AJAY KUMAR (He/Him/His)

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Research Interests

- My research interests include superconductivity, ultracold atomic systems, quantum information science, quantum optics, quantum computing, and trapped-ion platforms, with a strong emphasis on experimental realization and precision measurements.
- I am particularly interested in designing and implementing experiments to probe quantum coherence, many-body phenomena, and emergent quantum states, bridging fundamental physics with next-generation quantum technologies.

Education

2025 – Present ◇ **Ph.D. Physics, The University of Oklahoma (Norman, Oklahoma, USA).**

2022 – 2024 ◇ **M.Sc. Physics, Indian Institute of Technology Madras (Chennai, India).**
Thesis Advisor: *Prof. K. Sethupathi.*
Thesis title: *Superconductivity in High Entropy Alloys (HEAs).*

2019 – 2022 ◇ **B.Sc. (Honours) Physics, Ramjas College, University of Delhi (North Campus, Delhi, India)**.

2017 – 2019 ◇ **High School, Indian Modern Sr. Sec. School (Sonipat, Haryana, India)**.

Research Experience

2023 – 2024 ◇ **Master's Thesis :** Exploring Superconductivity in bulk $Ta_{1/6}\,Nb_{2/6}\,Hf_{1/6}\,Zr_{1/6}\,Ti_{1/6}$ High Entropy Alloys (HEAs) - Synthesis and Characterisation.
Thesis Advisor: *Prof. K. Sethupathi.*
Institute: *Indian Institute of Technology Madras (IIT Madras).*
Description: During my research at Low temperature physics laboratory in IIT Madras, I extensively studied high-entropy alloys (HEAs) and their fascinating superconducting properties. My focus revolved around understanding how the critical temperature (T_c) of these alloys can be tuned by varying synthesis parameters, composition, and external conditions such as temperature and magnetic fields.
Key Findings: Electrical transport measurements under varying magnetic fields (1 Tesla to 9 Tesla) demonstrated a high upper critical field, with a sharp resistivity drop at 2.9 K even at 9 Tesla. The calculated upper critical field (H_{c2}) was 12.41 Tesla, with a coherence length (ξ) of 5.15 nm. SEM–EDS analysis showed a uniform distribution of elements without cluster formation, consistent with the characteristic features of high-entropy alloys. Specific heat measurements indicated a transition temperature of 7.26 K, with the persistence of a superconducting gap near the critical temperature under high magnetic fields, underscoring robust superconducting properties. The Debye temperature (Θ_D) was calculated to be 200.6 K, and evaluations of the superconducting energy gap (Δ) suggested deviations from the BCS theory, potentially due to the alloy's highly disordered nature. Magnetic measurements confirmed a transition temperature of 7.4 K, with a distinct paramagnetic-to-diamagnetic shift, indicating a strong demagnetisation effect. This compound was identified as a type-II superconductor, with a lower critical field (H_{c1}) value of 19 milli-Tesla at 1.8 K, highlighting its potential for high-field applications.

Employment

Jan 2025 – Present
- **Teaching Assistant for the course PHYS 2514 (General Physics for Engineering and Science Majors), The University of Oklahoma.**
  Serve as a Teaching Assistant for PHYS 2514 at the University of Oklahoma, conducting four discussion sections per week with approximately 40 students per section. Lead problem-solving sessions that reinforce core physics concepts, provide detailed conceptual explanations, and guide students through analytical approaches to quantitative problems. Support students in strengthening their conceptual clarity, critical thinking, and application skills through interactive discussions and structured problem-solving strategies.

July 2025 – Dec 2025
- **Grader for courses PHYS 3223 (Modern Physics for Engineers), PHYS 1114 (General Physics for Non-Science Majors.), The University of Oklahoma.**
  As a grader for these courses, I was responsible for evaluating exams, interacting with students to discuss areas for improvement, and holding office hours to clarify their conceptual doubts.

June 2024 – June 2025
- **Physics Lecturer, Allen Carrer Institute (Chennai, India).**
  I was Placed as a Physics Lecturer at Allen Career Institute through campus placement at IIT Madras, I was posted at Allen Ambattur, Chennai, where I handle Leader Batches (one-year droppers) for JEE Advanced preparation.

Skills

Experimental Skills
- Arc melting technique, X-ray diffraction (XRD), SQUID magnetometry, Physical Property Measurement System (PPMS), four-probe electrical measurements, and ball milling and sintering methods.

Languages
- Strong reading, writing and speaking competencies for English, Hindi.

Coding
- Python,C, C++, Mathematica, LaTeX.

Misc.
- Academic research, teaching, training, consultation, LaTeX typesetting and publishing.

Awards and Achievements

2025
- **Quantum Technology Graduate Fellowship**, awarded by the Homer L.Dogde Department of Physics and Astronomy, University of Oklahoma.

2023–2024
- **Qualified GATE Physics Examination** (Graduate Aptitude Test in Engineering), a prestigious national-level examination; qualified consecutively in 2023 and 2024.

2022
- **Qualified JAM Examination** (Joint Admission Test for Master's).

2019
- **TATA Group Fellowship**, awarded for undergraduate studies based on an exceptional educational record.

2017
- **Certificate of Merit**, Central Board of Secondary Education (CBSE), for achieving an A grade in all five core subjects during high school.

2016
- **International Olympiad Rank 1735** and **State Rank 114 in Haryana**, Science and Mathematics International Talent Hunt Olympiad, with a score of 60.448/100.

Positions of Responsibility

2019–2020 ◇ **Cultural President**, Delhi University Students' Union (DUSU), University of Delhi.
Coordinated activities of various student-run clubs including music, dance, debating, fashion, and UPSC clubs. Prepared and managed budgets for all cultural events, and supported the planning and execution of various sports and cultural events.

2020–2021 ◇ **Sports President**, Delhi University Students' Union (DUSU), University of Delhi.
Supported the organisation and smooth conduct of various inter-college and intra-college sports events.

2024 – present ◇ **Physics Educator**, YouTube Channel.
Managing a YouTube channel dedicated to teaching physics concepts to students.

References

◇ **Prof. K. Sethupathi**
Department of Physics, Indian Institute of Technology Madras.
`Faculty Profile` | `ksethu@iitm.ac.in`

◇ **Prof. Somnath Chanda Roy**
Department of Physics, Indian Institute of Technology Madras.
`Lab Website` | `somnath@physics.iitm.ac.in`