

**Annual Report for Period:**03/2009 - 02/2010

**Submitted on:** 03/01/2010

**Principal Investigator:** Walter, Donald .

**Award ID:** 0750814

**Organization:** South Carolina St Univ

**Submitted By:**

Walter, Donald - Principal Investigator

**Title:**

A Partnership in Observational and Computational Astronomy

### Project Participants

#### Senior Personnel

**Name:** Walter, Donald

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

As PI, Walter has been responsible for the day-to-day operation of the project including oversight of the work by Co-PIs and others involved in the project.

He worked with the SC State Office of Sponsored Programs, the Grants and Contracts office and the Financial Management division on all financial and reporting issues including the Clemson subaward. He was responsible for all SC State internal reporting and accounting requirements. He, with the help of the part-time administrative assistance, executed all procurement and related financial transactions.

Walter was the main point of contact and responsible for communication among the partner institutions, Co-PIs, collaborators and students.

Walter conducted faculty research on the spectroscopy of RV Tauri stars. He had two observing runs at KPNO on the Coude Feed Telescope. He took the lead in preparing and submitting a Cycle 2 Guest Observer proposal to the NASA Kepler Mission to study RV Tauri and Semi-Regular variables in the Kepler field of view.

Walter made presentations on the POCA/PAARE project at several national and regional meetings including the 2009 Meeting of Astronomer sin South Carolina and the January 2010 meeting of the American Astronomical Society. Additional dissemination duties included issuing press releases, giving talks in the local community and appearing on a South Carolina TV station to discuss the 2012 topic.

He has worked with other members of the POCA team to carry out recruitment activities on the national and local level as described in detail in the Outreach section of this report.

Walter served as mentor to two SC State summer 2009 Tier I (basic level) interns and worked with two SC State Tier II (experienced) interns once they returned from their summer research experiences at Clemson and NOAO.

**Name:** Howell, Steven

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Howell is the Co-PI on this project from the National Optical Astronomy Observatory (NOAO). He has served as the mentor to the SC State faculty and students for research and a point of contact for access to KPNO facilities. Howell has worked with PI Walter and Co-PI Cash to develop short and long term plans to conduct collaborative research with him on RV Tauri stars.

Dr. Howell served as a mentor during the summer of 2009 to an SC State Tier II (experienced) astronomy intern at NOAO. Their work was presented at the January 2010 meeting of the American Astronomical Society. He will also serve as a research mentor to one or two SC State summer 2010 interns.

Howell is a major contributor to a research paper in preparation under the leadership of Co-PI Cash. Additionally, he provided significant input to a proposal for Kepler observing time submitted by Walter, Cash and Howell in January 2010. He also assisted in the initial training and observing run by Walter on the KPNO Coude Feed telescope in October 2009.

**Name:** Leising, Mark

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Leising is the Co-PI on this project from Clemson University (CU). He handles financial and administrative matters related to the subaward. He coordinates faculty and student participation at and with CU, including SC State access to CU observing facilities at KPNO and elsewhere.

He coordinated an overnight visit by four SC State students and three professors in July 2009 to discuss their summer's work, hear about research opportunities from graduate students and faculty, get to know Clemson, and hear more directly from students what graduate school is like. Research activities of everyone involved at both institutions was presented.

Dr. Leising served as the research mentor in the summer and fall of 2009 to a SC State POCA/PAARE Tier II (experienced) astronomy intern who conducted research at Clemson during the summer. The student and Dr. Leising presented their results in a poster at the January 2010 meeting of the American Astronomical Society. He is currently working on a paper using the results of that research. The paper is expected to be submitted sometime during Year 3 of this project.

**Name:** Smith, Daniel

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Smith has concentrated largely on two areas related to the project, recruitment and development of curriculum materials. He has personally contacted prospective freshmen to recruit them into the SC State physics program in general and the astronomy option in particular. He has developed recruitment materials for dissemination at conferences and to schools. He attended the October 2009 NSF HBCU-UP conference and manned a POCA/PAARE recruitment booth.

Smith has developed two new cosmology laboratory exercises and tested them on classes and summer students and is developing enhanced versions of those labs as described in the section of this report entitled Other Specific Products. He was sole author on a poster presented at the January 2010 meeting of the American Astronomical Society.

Smith has also spent time lecturing to the summer POCA/PAARE students.

