Book of Abstracts

Q-Karyashala
A 2-day workshop
June 27th & 28th, 2023
from 9.30 AM to 6:00 PM

Q-Karyashala 2023

27th – 28th June 2023
Faculty Hall, Main Building,
Indian Institute of Science

Agenda

Day 1 – Tuesday, 27th June 2023

Time	Program
08.30 AM Onwards	Registration
9.30 AM – 9.45 AM	Welcome Remarks by Prof. Akshay Naik, Chief Project Executive, QuRP
9.45 AM – 10.45 AM	Talk by Prof. Chandni Usha Title: Magic in 2D Flatland
10.45 AM – 11.15 AM	Tea break
11.15 AM – 12.15 PM	Talk by Dr. Atulasimha Jayasimha Title: Nanoscale magnetic devices: Applications to Hardware AI and Quantum Computing
12.15 PM – 2.00 PM	Lunch
2.00 PM – 3.00 PM	Interactive Session: QT Quiz
3.00 PM – 4.00 PM	Talk by Prof. Ambarish Ghosh Title: Nitrogen Vacancy (NV) Centres in Diamond
4.00 PM – 4.30 PM	Tea Break
4.30 PM – 6.00 PM	Batch I - Lab visit

Title: Magic in 2D Flatland

Speaker

Prof. Chandni Usha

(Assistant Professor at the Department of Instrumentation and Applied Physics. IISc)

Abstract :

'Graphene' or a single layer of graphite, is a two-dimensional (2D) sheet of carbon atoms, that has captured the attention of physicists, engineers, and material scientists for nearly two decades. When two layers of graphene are rotated with respect to each other, a fascinating interference structure called the 'moiré' pattern is created. The moiré has profound implications on the material properties of the underlying system, leading to exotic physics including superconductivity and magnetism. In this talk, I shall introduce you to the world of 2D and further discuss how two graphene layers at certain 'magic' angles have opened new surprises and exciting possibilities for electronic and optical devices using layered materials. I will discuss how a deep understanding of the quantum nature of electrons and some phenomenal advances in materials science have laid the foundations for numerous advances in 2D-based technology.

Biography:

Chandni Usha is an Assistant Professor at the Department of Instrumentation and Applied Physics. Her group studies electron transport in a variety of low dimensional semiconductor and metallic systems and in particular, two-dimensional electron systems in graphene and other layered materials, van der Waals heterostructures and ultrathin metallic wires. Other research interests include piezotronics and sensing using two dimensional materials and heterostructures.

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Title: Nanoscale magnetic devices-Applications to Hardware AI and Quantum Computing

Speaker

Prof. Jayasimha Atulasimha

(Qimonda Professor, Department of Mechanical and Nuclear Engineering & Electrical and Computer Engineering Virginia Commonwealth University)

Abstract :

A brief overview of some of the key challenges in classical and quantum computing. Following this, the potential use of nanoscale magnetic devices to solve such problems, as well as the rich and interesting physics in nanoscale magnetism that can be leveraged for such devices will be discussed.

For example, competing energies in nanoscale structures can lead to exotic spin states that we have shown could be key to extremely energy efficient computer memory [1] and AI hardware [2] that are amenable to implement in edge/IoT devices.

On the other hand, we have proposed the use of such nanomagnetic devices to address and control spin qubits [3]. By tuning the frequency of the nanomagnet's electric field drive to the Larmor frequency of the spins confined to a nanoscale volume, single-qubit quantum gates with fidelities approaching those of fault-tolerant quantum computing can be implemented [3].

References

[1] Nature Electronics 3, 539, 2020. [2] IEEE Access, 10, 84946, 2022. [3] Communication Physics 5, 284 (2022).

Biography:

Jayasimha Atulasimha is an Engineering Foundation Professor of Mechanical and Nuclear Engineering with a courtesy/affiliate appointment in Electrical and Computer Engineering and Physics at Virginia Commonwealth University. His current research interests include Nano magnetism, spintronics, non-volatile memory, hardware AI, and quantum computing with spins. He is a fellow of the ASME, an IEEE Senior Member, and past chair of the Technical Committee on Spintronics, IEEE Nanotechnology Council. He also serves as the Associate Director for the Institute for Sustainable Energy and Environment (ISEE) at VCU.

Personal Webpage:

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Title: Nitrogen-Vacancy (NV) Centres in Diamond

Speaker

Prof. Ambarish Ghosh

(Associate Professor at the Centre for Nanoscience and Engineering, IISc)

Abstract :

1) What is an NV center?
2) Key idea as a nanoscale sensor: optical property.
3) Diamond: material platform
4) Experimental setup: Scanning vs widefield magnetometry.
5) Quantum sensing with NV centers and various protocols and examples.

