Dr. Mohamad Numan

Curriculum Vitae

Current Position

- **Designation:** Research Associate - I
- **Affiliation:** Indian Association for the Cultivation of Science (IACS), Jadavpur, Kolkata
- **Duration:** 19^{th} December, 2024 - Present

Education

- **Ph.D. in Experimental Physics** 2019 - Dec, 2024
  - **Institute:** School of Physical Sciences, Indian Association for the Cultivation of Science (IACS)
  - **Remark:** Focus on Quantum materials and Quantum Magnetism
- **M.Sc. in Physics** 2017
  - **Institute:** The University of Burdwan, Burdwan
  - **Remark:** Specialization in Condensed Matter Physics
- **B.Sc. in Physics Honours** 2015
  - **College:** Bejoy Narayan Mahavidyalaya
  - **Affiliation:** The University of Burdwan
  - **Remark:** Graduated with first-class distinction (70.5%)

Personal Details

Date of Birth : August 29^{th}, 1994
Nationality : Indian
Sex/Gender: Male
Marital Status: Unmarried

Contact Details

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Title of the Ph.D. Thesis

Exploring Quantum Magnetism and Multiferroicity through Structural and Spectroscopic Studies of 3d Transition Metal Oxides

Ph.D. Thesis Advisor

Prof. Subham Majumdar
Senior Professor, School of Physical Sciences
Indian Association for the Cultivation of Science, Kolkata, India

Current Research Interests

- **Magnetic and Transport Phenomena in Layered Van der Waals Systems:** Exploration of magnetism, anomalous and topological Hall effects, non co-planar spin structure, Berry phase-driven mechanisms, and magneto-resistance phenomena in transition metal intercalated layered van der Waals and Kagome metals, emphasizing the relationship between structural, magnetic, and electronic transport properties.
- **Quantum Magnetism:** Investigation of spin chain systems, including spin-1/2 and spin-1 chains, frustrated and low-dimensional magnets, and quantum spin liquids, with a focus on unconventional magnetic phases and interactions.
- **Functional Materials for Emerging Applications:** Exploration of multiferroic and other advanced materials with coupled magnetic, electric, and structural properties, focusing on their synthesis, characterization, and potential applications.

Experimental, Technical, Instrumentation and Computation Skills

Experimental Skills:

- **Single Crystal Growth**: Expertise in advanced techniques such as chemical vapor transport (CVT), slow cooling, and flux methods to synthesize high-quality single crystals.
- **Magnetic Measurements**: Skilled in using vibrating sample magnetometers (VSM) and superconducting quantum interference devices (SQUID) magnetometers from Quantum Design for detailed magnetic property characterization over wide temperature and field ranges.
- **Transport Measurements**:
  - Proficient in performing four-probe resistivity measurements to investigate conduction mechanisms.
  - Skilled in analyzing magneto-resistance and Hall effect to explore spin-dependent scattering, charge carrier dynamics, and different kinds of Hall effects.
- **Cryogenics and Low-Temperature Systems**: Extensive experience in operating and maintaining helium and nitrogen-based cryostats for low-temperature experiments.
- **High-Temperature Synthesis**: Hands-on experience with high-temperature furnaces for material preparation using solid state method and heat treatments. Also expertise in Arc-melting.

Technical Skills:

- **Advanced Structural Analysis**: Proficient in single-crystal and powder X-ray diffraction (XRD) techniques, including structure refinement and phase identification.
- **Spectroscopic Techniques**: Expertise in Raman spectroscopy, X-ray absorption (XANES/EXAFS), X-ray photoelectron spectroscopy (XPS), and X-ray magnetic circular dichroism (XMCD) for analyzing electronic and magnetic properties.
- **Microscopy and Imaging**: Skilled in scanning electron microscopy (SEM) for microstructural characterization, including Energy-Dispersive Spectroscopy.
- **Data Analysis and Modeling**: Proficient in processing experimental data using specialized software such as `FullProf`, `GSAS-II`, `APEX3`, `CrysAlisPro`, `JANA`, `Olex2`, and `Demeter` (`Athena`, `Artemis`).
- **Experimental Techniques**: Expertise in performing transport measurements such as resistivity, magneto-resistance, and Hall effect studies to investigate conduction mechanisms, charge carrier dynamics, and spin-dependent scattering.

