

# Shivam Nitin Kajale

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Ph.D. candidate specializing in nanoelectronics and superconducting devices for energy-efficient computing. Skilled in cleanroom nanofabrication, material characterization, and automation. Proven track record in van der Waals spintronic devices, AI hardware accelerators, and custom instrumentation.

## Education

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**Present: Doctor of Philosophy (Ph.D.) in Media Arts and Sciences** (Electronics and Materials Science)

Massachusetts Institute of Technology, Cambridge, MA

- Awarded the MIT-HPI Design for Sustainability Grant for AI hardware innovation.
- Research on field-free switching of vdW magnets led to two high-impact publications.

**2023: Master of Science (S.M.) in Media Arts and Sciences**

CGPA: 4.95/5.00

Massachusetts Institute of Technology, Cambridge, MA

- Thesis: Study of vdW magnetic materials for spintronic applications

**2020: Dual Degree (B.Tech+M.Tech) in Electrical Engineering**

CGPA: 9.33/10.00

Indian Institute of Technology Bombay, Mumbai, India

- Ranked 1st in Electrical Engineering (Microelectronics) cohort.
- Thesis: Interaction of Surface Acoustic Waves and Magnetization

## Experiences

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**2025-Present: Systems Engineering Intern** — Cerebras System, Inc., CA

- Working across post-silicon bring-up and system engineering processes

**2021-Present: Research Assistant** — MIT, Cambridge, MA

Guide: Prof. Deblina Sarkar

- Developed the **first all-van der Waals** spin-orbit torque device for **field-free**, electrical switching of van der Waals magnets above room temperature for application in advanced MRAM and eNVM technologies.
- Designed **brain-inspired hardware accelerator** using stochastic magnetic tunnel junctions (s-MTJs), achieving random number generation 5000× more energy-efficiently than state-of-the-art algorithms for AI applications.
- Performed light penetration Monte-Carlo and heat transfer simulations to study thermal effects of photovoltaic neural implants, and their application in wireless biphasic stimulation of the brain through compact modelling and SPICE simulations
- Fabricated vdW spintronic devices using **cleanroom techniques**, including e-beam lithography, photolithography, sputtering, dry transfer, and etching, to achieve atomically smooth interfaces and precise device geometries.
- Executed extensive **electrical transport measurements**, including Hall, higher harmonic, magneto-transport, and I-V characterizations, to probe switching and magnetic properties of vdW devices, using **magnetic cryostats** and **self-developed LabVIEW** instrumentation and automation platforms.
- Built and utilized custom **micrometer resolution** magneto-optical Kerr effect (**MOKE**) setups (polar and longitudinal modes) and **FMR** system for accurately probing magnetic thin-films.
- Designed and built a cost-effective 2D material transfer system (4X cheaper than commercial options), enabling micrometer-precision placement of air-sensitive vdW flakes inside a glovebox for novel devices fabrication.

**2020: Digital Hardware Design Engineer** — Intel Corporation, Bangalore, India

- Design and verification of DFX logic of AI oriented graphics core in the Alder Lake SoC

**2019-20: Research Assistant** — IIT Bombay, India

Guide: Prof. Ashwin Tulapurkar

- Developed a finite-element method (FEM)-based simulation framework in **COMSOL Multiphysics** to model interactions between surface acoustic waves (SAWs) and magnetization in **piezoelectric and magnetic materials**.
- Implemented the Landau-Lifshitz-Gilbert (LLG) equation within COMSOL's mathematical module to enable

simulations of magnetization dynamics, **extending the platform's capabilities** for coupled magneto-dynamic, elasto-dynamic, and electrostatic analyses.

- Designed and **optimized interdigitated transducers** (IDTs) for efficient SAW generation, using parametric studies to improve energy conversion and validated results against analytical models
- Demonstrated coupled magnetoelastic phenomena, including acoustically-driven ferromagnetic resonance (ADFMR) and magnon-driven elastic wave propagation, providing insights into applications in spintronics.

**2018: Research Intern** — Purdue University, IN

*Guide: Prof. Pramey Upadhyaya*

- Built a simulation suite to study ferromagnetic nanoscale microwave source using LLG equation, driven by oscillating voltage, and induced Rabi oscillation in a qubit subjected to the nanomagnet's microwave field
- Developed a theoretical model for a room temperature voltage based driver for NV-centre qubits for quantum computing applications

**2017: Computer Vision Intern** — Superbolter™, Bangalore, India

- Designed and built a Python-based computer vision toolkit for a virtual reality interior designing platform
- Image processing utilizing OpenCV for segmenting RGB floorplans to create input for 3D virtual reality (VR) renditions of the spaces.

## Technical Skills

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**Nanofabrication:** Photolithography, e-beam lithography, 2D dry-transfer, atomic layer deposition, E-Beam deposition, sputter deposition, pulsed laser deposition, reactive ion etching, FIB lithography & sectioning

**Characterisation:** SEM, TEM, EDS, AFM, XRD, Raman, Magneto-transport, MOKE, Transistor I-V

**Programming:** LabVIEW, Python, MATLAB, VHDL, Verilog, C++, L<sup>A</sup>T<sub>E</sub>X, HTML

**Software:** COMSOL Multiphysics, Quantum Espresso, Cadence Virtuoso, Altera Quartus, OOMMF

## Awards & Achievements

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**2025:** GMAG Student Travel Award, American Physical Society (APS) for attending APS March Meeting 2025

**2023, 2024:** Secured the MIT-HPI **Design for Sustainability Award**, two years in a row (total \$300,000), for the design of brain-inspired low-energy computing devices for AI applications

**2022:** Delivered a talk at **TEDxBoston's** Planetary Stewardship forum, titled "A new race: making computation sustainable", creating awareness on the environmental impact of large scale AI and computation.

