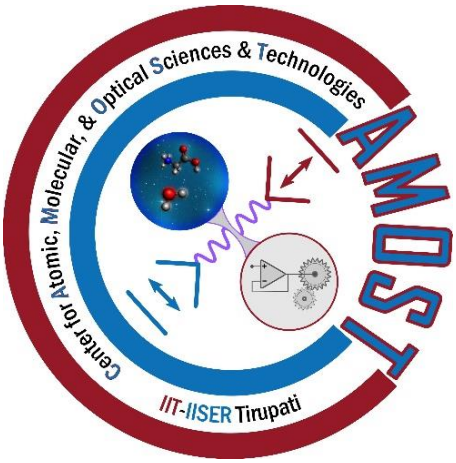
# CAMOST BROCHURE




## Center for Atomic, Molecular, & Optical Sciences & Technologies (CAMOST)

### A JOINT INITIATIVE OF IIT TIRUPATI & IISER TIRUPATI

भारतीय प्रौद्योगिकी संस्थान तिरुपति

TIRUPATI

IISER
TIRUPATI

## About CAMOST

AMO (Atomic, Molecular, and Optical) sciences encompass significant areas of human activities directly impacting life through applications in health, communication, navigation, metrology, space, internet and quantum technologies. Advances in the field of quantum computing would lead to exciting possibilities in solving problems related to weather modeling, evolution of our Universe, secure communication, etc.

Tirupati is the only town in India which is home to both an Indian Institute of Technology (IIT) and an Indian Institute of Science Education and Research (IISER). These two institutes started together at Tirupati in 2015 and have leveraged each other's unique strengths by sharing resources, and have now come together to establish the Center for Atomic, Molecular, & Optical Sciences & Technologies (CAMOST) to address key challenges in frontier areas of AMO sciences and technologies. Researchers from institutions pan-India would collaborate with each other under the aegis of CAMOST.

CAMOST is India's first such center in a University environment where some of the country's best undergraduate and graduate students interact closely with post-doctoral researchers and distinguished faculty. Close cooperation between scientists and engineers from IIT Tirupati, IISER Tirupati and also from several other premier institutes in India would come under CAMOST's initiatives. This partnership is already nucleated and the formal inauguration of CAMOST takes place at the hands of Dr Arabinda Mitra (Scientific Secretary, Office of the Principal Scientific Advisor, Government of India) on August 14$^{th}$, 2020, on the eve of the 73$^{rd}$ anniversary of the India's INDEPENDENCE DAY.

## Vision

Inspire tangible solutions to frontier problems in AMO Science and Technologies through innovative research initiatives in basic and applied science domains.

## Mission

To advance the field of AMO Sciences and Technologies by:

- Developing innovative solutions to frontier problems of AMO Quantum Science and Technology
- Contributing to solving key problems in atmospheric, space, and bio sciences
- Fostering human resources to meet 21$^{st}$ century challenges in AMO quantum Sciences & Technologies

## Thrust Areas

- Ultrafast physics: Quantum dynamics on attosecond time scale
- Quantum communication and Quantum technology applications
- Quantum photonics: Cold plasma applications
- Laboratory astrophysics, Astrochemistry, and Atmospheric Sciences
- Optical tweezers for biomedical applications
- Single molecule magnetism for high-density data storage
- Quantum Chemistry and Statistical Mechanics
- High Technology Devices

## Administrative Council

K N Satyanarayana
Director, IIT Tirupati

K N Ganesh
Director, IISER Tirupati

## Mentor & Convener

P C Deshmukh
Adjunct Professor, IIT Tirupati

## Scientific Advisory Council

Dilip Angom
PRL, Ahmedabad

E Krishnakumar
RRI, Bangalore

C P Safvan
IUAC, New Delhi
(President of ISAMP)

Dmitry Budker
JGU Mainz & UCB

John Costello
Dublin City University

Bhanu Pratap Das
Tokyo Institute of Technology

S T Manson
Georgia State University

G Ravindrakumar
TIFR, Mumbai

Roland Wester
University of Innsbruck

Jan Michael Rost
MPI for Complex Systems

## Core Administrative Members

Arijit Sharma
Coordinator, IIT Tirupati

S Sunil Kumar
Coordinator, IISER Tirupati

Koteswara Rao
HoD, Physics, IIT Tirupati

G Ambika
Chair, Physics, IISER Tirupati

## Principal Investigators

### IIT Tirupati

Arijit Sharma

Arun K Manna

Debasish Mondal

N N Murthy

P C Deshmukh

Rajib Biswas

Reetesh Gangwar

Swapnil Bhuktare

Vijaya K Gurugubelli

Vinay P Majety

### IISER Tirupati

Patmabati Mondal

Raghunath O R

Soumit Mandal

S Sunil Kumar

## Adjunct Members

Dhananjay Nandi

IISER Kolkata

G Aravind

IIT Madras

Koushik Saha

IIT Dharwad

R Hari Varma

IIT Mandi

Jobin Jose

IIT Patna

Rajesh K Kushawaha

PRL, Ahmedabad

S Sivakumar

KREA University

Sivarama Krishnan

IIT Madras

Ramachandra R Yalla

University of Hyderabad

G V Pavan Kumar

IISER Pune

## Joint Initiatives of IIT Tirupati & IISER Tirupati in AMO Sciences and Origin of CAMOST

IIT Tirupati and IISER Tirupati have been constructively sharing their resources, including faculty, to leverage each other's strengths. Below is a list of few initiatives in which both the institutes worked closely together, the latest of which marked the establishment of CAMOST.

