

Soichiro Hattori

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Education

Columbia University

New York, USA

PHD CANDIDATE, DEPARTMENT OF ASTRONOMY (GPA: 4.10)

Sep. 2021 - Expected May 2026

Advisors: Dr. Ruth Angus & Dr. Daniel Foreman-Mackey

MPhil: 2024, MA: 2023

New York University Abu Dhabi

Abu Dhabi, UAE

BS IN PHYSICS WITH MINOR IN COMPUTER SCIENCE (GPA: 3.78, cum laude)

Sep. 2012 - May 2016

Senior Thesis Advisors: Dr. Joseph D. Gelfand & Dr. David W. Hogg

Thesis Title: *Detecting Potential Jupiter-Analog Exoplanets in the Archival Kepler Dataset*

Open-Source Projects

jaxoplanet — 66 stars / 15 forks

Astronomical time series analysis with JAX [docs]

unpopular — 19 stars / 10 forks

An implementation of the Causal Pixel Model (CPM) for TESS data

Refereed Publications

FIRST-AUTHOR (CITATIONS: 63)

1. **Hattori, Soichiro**; Angus, Ruth; Foreman-Mackey, Daniel; Lu, Yuxi (Lucy); & Colman, Isabel, 2025, *Measuring Long Stellar Rotation Periods (>10 days) from TESS FFI Light Curves is Possible: An Investigation Using TESS and ZTF*, The Astronomical Journal, **170**, 15 (arXiv:2505.10376) [3 citations]
2. **Hattori, Soichiro**; Foreman-Mackey, Daniel; Hogg, David W.; Montet, Benjamin T.; Angus, Ruth; Pritchard, T. A.; Curtis, Jason L.; & Schölkopf, Bernhard, 2022, *The unpopular Package: A Data-driven Approach to Detrending TESS Full-frame Image Light Curves*, The Astronomical Journal, **163**, 284 (arXiv:2106.15063) [49 citations]
3. **Hattori, Soichiro**; Straal, Samayra M.; Zhang, Emily; Temim, Tea; Gelfand, Joseph D.; & Slane, Patrick O., 2020, *The Nonstandard Properties of a "Standard" PWN: Unveiling the Mysteries of PWN G21.5-0.9 Using Its IR and X-Ray Emission*, The Astrophysical Journal, **904**, 32 (arXiv:2009.10330) [11 citations]

N-TH AUTHOR

1. Evans-Soma, Thomas M.; Sing, David K.; Barstow, Joanna K.; Piette, Anjali A. A.; Taylor, Jake; et al. (incl. **Hattori, Soichiro**), 2025, *SiO and a super-stellar C/O ratio in the atmosphere of the giant exoplanet WASP-121 b*, Nature Astronomy, **9**, 845 (arXiv:2506.01771) [4 citations]
2. Lu, Yuxi (Lucy); Colman, Isabel L.; Sayeed, Maryum; Amard, Louis; Buder, Sven; et al. (incl. **Hattori, Soichiro**), 2025, *Evidence of Truly Young High- α Dwarf Stars*, The Astronomical Journal, **169**, 168 (arXiv:2410.02962) [6 citations]
3. Colman, Isabel L.; Angus, Ruth; David, Trevor; Curtis, Jason; **Hattori, Soichiro**; & Lu, Yuxi (Lucy), 2024, *Methods for the Detection of Stellar Rotation Periods in Individual TESS Sectors and Results from the Prime Mission*, The Astronomical Journal, **167**, 189 (arXiv:2402.14954) [16 citations]
4. Lu, Yuxi (Lucy); Angus, Ruth; Foreman-Mackey, Daniel; & **Hattori, Soichiro**, 2024, *In This Day and Age: An Empirical Gyrochronology Relation for Partially and Fully Convective Single Field Stars*, The Astronomical Journal, **167**, 159 (arXiv:2310.14990) [22 citations]
5. Grunblatt, Samuel K.; Saunders, Nicholas; Chontos, Ashley; **Hattori, Soichiro**; Veras, Dimitri; et al., 2023, *TESS Giants Transiting Giants. III. An Eccentric Warm Jupiter Supports a Period-Eccentricity Relation for Giant Planets Transiting Evolved Stars*, The Astronomical Journal, **165**, 44 (arXiv:2210.17062) [13 citations]
6. Lu, Yuxi Lucy; Curtis, Jason L.; Angus, Ruth; David, Trevor J.; & **Hattori, Soichiro**, 2022, *Bridging the Gap-The Disappearance of the Intermediate Period Gap for Fully Convective Stars, Uncovered by New ZTF Rotation Periods*, The Astronomical Journal, **164**, 251 (arXiv:2210.06604) [36 citations]
7. Saunders, Nicholas; Grunblatt, Samuel K.; Huber, Daniel; Collins, Karen A.; Jensen, Eric L. N.; et al. (incl. **Hattori, Soichiro**), 2022, *TESS Giants Transiting Giants. I.: A Noninflated Hot Jupiter Orbiting a Massive Subgiant*, The Astronomical Journal, **163**, 53 (arXiv:2108.02294) [22 citations]
8. Gelfand, J. D.; Straal, S.; & **Hattori, Soichiro**, 2019, MeV emission from pulsar wind nebulae, Memorie della Societa Astronomica Italiana, **90**, 92