**Name:** Cash, Jennifer

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Jennifer Cash has conducted faculty-level research on RV Tauri stars during Year 2. She was the lead author of a poster and a publication in the Proceedings of the Conference on Stellar Pulsation: Challenges for Theory and Observation. She was also a coauthor on two posters presented at the January 2010 meeting of the American Astronomical Society. She is currently taking the lead in preparing a publication for peer review that will be submitted by the end of the summer of 2010.

Cash has served as the lead faculty mentor at SC State. This includes organizing student skill-building sessions and talks by visiting astronomers. She was the mentor for two SC State interns during the summer of 2009 and one of those students coauthored a poster at the January 2010 meeting of the American Astronomical Society.

**Name:** Mayo, Elizabeth

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Dr. Mayo is the Planetarium Manager, an Assistant Professor of Physics and a Radio Astronomer at SC State. She has contributed to this project in a number of ways.

Mayo completed her Ph.D. in radio astronomy during Year 1 of the project. She, along with her faculty adviser at the University of Kentucky, is preparing two papers from her thesis work that should be submitted to ApJ and AJ respectively within the first few months of Year 3 of the project. One of those papers was presented as a poster with her as lead author at the January 2010 meeting of the American Astronomical Society.

Mayo has conducted outreach activities such as planetarium shows and talks during which she discusses the POCA/PAARE project and recruits prospective K-12 students to attend SCSU and major in physics.

Mayo has demonstrated use of radio telescopes and lectured to the SCSU PAARE undergraduates participating in summer research. In Year 3 she will be working with Co-PI Smith to develop one or more cosmology displays to be installed in the campus museum and planetarium

**Name:** King, Jeremy

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Dr. King was responsible for coordinating a research visit by an SCSU undergraduate to Kitt Peak National Observatory (KPNO) to observe on the 4-meter telescope with a senior graduate student from Clemson. This trip to KPNO was instrumental in inspiring the SCSU physics major to select the astronomy option as their major. This undergraduate subsequently was selected to conduct research at Clemson University in the summer of 2009.

Dr. King has also started developing an alternate website for the POCA project that will be similar to social network sites that are so popular with students.

**Name:** Mighell, Kenneth

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Dr. Mighell has collaborated on this PAARE project in his role as the NSF REU Site Director at KPNO. He has coordinated the preparations for the summer 2009 internship at KPNO by an SC State student and is preparing for two SC State students to intern there in the summer of 2010. He has designed the SC State POCA/PAARE internship to include full participation in the KPNO REU program. He has advised the SCSU PI on computer purchases for the SCSU students so their machines will be fully compatible with the other REU student machines.

**Name:** Hartmann, Dieter

**Worked for more than 160 Hours:** No

**Contribution to Project:**

Dr. Hartmann is preparing for SC State's participation in future optical follow-ups to Gamma Ray Bursts. This will include using a portion of SC State's guaranteed observing time on the KPNO 1.3-meter telescope known as the Robotically Controlled Telescope (RCT). Participation by SC State awaits final repair work on the RCT.

## Post-doc

## Graduate Student

## Undergraduate Student

**Name:** Davis, Graham

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Graham Davis is a physics major who selected the astronomy option. He held a POCA/PAARE scholarship in the 2008-09 year and the 2009-10 year. He was a POCA/PAARE Tier I (basic level) research intern in the summer of 2008 and presented his results in a student poster at the January 2009 meeting of the American Astronomical Society. He held a second POCA/PAARE Tier II (experienced) internship in the summer of 2009 at SC State.

**Name:** Durant, Patrick

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Patrick Durant is a physics major who was a POCA/PAARE Tier I (basic level) research intern in the summer of 2008 and presented his results as a student poster at the February 2009 national meeting of the Society of Black Physicists. He was a summer 2009 POCA/PAARE Tier II (experienced) intern under the mentorship of Co-PI Dr. Steven Howell at NOAO. He presented the results of research as the lead author of a poster at the January 2010 meeting of the American Astronomical Society. After long and careful consideration, he has decided to pursue the medical physics option rather than astronomy.

**Name:** Lalmansingh, Jared

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Jared Lalmansigh is a physics major with an astronomy option. He was a summer 2009 POCA/PAARE Tier II (experienced) astronomy intern who did his research at Clemson University under the mentorship of Co-PI Leising. He continued his research in the fall of 2009 and presented a paper as lead author at the January 2010 meeting of the American Astronomical Society. He is an SC State Presidential Scholar, which is a full scholarship; therefore, he cannot accept a PAARE scholarship during the academic year. He has received stipends for his summer and academic year work. In the summer of 2010 he will intern at NOAO under the direction of Co-PI Howell.

