

## Maria Womack

### Research Professor University of South Florida

#### Education

- Ph.D. Physics, 1991, Arizona State University
- B.S. Physics, 1985, Florida State University  
Minors in mathematics and humanities  
University Scholar, completed Honors Program

#### Professional Experience

##### **Research Professor, Aug 2015 – present**

Department of Physics, University of South Florida, Tampa, FL  
Lead externally-funded research program in astrophysics; supervise graduate and undergraduate research students, contribute to STEM education efforts for under-represented groups, assist development of online courses and curriculum; establish and develop new science collaborations across the university and the state.

##### **Expert consultant, Feb 2016 – Jun 2016**

##### **Program Director, Jan 2011 - Jan 2015 (intergovernmental personnel assignment) Division of Astronomical Sciences**

National Science Foundation, Arlington, VA

Managed annual budget of \$20 million; lead program director for the Stellar Astronomy and Astrophysics (Nov 2011-Jan 2014), and the Planetary Astronomy (Sep 2013 – Jan 2015) grant programs. I created and helped develop the new NSF-NASA partnership for observational extrasolar planet research: NN-EXPLORE; I reorganized the stellar astronomy and astrophysics and planetary astronomy programs, including establishing and assessing the NSF extrasolar planet portfolio. Other highlights include:

- Strategic planning and program development;
- Identified and supported emerging scientific trends and potentially transformative research and scholarship;
- Coordinated, scheduled and conducted review panels, identified and secured topical experts and made proposal assignments for merit review;
- Made funding recommendations based on merit review and budget allocations;
- Provided annual review, evaluation and oversight of funded programs;
- Conducted merit review and made well-justified funding recommendations for over 700 proposals; conveyed results to PIs;
- Worked with colleagues in Divisions of Physics (PHY), Materials Research (DMR) and Chemistry (CHE) and Office of Multidisciplinary Activities (OMA) of the Math and Physical Sciences (MPS) Directorate and the Geosciences Directorate (GEO) to secure joint funding for meritorious proposals;
- Point-of-contact for NSF, and the inter-agency (NSF, NASA and DOE) coordinator for Congressionally-appointed Astronomy and Astrophysics Advisory Committee;
- Worked with colleagues to prepare and present information on NSF's extrasolar planet

- research initiatives to staffers of U.S. House of Representatives Science, Space and Technology Committee, Subcommittee on Research;
- Worked with colleagues to prepare follow-up testimony for NSF's extrasolar planet research initiatives, for the House Committee on Science, Space and Technology;
  - Worked with colleagues to review and comment on draft testimony from the Department of the Air Force and the President's Science Advisor for a hearing on Threats from Space Objects, which was presented before the House Committee on Science, Space and Technology.

**College Director of Assessment for Student Learning, 2008-2011**

**Director of the SCSU Observatory, 2004 – 2015**

**Interim Director for SCSU Planetarium, 2002**

St Cloud State University, St. Cloud, MN

Worked with the Dean of the College of Science and Engineering, faculty and students to achieve research, teaching and assessment goals of the university; managed budgets and supervised student employees.

**Professor of Physics and Astronomy, 2005 – Aug 2015**

**Associate Professor of Physics and Astronomy, 1999-2005, tenured 2000**

**Assistant Professor of Physics and Astronomy, 1997-1999**

Department of Physics and Astronomy, St. Cloud State University, St. Cloud, Minnesota

Taught all levels of undergraduate physics and astronomy courses, including online format; conducted NSF- and NASA- funded research programs, including supervising 43 undergraduate researchers.

**Research Scientist, 2007-2008**

University of Central Florida, Department of Physics (sabbatical)

Initiated research program on extrasolar planet spectroscopy with Dr. J. Harrington.

**Assistant Professor of Physics, 1994-1997**

Pennsylvania State University at Erie, Division of Science

NASA-funded Planetary Science tenure-track faculty position: comet impact on Jupiter; conducted NSF-funded research programs with 8 undergraduate researchers.

**Adjunct Associate Professor, 1994-1998**

**Visiting Professor, 1995-1996**

**Postdoctoral Research Associate, 1992-1994**

Northern Arizona University, Department of Physics and Astronomy

Planetary science research, Native American astronomy outreach, research advising and mentoring for 7 undergraduate researchers, taught intro astronomy laboratory courses.

**Postdoctoral Research Associate, 1991-1992**

Arizona State University, Department of Chemistry.

Search for deuterated methane emission in interstellar molecular clouds.

**Faculty Associate, 1991**

Arizona State University, Department of Physics.

Taught graduate seminar.

**Grant Support and Funding History: \$1,136,804 total as PI & Co-I (\$1,021,804 as PI)**

- 2016-2019: **PI, NSF Planetary Astronomy**. This grant supports observation, analysis and modeling of carbon monoxide emission in comets. Funding also supports supervision of graduate and undergraduate research projects at USF, including participation of women and underrepresented minorities, an industrial practicum for a doctoral student, and establishes new science collaborations across the university and the state.
- 2010-2015: **PI, NSF Planetary Astronomy**. This grant supported analysis and modeling of measured carbon monoxide emission in comets, including supervision of graduate and undergraduate research projects at SCSU.
- 2001-2005: **PI, NSF Planetary Astronomy**. Observational and analytical studies of simple organic molecules in comets. The observations were conducted at national and international mm/sub-mm facilities as well as at the optical observatory at the SCSU campus. Funding also supported new imaging and spectroscopic equipment purchases for the SCSU Observatory and student wages.
- 2001-2004: **PI, NASA Planetary Astronomy**. Reduce and analyze data for comets Hale-Bopp and Hyakutake.
- 1999-2001: **Co-I, Toyota Tapestry Grant**, supported equipment purchases and stipends for Minnesota high school teachers to learn how to use telescope equipment that their schools already owned; helped teachers learn research skills and make contributions to the American Association of Variable Star Observers.
- 1996-2002: **PI, NSF Faculty Early Career Development Program (CAREER)**. Grant funded comprehensive research program that was integrated with a strong educational component. The grant supported numerous observing trips for comet Hale-Bopp and many other bright comets at mm/sub-mm telescopes in Arizona and Hawaii. It also funded all equipment needed (including telescope, CCD camera and computers) to establish SCSU student-run observatory for optical imaging of comets, conducted simultaneously with the radio spectroscopy. It also funded dozens of undergraduate student researchers, including travel to observatories and conferences.
- 1997-1999: **PI, NASA Comet Hale-Bopp Program**. Funded mm-wave spectroscopy of comet Hale-Bopp, reducing and analyzing the data and publishing the results.
- 1998: **PI, Jorge Scientific Corporation Travel Grant**, funded travel to the International Astronomical Union conference at Tenerife Canary Islands so I could present research results on comet Hale-Bopp.
- 1994-1997: I was one of only a few **NASA Planetary Astronomy tenure-track faculty appointees** (the grant was awarded to Penn. State U. at Erie, R. Knacke, PI). This supported my academic year salary, so I could teach physics and astronomy courses and analyze infrared data of Jupiter related to the 1994 impact of comet Shoemaker-Levy 9.
- 1995-1996: **PI, NSF Astronomy**. While still a postdoctoral researcher at NAU, I initiated one of the first observational programs in the U.S. to apply the new technique of millimeter-wavelength spectroscopy in comets. This grant paid for subsequent analyses of these data, publications, and new observations.
- 1992-1996: **Co-I, NASA Origins of Solar Systems Program**. This award supported observation and analysis of molecular emissions from comets and interstellar clouds in order to constrain models of solar system formation.
- 1995-1996: **PI, American Astronomical Society Small Research and Travel grants** to pay for observational research on comet Hale-Bopp.

