Daniel Foreman-Mackey

foreman.mackey@gmail.com, https://dfm.io
Associate Research Scientist, Center for Computational Astrophysics, Flatiron Institute

Education

PhD 2015, Department of Physics, New York University. Advisor: Hogg
MSc 2010, Department of Physics, Queen's University, Canada. Advisor: Widrow
BSc 2008, Department of Physics, McGill University, Canada.

Positions

Associate Research Scientist, Flatiron Institute, 2017–present.
Sagan Postdoctoral Fellow, University of Washington, 2015–2017.

Publications refereed: 57 / first author: 8 / citations: 6929 / h-index: 29 (2020-08-07)

Refereed publications

57 Plavchan, Peter; Barclay, Thomas; Gagné, Jonathan; Gao, Peter; *et al.* (incl. **DFM**), 2020, *Publisher Correction: A planet within the debris disk around the pre-main-sequence star AU Microscopii*, Nature, **583**

56 Hey, Daniel; Murphy, Simon; **Foreman-Mackey, Daniel**; Bedding, Timothy; *et al.*, 2020, *Maelstrom: A Python package for identifying companions to pulsating stars from their light travel time variations*, The Journal of Open Source Software, **5**, 2125

55 Plavchan, Peter; Barclay, Thomas; Gagné, Jonathan; Gao, Peter; *et al.* (incl. **DFM**), 2020, *A planet within the debris disk around the pre-main-sequence star AU Microscopii*, Nature, **582**, 497 (arXiv:2006.13248) [4 citations]

54 Hey, Daniel R.; Murphy, Simon J.; **Foreman-Mackey, Daniel**; Bedding, Timothy R.; *et al.*, 2020, *Forward Modeling the Orbits of Companions to Pulsating Stars from Their Light Travel Time Variations*, AJ, **159**, 202 (arXiv:2003.02379) [3 citations]

53 Agol, Eric; Luger, Rodrigo; & **Foreman-Mackey, Daniel**, 2020, *Analytic Planetary Transit Light Curves and Derivatives for Stars with Polynomial Limb Darkening*, AJ, **159**, 123 (arXiv:1908.03222) [5 citations]

52 Gillen, Edward; Briegal, Joshua T.; Hodgkin, Simon T.; **Foreman-Mackey, Daniel**; *et al.*, 2020, *NGTS clusters survey - I. Rotation in the young benchmark open cluster Blanco 1*, MNRAS, **492**, 1008 (arXiv:1911.09705) [3 citations]

51 **Foreman-Mackey, Daniel**; Farr, Will; Sinha, Manodeep; Archibald, Anne; *et al.*, 2019, *emcee v3: A Python ensemble sampling toolkit for affine-invariant MCMC*, The Journal of Open Source Software, **4**, 1864 (arXiv:1911.07688) [15 citations]

50 Angus, Ruth; Morton, Timothy D.; **Foreman-Mackey, Daniel**; van Saders, Jennifer; *et al.*, 2019, *Toward Precise Stellar Ages: Combining Isochrone Fitting with Empirical Gyrochronology*, AJ, **158**, 173 (arXiv:1908.07528) [8 citations]

49 David, Trevor J.; Petigura, Erik A.; Luger, Rodrigo; **Foreman-Mackey, Daniel**; *et al.*, 2019, *Four Newborn Planets Transiting the Young Solar Analog V1298 Tau*, ApJ, **885** (arXiv:1910.04563) [12 citations]

48 Bedell, Megan; Hogg, David W.; **Foreman-Mackey, Daniel**; Montet, Benjamin T.; & Luger, Rodrigo, 2019, *WOBBLE: A Data-driven Analysis Technique for Time-series Stellar Spectra*, AJ, **158**, 164 (arXiv:1901.00503) [12 citations]

47 Feinstein, Adina D.; Montet, Benjamin T.; **Foreman-Mackey, Daniel**; Bedell, Megan E.;

et al., 2019, *eleanor: An Open-source Tool for Extracting Light Curves from the TESS Full-frame Images*, PASP, **131**, 94502 (arXiv:1903.09152) [25 citations]

