

Preview of Award 0750814 - Annual Project Report

[Cover](#) |
[Accomplishments](#) |
[Products](#) |
[Participants/Organizations](#) |
[Impacts](#) |
[Changes/Problems](#)

Cover

| | |
|---|---|
| Federal Agency and Organization Element to Which Report is Submitted: | 4900 |
| Federal Grant or Other Identifying Number Assigned by Agency: | 0750814 |
| Project Title: | A Partnership in Observational and Computational Astronomy |
| PD/PI Name: | Donald Walter, Principal Investigator Jennifer Cash, Co-Principal Investigator Steven B Howell, Co-Principal Investigator Mark D Leising, Co-Principal Investigator Daniel M Smith, Co-Principal Investigator |
| Recipient Organization: | South Carolina State University |
| Project/Grant Period: | 03/01/2008 - 02/28/2015 |
| Reporting Period: | 03/01/2013 - 02/28/2014 |
| Submitting Official (if other than PD\PI): | Donald Walter Principal Investigator |
| Submission Date: | 03/11/2014 |
| Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions) | Donald Walter |

Accomplishments

* What are the major goals of the project?

The specific goals of POCA are to:

1. Enhance faculty research at South Carolina State University (SCSU) that leads to collaborative activities and an increase in peer reviewed publications including SCSU faculty serving as first authors
2. Increase the use of small telescopes at the National Optical Astronomy Observatory (NOAO) by all three partners for research and training in line with one of the recommendations of the NSF AST Senior Review Committee
3. Increase the number of underrepresented minorities pursuing graduate degrees in astronomy, specifically those entering the program at Clemson University (CU)
4. Increase the number of undergraduates at SCSU engaged in astronomical activities, including an increase in the number of physics majors in the astronomy option
5. Share research facilities at KPNO in such a way that students, faculty and research scientists at all three institutions participate and derive benefits
6. Develop and distribute to the community at large inquiry-based, laboratory exercises and web-based activities related to cosmology
7. Enhance and expand the existing outreach programs to the K-12 community through museum displays, planetarium shows and public observing sessions at the Stanback Museum and Planetarium at SCSU and the planetarium at CU

*** What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?**

Major Activities:

Goal 1: Walter and Cash continue to strengthen their research at SCSU

- a) Co-PI Howell and PI Walter publish a paper on the variable R CrB in August 2013: *PASP*, 125, 879
- b) PI Walter is a coauthor in a paper on the RCT 1.3-meter Robotic Telescope in January 2014, *AJ*, 147, 49
- c) Co-PI Cash is co-lead author and PI Walter a coauthor with PAARE collaborators Hinkle and Mighell and others on a publications submitted to *AJ* on the topic of RV Tauri and Semiregular variables in the Kepler Observatory field of view. The paper is currently under review.

Goal 2: Use of small telescopes at NOAO

- a) Walter had 3 observing runs on the KPNO Coude Feed telescope during this reporting period studying RV Tauri, Semiregular and Peculiar Stars
- b) Clemson used the SARA North (KPNO) and SARA South (CTIO) telescopes on a variety of projects.
- c) SCSU and Clemson faculty submitted a proposal to NSF PAARE for enhanced use of the SARA and RCT 1.3meter telescopes over the next 3 years to study RV Tauri, Semiregular and Hebig Ae/Be stars. The proposal is pending at the time of this report.

Goal 3: Increase the number of underrepresented minorities pursuing graduate degrees in astronomy.

- a) Clemson graduate student S. Hampton completed his MS work on black holes and graduated in May 2013. For his Ph.D. work he chose to change to a subfield of physics that is not available at Clemson and therefore changed institutions.
- b) Clemson graduate student A. Delgado-Navarro has passed her Ph.D. qualifying exams and continues to conduct her research.
- c) SCSU PAARE undergraduate Charles Kurgatt graduated from SCSU with his B.S. in physics with astronomy option in May 2013. He entered the MS program in Engineering Physics at Appalachian State University in the fall of 2013. While this is not a graduate degree in astronomy, it is in a closely related field.

Goal 4: Increase the number of undergraduates at SCSU engaged in astronomical activities.