**Telescope access granted at national and international facilities: \$1M+ estimated value**

- 2016: Institut de Radioastronomie Millimetrique (IRAM) 30-m telescope, Spain.
- 2016: Arizona Radio Observatory Submillimeter Telescope (SMT) 10-m.
- 2016: Arizona Radio Observatory Kitt Peak 12-m telescope.
- 2016-2017: NASA Kepler 2 space observatory (K2).
- 2011: W.M. Keck Observatory 10-m telescope, Hawaii.
- 1990-2005: National Radio Astronomy Observatory 12m telescope, Kitt Peak.
- 1990-1993: Caltech Submillimeter Observatory 10-m telescope, Hawaii.
- 1993-1995: National Undergraduate Research Observatory, Arizona.
- 1993-1994: James Clerk Maxwell Telescope, 15-m, Hawaii.
- 1988-1990: Kitt Peak National Observatory coude-feed.

**Teaching and Assessment Experience**

While at St. Cloud State, I taught all levels of physics and astronomy courses, including online format. I oversaw all aspects of the astrophysics track of the B.S. physics major, and the B.S. Physics Education major. This included program development and assessment, modernization and reform, course curriculum development, undergraduate-student advising, and mentoring. I also led efforts to enhance undergraduate student facilities (including the observatory and physics major computing lab). Other highlights include:

- Helped develop the Physics Education curriculum to meet the State of Minnesota Board of Teacher Education new licensure requirements for junior and senior high school teacher candidates;
- Led the department through the university-wide general education overhaul, including coordination with statewide transfer curriculum standards;
- Secured final approval of our general education courses and oversight of the early stages of implementation;
- Worked with colleagues to write and publish physics and astronomy laboratory exercise manuals, which raised over \$100,000 for departmental laboratory equipment, supplies and student scholarships for recruitment.

During 2009-2011 I served as an **elected member of the Minnesota Online Academic Services Committee**. This committee's purpose is to review, develop, and recommend to the Minnesota Online Council guidelines, policies, and/or procedures that will promote strategic curriculum development and technology employment that applies best practices regarding online learning into the design and delivery of courses within the Minnesota State Colleges and Universities system.

I served as the **Director of Student Learning Assessment** for the College of Sciences and Engineering at SCSU for three years. I led monthly meetings with faculty representatives to set goals, document assessment of goals, and kept departments on track for monthly and annual deadlines for accreditation. Other major responsibilities were to:

- Prepare and present annual reports to the Dean of the College summarizing and analyzing all the departments' progress toward meeting the Higher Learning Commission (HLC) goals, identifying successes and concerns in academic programs;
- Lead the College through completion of accreditation process with the HLC;
- Help the College meet annual goals and satisfy requirements for the university in 2010 for the HLC's Academy for Assessment, needed for HLC accreditation.

### **Significant Educational and Public Outreach**

During summers from 1994 – 1998 I was the **Lead instructor and facilitator for “Stargazer” Workshop** at Northern Arizona University. In addition to astronomical activities, I worked with Navajo astronomers Nancy Maryboy and David Begay and NAU professor Barry Lutz to develop a joint Western-Navajo astronomy curriculum for “Stargazer.” This camp was selected for special recognition by NASA and given the opportunity to fly a piece of student-produced artwork from the Stargazer camp aboard NASA Space Shuttle STS-88 Endeavour flight. I also conducted other astronomical public observing sessions on the Navajo reservations, explaining some of it in the Navajo language.

During summers 1995 and 1996 I was **Instructor for the NAU/NASA Jupiter Watch** undergraduate research program, which recruited students nationally for research training with the 30-inch National Undergraduate Research Observatory (optical) telescope. I taught students data collection, reduction and analysis techniques using National Optical Astronomy Observatory (NOAO)’s IRAF software.

From 1997 – 2011 I developed and gave dozens of planetarium shows to university students and members of the public, including many public-astronomy nights. In 2002 I was the **SCSU Planetarium Director**, during which time I oversaw the operation of the planetarium, including the budget, trained and supervised student employees.

From 2004 - 2015 I was **Director of the SCSU Observatory**, for which I manage the budget, scheduling, operation and maintenance of the on-campus student-run observatory. I also:

- Secured funding from NSF for a \$60,000 upgrade to the observatory with two telescopes, imaging and spectroscopic CCD cameras, filters, and computers;
- Trained students to conduct research with the observatory, and to assist with public observing nights;
- Supervised over 30 paid student research assistants to conduct observations and analyze results using advanced computer techniques

### **Invited Talks, Presentations and Workshops**

2015	NSF Grant Strategies Workshop, USF
2015	University of Central Florida, Dept of Physics, “Carbon monoxide in Comets,” colloquium
2015	University of South Florida, Dept of Physics, “Writing a great research proposal” graduate seminar lecture
2014	University of South Florida, Dept of Physics, “Research communities and the craft of proposal writing,” graduate seminar lecture
2013	University of S. Florida, Dept. of Physics, “Proposal writing: Selling your Best Idea,” graduate seminar lecture
2011	St. Cloud State University, “NSF Funding Opportunities and Tips for Success;”
2010	Minnesota State University Moorhead, Department of Physics and Astronomy, “Using Spectra to Probe Cometary Atmospheres,” colloquium
2010	Winter Workshop at University of Central Florida: Exoplanets for Planetary Scientists, “Challenges of a Ground-based Search for Water in a Hot Jupiter: HD 209458b,” invited review talk
2009	University of South Florida, Department of Physics, “Spectral Clues to the Origin of Organic Molecules in Comets,” colloquium

