Philip Mocz

Department of Astrophysical Sciences
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Research Interests computational fluid dynamics • magnetohydrodynamics • turbulence • quantum dark matter • galaxy evolution & feedback • black hole physics • cosmological simulations • star formation

Positions

Princeton University, Princeton, NJ — Sept 2017 - present
Einstein Fellow

Education

Harvard University, Cambridge, MA — Sept 2012 - May 2017
Ph.D., Astrophysics
Secondary Field in Computational Science and Engineering (May 2015)
Moving mesh magnetohydrodynamics: magnetic processes in star formation and cosmology
(advisor: L. Hernquist)

Harvard University, Cambridge, MA — May 2014
S.M., Astrophysics

Harvard University, Cambridge, MA — Sept 2008 - May 2012
A.B., Mathematics and Astrophysics, *Summa Cum Laude* w/ highest honors

Honors & Awards

Spitzer Fellowship	2020 - 2022
Einstein Fellowship	2017 - 2020
Eric Keto Prize	2017
Harvard Merit Fellowship	2016
NASA Earth and Space Science Fellowship (NESSF)	2015 - 2017
NSF Graduate Research Fellowship	2012 - 2015
Peirce Fellowship (Harvard)	2012
Derek Bok Center Certificate of Distinction in Teaching (Harvard)	2012
John Harvard Scholar	2008 - 2012
Phi Beta Kappa (Harvard)	2011
Leo Goldberg Prize for Astronomy Junior Thesis (Harvard)	2011
CAS vacation scholarship (Swinburne Univ. of Technology)	2011
Weissman International Internship Program Scholarship	2010
Detur Prize (Harvard)	2009
Harvard College Program for Research in Science and Engineering	2009

Publications

24. **The Dense Gas Fraction and The Critical Density Required for Star Formation**
Burkhart, B.; **Mocz, P.**; 2018 MNRAS submitted

23. **Star formation from dense shocked regions in supersonic isothermal magneto-turbulence**
Mocz, P.; Burkhart, B.; 2018 MNRAS 480, 3916

22. **Evolution of the Black Hole Mass Function in Star Clusters from Multiple Mergers**
Christian, P.; **Mocz, P.**; Loeb, A.; 2018 ApJL 858, 8

21. **Schrödinger-Poisson–Vlasov-Poisson correspondence**
Mocz, P.; Lancaster, L.; Fialkov, A.; Becerra, F.; Chavanis, P.-H.; 2018 Phys. Rev. D 97, 3519

20. **Non-ideal magnetohydrodynamics on a moving mesh**
Marinacci, F.; Vogelsberger, M.; Kannan, R.; Mocz, P.; Pakmor, R.; Springel, V.; 2018 MNRAS, 476, 2476

19. **Galaxy Formation with BECDM: I. Turbulence and relaxation of idealised haloes**
Mocz, P.; Vogelsberger, M.; Robles, V.; Zavala J.; Boylan-Kolchin, M.; Fialkov A.; Hernquist, L.; 2017 MNRAS, 471, 4

18. **Unveiling the role of the magnetic field at the smallest scales of star formation**
Hull C.L.H.; Mocz, P.; Burkhart, B.; Goodman, A.A.; Girart, J.M.; Cortés, P.C.; Hernquist, L.; Li, Z.-Y; Lai, S.-P.; Springel, V.; 2017 ApJL, 842, 9

17. **Moving mesh simulations of star forming cores in magneto-gravo-turbulence**
Mocz, P.; Burkhart, B.; Hernquist, L.; McKee, C.; Springel, V.; 2017 ApJ, 838, 1

16. **Integer lattice dynamics for Vlasov-Poisson**
Mocz, P.; Succi, S.; 2017 MNRAS, 465, 3154

15. **Correspondence between constrained transport and vector potential methods for MHD**
Mocz, P.; 2017 J. Comp. Phys., 328, 221

14. **A moving mesh unstaggered constrained transport scheme for MHD**
Mocz, P.; Pakmor, R.; Springel, V.; Vogelsberger, M.; Marinacci, F.; Hernquist, L.; 2016 MNRAS, 463, 477