- a) SCSU PAARE undergraduate C. Kurgatt graduated with his B.S. in physics with astronomy option in May 2013.
- b) Two SCSU PAARE undergraduates C. Laursen and B. Pugh will graduate with their B.S. in physics with astronomy option in May 2014.
- c) SCSU PAARE undergraduate J. Eleby will graduate with her B.S. in physics with astronomy option in December 2014.
- d) Co-PI Cash conducted Kepler research with physics undergraduate J. Eleby and computer science undergraduate S. Rivers in 2013. They presented their results at the January 2014 AAS meeting.
- e) Co-PI Smith worked with physics major S. Pohkrel on web-based cosmology activities in

2013-14.

f) SCSU PAARE undergraduate B. Pugh held a summer 2013 internship in astronomy at the University of South Carolina.

g) SCSU PAARE undergraduate M. McKay has been awarded a 2014 summer internship at the National Radio Astronomy Observatory (NRAO).

Goal 5: Share Resources at KPNO

a) PI Walter, Co-PI Cash and NOAO Collaborator Hinkle are sharing results from the KPNO 2.1-meter and the Coude Feed telescope as part of their study of RV Tauri and Semiregular variables including a publication submitted and under review.

b) PI Walter, Co-PI Howell and others are sharing their results from the 4-meter and Coude Feed at KPNO. This includes results in one publication and a second one in preparation.

c) SCSU and Clemson faculty have submitted a proposal to NSF PAARE for a 3-year study that will use the SARA telescopes at KPNO and CTIO and the 1.3-meter RCT telescope at KPNO.

Goal 6: Develop & distribute inquiry-based lab exercises and web-based activities related to cosmology.

a) Co-PI Smith received an award from the South Carolina Space Grant Jove program to continue his PAARE-related work in this area in 2012 and began his project during this reporting period in 2013. His JOVE works compliments his PAARE work.

b) Smith gave an oral presentation of some of the results of his PAARE work at the Meeting of Astronomers in South Carolina in April 2013.

c) Smith gave an poster presentation on the most recent lab he developed under PAARE at the July 2013 meeting of the American Association of Physics Teachers.

Goal 7 : Enhance and expand the existing outreach programs

Work in this area has been significantly reduced since the planetarium director and collaborator on this award left SCSU nearly three years ago and no replacement has been hired by the university due to the current fiscal environment. Nonetheless, Co-I Cash has conducted some K-12 outreach with local schools and she and Co-I Smith have promoted astronomy activities as faculty sponsors of the SCSU chapter of the Society of Physics students.

Specific Objectives:

Significant Results:

Key outcomes or Other achievements:

*** What opportunities for training and professional development has the project provided?**

During the reporting period, five (5) undergraduates received training in astronomical data reduction and analysis including work with IDL and/or IRAF software. A total of eight (8) undergraduates received scholarships or stipends to participate in the senior-level astrophysics course and/or conduct independent study research.

Faculty Walter, Cash, and Smith all received support to conduct research, publish in referred journals and present their results at professional meetings as described elsewhere in this report.

Three graduate students at Clemson were supported to conduct research; One finished his MS thesis and one passed her Ph.D.

qualifying exams.

*** How have the results been disseminated to communities of interest?**

- Outreach activities were held with local K-12 schools.
- Two referred articles have been published (1 in AJ, 1 in PASP) and a third has been submitted to AJ
- Two faculty poster presentations at the American Astronomical Society meeting in January 2014
- 3 faculty oral presentations & 1 student poster presentation at the Meeting of Astronomers in South Carolina in April 2013
- One faculty poster presentation at the July 2013 meeting of the American Association of Physics Teachers
- Web posting of cosmology labs and simulations: <http://physics.scsu.edu/~dms/cosmology/simulations.html>
- Web posting of our project web page: <http://physics.scsu.edu/paare>

*** What do you plan to do during the next reporting period to accomplish the goals?**

We are currently in a no-cost extension period with very limited funds remaining. We will use those resources and others available to us to concentrate on scholarship, fellowship and stipend support for our undergraduates and graduate students. We intend to publish 2 more articles in the coming year on our PAARE research and continue to examine data from our ground and space based projects for additional, future publications related to RV Tauri, Semiregular and Peculiar Stars.