1. **The 7th Topical Conference (TC7) of the Indian Society of Atomic and Molecular Physics (ISAMP)** was held under the joint auspices of the IIT Tirupati and IISER Tirupati from 6th to 8th January 2018.
   Conveners: P C Deshmukh and Bhas Bapat; Conference Secretary: S Sunil Kumar
   Proceedings of the Conference have been published by Springer (2019), under the title 'Quantum Collisions and Confinement of Atomic and Molecular Species, and Photons'
   Editors: P C. Deshmukh, E. Krishnakumar, S Fritzsche, M Krishnamurthy, and S. Majumder
   ISAMP-TC7 was attended by well over a hundred participants including many from abroad.
2. **Deliberations in Atomic Physics (DAP)**: A new seminar-cum-discussion series, DAP was launched in March 2018. This consisted of a 2-Days Workshop on ULTRAFAST and MANY-BODY ATOMIC PHYSICS, and was held at IIT Tirupati on 8th and 9th March 2018.
   DAP was attended by select invited participants from IIT Delhi, PRL Ahmedabad, IIT Madras, IISER Tirupati, IIT Mandi, IIT Patna, IIT Roorkee, GCE Gaya, and GSU USA.
3. **Establishment of CAMOST**: One-day symposium was held on 20th March 2019 when some senior AMO scientists and several young scientists from various places in India met at IIT Tirupati to discuss the formation of the CAMOST at Tirupati.
   Convener: P C Deshmukh
   Presided by: K N Satyanarayana (Director, IIT Tirupati) and K N Ganesh (Director, IISER Tirupati)
   **Attendees:**
   S T Manson (GSU, USA)
   E Krishnakumar (RRI, Bengaluru)
   Dilip Angom (PRL, Ahmedabad)
   C P Safvan (IUAC, New Delhi)
   G Ambika (IISER Tirupati)
   S Sivakumar (KREA University)
   Arijit Sharma, Reetesh Gangwar, Vinay P Majety (IIT Tirupati)
   S Sunil Kumar, Soumit Mandal (IISER Tirupati)
   Koushik Saha (IIT Dharwad), Rajesh K Kushawaha (PRL, Ahmedabad)
   Sivarama Krishnan (IIT Madras), Dhananjay Nandi (IISER Kolkata)

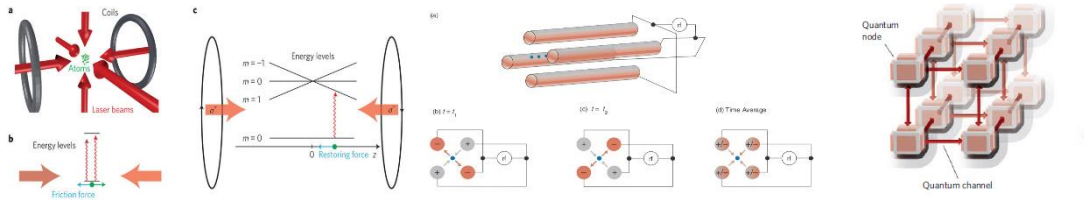
   Senior AMO scientists emphasized the urgent need for having such a national resource to be set up and expressed happiness that such a center is now realizable due to the vision of the Directors of IIT Tirupati and IISER Tirupati, crystallizing the long standing aspirations of AMO scientists in the country. The special opportunity at Tirupati was recognized considering the significant pool of young faculty at IIT Tirupati and IISER Tirupati who specialized in AMO sciences. E Krishnakumar, Dilip Angom and C P Safvan submitted detailed reports recommending the formation of CAMOST at Tirupati.

# Precision Measurement Lab

## Arijit Sharma

### Research Interests:

- Laser cooling and trapping of atoms/ions
- Precision laser spectroscopy
- Quantum communication
- Frequency metrology
- Quantum technology applications




### Recent Work:

"Sawtooth wave adiabatic passage slowing of dysprosium" - Niels Petersen, Florian Mühlbauer, Lykourgos Bougas, Arijit Sharma, Dmitry Budker, Patrick Windpassinger. Phys. Rev. A 99 (2019) 063414

### Ongoing Work:

- A hybrid quantum network of trapped cold atoms and ions
- Atomic clocks based on trapped ions and thermal atomic vapor
- Cavity ringdown spectroscopy of harmful pollutants

### Future Work:

- A hybrid quantum network comprising a solid-state quantum node
- Portable atomic clocks and inertial sensors
- Cavity ringdown spectroscopy of cold plasma

### Group Members:


Arijit Sharma


M Siva Kumar


S Chakraborty

### Collaborators:

### Website: https://sites.google.com/view/arijitsharma

# Modelling and Simulations of Molecules and Materials

## Arun K Manna

**Nature of Work:** Theoretical and Computational

### Broad Research Directions:

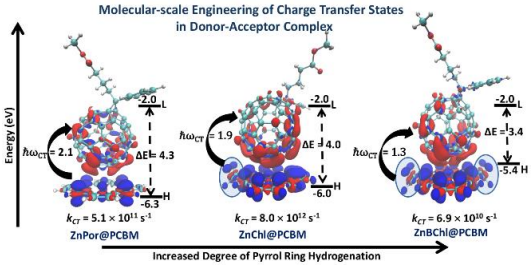
Unraveling microscopic origins of various quantum driven phenomena & development of potent molecules and exotic materials for energy, environment, health care's applications, and also for use as components in advanced optical and electrical devices.

