

Paul A. Torrey

Curriculum Vitae

Massachusetts Institute of Technology
77 Massachusetts Ave., Bldg 37-582B
Cambridge, MA 02139
Phone: 703 967 7560
email: ptorrey@mit.edu

<http://www.mit.edu/~ptorrey>

Education

Harvard University Center for Astrophysics Cambridge, MA
MA in Astronomy & Astrophysics 2010
Ph.D. in Astronomy & Astrophysics 2014
Advisor: Lars Hernquist
Thesis: *Probing Galaxy Formation and Evolution through Numerical Simulations and the Distribution of Heavy Elements*

Cornell University College of Engineering Ithaca, NY
Bachelor of Science in Applied Physics – Cum Laude 2008

Professional Experience

Postdoctoral Fellow MIT (joint w/ Caltech) with Mark Vogelsberger 2014 –
Postdoctoral Fellow Caltech (joint w/ MIT) with Phil Hopkins 2014 –
Graduate Student Harvard University with Lars Hernquist 2008 – 2014
Undergrad Researcher Cornell University with Joe Burns 2007 – 2008
Space Grant Intern JPL with Lee Johnson 2007
Mechanical Engineer CUSat Air Force Research Lab Competition 2006 – 2007

Honors and Awards

Eric R. Keto Prize for Ph.D. thesis in theoretical astrophysics at Harvard 2014
Bok Center “Excellence in Teaching” Award (2 times) 2010 & 2011
Prize Fellowship – Harvard University 2008
Carrier Scholarship – Cornell University 2004

Mentoring and Advising

I have served as a primary science adviser to the following students:

Ryan McKinnon — MIT Ph.D. student 2014 –
Project: *Dust production and destruction in galaxy formation models*

Renato Guimaraes — MIT Summer Student 2015
Project: *Comparative analysis of real and mock HUDF galaxy properties*

Stephen Chen — MIT undergraduate researcher 2015
Project: *A physical model for the origin and fate of MgII absorbers*

Francisco Machado — MIT undergraduate researcher 2014 – 2015
Project: *The impact of galaxy mergers on galaxy number density evolution*

Meghna Saxena — MIT undergraduate researcher 2014 – 2015
Project: *The spatial distribution of LLSs in cosmological simulations*

Proposals and Grants

Co-Investigator on NSF RUI Grant (Award: \$260,000) <i>Galaxy Encounters on FIRE: Decoding Interaction Induced Star Formation</i>	2015
Co-Investigator on ALMA Cycle 3 (Award: 12 hours) <i>Arp 220 Nuclear Disks at 50 mas Resolution</i>	2015
Co-Investigator on NASA HST Cycle 22 Theory Grant (Award: \$120,000) <i>Observing the Origins of Galaxy Structure in the Illustris Simulation</i>	2014
Co-Investigator on NASA HST Cycle 22 Theory Grant (Award: \$120,000) <i>Clusters of Galaxies in the last 5 Billion Years: from the Brightest Cluster Galaxy to the Intra-Cluster Light</i>	2014
Co-Investigator on NOAO Gemini Proposal (Award: 16 hours on Gemini) <i>Unveiling the Young Central Stellar Disk in Arp 193</i>	2012

Invited Talks and Seminars

CUPC — Invited Speaker	Oct 2015
IMPS Seminar — UC Santa Cruz	April 2015
Seminar – Fermi National Lab	March 2015
Cosmology Seminar — Institute for Advanced Study	Oct 2014
Colloquium – Univ. of Hawaii	Oct 2013
TAC Seminar – Berkeley	Nov 2013
Extra-galactic Seminar – Herzberg Institute for Astrophysics	April 2013
Physics and Astro. Seminar – Univ. of Victoria	April 2013
Invited Conference Talk – Metals in an Evolving Universe	June 2012

Contributed Talks and Presentations

3DHST Data Release Conference — Yale	Nov 2015
MKI Visiting Committee — MIT	April 2015
Journal Club Presentation — Northwestern	March 2015
Contributed Conference Talk — AGN Conference in Chile	March 2015
Contributed Workshop Talk — AGN Ionization Echoes	March 2014
Galaxy Lunch Seminar — Cornell University	May 2014
GalRead — Princeton University	Jan 2014
Tea Talk — Caltech	Oct 2013
Lunch Seminar — MIT	Nov 2013
Contributed Conference Talk — First Annual AREPO Users Workshop	Sept 2013
Contributed Conference Talk — Feedback, Feeding, and Fireworks	June 2013
Contributed Conference Talk — Mergers in an Evolving Universe	Oct 2011
Extra-galactic Discussion Group — Univ. of Hawaii	March 2011
Astronomy Seminar — Australian National University	Sept 2011