Supporting Files

| Filename | Description | Uploaded By | Uploaded On |
|--------------------|---|---------------|-------------|
| SCSU-pics-2014.pdf | Images of physics undergraduates at SCSU participating in PAARE activities. | Donald Walter | 03/11/2014 |

Products

Books

Book Chapters

Conference Papers and Presentations

Inventions

Nothing to report.

Journals

Hartig, E., Cash, J., Hinkle, K., Lebzelter, T., Mighell, K. and Walter, D. (2014). Kepler and the Long Period Variables. *The Astronomical Journal*. . Status = SUBMITTED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes

Howell, Steve B., Rector, Travis A. and Walter, Donald (2013). Optical Spectroscopy at Deep Light Minimum of R Coronae Borealis. *Publications of the Astronomical Society of the Pacific*. 125 879. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1086/672163

Strolger, L.-G., Gott, A.M., Carini, M., Engle, S., Gelderman, R., Guinan, E., Laney, C.D., McGruder, C., Treffers, R.R., and Walter, D.K. (2014). The RCT 1.3-meter Robotic Telescope: Broad-band Color Transformation and Extinction Calibration. *The Astronomical Journal*. 147 49. Status = PUBLISHED; Acknowledgment of Federal Support = Yes ; Peer Reviewed = Yes ; DOI: 10.1088/0004-6256/147/3/49

Licenses

Nothing to report.

Other Products

Educational aids or Curricula.

Smith has developed a total of 12 new labs or simulations over the 6 years of the PAARE project at SC State, including one new lab during this reporting period: "Curvature of the Universe from Cosmic Microwave Background Fluctuations". Additionally he has made minor modifications and updates to most of the other labs and simulations.

All of the products are related to cosmology. They are designed to be used by non-science majors as well as in introductory science courses. They have been tested and some have been institutionalized in physics and physical science courses at SC State. Additionally, they have been introduced to middle and high school teachers in South Carolina at several local workshops, at statewide meetings of college astronomy faculty and at the national level during meetings of the American Association of Physics Teachers. All the labs have downloadable content.

Dissemination: Local teacher workshops, state and national meetings of astronomers and physics teachers via workshops and/or posters, and at the website: <http://physics.scsu.edu/~dms/cosmology/simulations.html>

Other Publications

Walter, D.K. (2013). *A Spectroscopic Study of RV Tauri and Semiregular Variables*. An oral presentation at the April 13, 2013, Meeting of Astronomers in South Carolina (MASC). A summary of the multiyear study of these objects under the PAARE program at SC State and collaborators was presented. This work has included ground- and space-based observations and analysis carried out by faculty, students and collaborating scientists. Status = OTHER; Acknowledgement of Federal Support = Yes

McGruder, C.H.; Carini, M.T.; Engle, S.G.; Gelderman, R.; Guinan, E.F.; Laney, D.; Strolger, L.; Treffers, R.R.; and Walter, D.K. (2014). *Astrometric and Photometric Accuracy of the 1.3 m Robotically Controlled Telescope at Kitt Peak*. A poster presentation at the January 2014 meeting of the American Astronomical Society. A total of over 7,000 star measurements on 37 plates taken through the R filter with the 1.3m telescope to produce astrometric results when compared to the Nomad catalog of 0.058" in RA and 0.125" in Declination. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Smith, D.M. (2013). *Curvature of the Universe CMB Lab for Non-Science Majors*. A poster presentation at the American Association of Physics Teachers (AAPT) in July 2013. A new inquiry-based lab developed under PAARE was presented using results on the CMB. The lab has been successfully piloted at SC State in a sophomore physics laboratory course and modified for non-science students. Status = OTHER; Acknowledgement of Federal Support = Yes

