
Education

Ph.D. (August 2014 – July 2020)

Department of Physics,

Indian Institute of Science Education and Research (IISER) Mohali, India

Thesis: *A study of critical behavior and the magnetocaloric effect in rare-earth double perovskites, 3d-metal chromites, and the ferromagnetic Weyl semi-metal $\text{Co}_3\text{Sn}_2\text{S}_2$.*

Advisor: Prof. Yogesh Singh

Field of Study: Magnetism, Condensed Matter Physics

M.Sc. Physics (August 2010 – June 2012)

Department of Physics,

Aligarh Muslim University, Aligarh, India

B.Sc. (Hons) Physics (August 2007 – June 2010)

Department of Physics,

Aligarh Muslim University, Aligarh, India

Post Ph.D. Experience

Postdoctoral Fellow (October 2023 – Present)

Max Planck Institute for Solid State Research, Stuttgart, Germany

Postdoctoral Fellow (August 2021 – September 2023)

Institute for Basic Sciences (IBS). Sungkyunkwan University (SKKU), Suwon, South Korea

Research Associate (March 2021 – June 2021)

Jawaharlal Nehru Centre for Advanced Scientific Research, Bangalore, India

Research Experience

My research focuses on the synthesis and in-depth investigation of quantum materials, including strongly correlated electron systems, geometrically frustrated magnets, and low-dimensional spin-chain compounds. I grow high-quality single crystals and polycrystalline samples, and employ a suite of advanced techniques; such as X-ray diffraction, magnetometry, heat capacity, electrical transport, and neutron diffraction to probe their structural and magnetic properties. My work aims to uncover complex ground states and emergent quantum phenomena, including partial molecular orbital formation, spin-glass behavior, and field-induced quantum phase transitions.

Ph.D. Research

Critical Behaviour of Magnetic Materials

During my Ph.D., I investigated the critical behavior of magnetic materials, including 3d-metal chromites, rare-earth-based double perovskites, and van-der-Waals ferromagnets near phase transitions. This research provided insights into the magnetization and magnetocaloric effects driven by the interplay of magnetic sublattices.

Strongly Correlated Frustrated Magnetic Systems

The latter part of my Ph.D. work focused on strongly correlated frustrated magnetic systems, specifically Kitaev Quantum Spin Liquid candidates such as $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$, Cu_2IrO_3 , $\text{Ag}_3\text{LiIr}_2\text{O}_6$, and $\text{K}_x\text{Ir}_y\text{O}_2$. This work aimed to deepen our understanding of these complex systems' underlying physics.

Postdoctoral Research

Magnetism in Trimer-Based Hexagonal Perovskites

In my first postdoctoral position, I investigated the magnetic properties of trimer-based hexagonal perovskites, specifically $\text{Ba}_4(\text{Nb,Ta})\text{Mn}_3\text{O}_{12}$. These compounds feature Mn_3O_{12} trimers formed by face-sharing MnO_6 octahedra arranged on a geometrically frustrated triangular lattice. To understand their magnetism, I employed a molecular orbital

framework, providing insight into the interplay between structural motifs and the emergence of collective magnetic behavior.

Single Crystal Growth and Quantum Spin Chains

At the Max Planck Institute (MPI), my current research involves the single crystal growth of one-dimensional zigzag spin chain compounds such as CaCoV_2O_7 , SrCoV_2O_7 , and ZnCoV_2O_7 . These compounds are of particular interest due to their potential to exhibit magnetic field-induced quantum phase transitions at relatively low magnetic fields.

Hands on Experiments

Polycrystalline Synthesis Techniques:

Extensive experience in the synthesis of polycrystalline materials using various solid-state methods, including conventional solid-state reaction, ion-exchange reaction, and arc melting techniques.

Single Crystal Growth Methods:

Proficient in multiple single crystal growth techniques, such as flux growth, the Bridgman–Stockbarger method, the Czochralski process, chemical vapor transport (CVT), and the optical floating zone (OFZ) method.

Structural and Morphological Characterization:

Skilled in structural and surface characterization using X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), and Raman spectroscopy.

Magnetic Property Measurements:

Expertise in measuring and analyzing magnetic properties using both AC and DC magnetization techniques, as well as neutron diffraction for probing long-range magnetic order.

Electronic and Thermal Transport Measurements:

Hands-on experience with electronic transport measurements including resistivity and Hall effect, as well as thermal transport techniques for probing lattice and electronic contributions.

Phase Transition Studies:

In-depth experience in detecting and characterizing phase transitions through specific heat measurements and complementary thermal transport analysis.

High-Pressure Measurements:

Skilled in conducting magnetization and resistivity measurements under high pressure, up to ~ 2.1 GPa.

