2015.

Presentations:

- Laser Spectroscopy of short-lived nuclei, Nuclear Physics Discussion Group, UM-DAE Centre for Excellence in Basic Sciences, Mumbai, April 2016.
- Proton-induced reactions of Se isotopes, PLPIC meeting, Tata Institute of Fundamental Research, Mumbai, June 15, 2015.

Collaborations

- Nuclear Physics Division, Bhabha Atomic Research Centre : Dr. A. Saxena on Proton-induced reactions of Se isotopes".

Neelam Upadhyay

Lectures given outside CEBS

- Taught M.Sc. Semester-IV elective course on "Nuclear Reactions" at University Department of Physics, University of Mumbai

Collaborations:

- CEBS : Prof. Ameeya Bhagwat and
- BARC : Prof. B. K. Jain on "Aspects of Non-locality in Low Energy Scattering Processes".

P. Brijesh

Workshop Attended

Newton-Bhabha Workshop on High-Field Science, Kerala-India, March 2016.

S. M. Chitre:

Visits:

- Senior Visitor at the Institute of Astronomy, Cambridge, May – June 2015 with offer of the local hospitality.
- Visited Stanford University, California, July 2015

Invited talks:

- "How Well Do We Know Our Sun!" at Udaipur Solar Observatory, Udaipur, Rajasthan August 2015
- "Dr. Vainu Bappu and his Legacy to solar Astronomy in India" at Indian Institute of Astrophysics (IIA), Bangalore, November 2015
- "Reminisciences on Indian Solar Astronomy" at Tata Institute of Fundamental Research (TIFR), Mumbai, December 2015

Collaboration:

- Institute of Astrophysics, University of Cambridge : Professor Douglas Gough and Prof. Christopher Tout
- Department of Physics, Stanford University : Professor Phil Schrerrer

Other Recognition:

- Hamied Exchange Fellowship programme support of local expenses and international travel at Cambridge.

Sangita Bose

Invited talks:

- "Superconducting Nanostructures" at the workshop on "Superconductivity on the Verge" from 27 Jul 2015 through 31 Jul 2015 at Lorentz Center, Leiden, Netherlands.
- "Superconducting Nanostructures" at the Young Achiever's Award in 60th DAE-SSPS in December, 2015 at Delhi, India.

Collaborations:

- TIFR : Prof. Pratap Raychaudhuri on the following projects:
  "Probing matching effects in NbN anti-dot array"
  "Superconducting properties on Nb-Cu nanocomposites and nano-alloys"
  "Modelling of Point-contact Andreev reflection for superconductor-superconductor junctions"
- Nanoscience center, Mumbai University : Prof. H. Muthurajan on the following projects:
  "Superconducting properties on Nb-Cu nanocomposites and nano-alloys"
  "Low temperature electrical properties of a semiconductor bridge igniter"
- CEBS : Dr. Neeraj Aggarwal on"Organic light emitting devices: search for efficient emitters"

Sujit Tandel

Invited talks at international conferences

- "Structure of Pt isotopes along the line of stability"at International Conference on Recent Trends in Nuclear Structure and Implications in Astrophysics, January 4-8, 2016, Puri, India
- "Isomers and oblate collectivity at high spin in neutron-rich Pt isotopes", at International Conference on Nuclear Structure and Related Topics, July 14-18, 2015, Dubna, Russia

Lectures given outside CEBS:

- "Recoil Decay and Isomer Tagging", at School on Experimental Techniques in Gamma-Ray Spectroscopy, April 25-29, 2016, Inter-University Accelerator Centre, New Delhi, India

Collaborations:

- **Within India**:
  (i) Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai

(ii) Department of Nuclear and Atomic Physics, Tata Institute of Fundamental Research, Mumbai

(iii) Inter-University Accelerator Centre, New Delhi

(iv) Andhra University, Visakhapatnam

- **Outside India**:

(i) Argonne National Laboratory, Argonne, IL, USA

(ii) University of Massachusetts Lowell, MA, USA

(iii) University of Notre Dame, Indiana, USA

(iv) Peking University, Beijing, China

(v) University of Manchester, UK

Tripti Bameta

Invited talks:

- Additivity of maximum forces generated by multiple laments or motors and its dependence on equilibrium at Comp u-2016 IISER, Pune.

