

# ANNA LORRAINE ROSEN, PH.D.

anna.rosen@cfa.harvard.edu  $\diamond$  [www.anna-rosen.com](http://www.anna-rosen.com)

Institute for Theory and Computation, Center for Astrophysics | Harvard & Smithsonian, Cambridge MA 02138

## EDUCATION

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**Ph.D.**, Astronomy & Astrophysics, University of California, Santa Cruz 2017  
Advisors: Mark Krumholz, Enrico Ramirez-Ruiz  
**M.S.**, Astronomy & Astrophysics, University of California, Santa Cruz 2012  
**B.A.**, Physics & Astrophysics, 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

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Institute for Theory and Computation (ITC) Post-doctoral Fellowship, Harvard University 2020-2022  
NASA Einstein Post-doctoral Fellowship, Harvard University 2017-2020  
NASA Hubble Post-doctoral 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 Graduate Research Fellowship Program 2011  
Daniel Edward Wark Memorial Scholarship (UC Berkeley Astrophysics Department) 2009  
NASA Motivating Undergraduates in Science and Technology Scholarship 2007  
Alexander Frolich Award for excellence of achievement in Physics (LAPC) 2007  
NASA JPL Undergraduate Scholars Award for excellence of achievement in Physics 2007  
Thomas McCutcheon Award for excellence of achievement in Mathematics (LAPC) 2006

## SUCCESSFUL PROPOSALS

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

1. Co-I, Chandra Observation, Cycle 21 (awarded 100 ks) 2019  
Title: *A Superstar 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

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<b>Computer Languages</b>	C++, Fortran, IDL, Python, R, MPI
<b>Simulation Codes</b>	ORION2, GIZMO
<b>Analysis Codes</b>	<i>yt</i> , RADMC-3D, GLUE

## ADVISING EXPERIENCE

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### Graduate Students:

Grace Olivier (grad student at OSU), <i>Evolution of Stellar Feedback in H II Regions and The X-ray Emission from the Massive Binary WR 20a</i>	2020*
Michael Foley (grad student at Harvard), <i>Bubbles around Intermediate and High-mass Stars due to Wind Feedback</i>	2018-2019*
Hope Chen (grad student at Harvard), <i>Effects of an Embedded B-Star Wind in Ophiuchus</i>	2018-2019

### Undergraduate Students:

Mikayla Wilson (physics & astronomy undergrad at TCU), Banneker Intern at Harvard <i>Tracing the Evolution of Molecular Outflows in Massive Star Formation</i>	2020
Monica Gallegos-Garcia (now astro grad at Northwestern), Banneker Intern at Harvard <i>Winds in Star Clusters Drive Kolmogorov Turbulence</i>	2018-2020*
Courtney Bishop (physics undergrad at College of William & Mary), SAO NSF REU program <i>Comparing Molecular Line Tracers in Outflows Generated by Massive Star Formation</i>	2018
Evan Carter (physics undergrad at UCSC, then astro masters student at Wesleyan), <i>Synthetic Observations of Low-Mass Star Formation: Implications for Current SED-Fitting Methods</i>	2014-2016

### High School Students:

Shreya Karri <i>Census of Stellar Feedback in the Milky Way</i>	2019
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\* Denotes students whose project or contribution led to or will soon lead to a refereed publication

## SERVICE EXPERIENCE

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NASA JWST Cycle 1 Panelist	2021
Member, Harvard Astronomy Diversity, Equity, and Inclusion (DEI) Committee	2021-Present
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	1 year
SOC/LOC Member for Harvard-Heidelberg Star Formation meeting, Harvard-Smithsonian CfA	2017, 2019 (Chair)
Organizer, Diverse Topics in Astronomy Lecture Series, Lamat REU Program, UCSC	2015, 2016
Organizer, Space Telescope Proposal Writing Workshop, UCSC Astronomy & Astrophysics Department	2015
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, UCSC Astronomy & Astrophysics Department	2012-2016

## TEACHING EXPERIENCE

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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

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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<sup>ST</sup>-AUTHORED PUBLICATIONS)

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1. “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., submitted to *Monthly Notices of the Royal Astronomical Society*, [NASA ADS](#)
2. “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., submitted to *Monthly Notices of the Royal Astronomical Society*, [NASA ADS](#)
3. “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* (in press), [NASA ADS](#)
4. “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](#)
5. “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.**, submitted to *The Astrophysical Journal*, [NASA ADS](#)
6. “Blowing Bubbles around Intermediate-Mass Stars: Feedback from Main-sequence Winds is not Enough”  
**Rosen, A.L.**, Offner, S.S.R., Foley, M.M., Lopez, L.A., submitted to *The Astrophysical Journal*, [NASA ADS](#)
7. “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., submitted to *Monthly Notices of the Royal Astronomical Society*, [NASA ADS](#)
8. “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](#)
9. “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](#)
10. “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](#)
11. “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](#)
12. “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](#)

