# ANNA LORRAINE ROSEN, PH.D.

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Center for Astronomy & Space Sciences, University of California San Diego (UCSD), La Jolla, CA 92093

## EDUCATION

**Ph.D.**, Astronomy & Astrophysics, University of California, Santa Cruz *2017*
Advisors: Mark Krumholz, Enrico Ramirez-Ruiz
Thesis: *The Destructive Birth of Massive Stars & Massive Star Clusters*
**M.S.**, Astronomy & Astrophysics, University of California, Santa Cruz *2012*
**B.A.**, Physics & Astrophysics (double major), University of California, Berkeley *2009*
Cumulative GPA: 3.81/4.0 , Major GPA: 3.82/4.0, Honors: Fall 2007-2009, General Distinction
**Community College Transfer Student**, Los Angeles Pierce College (LAPC) *2007*
Cumulative GPA: 3.95/4.0 , Major GPA: 4.0/4.0
Dean's Honors: 2003-2007, President's Honor: 2004-2007

## AWARDS AND RESEARCH POSITIONS

University of California Chancellor's Postdoctoral Fellowship, UCSD *2022-*
National Science Foundation Astronomy & Astrophysics Postdoctoral Fellowship, UCSD *2022-*
Institute for Theory and Computation (ITC) Postdoctoral Fellowship, Harvard University *2020-2022*
NASA Einstein Postdoctoral Fellowship, Harvard University *2017-2020*
NASA Hubble Postdoctoral Fellowship (declined) *2017*
Rodger Doxsey Dissertation Prize, American Astronomical Society *2017*
ARCS (Achievement Rewards for College Scientists) Foundation Fellowship *2016*
American Association of University Women (AAUW) American Dissertation Year Fellowship *2016*
Excellence in Mentoring Award, UC Santa Cruz Astronomy & Astrophysics Department *2015*
American Astronomical Society International Travel Grant *2014, 2016, 2017*
National Science Foundation (NSF) Graduate Research Fellowship Program *2011*
NASA Minority Initiatives Internship, NASA Jet Propulsion Laboratory (JPL) *2008*
Daniel Edward Wark Memorial Scholarship, UC Berkeley Astrophysics Department *2009*
NASA Motivating Undergraduates in Science and Technology Internship, NASA JPL *2008*
NASA Motivating Undergraduates in Science and Technology Scholarship *2007-2008*
NSF Research Experience for Undergraduates (REU) Internship, UC Davis Physics Department *2007*
Alexander Frolich Award for excellence of achievement in Physics, LAPC *2007*
NASA JPL Undergraduate Scholars Award for excellence of achievement in Physics, LAPC *2007*
Thomas McCutcheon Award for excellence of achievement in Mathematics, LAPC *2006*

## SUCCESSFUL PROPOSALS

Total of grants obtained as Principal Investigator: $174,825

1. Co-I, Chandra Observation, Cycle 21 (awarded 100 ks) *2019*
   Title: *A Super Star Cluster is Born: Probing the X-ray Emission of H72.97-69.39 in LMC-N79*
2. PI, Chandra Theory, Cycle 16 *2014*
   Title: *To Leak or Not to Leak: Where are the Missing X-ray Photons from Massive Star Clusters?*
3. PI, Hubble Archival, Cycle 21 *2013*
   Title: *Simulating the Birth of Massive Star Clusters: Is Destruction Inevitable?*

## TECHNICAL SKILLS

| | |
|---|---|
| **Computer Languages** | C++, Python, MPI, Mathematica, Fortran, IDL, R |
| **Simulation Codes** | Orion2, Gizmo |
| **Analysis Codes** | *yt*, radmc-3d, glue |

## ADVISING EXPERIENCE

**Graduate Students:**

Paarmita Pandey (grad student at OSU) *2022-present*
*Fermi Observations of the Diffuse $\gamma$-ray Emission of Young Massive Star Clusters*