Uma Divakaran

Invited talks:

- Non-equilibrium dynamics in quantum phase Transitions in the Seminar at IIIT-B, Mumbai, January 2016.
- Non-equilibrium dynamics in localization-delocalization transition in the Conference on Quantum disordered systems at Institute of Mathematical Science, Chennai, March 2016.

Externally funded Research Projects

9 Externally funded Research Projects:

Name of the Principal Investigator	Title of the Project	Funding Agency	Duration	Total Project Amount
Dr. Jacinta D'Souza	Spectroscopic analyses of flagellar proteins from chlamydomonas reinhardti and homologous ciliary proteins from human	Ministry of Science & Technology, Department of Biotechnology (DBT)	3 years from August, 2012	61,61,600/-
Dr. Ameeya Bhagwat	Microscopic global nuclear mass formula	Department of Science and Technology (DST)	3 years from June, 2011	21,50,000/-
Dr. Neeraj Agarwal	New Bodipy derivatives and their anthracene-fused-porphyrin composites for the up-conversion of energy	Department of Science and Technology (DST)	3 years from January, 2012	21,00,000/-
Dr. Gargi Shaw	Numerical simulations of molecular astrophysics and their spectra applications to star forming regions from local high redshift universe	Science and Engineering Research Board (SERB)	3 years from July, 2012	12,84,000/-
Dr. Sangita Bose	Superconductivity in Engineered Granular Thin Films	Indian National Science Academy (INSA)	3 years from January, 2013	5,00,000/-
Dr. Sangita Bose	Tunneling studies in novel supercoductors and nanocomposites	Science and Engineering Research Board (SERB)	3 years from July, 2012	26,00,000/-
Dr. Sangita Bose	Vortex matching studies in anti-dot arrays of dis-ordered superconducting NbN	Science and Engineering Research Board (SERB)	3 years	18,00,000/-

Dr. M. Hemalatha	Laser Spectroscopy of nuclei away from stability	Board of Research in Nuclear Sciences (BRNS) for Yong Scientist Research Award-2012	3 years from October, 2012	17,00,000/-
Dr. Subhojit Sen (Ramalingaswami Fellowship)	Epigenetic Study of Environmental influence of Quality of Life	Ministry of Science & Technology, Department of Biotechnology (DBT)	5 years from September, 2013	82,00,000/-
Dr. Tripti Bameta	INSPIRE Faculty Award	Department of Science and Technology (DST)	Maximum 5 years from August, 2013	19,00,000/- (For First Year)
Dr. Prachi Chandrachud	Dr. D.S. Kothari Postdoctoral Fellowship	University Grant Commission (UGC)	Maximum 3 years from September, 2013	3,93,000/-
Dr. Ishita Mehta	INSPIRE Faculty Award	Department of Science and Technology (DST)	Maximum 5 years from September, 2013	19,00,000/- (For First Year)
Dr. Mahendra Patil	Computational Studies of Synergistic Catalysis: Reactivity, Mechanism, Stereoselectivity and Catalyst Screening. (DST-Fast Track Project for Young Scientist)	Department of Science and Technology (DST)	3 years from March, 2014	23,00,000/-

External UGC Grants:

Name of the Faculty	Title	Funding Agency	Duration	Amount in Rs.
Dr. Sujit Tandel	UGC Associate Professor	University Grant Commission (UGC)	June 2014 To March 31 2015	11,00,000/- + 6,00,000/- (startup grant)
Dr. Ananda Hota	UGC Assistant Professor	University Grant Commission (UGC)	June 2014 To March 31 2015	11,00,000/- + 6,00,000/- (startup grant)
Dr. Basir Ahmad	UGC Assistant Professor	University Grant Commission (UGC)	June 2014 To March 31 2015	11,00,000/- + 6,00,000/- (startup grant)

Colloquia

10 Colloquia

CEBS organises colloquia on Tuesdays at 3.45p.m. on topics of academic interest by reputed speakers, researchers, scientist etc. to facilitate exchange of ideas. The list of such colloquia held during 2015-16 is reproduced below:

- April 7, 2015: Dr. M.K. Tiwari, National Physics Laboratory (NPL), New Delhi, **"Reactive Nitrogen and the Environment: A Crisis Looming Large".**

- April 14, 2015: Dr. Shiva Gopalakrishnan, Department of Mechanical Engineering Indian Institute of Technology, Bombay, **"Advanced numerical methods for modelling continuum phenomena on modern computer architectures".**

- August 11, 2015: Prof. Pankaj S. Joshi, Tata Institute of Fundamental Research (TIFR), Mumbai **"Can I see a Black Hole? --Life and Death of Massive Collapsing Stars--"**.