Talks, Presentations, Workshops/Summer Schools

INVITED TALKS

2025	Oxford University SPI-MAX Seminar	Oxford, UK
2025	Yale University Exoplanet Seminar	New Haven, USA
2023	Imperial College London James Owen Group	London, UK

CONFERENCE PRESENTATIONS

2025	Boston Area Planetary Science Meeting 1 Oral Presentation	Boston, USA
2025	ExoNYC II 1 Oral Presentation	New York, USA
2023	Exoclimes VI 1 Poster Presentation	Exeter, UK
2023	241st AAS Winter Meeting 1 Oral Presentation	Seattle, USA
2022	Cool Stars 21 1 Poster Presentation	Toulouse, France
2020	235th AAS Winter Meeting Meeting 2 Oral Presentations	Honolulu, USA
2019	Supernova Remnants II: An Odyssey in Space after Stellar Death 1 Poster Presentation	Chania, Greece

WORKSHOPS/SUMMER SCHOOLS

2023	ExoSLAM summer school	Exeter, UK
2020	online.tess.science Working Meeting	Global (Remote)
2020	TESS Ninja 3: Expanding the Science of TESS Workshop	Sydney, Australia
2019	Advancing Theoretical Astrophysics Summer School	Amsterdam, Netherlands

Skill Highlights

Programming Languages	Python
Programming Packages	JAX, NumPy, Astropy, NumPy, Matplotlib, Jupyter/IPython
Operating Systems	macOS and Linux (Ubuntu)
Languages	Native speaker of English and Japanese

Work Experience

Research Assistant	New York, USA
ANGUS GROUP, DEPARTMENT OF ASTROPHYSICS, AMERICAN MUSEUM OF NATURAL HISTORY	April 2021 - Sep. 2021
Started project on recovering long rotation periods (>10 days) from stars in the <i>TESS</i> Continuous Viewing Zones	
Research Assistant	Abu Dhabi, UAE
GELFAND GROUP, PHYSICS PROGRAM, NEW YORK UNIVERSITY ABU DHABI	Aug. 2020 - April 2021
Detection of UV and X-ray transients in starburst galaxy IC10 using <i>Swift</i> data	
Assistant Instructor of Physics	Abu Dhabi, UAE
NEW YORK UNIVERSITY ABU DHABI	Sep. 2017 - Aug. 2020
Led recitation sessions, held office hours, assisted in creating exams and quizzes, and graded for:	
<ul style="list-style-type: none">• Foundations of Science 5 & 6 (equivalent to Physics III: Oscillators, Waves, Fourier Transforms, Optics, Basic QM)• Foundations of Science 1 & 2 (equivalent to Physics I: Introductory Classical Mechanics)• Lab component of Foundations of Science 1 & 2. Also prepared and delivered Introduction to Python lecture• Observing the Universe (General Education course)	

Research Experience

Revisiting the Parameter Space for Stellar Limb Darkening Coefficients	New York, USA
SUPERVISED BY DR. DANIEL FOREMAN-MACKEY, GOOGLE DEEPMIND	Jan. 2025 - Present
<ul style="list-style-type: none">• We show that adding a concavity constraint based on physical arguments for the commonly used quadratic limb-darkening removes 50% of the u_1-u_2 parameter space where u_1, u_2 are limb-darkening coefficients.• The excluded region reduces degeneracy with other parameters (e.g., impact parameter and transit duration) that are known to complicate transit light-curve modeling.• Currently applying our approach to higher-order cubic limb-darkening.	

jaxoplanet: A Robust Approach to Constructing Planetary Spectra from JWST Exoplanet Data

New York, USA

SUPERVISED BY **DR. RUTH ANGUS, AMNH** AND **DR. DANIEL FOREMAN-MACKEY, GOOGLE DEEPMIND**

Sep. 2022 - Present

- Developing an approach to produce transmission spectra by **simultaneously** fitting multiple spectroscopic JWST light curves, as opposed to the currently used two-step approach.
- Approach is able to capture covariances between all transit model parameters.
- Model is written with **JAX** and **NumPyro** to enable use of gradient-based inference methods such as **Hamiltonian Monte Carlo**.
- Validated our approach by comparing our spectrum to published spectrum for JWST NIRSpec G395H data of WASP-39 b.