13. **Improving the convergence properties of the moving-mesh code AREPO**
Pakmor, R.; Springel, V.; Bauer, A.; Mocz, P.; Munoz, D.J.; Ohlmann, S.T.; Schaal, K.; Zhu, C.; 2016 MNRAS, 455, 1134

12. **The large-scale properties of simulated cosmological magnetic fields**
Marinacci, F.; Vogelsberger, M.; Mocz, P.; Pakmor, R.; 2015 MNRAS, 453, 3999

11. **Reducing noise in moving-grid codes with strongly-centroidal Lloyd mesh regularization**
Mocz, P.; Vogelsberger, M., Pakmor, R., Genel, S., Springel, V., Hernquist, L.; 2015 MNRAS, 452, 3853

10. **Numerical solution to the non-linear Schrödinger equation using smoothed-particle hydrodynamics**
Mocz, P.; Succi, S.; 2015 Phys. Rev. E, 91, 053304

9. **Interpreting MAD within multiple accretion regimes**
Mocz, P.; Guo, X.; 2015 MNRAS, 447, 1498

8. **A constrained transport scheme for MHD on unstructured static and moving meshes**
Mocz, P.; Vogelsberger, M.; Hernquist, L. 2014 MNRAS, 442, 43

7. **Do high-redshift quasars have powerful jets?**
Fabian, A.C.; Walker, S.A.; Celotti, A.; Ghisellini, G.; Mocz, P.; Blundell, K.M.; McMahon, R.G. 2014 MNRAS, 442L, 81

6. **A discontinuous Galerkin method for solving the fluid and magnetohydrodynamic equations in astrophysical simulations**
Mocz, P.; Vogelsberger, M.; Sijacki, D.; Pakmor, R.; Hernquist, L. 2014 MNRAS, 437, 397

5. **Cosmological growth and feedback from supermassive black holes**
   Mocz, P.; Fabian, A.C.; Blundell, K.M.; 2013 MNRAS, 432, 3381
4. **The Tully-Fisher relation for 25,000 Sloan Digital Sky Survey galaxies as a function of environment**
   Mocz, P.; Glazebrook, K.; Green A.; 2012 MNRAS, 425, 296
3. **Inverse-Compton ghosts and double-lobed radio sources in the X-ray sky**
   Mocz, P.; Fabian, A.C.; Blundell, K.M.; 2011 MNRAS, 413, 1107
2. **The inverse-Compton ghost HDF 130 and the giant radio galaxy 6C 0905+3955: matching an analytic model for double radio source evolution**
   Mocz, P.; Fabian, A.C.; Blundell, K.M.; Goodall, P.T.; Chapman, S.C.; Saikia, D.J.; 2011 MNRAS 417, 1576
1. **A Detection of an X-ray Wind and an Ionized Disk in the Chandra HETGS Observation of the Seyfert 2 Galaxy IRAS 18325-5926**
   Mocz, P.; Lee, J.C.; Iwasawa, K.; Canizares, C.R.; 2011 ApJ, 729, 30

Presentations

Quantum Wave Dark Matter and the Classical Limit
MX Dark Matter, Nov 2018. *Invited*

Small-scale features in fuzzy dark matter cosmology
Einstein Symposium, Oct 2018

Soliton core formation in fuzzy dark matter and the classical limit
CITA theory seminar, Sept 2018. *Invited*

Galaxy Formation with Bose-Einstein Condensate Dark Matter
Ringberg Computational Galaxy Formation, Mar 2018. *Invited*

Magneto- and turbulent regimes of star formation
ALMA NA Taiwan Joint Workshop: Magnetic Fields or Turbulence?, Feb 2018

Solving Vlasov-Poisson dynamics on an integer lattice
CIRM Collisionless Boltzmann (Vlasov) Equation and Modeling of Self-Gravitating Systems and Plasmas, Oct 2017

The role of magneto-turbulence in star formation
Einstein Symposium, Oct 2017

Galaxy Formation with Axion Dark Matter
CCA NY Area Computational Hydro Workshop, Sept 2017

