Vishal Upendran

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Research interests

- **Solar/stellar atmosphere**: Dynamics of the solar atmosphere especially relating to the formation and evolution of energetic events (solar/stellar flares, Jets, plumes, etc) and atmospheric/coronal heating. Studies using remote sensing measurements in the form of spectroscopy/photometry/spectropolarimetry.
- **Solar wind and space weather**: Solar wind emergence, acceleration and propagation, Space weather studies, modelling and forecasting. Studies relating remote sensing measurements to in-situ measurements.
- **Simulations:** MHD simulations and application to understand various astrophysical environments, and particularly to solar atmospheric dynamics/thermodynamics, 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.

Education

- **Inter University Centre for Astronomy and Astrophysics, Pune**
  PhD in Astrophysics, under Prof. Durgesh Tripathi, IUCAA. *2018-2023(exp)*
  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 *2013-2018*
  CGPA: 9.17/10.0
  Masters Thesis: Solar wind prediction and modelling using deep learning methods.

Awards and scholarships

- 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 **Outstading Student Presentation Award (OSPA)** at the American Geophysical Union meeting 2021.
- Awarded the **ISRO-RESPOND grant 2022** for the project "Solar Flares: Physics and Forecasting for better understanding of Space Weather" as **Co-Principal Investigator**.
- Awarded the **Nvidia Academic Hardware grant 2021** for the project "Solar wind source region estimation using deep learning" as **Principal Investigator**.
- Offered a fully-funded summer internship program at NASA-SETI **Frontier Development Lab** (FDL) 2020.
- Offered Junior Research Fellowship by Council of Scientific and Industrial Research – University Grants Commission, India for pursuing research in India.
- Offered a fully funded PhD position at Inter-University Center for Astronomy and Astrophysics (IUCAA) in Pune, 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 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
- **Mentoring the Doctoral thesis of Mr. Biswanath Malaker** **Dec 2021– Present**
  Tentative Thesis title: Statistics and properties of solar coronal outflows
  Supervisor: Prof. Durgesh Tripathi

Publications

- 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.
- Vishal Upendran and Durgesh Tripathi 2021. **On the formation of solar wind & switchbacks, and quiet Sun heating**. ApJ 926 138,
- 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
- Vishal Upendran and Durgesh Tripathi 2021. **On the Impulsive Heating of Quiet Solar Corona**. ApJ 916 59.
- Upendran, V., Cheung, M. C. M., Hanasoge, S., Krishnamurthi, G. 2020. **Solar wind prediction using deep learning**. Space

Weather, 18, e2020SW002478. https://doi.org/10.1029/2020SW002478 .

In - preparation

- Upendran. V, Tripathi. D, Mithun N.P.S, Vadawale. S, Sarkar. A, + "Impulsive heating of the X-ray quiet solar corona".
- Upendran. V, Tripathi. D, Ganju. S, Cheung. M, "Solar wind source region estimation using deep learning".
- Upendran. V, Tripathi. D, Vaidya B., + "A 2.5D numerical simulation of interchange reconnection at different heights in the solar atmosphere".
- Rajhans A, .., Upendran V,... "Multi-Stranded Simulations Mimicking FOXSI and AIA Observations : A Single Power-Law Distribution for Transients and Steady Background"

Press releases

- **Keeping Tabs on the Quiet Sun** — **Aug 2021**
  AAS Nova by Susanna Kohler

Invited talks

- **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 (Online)** — **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
- **Dept. of Physics, IIT - Madras** — **April 2022**
  On the origin of solar wind and solar coronal heating
- **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

- **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

- **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*

Services

- Reviewer for articles in the journal AGU: Spaceweather.
- Reviewer for articles in the journal Solar Physics.

Teaching experience

- **Introductory Summer School in Astronomy and Astrophysics** **June 2022**
  Python and Machine learning lectures
  A repeat of the the Python and ML course from 2021.
- **Introduction to Astronomy and Astrophysics II** **Jan 2022–March 2022**
  Teaching assistant to Prof. Durgesh Tripathi, IUCAA
  - Assisted in evaluation of examinations and talks for first year graduate students of IUCAA Pune.
- **Introductory Summer School & Refresher Course in Astronomy and Astrophysics** **June 2021**
  Python and Machine learning lectures
  - Gave two lectures and conducted hands-on tutorial sessions in python and machine learning for participants of the school, ranging from undergraduate students to college teachers.
  - The lectures concluded with some hands-on simple "projects" which would let interested students take up further study.
  - Some gleanings from when the participants "lived" through any machine learning algorithm may be found here: `https://www.linkedin.com/posts/vishal-upendran1995_i-gave-a-bunch-of-lectures-at-the-iucaa-summer-activity-6806254311706886144-QHAR?utm_source=linkedin_share&utm_medium=member_desktop_web`.
- **Science of the star in our backyard: Introduction and data analysis** **26 Dec 2019–29 Dec 2019**
  Hands–on data analysis session
  - Organized a hands–on solar data analysis session in python for Bachelors and Masters level students along with two other members of the IUCAA solar group.
  - Workshop went for over 7 hours spanning two days, and had $\approx$ 50 students selected from all over India.
- **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
  - Assisted in setting up and correction of assignments for students in geometric modeling of curves, surfaces and point clouds.
  - Handled the laboratory classes along with the team of teaching assistants for around 60 undergraduate students in performing hands on 3D modeling using Autodesk Inventor.
- **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
  - Assisted in teaching Introduction to C language and OpenGL for first year students at Dept. of Engineering design, IIT Madras.
  - Handled the laboratory and lecture classes along with the team of teaching assistants for around 60 undergraduate students.

Positions of Responsibility

- **CosmicVarta** **Sep 2021 – Present**
  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. We shall be expanding into different social media, languages and modes of communication.
- **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.
- **Mentoring of Individual Transformation (MITR), IIT Madras** **2015–2016**
  Undergraduate student mentor at MITR, IIT Madras.
- **Shaastra, IIT Madras** **2014–2015**
  Coordinator, Astronomy data analysis workshop

Undergraduate research experience

- **Light curve classification using Deep learning** **Feb 2017–Sep 2017**
  Physics and Astronomy club, IIT Madras
  - Designed a deep classifier for detection and classification of **Kepler light curves** for Exoplanet detection using Kaggle exoplanet dataset.
  - Network gives a 98% accuracy on the available test dataset during prediction.
- **Modelling of biological muscles for Myorobotics emulation** **May 2016–Aug 2016**
  Advisors: Prof. Jörg Conradt, Dr. Christoph Richter, Neuroscientific System Theory, TU Munich
  - Developed a framework for Myorobotics and Neuromorphic engineering by mathematically modelling muscles using muscle actuation data to emulate them in intelligent robots, by interfacing SpiNNaker- a Spikking Neural Network generator with a muscular actuation setup.
  - Library for controller, to enable existing intelligent robotic setup generate a muscle-inspired adaptive response and actuation created.
  - Available as Upendran, Vishal, Christoph Richter, and Jorg Conradt. "Modelling of biological muscles for Myorobotics emulation." (2016), on Media TUM – the media and publication repository of TU Munich.
- **Refreshable Braille Monitor** **Jan 2016–April 2016**
  Advisor: Dr. Sandipan Bandyopadhyay (IIT Madras)
  - Developed a prototype single cell Braille monitor with a novel actuation mechanism using shape memory alloys to optimize performance and heat generation by manufacturing the product at less than 50% of the market price, thus potentially making it affordable to public.
  - Led a team of 5 students in managing budget and materials, while performing mathematical optimization for performance and heat generation, and electronic design of the product.