46 Kruse, Ethan; Agol, Eric; Luger, Rodrigo; & **Foreman-Mackey, Daniel**, 2019, *Detection of Hundreds of New Planet Candidates and Eclipsing Binaries in K2 Campaigns 0-8*, The Astrophysical Journal Supplement Series, **244**, 11 (arXiv:1907.10806) [10 citations]

45 Angus, Ruth; Morton, Timothy; & **Foreman-Mackey, Daniel**, 2019, *stardate: Combining dating methods for better stellar ages*, The Journal of Open Source Software, **4**, 1469 [3 citations]

44 Kostov, Veselin B.; Schlieder, Joshua E.; Barclay, Thomas; Quintana, Elisa V.; *et al.* (incl. **DFM**), 2019, *The L 98-59 System: Three Transiting, Terrestrial-size Planets Orbiting a Nearby M Dwarf*, AJ, **158**, 32 (arXiv:1903.08017) [21 citations]

43 Siemiginowska, Aneta; Eadie, Gwendolyn; Czekala, Ian; Feigelson, Eric; *et al.* (incl. **DFM**), 2019, The Next Decade of Astroinformatics and Astrostatistics, Bulletin of the American Astronomical Society, **51**, 355 (arXiv:1903.06796)

42 Van Eylen, Vincent; Albrecht, Simon; Huang, Xu; MacDonald, Mariah G.; *et al.* (incl. **DFM**), 2019, *The Orbital Eccentricity of Small Planet Systems*, AJ, **157**, 61 (arXiv:1807.00549) [48 citations]

41 Luger, Rodrigo; Agol, Eric; **Foreman-Mackey, Daniel**; Fleming, David P.; *et al.*, 2019, *starry: Analytic Occultation Light Curves*, AJ, **157**, 64 (arXiv:1810.06559) [31 citations]

40 Brewer, John M.; Wang, Songhu; Fischer, Debra A.; & **Foreman-Mackey, Daniel**, 2018, *Compact Multi-planet Systems are more Common around Metal-poor Hosts*, ApJ, **867** (arXiv:1810.10009) [11 citations]

39 Ness, Melissa K.; Silva Aguirre, Victor; Lund, Mikkel N.; Cantiello, Matteo; *et al.* (incl. **DFM**), 2018, *Inference of Stellar Parameters from Brightness Variations*, ApJ, **866**, 15 (arXiv:1805.04519) [3 citations]

38 Brewer, Brendon; & **Foreman-Mackey, Daniel**, 2018, *DNest4: Diffusive Nested Sampling in C++ and Python*, Journal of Statistical Software, **86**, 1 (arXiv:1606.03757) [17 citations]

37 Luger, Rodrigo; Kruse, Ethan; **Foreman-Mackey, Daniel**; Agol, Eric; & Saunders, Nicholas, 2018, *An Update to the EVEREST K2 Pipeline: Short Cadence, Saturated Stars, and Kepler-like Photometry Down to Kp = 15*, AJ, **156**, 99 (arXiv:1702.05488) [68 citations]

36 Teague, Richard; & **Foreman-Mackey, Daniel**, 2018, *A Robust Method to Measure Centroids of Spectral Lines*, Research Notes of the American Astronomical Society, **2**, 173 (arXiv:1809.10295) [17 citations]

35 Teague, Richard; Bae, Jaehan; Bergin, Edwin A.; Birnstiel, Tilman; & **Foreman-Mackey, Daniel**, 2018, *A Kinematical Detection of Two Embedded Jupiter-mass Planets in HD 163296*, ApJ, **860** (arXiv:1805.10290) [82 citations]

34 Hogg, David W.; & **Foreman-Mackey, Daniel**, 2018, *Data Analysis Recipes: Using Markov Chain Monte Carlo*, The Astrophysical Journal Supplement Series, **236**, 11 (arXiv:1710.06068) [44 citations]