- September 01, 2015: Prof. Amitabha Chattopadhyay , Centre for Cellular and Molecular Biology (CCMB), Hyderabad **" Biomembranes: Where Physics, Chemistry, Biology and Medicine Meet "**

- September 15, 2015: Dr. Vivek Polshettiwar, Tata Institute of Fundamental Research (TIFR), Mumbai **" Shape and Morphology Controlled Nanomaterials for Energy and Environment"**

- October 06, 2015: Prof. Nilmani Mathur, Tata Institute of Fundamental Research (TIFR), Mumbai **"Quantum Chromodynamics and the origin of mass"**.

- November 03, 2015 : Dr. Ramkumar Sambasivan, Institute for Stem Cell Biology and Regenerative Medicine **"Mechanisms governing vertebrate mesoderm development"**.

- January 07, 2016: Prof. Madhu Sudan, Harvard University, **"Mathematics, Proofs and Computation"**.

- January 12, 2016: Prof. P.C. Agrawal, UM-DAE CEBS, Mumbai **"X-ray Sky through ASTROSAT's Eyes".**

- January 19, 2016: Dr. Zia Saquib, Executive Director, C-DAC, Mumbai, "Security & privacy in cyber physical systems".

- February 02, 2016 :Dr. Lipi Thukral, IGIB, New Delhi, **"Exploring Bio-molecular Recognition using Multi-scale Computer Simulations "**.

- February 09, 2016: Prof. Swati Patankar, Indian Institute of Technology- Bombay (IIT-B), Mumbai, **"Getting proteins to their final destinations: specific trafficking and randomness in the malarial parasite "**.

- February16, 2016, 2015: Prof. Amol Dighe, Tata Institute of Fundamental Research (TIFR), Mumbai **"The changing flavours of neutrinos: journey to Nobel 2015 and beyond".**

- February 29, 2016: Prof. J. Maharana , National Institute for Science Education and Research (NISER), Bhubaneshwar **"String Theory and Unification**". .

- March 08, 2016: Prof. R. D. Lele , Emeritus Director of Nuclear Medicine & PET-CT and Chairman, Scientific Advisory Committee at Jaslok Hospital & Research Centre, Mumbai , "**Four new approaches for validation of Ayurvedic herbal drugs**"

- March 15, 2016: Prof. Sanjeev Dhurandhar, Inter-University Centre for Astronomy and Astrophysics (IUCAA), Pune "**Einstein's Centennial gift : Gravitational Waves Discovered**"

- March 29, 2016: Prof. Vidita Vaidya, Tata Institute of Fundamental Research (TIFR), Mumbai , **"The Emotional Brain- Imprints of Life History".**

Events

11 Events

11.1 Meetings:

During the year 2015-2016, the following meetings were conducted:

Total ten Faculty Meetings were held during 2015-2016
21st Meeting of the Governing Council : April 20, 2016
12th Meeting of the Academic Board : August 12, 2015
13th Mettingof the Acdemic Board : January 22, 2016

11.2 Academic events:

- **Foundation Day Programme:**

The 8th CEBS Foundation Day lecture was schdled on September 18, 2015 in the Pherozshah Mehta Auditorium, University of Mumbai, Kalina. Prof. J.P. Mittal, M.N. Saha Distinguished Fellow, BARC, ha invited to deliver lecture. He has delivered lecture on "Excitement in Basic Research". The talk has been followed by a Bharatnam Dance Recital by Ms. Sindhuja Bheesette.

- **Workshop: Novae and Accreting Binaries: A multi-wavelength study:**

The workshop “Novae and Accreting Binaries: A multi-wavelength study” was held during December 2-6, 2015, at the Centre for excellence in Basic Sciences (CEBS), University of Mumbai. The workshop was jointly organized by CEBS and IUCAA and was generously funded by Infosys foundation. The coordinators for this workshop were Dr. Gargi Shaw and Dr. Ranjeev Misra.