Teaching

Teaching Fellow — Harvard University Course: “ <i>The Energetic Universe</i> ”	Fall 2010
Head Teaching Fellow (135 Students; 5 Staff) - Harvard University Course: “ <i>The Energetic Universe</i> ”	Fall 2011
Guest Lecturer — MIT Course: 8.902 “ <i>Astrophysics II</i> ”	Fall 2015
Guest Lecturer — Harvard Extension School Course: “ <i>Stars and Galaxies</i> ”	Fall 2015

Service

Seminar Organizer — MIT	2015
Science Judge — CUPC Astrophysics Category	2015
Science by the Pint — Featured Speaker (public outreach event)	2015
Main Street Partners — Consultant (advise small businesses on best practices)	2014 — 2015
Mentor — Harvard Graduate Student Mentoring Program	2013 — 2014
Graduate Admissions Committee — Harvard Astronomy Department	2014
Referee for:	
<i>MNRAS</i>	2012 —
<i>ApJ Letters</i>	2015 —

Professional Training

XSEDE Intel Xeon Phi Training	Nov 2014
Saas Fee Winter School	March 2013
Santa Cruz Computational Galaxy Formation Workshop	July 2012

Press

“The Story of God” — National Geographic filmed interview with Morgan Freeman
Air date: Spring 2016

“Virtual Universe” — ABC filmed interview with Graham Phillips
Air date: Oct. 2015 (<http://www.abc.net.au/catalyst/stories/4107265.htm>)

“Seeing the Universe form before your eyes” — Interview with LA Times
Print date: May 2014

“Recreating a Slice of the Universe” — Press Release
Release date: Aug. 2012 (<http://www.cfa.harvard.edu/news/2012/pr201223.html>)

“Galaxies out of a Supercomputer” — Press Release
Release date: May 2014 (h-its.org/scientific-news/in-nature-galaxies-out-of-a-supercomputer/)

Publications

First Author Papers

1. “*The Metallicity Evolution of Interacting Galaxies*”
Torrey, Cox, Kewley, & Hernquist, ApJ., 746, 102, 2012
2. “*Moving Mesh Cosmology: The properties of gas disks*”
Torrey, Vogelsberger, Sijacki, Springel, & Hernquist, MNRAS., 427, 2224, 2012
3. “*A physical model for cosmological simulations of galaxy formation: multi-epoch model validation*”
Torrey, Vogelsberger, Genel, Sijacki, Springel, & Hernquist, MNRAS., 438, 1985, 2014
4. “*The Illustris Simulation Observatory: A Catalog of Mock Galaxy Images and Spectra*”
Torrey, Snyder, Vogelsberger, Hayward, Genel, Sijacki, Springel, Hernquist, Nelson, Kriek, Pillepich, Sales, McBride, MNRAS, 447, 2753, 2015
5. “*An analysis of the evolving comoving number density of galaxies in hydrodynamical simulations*”
Torrey, Wellons, Machado, Griffen, Nelson, Rodriguez-Gomez, McKinnon, Pillepich, Ma, Vogelsberger, Springel, & Hernquist, MNRAS, 454, 2770, 2015
6. “*The balance between star formation and feedback in galactic nuclei*”
Torrey, Hopkins, Faucher-Giguere, & Vogelsberger, MNRAS, (submitted)

Second Author Papers Led by Students

7. “*Formation of Massive, Compact Galaxies in a Cosmological Simulation*”
Wellons, Torrey, Ma, Hernquist, Vogelsberger, Kriek, van Dokkum, Nelson, Genel, Springel, Sijacki, Snyder, Nelson, Sales, Pillepich, Rodriguez-Gomez, MNRAS, 449, 361, 2015
8. “*Dust Formation in Milky Way-like Galaxies*”
McKinnon, Torrey, & Vogelsberger, MNRAS (submitted)
9. “*Simulated high-z massive, compact galaxies take diverse evolutionary paths to $z=0$* ”
Wellons, Torrey, Ma, Rodriguez-Gomez, Pillepich, Nelson, Genel, Vogelsberger, & Hernquist, MNRAS, (accepted)