33 Angus, Ruth; Morton, Timothy; Aigrain, Suzanne; **Foreman-Mackey, Daniel**; & Rajpaul, Vinesh, 2018, *Inferring probabilistic stellar rotation periods using Gaussian processes*, MNRAS, **474**, 2094 (arXiv:1706.05459) [58 citations]

32 **Foreman-Mackey, Daniel**, 2018, *Scalable Backpropagation for Gaussian Processes using Celerite*, Research Notes of the American Astronomical Society, **2**, 31 (arXiv:1801.10156) [13 citations]

31 **Foreman-Mackey, Daniel**; Agol, Eric; Ambikasaran, Sivaram; & Angus, Ruth, 2017, *Fast and Scalable Gaussian Process Modeling with Applications to Astronomical Time Series*, AJ, **154**, 220 (arXiv:1703.09710) [151 citations]

30 Montet, Benjamin T.; Tovar, Guadalupe; & **Foreman-Mackey, Daniel**, 2017, *Long-term Photometric Variability in Kepler Full-frame Images: Magnetic Cycles of Sun-like Stars*, ApJ, **851**, 116 (arXiv:1705.07928) [41 citations]

29 Grunblatt, Samuel K.; Huber, Daniel; Gaidos, Eric; Lopez, Eric D.; *et al.* (incl. **DFM**), 2017, *Seeing Double with K2: Testing Re-inflation with Two Remarkably Similar Planets around Red Giant Branch Stars*, AJ, **154**, 254 (arXiv:1706.05865) [29 citations]

28 Luger, Rodrigo; **Foreman-Mackey, Daniel**; & Hogg, David W., 2017, *Linear Models for Systematics and Nuisances*, Research Notes of the American Astronomical Society, **1**, 7 (arXiv:1710.11136) [6 citations]

27 Price-Whelan, Adrian M.; & **Foreman-Mackey, Daniel**, 2017, *schwimmbad: A uniform interface to parallel processing pools in Python*, The Journal of Open Source Software, **2**, 357 [12 citations]

26 Luger, Rodrigo; Sestovic, Marko; Kruse, Ethan; Grimm, Simon L.; *et al.* (incl. **DFM**), 2017, *A seven-planet resonant chain in TRAPPIST-1*, Nature Astronomy, **1**, 129 (arXiv:1703.04166) [155 citations]

25 Price-Whelan, Adrian M.; Hogg, David W.; **Foreman-Mackey, Daniel**; & Rix, Hans-Walter, 2017, *The Joker: A Custom Monte Carlo Sampler for Binary-star and Exoplanet Radial Velocity Data*, ApJ, **837**, 20 (arXiv:1610.07602) [32 citations]

24 **Foreman-Mackey, Daniel**; Morton, Timothy D.; Hogg, David W.; Agol, Eric; & Schölkopf, Bernhard, 2016, *The Population of Long-period Transiting Exoplanets*, AJ, **152**, 206 (arXiv:1607.08237) [51 citations]

23 Henderson, Calen B.; Poleski, Radosław; Penny, Matthew; Street, Rachel A.; *et al.* (incl. **DFM**), 2016, *Campaign 9 of the K2 Mission: Observational Parameters, Scientific Drivers, and Community Involvement for a Simultaneous Space- and Ground-based Microlensing Survey*, PASP, **128**, 124401 (arXiv:1512.09142) [53 citations]

22 Hogg, David W.; Casey, Andrew R.; Ness, Melissa; Rix, Hans-Walter; *et al.* (incl. **DFM**), 2016, *Chemical Tagging Can Work: Identification of Stellar Phase-space Structures Purely by Chemical-abundance Similarity*, ApJ, **833**, 262 (arXiv:1601.05413) [50 citations]

21 Luger, Rodrigo; Agol, Eric; Kruse, Ethan; Barnes, Rory; *et al.* (incl. **DFM**), 2016, *EVEREST: Pixel Level Decorrelation of K2 Light Curves*, AJ, **152**, 100 (arXiv:1607.00524) [139 citations]

20 Angus, Ruth; Aigrain, Suzanne; & **Foreman-Mackey, Daniel**, 2016, *Stellar rotation period inference with Gaussian processes*, IAU Focus Meeting, **29A**, 191