### Specific Research Areas:

- ***Multiscale modelling*** *(both ab initio and classical simulations)* of molecules and materials for **optoelectronics, photovoltaics, thermoelectric and spintronics** applications
- Functional **molecules**, **solids** and **low-dimensional materials** are of potential interest

### Recent Contributions:

- Photoinduced charge-transfer kinetics in Zn-porphyrin and fullerene-based donor-acceptor complexes in polar medium, R Ahmed and A K Manna, *Phys. Chem. Chem. Phys.* 22 (2020) 14822
- Sensing of metal ions by dimethyl glyoxime, S Y Ali, K D Reddy and A K Manna, *J. Phys. Chem. A* 123 (2019) 9166

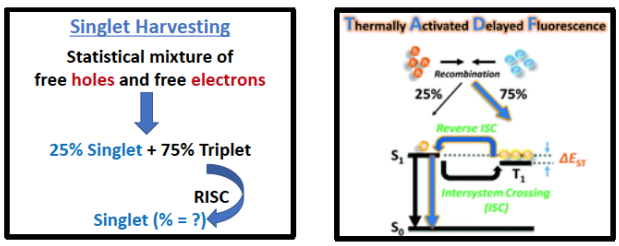



### Specific Contributing Area under CAMOST:

**Thermally activated Delayed Fluorescence (TADF) in Functional Organic Molecules**

### Objectives:

- *Ab Initio* modelling of **functional organic molecules ($\pi$-conjugated ones)** for use in photonic applications
- Mechanistic understanding of **TADF** by **Singlet-Harvesting** via **Reverse Inter System Crossing (RISC)**
- Effects of introducing different hetero atoms (B, N, P and S, etc.) on organic molecular TADF properties
- Development of potent organic-based TADF molecules for OLED application




Schematic illustrating **Singlet-Harvesting & TADF** [Yang et al., Chem. Soc. Rev. 46 (2017) 915-1016]

**Group Members:** Arun K Manna and Raka Ahmed

**Website:** https://mannaarun17.wixsite.com/manna


Arun K Manna


Raka Ahmed

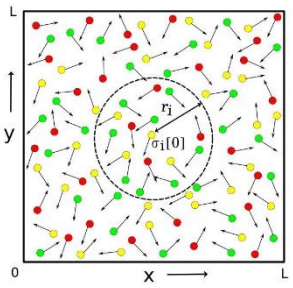
# Non-equilibrium Statistical Mechanics

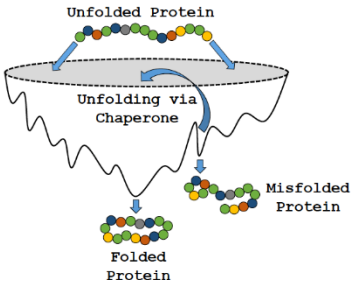
## Debasish Mondal

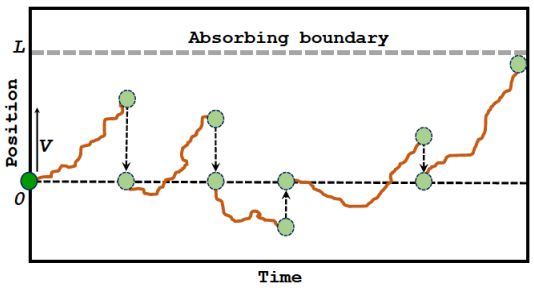
**Nature of Work:** Theoretical and Computational Studies

**Research Interests:**

- Stochastic thermodynamics in biochemical processes
- Narrow escape problem in cellular micro-domains
- Chemistry and physics of active matters
- Stochastic resetting in chemical physics




**Recent Work:**

- Peclet number governs transition to acceleratory restart in drift-diffusion, J. Phys. A: Math. Theor. 52 (2019) 255502
- Pseudochemotaxis in inhomogeneous active Brownian systems, Phys. Rev. E 97 (2018) 042612

**Ongoing Work:**

- Noise-induced symmetry breaking of self-regulators: A dynamical transition towards homochirality
- Rain with restart
- Stochastic resetting in entropic transport
- Lossless entropic information engine

**Imminently Proposed Future Work:**

- Translocation of macromolecules in active environment
- Entropic Feller processes
- Quantum information engine

**Group Members:**


Debasish Mondal


Syed Yunus Ali


Rafna Rafeek

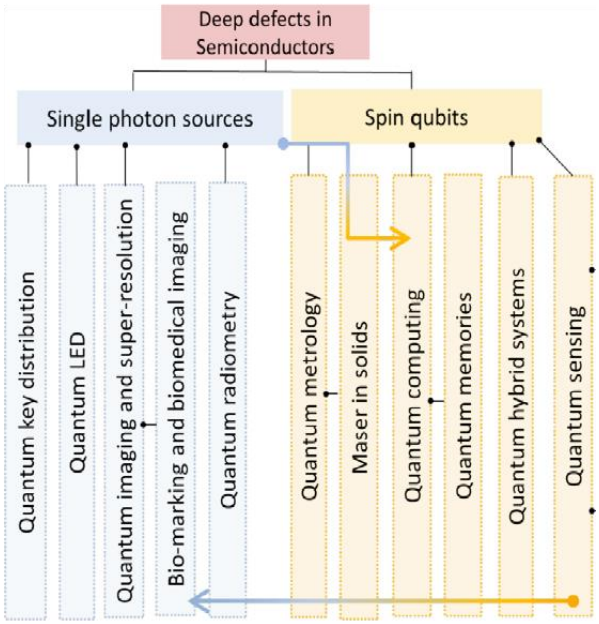
**Website:** https://iittp.ac.in/dr-debasish-mondal

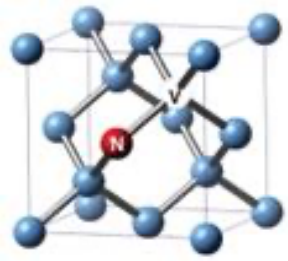
## Quantum Sources and Read-out Electronics

### N N Murthy

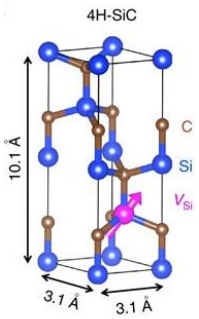
**Area of interest:** Defect Engineering for room-temperature single photon emission from color centers in SiC and Diamond, Read-out circuits for Quantum processors