13. “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](#)
14. “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](#)
15. “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](#)
16. “Massive Star Formation via the Collapse of Subvirial and Virialized Turbulent Massive Cores”  
**Rosen, A.L.**, Li, P.S., Zhang, Q., Burkhardt, B., 2019, *Astrophysical Journal*, 887, 108, [NASA ADS](#)
17. “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](#)
18. “Hybrid Adaptive Ray-Moment Method (HARM<sup>2</sup>): 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](#)
19. “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](#)
20. “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](#)
21. “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

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Given **33** invited talks and **32** contributed talks to date, including

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| 1. Talk, Ringberg Virtual Seminar Series  | 2021 |
| 2. Invited Talk, Purdue University; Astrophysics Seminar; West Lafayette, IN  | 2021 |
| 3. Invited Colloquium, Carnegie Observatories; Pasadena, CA   | 2021 |
| 4. Invited NSF REU Colloquium, Center for Astrophysics   Harvard & Smithsonian<br>Cambridge, MA                             | 2021 |
| 5. Invited Talk, University of Wisconsin, Madison; Astronomy Lunch Talk; Madison, WI  | 2021 |
| 6. Invited Talk, Los Alamos National Laboratory; Los Alamos, NM   | 2021 |
| 7. Invited Colloquium, Caltech Astronomy Colloquium; Pasadena, CA   | 2021 |
| 8. Invited Colloquium, Royal Observatory of Edinburgh; Edinburgh, Scotland  | 2021 |
| 9. Invited Talk, JILA Astrophysics Friday Seminar; University of Colorado, Boulder,<br>Boulder, CO                          | 2021 |
| 10. Invited Colloquium, Rice University Physics & Astronomy Department; Houston, TX   | 2021 |
| 11. Invited Colloquium, University of Chicago Astronomy & Astrophysics Department;<br>Chicago, IL                           | 2021 |
| 12. Invited Talk, Tuesday Lunch Seminar, UCLA Astronomy Department; Los Angeles, CA   | 2020 |
| 13. Invited Review Talk, Radiation Hydrodynamics: Implementation and Application;<br>Royal Astronomical Society; London, UK | 2019 |
| 14. Talk, NASA Hubble Symposium; Washington, DC   | 2019 |

