Vishal Upendran

https://vishal-upendran.github.io/
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Research interests

- **Solar/stellar atmosphere**: Dynamics of the solar/stellar atmospheres especially relating to the formation and evolution of energetic events (flux emergence, solar/stellar flares, jets, plumes, etc) and atmospheric/coronal heating. Statistical studies using remote sensing measurements in the form of spectroscopy/photometry/spectropolarimetry.
- **Heliosphere and space weather**: Solar wind emergence, acceleration and propagation; Heliospheric transient events across various scales; Space weather studies, modelling and forecasting. Studies relating remote sensing measurements to in-situ measurements. Space weather and stellar wind - magnetospheric interactions of exoplanets.
- **Near-Earth dynamics**: Magnetospheric forcing by the solar wind, internal magnetospheric dynamics, geomagnetic storms.
- **Simulations:** Magnetohydrodynamic simulation in astrophysical context, particularly for solar atmospheric dynamics; Radiative transfer studies.
- **Big data**: Application of Information theory, Computer vision, Machine learning & Deep learning to various aspects of astrophysics, with focus towards developing forecasting, inversion and open source pipelines using explainable and physics inspired models.

Employment and experience

- **SETI Institute**
  Research Scientist *Feb 2025 – Present*
- **Bay Area Environmental Research Institute**
  Research Associate *April 2023- Feb 2025*
- **Frontier Development lab**
  Faculty *June 2023 – Sept 2023*
  Lead the FDL-X team of 'Multiscale Geoeffectiveness', culminating in the development of an end-to-end Sun to the solar wind to global geomagnetism forecaster.

Education

- **Inter University Centre for Astronomy and Astrophysics, Pune**
  PhD in Astrophysics, Guide: Prof. Durgesh Tripathi, IUCAA. *July 2018-March 2023*
  Thesis: Heating and dynamics of the solar atmosphere
- **Indian Institute of Technology – Madras, Chennai, India**
  Dual degree: B.Tech (Engineering design) + M.Tech (Biomedical design), Minor in Physics *July 2013- July 2018*
  CGPA: 9.17/10.0
  Masters Thesis: Solar wind prediction and modelling using deep learning methods.

Research grants

- **2025**: Awarded the **NASA-ROSES Heliophysics Guest Investigator** grant for the project "Understanding solar wind formation and source region localization using interpretable deep learning" as **Principal Investigator**.
- **2023**: Awarded the **Indo-French Center for the Promotion of Advanced Research grant** for the project " Investigating the origin of switchbacks in the solar corona via interchange reconnection - A statistical and multi-instruments approach including machine learning" as **Collaborator**, with P.I Prof. Durgesh Tripathi and Dr. Clara Froment.
- **2022**: Awarded the **ISRO-RESPOND grant** for the project "Solar Flares: Physics and Forecasting for better understanding of Space Weather" as **Co-Principal Investigator**.
- **2021**: Awarded the **Nvidia Academic Hardware grant** for the project "Solar wind source region estimation using deep learning" as **Principal Investigator**.

Awards and honours

- Awarded the **K.D Abhyankar best thesis presentation** at the **Astronomical Society of India meeting - 2024** for thesis titled "Heating and dynamics of the solar atmosphere".
- Awarded the **International Astronomical Union** grant of **2000 Euros** for giving two contributed talks at the IAU General Assembly 2022 in Busan, South Korea.
- Awarded the **Outstanding Student Presentation Award (OSPA)** at the American Geophysical Union meeting 2021.
- Offered a fully-funded summer internship program at NASA-SETI **Frontier Development Lab** (FDL) 2020. Developed **DAGGER**: An open source geomagnetic perturbation forecasting pipeline using deep learning as a part of the program in a team of 4 researchers, 2 leads and 3 mentors over the course of 8 weeks.

- Offered Junior Research Fellowship by Council of Scientific and Industrial Research – University Grants Commission, India for pursuing research in India.
- **DAAD-WISE scholar 2016**: One among the 170 students selected from 3000 students across all over India to perform research at a premier institute in Germany for 80 days.