Instrumentation Skills:

I have developed and programmed custom experimental setups using `LabVIEW`, including:

- A `Resistivity Measurement Setup`: Designed for studying the low-temperature behavior of materials in the range of 4–300 K using a close circuit refrigerator.
- A `Dielectric Constant Measurement Facility`: Operational over the temperature range of 4–300 K and the frequency range of 20 Hz to 1 MHz.
- A `Polarization Measurement System`: Built for analyzing pyroelectric currents at low temperatures.
- `Thermo-electric Effect Measurement`: Close cycle refrigerator (4-300 K) integrated system capable of recording temperature variation data.

In addition, I have extensive experience in automating experiments and programming laboratory instruments using LabVIEW.

Computational Skills:

I possess expertise in computational techniques and tools for data analysis and simulations:

- `Density Functional Theory (DFT)` calculations using the VASP package, with additional proficiency in post-processing the simulated data using own code.
- Programming experience in `Python`, with a focus on developing custom scripts for data analysis and visualization.
- Proficiency in plotting software, including `Origin`, `Gnuplot`, and `Matplotlib`, for high-quality data visualization.
- Familiarity with multiple platforms: `Linux` and `Windows`, ensuring adaptability in different computing environments.

Publications

In peer reviewed journals:

- **Magnetic Metastability driven Anomalous Hall Effect in Fe_xTaS_2**
  Mohamad Numan, Prasanta Chowdhury, Sanat Adhikary, Saurav Giri, Jhuma Sannigrahi, Matthias Gutmann, Souvik Chatterjee and Subham Majumdar
  Under review - Phys. Rev. B **arXiv:2501.17453**

- **Magnetic field induced arrested state and observation of spontaneous anomalous Hall effect in $TbMn_6Sn_6$**
  Tamali Roy, Prasanta Chowdhury, **Mohamad Numan**, Saurav Giri, Subham Majumdar, Sanat Kumar Adhikari and Souvik Chatterjee
  Under review - Applied Physics Letters **arXiv:2411.18950**

- **Suppression of Intrinsic Hall Effect through Competing Berry Curvature in $Cr_{1+\delta}Te_2$**
  Prasanta Chowdhury, Jyotirmay Sau, **Mohamad Numan**, Jhuma Sannigrahi, Matthias Gutmann, Saurav Giri, Manoranjan Kumar and Subham Majumdar
  Phys. Rev. Materials 9, 024407 (2025)

- **Magnetic excitation in $CuSeO_3$: a Raman scattering study**
  Mohamad Numan, Binoy Krishna De, Divya, Pradip Manna, Vasant Sathe, Saurav Giri and Subham Majumdar
  Under review - Phys. Rev. B

- **Interplay between lattice and magnetism in the distorted diamond spin-chain compound $Cu_3Nb_2O_8$**
  Mohamad Numan, Gangadhar Das, Manjil Das, Saurav Giri, Giuliana Aquilanti and Subham Majumdar
  Journal of Magnetism and Magnetic Materials 614, 172674 (2024)

- **Exploring the impact of Cr-doping on the crystallographic and magnetic structure of Mn_5Si_3 antiferromagnetic alloy**,
  Sanat Kumar Adhikari, Riya Roy, **Mohamad Numan**, Ashok Das, Rosni Roy, Sambhu Charan Das, Jhuma Sannigrahi, Sabyasachi Pramanick, Kalyanashis De, Qiang Zhang, Sergiu Levcenco, Edmund Welter, Sudipta Bandyopadhyay, Rajib Mondal and Souvik Chatterjee
  Phys. Rev. Materials 8, 064405 (2024)

