

RYAN F. TRAINOR

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Contact:

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Research Interests:

- Feedback from stars and black holes in galaxy formation, particularly at low galaxy masses
- Physical properties of galaxies 1-3 Gyr after the Big Bang, including the reionization epoch
- Lyman-alpha emission as a tracer of star formation, QSO activity, and large-scale structure
- High-redshift QSOs and the most massive black holes over cosmic time
- Optical and near-IR imaging and spectroscopy including instrumentation

Education:

California Institute of Technology

- PhD in Astrophysics (Defended August 2014, Conferred June 2015)
Thesis: *Faint Galaxies in the Mpc-scale Environments of Hyperluminous QSOs at $2 < z < 3$*
Advisor: Charles Steidel
- MS in Astrophysics (June 2010)

University of California, Irvine

- BS in Physics (Honors, Phi Beta Kappa, *magna cum laude*)
Honors Thesis: *Improving Galaxy Mass Estimates by Accounting for Binary Systems*
Advisors: Manoj Kaplinghat & James Bullock

Honors & Awards:

- Miller Fellowship (UC Berkeley, 2014-2017)
- Troesh Graduate Fellowship in Astronomy (Caltech, 2013)
- Outstanding Senior in Physics (UC Irvine, 2008)

Publications:

16. Trainor, R. F., Strom, A. L., Steidel, C. C., Rudie, G. C., *The Rest-Frame Optical Spectroscopic Properties of Ly α -emitters at $z \sim 2.5$* , ApJ 832, 171 (2016)
15. Strom, A. L. including RFT, *Nebular Emission Line Ratios in $z \sim 2-3$ Star-Forming Galaxies with KBSS-MOSFIRE: Exploring the Impact of Ionization, Excitation, and Nitrogen-to-Oxygen Ratio*, arxiv: 1608.02587
14. Steidel, C. C. et al. including RFT, *Reconciling the Stellar and Nebular Spectra of High Redshift Galaxies*, ApJ 826, 159 (2016)
13. Martin, D. C. et al. including RFT, *A Newly Forming Cold Flow Protogalactic Disk, a Signature of Cold Accretion from the Cosmic Web*, ApJ 824, L5 (2016)
12. Erb, D. K. et al. including RFT, *A High Fraction of Ly-alpha-Emitters Among Galaxies with Extreme Emission Line Ratios at $z \sim 2$* , arxiv: 1605.04919
11. Mostardi, R. E. et al. including RFT, *A High-Resolution Hubble Space Telescope Study of Apparent Lyman Continuum Leakers at $z \sim 3$* , ApJ 810, 107 (2015)
10. Trainor, R. F., Steidel, C. C., Strom, A. L., Rudie, G. C., *The Spectroscopic Properties of Ly α -Emitters at $Z \approx 2.7$: Escaping Gas and Photons from Faint Galaxies*, ApJ 809, 89 (2015)

9. Steidel, C.C. et al. including **RFT**, *Strong Nebular Line Ratios in the Spectra of $z \sim 2-3$ Star Forming Galaxies: First Results from KBSS-MOSFIRE*, ApJ 795, 165 (2014)
8. Erb, D. K. et al. including **RFT**, *The Ly-alpha Properties of Faint Galaxies at $z \sim 2-3$ with Systemic Redshifts and Velocity Dispersions from Keck-MOSFIRE*, ApJ 795, 33 (2014)
7. Mostardi, R. E. et al. including **RFT**, *Narrowband Lyman-Continuum Imaging of Galaxies at $z \sim 2.85$* , ApJ 779, 65 (2013)
6. Kulas, K. R. et al. including **RFT**, *The Mass-Metallicity Relation Of A $Z \sim 2$ Protocluster With MOSFIRE*, ApJ 774, 130 (2013)
5. **Trainor, R. F.**, Steidel, C. C., *Constraints on Hyperluminous QSO Lifetimes via Fluorescent Ly α Emitters at $Z \sim 2.7$* , ApJ 775, L3 (2013)
4. McLean, I. S. et al. including **RFT**, *MOSFIRE, the multi-object spectrometer for infra-red exploration at the Keck Observatory*, SPIE 8446, 0J (2012)
3. **Trainor, R. F.**, Steidel, C. C., *The Halo Masses and Galaxy Environments of Hyperluminous QSOs at $Z \sim 2.7$ in the Keck Baryonic Structure Survey*, ApJ 752, 39 (2012)
2. Rudie, G. C. et al. including **RFT**, *The Gaseous Environment of High- z Galaxies: Precision Measurements of Neutral Hydrogen in the Circumgalactic Medium of $z \sim 2-3$ Galaxies in the Keck Baryonic Structure Survey*, ApJ 750, 67 (2012)
1. Minor, Q. E. et al. including **RFT**, *Correcting Velocity Dispersions of Dwarf Spheroidal Galaxies for Binary Orbital Motion*, ApJ 721, 1142 (2010)