- 2009 SCSU, “A Guided Tour of Five Exotic Exoplanets,” public lecture
- 2000 Univ. of Toledo Dept. of Physics and Astronomy, “Outbursts in Comets at Large Heliocentric Distances,” colloquium
- 1999 American Astronomical Society meeting (Atlanta), invited session for NSF CAREER Awardees, “Cometary Activity Beyond 4 AU”
- 1999 NRAO Conference: Imaging at Radio through Submillimeter Wavelengths, “On the Fly Imaging of Neutral and Ionized Molecules in Comet Hale-Bopp,” invited review
- 1999 University of Minnesota Astronomy Dept, “Millimeter-wavelength Observations of Comet Hale-Bopp,” colloquium
- 1999 Asteroids, Comets, and Meteors meeting, Cornell University, “On the Activity of Distant Comets,” invited review
- 1999 Minnesota Optical Society, “Millimeter-wavelength Spectral Imaging of Comets: New Insights into Gas Dynamics”
- 1998 Western Regional NASA Space Grant meeting, "Native American Astronomy Education in the Stargazer Program," invited speaker
- 1996 Panel Discussion on Comet Hyakutake, American Astronomical Society meeting, Madison, WI
- 1995 American Association for Physics Teachers meeting, Spokane, WA, "Carbon Chemistry in Comets," invited review
- 1996 Univ. of Toledo Dept. of Physics and Astronomy, “Observational Constraints to Solar System Formation,” colloquium
- 1994 Pennsylvania State Univ. at Erie, Division of Science, “Millimeter-wavelength Observations of Organic Species in Comets,” colloquium
- 1995 Max Planck Institut fur Astronomie, Bonn, “N<sub>2</sub>H<sup>+</sup> in Quiescent Gas: Evidence for Colliding Clouds,” colloquium
- 1991 Univ. Massachusetts at Amherst, “Interstellar Nitrogen Chemistry as Revealed from Observations of N<sub>2</sub>H<sup>+</sup>,” colloquium

### Notice in Popular Press

- “[Hitching a Ride on Comet 29P](#),” 2016, USF News.
- “[Contemplating the Chemical Composition of Comets and Exoplanets](#),” 2015, People Behind the Science podcast with Marie McNeely.
- “An Inside Look at NSF,” Fundamentals Newsletter, SCSU, 2012
- “NASA Mission Hits Home,” University Chronicle, 2005
- “[SCSU Professor, Students Train Eyes on NASA Mission](#),” WCCO, 2005
- “SCSU's Womack monitored Deep Impact from home,” St. Cloud Times, 2005
- “[Astronomers’ Holiday Special – a July 4 Comet Bash](#)”, University of Arizona News, 2005
- “Students of SCSU Professor’s space camp get patch launched,” St. Cloud Times, 1998
- “[Cometwatcher](#),” Research Penn State, 1997

### Other Contact with Media and Press Releases

- “[Rosetta captures comet dust after finally finding Philae](#),” 2016, in Chemistry World, contributed expert comments to article about press release for European spacecraft mission.
- “[Comet 67P’s carbon blanket promises solar system birth insights](#),” 2015, in Chemistry World, contributed expert comments to article about press release for European spacecraft result.
- “[Global perspectives on a comet](#),” 2014, NSF Press release about comet ISON photography

contest, reprinted in [Astrobiology Magazine](#), [CBSNews](#).

“[Celestial Pollution](#),” 2013, Gemini Observatory Press Release about meteor shower, reprinted in [Space.com](#).

“[Spiral arms hint at the presence of planets](#),” 2011 in NSF Press Release.

Multiple other radio, television and social media interviews for unusual events (e.g. comets, solar and lunar eclipses, meteors, brooms “[standing on end](#)”) since 1991

### **Additional Professional and Public Service**

SCSU Faculty Senate, 2008-2010

SCSU University Steering Committee on Assessment of Student Learning, 2008-2011

SCSU College of Science and Engineering Curriculum Committee, 2005-2007

SCSU College of Science and Engineering Assessment Committee, 2000-2011

SCSU Committee on the Institution, 2006-2011

SCSU Master’s thesis committee member, M.S. Electrical Engineering, S.Y. Choi,

“Automatic modulation classification on software defined radio,” 2008-2009

SCSU Chair, search committee for department faculty positions, multiple years

SCSU Public Observing Nights, 1997-2010

SCSU Planetarium Shows, 1997-2010

Workshops with High School Teachers on observing variable stars, 1999-2000, Minnesota

SCSU Faculty advisor to students majoring in physics, radiologic technology and nuclear medical technology, 1994-2011

SCSU Committee of student workers, 1997-2011

SCSU Departmental committee of retention, promotion and tenure, 2005-2011

SCSU Working group, Wiki-users, 2008-2010

Faculty advisor, Penn State Erie, Women in Science and Engineering, 1994-1997

NSF Review Panels and external reviewer, since 1993

NASA Review Panels and external reviewer, since 1992

Reviewer for journals *Icarus* and *Astrophysical Journal*, since 1994

Scientific Organizing Committee, for International Astronomical Union Colloquium

No.186: "Cometary Science after Hale-Bopp" meeting in Tenerife, Canary Islands, 2000-2002

NASA Planetary Data Systems Small Bodies Node International Halley Watch Peer Review Committee, 1993

Public lectures on astronomical topics, since 1995

Coach, “Odyssey of the Mind” problem-solving tournament, 2012

Astronomy Day activities with tourists on the National Mall, Washington, DC, 2013

Public and professional outreach with social media, since 2013

Advice and mentoring to Aspiration Creation group working with European Space Agency to involve African American students with Mars research, 2015.

