

# Souvik Bose, Ph.D.

<https://www.linkedin.com/in/souvikb-solar> — <https://github.com/souvikita>

**Summary** — Research scientist at Lockheed Martin/NASA and SETI with a strong background in image processing applications with AI focusing on high-resolution solar observations and cutting-edge numerical simulations. Awarded 2022 IAU Best Ph.D. Thesis Prize in the world, fellow of the Royal Astronomical Society of London.

## Skills & Expertise

**Observing experience** NASA IRIS Satellite planner: 2–3 weeks per year since 2019, Swedish 1-m Solar Telescope (SST), La Palma, Canary Islands, Spain: 2–3 weeks per year since 2018.  
**Programming** Python, Bash, IDL, C, Jupyter, UNIX, SLURM, git, LATEX  
**Software** MPI parallel programming, Scientific Computing, PyTorch, Scikit learn, Google Cloud Platform, Vapor.  
**Space Physics** Numerical simulations of astrophysical systems, computational astrophysics, solar & plasma physics  
**Team dynamics** Team player, cross-functional collaboration, authorship of research papers, communication skills.

## Professional Experience

### Lockheed Martin Solar & Astrophysics Lab (LMSAL)–NASA–SETI

March 2022 – present

#### Research Scientist

- Engaged in critical research on the analysis of ground and space-based imaging data from multiple NASA missions and advanced numerical simulations.
- Made mission-critical contributions to NASA's Interface Region Imaging Spectrograph (IRIS) and Solar Dynamics Observatory (SDO) missions, including determination of the science observing programs and inputs into the daily upload of commands to the IRIS spacecraft.
- Contributed towards the development of data analysis and modeling pipeline for the upcoming NASA's 350M USD MUlti-slit Solar Explorer (MUSE) mission launching in July 2027.
- Co-investigator for the Solar eruptionN Integral Field Spectrograph (SNIFS), a NASA sounding rocket mission, launching in July 2025.
- Invited as an expert to be a part of an international team (comprising of 8 world leading scientists) to solve some of the fundamental questions about solar physics by combining machine learning, simulations, and observations.
- Fostered international collaborations with leading institutions (e.g., Harvard, Univ. of Tokyo, CSIRO Australia) to advance solar and space physics research.
- Applied machine learning techniques to analyze multi-dimensional datasets, resulting in publications in high-impact journals including **Nature**.
- Delivered invited talks at international conferences, showcasing expertise in solar physics and AI-driven imaging and data analysis.

### University of Oslo, Norway

November 2021– March 2022

#### Post-doc Researcher

- Worked on high-resolution, multi-dimensional, imaging datasets from ground and space-based (NASA) observations and combined them with advanced numerical simulations.
- Developed innovative dimensionality reduction techniques (PCA, SVD,  $t$ -SNE) to analyze high-resolution solar imaging datasets.
- Applied state-of-the-art machine learning approaches ( $k$ -means) to cluster, and subsequently utilized advanced 3D morphological image processing techniques to detect, classify, and segment images.
- Performed extensive numerical radiative transfer computations on multiple international supercomputing clusters such as Norway's Betzy and NASA's Pleiades supercomputers.
- Published key research papers in leading international journals.

### NASA Frontier Development Lab (FDL), NASA Ames Research Center

June 2019 – August 2019

#### Space exploration researcher

NASA FDL applies AI technologies to space science in partnership with leading research organizations such as Google Cloud and NVIDIA to push the frontiers of research and develop new tools to help solve some of the biggest challenges humanity faces today. This is a highly competitive 10-week sprint that includes AI and space exploration researchers from all over the world.

Key contributions include –

- Development of a novel machine learning framework based on convolutional neural networks (CNNs) that exploits spatial patterns on the solar surface across multiwavelength images to compensate for image degradation.
- Development of a unique image-to-image translation technique based on an encoder-decoder framework to synthetically generate ultraviolet images of the Sun and explore their suitability for scientific studies.
- Co-authored a publicly available PyTorch pipeline hosted on Zenodo (10.5281/zenodo.6954828), contributing to open science initiatives.
- Presented findings at leading AI conferences (e.g., NeurIPS) and published in high-impact journals.

## Education

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### University of Oslo, Norway

*Ph.D. in astrophysics (with distinction)*

### Indian Institute of Astrophysics, Bangalore

*Master of Technology in Astronomical Instrumentation (first class honors)*

### University of Burdwan, India

*Bachelor of Engineering in Electronics and Communication (first class honors)*

## Awards & accomplishments

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- **NASA Robert H. Goddard Exceptional Science Achievement Award** for extraordinary and sustained team efforts as a part of the Solar Dynamics Observatory mission, September 2024.
- **National Science Foundation (NSF)** travel award of up to \$3,500 to deliver an invited talk in Tenerife, Spain, June 2024.
- **American Astronomical Society's (AAS)** Thomas Metcalf travel award of up to \$5,000 to present my work at the prestigious Hinode/IRIS meeting in MT, USA, July 2024.
- **International Astronomical Union (IAU) best Ph.D. thesis prize** in the world for outstanding scientific achievement in astrophysics by the Sun and Heliospheric division of the IAU, July 2022.
- **Fellowship from the Royal Astronomical Society of London** for substantial early career contributions in solar astrophysics, July 2020.
- **NASA Award of Merit** to acknowledge outstanding contributions in the field of artificial intelligence for space exploration and humanity, NASA Ames Research Center, August 2019.