Student Mentoring:

Shanon Oden (2014-2016)

- UC Berkeley 3rd/4th year undergraduate (Astronomy & Physics major)
- Developed software using python to automatically search for and characterize Lyman-alpha emission lines in Keck/LRIS spectra.
- *Shanon is now an employee at a Bay Area tech company and will attend UC Santa Barbara for a Physics PhD starting in Fall 2016*

Anna de Graaff (2015-2016)

- University of Edinburgh 3rd year undergraduate (visiting student at UC Berkeley)
- Used python and Galfit to measure galaxy sizes and morphologies in Hubble/WFC3 images of high-redshift galaxies and compared to results of simulations.
- *Anna was selected for a research program at Leiden University for Summer 2016*

Elizabeth Trenholm (2016-present)

- UC Berkeley 3rd year undergraduate (Astronomy major)
- Stacking Keck/LRIS narrow-band Lyman-alpha images and broad-band (UV continuum) images to search for Lyman-alpha halos around dwarf galaxies.

Jose Zamora (2016-present)

- UC Berkeley 1st year undergraduate (ChemE major, Astronomy minor)
- Radiative-transfer post-processing of galaxy-formation simulations to measure the escape of ionizing photons and Lyman-alpha photons from forming galaxies (with Prof. Dan Kasen).

Duncan Rocha (May 2016)

- High School Senior at Drew School in San Francisco
- One-month research internship using python to study correlations between the physical sizes and morphologies of galaxies with their Lyman-alpha spectra.

Elijah Wilensky (August-September 2016)

- High School Junior at Berkeley High School
- Research internship using python to stack continuum images of Lyman-alpha-selected galaxies and measure spectral energy distribution

Teaching Experience:

Instructor of Record

- *Introduction to General Astronomy* (UC Berkeley Summer Session)
Taught Astro 10 (algebra-based Intro to Astronomy for non-majors) to 61 undergraduate students including both UC Berkeley students and visiting international students. Class included weekly laboratory exercises and star parties using the rooftop telescope.
Student Evaluations: 6.7/7 for Teaching Effectiveness

Guest Lecturer

- *Introduction to Modern Cosmology* (Prof. Chung-Pei Ma)
Two-hour guest lecture covering history of astronomy, Kepler's Laws, and Newtonian dynamics
- *Introduction to Modern Cosmology* (Prof. Leo Blitz)
Two-hour guest lecture covering special relativity, general relativity, and black holes

Teaching Assistant for Undergraduate Classes

- *Introduction to Astronomy* (Caltech non-major course, calculus-based)
Led weekly hour-long lecture/discussion section (including lesson-planning and creation of lecture materials); wrote and graded problem sets, end-of-term projects, and midterm/final; supervised field trip to Palomar Observatory
- *Galaxies & Cosmology* (Caltech astronomy major course)
Head TA for Massive Open Online Course (MOOC) component with **28,000+ enrolled students**; moderated discussion forums; wrote problem sets and weekly quizzes; managed automated grading system and use of website platform

Teaching Assistant for Graduate Classes

- *Radiative Processes in Astrophysics* (Caltech)
Held office hour discussions, wrote and graded homework
- *The Interstellar Medium* (Caltech)
Held office hour discussions, wrote and graded homework

Youth Education

- Co-taught 4-week lab-based summer school program *Forces & Rocketry* for junior-high students in Pasadena Unified School District, including curriculum development

Pedagogy Development

- Co-founding member and presenter in Caltech *Workgroup for Educational Science and Technology* (WEST)
- Participant in NASA's Center for Astronomy Education *Teaching Excellence Workshop*

Outreach & Stewardship:

Berkeley Astronomy Department Outreach

- Organizational help and mentoring for new *Undergraduate Astronomy Society* at UC Berkeley (2015-present)
- Public lecture: *How to Grow a Galaxy* for UC Berkeley Astro Night (~150 attendees)
- Public lecture: *Supermassive Black Holes and the Growth of Galaxies* at the City College of San Francisco (~30 attendees)
- Public lecture: *How to Grow a Galaxy* for Science@Cal (~150 attendees)
- Co-facilitator of outreach email account and Ask-An-Astronomer website
- Volunteer: Cal Day, Astro Night
- Career day speaker at Berkeley High School
- STEM week speaker at Los Altos High School