Biography:

Ambarish Ghosh is an Associate Professor at the Centre for Nanoscience and Engineering, IISc. He is known for his contributions to nanorobots, active matter physics, plasmonics, and metamaterials. His group has wide interests in studying light-matter interactions in novel nanoscale systems, ranging from electron bubbles in superfluid helium to helical nanoplasmonic devices, and magnetic nano-propellers.

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Q-Karyashala 2023

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Agenda

Day 2 – Wednesday, 28th June 2023

Time	Program
9.30 AM – 10.30 AM	Talk by Dr. Chandan Kumar Title: Origin of electrical resistance in mesoscopic devices
10.30 AM – 11.15 AM	Talk by Dr. Abhay Shastry Title: Quantum Machine Learning beyond the hype
11.15 AM – 11.45 AM	Tea break
11.45 AM – 12.30 PM	Talk by Dr. Rohit K Ramakrishnan Title: The Quantum Internet – A New Frontier
12.30 PM – 2.00 PM	Lunch
2.00 PM – 3.00 PM	Talk by Dr. Asha Bhardwaj Title: Low loss quantum communication in optical fibre: Exploring visible regime
3.00 PM – 4.00 PM	Interactive session with Prof. Apoorva D Patel, Convener, IISc Quantum Technology Initiative.
4.00 PM - 4.10 PM	Concluding Remarks
4.10 PM – 4.30 PM	Tea Break
4.30 PM – 6.00 PM	Batch II - Lab visit
4.30 PM onwards	Distribution of participation certificate

Title: Origin of electrical resistance in mesoscopic devices

Speaker

Prof. Chandan Kumar

(Assistant Professor at the Centre for Nano Science and Engineering, IISc)

Abstract :

Electrical resistance is usually associated with lattice imperfections. However, even a perfect crystal free of defects or faults shows finite resistance, determined by the number of channels available for conduction. This resistance usually appears at the contacts and is known as quantum resistance or Landauer -Sharvin resistance. Moreover, electrons can also behave as viscous fluid, raising the fundamental question – what is the ultimate conductance limit of strongly interacting hydrodynamic electrons? The talk will discuss the origin of electrical resistance in various transport regimes – Ohmic, ballistic and hydrodynamic. It will also emphasize the need for local spectroscopy tools which are required to image the resistance of device in real space. The talk will present how the constraint of the ballistic electrons can be lifted by viscous electronic fluid, with significant impact for future science and technology.

Biography:

Chandan Kumar is an Assistant Professor at the Centre for Nano Science and Engineering, IISc Bangalore. His research interest is aimed at fabricating novel low-dimensional materials, ranging from 1D carbon nanotubes to 2D van der Waals heterostructures, and understanding their emergent phenomena using various electrical transport and quantum imaging techniques at cryogenic temperatures. In addition, the group is also involved in developing novel scanning probe techniques to visualize electrons in mesoscopic devices.

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Title: Quantum Machine Learning beyond the hype

Speaker

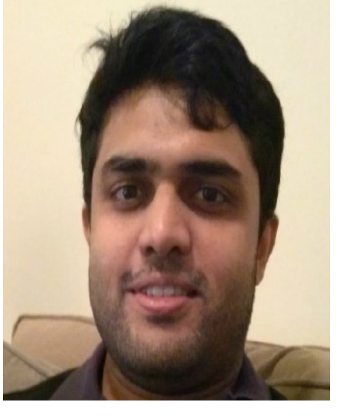
Dr. Abhay Shastry

(Postdoc in the Department of Computer Science and Automation (CSA), IISc)

Abstract :

Quantum Computing offers credible Quantum Advantages, its popular media coverage has led to a misconception that it can solve problems efficiently because it can ``check all solutions in parallel using quantum superposition.” In reality, quantum computers will not replace classical computers for all tasks but will be used as special-purpose devices which speed up some subroutines. We will first give a brief introduction to the field of Quantum Computing and discuss its implication for certain Machine Learning tasks. We briefly discuss quantum kernel methods which may offer speed-ups in supervised machine learning.

Biography:



Abhay Shastry is a postdoc in the Department of Computer Science and Automation(CSA) at the Indian Institute of Science. His doctoral work was in physics and dealt with theoretical questions pertaining to nonequilibrium quantum systems..