Mentoring and supervision

- **Mentoring ISRO-RESPOND project & Ph.D. thesis of Mr. Linn Abraham** **May 2023 – Present**
  ISRO Respond project: Solar flare forecasting using interpretable deep learning
  Supervisor: Prof. Durgesh Tripathi
- **Mentoring the ISRO Respond project of Mr. Deepak Kathait** **May 2023 – Present**
  Thesis title: Understanding the physics of solar flares
  Supervisor: Prof. Durgesh Tripathi
- **Mentoring the Ph.D thesis of Mr. Biswanath Malaker** **July 2021 – Present**
  Thesis title: Multi-wavelength Observations of Polar Plumes and Jets
  Supervisor: Prof. Durgesh Tripathi
- **Supervised the internship of Mr. Pranava Seth** **April 2023 – Nov 2024**
  Project title: An Artificial Intelligence (AI) based chromospheric feature extractor and classifier for SUIT
- **Mentored the internship of Mr. Archit Dubey** **May 2023– Aug 2023**
  Project title: Effect of mesh size on diffraction in Multislit Solar Explorer
  Supervisor: Dr. Bart de Pontieu / Dr. Gary Kushner
- **Mentored the Master's thesis of Ms. Kajal Kesare** **Oct 2021– June 2022**
  Thesis title: Quantifying information transfer due to solar wind from the Sun to 1 AU
  Supervisor: Prof. Durgesh Tripathi

Press releases

- **NASA-enabled AI Predictions May Give Time to Prepare for Solar Storms** **Mar 2023**
  NASA press release by Vanessa Thomas
  `https://www.nasa.gov/feature/goddard/2023/sun/nasa-enabled-ai-predictions-may-give-time-to-prepare-for-solar-storms`
- **Keeping Tabs on the Quiet Sun** **Aug 2021**
  AAS Nova by Susanna Kohler
  `https://aasnova.org/2021/08/09/featured-image-keeping-tabs-on-the-quiet-sun/`

Services

- Panel member for NASA funding proposal evaluation committe.
- Invited reviewer for ISRO-RESPOND funded projects.
- Reviewer for articles in AGU: Spaceweather.
- Reviewer for articles in The Astrophysical journal.
- Reviewer for articles in Frontiers in Astronomy and Space Sciences.
- Reviewer for articles in RAS Techniques and Instruments.
- Reviewer for articles in Solar Physics.

Teaching experience

- **Introductory Summer School in Astronomy and Astrophysics** **June 2022**
  Python and Machine learning lectures
- **Introduction to Astronomy and Astrophysics II** **Jan 2022–March 2022**
  Teaching assistant to Prof. Durgesh Tripathi, IUCAA
- **Introductory Summer School & Refresher Course in Astronomy and Astrophysics** **June 2021**
  Python and Machine learning lectures
- **Science of the star in our backyard: Introduction and data analysis** **26 Dec 2019–29 Dec 2019**
  Hands–on data analysis session
- **Teaching Assistant to Prof. M. Ramanathan and Prof. G. Saravanakumar, IIT Madras** **Jan 2018–May 2018**
  Taught Geometric and 3D modelling at Dept. of Engineering Design, IIT Madras
- **Teaching Assistant to Prof. M. Ramanathan, Dept. of Engineering design, IIT Madras** **June 2017–Dec 2017**
  Taught C language at Dept. of Engineering Design, IIT Madras

Professional activities and position of responsibilities

- **"Deep learning in solar physics" meeting at Rosseland Centre for Astrophysics, Oslo, Norway** **2024 – 2025**
  Invited member

- **International Space Science Institute team** **2024 – 2025**
  Invited member
  Invited for the team "Quantitative comparisons of solar surface flux transport models"
- **SUIT - Aditya L1 science working group** **2022 – Present**
  Group leader
  Leading one of the SUIT science working groups for chromospheric studies.
- **CosmicVarta** **Sep 2021 – Dec 2024**
  Editorial team member
  CosmicVarta is a science popularization initiative by graduate students based in India. We bring out the state of the art research done by researchers in India to the general public in the form of popular science articles and interviews.
- **5th Asia-Pacific Solar Physics Meeting** **Sep 2019 – Feb 2020**
  Local Organizing Committee member
- **Horizon: The Physics and Astronomy club, IIT Madras** **2016–2017**
  Lead the Astronomy and physics club at IIT Madras as club head.
- **Design and Media team – IIT Madras** **2015–2016**
  Lead the official Design team of IIT Madras as co-head.
- **Design and Media – The Fifth Estate, IIT Madras** **2015–2016**
  Lead the Design team of student media body of IIT Madras as a co-head.