**Name:** Nesmith, Eva

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Eva Nesmith was a summer 2009 POCA/PAARE Tier I (basic level) astronomy intern at SC State. She conducted research under the mentorship of Co-PI Cash on RV Tauri light curves. Nesmith continued her research in the fall semester of 2009 and was lead author on a poster presented at the January 2010 American Astronomical Society meeting. She is going to be a Tier II (experienced) research at NOAO in the summer of 2010. She intends to remain a math major until graduation in May 2011; however, she has expressed a strong interest in going to graduate school, possibly in astronomy.

**Name:** Pryor, Alexis

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Alexis Pryor joined the POCA/PAARE project in October 2009 when she changed her major to physics with the astronomy option. She has received a scholarship for the spring 2010 term and will be a Tier I (basic level) summer intern at SC State in the summer of 2010.

**Name:** Jamison, Keisha

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Keisha Jamison was a Tier I (basic level) POCA/PAARE astronomy intern at SC State during the summer of 2009. She worked under the direction of Co-PI Cash on RV Tauri light curves. At the end of the summer, she decided to remain a math major and no longer pursue astronomy.

**Name:** Julien, Osei

**Worked for more than 160 Hours:** Yes

**Contribution to Project:**

Osei Julien was a Tier I (basic level) POCA/PAARE astronomy intern at SC State during the summer of 2009. He worked under the direction of PI Walter on the spectra of RV Tauri type stars. At the end of the summer, he decided to remain a major in Electrical Engineering Technology and no longer pursue astronomy.

## Technician, Programmer

## Other Participant

## Research Experience for Undergraduates

### Organizational Partners

#### Clemson University

Clemson astronomers, specifically Co-PI Mark Leising, served as the research mentor to SC State summer 2009 intern Jared Lalmansigh. Their work was presented at the January 2010 meeting of the American Astronomical Society.

Four SCSU students and three professors visited Clemson in July 2009 to discuss their summer's work, hear about research opportunities from graduate students and faculty, get to know Clemson, and hear more directly from students what graduate school is like. Research activities of

everyone involved at both institutions was presented.

Clemson has worked with PI Walter to recruit students into the POCA/PAARE graduate fellowship program at Clemson.

### **Western Kentucky University**

Astronomers at Western Kentucky University (WKU) have worked with SCSU astronomers to prepare the 1.3 meter telescope, also known as the Robotically Controlled Telescope (RCT), for research use under the PAARE award. SCSU and WKU have collaborated with other schools over the years in the management of the telescope. Lightning strikes in the summer of 2008 have resulted in multiple equipment failures. SCSU and WKU worked on those problems and the telescope is being prepared to be brought online. The RCT will be used by SCSU in its long term study of RV Tauri stars.

### **National Optical Astronomy Observatory**

NOAO personnel Co-PI Howell and Senior Personnel Mighell have collaborated on this project in a number of ways. They have helped coordinate and plan both student research and faculty research.

Up to 20% of Howell's time is being allocated to the POCA/PAARE project. Howell has provided archival spectra from the Coude Feed telescope that contribute significantly to the RV Tauri research at SC State. He has helped SC State faculty members organize their research project through near-term and long-term planning. He has also provided training and guidance in the use of the Coude Feed telescope at KPNO by Walter and made significant contributions to a Cycle 2 Guest Observer proposal submitted by Walter, Cash and Howell.

Mighell is the NSF REU Site Coordinator at KPNO and helped SC State coordinate a summer intern to KPNO to work with Howell in the summer of 2009. Mighell himself spoke to the student and helped motivate him to participate. He is currently working with SC State to coordinate the visit by two SC State interns in the summer of 2010.

Howell conducted a research visit to SC State in April 2009. Both Howell and Mighell will visit SC State in April 2010

## **Other Collaborators or Contacts**

### **Activities and Findings**

#### **Research and Education Activities: (See PDF version submitted by PI at the end of the report)**

A variety of activities were supported in Year 2 under the SCSU PAARE award that are not described in detail elsewhere in this report.