Eleby, J. (2013). *Phase Analysis of RV Tauri and Semi-regular Variables*. An undergraduate student poster presentation at the April 13, 2013, Meeting of Astronomers in South Carolina (MASC). Light curves were examined of 10 of these objects in the AAVSO database for whom we also have ground-based spectroscopic data spanning a period of nearly a decade. Model fits to the period and amplitude of each object were attempted using the AAVSO data. A good fit was found for most of the objects. Status = OTHER; Acknowledgement of Federal Support = Yes

Cash, J. (2013). *Preliminary Results from Kepler Light Curves of Semiregular and RV Tauri Variable Stars*. An oral presentation at the April 13, 2013, Meeting of Astronomers in South Carolina (MASC). The preliminary results of a multi-cycle program studying 13 RV Tauri and Semiregular variables in the Kepler field of view. New and archival light curves were examined, cotrending and data shifting were applied. The usefulness of each approach varied from object to object. Status = OTHER; Acknowledgement of Federal Support = Yes

Walter, D.K.; Brittain, S.D.; Cash, J.; Hartmann, D.; Hinkle, K.H.; Howell, S.B.; King, J.R.; Leising, M.D.; Mighell, K.J. and Smith, D.M. (2014). *Update on the NSF PAARE Project at South Carolina State University*. A presentation at the January 2014 meeting of the American Astronomical Society. The poster summarized the successes and challenges over the past six years under "A Partnership in Observational and Computational Astronomy", a collaboration between astronomers at SC State, Clemson University and the National Optical Astronomy Observatory. Status = PUBLISHED; Acknowledgement of Federal Support = Yes

Smith, D.M. (2013). *Web-Based Apps to Teach Cosmology for Non-Science Majors*. An oral presentation at the April 13, 2013, Meeting of Astronomers in South Carolina (MASC). An overview and demonstration of several web-based applications and simulations developed under PAARE that explore cosmology topics for the non-scientist. The talk included examples related to Dark Energy, Dark Matter, the Big Bang and Inflation. Status = OTHER; Acknowledgement of Federal Support = Yes

Patents

Nothing to report.

Technologies or Techniques

Nothing to report.

Thesis/Dissertations

Shaun Hampton. *Pair Production by Primordial Black Hole Evaporation*. (2013). Clemson University. Acknowledgement of Federal Support = Yes

Websites

Labs and Simulations

<http://physics.scsu.edu/~dms/cosmology/simulations.html>

SC State POCA/PAARE website that is the major dissemination point for the laboratory exercises and web-based activities related to cosmology under Goal #6.

POCA A Partnership in Observational and Computational Astronomy

<http://physics.scsu.edu/paare/>

The SC State PAARE project website. Includes activities, people, reports and other information related to the project.

Participants/Organizations

What individuals have worked on the project?

| Name | Most Senior Project Role | Nearest Person Month Worked |
|--------------------------|---------------------------------------|-----------------------------|
| Walter, Donald | PD/PI | 3 |
| Cash, Jennifer | Co PD/PI | 2 |
| Howell, Steven | Co PD/PI | 0 |
| Leising, Mark | Co PD/PI | 1 |
| Smith, Daniel | Co PD/PI | 1 |
| Hinkle, Kenneth | Co-Investigator | 0 |
| Mighell, Kenneth | Co-Investigator | 0 |
| Brittain, Sean | Faculty | 1 |
| Hartmann, Dieter | Faculty | 1 |
| King, Jeremy | Faculty | 0 |
| Delgado-Navarro, Adriana | Graduate Student (research assistant) | 12 |
| Hampton, Shaun | Graduate Student (research assistant) | 3 |
| Lalmansingh, Jarad | Graduate Student (research assistant) | 3 |
| Adhikari, Madan | Undergraduate Student | 9 |

| Name | Most Senior Project Role | Nearest Person Month Worked |
|---------------------|--------------------------|-----------------------------|
| Eleby, Johnae | Undergraduate Student | 9 |
| Kurgatt, Charles | Undergraduate Student | 3 |
| Laursen, Charles | Undergraduate Student | 9 |
| McKay, Myles | Undergraduate Student | 9 |
| Nicholson, Danielle | Undergraduate Student | 4 |
| Pokhrel, Sampanna | Undergraduate Student | 11 |
| Pugh, Bryan | Undergraduate Student | 11 |