**Major applications of defects in semiconductors**:

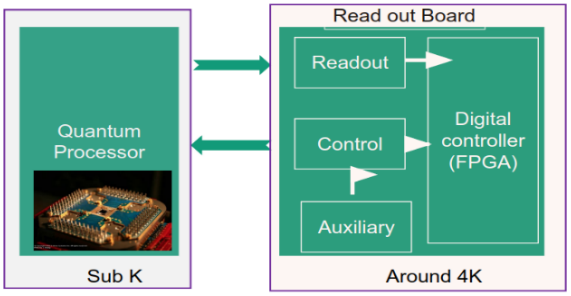



NV centers in Diamond




Si vacancy in 4H-SiC




Quantum processor interfaced to classical controller

**Materials:** Synthetic diamond, 4H-SiC, 6H-SiC, 3C-SiC

**Recent Work:**

- S Mohapatra, P K Sahu, S Rath, P K Sahoo, S Varma, N V L Narasimha Murty, Superlattices and Microstructures, 142 (2020) 1065049
- S Mohapatra, P K Sahu, S Rath, and N V L Narasimha Murty, Diamond and Related Materials, 106 (2020) 107822

**Group Members:**

N N Murty

V L Vineela

A Shilpa

**Website:** https://iittp.ac.in/dr-n-n-murty

## Excited State and Multiscale Computational Chemistry Group

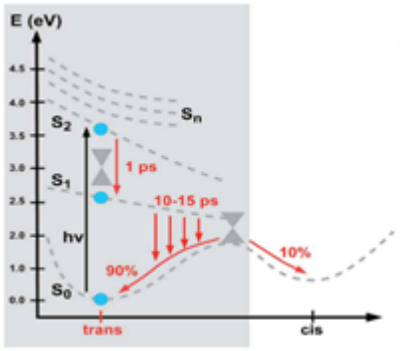
### Padmabati Mondal

**Research Interests:** Quantum photo-physics/chemistry, Quantum biology

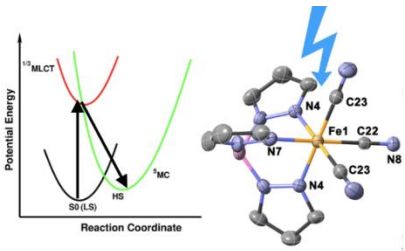
**Nature of work:** Theoretical and Computational

Our group is interested in theory and application of quantum chemical and multiscale methodologies on the excited-state physical and chemical phenomena of atoms and molecules relevant to biological and material science. Few of ongoing and future interests are

- Photoinduced ultrafast nonadiabatic dynamics.
- Photochemistry and spectroscopy of biologically relevant system and environmental effect for biomedical applications.
- Relativistic Jahn-Teller effect in transition metal complexes.
- Light-induced spin crossover and single molecule magnetism involving transition metals for high-density data storage.
- Quantum chemistry-based force fields development.




**Photoisomerization of Azobenzene**




light-induced spin crossover in Fe-complex

**Collaborators**:

S Sunil Kumar and Soumit Sankar Mandal (IISER Tirupati), Miquel Huix Rotllant (Aix-Marseille University, France), Markus Meuwly (University of Basel, Switzerland)

**Group members:**


Padmabati Mondal


Soumyadip Ray


Ranjitha R

**Selected publications:**


- P Mondal et al., J. Photochem. Photobiol. A: Chemistry 387 (2020) 112164
- P Mondal et al., Phys. Chem. Chem. Phys. 21 (2019) 8874
- P Mondal et al., Chem. Sci., 9 (2018) 4671
- P Mondal et al., Chem. Phys. 9 (2011) 56
- D Koner+, P Mondal et al., J. Chem. Phys. 153 (2020) 010901


**Website:** http://www.iisertirupati.ac.in/faculty/padmabatimondal/padmabati.php

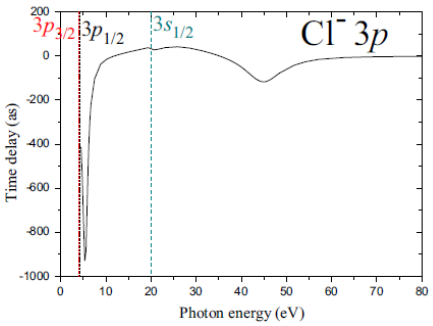
## Theoretical Atomic, Molecular and Optical Physics (AMOP)

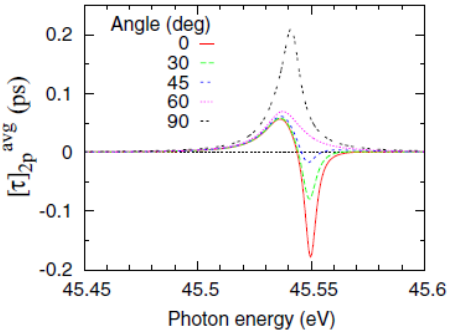
### P C Deshmukh

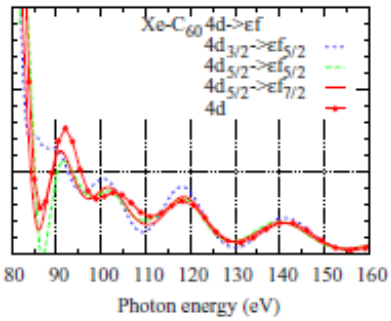
Relativistic many-body theory explorations of ultra-fast probing of electron dynamics