- **Effect of carrier localization on anomalous Hall effect in the structurally chiral β-Mn type $Co_7Zn_7Mn_6$ alloy**,
  Prasanta Chowdhury, **Mohamad Numan**, Shuvankar Gupta, Souvik Chatterjee, Saurav Giri and Subham Majumdar
  Phys. Rev. B 109, 134428 (2024)

- **Role of crystal and magnetic structures in the magnetoelectric coupling in $CaMn_7O_{12}$**,
  Jhuma Sannigrahi, Md Salman Khan, **Mohamad Numan**, Manjil Das, Anupam Banerjee, Manh Duc Le, Giannantonio Cibin, Devashibhai Adroja and Subham Majumdar
  Phys. Rev. B 109, 054417 (2024)

- **Electronic and structural aspects of the chiral helimagnetic compound Cu_2OSeO_3**,
  Mohamad Numan, Gangadhar Das, Prabir Dutta, Manjil Das, Gouranga Manna, Saurav Giri, Giuliana Aquilanti and Subham Majumdar
  Journal of Physics and Chemistry of Solids 184 (2024) 111712

- **Evidence of exchange striction and charge disproportionation in the magnetoelectric material Ni_3TeO_6**,
  Mohamad Numan, Gangadhar Das, Md Salman Khan, Gouranga Manna, Anupam Banerjee, Saurav Giri, Giuliana Aquilanti and Subham Majumdar
  Phys. Rev. B 106, 214437 (2022)

- **Vacancy induced mixed valence state in nickel tellurate Ni_3TeO_6**,
  Mohamad Numan, Md Salman Khan and Subham Majumdar
  Materials Today: Proceedings 57 (2022) 151–156

Talks/Participation in Academic Events

At conferences:

- **"International Conference on Magnetic Materials and Applications (ICMAGMA-2025)"**
  Poster presentation at the **J.N. Tata Auditorium**, Indian Institute of Science (IISc), Bengaluru, India.
  February 12 - 14, 2025

- **"Recent Trends in Condensed Matter Physics: Exploring Quantum Materials (RTCMPQM 2024)"**
  Oral presentation at the **School of Physical Sciences**, Indian Association for the Cultivation of Science, Jadavpur, Kolkata, India
  February 15th and 16th, 2024

- "**International Conference on Advanced Materials: Properties and Applications**"
  Poster presented at the **School of Physical and Applied Sciences and School of Chemical Sciences**, Goa University, Taleigao, Goa, India
  February 20 - 24, 2023

- "**RECENT TRENDS IN CONDENSED MATTER PHYSICS 2023**"
  Poster presented at the **School of Physical Sciences**, Indian Association for the Cultivation of Science, Jadavpur, Kolkata, India
  January 12 - 13, 2023
- "**International Symposium on Materials of the Millennium: Emerging Trends and Future Prospects**"
  Online poster presented at the **School of Technology**, Pandit Deendayal Energy University, Gujrat, India
  November 19 - 21, 2021

Teaching Experiences

- Teaching assistant for UG Physics Laboratory at IACS BS-MS program in **Spring 2020**. Course instructor: Prof. Subham Majumdar and Dr. Mintu Mondal.
- Teaching assistant for UG Physics Laboratory at IACS BS-MS program in **Autumn 2020**. Course instructor: Prof. Subham Majumdar and Dr. Mintu Mondal.

Awards and Achievements

- Qualified Joint Entrance Screening Test (JEST) in March 2018, All India Rank 40.
- Qualified Joint CSIR-UGC NET examination in December 2017, organised by Council of Scientific Research (CSIR) and University Grants Commission (UGC), Govt. of India, All India Rank 40.
- Qualified Joint CSIR-UGC NET examination in December 2018, organised by Council of Scientific Research (CSIR) and University Grants Commission (UGC), Govt. of India, All India Rank 51.
- Qualified Graduate Aptitude Test in Engineering (GATE) in 2018, All India Rank 833.
- Qualified Graduate Aptitude Test in Engineering (GATE) in 2019, All India Rank 139.

References

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(Ph.D. supervisor)
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