Full details of individuals who have worked on the project:

Donald Walter

Email: dkw@physics.scsu.edu

Most Senior Project Role: PD/PI

Nearest Person Month Worked: 3

Contribution to the Project: Project management (financial, reporting, supervision, planning); Faculty research; mentor undergraduate student research; dissemination via meetings and publications; outreach via talks and recruiting events to K-12 community

Funding Support: NASA Kepler Mission - studying RV Tauri and Semiregular variables (NASA awards: NNX11AB82G and NNX13AC24G)

International Collaboration: Yes, Austria

International Travel: No

Jennifer Cash

Email: jcash@physics.scsu.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 2

Contribution to the Project: Faculty research on RV Tauri and Semiregular variable stars; co-lead author on submitted publication on Kepler study of RV Tauri and Semiregular variables; outreach activities including organizing K-12 workshop and Society of Physics Student physics fair; mentor for undergraduate student research; PI on NASA/EPSCoR Joint Venture Project to develop use of Kepler data for NASA EPO website.

Funding Support: NASA South Carolina Space Grant & EPSCoR Joint Venture Award

International Collaboration: Yes, Austria

International Travel: No

Steven B Howell

Email: howell@wiyn.org

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 0

Contribution to the Project: Collaborate on reduction and analysis of Coude Feed spectra; dissemination via publication on peculiar star R CrB with PI Walter; consult with PI Walter and Co-PI Cash on analysis of Kepler data

Funding Support: None

International Collaboration: No

International Travel: No

Mark D Leising

Email: lmark@clemson.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Managed Clemson subaward; mentor to two PAARE-funded graduate students; help develop and write collaborative proposal with SC State faculty.

Funding Support: None other

International Collaboration: No

International Travel: No

Daniel M Smith

Email: dsmith@scsu.edu

Most Senior Project Role: Co PD/PI

Nearest Person Month Worked: 1

Contribution to the Project: Development of curricula products, specifically cosmology-related lab activities and web simulations; dissemination via workshops and posters at national and state meetings; mentor to undergraduate student researcher

Funding Support: "Cosmic Microwave Background Analysis for Physics Undergraduates," PI for Project JOVE Award, South Carolina Space Grant Consortium/NASA EPSCoR, 2012-2013.

International Collaboration: No

International Travel: No

Kenneth Hinkle

Email: hinkle@noao.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 0

Contribution to the Project: Collaborative research & writing of paper on Kepler light curve analysis of RV Tauri and Semiregular variables.

Funding Support: None

International Collaboration: Yes, Austria

International Travel: No

Kenneth Mighell

Email: mighell@noao.edu

Most Senior Project Role: Co-Investigator

Nearest Person Month Worked: 0

Contribution to the Project: Collaborative research and writing of paper on Kepler light curves of RV Tauri and Semiregular variables.

Funding Support: None

International Collaboration: Yes, Austria

International Travel: No

Sean Brittain

Email: sbritt@clemson.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Outreach and mentor underrepresented minorities in high school and undergraduate programs; assisted with development and writing of collaborative proposal with SC State faculty

Funding Support: None

International Collaboration: No

International Travel: No

Dieter Hartmann

Email: hdieter@CLEMSON.EDU

Most Senior Project Role: Faculty

Nearest Person Month Worked: 1

Contribution to the Project: Mentor and serve as research advisor to two PAARE-funded graduate students; help develop and write collaborative proposal with SC State faculty.

Funding Support: None

International Collaboration: No

International Travel: No

Jeremy King

Email: jking2@clemson.edu

Most Senior Project Role: Faculty

Nearest Person Month Worked: 0

Contribution to the Project: Assisted in the development and writing of a collaborative proposal with the SC State faculty.

Funding Support: None

International Collaboration: No

International Travel: No

Adriana Delgado-Navarro

Email: adelgad@clemson.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 12

Contribution to the Project: PAARE fellowship; continuing work toward degree; passed PhD qualifying exam; research on novae.