Other Second Author Papers

10. “*An Integral Field Study of Abundance Gradients in nearby Luminous Infrared Galaxies*”
Rich, Torrey, Kewley, Dopita, & Rupke, ApJ., 753, 5, 2012
11. “*Galaxy pairs in the Sloan Digital Sky Survey – VI. The orbital extent of enhanced star formation in interacting galaxies*”
Patton, Torrey, Ellison, Mendel, & Scudder, MNRAS., 433, L59, 2013
12. “*The Slow Flow Model of Dust Efflux in Local Star-Forming Galaxies*”
Zahid, Torrey, Kudritzki, Kewley, Dave, & Geller, MNRAS., 436, 1852, 2013
13. “*Empirical Constraints for the Magnitude and Composition of Galactic Winds*”
Zahid, Torrey, Vogelsberger, Hernquist, Kewley, & Dave, Ap&SS, 349, 873, 2013
14. “*Galaxy mergers on a moving mesh: a comparison with smoothed-particle hydrodynamics*”
Hayward, Torrey, Springel, Hernquist, & Vogelsberger, MNRAS., 422, 1992, 2014
15. “*Mapping star formation in simulated galaxy encounters: Are interaction-induced starbursts nuclear or extended?*”
Moreno, Torrey, Ellison, Patton, Bluck, Bansal, & Hernquist, MNRAS, 448, 1107, 2015
16. “*On the Cosmic Evolution of Mg/Fe in QSO Absorption Line Systems*”
Dey, Torrey, Rubin, Zhu, Menard, & Suresh, MNRAS, 451, 2806, 2015
17. “*Stellar & Quasar Feedback in Concert: Effects on AGN Accretion, Obscuration, and Outflows*”

Hopkins, **Torrey**, Faucher-Giguere, Quataert, & Murray, MNRAS, (submitted)

18. “*Illustris Simulation Observatory II: Non-Parametric Galaxy Morphology at $z=0$* ”
Snyder, **Torrey**, Lotz, Genel, McBride, Vogelsberger, Xu, Pillepich, Nelson, Sijacki, Hernquist, & Springel,
MNRAS, 454, 1886, 2015

Co-Authored Papers

19. “*Galaxy pairs in the Sloan Digital Sky Survey – VI. The orbital extent of enhanced star formation in interacting galaxies*”
Scudder, Ellison, **Torrey**, Patton, & Mendel, MNRAS., 426, 549, 2012
20. “*A physical model for cosmological simulations of galaxy formation*”
Vogelsberger, Genel, Sijacki, **Torrey**, Springel, & Hernquist, MNRAS., 436, 3031, 2013
21. “*The Dynamics of Galaxy Pairs in a Cosmological Setting*”
Moreno, Bluck, Ellison, Patton, **Torrey**, & Moster, MNRAS., 436, 1765, 2013
22. “*Properties of galaxies reproduced by hydrodynamic simulations*”
Vogelsberger, Genel, Springel, **Torrey**, Sijacki, Xu, Snyder, Bird, Nelson & Hernquist, Nature., 507, 177, 2014
23. “*Halo assembly exposed in the faint outskirts: the stellar and dark matter haloes of Illustris galaxies*”
Pillepich, Vogelsberger, Deason, Rodriguez-Gomez, Genel, Nelson, **Torrey**, Sales, Marinacci, Springel, Sijacki,
& Hernquist, MNRAS, 444, 237, 2014
24. “*Introducing the Illustris Project: Simulating the coevolution of dark and visible matter in the Universe*”
Vogelsberger, Genel, Springel, **Torrey**, Sijacki, Xu, Snyder, Bird, Nelson & Hernquist, MNRAS, 444, 1518,
2014
25. “*The Illustris Simulation: the evolution of galaxy populations across cosmic time*”
Genel, Vogelsberger, Springel, Sijacki, Nelson, Snyder, Rodriguez-Gomez, **Torrey**, & Hernquist, MNRAS, 445,
175, 2014
26. “*Damped Lyman-alpha absorbers as a probe of feedback on a moving mesh*”
Bird, Vogelsberger, Haehnelt, Springel, Hernquist, **Torrey**, & Sijacki, MNRAS, 445, 2313, 2014
27. “*The colors of satellite galaxies in the Illustris Simulation*”
Sales, Vogelsberger, Genel, **Torrey**, Nelson, Rodriguez-Gomez, Wang, Pillepich, Sijacki, Springel, &
Hernquist, MNRAS, 447, L6, 2015
28. “*Star-forming galaxies and the star formation main sequence in the Illustris simulation*”
Sparre, Hayward, Springel, Vogelsberger, Genel, **Torrey**, Nelson, Sijacki, & Hernquist, MNRAS, 447, 3548,
2015
29. “*The neutral gas content of post-merger galaxies: implications for the role of gas in modulating star formation rates*”
Ellison, Fertig, Rosenberg, Nair, Simard, **Torrey**, & Patton, MNRAS, 448, 221, 2015
30. “*The Role of Galactic Outflows in the Circumgalactic Medium*”
Suresh, Bird, Vogelsberger, Genel, **Torrey**, Sijacki, Springel, & Hernquist, MNRAS, 448, 895, 2015
31. “*The merger rate of galaxies in the Illustris Simulation: a comparison with observations and semi-empirical models*”
Rodriguez-Gomez, Genel, Vogelsberger, Sijacki, Pillepich, Sales, **Torrey**, Snyder, Nelson, Springel, Ma,
Hernquist, MNRAS, 449, 49, 2015
32. “*The impact of feedback on cosmological gas accretion*”
Nelson, Genel, Vogelsberger, Springel, Sijacki, **Torrey**, & Hernquist, MNRAS, 448, 59, 2015
33. “*Galaxy Pairs in the Sloan Digital Sky Survey – X: Does gas content drive star formation rate enhancement in galaxy pairs?*”
Scudder, Ellison, Momjian, Rosenberg, **Torrey**, Fertig, Patton, & Mendel, MNRAS, 449, 3719, 2015