Caltech Astronomy Department Outreach Coordinator (2010-2014)

- Co-lead contact for departmental community and educational outreach efforts
- Organized and participated in visits of grad students to elementary and junior-high classrooms in Pasadena Unified School District (2010-2013)

- Organized and participated in long-term science fair project assistance and mentoring at Washington Middle School (2011-2012)
- Lead or co-organizer for major public outreach events at Caltech including viewings of SN 2011fe (~600 visitors), the May 2012 solar eclipse (~1000 visitors), and the June 2012 solar transit of Venus (~1800 visitors)
- Interviewed for articles on Caltech outreach in Pasadena Star (LA Times affiliate) and Arroyo Monthly magazines, as well as PR videos for Caltech advancement

Other Stewardship

- Member of organizing committee for 2016 Miller Institute Symposium
- Founding member and co-leader of UC Berkeley AstroJustice workgroup
- Caltech Graduate Student Representative to the Faculty (2012-2013)
- Member of Caltech Tech Zone (LGBTQI Ally-Training Program)
- Scientific referee for *The Astrophysical Journal*

Invited Research Talks:

- *The Snowbird Cosmic Lyman-Alpha Workshop*, University of Utah (March 2017)
- *Near-Far Galaxy Workshop (Review Talk)*, Sonoma, CA (December 2016)
- *Feedback in Galaxy Formation*, University of Hawaii, Hilo (October 2016)
- *Cosmology Seminar*, UC Davis (November 2015)
- *IMPS Seminar*, UC Santa Cruz (September 2015)
- *Astrophysics Seminar*, UC Irvine (May 2014)
- *ITC Seminar*, Harvard/CfA (December 2013)
- *Theoretical Astrophysics Center Seminar*, UC Berkeley (October 2013)
- *Lyman Alpha as an Astrophysical Tool*, Stockholm, Sweden (September 2013)

Contributed Research Talks:

- *Cosmic dawn of galaxy formation: linking observations and theory with new-generation spectral models*; Paris, France (June 2016)
- *The Escape of Lyman radiation from galactic labyrinths*; Kolymbari, Greece (April 2016)
- *The Physical Link between Galaxies and their Halos*; Garching, Germany (June 2013)
- *Keck Science Meeting*; San Diego, CA (September 2012)
- *AAS Meeting*; Austin, TX (January 2012)
- *New Horizons for High Redshifts*; Cambridge, UK (July 2011)
- *Galaxy Formation*; Durham, UK (July 2011)

Observing & Instrument Experience:

- W.M. Keck Observatory, Keck 1 & 2 10m Telescopes; LRIS, MOSFIRE, ESI (44 nights)
- Hubble Space Telescope; WFC3 and ACS
- Subaru 8.2m Telescope; MOIRCS (2 nights)
- Palomar Observatory, Hale 5m Telescope; WIRC, TripleSpec (3 nights)
- Las Campanas Observatory, Magellan 6.5m Telescopes (3 nights); FourStar, FIRE
- MOSFIRE instrument team member; lead role in modeling the instrument flexure and calibrating the flexure compensation system; also assisted in instrument calibration and commissioning (8 nights on telescope plus 2 years in lab)

Recent Observing and Funding Proposals (Post-PhD):

- Miller Postdoctoral Fellowship awarded by the Miller Institute for Basic Research in Science (2014-2017), \$276,757 estimated total funding
- **PI**, Hubble Space Telescope Cycle 24 (2016): *QSO and Galaxy Growth Probed by Faint Ly α -Emitters*, 20 orbits awarded, \$91,956 total funding
- Co-I (lead observer, PI Eliot Quataert): Keck/LRIS 2015A (1.5n)
- Co-I (lead observer, PI Eliot Quataert): Keck/MOSFIRE 2015B (2n)

- Co-I (lead observer, PI Eliot Quataert): Keck/MOSFIRE 2016B (2n)
- Co-I (lead observer, PI Eliot Quataert): Keck/MOSFIRE 2017B (2n)
- Co-I (PI Gwen Rudie): Magellan/FIRE 2016B (3n)
- Co-I (PI Gwen Rudie): Magellan/FIRE+MaGE 2017A (3n)
- Co-I (PI Gwen Rudie): Magellan/FIRE+MaGE 2017B (3n)

Professional References:

Prof. Charles Steidel, Caltech

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Prof. Eliot Quataert, UC Berkeley

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