<http://www.planetary.org/blogs/guest-blogs/2016/0226-atlanta-students-bring-mars-to-earth.html>

**Refereed Publications (chronological order)**

1. Womack, M., Theobald, J. 1989, "Spatial Profiles of CN, C<sub>2</sub>, NH, NH<sub>2</sub>, H<sub>2</sub>O<sup>+</sup>, CO<sup>+</sup> and CO<sub>2</sub><sup>+</sup> in Comet P/ Halley," Publ. Astr. Soc. Pacific, 101, 881.
2. Womack, M., L.M. Ziurys, and S. Wyckoff, 1991, N<sub>2</sub>H<sup>+</sup> in Orion: Chemical Clues to the Dynamics of the Quiescent Gas, *Astrophysical Journal Letters*, 370, L99.
3. Tegler, S.C., L.F. Burke, S. Wyckoff, M. Womack, U. Fink, M. DiSanti 1992, NH<sub>3</sub> and NH<sub>2</sub> in the Coma of Comet Brorsen-Metcalf, *Astrophysical Journal*, 384, 292.
4. Womack, M., L.M. Ziurys and S. Wyckoff, 1992, A Survey of N<sub>2</sub>H<sup>+</sup> in Dense Clouds: Implications for Interstellar Ion-Molecule and Nitrogen Chemistry, *Astrophysical Journal*, 387, 417.
5. Womack, M., L.M. Ziurys and S. Wyckoff, 1992, Estimates of N<sub>2</sub> Abundances in Dense Molecular Clouds, *Astrophysical Journal*, 393, 188.
6. Womack, M., S. Wyckoff and L.M. Ziurys, 1992, Observational Constraints on Solar Nebula Nitrogen Chemistry: N<sub>2</sub>/NH<sub>3</sub>, *Astrophysical Journal*, 401, 728.
7. Lutz, B.L., M. Womack, and R.M. Wagner, 1993, Ion Abundances and Implications for Photochemistry in Comets Halley (1986 III) and Bradfield (1987 XXIX), *Astrophysical Journal*, 407, 402.
8. Womack, M., L.M. Ziurys, and L. Sage, 1993, N<sub>2</sub>H<sup>+</sup> in the Orion Ambient Ridge: Cloud Clumping vs. Rotation, *Astrophysical Journal Letters*, 406, L29.
9. Womack, M., B.L. Lutz, and R.M. Wagner, 1994, Pre- and Post-Perihelion Abundances of Gas and Dust in Comet Halley *Astrophysical Journal*, 433, 886.
10. Womack, M., Ziurys, L.M., and Apponi, A.J. 1995, A Search for Interstellar CH<sub>3</sub>D, *Astrophysical Journal*, vol. 461, p. 897.
11. Noll, K.S., Gilmore, D., Knacke, R., Womack, M., Griffith, C.A., Orton, G. 1997, CO in Jupiter After Comet Shoemaker-Levy 9, *ICARUS*, 126, Issue 2, pp. 324-335.
12. Womack, M., Stern, S.A., and Festou, M.C., 1997, Millimeter-wavelength Spectroscopy of CO, HCN, H<sub>2</sub>CO, and CH<sub>3</sub>OH in C/1996 B2 (Hyakutake), *Planetary and Space Science*, vol. 45, pp. 711-715.
13. Womack, M., Festou, M.C., and Stern, S.A., 1997, The Heliocentric Evolution of Key Species in the Distantly-Active Comet C/1995 O1 (Hale-Bopp), *Astronomical Journal*, Vol. 114, p. 2789.
14. Womack, M., Festou, M.C., Stern, S.A. and Homich, A. 1997, Maps of HCO<sup>+</sup> Emission in C/1995 O1 (Hale-Bopp), *Earth, Moon and Planets (Hale-Bopp Edition)*, vol. 77, no. 3, 259-264.
15. Braunstein, M., Womack, M., et al. 1997, A CCD Image Archive of Comet C/1995 O1 (Hale-Bopp): Dust Expansion Velocities, *Earth, Moon and Planets (Hale-Bopp Edition)*, vol. 78, no. 1, 219-227.
16. Womack, M. and Stern, S.A. 1999, The Detection of CO in 2060 Chiron, *Solar System Res.*, vol. 33, p. 187.
17. Bockelee-Morvan, D., Biver, N., Moreno, R., Colom, P., Crovisier, J., Gerard, E., Henry, F., Lis, D. Matthews, H., Weaver, H.A., Womack, M., Festou, M.C. 2001, "Outgassing behavior and composition of comet C/1999 S4 (LINEAR) during its disruption," *SCIENCE*, 292, pp. 1339-1343
18. Meech, K.J. and 208 co-authors including M. Womack, 2005, *SCIENCE*, 310, 5746, 265-269, "Deep Impact: Observations from a Worldwide Earth-Based Campaign."
19. Biver, N., Bockelee-Morvan, D., Crovisier, J., Lis, D.C., Moreno, R., Colom, P., Henry, F., Herpin, F., Paubert, G. and M. Womack, 2006, "Radio wavelength molecular observations of comets C/1999 T1 (McNaught-Hartley), C/2001 A2



- (LINEAR), C/2001 WM1 (LINEAR), and 153P/Ikeya-Zhang,” *Astronomy and Astrophysics*, 449, 1255B.
20. Milam, S.N., Remijan A.J., Womack, M., Abrell, L., Ziurys, L.M., Wyckoff, S., Apponi, A.J., Friedel, D.N., Snyder, L.E., Veal, J.M., Palmer, P., Woodney, L.M., A’Hearn, M.F., Forster, J.R., Wright, M.C.H., de Pater, I., Choi, S. and Gesmundo, M. 2006, *Astrophysical Journal*, 649, 1169.
  21. Remijan, A.J., Milam, S.N., Womack, M., Apponi, A.J., Ziurys, L.M., Wyckoff, S., A’Hearn, M.F., dePater, I., Forster, J.R., Friedel, D.N., Palmer, P., Snyder, L.E., Veal, J.M., Woodney, L.M., Wright, M.C.H. 2008, “The Distribution, Excitation, and Formation of Cometary Molecules: Methanol, Methyl Cyanide, and Ethylene Glycol,” *Astrophysical Journal*, 689, 613-621.
  22. Womack, M., Sarid, G., Wierzchos, 2016, “Carbon monoxide in distant comets,” *Publications of the Astronomical Society of the Pacific*, review article, in press.