Publications

1. Jithu Athalathil, Bhargav Vaidya, Sayan Kundu **Vishal Upendran**, Mark Cheung, Surface Flux Transport Modelling using Physics Informed Neural Networks, 2024 ApJ 975 258. https://iopscience.iop.org/article/10.3847/1538-4357/ad7d91.
2. Biswanath Malaker, **Vishal Upendran** and Durgesh Tripathi, Thermodynamic Evolution of Plumes, 2024 ApJ 974 163. https://iopscience.iop.org/article/10.3847/1538-4357/ad6c4b
3. **Vishal Upendran**, Durgesh Tripathi, Mithun N.P.S, Santosh Vadawale, Anil Bhardwaj, Nanoflare Heating of the Solar Corona Observed in X-rays, 2022 ApJL 940 L38. https://iopscience.iop.org/article/10.3847/2041-8213/aca078.
4. **Vishal Upendran**, Panagiotis Tigas, Bashi Ferdousi, Téo Bloch, M.C.M Cheung, Siddha Ganju et. al. 2022. Global geomagnetic perturbation forecasting using Deep Learning. Space Weather, 20, e2022SW003045. https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2022SW003045
5. **Vishal Upendran** and Durgesh Tripathi 2022. On the formation of solar wind & switchbacks, and quiet Sun heating. ApJ 926 138. https://iopscience.iop.org/article/10.3847/1538-4357/ac3d88
6. **Vishal Upendran** and Durgesh Tripathi 2021. Properties of the C II 1334 Å line in Coronal Hole and Quiet Sun as Observed by IRIS. ApJ 922 112. https://iopscience.iop.org/article/10.3847/1538-4357/ac2575.
7. **Vishal Upendran** and Durgesh Tripathi 2021. On the Impulsive Heating of Quiet Solar Corona. ApJ 916 59. https://iopscience.iop.org/article/10.3847/1538-4357/abf65a#artAbst.
8. **Vishal Upendran**, Mark Cheung, Shravan Hanasoge, Ganapathy Krishnamurthi. 2020. Solar wind prediction using deep learning. Space Weather, 18, e2020SW002478. https://doi.org/10.1029/2020SW002478 .

In-press

1. Soumya Roy, ... Vishal Upendran, ...: X-class flare on Dec 31, 2023, observed by the Solar Ultraviolet Imaging Telescope on board Aditya-L1, accepted, ApJL

Under review

1. **Vishal Upendran**, Durgesh Tripathi, Bhargav Vaidya, Takaaki Yokoyama, Mark Cheung: Comparison of plasma dynamics in Coronal Holes and Quiet Sun using flux emergence simulations . **The Astrophysical Journal**.
2. Abhishek Rajhans, .., **Vishal Upendran**,... Multi-Stranded Simulations Mimicking FOXSI and AIA Observations : A Single Power-Law Distribution for Transients and Steady Background.**The Astrophysical Journal**.
3. Pranav Seth, **Vishal Upendran**,... : SPACE-SUIT: An Artificial Intelligence based chromospheric feature extractor and classifier for SUIT. **Solar Physics**.

In - preparation

1. **Vishal Upendran**, Durgesh Tripathi, Siddha Ganju, Mark Cheung, Solar wind source region estimation using deep learning.
2. Linn Abraham, **Vishal Upendran**,... : Interpretable Deep Learning for Solar Flare predictions, Astronomical Society of India (ASI) meeting 2024.
3. Deepak Kathait, Soumya Roy, **Vishal Upendran**,...: Observations of solar flare on the 5th of August 2023., Astronomical Society of India (ASI) meeting 2024.
4. Raman Mukundan, ... **Vishal Upendran**, ...: Multiscale Geoeffectiveness Forecasting: Upgrading the DAGGER Pipeline, American Geophysical Union (AGU) Fall meeting (2023).