19 Wang, Dun; Hogg, David W.; **Foreman-Mackey, Daniel**; & Schölkopf, Bernhard, 2016, *A Causal, Data-driven Approach to Modeling the Kepler Data*, PASP, **128**, 94503 (arXiv:1508.01853) [13 citations]

18 Fischer, Debra A.; Anglada-Escude, Guillem; Arriagada, Pamela; Baluev, Roman V.; *et al.*

(incl. **DFM**), 2016, *State of the Field: Extreme Precision Radial Velocities*, PASP, **128**, 66001 (arXiv:1602.07939) [140 citations]

17 **Foreman-Mackey, Daniel**, 2016, *corner.py: Scatterplot matrices in Python*, The Journal of Open Source Software, **1**, 2 [725 citations]

16 Schölkopf, Bernhard; Hogg, David W.; Wang, Dun; **Foreman-Mackey, Daniel**; *et al.*, 2016, *Modeling confounding by half-sibling regression*, PNAS, **113**, 27 [25 citations]

15 Angus, Ruth; **Foreman-Mackey, Daniel**; & Johnson, John A., 2016, *Systematics-insensitive Periodic Signal Search with K2*, ApJ, **818**, 109 (arXiv:1505.07105) [19 citations]

14 Ambikasaran, Sivaram; **Foreman-Mackey, Daniel**; Greengard, Leslie; Hogg, David W.; & O'Neil, Michael, 2016, *Fast Direct Methods for Gaussian Processes*, IEEE Transactions on Pattern Analysis and Machine Intelligence, **38**, 252 (arXiv:1403.6015) [266 citations]

13 Montet, Benjamin T.; Morton, Timothy D.; **Foreman-Mackey, Daniel**; Johnson, John Asher; *et al.*, 2015, *Stellar and Planetary Properties of K2 Campaign 1 Candidates and Validation of 17 Planets, Including a Planet Receiving Earth-like Insolation*, ApJ, **809**, 25 (arXiv:1503.07866) [83 citations]

12 Barclay, Thomas; Quintana, Elisa V.; Adams, Fred C.; Ciardi, David R.; *et al.* (incl. **DFM**), 2015, *The Five Planets in the Kepler-296 Binary System All Orbit the Primary: A Statistical and Analytical Analysis*, ApJ, **809**, 7 (arXiv:1505.01845) [23 citations]

11 Angus, Ruth; Aigrain, Suzanne; **Foreman-Mackey, Daniel**; & McQuillan, Amy, 2015, *Calibrating gyrochronology using Kepler asteroseismic targets*, MNRAS, **450**, 1787 (arXiv:1502.06965) [86 citations]

10 **Foreman-Mackey, Daniel**; Montet, Benjamin T.; Hogg, David W.; Morton, Timothy D.; *et al.*, 2015, *A Systematic Search for Transiting Planets in the K2 Data*, ApJ, **806**, 215 (arXiv:1502.04715) [85 citations]

9 Weisz, Daniel R.; Johnson, L. Clifton; **Foreman-Mackey, Daniel**; Dolphin, Andrew E.; *et al.*, 2015, *The High-mass Stellar Initial Mass Function in M31 Clusters*, ApJ, **806**, 198 (arXiv:1502.06621) [34 citations]

8 Schölkopf, Bernhard; Hogg, David W.; Wang, Dun; **Foreman-Mackey, Daniel**; *et al.*, 2015, Removing systematic errors for exoplanet search via latent causes, ICML, **37**, 2218 (arXiv:1505.03036) [7 citations]

7 Barclay, Thomas; Endl, Michael; Huber, Daniel; **Foreman-Mackey, Daniel**; *et al.*, 2015, *Radial Velocity Observations and Light Curve Noise Modeling Confirm that Kepler-91b is a Giant Planet Orbiting a Giant Star*, ApJ, **800**, 46 (arXiv:1408.3149) [50 citations]