Emulating Galaxy Formation Semi-analytic Models with a Graph Neural Network

New York, USA

FIRST-YEAR PROJECT, SUPERVISED BY **DR. GREG BRYAN, COLUMBIA UNIVERSITY**

Sep. 2021 - Sep. 2022

- Tested using a graph neural network (GNN) as an emulator for the Santa-Cruz semi-analytic model (SC-SAM) of galaxy formation.
- Ran the SC-SAM while changing the mass-outflow rate astrophysical parameter to create dataset.
- Showed novel result that GNN could generalize to work over a range of astrophysical parameters by modifying the publicly available **MANGROVE** GNN package and developing a method to incorporate the astrophysical parameters into the merger trees.
- Benchmarked GNN emulator performance to Random Forest (RF) regressor and showed GNN outperforms RF.

Extracting Long Stellar Rotation Periods from TESS FFI Light Curves

New York, USA

SUPERVISED BY **DR. RUTH ANGUS, AMNH**

April 2021 - Present

- Adapting **unpopular** to and extract long (>10 day) stellar rotation periods TESS FFI sources in the Continuous Viewing Zones (CVZ).
- Validating approach by comparing stitched TESS multi-sector periods to those obtained from ZTF light curves (longer baseline).
- Able to recover rotation periods of up to ~80 days from TESS light curves of M dwarfs in the Northern CVZ.
- First-author paper submitted to The Astronomical Journal

The unpopular Package: Background-Corrected Light Curves from TESS FFIs

New York, USA & Abu Dhabi, UAE

SUPERVISED BY **DR. DANIEL FOREMAN-MACKEY, GOOGLE DEEPMIND** AND **PROF. DAVID W. HOGG, NYU**

June 2019 - May 2022

- Developed **unpopular**, an **open-source Python package** to obtain de-trended light curves for variable sources in TESS full-frame images (FFI).
- Causal Pixel Model (CPM) method obtains de-trended light curves by exploiting causal structure of instrumental effects in FFIs.
- Method works at pixel-level by modeling noise as a linear combination of light curves from other appropriately selected pixels.
- Studied and implemented L_2 **regularization (ridge regression)** and **train-and-test framework** to prevent overfitting.
- Presented results at 235th AAS meeting and published first-author paper in The Astronomical Journal

Reanalysis of Pulsar Wind Nebula G21.5-0.9

Abu Dhabi, UAE

SUPERVISED BY **PROF. JOSEPH GELFAND, NYUAD**

May 2018 - Nov. 2020

- **First-author of paper (published in ApJ)** on reanalyzing archival data and modeling the pulsar wind nebula (PWN) G21.5-0.9.
- Wrote Python scripts to automate **XSPEC** data analysis for X-ray spectra.
- Ran **Markov Chain Monte Carlo** to quantify uncertainties for X-ray model parameters.
- Presented results at 235th AAS meeting.

Detecting Potential Jupiter-Analog Exoplanets in the Archival Kepler Dataset

New York, USA & Abu Dhabi, UAE

CAPSTONE PROJECT, SUPERVISED BY **PROF. DAVID W. HOGG, NYU** AND **PROF. JOSEPH GELFAND, NYUAD**

June 2014 - May 2016

- Implemented data analysis pipeline in Python to search for potential Jupiter-like exoplanets in entire *Kepler* dataset (1TB+).
- Modified the box-fitting algorithm to efficiently analyze entire dataset in less than 5 days.
- Wrote Bash scripts to to restructure more than 2 million files into format suitable for analysis.
- Detected 18 new candidate stars for hosting Jupiter-analog exoplanets.

Minimizing Telescope Tracking Error with Gaussian Processes

Tübingen, Germany

EMPIRICAL INFERENCE DEPARTMENT, **MAX PLANCK INSTITUTE FOR INTELLIGENT SYSTEMS**

June 2015 - Aug. 2015

- Collaborated on research project to minimize telescope tracking error using Gaussian processes.
- Studied Gaussian processes and implemented them in Python.
- Found appropriate covariance function and hyperparameters to minimize tracking error.