April 4, 2009, Bob Jones University, Greenville, SC

Annual Meeting of Astronomers in South Carolina (MASC)

Student Poster by Patrick Durant: 'Analysis of Emission Lines in Select RV Tauri Stars'

Student Poster by Graham Davis: 'Methods of Period Determination in RV Tauri Stars'

Oral Presentation by PI Walter: 'Partnering to Increase Diversity in Astronomy'

April 15-18, 2009, Orangeburg County, Orangeburg, SC

Balloon launch workshop and two successful balloon launches

PI Walter and SC State physics majors participated. in this collaborative effort with other schools including the University of Houston ? Downtown (lead institution), Medgar Evers College and Orangeburg Calhoun Technical College. The project is funded by a grant from the NSF Geosciences Division and is designed to increase diversity in the geosciences. These launches involve payloads that weigh no more than 12 pounds and use regular weather balloons to carry the payload aloft. The scientific objective of the launches was to measure ozone content and meteorological quantities (e.g. temperature) as a function of altitude up to 100,000 feet above the launch site. While this does not directly relate to the POCA/PAARE project, the project is building a balloon launch capability at SC State that will allow the institution to engage in future balloon launches with astronomical payloads.

April 20-23, 2009, SC State University, Orangeburg, SC

Co-PI Howell visited SC State to confer with Cash, Smith, Mayo and Walter. Howell also met with SC State students to discuss their research.

Plans for the summer 2009 students were developed. Discussion also included the future direction of research including use of the Coude Feed telescope, proposing to use the NASA Kepler Observatory and plans to write a series of research papers on RV Tauri stars.

May 31-June 5, 2009, Los Alamos National Laboratory, Sante Fe, NM

Conference: Stellar Pulsation: Challenges for Theory and Observation

Poster Presentation by Co-PI Cash: 'A Long Term Photometric and Spectroscopic Study of RV Tauri Stars'

May-August 2009

A total of 6 SC State undergraduate students were funded by POCA/PAARE to receive training and conduct research during the summer of 2009. Four (4) were at SC State and considered Tier I (basic level) researchers. Two (2) others were Tier II (experienced) researchers. One each of the Tier II students worked at Clemson University and NOAO. Details of their training and research can be found in the Training section of this report.

July 20-21, 2009, Clemson University, Clemson, SC

Four SC State POCA/PAARE Tier I students and three SC State professors visited Clemson to discuss their summer's work, hear about research opportunities from graduate students and faculty, get to know Clemson, and hear more directly from students what graduate school is like. Additionally, the SC State POCA/PAARE Tier II student working at Clemson during the summer was present as were other Clemson REU students and faculty. Research and education activities of everyone involved at both institutions were presented.

July 30-August 2, 2009, Florida Institute of Technology, Melbourne, FL

SARA REU End-of-the-Summer Meeting

SC State POCA/PAARE Tier II student Jared Lalmansingh, who conducted his research at Clemson presented his results at the SARA meeting.

October 1-4, 2009, Kitt Peak National Observatory, Tucson, AZ

PI Walter conducted an observing run on the Coude Feed telescope, acquiring spectra of RV Tauri and Semi-Regular stars in the wavelength range of 3700-5100 angstroms. This was his first time on the Coude Feed and his training on the telescope and instrument is described under the Training section.

October 23, 2009, HBCU-UP Seminar Series, SC State University, Orangeburg, SC

Oral Presentation by POCA student Patrick Durant:

'In Depth Analysis of Select RV Tauri Types'

November 9, 2009 WLTX TV Station, Columbia, SC

PI Walter was part of a taped program on the 2012 topic. Walter was interviewed as the astronomy resource person who attempted to debunk various ideas related to the popular treatment of the subject.

January 7, 2010, American Astronomical Society Meeting, Washington, DC

Poster presentation by SC State astronomer Dr. Elizabeth Mayo as lead author. 'Cosmic Convergence: Art and Science', Poster # 600.01

This poster was not reported with the other posters in this report under One-time Publications because it has not yet appeared in the Bulletin of the American Astronomical Society.

January 15, 2010, NASA Kepler Observing Proposal

PI Walter and Co-PIs Cash and Howell submitted a proposal to use NASA's Kepler Observatory to continuously monitor for a year RV Tauri and Semi-Regular variables in the Kepler field of view. If the proposal is awarded, this will provide unprecedented photometric accuracy and temporal coverage of these objects.

January 26-29, 2010, Kitt Peak National Observatory, Tucson, AZ

PI Walter conducted an observing run on the Coude Feed telescope, acquiring spectra of RV Tauri and Semi-Regular stars in the wavelength range of 3700-5100 angstrom

## Findings:

Findings on the role that magnetic fields play in star formation are being prepared to submit for peer review by Dr. Elizabeth Mayo of the SC State POCA/PAARE project and her thesis advisor Dr. T. Troland of the University of Kentucky. The specific findings will be reported once they have passed peer review.