**2020:** Akshay Dhole Memorial Award for securing **Rank 1** in Electrical Engineering - Microelectronics batch of 2020, IIT Bombay

**2018:** Nominated as the **Indian delegate to the Metropolitan Environmental Resource Management (MERM)** camp at Chulalongkorn University (CU), Bangkok. Awarded **first prize** for focus report on **Indoor Air Pollution mitigation**

**2015:** All India Rank (AIR) 296 in IIT JEE-Advanced out of 150 thousand candidates

**2014:** Awarded fellowship for pursuing research under Kishore Vaigyanik Protsahan Yojana (KVPY), with AIR 191, by Department of Science & Technology of the Government of India

**2011:** Granted scholarship under National Talent Search Exam, by the Government of India

## Publications

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[11] Jang K., Kajale S.N., Joy B., Bono D.C., Neltner B., Sarkar D., "CircTrek: A wearable device for continuous monitoring of circulating cells at single-cell resolution", 2025 (*accepted at npj Biosensing*)

[10] Kajale S.N., Nguyen T., Hung N.T., Li M., Sarkar D., "Field-free deterministic switching of all-van der Waals spin-orbit torque system above room temperature", **Science Advances**, 10, eadk8669 (2024)

[9] Kajale S.N., Nguyen T., Chao C.A., Bono D.C., Boonkird A., Li M., Sarkar D., "Current-induced deterministic switching of van der Waals ferromagnet at room temperature", **Nature Communications** 15, 1485 (2024)

- [8] Kajale S.N., Hanna J., Jang K., Sarkar D., "Two-dimensional magnetic materials for spintronic applications", **Nano Research** 17, 743–762 (2024)
- [7] Ryu J., Kajale S.N., Sarkar D., "Van der Waals magnetic materials for current-induced control toward spintronic applications", **MRS Communications** 14, 1113–1126 (2024)
- [6] Yadav S., Lee R., Kajale S., Joy B., Saha M., Bull Loey., Cao Sarah., Mitragotri S., Bono D., Sarkar D., "Non-surgical Bioelectronic Implant for Targeted Focal Brain Stimulation", 2024 (*under review at Nature Biotechnology*)
- [5] Rustagi A., Kajale S.N., Upadhyaya P. "Manipulating quantum impurity spins via dynamical modes of nanomagnets", 2022 (*under review at Applied Physical Letters*, arXiv: 2203.03652)
- [4] Verma S., Kajale S., Gomez-Bombarelli, R "Machine learning for accurate and fast bandgap prediction of solid-state materials", 2022 IEEE High Performance Extreme Computing Conference (**IEEE HPEC**), pp. 1-2, 2022
- [3] Kajale S.N., Yadav S., Cai Y., Joy B., Sarkar D. "2D material based field effect transistors and nanoelectromechanical systems for sensing applications", **iScience** , Volume 24, Issue 12, 103513, 2021
- [2] Rustagi A., Solanki A. B., Kajale S., Bogdanov S., Dilley N. R., Shen T., Debashis P., Chen Z., Appenzeller J., Chen Y., ShalaeV. M., Upadhyaya P. "Quantum-classical spin hybrids: leveraging spintronic tools for information processing applications", Proc. SPIE 11470, **Spintronics XIII**, 114702B, 2020
- [1] Kajale, S.N., "Interaction of Surface Acoustic Waves and Magnetisation". 2020. IIT Bombay, M.Tech. Thesis

## Seminars and Conferences

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**Dec, 2024:** Poster presentation at the **38th NeurIPS Conference** workshop on Machine Learning with New Computing Paradigms (**MLNCP**), titled "Energy-efficient random number generation using stochastic MTJs"

**Jun, 2024:** Oral presentation at the 24th International Conference on the Science and Applications of Nanotubes and Low-Dimensional Materials (**NT24**), titled "Field-free deterministic switching of a van der Waals ferromagnet above room temperature"

**Jun, 2024:** Delivered a talk at the Spintronics Seminar series hosted by Trinity College Dublin

**Apr, 2024:** Seminar talk titled "Propelling van der Waals magnets towards energy-efficient spintronics" at the NanoBio Seminar Series at MIT

**Jan, 2024:** Poster presentation at the Microsystems Annual Research Conference (MARC) 2024

## Service and Mentorship

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**2025:** Served on MIT's Microsystems Annual Research Conference (MARC 2025) committee as a Session Chair

**2024:** Mentored a visiting scholar from TU Delft through his Masters thesis work at MIT

**2023:** Voluntary appointment as a Teaching Assistant for the Life Nanomachine Symbiosis (MAS.S66) course

**2021-Present:** Trained and mentored five undergraduate students through MIT's Undergraduate Research Opportunities Program (UROP)

**2017-18:** Served as General Secretary of Electrical Engineering Students' Association, IIT Bombay and organised events like freshmen orientation, quizzes, sports meets, valedictory function and the annual department festival Avritti