15. Invited Talk, Astronomy Seminar, Rutgers University Physics & Astronomy Department; Piscataway, NJ *2019*
16. Talk, Crete III Through Dark Lanes to New Stars: Celebrating the Career of Prof. Charlie Lada; Crete, Greece *2019*
17. Talk, Zooming in on Star Formation; Nafplio, Greece *2019*
18. Invited Review Talk, International Space Science Institute, Star Formation Workshop; Bern, Switzerland *2019*
19. Talk, UT Austin Astronomy Department, ISM & Planets Seminar; Austin, TX *2018*
20. Invited Talk, Gas Fueling of Galaxy Structures Across Cosmic Time, Astro 3D Workshop; Barossa Valley, South Australia *2018*
21. Invited Colloquium, University of Florida Astronomy Department; Gainesville, FL *2018*
22. Talk, NASA Einstein Symposium, Harvard-Smithsonian CfA; Cambridge, MA *2018*
23. Invited Review Talk, Stars Birth & Death: GMT Community Science Meeting; Honolulu, HI *2018*
24. Talk, The Wonders of Star Formation; Edinburgh, UK *2018*
25. Talk, Tracing the Flow: Galactic Environments and the Formation of Massive Stars; Lake Windermere, UK *2018*
26. Talk, Olympian Symposium 2018: Gas and stars from milli- to mega- parsecs; Paralia Katerini, Greece *2018*
27. Talk, SESTAS at MPA, Max Planck Institute for Astronomy (MPA), Garching, Germany *2018*
28. Talk, Star and Planet Formation Seminar; European Southern Observatory (ESO), Garching, Germany *2018*
29. Talk, Early Phase of Star Formation; Ringberg, Germany *2018*
30. Talk, ITC Luncheon, Harvard-Smithsonian CfA; Cambridge, MA *2018*
31. Invited Talk, Astrophysical Shocks Meeting, AIP Potsdam; Potsdam, Germany *2018*
32. Invited Talk, High Energy Seminar, Harvard-Smithsonian CfA; Cambridge, MA *2017*
33. Talk, NASA Einstein Symposium, Harvard-Smithsonian CfA; Cambridge, MA *2017*
34. Invited Talk, ITC Luncheon, Harvard-Smithsonian CfA; Cambridge, MA *2017*
35. Invited Talk, Astronomy Seminar, University of Massachusetts Lowell; Lowell, MA *2017*
36. Invited Talk, Astronomy Seminar, University of Connecticut; Storrs, CT *2017*
37. Invited Colloquium, Department of Astronomy, University of Massachusetts Amherst; Amherst, MA *2017*
38. Talk, Multi-Scale Star Formation; Morelia, Michoacan, Mexico *2017*
39. Dissertation Talk, 229th AAS Meeting; Grapevine, TX *2017*
40. Talk, Tuesday Seminar, University of Chicago; Chicago, IL *2016*
41. Talk, CITA Seminar, Canadian Institute for Computational Astrophysics; Toronto, Canada *2016*
42. Talk, Galaxy Journal Club, Space Telescope Science Institute; Baltimore, MD *2016*
43. Talk, Thunch Seminar, Princeton; Princeton, NJ *2016*
44. Invited Talk, Galaxies & Cosmology Seminar, Harvard-Smithsonian CfA; Cambridge, MA *2016*
45. Talk, MIT Astrophysics Brown Bag Lunch Series, MIT Kavli Institute; Cambridge, MA *2016*
46. Invited Talk, CCAPP Seminar, Ohio State University; Columbus, OH *2016*
47. Talk, Columbia Astronomy Seminar, Columbia; Manhattan, NY *2016*
48. Talk, Galaxy Lunch Seminar, Yale; New Haven, CT *2016*
49. Invited Talk, TAPIR Seminar, Caltech; Pasadena, CA *2016*
50. Talk, Thursday Theory Seminar, Carnegie Observatories; Pasadena, CA *2016*
51. Talk, Star Formation in Different Environments; Quy Nhon, Vietnam *2016*
52. Invited Talk, Cosmology Seminar, KIPAC/Stanford, Palo Alto, Ca *2016*
53. Invited Talk, Cosmocub, UCSC; Santa Cruz, CA *2016*
54. Talk, From Stars to Massive Stars; Gainesville, Florida *2016*
55. Invited Talk, Computational Astrophysics Meeting; ANU RSAA, Canberra, Australia *2016*

56. Talk, XXIXth IAU General Assembly, IAUS 316: Formation, Evolution, and Destruction of Massive Star Clusters; Honolulu, Hawaii 2015
57. Talk, Soul of High Mass Star Formation; Puerto Varas, Chile 2015
58. Invited Talk, Star & Planet Formation Day; Gainesville, Florida 2015
59. Invited Talk, Florida ASTROWIN Workshop: Star Formation Feedback; Gainesville, Florida 2015
60. Invited Talk, Formation of Massive Star Clusters Workshop; Prague, Czech Republic 2014
61. Invited Talk, Chemical Evolution Workshop; DARK Copenhagen, Denmark 2014
62. Talk, Summer FLASH, UCSC, Santa Cruz, CA 2014
63. Talk, Olympian Symposium on Star Formation; Paralia Katerinis, Mount Olympus, Greece 2014
64. Invited Talk, Geophysical & Astrophysical Fluid Dynamics Seminar; UCSC, Santa Cruz, CA 2012
65. Talk, XXVIIIth IAU General Assembly Meeting, JD 2: Very Massive Stars in the Local Universe; Beijing, China 2012
66. Talk, Friday Lunch Astrophysics Seminar Hour (FLASH); UCSC, Santa Cruz, CA 2012
67. Poster, Four Decades of Research on Massive Stars: A Scientific Meeting in Honour of Anthony F.J. Moffatt; Montreal, Canada 2011
68. Poster, 215th AAS Meeting; Washington, DC 2010

## **PUBLIC OUTREACH**

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- Science Matter Expert, NASA Community College Network (pilot program) 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,”  
Lamat REU Program, UCSC 2016
- Speaker, “Then and Now: From North Hills Prep to a Ph.D. in Astrophysics,”  
North Hills Prep School 2016
- Astronomy Outreach Activity, Expanding Your Horizons Workshop for Young Girls,  
Hartnell College 2015
- 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,  
Soquel High School 2015
- Women in Science & Engineering (WiSE) Astronomy Education Outreach Presentation,  
Seaside High School 2014
- Panelist, STEM Diversity Professional Development Workshop Series, UCSC 2014
- Author, [www.astrobites.org](http://www.astrobites.org), [Link to my articles](#) 2011-2013

WiSE Education Outreach Presentation, Santa Cruz High School  
Panelist, Girls Scouts “Girls Go Tech” Event, NASA Ames, Moffatt Field, CA

*2011*

*2011*