Jennifer Rodriguez (grad student at OSU) *2022-present*
*Chandra Observations of the Diffuse X-ray Emission of 30 Doradus*

Sabrina Appel (grad student at Rutgers) *2020-present**
*Effects of B-fields and Feedback on the Shape and Evolution of the Density PDF in Star Formation*

Grace Olivier (grad student at OSU, postdoc at Texas A&M), *2020-present**
*Evolution of Stellar Feedback in H II Regions* and
*X-ray Emission from the Massive Binary WR 20a*

Michael Foley (grad student at Harvard) *2018-2019**
*Bubbles around Intermediate and High-mass Stars due to Wind Feedback*

Hope Chen (grad student at Harvard, postdoc at UT Austin) *2018-2019*
*Effects of an Embedded B-Star Wind in Ophiuchus*

**Undergraduate Students:**

Mikayla Wilson (astro grad student at UCSC), Banneker Intern, Harvard *2020*
*Tracing the Evolution of Molecular Outflows in Massive Star Formation*

Monica Gallegos-Garcia (astro grad student at Northwestern), Banneker Intern, Harvard *2018-2020**
*Winds in Star Clusters Drive Kolmogorov Turbulence*

Courtney Bishop (physics undergrad at College of William & Mary), SAO NSF REU program *2018*
*Comparing Molecular Line Tracers in Outflows Generated by Massive Star Formation*

Evan Carter (physics undergrad at UCSC, astro masters student at Wesleyan), *2014-2016*
*Synthetic Observations of Low-Mass Star Formation: Implications for Current SED-Fitting Methods*

**High School Students:**

Shreya Karri *2019*
*Census of Stellar Feedback in the Milky Way*

* Denotes students whose project or contribution led to or will soon lead to a refereed publication

## SERVICE EXPERIENCE

Co-Editor, *Frontiers in Astronomy and Space Sciences* Research Topics collection on *2023*
*Star formation: Numerical Simulations and What They Teach Us*
SOC co-chair, Olympian Symposium 2023: Star Formation in the Era of *JWST* *2022-2023*
Science Working Group Member, *PRIMA Far-IR Probe Mission Concept* *2022-*
NASA JWST Cycle 1 Panelist *2021*
Member, Harvard Astronomy Diversity, Equity, and Inclusion (DEI) Committee *2021-2022*
Member, CfA Inclusion, Diversity, and Equity in Astronomy (CfA-IDEA) Committee *2020-2021*
Referee for A&A, ApJ, MNRAS, & RAA
CfA Galaxies & Cosmology Seminar Organizer *2019-2021*
NASA Theory Astrophysics Program Panelist *2019*
NASA Earth and Space Science Fellowship (NESSF) Reviewer *2019*
Organizer, Equity & Inclusion Journal Club, Harvard-Smithsonian CfA *2018-2019*
Proposal Reviewer for the Czech Science Foundation *2018*
ITC Post-doctoral Fellowship Committee Member, Harvard-Smithsonian CfA *2017*
SOC/LOC Member for Harvard-Heidelberg Star Formation meeting, *2017, 2019 (Chair)*
Harvard-Smithsonian CfA

Organizer, Diverse Topics in Astronomy Lecture Series, Lamat REU Program, UCSC *2015, 2016*
Organizer, Space Telescope Proposal Writing Workshop, *2015*
UCSC Astronomy & Astrophysics Department
Member of the LAMAT Research Internship Admissions Committee *2014*
Undergraduate Student Mentor, UCSC Women in Physics Group *2013-2017*
Graduate Student Mentor, UCSC Astronomy & Astrophysics Department *2012-2013, 2016-2017*
Astronomy Graduate Student Representative, UCSC Graduate Student Association *2012-2013*
Organizer, Applying to the NSF GRFP Workshop, *2012-2016*
UCSC Astronomy & Astrophysics Department

