

# Shinjan Mandal

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## Summary

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I am a doctoral candidate at the Indian Institute of Science, Bangalore, studying the transport properties of quantum materials using a combination of atomistic modelling and first-principles calculations.

## Education

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**2018 - present**    **PhD** at Indian Institute of Science (IISc), Bangalore  
Advisor: Manish Jain  
Thesis title: Interplay of Electrons and Phonons in 2D Materials  
**2017 - 18**        **MSc in Physics** at IISc, Bangalore  
**2013 - 17**        **BSc(Research) with major in Physics** at IISc, Bangalore

## Research Works

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### Publications

- [1] P. S. Mahapatra, B. Ghawri, M. Garg, **Shinjan Mandal**, K. Watanabe, T. Taniguchi, M. Jain, S. Mukerjee, and A. Ghosh. “**Misorientation-controlled cross-plane thermoelectricity in twisted bilayer graphene**”. In: *Physical Review Letters* 125.22 (2020), p. 226802. DOI: 10.1103/PhysRevLett.125.226802.
- [2] B. Ghawri, P. S. Mahapatra, M. Garg, **Shinjan Mandal**, S. Bhowmik, A. Jayaraman, R. Soni, K. Watanabe, T. Taniguchi, H. R. Krishnamurthy, M. Jain, S. Banerjee, U. Chandni, and A. Ghosh. “**Breakdown of semi-classical description of thermoelectricity in near-magic angle twisted bilayer graphene**”. In: *Nature communications* 13.1 (2022), p. 1522. DOI: 10.1038/s41467-022-29198-4.
- [3] B. Ghawri, P. S. Mahapatra, M. Garg, **Shinjan Mandal**, A. Jayaraman, K. Watanabe, T. Taniguchi, M. Jain, U. Chandni, and A. Ghosh. “**Non-Boltzmann thermoelectric transport in minimally twisted bilayer graphene**”. In: *Physical Review B* 109.4 (2024), p. 045436. DOI: 10.1103/PhysRevB.109.045436.
- [4] M. K. Jat, P. Tiwari, R. Bajaj, I. Shitut, **Shinjan Mandal**, K. Watanabe, T. Taniguchi, H. R. Krishnamurthy, M. Jain, and A. Bid. “**Higher-order Bragg gaps in the electronic band structure of bilayer graphene renormalized by recursive supermoiré potential**”. In: *Nature communications* 15.1 (2024), p. 2335. DOI: 10.1038/s41467-024-46672-3.
- [5] S. Sett, R. Debnath, A. Singha, **Shinjan Mandal**, Jyotsna KM, V. Raghunathan, M. Bhakar, G. Sheet, M. Jain, and A. Ghosh. “**Emergent inhomogeneity and non-locality in a graphene field-effect transistor on a near-parallel moiré superlattice of transition metal dichalcogenides**”. In: *Nano Letters* (2024). DOI: 10.1021/acs.nanolett.4c01755.
- [6] K. P. Bera<sup>†</sup>, D. Solanki<sup>†</sup>, **Shinjan Mandal**<sup>†</sup>, R. Biswas, T. Taniguchi, K. Watanabe, V. Raghunathan, M. Jain, A. Sood, and A. Das. “**Twist Angle Dependent Phonon Hybridization in WSe<sub>2</sub>/WSe<sub>2</sub> Homobilayer**”. In: *ACS Nano* (2024). (†equal contribution). DOI: 10.1021/acsnano.4c06767.
- [7] **Shinjan Mandal**, I. Maity, H. R. Krishnamurthy, and M. Jain. “**Phonon Linewidths in twisted bilayer graphene near Magic Angle**”. In: *Physical Review B (in press)* (2024).