Instrumentation Expertise:

- Extensive experience operating and troubleshooting the Quantum Design PPMS EverCool system with a helium-3 insert.
- Proficient in managing and troubleshooting Cryogenic Limited SQUID magnetometers with helium-3 options.
- Hands-on handling of Liquid Helium and Liquid Nitrogen plants for cryogenic operations.

Data Analysis and Visualization:

- Proficient in the analysis of X-ray and neutron diffraction data using Rietveld refinement methods via **Jana** and **FullProf** software suites.
- Skilled in using **VESTA** for three-dimensional crystal structure visualization.
- Experienced in **OriginPro** and **MATLAB** for data plotting, modeling, and advanced analysis.

Achievements

- **CSIR - Junior Research Fellowship (JRF):** CSIR-UGC NET JRF (Physical Sciences) qualified, held in June 2015 with AIR 148.
- **Joint Entrance Screening Test (JEST):** JEST (Physical Sciences) qualified, held in Feb 2014 with AIR 330.
- **Graduate Aptitude Test in Engineering (GATE):** GATE (Physical Sciences) qualified, held in March 2014 with AIR 275

Teaching Experience

- **Aug 2014 – April 2016:** Teacher Assistant in Physics BS-MS Teaching Labs at IISER Mohali, India
- **Nov 2012 – May 2013:** Physics Teacher in 11th – 12th Standard Classes and Labs at AMS Aligarh, India.

Publications

In Communication

1. Dichotomous two-orbital electrons as a platform for pure Mott transition

M Kim*, S Lee*, I Park*, **A Ali***, D Wulferding, K Son, G Han, R Goel, J H Lee, H Luetkens, C Wang, C Kim, J H Shim, and S K Choi

** These authors contributed equally to this work.*

[Nature Materials \(Under Review\)](#)

2. Isotropic ferromagnetic moment in the magnetoelectric antiferromagnet $\text{Co}_4\text{Ta}_2\text{O}_9$: Realization of the P1 magnetic space group

R Goel, K Son, M J Gutmann, D G Oh, K Kumar, **A Ali**, S J Mun, D Bhosale, G Kim, N Lee, Y J Choi, S W Cheong, V Kiryukhin and S K Choi

[Phys. Rev. Research \(Under Review\)](#)

3. A magnetocaloric study of the magnetostructural transitions in NiCr_2O_4

A Ali, G Sharma, and Y Singh

arXiv:1811.07836

<https://arxiv.org/abs/1811.07836>

4. Crystal Growth and Magnetic Properties of 1D spin chain ZnCoP_2O_7

A Ali, P Pascal, A K Yogi and Y Masahiko Isobe

arXiv:1811.07836

[Under Preparation](#)

Published

1. Exploring Low-Dimensional Magnetism in Cobalt Vanadates, ACoV_2O_7 ($A = \text{Ca}, \text{Sr}$):

Crystal Growth and Magnetic Properties of Effective Spin-1/2 Zigzag Chains

A Ali, G Kaur, A Maurya, P Puphal, Isha, A K Yogi, and M Isobe

APL Mater. 13, 071111 (2025)

