Neelanchal Joshi

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Research Interests

Helioseismology, Inertial Modes in the Sun, Solar Flows, Machine Learning, Computational Astrophysics

Education

Max Planck Institute for Solar System Research • Göttingen, DE — August 2022 – Present
PhD (Physics, University of Göttingen) • Advisors: Laurent Gizon, ZC Liang, Damien Fournier
Thesis: Measuring multiscale solar flows using local correlation tracking - Applications to SDO/HMI and preparation for the ESA Vigil/PMI Mission
External Student Representative – PhDNet

Birla Institute of Technology and Science Pilani • Pilani, RJ — July 2017 – July 2022
M.Sc. (Physics), B.E. (Electrical and Electronics) • CGPA: 8.28/10.0
Master's Thesis: Solar Magnetogram Generation using Deep Learning
Bachelor's Thesis: Estimating structural and dynamical parameters for Red Giants using MCMC Simulations

Kendriya Vidyalaya ONGC • Dehradun, UK — April 2015 – March 2017
Senior Secondary Certificate • Percentage: 97.6%, 100/100 in English, Chemistry

Research Experience

Doctoral Researcher – Max Planck Insitute for Solar System Research — Aug 2022 – Present
Solar Physics, Inertial Modes

- Developed an LCT pipeline to detect, extract and characterize Solar Inertial Modes in the SDO/HMI dataset
- Integrated image-processing and big-data workflows to analyse ∼1TB of solar image data per year since 2010
- Performed a comprehensive study to establish the flow sensitivity of ESA's upcoming Vigil/PMI instrument

Research Intern – Tata Institute of Fundamental Research — June 2021 – July 2022
Machine Learning, Solar Physics

- Worked at the Seismology Group on machine learning applications in Helio- and Asteroseismology
- Implemented conditional GANs to translate a century's worth of Ca II K spectroheliograms into Magnetograms
- Generated magnetograms will be subsequently used to study the evolution of sun's polar field and tilt angles
- Used MCMC simulations to estimate structural and dynamical parameters for stars using PSD observations

Research Intern – Institute of Seismological Research — May 2019 – July 2019
Seismology, Data Analysis

- Wrote a MATLAB standalone package to compute the source parameters for Earthquakes in Kuttch, Gujarat
- The testing was done using past earthquake signals and the results were verified using seismic scaling relations
- The package helped in probabilistic earthquake forecasting and zoning of various vulnerable areas in Gujarat
- Remodeled the existing processing framework from FORTRAN to MATLAB for speed and compatibility

Referred Publications

- **Joshi, N.**, Liang, Z.-C., Fournier, D., Mandowara, Y., Bogart, R. S., Mukhopadhyay, S., & Gizon, L., "Horizontal velocity eigenfunctions of solar inertial modes using local correlation tracking of magnetic features", *submitted to Astronomy & Astrophysics*, 2026.
- **Joshi, N.**, Liang, Z.-C., & Gizon, L., "A synthetic parameter analysis of correlation tracking of granulation and magnetic features for the PMI instrument", *in preparation*, 2026.

Conference Proceedings

- **Joshi, N.**, Kalgaonkar, P., "Implementation of CCSDS Hyperspectral Image Compression Algorithm on FPGA on-board a nanosatellite", *European Conference for Aeronautics and Space Sciences*, Spain, 2019
- Prasad, A., Jain, Y., **Joshi, N.**, Gupta, N., Singhania, V., and Sreedharan, Y., "Interfacing Architecture between Telemetry and On-Board Computer for a Nanosatellite", *IEEE Aerospace Conference*, USA, 2020
- **Joshi, N.**, Liang, Z.C., Fournier, D., Gizon, L. "Observations of eigenfunctions of solar inertial modes using local correlation tracking of magnetic features", *International Conference on Mathematical and Numerical Aspects of Wave Propagation*, Germany, 2024
- **Joshi, N.**, Liang, Z.-C., Fournier, D., & Gizon, L., "Observing solar inertial modes using local correlation tracking", *SDO 2025 Science Workshop: A Gathering of the Helio-hive!*, 2025.