## TEACHING EXPERIENCE

Instructor, UCSD Transfer Student Workshop Series, Introduction to Python Programming *2022*
Guest Lecture, UT Austin Computational Astrophysics & UCSD Radiative Processes Courses *2022*
"Modeling Radiative Feedback in (Massive) Star Formation Simulations"
Co-Instructor, Python Programming Bootcamp, Lamat Program, UCSC *2015*
Activity Designer/Facilitator, Institute for Science & Engineering Educators *2011*
Professional Development Program (PDP), Hartnell College
Teaching Assistant, "Astronomy 2: Overview of the Universe", UCSC *2010*
Grader, "Astronomy C161: Relativistic Astrophysics & Cosmology", UC Berkeley *2010*
Undergraduate Student Instructor, "Astronomy C10: Introduction to Astronomy", UC Berkeley *2009*

## PROFESSIONAL DEVELOPMENT

Diversity & Inclusion Certificate Program, UCSC Office for Diversity, Equity, and Inclusion *2017*
Institute for Science & Engineering Educators, PDP for Inquiry-based Education, UCSC *2011*
Astronomy 300: Instruction Techniques in General Astronomy (course), UC Berkeley *2009*

## REFEREED PUBLICATIONS (8 1$^{ST}$-AUTHORED PUBLICATIONS)

1. "What Sets the Star Formation Rate of Molecular Clouds? The Density Distribution as a Fingerprint of Compression and Expansion Rates"
   Appel, S.M., Burkhart, B., Semenov, V.A., Federrath, C., **Rosen, A.L.**, Tan, J.C.; submitted to *The Astrophysical Journal*
2. "A Multiwavelength Study of the Massive Colliding Wind Binary WR 20a: A Possible Progenitor for Fast-Spinning LIGO Binary Black Hole Mergers"
   Olivier, G.M., Lopez, L.A., Auchettl, K., **Rosen, A.L.**, Batta, A., Neugent, K.F., Ramirez-Ruiz, E., Jayasinghe, T., Vallely, P.J., Rowan, D.M.; submitted to *The Astrophysical Journal*, NASA ADS
3. "The TEMPO Survey I: Predicting Yields of the Transiting Exosatellites, Moons, and Planets from a 30-day Survey of Orion with the Nancy Grace Roman Space Telescope"
   Limbach, M.A., Soares-Furtado, M., Vanderburg, A., Best, W.J., Cody, A.M., D-Onghia, E., Heller, R., Hensley, B.S., Kounkel, A., Kraus, A., Mann, A.W., Robberto, M., **Rosen, A.L.**, Townsend, R., Vos, J.M., *Publications of the Astronomical Society of the Pacific* (in press), NASA ADS
4. "Effects of the environment on the multiplicity properties of stars in the STARFORGE simulations"
   Guszejnov, D., Raju, A.N., Offner, S.S.R., Grudić, M.Y, Faucher-Giguère, C., Hopkins, P.F., **Rosen, A.L.**; 2023, *Monthly Notices of the Royal Astronomical Society*, 518, 4693, NASA ADS
5. "A Massive Star is Born: How Feedback from Stellar Winds, Radiation Pressure, and Collimated Outflows Limits Accretion onto Massive Stars"
   **Rosen, A.L.**; 2022, *The Astrophysical Journal*, 941, 202, NASA ADS, ApJ