#### **Other relevant professional publications**

1. Riles, K., Duffy, A., Weltman, A., Kennefick, D., Parkinson, D., Womack, M., Smartt, S., Davis, T., Murphy, T. 2016, “[Gravitational waves discovered: top scientists respond](#),” in *The Conversation*, expert panel opinion piece, reprinted in [Newsweek](#) and [US News & World Report](#).
2. Womack, M. 2015, “Astronomy Decadal Reports Primer,” *Astrobetter*, <http://www.astrobetter.com/blog/2015/09/09/astronomy-decadal-reports-primer-new-worlds-new-horizons-visions-voyages-and-nsf-portfolio-review-committee/>
3. Womack, M. 2015, “The Astronomy OIR Study recommendations for the LSST era,” *Astrobetter*, <http://www.astrobetter.com/blog/2015/09/16/the-astronomy-oir-study-recommendations-for-the-lsst-era/>
4. Womack, M. 2015, “How will NSF pay for the Astronomy OIR Study recommendations?” *Astrobetter*, <http://www.astrobetter.com/blog/2015/09/22/how-to-pay-for-the-oir-study-recommendations/>

#### **International Astronomical Union Telegrams**

1. Womack, M., S.A. Stern, 1994, “Upper Limits to CO in 2060 Chiron,” *IAUC* 5957.
2. Womack, M., Stern, S.A., Festou, M.C. 1995, “CO in Hale-Bopp,” *IAUC* 6276.
3. Womack, M., Stern, S.A. 1995, “Detection of CO in 2060 Chiron,” *IAUC* 6193.
4. Womack, M., Festou, M.C., and Stern, S.A. 1996, “CO, HCN, CH<sub>3</sub>OH and H<sub>2</sub>CO in Comet Hyakutake (1996 B2),” *IAUC* 6345.
5. Womack, M., Woodney, L.M., Festou, M.C., McMullin, J., A’Hearn, M., Suswal, D., and Stern, S.A. 1996, “Detection of Methanol in Hale-Bopp,” *IAUC* 6382.
6. Woodney, L., Womack, M., et al. 1996, “Detection of H<sub>2</sub>S in Hale-Bopp,” *IAUC* 6408.
7. Womack, M., and Suswal, D. 1996, “Detection of HCN in Comet Tabur,” *IAUC* 6485.
8. Womack, M., Faith, D., Festou, M.C., Slater, D., and Stern, S.A. 1997, “Ortho-to-para Ratio in Hale-Bopp,” *IAUC* 6542

#### **Meeting Abstracts and Presentations (chronological order)**

1. Wyckoff, S.; Wehinger, P. A.; Belton, M. J. S.; Spinrad; Wagner, R. M.; Womack, M., 1986, “Spectral Evolution of Comet P/Halley: 1984-1986”, *BAAS*, 18, 813.
2. Wyckoff, S., P.A. Wehinger, M. Womack, A.J. Ferro, B.A. Peterson, S. Tegler, and J. Theobald 1987, “Optical Spectroscopy of Comet Halley”, *B.A.A.S.*, 19, No. 3.

3. Womack, M. and Theobald, J. 1988, "Violet and Red Systems of CN in the Spectrum of Comet Halley", B.A.A.S., 20, No. 3.
4. Womack, M. and Theobald, J. 1989 "Spatial Profiles of Free Radicals in Comet Halley", Astron. Soc. Pacific, Berkeley Meeting, June 1989.
5. Womack, M. and S. Wyckoff, 1989, "Spatial Distributions of Molecules in Comet Halley", B.A.A.S., 21, No. 3.
6. Wehinger, P.A., Wyckoff, S., Womack, M., Peterson, B.A., 1989, "Echelle Spectra of the CN (0,0) Violet system in comet Brorsen-Metcalf", BAAS, 21, 933.
7. Womack, M., P. Wehinger, S. Wyckoff, and B. Peterson, 1990, "The 12CN/13CN Abundance Ratio in Comets and Local Interstellar Medium", BAAS, 21, 4, 1124.
8. Womack, M., P.A. Wehinger, S. Wyckoff, and B.A. Peterson, 1990, "The 12CN/13CN Abundance Ratio in the Local Interstellar Medium", Protostars and Planets III meeting.
9. Womack, M., L.M. Ziurys, and S. Wyckoff, 1990, "N<sub>2</sub>H<sup>+</sup> in Warm and Cold Clouds", B.A.A.S., 22, No. 2, 800
10. Burke, L.F., S.C. Tegler, S. Wyckoff, M. Womack, U. Fink, and M. DiSanti, 1990, "NH<sub>2</sub> in the Coma of Comet Brorsen-Metcalf", B.A.A.S, 22, No. 3.
11. Wyckoff, S., S.C. Tegler, L. Engel, M. Womack, A. Ferro and B. Peterson, 1990, "Ammonia and N Abundances in Comets", B.A.A.S., 22, No. 3.
12. Womack, M., S. Wyckoff, P.A. Wehinger, and B.A. Peterson, 1990, "A Spectroscopic Atlas of Comet Halley (3200 – 9200Å)", B.A.A.S., 22, No. 3.
13. Womack, M., Ziurys, L.M., Wyckoff, S., and Sage, L. 1991, "N<sub>2</sub>H<sup>+</sup> in Orion: Two Clouds at KL/IRc2?", B.A.A.S., 22, No. 4, 1329.
14. Womack, M. 1991, "N<sub>2</sub>H<sup>+</sup> in the Orion Quiescent Gas", Steward Obs. Internal Symposium.
15. Womack, M., S. Wyckoff, and L.M. Ziurys, 1991, "Molecular Cloud Diagnostics of Solar Nebula Chemistry", B.A.A.S., 23, No. 3, 1232.
16. Wyckoff, S., M. Womack and L.M. Ziurys, 1991, "Cometary Diagnostics of Solar Nebula Chemistry", B.A.A.S., 23, No. 3, 1234.
17. Womack, M., Lutz, B.L., and R.M. Wagner, 1992, "Molecular Ions in Comets Halley and Bradfield (1987 XXIX)", B.A.A.S., 24, No. 3, 999.
18. Womack, M., L.M. Ziurys and L.J. Sage, 1993, "Cloud Clumping of the Orion Ambient Ridge: No Rotation About KL/IRc2", B.A.A.S., 24, No. 4, 1199.
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22. Womack, M., Ziurys, L.M., Apponi, A.J. and Yoder, J.T. 1994, "Interstellar CH<sub>3</sub>D: Deuterated methane in the Orion hot core?," AIP 312, 305.
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24. Noll, K., Gilmore, D., Knacke, R., Womack, M., Fajardo-Acosta, S., Orton, G., Griffith, C. "Evolution of CO on Jupiter Before, During and After SL9", International Astronomical Union, May 1995.
25. Womack, M. "Carbon Chemistry in Comets", Topics in Modern Astronomy, American Assoc. of Physics Teachers, Aug. 1995.