## Selected Refereed Publications

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- **On the million-degree signature of spicules**, Souvik Bose, Jayant Joshi, Paola Testa, and Bart De Pontieu *accepted for publication in ApJ letters* [arXiv:2503.08887](https://arxiv.org/abs/2503.08887), (2025).
- **Chromospheric and Coronal heating in active region plage by dissipation of currents from braiding**, Souvik Bose, Bart De Pontieu, Viggo Hansteen, et al. *in Nature Astronomy*, **8**, (2024), 697–705.
- **Comprehensive Synthesis of Magnetic Tornado: Cospacial Incidence of Chromospheric Swirls and Extreme-ultraviolet Brightening**, Hidetaka Kuniyoshi, Souvik Bose and Takaaki Yokoyama *ApJ Letters*, **969** (2024) 2.
- **The Solar Eruption Integral Field Spectrograph sounding rocket**, V. Herde, P. Chamberlin, D. Schmit, A. Daw, R. Milligan, V. Polito, S. Bose, S. Boyajian, ... J. Wallace, *Solar Physics*, **299**, (2024), 2.
- **The chromosphere underneath a Coronal Bright Point**, Souvik Bose, Daniel Nóbrega-Siverio, Bart De Pontieu and Luc Rouppe van der Voort, *ApJ*, **944** (2023) 171.
- **Numerical simulations and observations of Mg II in the solar chromosphere**, Viggo Hansteen, Juan Martínez-Sykora, Mats Carlsson, Bart De Pontieu, Milan Gosic and Souvik Bose, *ApJ*, **944** (2023) 131.
- **Properties of shock waves in the quiet Sun chromosphere**, Harsh Mathur, Jayant Joshi, K. Nagaraju, Luc Rouppe van der Voort and Souvik Bose, *A&A*, **668** (2022) A153.
- **Exploring the Limits of Synthetic Creation of Solar EUV Images via Image-to-image Translation**, Valentina Salvatelli, Luiz F.G. dos Santos, Souvik Bose, Brad Neuberg, et al. *ApJ*, **937** (2022) 100.
- **Evidence of multithermal nature of spicular downflows**, Souvik Bose, Luc Rouppe van der Voort, Jayant Joshi, Vasco M.J. Henriques, Daniel Nóbrega-Siverio, Juan Martínez-Sykora, and Bart De Pontieu *A&A*, **654** (2021) A51.
- **Spicules and downflows in the solar chromosphere**, Souvik Bose, Jayant Joshi, Vasco M.J. Henriques, and Luc Rouppe van der Voort *A&A*, **647** (2021) A147.
- **High-resolution observations of the solar photosphere, chromosphere and transition region**, L.H.M. Rouppe van der Voort, B. De Pontieu, M. Carlsson, J. de la Cruz Rodríguez, S. Bose, et al. *A&A*, **641** (2020) A146
- **Multi-Channel Auto-Calibration for the Atmospheric Imaging Assembly using Machine Learning**, Luiz F.G. dos Santos, Souvik Bose, Valentina Salvatelli, et al. *A&A*, **648** (2021) A53.
- **Characterization and formation of on-disk spicules in the Ca II K and Mg II k spectral lines**, Souvik Bose, Vasco M.J. Henriques, Jayant Joshi, & Luc Rouppe van der Voort *A&A*, **631** (2019) L5.
- **Semi-empirical model atmospheres for the chromosphere of the sunspot penumbra and umbral flashes**, Souvik Bose, Vasco M.J. Henriques, Luc Rouppe van der Voort & Tiago M.D. Pereira *A&A*, **627** (2019) A46.

A complete list of my publications can be found in [Google Scholar](#).

## Selected Professional presentations

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- Oral presentation on **Chromospheric and Coronal Heating in Active Regions: A Joint Perspective from Observations and Numerical Simulations** at the international conference on Sun, Space Weather, and Solar-Stellar Connection held in Bangalore, India, from 20–24 January 2025.

