Nastaran Farhang

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Areas of Specialisation:

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

Education:

2014–2018 Ph.D. in Solar Physics, University of Zanjan
Dissertation: Modeling Solar Flares Using a Cellular Automaton Avalanche Model Optimized for Energy Release

2011–2013 M.Sc. in Astrophysics, University of Zanjan
Thesis: Detection of the Fast and Slow Magnetohydrodynamic Waves in Solar Coronal EUV Images

2007–2011 B.Sc. in Physics, Isfahan University of Technology
Project: Design of a Foucault Pendulum for the Central Library of the Isfahan University of Technology

Academic Appointments:

2023–present Postdoctoral Research Associate, University of Sydney
2021–2022 Postdoctoral Research Associate, Isfahan University of Technology
2018–2024 Visiting Scholar, University of Zanjan
2016–2017 Visiting Lecturer in Fundamental Physics, University of Zanjan
2016–2017 Teaching Assistant in Quantum Mechanics, University of Zanjan
2014–2015 Led orientation sessions at the Observatory, University of Zanjan

Peer-Reviewed Journal Publications:

2024 Complex Network View of the Sun's Magnetic Patches. I. Identification
The Astrophysical Journal Supplement Series
Zahra Tajik, Nastaran Farhang, Hossein Safari & Michael S. Wheatland
https://doi.org/10.3847/1538-4365/ad4642

2022 Evidence of SOC in Time Series by HVG Approach
Scientific Reports
Bardia Kaki, Nastaran Farhang & Hossein Safari
https://doi.org/10.1038/s41598-022-20473-4

2022 Do Cellular Automaton Avalanche Models Simulate QPPs?
The Astrophysical Journal
Nastaran Farhang, Farhad Shahbazi & Hossein Safari
https://doi.org/10.3847/1538-4357/ac85ba

2020 Solar Flare Modified Complex Network
The Astrophysical Journal
Amin Najafi, Amir Hossein Darooneh, Akbar Gheibi & Nastaran Farhang
https://doi.org/10.3847/1538-4357/ab8301

2019 Resonant Absorption of a Solar Coronal Loop
Iranian Journal of Astronomy and Astrophysics
Javad Ganjali, Nastaran Farhang, Shahriar Esmaeili, Mohsen Javaherian & Hossein Safari
https://doi.org/10.22128/ijaa.2018.328.1047

2019 Energy Balance in Avalanche Models for Solar Flares
The Astrophysical Journal Letters

Nastaran Farhang, Michael S. Wheatland & Hossein Safari
https://doi.org/10.3847/2041-8213/ab40c3

2018 Principle of Minimum Energy in Magnetic Reconnection
The Astrophysical Journal
Nastaran Farhang, Hossein Safari & Michael S. Wheatland
https://doi.org/10.3847/1538-4357/aac01b

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

Research Presentations:

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

Thesis Supervision:

2021–2024 Ph.D. Advisor to Zahra Tajik, University of Zanjan
Dissertation: Investigation of Solar Magnetic Network's Properties

2020–2023 Ph.D. Advisor to Bardia kaki, University of Zanjan
Dissertation: SOC vs. Chaotic Systems Using HVG Methodology

2018–2020 Ph.D. Advisor to Amin Najafi, University of Zanjan
Dissertation: Structure of Solar Flare Energy Network: Hybrid Model Approach

2017–2018 M.Sc. Advisor to Javad Ganjali, University of Zanjan
Thesis: Oscillations and Weak Damping of Solar Coronal Loops

2017–2018 M.Sc. Advisor to Mahdieh Makoue, University of Zanjan
Thesis: The Complex Network of Solar Active Regions

2017–2018 M.Sc. Advisor to Elham Molavi, University of Zanjan
Thesis: 3D Simulation of Coronal Magnetic Field and Solar Flare Models

Book Translations:

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.

Skills:

Programming Python, MATLAB
Proficient in leveraging AI tools to streamline workflow
Professional Communication, Collaboration, Leadership

Awards, Scholarships, Visits, Grants:

2007 Full tuition waiver for the B.Sc. degree at Isfahan University of Technology
Awarded for outstanding performance in the national university entrance examination (ranked in the top 1%)

2011 Full tuition waiver for the M.Sc. degree at the University of Zanjan
Awarded for outstanding academic performance during coursework

2013 Top poster award at the "17th Meeting on Research in Astronomy", IASBS, Zanjan, Iran

2014 Full tuition waiver for the Ph.D. degree at the University of Zanjan
Awarded for outstanding performance in the national Ph.D. entrance examination (ranked in the top 2%)

2018 The funding award of the Ministry of Science, Research and Technology of Iran for a six-month sabbatical at the University of Sydney

2018 The Iran Science Elites Federation's award for publishing articles in the leading journals of astronomy and astrophysics

2021 Iran National Science Foundation (INSF) grant for research on "Solar Atmospheric Features" (Grant No. 99012824)
This award provided full salary support and research expenses for 18 months

References:

Professor Michael S. Wheatland
Sydney Institute for Astronomy, School of Physics, University of Sydney
michael.wheatland@sydney.edu.au

Professor Andrew Melatos
School of Physics, University of Melbourne
amelatos@unimelb.edu.au

Professor Farhad Shahbazi
Department of Physics, Isfahan University of Technology
shahbazi@cc.iut.ac.ir

Professor Hossein Safari
Physics Department, Faculty of Science, University of Zanjan
safari@znu.ac.ir

Background:

I earned my Ph.D. in Solar Physics from the University of Zanjan in October 2018. Since then, I have been actively engaged in research and academic activities as both a visiting scholar and a postdoctoral researcher. My work spans a broad range of topics within solar physics (coronal loop oscillations, avalanche models for energy release during solar flares, complex network approaches to solar activity, and statistical analysis and modeling of solar flares) and has been carried out primarily within collaborative teams. In some cases, the research has been conducted in the context of Ph.D. and M.Sc. projects where my contributions have included advising, coordination, and methodological development. My research often requires extensive data preparation and long-term analysis, with outcomes typically leading to publications over multi-year timescales. Selected collaborative 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 flares (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 comprehensive "CLEAN" flare catalog for spatio-temporal correlation studies (since 2023)
  [with the University of Sydney and the University of Melbourne]

The results of the ongoing collaborations are in preparation for publication.

Current Research Focus:

My research at the University of Sydney centers on the statistical characterization and modeling of solar flares, with a focus on SXR and EUV data. The project integrates observational data analysis, time series modeling, and AI techniques to improve flare identification 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 to improve HMM predictions. Synthetic data generation and injection-recovery tests are employed to validate the robustness of detection techniques.

In parallel, I have developed a deep learning framework based on Convolutional Neural Networks (CNNs), extended with BiLSTM and Transformer layers, to identify flare events directly from high-cadence GOES SXR data. This approach significantly expands the flare catalog beyond GOES archive. A Bayesian post-processing is employed to estimate the probability of true vs. spurious detections.

Complementary studies include:

- 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 identification frameworks with potential implications for space weather forecasting.

Research Plan:

My planned research builds on recent work in flare detection and catalog development. I will focus on temporal and spatial correlation analyses of flare emissions across active regions. In addition, I plan to reassess the scaling relations between energy budgets in SXR, EUV, and HXR. These studies will provide a clearer picture of how energy is distributed and released in solar flares, supporting more accurate interpretations of observational data.