**Illustrative Research Work:**

- S Saha+ *Photodetachment: Shape resonance effect* Phys. Rev. A 99 (2019) 043407
- A Mandal+ *Study on 4d of free and confined Xe: Relativistic effect* Phys. Rev. A 96 (2017) 053407
- V K Dolmatov+ *Enhancement in delay for giant resonance* Phys. Rev. A 91 (2015) 053415
- S Banerjee+ *Study in the vicinity of Fano resonance: Strong angle dependence*, Phys. Rev. A 99 (2019) 013416
- A S Kheifets et al. *Angle dependence of time delay: Effect near CM*, 94 (2016) 013423
- P C Deshmukh+ *Time delay in confined atoms: Oscillation due to confinement resonances*, Phys. Rev. A 89 (2014) 053424





A Mandal


S Saha


S Banerjee


G Aarthi


J Jose


H R Varma


A K Yadav


S T Manson

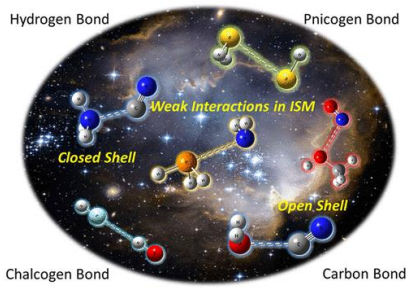

A S Kheifets


V K Dolmatov

**Website:** https://iittp.ac.in/dr-p-c-deshmukh

## Computational and Quantum Chemistry Group

### Raghunath O Ramabhadran




**Weak interactions in interstellar medium**

**Research Interests**: Computational Astrochemistry and Electronic Structure Methods

**Nature of Work**: Computational and Theoretical

Our group works in the emerging area of computational astrochemistry (with an emphasis on prebiotic and interstellar chemistry). It connects the possible chemistry which might have been responsible for the origin of life with contemporary chemistry, and further sheds light on how much more there is to learn, even about the chemistry of small molecules.

**Ongoing and future works**:

- Highlighting the role of metal-ions in interstellar chemistry *vis-à-vis* formamide formation
- Use of clusters to mimic interstellar surface chemistry
- Probe putative mechanisms of interconversion between thioformaldehyde, formaldehyde and formamide in the interstellar medium
- rate-coefficient computations of a reaction critical to interstellar ammonia generation (with S. Sunil Kumar)
- Gauging the plausibility of glycine existing in the interstellar medium from thermodynamical and kinetic aspects
- Mechanistic understanding of the formation of chiral propylene oxide in the interstellar medium
- Calibration and assessment of electronic structure methods for accurate computations of rate coefficients in interstellar reactions
- Collaboration with Dr. Sunil Kumar (Experimental Astrophysics) to understand features of interstellar reactions

**Group members**:

Left to right:
Sourakalya Thripati, Sonali S Powar, Raghunath O Ramabhadran, Roshni Periera, Vishwanath

**Selected publications:**


- M Kumar+, R O Ramabhadran et al. et al. Chem. Commun. 55 (2019) 9359
- D Csokas+, R O Ramabhadran, et al. Org. Biomol. Chem. 17 (2019) 6293
- K Gopalsamy +, R O Ramabhadran, ACS Earth Space Chem. 3 (2019) 1080
- R O Ramabhadran et al., Tetrahedron. 74 (2018) 1
- S Thripati+, R O Ramabhadran, J. Phys. Chem. A 121 (2017) 8659


**Collaborators:** S Sunil Kumar (IISER Tirupati)

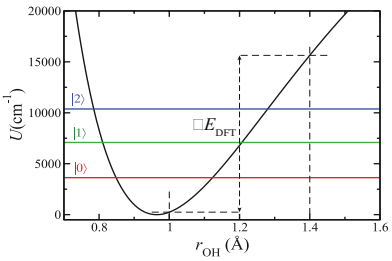
**Website**: http://www.iisertirupati.ac.in/faculty/raghurama/raghu.php

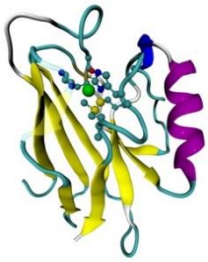
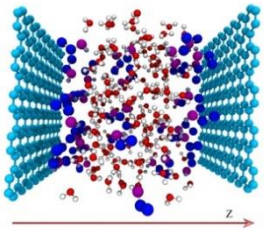
## Theoretical and Computational Chemistry

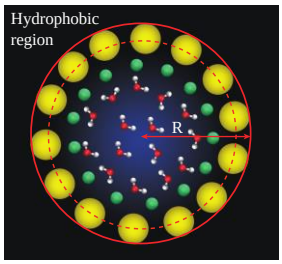
### Rajib Biswas

### Research Activities:

1. **Theoretical Spectroscopy:** Despite its extensive use, meaningful interpretation of IR spectroscopy faces the formidable challenge of establishing the connection among the experimental spectra to molecular structures in the bulk phase. Experimental spectra show a superposition of different transient solvation structures, hence represent the macroscopic response. Moreover, the presence of strong anharmonic couplings leads to further delocalization through mixing the character of different vibrational modes. On the contrary, the microscopic resolution of computer simulation assisted spectroscopy modelling enables us to study these systems at the molecular level. We develop and use several theoretical spectroscopy methodologies to establish the structure-spectrum correlations in rather quantitative way.
2. **Structure, Dynamics and Biological Activities of Metalloproteins:** Metalloproteins play critical responsibilities in many biological activities, and their malfunctioning or anomalous over-expression has been related to a variety of diseases. We use advanced state of the art computational methodologies to study structure, dynamics and function of these special class of bio-macromolecules.
3. **Water Dynamics at Surfaces & Interfaces:** In nature, water is frequently found in contact with a variety of surfaces of different length scales. This includes lipid bilayers, reverse micelles, biomolecules like proteins, DNA etc. While the presence of surfaces and interfaces disrupts the uninterrupted hydrogen bond network of liquid water, confinement on a mesoscopic scale originates novel features. We investigate the rich dynamics of water in presence of different exotic surfaces and interfaces by computer simulations and phenomenological modelling approach.