6 **Foreman-Mackey, Daniel**; Hogg, David W.; & Morton, Timothy D., 2014, *Exoplanet Population Inference and the Abundance of Earth Analogs from Noisy, Incomplete Catalogs*, ApJ, **795**, 64 (arXiv:1406.3020) [157 citations]

5 Dawson, Rebekah I.; Johnson, John Asher; Fabrycky, Daniel C.; **Foreman-Mackey, Daniel**; *et al.*, 2014, *Large Eccentricity, Low Mutual Inclination: The Three-dimensional Architecture of a Hierarchical System of Giant Planets*, ApJ, **791**, 89 (arXiv:1405.5229) [51 citations]

4 Dorman, Claire E.; Widrow, Lawrence M.; Guhathakurta, Puragra; Seth, Anil C.; *et al.* (incl. **DFM**), 2013, *A New Approach to Detailed Structural Decomposition from the SPLASH and PHAT Surveys: Kicked-up Disk Stars in the Andromeda Galaxy?*, ApJ,

779, 103 (arXiv:1310.4179) [43 citations]

3 Brewer, Brendon J.; **Foreman-Mackey, Daniel**; & Hogg, David W., 2013, *Probabilistic Catalogs for Crowded Stellar Fields*, AJ, **146**, 7 (arXiv:1211.5805) [28 citations]

2 **Foreman-Mackey, Daniel**; Hogg, David W.; Lang, Dustin; & Goodman, Jonathan, 2013, *emcee: The MCMC Hammer*, PASP, **125**, 306 (arXiv:1202.3665) [3783 citations]

1 Weisz, Daniel R.; Fouesneau, Morgan; Hogg, David W.; Rix, Hans-Walter; *et al.* (incl. **DFM**), 2013, *The Panchromatic Hubble Andromeda Treasury. IV. A Probabilistic Approach to Inferring the High-mass Stellar Initial Mass Function and Other Power-law Functions*, ApJ, **762**, 123 (arXiv:1211.6105) [29 citations]

Preprints & white papers

7 Gordon, Tyler; Agol, Eric; & **Foreman-Mackey, Daniel**, 2020, A Fast, 2D Gaussian Process Method Based on Celerite: Applications to Transiting Exoplanet Discovery and Characterization, arXiv e-prints (arXiv:2007.05799)

6 Villaume, Alexa; **Foreman-Mackey, Daniel**; Romanowsky, Aaron J.; Brodie, Jean; & Strader, Jay, 2020, The Assembly History of M87 Through Radial Variations in Chemical Abundances of its Field Star And Globular Cluster Populations, arXiv e-prints (arXiv:2006.16280)

5 Angus, Ruth; Beane, Angus; Price-Whelan, Adrian M.; Newton, Elisabeth; *et al.* (incl. **DFM**), 2020, Exploring the evolution of stellar rotation using Galactic kinematics, arXiv e-prints (arXiv:2005.09387)

4 Wang, Dun; Hogg, David W.; **Foreman-Mackey, Daniel**; & Schölkopf, Bernhard, 2017, A pixel-level model for event discovery in time-domain imaging, arXiv e-prints (arXiv:1710.02428) [4 citations]

3 Barnes, Rory; Deitrick, Russell; Luger, Rodrigo; Driscoll, Peter E.; *et al.* (incl. **DFM**), 2016, The Habitability of Proxima Centauri b I: Evolutionary Scenarios, arXiv e-prints (arXiv:1608.06919) [46 citations]

2 Montet, Benjamin T.; Angus, Ruth; Barclay, Tom; Dawson, Rebekah; *et al.* (incl. **DFM**), 2013, Maximizing Kepler science return per telemetered pixel: Searching the habitable zones of the brightest stars, arXiv e-prints (arXiv:1309.0654)

1 Hogg, David W.; Angus, Ruth; Barclay, Tom; Dawson, Rebekah; *et al.* (incl. **DFM**), 2013, Maximizing Kepler science return per telemetered pixel: Detailed models of the focal plane in the two-wheel era, arXiv e-prints (arXiv:1309.0653)

Selected invited talks & tutorials

A modular ecosystem for probabilistic data analysis, 2019, Invited Talk, Open Digital Infrastructure in Astronomy conference, Kavli Institute for Theoretical Physics.