6. "Effects of the environment and feedback physics on the initial mass function of stars in the STARFORGE simulations"
   Guszejnov, D., Grudić, M.Y, Offner, S.S.R., Faucher-Giguère, C., Hopkins, P.F., **Rosen, A.L.**; 2022, *Monthly Notices of the Royal Astronomical Society*, 515, 4929, NASA ADS
7. "Cluster assembly and the origin of mass segregation in the STARFORGE simulations"
   Guszejnov, D., Markey, C., Offner, S.S.R., Grudić, M.Y, Faucher-Giguère, C., **Rosen, A.L.**, Hopkins, P.F.; 2022, *Monthly Notices of the Royal Astronomical Society*, 515, 167, NASA ADS
8. "Dust in the Wind with Resonant Drag Instabilities: I. The Dynamics of Dust-Driven Outflows in GMCs and H II Regions"
   Hopkins, P.F., **Rosen, A.L.**, Squire, J., Panopoulou, G.V., Soliman, N.H., Seligman, D., Steinwandel, U.P.; *Monthly Notices of the Royal Astronomical Society*, 517, 1491, NASA ADS
9. "The dynamics and outcome of star formation with jets, radiation, winds, and supernovae in concert"
   Grudić, M.Y, Guszejnov, D., Offner, S.S.R., **Rosen, A.L.**, Raju, A.N., Faucher-Giguère, C., Hopkins, P.F.; 2022, *Monthly Notices of the Royal Astronomical Society*, 512, 216, NASA ADS
10. "Less wrong: a more realistic initial condition for simulations of turbulent molecular clouds"
    Lane, H.B., Grudić, M.Y, Guszejnov, D., Offner, S.S.R., Faucher-Giguère, C., **Rosen, A.L.**; 2022, *Monthly Notices of the Royal Astronomical Society*, 510, 4767, NASA ADS
11. "ORION2: A magnetohydrodynamics code for star formation"
    Li, P.S., Cunningham, A.J., Gaches, B.L., Klein, R.I., Krumholz, M.R., Lee, A.T, McKee, C.F., Offner, S.S.R., **Rosen, A.L.**, Skinner, M.A., *Journal of Open Source Software*, JOSS
12. "The Effects of Magnetic Fields and Outflow Feedback on the Shape and Evolution of the Density PDF in Turbulent Star-Forming Clouds"
    Appel, S.M., Burkhart, B., Semenov, V.A., Federrath, C., **Rosen, A.L.**; 2022, *The Astrophysical Journal*, 927, 75, NASA ADS
13. "Observations of the Ag(3x1) Phase on Ge(111)"
    Mullet, C.H., **Rosen, A.L.**, Chiang, S., 2021, *Journal of Vacuum Science & Technology A*, 39, Issue 5, NASA ADS
14. "Evolution of Stellar Feedback in H II Regions"
    Olivier, G.M., Lopez, L.A., **Rosen, A. L.**, Nayak, O., Reiter, M., Krumholz, M. R., Bolatto, A.D., *Astrophysical Journal*, 2021, 908, 68, NASA ADS
15. "Continuity of Accretion from Clumps to Class 0 High-Mass Protostars"
    Avison, A., Fuller, G.A., N. Peretto, N., Duarte-Cabral, A., **Rosen, A.L.**, Traficante, A., Pineda, J.E., Güsten, R., & Cunningham, N., 2021, *Astronomy & Astrophysics*, 645, A142, NASA ADS
16. "Winds in Star Clusters Drive Kolmogorov Turbulence"
    Gallegos-Garcia, M., Burkhart, B., **Rosen, A.L.**, Naiman, J.P., Ramirez-Ruiz, E., 2020, *Astrophysical Journal Letters*, 899, 30, NASA ADS
17. "The Role of Outflows, Radiation Pressure, and Magnetic Fields in Massive Star Formation"
    **Rosen, A. L.**, Krumholz, M. R., 2020, *Astronomical Journal*, 160, 78, NASA ADS
18. "Zooming in on Individual Star Formation: Low- and High-mass Stars"
    **Rosen, A.L.**, Offner, S.S.R, Sadavoy, S.I., Bhandare, A., Vázquez-Semadeni, Ginsburg, A., 2020, *Space Science Reviews*, 216, 62, NASA ADS
19. "Formation and Evolution of Disks Around Young Stellar Objects"
    Zhao, B, Tomida, K, Hennebelle, P., Tobin, J.J., Maury, A., Hirota, T., Sánchez-Monge, Á., Kuiper, R., **Rosen, A.**, Bhandare, A., Padovani, M., Lee, Y., 2020, *Space Science Reviews*, 216, 43, NASA ADS
20. "Circumbinary Disks: Accretion and Torque as a Function of Mass Ratio and Disk"
    Duffell, P.C., D'Orazio, D., Derdzinski, A., Haiman, Z., MacFayden, A., **Rosen, A.L.**, & Zrake, J., 2020, *Astrophysical Journal*, 901, 25, NASA ADS
21. "Massive Star Formation via the Collapse of Subvirial and Virialized Turbulent Massive Cores"
    **Rosen, A.L.**, Li, P.S., Zhang, Q., Burkhart, B., 2019, *Astrophysical Journal*, 887, 108, NASA ADS