### Recent Contributions:

- T Samanta, R Biswas, S Banerjee and B Bagchi, J. Chem. Phys. 149 (2018) 044502
- T Samanta, R Dutta, R Biswas and B Bagchi, Chem. Phys. Lett. 702 (2018) 96 (2018)
- R Biswas, W Carpenter, J A Fournier, G A Voth, and A. Tokmakoff, J. Chem. Phys. 146 (2017) 154507

### Group Members:


Rajib Biswas


K Devendra


Albin Joy

**Website:** https://sites.google.com/view/rajibbiswas/home

# Plasma Processing Lab

## Reetesh Kumar Gangwar

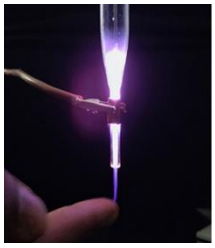
### Research Activities:

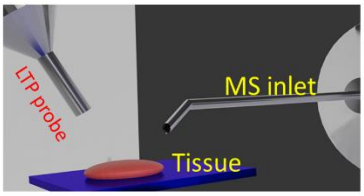
**Fundamental Research:**

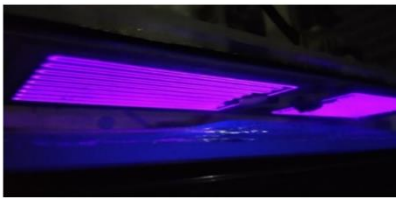
- Study the plasma-surface interaction
- Relativistic many-body physics for plasma relevant cross-section calculations
- Non-equilibrium plasma modeling and simulation

**Applied Research:**

- A low temperature plasma probe for rapid cancer diagnosis
- Hybrid plasma reactor for waste-water treatment
- Cold Atmospheric Pressure Plasma for agriculture and food processing
- Optical cavity-based sterilization unit for PPEs and N95 masks





### Recent Publications:

- Florent P Sainct, et al., *Spatially resolved Spectroscopic Diagnostics of a Miniature RF Atmospheric Pressure Plasma Jet in Argon Open to Ambient Air*, Plasma 3 (2020) 38
- S Baghel, et al., *Diagnostic of low temperature neon plasma through fine-structure resolved collisional-radiative model, Plasma Sources* Sci. Technol. 28 (2019) 115010
- R K Gangwar, et al., *Autoresonance cooling of Ions in an Electrostatic Ion Beam Trap*, Phys. Rev. Lett. 119 (2017) 103202

### Group Members:


R K Gangwar


P S N S R Srikar


Allabakshi


S Vedavarshini

### Collaborators:

Rajesh Srivastava, Shibdas Banerjee, Oded Heber, Ramesh Narayanan, L. N. Rao, Dr. Shihabudheen M. Maliyekkal

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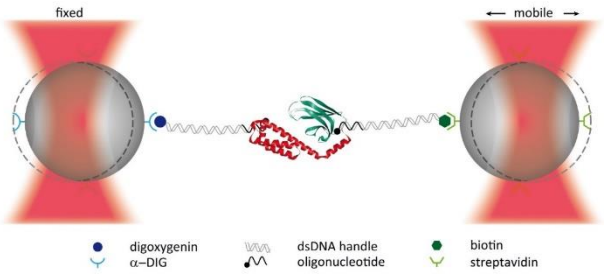
## Single Molecule Spectroscopy Lab

### Soumit Sankar Mandal

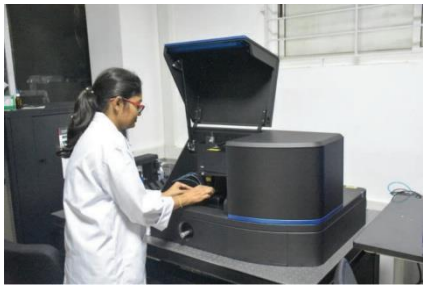
**Research Interests**: Single molecule spectroscopy with optical tweezer

**Nature of Work**: Experimental

- Structure and energetics associated with origin of clinically relevant biomolecules
- Trapping and investigation of thermo-plasmonic properties of metal/metal oxide nanoparticles, quantum dots
- Theoretical validation using molecular dynamics simulations (collaborations)




Force spectroscopy with optical tweezers



Lumicks C-trap @IISER T

**Collaborators**:

Padmabati Mondal (IISER Tirupati)

Remus T Dame (Leiden University, Netherlands)

Matthias Rief (Technical University of Munich, Germany)

**Selected Publications:**


- S S Mandal, et al. Proc. Natl. Acad. Sci. U.S.A. 114 (2017) 6040
- F Ziegler+, S S Mandal et al., Proc. Natl. Acad. Sci. U.S.A. 113 (2016) 7533
- S S Mandal et al, Bioelectrochemistry 98 (2014) 46


**Website:** http://www.iisertirupati.ac.in/faculty/soumitmandal/soumit.php

## Astrobiolab

### S Sunil Kumar

**Research Interests**: Laboratory Astrophysics and Astrochemistry

**Nature of Work:** Experimental + Computational

**Experimental**: Radiofrequency ion-trap setup is being developed at IISER Tirupati to address problems such as

- Physics & Chemistry of the Interstellar Medium (ISM) & atmospheric sciences
- Toward solving a century-old puzzle in astronomy: The Diffuse Interstellar Bands (DIBs)
- Origin of life in outer space – state of the art spectroscopic techniques to Identify biomolecules in the ISM.
- Origin of chirality in biomolecules and fluorescence in biomolecules
- Effect of environment on the function of biomolecules
- Determine stability of molecules against photodestruction and chemical processes