34. *“Hot Gaseous Coronae around Spiral Galaxies: Probing the Illustris Simulation”*
Bogdan, Vogelsberger, Kraft, Hernquist, Gilfanov, **Torrey**, Churazov, Genel, Forman, Murray, Vikhlinin, Jones, & Boehringer, ApJ, 804, 72, 2015
35. *“Galaxy Pairs in the Sloan Digital Sky Survey IX. - Studying Gas Depletion in Galaxy Interactions”*
Fertig, Rosenberg, Patton, Ellison, **Torrey**, & Scudder, MNRAS (submitted)
36. *“The Illustris simulation: Evolving population of black holes across cosmic time”*
Sijacki, Vogelsberger, Genel, Springel, **Torrey**, Snyder, Nelson, & Hernquist, MNRAS, 452, 575, 2015
37. *“The Illustris Simulation: Public Data Release”*
Nelson, Pillepich, Genel, Vogelsberger, Springel, **Torrey**, Rodriguez-Gomez, Sijacki, Snyder, Griffen, Marinacci, Blecha, Sales, Xu, & Hernquist, A&C, 13, 12, 2015
38. *“Hydrogen Reionization in the Illustris Universe”*
Bauer, Springel, Vogelsberger, Genel, **Torrey**, Sijacki, Nelson, & Hernquist, MNRAS, 453, 3593, 2015
39. *“The Incidence of Low-Metallicity Lyman-Limit Systems at $Z=3.5$: Implications for the Cold-Flow Hypothesis of Baryonic Accretion”*
Cooper, Simcoe, Cooksey, O’Meara, & **Torrey**, ApJ, 812, 58, 2015
40. *“Large-Scale Mass Distribution in the Illustris Simulation”*
Haider, Steinhauser, Vogelsberger, Genel, Springel, **Torrey**, & Hernquist, MNRAS, (submitted)
41. *“Recoiling black holes: prospects for detection and implications of spin alignment”*
Blecha, Sijacki, Kelley, **Torrey**, Vogelsberger, Nelson, Genel, Springel, Snyder, & Hernquist, MNRAS, (submitted)
42. *“Halo Clustering, the Color-Age Relation and Galactic Conformity in the Illustris Simulation”*
Bray, Pillepich, Sales, Zhu, Genel, Rodriguez-Gomez, **Torrey**, Nelson, Vogelsberger, Springel, Eisenstein, & Hernquist, MNRAS, (submitted)
43. *“The Formation of Dwarf Galaxies in Clusters: a view from the Illustris Simulation”*
Mistani, Sales, Pillepich, Sanchez-Janssen, Vogelsberger, Genel, Nelson, Rodriguez-Gomez, Sijacki, **Torrey**, Springel, & Hernquist, MNRAS, (submitted)
44. *“The Mass Distribution of Baryons and Dark Matter Around Milky Way-sized Halos in Illustris”*
Taylor, Boylan-Kolchin, **Torrey**, Vogelsberger, & Hernquist, MNRAS, (submitted)
45. *“Galaxy Pairs in the Sloan Digital Sky Survey XIV. - The Influence of the Closest Companion”*
Patton, Qamar, Ellison, Bluck, Simard, Mendel, Moreno, & **Torrey**, MNRAS (submitted)
46. *“The stellar mass assembly of galaxies in the Illustris simulation: growth by mergers and the spatial distribution of accreted stars”*
Rodriguez-Gomez, Pillepich, Sales, Genel, Vogelsberger, Zhu, Wellons, Nelson, **Torrey**, Springel, & Hernquist, MNRAS (submitted)