The aim of this workshop was to provide an overview of research problems and to stimulate interest in this area of research among the participants of this workshop. There were 58 participants from all over India including faculty members, PhD students and MSc students. The first two days of the workshop were devoted to X-ray binaries and the next two days were on the Optical and IR studies of Novae. On the last day of the workshop, we covered Radio studies of Quasars and micro-quasars. Talks were given by faculties of CEBS, IUCAA, TIFR, PRL, IIA, SNBNCBS and IIT (Kharagpur). Besides talks, an integral part of the workshop was data analysis demonstrations and we conducted that in afternoon sessions.

- **Summer Associate research Programme (SARP):**

During the regular faculty meeting on 11th February 2015, a proposal from Dr. Ananda Hota to launch a formal summer project programme at CEBS for external students was discussed and approved. It was named as the Summer Associate Research Programme (SARP). Title of possible projects and a brief write up on it were asked from CEBS faculties,

and several projects were received. SARP was declared in the CEBS Notice Board, website (http://www.cbs.ac.in/academics/summer-research-program) and circulated by individual faculties and students in the social media Facebook. Applications were invited from students from all over India by filling up a Google Form. This web-based application procedure has given an equal-oppertunity to undergraduate students of the nation for getting a short exposure to research in basic sciences at a centre for excellence. Students from Universities at remote locations and underdeveloped regions of India were encouraged to apply. Students were asked to go through all the write ups on different projects and select a guide by whom they wish to get selected and work with. Total of 67 students applied to the programme. Each project guide went through their career performances and write up with in the CV for research interest and experiences, and selected them to work in the declared projects. The programme duration was from May 15, 2015 to July 15, 2015 and total of 21 students from 14 different institutions participated.

- **Student's Science Club:**

The Science Club of CEBS aims to provide the students of CEBS an opportunity to learne and explain the various aspects of Science and doing scientific research. This year Science club organized the following Sections:

- ✓ **Telecasts and Documentaries:**

Telecasts and documentaries on interesting scientific discoveries screened weekly throughout the year saw a large number of students turning up to satiate their thirst for knowledge and understanding.The list of such docuemntaries is given below

I. An Inconveniet Truth – Climate change featuring the 2007 Noble peace prize winner AI Gore
II. Homi Bhabha – The life of Dr. Bhabha releasded by TIFR
III. How Long is 1 Meter? – A talk by Prof. Klaus Von Klitzing
IV. On the Hunt for the 'GOD' Particle - Released by CERN about their successful search for the Higgs Boson
V. The Great Math Mystery – Documentary about Math and the Universe.
VI. The year of pluto – A session about the New Horizons mission to Pluto.

- ✓ **Rendezvous Session:**

Rendezvous is a fortnightly event of the CEBS Science Club where active researchers in the basic sciences are invited to share their ideas and thoughts with students of CEBS. These sessions are academic in nature, and are aimed primarily at undergraduate students who are interested in pursuing research in the future. The aim of these sessions is to provide students an opportunity to gain insights into contemporary scientific ideas, and the inherent nature and methodology of research, with the hope that students will be motivated to pursue these ideas further. Theses sessions are listed below

I. October 11, 2015 – Mr. Ninad Jetty, CEBs Alumnia on his experience of doing project.
II. October 19, 2015 – Dr. R. K. Vatsa (BARC) on the topic "Probing the 'C' in Chemist".

III. October 26, 2015 – Dr. Swati Patankar on the topic “Noble Prize in Physiology and Medicine 2015.”
IV. November 04, 2015 –Dr. Subhojit Sen (CEBS) on the topic “Nature Vs. Nature:What makes us Human”.
V. January 07, 2016 – Prof. Madhu Sudan (Harvard University) on the topic “Mathematics, Proofs and Computation”.
VI. March 28, 2016 - Prof. Anwesh Mazumdar, HBCSE (TIFR) on the topic "EXTRASOLAR PLANETS; The search for a new world".
VII. March 29, 2016- Prof. Vidita Vaidya, DBS-TIFR on the topic "NEUROSCIENCE :THEN AND NOW; A meandering walk through the history of neuroscience".
VIII. April 02, 2016- Prof. G. Ravindra Kumar, DNAP-TIFR on the topic "STELLAR BANG FOR A LIGHT BUCK"
IX. April 12, 2016 – Prof. Mahan Mj. (TIFR) on the topic “Hyperbolic Geometry and Chaos in the Complex Plane”.