**Computational**: Quantum chemical calculations that complements experimental findings

CAD design of the setup

Cryogenic ion trap setup under construction

**Collaborators**:

Raghunath Ramabhadran, Padmabati Mondal (IISER Tirupati); P. C. Deshmukh, Arijit Sharma, & Reetesh Gangwar (IIT Tirupati); Holger Kreckel (MPI for Nuclear Physics, Heidelberg); Roland Wester (University of Innsbruck, Austria); Rajesh Kushawaha (PRL, Ahmedabad), G. Aravind (IIT Madras)

**Current Group Members:**

S Sunil Kumar, Hemanth Dinesan, Salvi M, Uma N N, Abheek Roy, Gayathry R

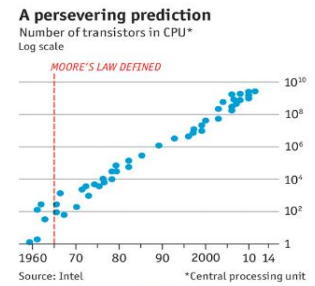

**Selected publications:**

- S Sunil Kumar et al., Sci. Adv. 4 (2019) eaar3417
- S Sunil Kumar et al. APJ 776 (2013) 25
- S Sunil Kumar et al. J. Phys. Chem. A 115 (2011) 10383
- S Sunil Kumar et al., Phys. Chem. Chem. Phys. 18 (2016) 22668

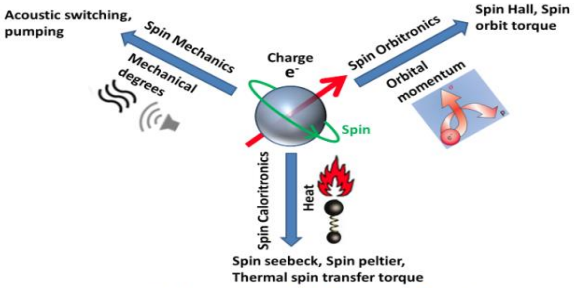
**Website:** http://www.iisertirupati.ac.in/people/faculty/sunil.php

## Nanoscale devices for electronic applications

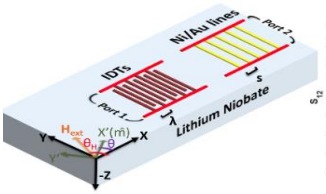
Swapnil Bhuktare

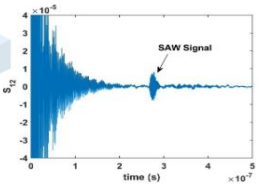



Moore's Law

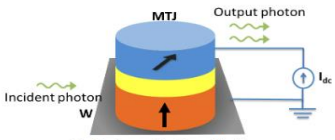



Spintronics, spin degrees of freedom



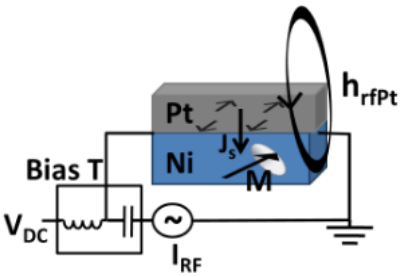




Magnon-phonon coupling, acoustic waves by magnetization dynamics

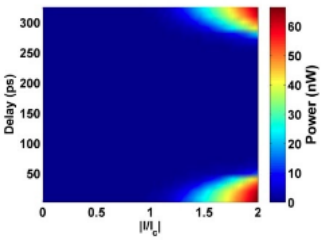


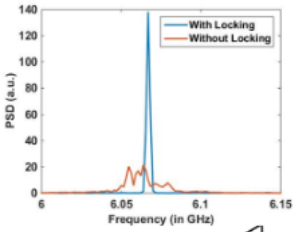

Spintronic Oscillators

S. Bhuktare et al. Phys. Rev. Appl. 7, 014022 (2017)
S. Bhuktare et al. Sci. Rep. 7, 840 (2017)

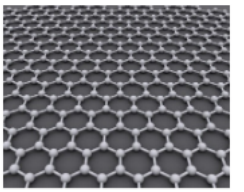



Spin-Torque FMR

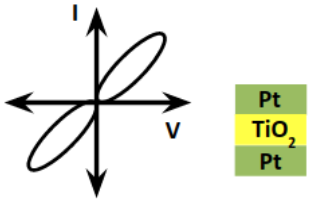


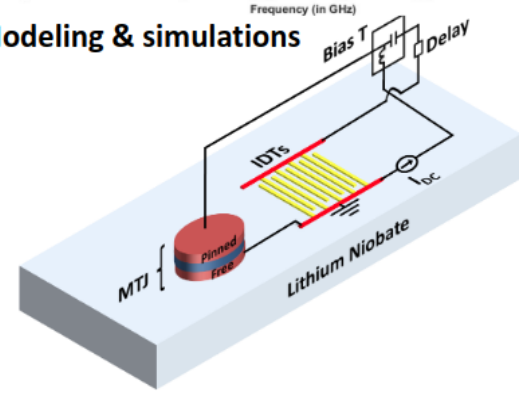

Modeling & simulations



Novel 2D materials, Terfenol-D




Memristive devices for neuromorphic computing applications




Spintronic feedback oscillators, locking & synchronization

S. Bhuktare et al. Phys. Rev. Appl. 7, 014022 (2017)
S. Bhuktare et al. Sci. Rep. 7, 840 (2017)
Wikipedia

**Website:** https://iittp.ac.in/dr-swapnil-bhuktare

## Nanoelectronics and device modeling

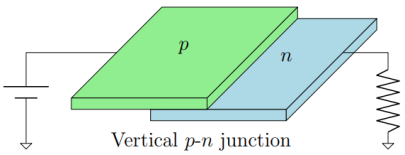
Vijaya Kumar Gurugubelli

### Research Activities:

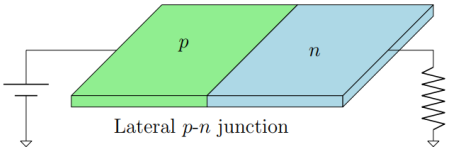
**Atomically thin p-n junctions**

Can be realized in

- 3D materials, e.g. Si, Ge, with reduced dimensionality
- 2D materials, e.g. MoS2, WS2



Vertical $p$-$n$ junction



Lateral $p$-$n$ junction

2D material: Single or multiple layers with strong in-plane bonds and weak out-of-plane bonds.

