Nastaran Farhang

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Current Position

Postdoctoral Research Associate, University of Sydney

Areas of Specialisation

Physics; Solar Physics; Signal Processing; Complex Systems; Plasma Physics; Data Analysis

Academic Appointments

Education:

2007–2011 B.Sc. in Physics, Isfahan University of Technology

2011–2013 M.Sc. in Astrophysics, University of Zanjan

2014–2018 Ph.D. in Solar Physics, University of Zanjan

Teaching Experience:

2014–2015 Led orientation sessions at the observatory, University of Zanjan

2016–2017 Teaching Assistant: Quantum Mechanics, University of Zanjan

2016–2017 Visiting Lecturer: Fundamental Physics, University of Zanjan

Thesis Supervision:

2017–2018 M.Sc. Advisor: "The Complex Network of Solar Active Regions"

2017–2018 M.Sc. Advisor: "3D Simulation of Coronal Magnetic Field and Solar Flare Models"

2017–2018 M.Sc. Advisor: "Oscillations and Weak Damping of Solar Coronal Loops"

2018–2020 Ph.D. Advisor: "Structure of Solar Flare Energy Network: Hybrid Model Approach"

2020–2023 Ph.D. Advisor: "SOC vs. Chaotic Systems Using HVG Methodology"

2021–2024 Ph.D. Advisor: "Investigation of Solar Magnetic Network's Properties"

Research Experiences:

2018 Visiting Student, University of Sydney

2018–2024 Visiting Scholar, University of Zanjan

2021–2022 Postdoctoral Researcher, Isfahan University of Technology

2023–PRESENT Postdoctoral Research Associate, University of Sydney

Books

2018 Translation of *Magnetohydrodynamics of the Sun - Volume 1* by *Eric Priest* into Persian, in collaboration with Prof. Safari et al., ISBN: 978-622-95156-5-5.

2019 Translation of *Magnetohydrodynamics of the Sun - Volume 2* by *Eric Priest* into Persian, in collaboration with Prof. Safari et al., ISBN: 978-622-95156-9-3.

Top Publications

2014 Automated Tracking of Solar Coronal Loops and Detection of their Oscillations
Iranian Journal of Physical Research
https://ijpr.iut.ac.ir/article$_1$067.*html?lang* = *en*

2018 Principle of Minimum Energy in Magnetic Reconnection
The Astrophysical Journal
https://doi.org/10.3847/1538-4357/aac01b

2019 Energy Balance in Avalanche Models for Solar Flares
The Astrophysical Journal Letters
https://doi.org/10.3847/2041-8213/ab40c3

2019 Resonant absorption of a solar coronal loop
Iranian Journal of Astronomy and Astrophysics
https://doi.org/10.22128/ijaa.2018.328.1047

2020 Solar Flare Modified Complex Network
The Astrophysical Journal
https://doi.org/10.3847/1538-4357/ab8301

2022 Do Cellular Automaton Avalanche Models Simulate QPPs?
The Astrophysical Journal
https://doi.org/10.3847/1538-4357/ac85ba

2022 Evidence of SOC in Time Series by HVG Approach
Scientific Reports
https://doi.org/10.1038/s41598-022-20473-4

2024 Complex Network View of the Sun's Magnetic Patches. I. Identification
The Astrophysical Journal Supplement Series
https://doi.org/10.3847/1538-4365/ad4642

Research Presentations

2013 17th Meeting on Research in Astronomy, IASBS, Iran (Poster)
2017 4th SOLARNET Meeting, Spain (Oral)
2017 20th Meeting on Research in Astronomy, IASBS, Iran (Poster)
2018 University of Sydney, Australia (Oral)
2019 12th National Conference on Astronomy and Astrophysics of Iran, Iran (Poster)
2020 13th National Conference on Astronomy and Astrophysics of Iran, Iran (Oral)
2020 Isfahan University of Technology, Iran (Oral)
2021 Isfahan University of Technology, Iran (Oral)
2022 15th National Conference on Astronomy and Astrophysics of Iran, Iran (Oral)
2022 5th (Virtual) Workshop on Transient Events and Multi-Messenger Astrophysics, INO & IUT Joint Workshop, Iran (Oral)
2023 University of Sydney, Australia (Oral)
2024 University of Melbourne, Australia (Oral)

Skills

Programming:
Python, MATLAB

Digital Adaptability:
Proficient in leveraging AI tools to streamline workflow

Professional Skills:
Communication, Collaboration, Leadership

Grants

2021 INSF grant for research on "Solar Atmospheric Features" (Grant No. 99012824).

References

Professor Michael S. Wheatland
Sydney Institute for Astronomy, School of Physics, University of Sydney
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Professor Andrew Melatos
School of Physics, University of Melbourne
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Professor Farhad Shahbazi
Department of Physics, Isfahan University of Technology
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Professor Hossein Safari
Physics Department, Faculty of Science, University of Zanjan
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Background

I earned my Ph.D. in Astronomy/Solar Physics from the University of Zanjan on October 17, 2018. Since then, I have been actively involved in research and academic activities as a visiting scholar and postdoctoral researcher. My work spans a broad range of topics within solar and plasma physics, and I have engaged in multiple international collaborations with leading institutions, including the University of Sydney, the University of Melbourne, the University of Helsinki, Texas A&M University, the Isfahan University of Technology, the University of Zanjan, and the University of Maragheh.

Selected collaborative research projects include:

- Oscillation and damping of solar coronal loops in EUV emissions (2019)
  [with Texas A&M University, University of Maragheh, and University of Zanjan]
- Statistical methods for analyzing deviations from ideal power-law distributions (2019)
  [with the University of Sydney, University of Helsinki, and University of Zanjan]
- Network-based study on solar flare (2020)
  [with the University of Zanjan]
- Characterizing chaotic, self-organized critical, and random systems using network theory (2021)
  [with the University of Zanjan]
- Complex network analysis of magnetic patch evolution on the solar surface (2022)
  [with the University of Zanjan]
- Development of a "CLEAN" flare catalog for spatio-temporal correlation studies (since 2023)
  [with the University of Sydney and the University of Melbourne]

Current Research Focus

My ongoing research at the University of Sydney centers on the statistical characterization and modeling of solar flaring activity, with a focus SXR and EUV data. The project integrates observational data analysis, time series modeling, and machine learning techniques to improve flare detection and event classification. A key area of development is the application of a Hidden Markov Model (HMM) to identify the underlying magnetic states, i.e., background, rise, and decay phases, based on observations. The project extends to the use of Bayesian inference, Viterbi decoding, and parameter learning methods (including EM, GMM, and Dynamic Hamiltonian Monte Carlo) to improve HMM predictions. Synthetic data generation and injection-recovery tests are employed to validate the robustness of detection techniques.

Parallel efforts include:

- Temporal and spatial correlation analysis of EUV emission across active regions.
- Application of local extrema algorithms and continuous wavelet transforms for flare onset identification.
- Time series modeling using methods such as LOWESS, ARIMA, NIF, and RMSF to better capture flare dynamics.

This research contributes to a more refined understanding of solar flare statistics and aims to support the development of reliable, automated flare prediction frameworks with potential implications for space weather forecasting.