- Invited talk on **Recent advances in the observation of solar spicules** at the COSPAR General Assembly, held in Busan, S. Korea, from 13–21 July 2024.
- Oral presentation on **Chromospheric and coronal heating in an active region plage by dissipation of currents from braiding** at the 17th IRIS/Hinode/SPHERE meeting held in Bozeman, MT, USA, from July 22–27, 2024.
- Oral Presentation on **Chromospheric and Coronal heating in active region plage by dissipation of currents** at the RoCMI workshop held in Svalbard, Norway from 27 February – 02 March 2023.
- Invited talk on **The Dynamics of Spicules and mass-flows in the solar atmosphere** at the Indian Institute of Astrophysics, Bangalore, India, on 22 December 2022.
- Oral Presentation entitled **On the correlation between chromospheric and coronal heating in an active region moss** at the Hinode15/IRIS12 meeting held in Prague, Czech Republic from 19-23 September 2022.
- Invited talk on **High-resolution solar physics through ground- and space-based observations** at KASI, Daejeong, and Seoul National University (SNU), Seoul, Korea on 12 and 13 August 2022.
- Invited IAU PhD prize lecture **On the Dynamics of Spicules and Mass-Flows in the Solar Atmosphere** at the XXXI IAU General Assembly held in Busan, S. Korea from 02–11 August 2022.
- Oral Presentation entitled **On the relationship between spicules and coronal bright points** at the COSPAR Scientific Assembly held in Athens, Greece from 16–24 July 2022.
- Oral Presentation entitled **Multi-thermal nature of spicular downflows** at the joint Hinode-14/IRIS-11 virtual meeting held from 25-28 October 2021.
- Oral presentation on **Rapid downflows in the solar chromosphere** at the Royal Astronomical Society’s meeting on Modelling and observing the lower solar atmosphere: new solutions to old problems, organized virtually on 13 November 2020.
- Oral presentation entitled **Characterization and formation of Ca II K and Mg II k spectra of spicules** at the IRIS meeting held in Bangalore, India from 4-9 November, 2019.
- A TED-style talk on **How might we expand the capabilities of NASA’s Solar Dynamics Observatory using Machine Learning?** held at **Google** headquarters, Mountain View, on 16th August 2019 (Video available [here](#)).

## Selected Projects

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### AI-Driven Solar Image processing and synthesis

- Developed multiple CNN-based frameworks to restore degraded solar images, and synthesize ultraviolet images of the Sun, both of which are key to maximizing the scientific returns of future deep space missions.
- Published the PyTorch pipeline on Zenodo ([10.5281/zenodo.6954828](https://zenodo.org/doi/10.5281/zenodo.6954828)), contributing to open science.
- Presented findings at NeurIPS, showcasing AI applications in space science.

### Multi-Dimensional Solar Data Analysis

- Applied PCA, SVD, and  $t$ -SNE to analyze coordinated high-resolution solar imaging datasets from ground and space-based telescopes.
- Utilized  $k$ -means clustering and 3D image processing to perform automated identification of small-scaled, needle-like jets (spicules) from solar images *for the first time*.
- Creation of a dataset consisting of hundreds of thousands of spicule detections leading to in-depth statistical analysis.
- Published results in high-impact journals, advancing solar physics research.

### NASA MUSE Mission Pipeline Development

- Designed algorithms to process multi-wavelength solar imaging data, especially focusing on the impact of noise, for NASA’s 350M USD MUSE mission.
- Collaborated with a range of engineers and scientists.
- Enabled statistical validation of a range of numerical simulations corresponding to solar targets that would be observed with MUSE.

### Radiative Transfer Modeling on Supercomputers

- Performed large-scale (1D and 3D) radiative transfer computations on NASA’s Pleiades and Norway’s Betsy supercomputers.
- Developed innovative approaches to model solar atmospheric processes, reducing computation time by 60%.
- Collaborated with international teams to validate models against observational data.

## Teaching and supervision skills

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- Computational radiative transfer in solar atmosphere - **Winter School on Concepts in Solar Physics**, NIT Delhi, December 2023.
- AST 2210- Teaching Assistant of the bachelor’s course on **Observational Astronomy**.
- AST 5210- Taught massively-parallel, open-source **RH1.5D** radiative transfer code for the master’s course on **Stellar Atmospheres-I**.
- Mentored a PhD student (Dr. Vicki Knoer) enrolled at LASP, CU Boulder, defended in November 2024.

## Research Highlights and Press releases

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Many of my research publications have been highlighted in the press/media.

- [NASA Observations Find What Helps Heat Roots of ‘Moss’ on Sun](#). NASA Press Release on 16 April 2024.
- [Nasa team led by Indian-origin scientist unravels what is behind superheating of Sun’s mossy region](#) Article published by the leading national daily of India *The Times of India* on 11 May 2024.
- [Artificial Intelligence Helps Improve NASA’s Eyes on the Sun](#). NASA Press release on 23 July 2021.
- [Exploring Imbalances in the Sun’s Magnetic Flux](#) highlighted by the American Astronomical Society on 3 August 2018.

## Community Service

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I have been performing refereeing duties for various journals such as **Nature Astronomy**, **Astronomy and Astrophysics**, **The Astrophysical Journal (including letters)**, **Solar Physics**, **Frontiers**, and **Elsevier** since May 2020.

## Languages known

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- English: Advanced
- Hindi: Advanced
- Bengali: Native
- Assamese: Advanced