22. "unyt: Handle, manipulate, and convert data with units in Python"
Goldbaum, N.J., ZuHone, J.A., Turk, M.J., Kowalik, K., & **Rosen, A.L.**, 2018, *Journal of Open Source Software*, 3, 28, 809; NASA ADS
23. "Hybrid Adaptive Ray-Moment Method (HARM$^2$): A Highly Parallel Method for Radiation Hydrodynamics on Adaptive Grids"
**Rosen, A. L.**, Krumholz, M. R., Oishi, J.S., Lee, A.T., & Klein, R.I., 2017, *Journal of Computational Physics*, 330, 924; NASA ADS
24. "An Unstable Truth: How Massive Stars get their Mass"
**Rosen, A. L.**, Krumholz, M. R., McKee, C.F., & Klein, R.I., 2016, *Monthly Notices of the Royal Astronomical Society*, 463, 2553; NASA ADS
25. "Gone with the Wind: Where is the Missing Stellar Wind Energy from Massive Star Clusters?"
**Rosen, A. L.**, Lopez, L.A., Krumholz, M. R., & Ramirez-Ruiz, E.; 2014, *Monthly Notices of the Royal Astronomical Society*, 442, 2701; NASA ADS
26. "What Sets the Initial Rotation Rates of Massive Stars?"
**Rosen, A. L.**, Krumholz, M. R., & Ramirez-Ruiz, E.; 2012, *Astrophysical Journal*, 748, 97; NASA ADS

## SCIENTIFIC PRESENTATIONS

Given **46** invited talks and **36** contributed talks to date, including

1. Invited Colloquium, UC Davis Physics & Astronomy Colloquium; Davis, CA *2023*
2. Invited Colloquium, University of Hawaii Manoa Institute of Astronomy; Honolulu, HI *2023*
3. Invited Colloquium, University of Arizona & Steward Observatory; Tucson, AZ *2023*
4. Invited Colloquium, San Diego State University, Computational Sciences Research Center; San Diego, CA *2023*
5. Invited Keynote Talk, Science with the Line Emission Mapper: From Planets to Galaxies and Beyond; Harvard-Smithsonian CfA, Cambridge, MA *2023*
6. Invited Colloquium, The Ohio State University Astronomy Department; Columbus, OH *2023*
7. Invited Colloquium, University of Oregon Physics Department; Eugene, OR *2023*
8. Invited Talk, IAU Challenges & Innovations in Computational Astrophysics Meeting *2022*
9. Invited Seminar, UC San Diego Astronomy Seminar; La Jolla, CA *2022*
10. Invited Colloquium, The Ohio State University Astronomy Department; Columbus, OH *2022*
11. Invited Seminar, Canadian Institute for Theoretical Astrophysics; Toronto, Canada *2022*
12. Invited Colloquium, Durham University Astronomy Department; Durham, UK *2022*
13. Invited Colloquium, Carnegie Observatories; Pasadena, CA *2021*
14. Invited NSF REU Colloquium, Center for Astrophysics | Harvard & Smithsonian Cambridge, MA *2021*
15. Invited Colloquium, Caltech Astronomy Colloquium; Pasadena, CA *2021*
16. Invited Colloquium, Royal Observatory of Edinburgh; Edinburgh, Scotland *2021*
17. Invited Colloquium, Rice University Physics & Astronomy Department; Houston, TX *2021*
18. Invited Colloquium, University of Chicago Astronomy & Astrophysics Department; Chicago, IL *2021*
19. Invited Review Talk, Radiation Hydrodynamics: Implementation and Application; Royal Astronomical Society; London, UK *2020*
20. Invited Review Talk, International Space Science Institute, Star Formation Workshop; Bern, Switzerland *2019*
21. Invited Talk, Gas Fueling of Galaxy Structures Across Cosmic Time, Astro 3D Workshop; Barossa Valley, South Australia *2018*