26. Womack, M., Stern, S.A. 1995, ``Detection of CO in Chiron'', BAAS, 27, 33.07.
27. Womack, M., Festou, M.C., and Stern, S.A. 1996, ``CO, HCN, CH<sub>3</sub>OH and H<sub>2</sub>CO in Comet Hyakutake Before, During and After Perihelion'', B.A.A.S., 28, 188.
28. Womack, M. Panel Discussion on Comet Hyakutake, at American Astronomical Society meeting, June 1996.
29. Womack, M., Festou, M., and Stern, S.A. 1996, ``Parent Molecules in Comet Hyakutake'', ACM meeting, July 1996.
30. Womack, M., Suswal, D., Festou, M., Stern, S.A., and Slater, D. 1996, ``Millimeter-wavelength Spectroscopy of Comets Hyakutake and Hale-Bopp'', B.A.A.S., 29.
31. Womack, M., Festou, M.C., Mangum, J., and Stern, S.A., 1997, ``Millimeter-wavelength Images of Gaseous Emission in C/1995 O1 (Hale-Bopp)'', BAAS 29, 3406.
32. Pinnick, D.A., Womack, M., Moore, G., Faith, D., Wiest, A., Modi, C., Ricotta, J., and Suswal, D. 1997, ``Optical Images of C/1995 O1 (Hale-Bopp) During Perihelion'', BAAS, 29, 3214.
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38. Womack, M., Festou, M.C., Stern, S.A., and J. Mangum, 1998, ``Mm-wave maps of HCO<sup>+</sup> Emission and Molecular Ion Morphologies in C/1995 O1 (Hale-Bopp)'', First International Meeting of Comet Hale-Bopp, Tenerife, Proceedings, 53.
39. Braunstein, M., Womack, M., Deglman, F., Pinnick, D., Faith, D., Modi, C., Moore, S., Ricotta, J., Wiest, A., Ben-Bassat, O., Ruiz, J. 1998, ``CCD Image Archive of Comet C/1995 (O1) Hale-Bopp'', First International Meeting of Comet Hale-Bopp, Tenerife, 69.
40. Womack, M. "On the Activity of Distant Comets", Invited speaker, Asteroids, Comets and Meteors Meeting, 1999, Ithaca, NY.
41. Womack, M. and Homich, A. "Comparison of Long-term Activity of Comet Hale-Bopp at Visible and Mm-wavelengths", 1998, B.A.A.S., 31, 1709.
42. Womack, M., Pinnick, D.A., Mangum, J.G., Festou, M.C., Stern, S.A. 1999, "On the Fly Imaging of Neutral and Ionized Molecules in Comet Hale-Bopp", Conference at Radio through Submillimeter Wavelengths, Tucson, AZ
43. Pinnick, D.A. and Womack, M. 1999, "Spectral Analyses of HCN and CO Emission Maps of Comet Hale-Bopp," BAAS, 31, 1589.
44. Womack, M 2000, "Cometary Activity Beyond 4 AU", BAAS, 32, 4124.
45. Womack, M. 2000, "COMETWATCHERS: Bringing Research into the Undergraduate Astronomy Curriculum," BAAS, 32, 875.

46. Crovisier, J., Biver, N., Moreno, R., Lis, D., Bockelee-Morvan, D., Womack, M., Colom, P., Henry, F., Lecacheux, A., Paubert, G., Despois, D., and Weaver, H.A. 2001, "Spectroscopic Investigation of Comets C/1999 T1 (McNaught-Hartley) and C/2001 A2 (Linear) at Radio Wavelengths: Evidence for Chemical Diversity", *BAAS*, 33, 4306.
47. Cabanela, J., Womack, M., & Dickey, J.M. 2001, "Deep CO Observations of Four LSBs", *BAAS*, 199, 710.
48. Womack, M., Festou, M., Pinnick, D., Mangum, J.G. 2002, "OTF images and asymmetric outgassing from comet Hale-Bopp", *BAAS*, 34, 1607.
49. Festou, M., Womack, M., Pinnick, D., Mangum, J., 2002, "How anisotropic was the gas coma of comet C/Hale-Bopp?", *BAAS*, 34, 1212.
50. Milam, S., Womack, M., Ziurys, L.M., Wyckoff, S. 2005, "Simple Organics in Comets: Formaldehyde, Methyl Cyanide and Methanol", *IAU Symposium, Asilomar*.
51. Womack, M., S. Choi, M. Gesmundo, J. Swanson, 2007, "CO, HCN and H<sub>2</sub>S in comet C/2001 Q4 (NEAT)", *BAAS*, 39, 5308.
52. Womack, M., Harrington, J., Deming, D., Rojo, P., Fortney, J.J. 2008, "The search for water in HD209458b with transit spectroscopy over 0.7–2.4 micron", *BAAS*, 40, 1109
53. Womack, M., Harrington, J., Rojo, P., Deming, D., Fortney, J. 2010, "A ground-based search for water in HD 209458b using transit spectroscopy," proceedings UCF Winter Workshop: Exoplanets for Planetary Scientists, <http://planets.ucf.edu/node/206>.
54. Womack, M., Sarid, G., Wierzchos, K. 2016, "Gaseous activity of distant comets," *Bulletin of the American Astronomical Society*, 483,3006.
55. Wierzchos, K. and Womack, M. 2016, "CO in Centaur Echelus," *Bulletin of the American Astronomical Society*, 481,604.