Talks

Invited

- **Pune, India** — **Jan 2024**
  A multi-scale understanding of the Sun aided by artificial intelligence — *AI/ML applications in Astronomy and Astrophysics*
- **Oslo, Norway** — **Sept 2024**
  Coronal hole x Quiet Sun : Observations and simulations — *ROCS, University of Oslo*
- **Geneva, Switzerland** — **Feb 2024**
  Accelerating heliophysics workflows using interpretable deep learning — *Dept. of Physics, University of Geneva*
- **Geneva, Switzerland** — **Feb 2024**
  Accelerating heliophysics workflows using interpretable deep learning — *Dept. of Physics, University of Geneva*
- **Solar and cosmic plasma seminar** — **Oct 2023**
  Statistical constraints on impulsive heating of solar corona — *Kyoto University, Japan*
- **Science from In-situ measurements of Aditya-L1 (SIMA-01)** — **April 2023**
  Solar wind prediction using deep learning — *Vikram Sarabhai Space Center, India*
- **Machine learning workshop at the Astronomical Society of India meeting** — **March 2023**
  From Sun to Earth using Interpretable A.I. — *IIT Indore, India*
- **Aditya-L1 workshop at Manipal Academy of Higher Education** — **Nov 2022**
  Machine and deep learning, with applications to solar physics — *Udupi, India*
- **Young Astronomers' meeting** — **November 2022**
  CosmicVarta: An initiative to take current Indian research to the public — *Nainital, India*
- **Dept. of Physics, IIT-BHU** — **Nov 2022**
  Solar wind sources in the chromosphere — *Varanasi, India*
- **Dept. of Physics, IIT-BHU** — **Nov 2022**
  Accelerating heliophysics workflow with deep learning and interpretable AI — *Varanasi, India*
- **SPARC workshop: Machine Learning in Solar Physics and Space Weather at IISER Kolkata** — **June 2022**
  Accelerating space weather forecasts with deep learning and interpretable A.I
- **Geospace Environment Modeling (GEM) summer workshop 2022 at Hawaii** — **June 2022**
  Tutorial on using spherical harmonics with data
- **Robert Bosch Center for Data Science and Artificial Intelligence, IIT - Madras** — **April 2022**
  Accelerating astronomy workflow with deep learning and interpretable A.I — *IIT Madras, India*
- **Dept. of Physics, IIT - Madras** — **April 2022**
  On the origin of solar wind and solar coronal heating — *IIT Madras, India*
- **European Solar Physics Online Seminars (ESPOS)** — **Dec 2021**
  On the formation solar wind and switchbacks, and Quiet Sun heating
- **IUCAA Seminar** — **Dec 2021**
  On the formation solar wind and switchbacks, and Quiet Sun heating
- **Physikalisch-Meteorologische Observatorium Davos/World Radiation Center (PMOD/WRC)** — **May 2021**
  On the Impulsive Heating of Quiet Solar Corona

Public talks

- **National Science Day talk at IUCAA** — **Feb 2023**
  Introduction to Sun and the Aditya-L1 mission — *Pune, India*
- **Open workshop and tutorial at IIT-BHU** — **Nov 2022**
  Introduction to machine and deep learning — *Varanasi, India*
- **Solar eclipse special talk at IUCAA (English and Tamil)** — **Oct 2022**
  Aditya-L1: India's first mission to the Sun — *Pune, India*
- **IUCAA National Science Day celebrations** — **Feb 2022**
  The many ways to know our Universe
- **Athaang astronomy club** — **Feb 2022**
  The exhalations and snores of the slumbering Sun
- **Fergusson college, Pune, India** — **Aug 2021**
  From Sun to Earth using A.I

Conferences and Meetings

- **AIAPC: AI informed plasma physics** — **Oct 2024**
  Talk: Extracting physics using interpretable deep learning models — *Huntsville, Alamaba, U.S.A,*