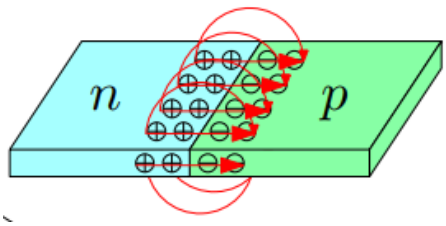
Each layer can be a single plane of atoms (e.g., Graphene, BN) or multiple planes of atoms (e.g. $MoS_2$)

Schematics of atomically thin pn-junction

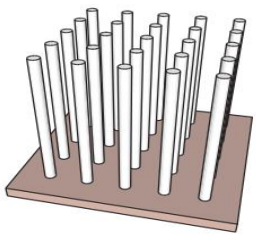
Find applications in

1. Electronics: Gate tunable rectifiers, Reconfigurable diodes
2. Optoelectronics: Photovoltaics, Photodetectors, LEDs

**Nanoscale Junction Electrostatics**



Schematic of a nanowire array


Schematic of electric field and depletion region

- Film thickness depends on the number of layers of 2D material.
- Due to quantum confinement of carriers along film thickness, the band structure and bandgap vary with film thickness.
- Hence, the build-in potential, given by the Fermi-level difference between p and n regions, is a function of thickness.
- As a result, the electrostatics that governs depletion width, capacitance etc. also changes.

### Selected Publications:


- V K Gurugubelli et al., Appl. Phys. Lett. 104 (2014) 203502
- V K Gurugubelli et al., J. Appl. Phys. 118 (2015) 034503

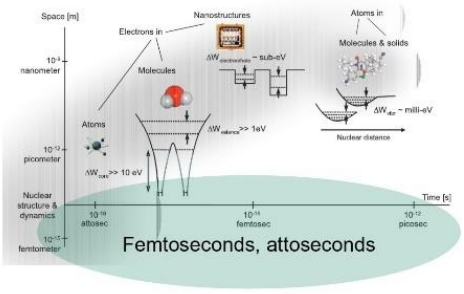

**Website**: https://iittp.ac.in/dr-vijaya-kumar-gurugubelli

## Theoretical Atomic, Molecular and Optical Physics (AMOP)

Vinay Pramod Majety

### Research Interests:

- Theoretical ultrafast few body physics
- Strong field and attosecond physics
- Ultrafast X-Ray physics
- Computational physics




Courtesy:
Reviews of Modern Physics, Vol 81, 2009, 0034-6861.

### Recent Contributions:

- L Mercadier et al. *Evidence of Extreme Ultraviolet Superfluorescence in Xenon*, Phys. Rev. Lett. 123 (2019) 023201
- Andrei Benediktovitch, Vinay P. Majety, and Nina Rohringer, *Quantum theory of superfluorescence based on two-point correlation functions*, Phys. Rev. A 99 (2019) 013839
- Thomas Kroll et al., *Stimulated X-Ray Emission Spectroscopy in Transition Metal Complexes*, Phys. Rev. Lett. 120 (2018) 133203

### Ongoing Work:

- Attosecond imaging and spectroscopy
- Photoelectron spectroscopy; Time delays in photoionization
- Atoms and molecules in strong fields
- Development of hybrid coupled channels approaches to laser-matter interaction

### Future Work:

- Exploration of new schemes that can be implemented using the current state of the art laser sources.

### Group Members:


Vinay P.


Hareesh C

### Collaborators:

**Website:** https://iittp.ac.in/dr-vinay-pramod-majety

Between IIT Tirupati and IISER Tirupati, we have a unique opportunity to benefit from the specialty available in AMO Sciences and Technologies to provide a fulcrum for a national resource in the field of AMO Sciences and Technologies. Together with adjunct members from several other universities and institutions along the length and breadth of India, CAMOST would aspire to generate and share state of the art resources for scientists across the country. What would provide a very special opportunity at CAMOST is the education programs at IIT Tirupati and IISER Tirupati where some of the best students in the country train under the tutoring of some of the best faculty.

The vibrant atmosphere in which young students, ranging from those who are fresh out of high school to those who are involved in graduate studies, many of whom pursuing research toward their doctoral theses and some engaged in post-doctoral research, in conjunction with some of the best scientists and engineers in the country, provides an unparalleled opportunity at CAMOST. CAMOST also benefits from the experience and leadership of the Members of its Scientific Advisory Council who come from across the world. CAMOST would undertake frontier research, and conduct regular seminars, webinars, workshops, and conferences, creating opportunities for AMO Scientists, Engineers, and Technologists to come together to seed and nurture frontier research pushing the very edges of technology. As the world stands at the threshold of the second quantum revolution, CAMOST commits itself in the service of the nation and that of mankind at large to push the frontiers of knowledge and technology. Conducting winter/summer schools for graduate students would also be on CAMOST's agenda at which some of the best faculty can come together and provide accelerated courses to graduate students.

The faculty at CAMOST gratefully acknowledges the guidance, support, and encouragement from the leadership at IIT Tirupati and IISER Tirupati without which the center would not even come into being. Support and guidance also from Members of the SAC is also gratefully acknowledged. CAMOST enthusiastically invites AMO scientists, engineers, and technologies from the whole of India to join its efforts, benefit from the same as well as contribute to that.