## Spintronics and Multifunctional Materials (SMM) Group

### Group Head:

Dr. Aga Shahee Office: Room 30, Department of Physics, University of Kashmir Assistant Professor, Email ID: <a href="mailto:shahee@uok.edu.in">shahee@uok.edu.in</a> Webpage: <a href="https://sites.google.com/view/q2m-group">https://sites.google.com/view/q2m-group</a>

At Spintronics and Multifunctional Materials (SMM) Group, we are a dedicated research group specializing in the synthesis, characterization, and application of multiferroic, spintronic and quantum materials. Our team is passionate about unraveling the mysteries of quantum phenomena and exploring the multifunctional properties of various physical systems, including nanostructures, single crystals, and bulk materials. Through our cutting-edge research, we strive to uncover new physics and discover innovative technological applications that harness the power of quantum effects and strongly correlated-electron states.

Our research efforts are focused on investigating new phases of quantum materials through a combination of design, discovery, and exploration. We are particularly interested in studying emergent phenomena, including conventional and unconventional magnetism, multiferroicity, spin-orbit torques, charge-orbital ordering, and magneto-structural phase transitions. To accomplish our research goals, we employ a diverse range of techniques, including synthesis and crystal growth methods, as well as advanced characterization tools such as scattering, thermodynamics, transport, and spectroscopy. By conducting experiments at low temperatures and under varying magnetic fields, we gain valuable insights into the behavior and properties of quantum materials.

Collaboration and knowledge exchange are fundamental to our research philosophy. We actively seek partnerships with researchers in the fields of materials science and condensed matter physics from around the globe. Through these collaborations, we aim to foster innovation and accelerate scientific advancements in the study of quantum materials.

As you explore our website, you will find detailed information about our research projects, publications, and the expertise of our team members. We also highlight our collaborations, facilities, and the latest news and events related to our research endeavors.

We welcome you to join us on this exciting journey into the world of quantum materials. Whether you are a fellow researcher, a student, or a potential collaborator, we invite you to explore the opportunities for engagement and collaboration with **SMM**. Together, let's push the boundaries of knowledge and pave the way for transformative discoveries in the field of quantum and multifunctional materials.

Thank you for visiting the SMM Group. We look forward to connecting with you and embarking on groundbreaking research together.

## **Research Interests and Topics**

#### 1. Discovery and Synthesis of New Quantum and Functional Materials:

- > Exploring novel materials with unique quantum properties
- > Investigating structure, electronic, magnetic, and optical characteristics

#### 2. Exploration of New Multiferroic Materials:

- > Studying materials with simultaneous ferroelectric and magnetic properties
- Investigating multiferroic behavior, coupling, and potential applications in magneto-electric devices and energy harvesting

#### 3. Quantum Magnetism of Spin-Orbital Entangled States and Its Implications:

- > Investigating the interplay between spin and orbital degrees of freedom in quantum materials
- > Understanding emergent phenomena arising from their entanglement
- Exploring quantum materials with frustrated magnetic interactions and their effects on emergent properties and potential applications

#### 4. Novel Spin-Orbital Order in Transition Metal Oxides:

- Examining the intricate interplay between spin, orbital, and lattice degrees of freedom in transition metal oxides
- > Investigating exotic spin and orbital orderings and their impact on material properties

#### 5. Magneto-Structural Phase Transitions and Charge Orbital Ordering in Manganites:

- Investigating the interplay between magnetism, crystal structure, and charge orbital ordering in manganite materials
- > Understanding mechanisms and properties of magneto-structural phase transitions

#### 6. Analysis of Lattice and Spin Structures of Strongly Correlated Oxides:

- > Characterizing lattice and spin structures in strongly correlated oxide materials
- > Understanding their correlation with electronic and magnetic properties

# 7. Structural, Optical, Electric, and Magnetic Properties of 3D Metal Oxides and Chalcogenide Materials:

- Characterizing and understanding properties of 3D metal oxides and chalcogenide materials
- > Investigating structural, optical, electrical, and magnetic behavior for potential application

#### 8. Development of 2D van der Waals Magnetic Materials for Spintronic Devices:

- > Exploring synthesis and properties of 2D van der Waals magnetic materials
- > Investigating their potential for spintronic applications and device fabrication

Our research involves a combination of synthesis and experimental techniques to gain a better understanding of these properties and their potential applications in areas such as energy, electronics, and information technology.