<https://doi.org/10.1063/5.0263606>

2. Cluster Spin Glass State in $\text{Ba}_3\text{Sb}_{1+x}\text{Co}_{2-x}\text{O}_{9-\delta}$: Cation Disorder and Mixed-Valence Co Dimers
A Ali, G Kaur, L Keller, M Isobe
 Phys. Rev. B 112, 024409 (2025)
<https://doi.org/10.1103/k7mm-g2zc>
3. Controlled growth of high-quality polar quantum magnets via chemical vapor transport
 H Haruhiro, R Datta, P Yadav, **A Ali**, S Lee, M J Gutmann, D Yoon, D Wulferding and S K Choi
 Cryst. Growth Des. 2025, 25, 13, 4991–4998
<https://doi.org/10.1021/acs.cgd.5c00471>
4. Partial molecular orbitals in face-sharing 3d manganese trimer: Comparative studies on $\text{Ba}_4\text{TaMn}_3\text{O}_{12}$ and $\text{Ba}_4\text{NbMn}_3\text{O}_{12}$
A Ali, HS Kim, P Yadav, S Lee, D Yoon, and SK Choi
 Phys. Rev. Research 6, 013231 (2024)
<https://doi.org/10.1103/PhysRevResearch.6.013231>
5. Strong coupling of lattice and orbital excitations in the quantum magnet: Anomalous temperature dependence of Raman phonons
 S Pal, A Seth, **A Ali**, Y Singh, DVS Muthu, S Bhattacharjee, and AK Sood
 Phys. Rev. B 108, L241103 (2023)
<https://doi.org/10.1103/PhysRevB.108.L241103>
6. Pressure tuning of structure, magnetic frustration, and carrier conduction in the Kitaev spin liquid candidate Cu_2IrO_3
 S Pal, P Malavi, A Sinha, **A Ali**, P Sakrikar, B Joseph, UV Waghmare, Y Singh, D V S Muthu, S Karmakar, and A K Sood
 Phys. Rev. B 107 085105 (2023)
<https://doi.org/10.1103/PhysRevB.107.085105>
7. Rare-earth tuned magnetism and magnetocaloric effects in double perovskites R_2NiMnO_6
A Ali, K Pasrija, G Sharma, S Kumar, and Y Singh
 J. Phys.: Condens. Matter 34 (2022) 095803 (9pp) (2021)
<https://iopscience.iop.org/article/10.1088/1361-648X/ac3e9e>
8. Probing signatures of fractionalization in the candidate quantum spin liquid Cu_2IrO_3 via anomalous Raman scattering
 S Pal, A Seth, P Sakrikar, **A Ali**, S Bhattacharjee, D. V. S. Muthu, Y Singh, and A. K. Sood
 Phys. Rev. B 104, 184420 (2021)
<https://doi.org/10.1103/PhysRevB.104.184420>
9. Graphene oxide and its derivatives as potential Ovchinnikov ferromagnets
 A Sinha, P Ranjan, **A Ali**, J Balakrishnan, A D Thakur
 J. Phys.: Condens. Matter 33 (2021) 375801 (11pp)
<https://iopscience.iop.org/article/10.1088/1361-648X/ac0d84>
10. Quantum disordered state in the J_1 - J_2 square-lattice antiferromagnet $\text{Sr}_2\text{Cu}(\text{Te}_{0.95}\text{W}_{0.05})\text{O}_6$
 S Yoon, W Lee, S Lee, J Park, C. H. Lee, Y.S. Choi, S.H. Do, W.J. Choi, W.T. Chen, F Chou, D.I. Gorbunov, Y Oshima, **A Ali**, Y Singh, A Berlie, I. Watanabe, and K. W. Choi
 Phys. Rev. Materials 5, 014411 (2021)
<https://doi.org/10.1103/PhysRevMaterials.5.014411>
11. Evolution of Magnetism in Graphene Oxide
 A Sinha, **A Ali**, and A.D. Thakur
 AIP Conference Proceedings 2265, 030521(2020)
<https://doi.org/10.1063/5.0017166>
12. Emergence of weak pyrochlore phase and signature of field-induced spin ice ground state in $\text{Dy}_{2-x}\text{La}_x\text{Zr}_2\text{O}_7$; $x = 0, 0.15, 0.3$
 Sheetal, **A Ali**, S Rajput, Y Singh, T Maitra, and C. S. Yadav
 J. Phys.: Condens. Matter 32 (2020) 365804 (9pp)
<https://doi.org/10.1088/1361-648X/ab8bf6>

13. Ferromagnetism in Graphene Oxide

A Sinha, **A Ali**, and A D Thakur

Materials Today: Proceedings 46 (2021) 6230-6233

<https://doi.org/10.1016/j.matpr.2020.04.771>

14. Robustness of the spin liquid state with respect to magnetic dilution in the bilayer kagome material $\text{Ca}_{10}\text{Cr}_7\text{O}_{28}$

A Balodhi, **A Ali**, and Y Singh

Phys. Rev. B 101, 184416 (2020)

<https://doi.org/10.1103/PhysRevB.101.184416>

15. A magnetocaloric study on the series of 3d-metal Spinel chromites ACr_2O_4 where A = Mn, Fe, Co, Ni, Cu, and Zn.

A Ali, and Y Singh

Journal of Magnetism and Magnetic Materials 499 (2020) 166253

<https://doi.org/10.1016/j.jmmm.2019.166253>

16. Rotating magnetocaloric effect in the ferromagnetic Weyl semi-metal $\text{Co}_3\text{Sn}_2\text{S}_2$.

A Ali, Shama, and Y Singh

Journal of Applied Physics 126, 155107 (2019)

<https://doi.org/10.1063/1.5120005>

17. Doping induced metal to insulator transition and the thermal transport properties in Germanium

A Ali, J Singh, and RK Gopal

AIP Conference Proceedings 2115, 030453 (2019)

<https://doi.org/10.1063/1.5113292>

18. Magnetocaloric effects from an interplay of magnetic sublattices in $\text{Nd}_2\text{NiMnO}_6$

A Ali, G Sharma, A Vardhan, K Pasrija, S Rajput, T Maitra, S Kumar, and Y Singh

J. Phys.: Condens. Matter 31 (2019) 305803 (8pp)

<https://doi.org/10.1088/1361-648X/ab151a>

19. Fe_6 clusters of tripodal alcohol ligands: Synthesis, structures, and magnetostructural properties

M Ashfaq, M Khalid, M Raizada, **A Ali**, M Faizan, M Shahid, M Ahmad

Polyhedron 163 (2019) 131-143

<https://doi.org/10.1016/j.poly.2019.02.019>

20. Exotic Low-Energy Excitations Emergent in the Random Kitaev Magnet Cu_2IrO_3

YS Choi, CH Lee, S Lee, S Yoon, WJ Lee, J Park, **A Ali**, Y Singh, JC OrainGareoung Kim, Jong-Soo Rhyee, Wei-Tin Chen, Fangcheng Chou, and Kwang-Yong Choi