- **ESPM** — **Sept 2024**
  Poster:Coronal hole and Quiet Sun comparison through observations and simulations — *Turin, Italy*
- **TESS 2024 meeting** — **April 2024**
  ***Talk**: Multiscale Geoeffectiveness Forecasting using SHEATH and DAGGER* — *Dallas, Texas, USA*
- **4th Eddy Symposium** — **Oct 2023**
  ***Talk**: Multiscale Geoeffectiveness Forecasting using SHEATH and DAGGER* — *Golden, Colorado, USA*
- **Hinode 16 / IRIS 13 meeting** — **Sept 2023**
  Poster: Flux emergence thermodynamics in Coronal Holes and Quiet Sun — *Niigata, Japan*
- **Hinode 16 / IRIS 13 meeting** — **Sept 2023**
  Poster: Statistical impulsive heating signatures in the solar corona — *Niigata, Japan*
- **Solar wind 16 conference** — **June 2023**
  Poster:Solar wind forecasting using interpretable deep learning — *Monterey, CA, USA*
- **Solar wind 16 conference** — **June 2023**
  Poster: Exploring the formation solar wind, switchbacks and Quiet Sun heating — *Monterey, CA, USA*
- **XXXI IAU General assembly: Symposium on "The Era of Multi Messenger Solar Physics"** — **August 2022**
  ***Talk**: Exploring the formation solar wind, switchbacks and Quiet Sun heating* — *Busan, S. Korea*
- **XXXI IAU General assembly: Symposium on "Machine Learning in Astronomy"** — **August 2022**
  ***Talk**: Accelerating astronomy workflow with deep learning and interpretable A.I* — *Busan, S. Korea*
- **Loops 10 workshop** — **June 2022**
  ***Talk**: Inferring quiet Sun heating using machine learning* — *CUP: Paris, France*
- **Loops 10 workshop** — **June 2022**
  Poster: Coronal heating in QS and Coronal holes — *CUP: Paris*
- **Astronomical Society of India meeting 2022** — **Mar 2022**
  Poster: Chromospheric and transition region dynamics in coronal holes and quiet sun — *IIT Roorkee: India*
- **American Geophysical Union (AGU) meeting 2021** — **Dec 2021**
  Poster: Machine learning inference of statistical signatures of heating events
- **American Geophysical Union (AGU) meeting 2021** — **Dec 2021**
  ***Talk**: Solar wind signatures in the chromosphere*
- **Hinode-14/IRIS-11 meeting** — **Oct 2021**
  ***Talk**: Chromospheric and transition region dynamics in coronal holes and quiet sun*
- **Solar Orbiter ISWG on Solar wind sources and connection** — **Oct 2021**
  ***Talk**: Solar wind prediction using deep learning*
- **16th European Solar Physics Meeting** — **Sep 2021**
  Poster: Inferring impulsive heating of quiet solar corona using machine learning
- **PSP scholars meeting** — **Aug 2021**
  ***Talk**: Solar wind prediction using deep learning*
- **Advances in observations and modelling of solar magnetism and variability.** — **March 2021**
  Poster: Chromospheric dynamics in Coronal holes and Quiet Sun
- **Astronomical Society of India (ASI) meeting 2021** — **Feb 2021**
  ***Talk**: Quiet sun coronal heating by nanoflares*
- **American Geophysical Union (AGU) meeting 2020** — **Dec 2020**
  Poster: Determining new representations of "Geoeffectiveness" using deep learning
- 5^{th} **Asia-Pacific Solar Physics Meeting** — **Feb 2020**
  ***Talk**: Solar wind prediction using Deep learning* — *IUCAA: Pune, India*
- **IRIS-10 conference** — **Nov 2019**
  Poster: Heating of the Quiet Corona — *Christ University: Bangalore, India*
- 1^{st} **Conference on Machine Learning in Heliophysics** — **Sep 2019**
  Poster: Solar wind prediction using Deep learning — *Royal Tropical Institute: Amsterdam, Netherlands*