He is now interested in applying the methods and tools of statistical physics to understand Machine Learning algorithms, especially in Deep Learning. More specifically, I am interested in understanding the need for layering in certain neural network architectures.

Title: The Quantum Internet – A New Frontier

Speaker

Dr. Rohit K Ramakrishnan

(Researcher in the Applied Photonics Lab, Department of Electrical Communication Engineering, IISc)

Abstract :

Quantum communication is a fascinating field that explores the transmission of information using the principles of quantum mechanics. At its core, it leverages the unique properties of quantum systems, such as superposition and entanglement, to enable secure and efficient data transmission. By encoding information onto quantum bits, or qubits, which can exist simultaneously in multiple states, quantum communication allows for enhanced security by detecting eavesdropping attempts. Moreover, the concept of a quantum internet takes this idea further, envisioning a global network connecting quantum devices and exchanging quantum information across vast distances. With the potential to revolutionize fields like cryptography, computation, and data transmission, quantum communication and the quantum internet hold immense promise for the future of information technology. The talk will cover the basics of quantum communication, its underlying principles, and the current development towards a quantum internet.

Biography:

Rohit Ramakrishnan is a researcher in the Applied Photonics Lab, Department of Electrical Communication Engineering, Indian Institute of Science Bangalore. He has submitted his PhD thesis on High Dimensional Quantum technology using Photonics under the guidance of Prof. T Srinivas. He has done his B.Tech in Electronics and Communication Engineering from the College of Engineering Trivandrum, Kerala and his Masters in Photonics from the International School of Photonics, CUSAT. He was previously a Research Assistant at the Centre for Quantum Technologies, National University of Singapore, where he worked on the Quantum Satellite project. Before that, he had worked as a Postgraduate researcher in the Quantum Optics research group at the Australian Defence Force Academy. He has co-developed Quantum Homodyne Tomographic Code for Photon Detection in Australia. He is one of the co-authors of the book “The Quantum Internet – The Second Quantum Revolution”, published by Cambridge University Press.

Title: Low loss quantum communication in optical fiber: Exploring visible regime

Speaker

Prof. Asha Bharadwaj

(Assistant Professor at the Department of Instrumentation and Applied Physics)

Abstract :

Optical fiber design for its ultra-low loss properties which finds its applicability in quantum technology. The conventional fiber design is based on solid-core fiber using silica as material for propagation while the proposed/designed fiber is based on hollow-core fiber having a single layer of silica cladding tubes. The guidance mechanism of this hollow core fiber is anti-resonance properties where the operating wavelength works in a forbidden wavelength band decided by the silica tube thickness. The advantage of using anti-resonance hollow core fiber (AR-HCF) is to avoid coupling between core and cladding modes using inhibited coupling mechanism. The design of AR-HCF is very well adapted by the research community as the loss is found to be less as the light is guided in the air core and it can be further reduced by optimizing the design parameters of the fiber. We have simulated the losses of these kinds of fibers using the 6-tube and 5-tube design configurations by introducing nested rings inside the silica cladding and elliptical cladding tubes. The fiber suffers different types of losses such as confinement loss, bending loss, and surface scattering loss. In our work, we have optimized the confinement loss and bending loss for the 6-tube case and avoided crossing along with the confinement loss for the 5-tube case. The low dispersion values are also obtained for ARHCF which makes these fiber designs suitable for communication experiments. The characterization of a commercially bought low-loss fiber (loss of 5 dB/km at 635 nm) is also presented where the low-loss specialty fiber is coupled with the standard single-mode fiber. Further, this fiber is tested using the single photon transmission setup. Thus, we demonstrate the single-photon transmission using the low-loss fiber integrated with an all-fiber setup in the visible range

Biography:

Asha Bharadwaj is an Assistant Professor at the Department of Instrumentation and Applied Physics. The main focus of her research group is on the fabrication of high-quality quantum dots. At present her group is working on colloidal carbon quantum dots and Transition metal dichalcogenide (TMDC) Quantum dots. Some part of her work is also dedicated to the optimization of Quantum dots precipitation in a glass host.

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Interactive session

with Prof. Apoorva D Patel

(Professor at the Centre for High Energy Physics & Convener, IISc Quantum Technology Initiative)

Biography:

Apoorva D. Patel is a Professor at the Centre for High Energy Physics, IISc. He is notable for his work on quantum algorithms, and the application of information theory concepts to understand the structure of genetic languages. His major field of work has been the theory of quantum chromodynamics, where he has used lattice gauge theory techniques to investigate spectral properties, phase transitions, and matrix elements.

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