Phy. Rev. Letters 122, 167202 (2019)

<https://doi.org/10.1103/PhysRevLett.122.167202>

21. Crystal engineering and magnetostructural properties of newly designed azide/acetate-bridged Mn_{12} coordination polymers

M Ashfaq, M Khalid, M Raizada, **A Ali**, M Faizan, M Shahid, M Ahmad

Cryst. Growth Des. 2019, 19, 2366-2379

<https://doi.org/10.1021/acs.cgd.9b00058>

22. The Role of Weakly Coordinating Thioether Group in the Ligation Controlled Molecular Self-Assemblies and Their Inter-Conversions in Ni (II) Complexes of L-methionine Derived Ligand

R Kumar, V Mutreja, G Sharma, S Kumar, **A Ali**, SK Mehta, P Venugopalan, R Kataria, and SC Sahoo

New J. Chem., 2019, 43, 11222-11232

<https://doi.org/10.1039/c9nj02573a>

23. Critical behavior near the ferromagnetic phase transition in double perovskite $\text{Nd}_2\text{NiMnO}_6$

A Ali, G Sharma, and Y Singh

AIP Conference Proceedings 1953, 040017 (2018)

<https://doi.org/10.1063/1.5032637>

24. Synthesis, structural and magnetic characterizations of a dinuclear copper (II) complex with an (N, S, O) donor ligand: Catecholase and phenoxazinone synthase activities

AK Ghosh, **A Ali**, Y Singh, CS Purohit, R Ghosh

Inorganica Chimica Acta 474 (2018) 156-163

<https://doi.org/10.1016/j.ica.2018.02.004>

25. Tyrosinase and catecholase-like activities of a dinuclear Cu (II) complex

A Chatterjee, HR Yadav, AR Choudhury, **A Ali**, Y Singh, R Ghosh

Polyhedron 141 (2018) 140-146

<https://doi.org/10.1016/j.poly.2017.11.040>

Recent Poster Presentations and Conferences

- Presented the recent work at the 30th International Conference on Low Temperature Physics (LT30) on 07-13th August 2025, which was held at Bilbao Exhibition Center, Bilbao, Spain
- Presented the recent work at the International Conference on Neutron Scattering (ICNS 2025) on 06-10th July 2025, which was held at Bella Center, Copenhagen, Denmark
- Presented the recent work at the German-French Crystal Growth Conference (DKT 2025) on 05-07th March 2025, which was held at Physics Institute, Goethe University, Frankfurt, Germany
- Participated in 26th Laboratory Course – Neutron Scattering 2024 on 02-13th September 2024, which was held at Julich Centre for Neutron Science (JCNS) Julich Germany
- Presented the recent work in the DPG Annual Spring Meeting of the condensed matter section (SKM) 2024, which was held in Berlin, Germany, from March 17 to 22, 2024
- Presented the recent work at the International Conference on Strongly Correlated Electron Systems (SCES) 2023, which was held in Incheon, South Korea, from July 02 to 07, 2023
- Presented the recent work at the 15th Asia Pacific Physics Conference, held online from August 21 to 26, 2022, in SKKU, South Korea.
- Attended a conference as Invited Speaker in STEMIO's Magnetism and Magnetic Materials Online Summit (SMMM-2021) Belgium, May 07, 2021
- Presented a paper at the 63rd DAE Solid State Physics Symposium held at GJUST Hisar Haryana during 18-22 December 2018
- Presented a paper at the 2nd International Conference on Condensed Matter & Applied Physics organized by Government Engineering College, Bikaner, during Nov. 24-25, 2017
- Presented a poster at an International Conference on Condensed Matter Physics held at Indian Statistical Institute Kolkata, India, Nov 14-16, 2017
- Presented a poster in a seminar on Advancement in Sciences and Technology (ONSAST-2017) organized by the Department of Applied Sciences, PEC University of Technology, Sector 12 Chandigarh, on March 04, 2017
- Participated in a National workshop on Recent Advances in Strongly Correlated Electronic Materials held in the Department of Physics IIT Roorkee during Feb 8-10, 2017
- Presented a poster at a conference with the title Emerging Trend in Advanced Functional Material held in the Institute of Physics Bhubaneswar during Dec 18-22, 2016
- Participated in a Workshop on Solid-state and material chemistry held on February 08, 2016, at the Institute of Nano Science and Technology, Mohali, India

References

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