22. Invited Colloquium, University of Florida Astronomy Department; Gainesville, FL *2018*
23. Invited Review Talk, Stars Birth & Death: GMT Community Science Meeting; Honolulu, HI *2018*
24. Invited Talk, Astrophysical Shocks Meeting, AIP Potsdam; Potsdam, Germany *2018*
25. Invited Colloquium, Department of Astronomy, University of Massachusetts Amherst; Amherst, MA *2017*

## PUBLIC OUTREACH

American Association of University Women (AAUW) STEM Ambassador *2022*
STEMEd for Girls program (panelist)
Speaker, "How to Make Massive Stars on a (super)Computer," Western Nevada College/NCCN *2022*
Science Matter Expert, NASA Community College Network (NCCN) *2021-Present*
Panelist, Astronomy Career Panel, Girls Inc., Lynn, MA *2021*
Panelist, "Meet a Scientist" Panel for Women's History Month, Marin Community College *2021*
Panelist, "Writing an Effective Proposal" presented to Harvard Graduate Students *2020*
Interviewee, "How to Make Stars on a (super)Computer," *2020*
Astrochats Interview hosted by MicroObservatory, Link to YouTube video
Speaker, "How to Make Massive Stars on a (super)Computer,"
Astronomy on Tap Boston Event *2020*
Presenter, "Visualizing Numerical Simulations with *yt*"
Center for Astrophysics | Harvard & Smithsonian *Demofest* *2019*
Speaker, "How to Make Stars on a (super)Computer,"
Women in Science and Engineering (WiSE) Science on Tap Event *2017*
Speaker, "An Unstable Truth: How Massive Stars get their Mass,"
AAUW Monterey Peninsula Chapter Meeting *2017*
Speaker, "How to Write an Effective Abstract," Lamat REU Program, UCSC *2016*
Organizer and Panelist, "Astronomy Grad Student and Post-doc Panel," *2016*
Lamat REU Program, UCSC
Speaker, "Then and Now: From North Hills Prep to a Ph.D. in Astrophysics," *2016*
North Hills Prep School
Astronomy Outreach Activity, Expanding Your Horizons Workshop for Young Girls, *2015*
Hartnell College
Speaker, "How to Make Stars on a (super)Computer," *2015*
UCSC, Monterey Astronomy Club, Scotts Valley High School
Speaker, "Computational Astrophysics", Stanford Pre-collegiate Summer Courses, Stanford *2015*
Speaker, "Star Formation and Stellar Feedback", Lamat Research Experience *2015, 2016*
for Undergraduates (REU) Program, UCSC
Speaker, "Reading Scientific Literature," Lamat REU Program, UCSC *2015*
Graduate Student Panelist, Advancement Via Individual Determination (AVID) Program, *2015*
Soquel High School
Women in Science & Engineering (WiSE) Astronomy Education Outreach Presentation, *2014*
Seaside High School
Panelist, STEM Diversity Professional Development Workshop Series, UCSC *2014*
Author, www.astrobites.org, Link to my articles *2011-2013*
WiSE Education Outreach Presentation, Santa Cruz High School *2011*
Panelist, Girls Scouts "Girls Go Tech" Event, NASA Ames, Moffatt Field, CA *2011*