✓ **Students Talks :**

a. Binary Quadratic Forms by Mr. Duattatrey Nath Srivastava
b. What is Dark Matter? By Mr. Swapnil Shankar
c. Structures Bases Drug Discovery by Mr. Nikhil S.
d. C.R.I.S.P.R.S by Mr. Anirudh Pillai
e. Pour L`amore De Mathematics by Mr. Praneel Samanta
f. Your Genes are not Enough by Mr. Upnishad Sharma and Mr. Anirudh Pillai
g. Patters and Randomness by Mr. Anton Iyer, Mr. Mohd. Nisham and Mr. Nikhil Vishwanath
h. Non Equilibrium Processes by Ms. Phalguni Shah
i. A tale of two crystals by Mr. Aditya Rajput
j. Introduction to Quantum Computing by Ms. Sharddha Singh and Mr. Samvit Mahapatra
k. Mazes to Amaze by Mr. Duttatrey Nath Srivastava

11.3 Social events

- **Jigyasa-2016:**

Jigyasa 2016 was conducted on January 31, 2016 with a total of over 170 participants from colleges all over Mumbai and Pune. The first round consisted of question across Physics, Chemistry, Mathematics and Biology, and was an individual examination. Based on an individual as well as group cut-off, the top 10 teams were selected to proceeed to the second round. Five of these were from CEBS. The questions in this round were to be solved by the group as a whole and consisted of analytical and experimental problems.

The stage round was conducted in the Department of Physics seminar hall, University of Mumbai. Five teams, from India Institue of Technology-Bombay, Institute of

Chemical Technolgy and Centre for Excellence in Basic Sciences competed. IIT-B bagged the first prize, and second place was shared by two temas from CEBS. Cash prizes upto Rs. 24000 were awarded to the top 3 teams and the finalists were also presented with event T-shirts.The event was sponsored by Bank of Baroda.

- **Ragnarok -2016:**

Ragnarok is the annual sports event of CEBS and is organised by the students themselves with active support from CEBS. Every year, one or two batches of students assume responsibility for the overall coordination of the events. The event was organised in January 2016 and comprised events like outdoor games: Cricket, football, basketball, volleyball, badminton, table teniis, carom and chess and indoor games : tennis, football and chess.With increasing craze of computer games, E-sports like Counter Strike Source and Age of Empries III, The Asian Dynasties are included in this year.

The fest was concluded with the prize distribution ceremony, with the medals and trophies distributed by the faculty members of CEBS.

- **ORIS-2016:**

Art is the line behind creative thoughts. Paintings, sculptures, origami, craft, etc are just different forms of expression of the artistic mind. ORIS-meaning expression- is the annual art fest organised by the CEBS art club to ignite creativity in the CBScients and to explore the world of colours.

ORIS 2016, had been organised from March 25-27, 2016 in room number PF-AG 09 in the campus of CEBS. All the students showed great interest and contributed their artwork in the event.

On the evening of March 25, the students had come together to decorate the room with different craft pieces, sketches and origami work. The next day, March 26, paintings had been made on papers with acrylic paints, pastels, charcoal pencil, water colour and lots more, and an origami workshop had been arranged by Professor R. Nagrajan. March 27 had been the day to see the brilliant strokes of brushes on the canvases. Nearly 30 canvases had been beautifully painted this year.

The art works included everything from elegant monotone drawings to the vivid coloured paintings. The event had been concluded with the display of the art works and some still photographs of a student in PF-AG 09 and in front of the Annabhu Sathe Bhawan on March 28, 2016. The enthusiastic participation of the all students and their contribution made the event a success.

- **Dhwani-2016:**

Dhwani, the annual music festival of CEBS, was held on April 05, 2016, in Marathi Bhasha Bhavan. The programme this year centred around the theme of reliving the roots of classical music in India, and featured 14 vocalists and 9 instrumentalists from across CEBS.

The event has three main sections - Carnatic Classical, Rebindra Sangeet and Hindustani Classical and Semi-classical. Two songs out of the five germs of Tyagaraja known as Pancharatna Kritis were performed in the Carnatic section, as well as two other kritis. The Rabindra Sangeet section included reciatations of some great poems alongwith melodious Bengali songs. The Hindustani section comprised of various classical songs, and also light music with a heavy classical influence, the festival culminated with a spirited instrumental rendition of Vande Mataram, that had the audience moving with their rhythm, and offered the evening a finish with flourish!

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