

# Michael S. Petersen

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## Research

Design, implement, execute, and analyse precision numerical models to understand dark matter dynamical evolution in disk galaxies and their halo environs, particularly our own Milky Way.

## Position

**Stephen Hawking Fellow** April 2022-  
*Institute for Astronomy, Royal Observatory Edinburgh, UK*  
**Postdoctoral Research Associate** September 2021-March 2021  
*Institut d'Astrophysique de Paris, France*  
**Postdoctoral Research Associate** May 2019-August 2021  
*Institute for Astronomy, Royal Observatory Edinburgh, UK*

## Education

**Doctor of Philosophy, Astronomy** February 2019  
*University of Massachusetts at Amherst, Amherst, MA, USA*  
*The non-linear dynamics of barred galaxy evolution in  $\Lambda$ CDM*

## Collaborations

### **Basis-function expansion (Beefy) Collaboration**

Co-leader of a Center for Computational Astrophysics (NYC)-led collaboration. The group is working to develop a holistic approach to galaxy evolution using basis function expansions. I am directly responsible for coordinating software development.

### **SEGAL Collaboration**

Assisting analysis of barred galaxies in the New Horizon simulation within the SEGAL collaboration (PI: Christophe Pichon [Institut Astrophysique de Paris]). The collaboration is developing a new kinetic theory-based picture of galactic dynamics. I am responsible for supplying a novel kinematic method to detect barred galaxies with unprecedented sensitivity.

## Service

### **Peer Reviewer**

Serving as a peer reviewer for Monthly Notices of the Royal Astronomical Society (MNRAS).

### **ROE Equality, Diversity and Inclusion Team Organiser** 2020-2021

Initiated a team to study issues of equality, diversity and inclusion at the Institute for Astronomy.

**ROE Seminar Organiser** 2019-2021  
Responsible for selection of speakers and organising delivery of talks for the Royal Observatory. Includes remote organisation and hosting during work-from-home period.

**ROE Local Universe Reading Group Organiser** 2019-2021  
Responsible for programming and hosting a roughly dozen-person reading group covering multiple research teams at the ROE. Includes remote organisation and hosting during work-from-home period.

**Teaching & Advising** **Columbia Post-Baccalaureate Program Research Advisor** 2020-2022  
Assisted advising, providing project guidance and numerical training, to a post-baccalaureate student at Columbia University, New York.

**University of Edinburgh Research Advisor** 2019-2021  
Designed and advised a masters project at the University of Edinburgh. Designed, sought funding for, and advised two summer research projects for advanced undergraduate students at the University of Edinburgh. Designed and advised seven research projects for undergraduate students at the University of Edinburgh over four semesters.

**Recent Invited Science Talks**

**Strasbourg Observatory** March 2022  
*A new picture for the Large Magellanic Cloud-Milky Way interaction*

**University of Surrey** February 2021  
*Modelling Milky Way dark matter from the largest to the smallest scales*

**Institute of Astronomy (Cambridge) Dynamics Group** May 2020  
*Bar models beyond analytic formulae*

**AIP (Potsdam) Local Universe Group** January 2020  
*Bespoke N-body experiments in barred galaxy dynamics*

**Recent Public Engagement Talks**

**Royal Observatory Edinburgh** January 2021  
*How do astronomers model gravity?*

**Royal Observatory Open Days** September 2020  
*Spaceship Earth: The amazing travels of our home through the cosmos*

**Highlands Astronomical Society** August 2020  
*Why Can't We Find Dark Matter?*

**Publications**

*First-author publications*

8. **Petersen, M. S.**, Weinberg, M. D., and Katz, N. *exp: N-body integration using basis function expansions*, 2022, MNRAS, 510:6201.

7. **Petersen, M. S.** & Peñarrubia, J. *Detection of the Milky Way reflex motion induced by the Large Magellanic Cloud infall*, 2021, Nature Astronomy, 5, 251. See summary of press coverage [here](#).

6. **Petersen, M. S.**, Weinberg, M. D., and Katz, N. *Using commensurabilities and orbit structure to understand barred galaxy evolution*, 2021, MNRAS, 500:838.
5. **Petersen, M. S.** & Peñarrubia, J. *Reflex motion in the Milky Way stellar halo resulting from the Large Magellanic Cloud infall*, 2020, MNRASL, 494:11.
4. **Petersen, M. S.**, Weinberg, M. D., and Katz, N. *Using torque to understand barred galaxy models*, 2019, MNRAS, 490:3616.
3. **Petersen, M. S.**, Gutermuth, R.A., Nagel, E., Wilson, G.W., Lane, J. *Early science with the Large Millimetre Telescope: new mm-wave detections of circumstellar discs in IC 348 from LMT/AzTEC*, 2019, MNRAS, 488:1462.
2. **Petersen, M. S.**, Katz, N. , & Weinberg, M.D. *The Dynamical Response of Dark Matter to Galaxy Evolution Affects Direct-Detection Experiments*, Phys Rev D, 2016. Figure 4 was featured as part of the journal's 'Kaleidoscope'.
1. **Petersen, M. S.**, Weinberg, M. D., and Katz, N. *Dark matter trapping by stellar bars: the shadow bar* 2016, MNRAS, 463:1952–1967.

First-author publications in review

2. **Petersen, M. S.**, Peñarrubia, J., and Jones, E. *Tidally stripped halo stars from the Large Magellanic Cloud in the Galactic North*, arXiv e-prints.
1. **Petersen, M. S.**, Weinberg, M. D., and Katz, N. *Using harmonic decomposition to understand barred galaxy evolution*, arXiv e-prints.

Significant co-authored publications

5. Donaldson, K., **Petersen, M. S.**, and Peñarrubia, J.. *Effects on the local dark matter distribution due to the Large Magellanic Cloud*, MNRAS submitted.
4. Reddish, J., Kraljic, K, **Petersen, M. S.**, and others. *The NewHorizon Simulation – To Bar Or Not To Bar*, MNRAS accepted.
3. Peñarrubia, J. & **Petersen, M. S.** *Identification of Sagittarius stream members in Angular Momentum space with Gaussian mixture techniques*, MNRASL 508:L26.
2. Weinberg, M. D. & **Petersen, M. S.** *Using Multichannel Singular Spectrum Analysis to Study Galaxy Dynamics*, 2021, MNRAS 501:5408.
1. Bary, Jeffrey S. & **Petersen, M. S.** *Anomalous Accretion Activity and the Spotted Nature of the DQ Tau Binary System* 2014, ApJ, 792:64.

Selected  
Observational  
Experience

**NASA IRTF**, Co-I (2018B, 2019B, 2020B), 12 nights  
*SpeX+MORIS Star Spot Monitoring of K2 Selected T Tauri Stars*  
*iSHELL Accretion and Gas Dynamics in Transition Disk-bearing Young*

*Stars Across the Substellar Boundary*

**KPNO 0.9m**, PI (2016-2017), 5 nights; Co-I (2014-2018), 30 nights

*Deep Imaging of Nearby Low Surface Brightness Disks*

*Ionization States of Green Pea Galaxies*

**Large Millimeter Telescope**, PI (Early Science 2,3,4 2014-2016), 60 hours

*Circumstellar Disk Masses in IC 348*

**Professional Links** **Research Webpage** <https://michael-petersen.github.io>

**Github Code Repository** <https://github.com/michael-petersen>

**References** **Christophe Pichon**  
Institut d'Astrophysique de Paris postdoctoral research supervisor.

**Jorge Peñarrubia**  
University of Edinburgh postdoctoral research supervisor.

**Martin D. Weinberg**  
University of Massachusetts, Amherst, dissertation advisor.