Exoplanet population inference, a tutorial, 2019, Invited Talk, Exostar19 conference, Kavli Institute for Theoretical Physics.

Astronomy as a testbed for statistical method development, 2019, Colloquium, Center for Statistics and Machine Learning, Princeton.

Data-driven discovery in the astronomical time domain, 2018, Colloquium, Institute for Theory and Computation, Harvard-Smithsonian Center for Astrophysics.

Data-driven discovery in the astronomical time domain, 2018, Colloquium, University of California, Santa Cruz.

A practical introduction to Gaussian Processes for astronomy, 2017, Invited Talk, Statistical Challenges in Astrophysics, University of New South Wales, Australia.

Data-driven discovery in the astronomical time domain, 2017, Interdisciplinary Colloquium, CIERA, Northwestern University.

Long-period transiting planets & their population, 2016, Invited talk, Exoplanets I, Davos.

Long-period transiting planets & their population, 2016, Invited talk, Statistical Challenges of Modern Astrophysics, Carnegie Mellon.

Long-period transiting planets & their population, 2016, Colloquium, Villanova.

Scalable Gaussian processes & the search for transiting exoplanets, 2015, Data Science at the LHC, CERN, Geneva.

Discovery & characterization of transiting exoplanets & their population, 2015, Colloquium, University of Washington.

Hierarchical inference for exoplanet population inference, 2015, IAU Symposium, Honolulu.

Data-driven models, 2015, Extreme precision radial velocities, Yale.

Population inference from noisy & incomplete catalogs, 2015, Local Group Astrostatistics, University of Michigan.

Time series analysis, Gaussian Processes, and the search for exo-Earths, 2014, PyData NYC conference, New York.

Introduction to Gaussian Processes, probabilistic graphical models, and deep learning, 2014, Astro Hack Week, University of Washington.

An astronomer's introduction to Gaussian processes, 2014, Bayesian Computing for Astronomical Data Analysis (Summer school at Penn State University).

Popular open-source software

emcee — 1061 stars / 379 forks
The Python ensemble sampling toolkit for affine-invariant MCMC [docs]

george — 346 stars / 114 forks
Fast and flexible Gaussian Process regression in Python [docs]

celerite — 141 stars / 33 forks
Scalable 1D Gaussian Processes in C++, Python, and Julia [docs]

daft — 552 stars / 108 forks
Render probabilistic graphical models using matplotlib [docs]

corner.py — 288 stars / 181 forks
Make some beautiful corner plots [docs]

exoplanet — 104 stars / 28 forks
Fast & scalable MCMC for all your exoplanet needs! [docs]

Grants

NSF-CDS&E (PI: Agol) *Development of fast, multi-dimensional Gaussian Processes for Exoplanet discovery and beyond*, $471,048.00, 2019–2022

NSF-AAG (PI: Agol), *Collaborative Research: Masses and architectures of (potentially habitable) exoplanet systems*, $491,950, 2016–2018

K2 Guest Observer – Cycle 3 (PI: Penny), *Free-Floating and Bound Planet Mass Measurements with K2: Ground- and Space-Based Photometry, Event Detection and*

Modeling, $84,000, 2016–2017

K2 Guest Observer – Cycle 3 (PI: Hogg), *Ultra-precise photometry in crowded fields: A self-calibration approach*, $100,000, 2016–2017

XSEDE (PI: Foreman-Mackey), *A systematic search for transiting exoplanets using K2*, 100,000 CPU hours, 2015–2016

Honors

Kavli Fellow, 2015.

Sagan Postdoctoral Fellowship, 2015–2017.

James Arthur Graduate Fellowship, 2014.

Horizon Fellowship in the Natural & Physical Sciences, 2012.

Henry M. MacCracken Fellowship, 2010.

NSERC Undergraduate Summer Research Award, 2007.

Professional service & activities

Topic Editor — Journal of Open Source Software

Active Referee — AAS Journals, MNRAS, PASP, Journal of Statistical Software, Journal of Open Source Software