Funding Support: None

International Collaboration: No

International Travel: No

Shaun Hampton

Email: sdhampt@clemson.edu

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: Finished MS thesis on black holes; graduated with MS in astronomy

Funding Support: None

International Collaboration: No

International Travel: No

Jarad Lalmansingh

Email: jaredlalmansingh@gmail.com

Most Senior Project Role: Graduate Student (research assistant)

Nearest Person Month Worked: 3

Contribution to the Project: PAARE fellowship; conducted research on supernova; transferred to another school pursuing M.S. in physics & astronomy

Funding Support: None

International Collaboration: No

International Travel: No

Madan Adhikari

Email: madan_addy@yahoo.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 9

Contribution to the Project: PAARE stipend and scholarship recipient; explored astronomy as a graduate school option by taking upper level astrophysics courses and working with PI Walter in the lab; will graduate from SCSU with a BS in physics in May 2013; has applied to several graduate schools in engineering

Funding Support: None

International Collaboration: No

International Travel: No

Johnae Eleby

Email: jeleby@scsu.edu

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 9

Contribution to the Project: PAARE undergraduate scholarship recipient; conducting research on RV Tauri and Semiregular

variables under the mentorship of CO-PI Cash; presented poster at the 2013 Meeting of Astronomers in South Carolina; coauthor on poster presented by Co-PI Cash at the January 2014 meeting of the American Astronomical Society; will graduate from SCSU in December 2014 with BS in physics & astronomy option

Funding Support: None

International Collaboration: No

International Travel: No

Charles Kurgatt

Email: ckurgatt@gmail.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 3

Contribution to the Project: PAARE undergraduate scholarship recipient; graduated from SCSU with BS physics & astronomy option; attending graduate school in Engineering Physics MS program.

Funding Support: None

International Collaboration: No

International Travel: No

Charles Laursen

Email: claurse19@gmail.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 9

Contribution to the Project: PAARE undergraduate scholarship recipient; conducting spectroscopic study of RV Tauri and Semiregular variables under mentorship of PI Walter; will graduate in May 2013 from SCSU with BS in physics and astronomy option.

Funding Support: None

International Collaboration: No

International Travel: No

Myles McKay

Email: mckaymyles@yahoo.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 9

Contribution to the Project: PAARE undergraduate scholarship recipient; assists Co-PI Cash with physics and astronomy outreach; president of campus chapter of the Society of Physics majors; will participate as a summer 2014 intern at the National Radio Astronomy Observatory in Charlottesville, VA.

Funding Support: None

International Collaboration: No

International Travel: No

Danielle Nicholson

Email: dnichols08@hotmail.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 4

Contribution to the Project: PAARE undergraduate scholarship recipient; explored astronomy as an possible career path during her last semester through upper level astrophysics course and talks/discussions with faculty; graduated from SCSU in December 2014 with BS in physics & the medical physics option.

Funding Support: None

International Collaboration: No

International Travel: No

Sampanna Pokhrel

Email: meviper010@yahoo.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 11

Contribution to the Project: PAARE undergraduate stipend recipient; conducted research with Co-PI Smith on developing web-based, cosmology activities; will present a poster at the April 2014 Meeting of Astronomers in South Carolina; will graduate from SCSU with a BS in physics in May 2013; has applied to several graduate schools in engineering

Funding Support: None

International Collaboration: No

International Travel: No

Bryan Pugh

Email: legends@sc.rr.com

Most Senior Project Role: Undergraduate Student

Nearest Person Month Worked: 11

Contribution to the Project: PAARE undergraduate scholarship recipient; summer astronomy intern at the University of South Carolina; conducting spectroscopic study of RV Tauri and Semiregular variables under mentorship of PI Walter; will graduate in May 2013 from SCSU with a BS in physics & the astronomy option

Funding Support: None

International Collaboration: No

International Travel: No

What other organizations have been involved as partners?

| Name | Type of Partner Organization | Location |
|--|------------------------------|-------------------|
| Clemson University | Academic Institution | Clemson, SC |
| National Optical Astronomy Observatory | Other Nonprofits | Tucson, AZ |
| Villanova University | Academic Institution | Villanova, PA |
| Western Kentucky University | Academic Institution | Bowling Green, KY |

Full details of organizations that have been involved as partners:

Clemson University**Organization Type:** Academic Institution**Organization Location:** Clemson, SC**Partner's Contribution to the Project:**

Facilities

Collaborative Research

More Detail on Partner and Contribution: Clemson and SC State collaborate in the use of small telescopes at KPNO and through undergraduate student research projects. Additionally, they have collaborated on several proposals submitted during the past year.