Galaxy Formation with Axion Dark Matter
Brown BASS talk, Sept 2017. *Invited*

Integer Lattice for Vlasov-Poisson
Harvard ITC luncheon talk, May 2017

Quantum Turbulence in Bose-Einstein Condensate Dark Matter
Harvard ITC luncheon talk, Mar 2017

Moving mesh simulations of star forming cores in magneto-gravo-turbulence
Cosmic Rays, Astrophysical Turbulence and Magnetic Reconnection Conference, IIP, Natal, Brazil, Dec 2016. *Invited*

Moving mesh simulations of star forming cores in magneto-gravo-turbulence
Berkeley TAC seminar, Nov 2016

Moving mesh simulations of star forming cores in magneto-gravo-turbulence
Harvard ITC luncheon talk, Sept 2016

Moving mesh magnetohydrodynamics
Astronum Conference, Monterey, CA, Jun 2016

Moving mesh magnetohydrodynamics and applications to star forming cores
Crutcher & Heiles Conference, Madison, WI, May 2016

Moving Mesh and Smoothed Particle Methods for Computational Fluid Dynamics
Istituto per le Applicazioni del Calcolo "Mauro Picone", Rome, Jan 2015. *Invited*

A discontinuous Galerkin method for solving the fluid and MHD equations in astrophysical simulations
Southern Cross Conference Series VI: Feeding, Feedback, and Fireworks: Celebrating Our Cosmic Landscape, Jun 2013

Tully-Fisher Relationships for SDSS Galaxies as a Function of Environment
Centre for Astrophysics and Supercomputing, Swinburne Univ. of Technology, Aug 2011

Cosmological growth and feedback of massive black holes
University of Cambridge, Institute of Astronomy X-Ray Group Talk, Jul 2011

SMA Observation of the Extended Emission in the High-Mass Star Forming Region AFGL 2591
Harvard University, CfA, May 2011

X-ray spectroscopy of silicate dust in the ISM and environments around XRBs
Harvard University, CfA, Junior Thesis Presentations, Apr 2011

Laboratory and Astronomical Observations of the CN Radical
Harvard University, CfA, Mar 2011

Double radio sources and inverse-Compton ghosts in the X-ray sky
University of Cambridge, Institute of Astronomy X-Ray Group Talk, Aug 2010

A Search for X-Ray Winds and Strong Gravity Around a Supermassive Black Hole In A Distant Galaxy
PRISE Talk, Harvard University, Aug 2009

Teaching

Astronomy 151. Astronomical Fluid Dynamics. *Teaching Fellow*, Spring 2016
- student evaluation score 5.0/5.0, 5 students
- duties: office-hours, grading, special topics sections

Applied Computation 274. Computational Fluid Dynamics. *Section leader*, Fall 2014
- student evaluation score 4.5/5.0, 5 students
- duties: lectures, office-hours, course material and homework development, grading, final project supervision

Applied Computation 274. Computational Fluid Dynamics. *Section leader*, Spring 2014
• student evaluation score 4.0/5.0, 6 students
• duties: office-hours, course material and homework development, grading, final project supervision

Applied Mathematics 205. Advanced Scientific Computing: Numerical Methods. *Section leader*, Fall 2012
• student evaluation score 4.7/5.0, 56 students
• duties: weekly section, office-hours, course material and homework development, final project supervision

Skills

Programming: C/C++, Python, Matlab, Mathematica, Javascript, MPI, CUDA, SQL
Software: IRAF, DS9, CIAO, ISIS, XSTAR, MIRIAD, MIR-IDL
Web: HTML5, CSS

Student Advising

Lachlan Lancaster (graduate student, Princeton, 2017-2018)
Alex Gurvich (undergraduate student, CMU, 2016)
Sruthi Narayanan (undergraduate student, MIT, 2016)

Outreach & Service

Harvard Astronomy Department Peer Mentor. 2015 - 2017

Library Committee Graduate Student Representative, Harvard-Smithsonian CfA. 2015 - 2017

Einstein in the Classroom. Spring 2015. Engaging with Pierce Middle School in the greater Boston area, to offer physics activities in classroom covering relativity, spacetime curvature, the life cycles of stars, the relative sizes of the objects that occupy the observable universe.