### Submitted

- [8] R. Dutta, A. Ghosh, **Shinjan Mandal**, K. Watanabe, T. Taniguchi, S. Banerjee, H. R. Krishnamurthy, M. Jain, and A. Das. “**Electric field tunable superconductivity in near magic angle twisted bilayer graphene**”. In: *arXiv:2402.11649* (2024).
- [9] S. Kumbhakar, T. K. Maji, B. Tongbram, **Shinjan Mandal**, S. H. Soundaraj, B. Debnath, T. P. Sai, M. Jain, H. R. Krishnamurthy, A. Pandey, and A. Ghosh. “**Engineering ultra-strong electron-phonon coupling and nonclassical electron transport in crystalline gold with nanoscale interfaces**”. In: *arXiv:2405.14684* (2024).
- [10] **Shinjan Mandal**, S. H. Soundararaj, M. Jain, and H. R. Krishnamurthy. “**Possibilities for enhanced electron-phonon interactions and high-T<sub>c</sub> superconductivity in engineered Au-Ag nano-structures**”. In: *arXiv:2408.15820* (2024).

## Under Preparation

- [11] D. Solanki, K. P. Bera, **Shinjan Mandal**, M. Jain, A. Sood, and A. Das. “**Evolution of G and 2D Raman Modes in Twisted Bilayer Graphene**”. In: *Under Preparation* (2024).
- [12] **Shinjan Mandal**, I. Maity, H. R. Krishnamurthy, and M. Jain. “**PARPHOM: PARallel PHOnon calculator for Moiré systems**”. In: *Under Preparation* (2024).
- [13] R. Soni, S. Datta, R. Bajaj, S. Bhowmik, **Shinjan Mandal**, K. Watanabe, T. Taniguchi, M. Jain, and C. Usha. “**Enhanced Phonon-Assisted Tunneling in Metal - Twisted Bilayer Graphene Junctions**”. In: *Under Preparation* (2024).

## Softwares Developed

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### PARPHOM: PARallel PHOnon calculator for Moiré systems

A massively parallel Python/FORTRAN hybrid package interfaced with LAMMPS, that computes the force constants in moiré systems, and uses that information to compute the phonon spectra

### ELPHONSO: ELection PHONon SOLver

FORTRAN package with hybrid parallelization (MPI+OpenMP) to compute the electron phonon coupling coefficients in systems with large number of atoms. A tight binding code written exclusively to handle large systems is an accessory to this project.

## Teaching Experience

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TA for PH203: Quantum Mechanics I Nov 2020 - Feb 2021, Aug 2021 - Dec 2021  
TA for PH320: Condensed Matter Physics II Aug 2022 - Dec 2022  
TA-ship duties included conducting regular tutorial sessions and grading assignments for a mixed class of undergraduate and graduate students in PH203 and a class of advanced graduate students in PH320.

## Skills

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General Computational Proficiency    FORTRAN, Python, Matlab, Mathematica  
Extensive experience in MPI and OpenMP parallelization  
Specialized Softwares                    LAMMPS, Quantum Espresso, Wannier90, EPW

## Academic Highlights

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DCOMP Travel Award APS March Meeting, 2024 2024  
Senior Research Fellowship, Department of Science and Technology, India 2020  
Junior Research Fellowship, Department of Science and Technology, India 2018  
MP Birla Award (for securing a rank of 9 among ~ 600,000 students in WBCHSE) 2013  
KVPY Scholarship, Department of Science and Technology (Awarded to ~ top 250 students across India) 2012

## Conferences and Talks

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APS March Meeting, 2024, Minneapolis, USA [Talk] March, 2024  
Workshop on moiré materials, ICTP, Italy [Talk] Jan, 2024  
Recent Progress in Graphene Research, Bangalore, India [Talk] Nov, 2023  
NAMMA Psi-K, JNCASR & IISc, Bangalore, India [Poster] July, 2023  
Indo-Israel Meeting, Weizmann Institute of Science, Rehovot, Israel [Poster] July, 2023  
APS March Meeting, 2022 (online) [Talk] March, 2022  
Novel Phases of Quantum Matter, ICTS, Bangalore, India [Poster] Dec, 2019

## References

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Prof. Manish Jain Department of Physics Indian Institute of Science mjain@iisc.ac.in	Prof H R Krishnamurthy Department of Physics Indian Institute of Science hrkrish@iisc.ac.in	Prof. Anindya Das Department of Physics Indian Institute of Science anindya@iisc.ac.in
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