### Meeting Proceedings

1. Womack, M., 1990, "N<sub>2</sub>H<sup>+</sup> in Warm and Cold Clouds", Workshop on Observations of Recent Comets (1990), ed. W.F. Huebner, P.A. Wehinger, J. Rahe, I. Konno, Southwest Research Institute, 110.
2. Womack, M., Ziurys, L.M., Apponi, A.J., and Yoder, J.T. 1994, "Interstellar CH<sub>3</sub>D: Deuterated Methane in the Orion Hot Core?", *Physical Chemistry of Molecules and Grains in Space meeting*, Mont Sainte-Odile (France), 305.
3. Womack, M., and Stern, S.A., 1997, "Observations of Carbon Monoxide in (2060) Chiron", *LPSC*, 28, 1575.
4. Stern, S.A, Womack, M., and Festou, M.C. 1997, "Heliocentric Evolution of Key Species in Comet C/1995 O1 (Hale-Bopp)", *LPSC*, 28, 1375.
5. Womack, M., Festou, M., Stern, S. 2000, "On the Fly Imaging of Neutral and Ionized Molecules in Comet Hale-Bopp", *ASP Conference Proceedings*, Vol. 217, 82.
6. Festou, M.C., Barale, O., Davidge, T., Stern, S.A., Tozzi, G.P., Womack, M., and Zucconi, J.M. 2002, *Proceedings from IAU Colloquium No. 186 "On the Identity of Cometary CN Parent Molecule"*.
7. Womack, M. 2010, "Challenges of a Ground-based Search for Water in a Hot Jupiter: HD 209458b," review, proceedings Univ. Central Florida Winter Workshop: Exoplanets for Planetary Scientists, <http://planets.ucf.edu/node/206>.

**Society Membership**

American Astronomical Society (AAS)

Division for Planetary Sciences

International Astronomical Union

Division F Commission 15 Physical Study of Comets & Minor Planets

Division F Commission 51 Bio-Astronomy

Division F Commission 53 Extrasolar Planets

**Student Research Supervised**

Students are listed according to year the work started. Also listed are the students' occupations after graduation, when known. Funds for the SCSU Observatory equipment and student wages were obtained from National Science Foundation grants. Research requirements were frequently incorporated in all upper level undergraduate astrophysics courses at SCSU; undergraduate research at USF conducted to fulfill requirements for the physics major.

**1993**

1. Sean McKeown, "Mm-wave Spectroscopy of Comet Swift-Tuttle" (REU student at NAU), B.S. 1994 Physics and Theology, Georgetown Univ., M.S. Physics, Northwestern University. Now I.T. Director at Oracle Corp.
2. Bret Huggard, "Optical Imaging of Collision of Comet SL9 with Jupiter," and "HST Ultraviolet spectroscopy of Interstellar Clouds." B.S. 1996, Physics and Astronomy, Northern Arizona Univ., later telescope operator and electronics technician at Kitt Peak National Observatory, Arizona.
3. Kartik Sheth, "Interstellar Optical Spectroscopy," (REU student at NAU), B.S. Grinnell College, Ph.D. Astronomy Univ. Maryland, co-supervised with B. Lutz. Now Deputy Program Scientist at NASA.

**1994**

4. Brian Cudnik, "Optical Imaging of Jupiter and Mars." B.S. 1994, Physics and Astronomy, NAU, M.S. San Diego State University, 1998. Now Laboratory Specialist at Prairie View A&M University
5. Ray Graham, "CO spectra of Comet P/Schwassmann-Wachmann 1," B.S. 1997, Electrical Engineering, Penn State Erie, Engineer at Harris Corporation, Aerospace Division. Now President of Bitwise Design.

**1995**

6. Dennis Faith, "Imaging Comet Hale-Bopp," B.S. Biology 1997, Penn State Erie. Now physician at FirstLight Health System, Minnesota.

**1996**

7. Oren Ben-Bassat, "CCD Imaging of Comet Hale-Bopp," B.S. Physics, 1997, Brandeis

Univ., Ph.D. Mathematics, University of Pennsylvania 2006. Later at Einstein Institute of Mathematics.

8. Javier Ruiz, "CCD Imaging of Comet Hale-Bopp", B.S. Physics, 1997, NAU.
9. Dave Suswal, "Mm-wave spectroscopy of Comet Hale-Bopp," B.S. Physics, 1997, Penn State Erie, Special Education aide, Deary High School, Deary, Idaho.
10. Steve Spencer, "Infrared Spectroscopy of Jupiter," B.S. Math, 1997, Penn State Erie, systems engineer, Aquilent.

### **1997**

11. Chintan Modi, "CCD Imaging of Comet Hale-Bopp," B.S. Biochemistry and Molecular Biology, Penn State University. Now working at Merck Co.
12. Jack Ricotta, "CCD Imaging of Comet Hale-Bopp," B.S. Mech. Engineering, Penn State Univ., lead application developer at Progressive Insurance.
13. Scott Moore, "CCD Imaging of Comet Hale-Bopp," Environmental Science major at Penn State University, Now posting Specialist and Internet Research Assistant at Penn State Univ.
14. Aric Wiest, "Photography and CCD Imaging of Comet Hale-Bopp," B.S. Biology, 1998, Penn State Erie, M.S., Biology at Texas A&M University, 2002. Now faculty member at Univ. Missouri-Kansas City.
15. Trevor Uhl, "Mm-wave Spectroscopy of Comet Hale-Bopp," (REU student at NAU), B.S. Physics and Astronomy 1997, Yale University, Now at Investment Research & Risk Analysis at Reliance Funds, NY.
16. Jean Zilka, "Data Reducation and Analysis of Comet Hale-Bopp," B.E.S. Physics, 1999, SCSU. Now working at DeVry Univ.
17. Frank Deglman, "CCD Imaging and Data Reduction of Comets with SCSU Observatory," B.S. Physics, 1996, SCSU. Now telescope operator and engineer at McDonald Observatory.
18. April Homich, "CCD Imaging and Analysis of Comets" and "Mm-wave Spectroscopy of Comets," B.S. Physics, SCSU, 2000, M.S. Astronomy University of Minnesota, 2003.

### **1998**

19. Marcel Goldschen-Ohm, "Analysis of Dust Jets in Comet Hale-Bopp", "Stellar spectroscopy", in ASTR 312, B.S. physics, SCSU. Ph.D., Physics, 2009, Univ. Wisconsin-Madison, assistant scientist at UW-Madison.
20. Ahnie Jacobson, "Image Reduction of Comet Hale-Bopp", B.A. Math, 1998, College of St. Benedict, M.S. Applied and Computational Mathematics, U. of Minnesota, Duluth.

21. Mike Spinar, "Mm-wave Imaging of Comet Hale-Bopp," B.S. Meteorology, 2001, SCSU. Now graduate student in atmospheric science, University of Illinois, Urbana-Champaign
22. Brian Henning, "CCD Imaging of Comets," B.A. computer science, SCSU, 2001, senior engineer at Target.
23. Grant Aaker, "Analysis of Dust Jets in Comet Hale-Bopp," post-secondary student, B.S. Lewis and Clark College, philosophy. Currently in med school at Cornell and filmmaker.
24. Aaron Lemke, "Image Reduction of Comet Hale-Bopp Data," post-secondary student.
25. Sarah Reed, "CCD Imaging of Comets with SCSU Observatory," also in ASTR 311, B.S. Physics 2002; UC at Berkeley, Environmental Science, Policy and Management, Ph.D. 2013, postdoctoral scholar at Lawrence Hall of Science at UC-Berkeley.