National Optical Astronomy Observatory**Organization Type:** Other Nonprofits**Organization Location:** Tucson, AZ**Partner's Contribution to the Project:**

Facilities

Collaborative Research

More Detail on Partner and Contribution: SC State has collaborated with research astronomers at NOAO during the past year including submission of a paper that is currently under review. Additionally, SC State has had 3 separate observing runs on the Coude Telescope at Kitt Peak.

Villanova University**Organization Type:** Academic Institution**Organization Location:** Villanova, PA**Partner's Contribution to the Project:**

Facilities

Collaborative Research

More Detail on Partner and Contribution: SC State partners with Western Kentucky University and Villanova in the management of the 1.3meter Robotically Controlled Telescope (RCT) at Kitt Peak. All three institutions provide in-kind technical support for the facility. The telescope provides ground-based photometric and imagery data for faculty and students in research, education and outreach.

Western Kentucky University**Organization Type:** Academic Institution**Organization Location:** Bowling Green, KY**Partner's Contribution to the Project:**

Facilities

Collaborative Research

More Detail on Partner and Contribution: SC State partners with Western Kentucky University and Villanova in the management of the 1.3meter Robotically Controlled Telescope (RCT) at Kitt Peak. All three institutions provide in-kind technical support for the facility. The telescope provides ground-based photometric and imagery data for faculty and students in

research, education and outreach.

Have other collaborators or contacts been involved? Yes

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The research on Peculiar stars (R CrB and XX Oph), RV Tauri and Semiregular variables will lead to a better understanding of these objects. These stars have periods on the order of months and they show significant irregularities in their light curves compared to shorter period, well behaved Cepheids, making our objects more difficult to observe over a complete cycle. As a result, there are fewer in depth studies in the literature on RV Tauri and Semiregular variables. Our spectroscopic database from the Coude Feed was started more than a decade ago by Co-PI Howell, and has been extended under this award by PI Walter and others. This has allowed the researchers a long baseline from which to compare the spectroscopic changes and their relationship to photometric changes. Existing photometry from the AAVSO for some stars and new Kepler data has been combined with the spectroscopy. One paper on the subject (R CrB) has been published this past year and another, on the objects in the Kepler field of view, has been submitted.

Co-Pi Smith has developed inquiry-based labs, simulations and other curriculum products that have been tested and integrated into courses at SCSU. These products have been introduced to teachers in the K-12 and college community through workshops and talks, and some of the participants have begun to use these resources. These products will help communicate the concepts related to cosmology such as dark energy, dark matter and the big bang in a visual and comprehensible manner to novices and non-science students as well as science majors being exposed to the topics for the first time. Smith's resources will help overcome some of the fear and confusion these individuals encounter when exposed to more traditional material on the subjects.

What is the impact on other disciplines?

Nothing to report.

What is the impact on the development of human resources?

During the reporting period, three underrepresented minorities progressed toward advanced degrees. S. Hampton completed his MS thesis in April 2013 and graduated with an MS in astronomy from Clemson. He chose to pursue a Ph.D. in theoretical particle physics at another university since Clemson is not involved in that discipline. A. Delgado-Navarro passed her Ph.D. qualifying exam and continues to conduct research on classical novae under Clemson collaborators Leising and Hartmann. J. Lamansigh did not complete his MS at Clemson because of a lower than required GPA. He did, however, transfer to Texas A&M University at Commerce in pursuit of an MS in either physics or astronomy.