Technical Skills

- **Operating Systems**: Mac OS, Linux, Windows, Petalinux
- **Programming languages**: Python, C, C++, JavaScript, HTML, Assembly Language, Verilog, Linux/Unix Shell
- **Frameworks**: Tensorflow, PyTorch, Astropy, Pandas, NumPy, Keras, OpenCV, MPI, Pillow, Qiskit, SciPy, Emcee, Matplotlib, Jupyter, Spyder, LaTeX, MATLAB, Simulink, LTspice, Microwind, ModelSim, Xilinx Vivado

Projects

A Study of Image Sentiment and Visual Attention – Dept. of EEE, BITS Pilani Sept 2020 - Nov 2020
Pilani, RJ

- Implemented a Deep Neural Network using 2 VGG Streams along with a subnetwork using Keras
- Aim was to evaluate how sentiment and emotional prioritization effect in images relates to human attention
- Extensively analysed various subnetworks using EMOd and CAT2000 datasets on MIT Saliency Benchmarks

Design of a Co-Processor for RISC V Architecture – Dept. of EEE, BITS Pilani Jan 2020 - May 2020
Pilani, RJ

- Modelled a RISC-V co-processor implementing a compression algorithm by extending the ISA of the processor
- Designed a controller and memory layout for the co-processor implementing CCSDS 123 compression algorithm
- Performed behavioural simulations on the hyperspectral compression algorithm IP using Verilog test benches

Quantum Chaos and Many-body Quantum Scarring – Dept. of Physics, BITS Pilani Jan 2021 - May 2021
Pilani, RJ

- Studied Lagrangian and Hamiltonian Formalism of chaotic classical and quantum dynamical systems
- Analysed the time evolution of the Kicked Top and Rotor systems to find scarred quantum states numerically
- Wrote programs to visualise the Husimi distribution of the scarred eigenstates with lowest IPR using Python

Adaptive Backstepping Controller Design for UAVs – Dept. of EEE, BITS Pilani Jan 2021 - May 2021
Pilani, RJ

- Designed an adaptive backstepping controller for damaged UAVs to control the sideslip angle and roll rate
- The controller performed well under a shift in COG, thereby allowing reasonable control of damaged UAVs

Extra Curricular Activities

Lead, On-Board Computing – Team Anant Mar 2018 - May 2020
BITS Pilani

- Head of a 6 member subsystem at Team Anant, the official student satellite team of BITS Pilani
- Collaborated with ISRO for critical design review and verification as a part of their Student Satellite Program
- Designed the hardware architecture of the satellite and implemented the compression algorithm on an FPGA
- Devised the Telemetry-OBC inter-subsystem protocols and performed various other system engineering tasks

Coordinator – Department of Paper Evaluation and Presentation, APOGEE Mar 2019 - May 2020
BITS Pilani

- Head of a 35-Member team which conducts the one of the oldest Paper Presentation Events in India
- Conducted Scientia, a lecture series for 750+ students, facilitating deliberation on science and technology
- Responsible for organising scientific guest-lectures during the university's technical festival, APOGEE

Introduction to Quantum Computing Course – The Coding School Oct 2020 - May 2021
IBM Quantum

- Completed a course on Quantum Computing by The Coding School in collaboration with IBM Quantum
- Learnt the theory behind QIC using IBM Quantum Experience with a focus on Qiskit-based programming

Technical Lead and Founding Member – The Opportunity Project Mar 2020 - May 2021
BITS Pilani

- Lead a 20-member team's technical efforts towards building an experiential learning discovery platform
- Built a web-based product connecting 1000+ curated opportunities to 500+ users across BITS Pilani and IITs

Achievements

- Awarded the **INSPIRE Scholarship for Higher Education** by the Government of India for academic excellence
- Received a **Letter of Commendation** from the Hon. HRD Minister Smriti Irani for outstanding academic record
- Part of the Indian Delegation invited by the Japanese Govt under the **Sakura Science Exchange Program**