### 1999

26. Andrea Tollison, "CCD Imaging of Comets with SCSU Observatory," in ASTR 311, B.S. Physics, SCSU. Edmund Industrial Optics, Data Systems Analyst at Mastery Charter Schools.
27. Jessica Hafner, "CCD Imaging of Comets with SCSU Observatory," undeclared, SCSU
28. Jason Cook, "CCD Imaging of Comets with SCSU Observatory," in ASTR 311, B.S. physical science education major, SCSU. Now teaching high school.
29. Steven Dorsher, "CCD Imaging of Comets with SCSU Observatory," in ASTR 311, post-secondary student, SCSU, member US TEAM 2000 Physics Olympiad. Now graduate student in physics at Louisiana State University.

### 2000

30. Laura Lockwood, "Stellar Spectroscopy with SCSU Observatory," in ASTR 312, B.S. Meteorology, SCSU, 2002, now meteorologist, Director of Operations, Weatherology.
31. Corey Strom, "Variable Star Lightcurves" in ASTR 312, ASTR 323 CCD Imaging of Comets, B.S. Physics, SCSU, B&C Plumbing.
32. Andy Matt, "Stellar Spectroscopy with SCSU Observatory" in ASTR 312, computer science, SCSU
33. Kar-Yeong Teoh, "Scientific Databases on the Internet, computer maintenance," B.S. computer science, SCSU. Now at Unisys Corp.
34. Judith Peters, in ASTR 323, B.S. physics, SCSU, M.S. Mechanical Engineering SCSU, LPKB Engineering.
35. Brent Williams, in ASTR 323, B.S. physics, SCSU, Ph.D. Univ. California Berkeley, Raymond R. Tucker Distinguished assoc. professor at Washington U. at St. Louis.

36. Megan Broberg, in ASTR 323, B.S. earth science, SCSU, now pursuing graduate studies.
37. Pete Crandall, in ASTR 323, SCSU, "CCD Observations of Comets," B.S. physics, product manager at TE Connectivity.

### **2001**

38. Jeff Ward, "SHINY: linux laptops and image acquisition," B.S. computer science, SCSU, 2004, Senior Software Engineer at Akamai Technologies.
39. Eric Richey, "CCD Observations of comets," computer science major, SCSU
40. Michelle Kawecki, "Observing Comets," physics major, SCSU

### **2003**

41. Nicholas Johnson, in ASTR 311, "Planetary spectra," B.S. computer science, 2004, SCSU
42. Laura Holt in ASTR 311, "Optical images of comets," B.S. physics, 2004
43. Jesse Belschner in ASTR 311, "Optical images of comets," B.S. physics, 2004. Now a medical physicist in Minnesota.

### **2004**

44. Kyle Nestor, "Observing Comets," B.S. aviation, 2006, SCSU, Captain, Challenger 300 at Harley-Davidson Motor Co.
45. Matt Gesmundo, "Observing comets" in ASTR 323, physics major, SCSU, B.S. electrical engineering 2007. Project engineer at Nortech systems.
46. Sung Yeol Choi, "Computer programming and data reduction," computer science major, SCSU, B.S. computer engineering 2006, M.S. electrical and computer engineering, 2009, SaaS developer at Isola Group.
47. Todd Stanley, "Planetary spectroscopy with the SCSU Observatory" in ASTR 323, B.S. physics, 2005, now software engineer at Hysitron.

### **2005**

48. Joshua Swanson, "Mm-wave spectra of comet C/2001 Q4 NEAT," in ASTR 311, B.S. physics, 2007, SCSU. Ph.D. Univ. Wisconsin-Madison, postdoctoral researcher at Brown Univ; Engineer at Intel, Oregon.
49. Dan Hessler, in ASTR 311, "Optical spectra of Mars," ASTR 311, physics, SCSU

### **2006**

50. Tom Pundsack in ASTR 323, "Optical spectra of comets," B.S. physics, 2007, SCSU.



Ph.D. physics, Univ. Minnesota 2014; Instrument Service Specialist, Pace Analytical.

## 2008

51. Andy Davies in ASTR 311, “Spectra of Hot Jupiters,” B.S. physics, astrophysics track, SCSU 2011, graduate student Univ. Rochester dept of physics.
52. Brody Fuchs, “Internal energy of Io,” in ASTR 311, B.S. physics major with astrophysics track, 2010, SCSU, now graduate student in Dept Atm Science, Colorado State Univ.
53. Eric Bye, “Detecting Exoplanets,” in ASTR 311, computer science major, SCSU
54. Nishu Karna, “Diversity of Comets” in ASTR 311 and “Auroral activity and sunspots” in ASTR 312, B.S. physics, 2010, SCSU, now graduate student at George Mason Univ.

## 2009

55. Tim Roettger in ASTR 312, “Orbits of Binary Stars and Extrasolar Planets Learning Activity,” majoring in physics, SCSU.
56. Judd Worley in ASTR 312, “Gravitational collapse of diffuse and dense molecular clouds,” physics teaching major, SCSU.

## 2010

57. Shannon Escoto, “Studies of Hale-Bopp’s lightcurve,” physics major, SCSU.
58. Thomas Erdahl, “Dust and CO in comet Hale-Bopp,” M.S. in statistics, SCSU.

**Note: Did not work with students while at NSF from 2011-2015**

## 2015

59. Kacper Wierzchos, “Millimeter-wavelength spectroscopy and optical photometry of comets,” applied physics doctoral student, USF.
60. Ryan Mack, “Measuring millimeter-wavelength spectra of comet Hale-Bopp,” dual physics and math undergraduate major, USF.

## 2016

61. Timothy Cox, “Comet Lightcurve Project phase angle analysis,” physics major, USF.
62. Isabel Rivera, “Comet Lightcurve Project phase angle analysis,” physics major, USF.
63. Nathan Lastra, “Comet Lightcurve Project time series analysis,” physics major, USF.
64. Anthony Curtis, “Comet Lightcurve Project time series analysis,” physics major, USF.