A total of 9 undergraduate STEM majors were directly impacted by PAARE during this reporting period. This included 8 physics majors who received stipends and/or scholarships to study astronomy and one computer science student who did not receive PAARE funding, but did make use of PAARE-purchased hardware and software in her astronomical research project under Co-PI Cash. C. Kurgatt graduated in May 2013 with a BS in physics with the astronomy option and is now in graduate school in a related field, engineering physics. D. Nicholson graduated in December 2013 with a BS in physics and the medical physics option. She is currently employed in the medical physics field. C. Laursen and B. Pugh will graduate in May 2013 with the BS in physics with the astronomy option. Their future plans are uncertain at the time of this report. S. Pokhrel and M. Adiharki will graduate in May 2013 with a BS in physics. They have both applied to several graduate schools in engineering. J. Eleby will complete her BS in physics with the astronomy option in December 2014. M. McKay has completed his sophomore year as a physics major with the astronomy option. He will participate as a 2014 summer intern at the National Radio Astronomy Observatory in Charlottesville, VA.

SCSU faculty Cash, Smith and Walter continue to develop their professional skills through research, teaching and outreach. During the past year they have collaboratively published papers, presented at meetings and developed web-based resources as described elsewhere in this report. Their work has been in collaboration with PAARE colleagues at NASA, Clemson and NOAO.

What is the impact on physical resources that form infrastructure?

PAARE supports SCSU's participation in the Robotically Controlled Telescope (RCT) Consortium which in turn provides access to

the 1.3 meter RCT at Kitt Peak. Hardware and software support described below further supports the physics area's Computational Physics Lab, Room 306 Davis Hall, on the campus of South Carolina State University. The computational lab is providing infrastructural support to other physics projects in the department (and potentially to faculty in biology and chemistry) through the shared use of the linux machines and UNIX server described below.

What is the impact on institutional resources that form infrastructure?

The support PAARE provides for the Computational Physics Lab and the UNIX server potentially can serve to attract other research projects to the department as this is the only computational lab in the sciences on campus. The SCSU administration has included the Computational Physics Lab and PAARE-support RCT resource as part of its publicity and documentation used in promoting the research capabilities of the university to industry and other potential partners.

What is the impact on information resources that form infrastructure?

PAARE purchased 5 linux workstations as well as several Mac and Windows laptops in previous years that are used for research. Additionally, PAARE provides financial assistance to the upkeep of the physics UNIX web and mail server (<http://physics.scsu.edu>). We note that the physics UNIX server is the only one on campus that the Computer Center allows to be operated independently of their staff. This is due to the secure and robust nature of the physics server and its extensive use in research. A Mac workstation was previously funded by PAARE for Smith to develop his products.

PAARE previously supported the purchase of a color laser printer that is used to generate brochures and other recruitment materials for the physics area and the Department of Biological and Physical Sciences.

PAARE previously supported the purchase of an IDL minilab license, KaleidaGraph and other software that is used along with the hardware by Cash, Walter, Smith and others in research and teaching, such as in the physics course P 338 "Scientific Image Analysis" and other physics classes and research courses. These software packages provide the physics undergraduates with experiences that will be helpful in graduate school or on the job. In many cases, this is the only opportunity on campus to acquire such skills.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

During this reporting period we held no major EPO events for the public such as the Venus Transit in June 2012 which was reported in the previous annual report. When such events occur, they afford the opportunity to bring the excitement of astronomy to the public and help them better understand how their tax dollars are spent.

Changes/Problems

Changes in approach and reason for change

We note that we will continue to pursue the goals of the project. However, we are in a period of a no cost extension with a limited amount of funding remaining. Therefore the products and outcomes will be fewer in number when compared to previous years.

Actual or Anticipated problems or delays and actions or plans to resolve them

Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects

Nothing to report.

Significant changes in use or care of vertebrate animals

Nothing to report.

Significant changes in use or care of biohazards

Nothing to report.

Figure 1

PAARE Undergraduate Johnae Eleby fitting variable star light curves



Figure 2

PAARE Undergraduate Charles Kurgatt (second from left) graduating in May 2013



Figure 3

PAARE Undergraduate Danielle Nicholson in the introductory astrophysics class



Figure 4

PAARE Undergraduate Myles McKay (left, behind table) registering students for the campus physics fair in November 2013.