Findings from an effort lead by Co-PI Cash and including Co-PI Howell, PI Walter and SC State student researchers is being prepared for

submission. Their work discusses the appropriate application of various fitting methods to light curves for RV Tauri and Semi-Regular variables. Fitting light curves to these variable types has historically been problematic because they often vary in unpredictable ways. The specific findings will be reported once they have passed peer review.

Findings from an effort lead by Co-PI Leising and an SCSU student researcher is being prepared for submission. Their results will discuss the use of the to-be-launched NuSTAR satellite for the purpose of detecting Type Ia supernovae. Their findings will be reported once they have passed peer review.

### **Training and Development:**

- May 19-25, 2009, SC State University, Orangeburg, SC

SC State physics major Jared Lalmansingh received training from PI Walter in IDL and background astronomical topics related to his upcoming summer research experience at Clemson University

- May 26 - August 3, 2009, Clemson University, Clemson, SC

SC State physics major Jared Lalmansingh was a PAARE-funded research

intern working under Co-PI Dr. Mark Leising at Clemson. His training included more IDL, astronomical topics related to his research project on supernovae, writing, speaking and programming. Additionally, his summer work led to a poster presentation at the January 2010 meeting of the American Astronomical Society.

- June 1 - July 31, 2009, NOAO, Tucson, AZ

SC State physics major Patrick Durant was funded under PAARE to conduct research with Co-PI Dr. Steve Howell at NOAO and further develop his research skills. His summer work with Howell was at a more advanced level than his previous work at SC State and included work on RV Tauri stars, as well as more advanced work with IRAF, spectroscopy and other astronomical topics. This internship led to a poster presentation at the January 2010 meeting of the American Astronomical Society by student Durant.

- June 1 - July 24, 2009, SC State University, Orangeburg, SC

The SCSU REU-like astronomy program funded under PAARE included training for four SCSU STEM majors (Graham Davis, Keisha Jamison, Osei Julian, and Eva Nesmith). The students were trained in the use of the Linux operating system, IDL and IRAF software packages as well as how to write and orally present their research. They were also given an overview of the field of astronomy and conducted research projects which lead to a poster presentation at the January 2010 meeting of the American Astronomical Society.

- August 18 - December 11, 2009, SC State University, Orangeburg, SC

SC State physics majors Patrick Durant and Jared Lalmansingh received additional research training while taking an upper level physics course (P 498 - Special Topics in Astronomy) from PI Walter. They continued to develop their astronomical research skills by extending their summer work, writing abstracts and interim reports. Each student prepared a poster for submission and presentation at the January 2010 meeting of the American Astronomical Society.

- August 18 - December 11, 2009, SC State University, Orangeburg, SC

SC State math major and PAARE summer intern Eva Nesmith continued her summer research training under the guidance of Co-PI Jennifer Cash. This included more work with IDL, programming and using various mathematical algorithms to fit light curves to AAVSO data. This training led to a poster presentation at the January 2010 meeting of the American Astronomical Society.

- October 1-4, 2009, KPNO, Tucson, AZ

PI-Walter received training on the use of the Coude Feed Telescope at Kitt Peak National Observatory. Co-PI Steve Howell and NOAO staff member Daryl Willmarth provided the training. Walter carried out observing runs on the Coude Feed in October 2009 and January 2010 (see elsewhere in this report)

### **Outreach Activities:**

A variety of outreach activities were supported in Year 2. In addition to the specific activities listed below, faculty members participated in numerous other activities such as planetarium shows and judging science fairs that promoted the project and advanced the public's understanding of astronomy while not specifically described below.

The POCA/PAARE project concentrated much of its outreach activities in Year 2 toward recruitment efforts aimed at three distinct groups: (1) high school students in grades 9-12 who were potential future incoming freshmen at SC State, especially those interested in physics and astronomy; (2) STEM majors at SC State and underrepresented minority students at other institutions nationally who were prospects for the

summer 2010 undergraduate internships in astronomy funded by POCA/PAARE; and (3) underrepresented minorities nationally who are prospective candidates for the POCA/PAARE graduate fellowship in astronomy at Clemson.

October 2009

A packet with a cover letter, flyers and a poster describing the POCA/PAARE graduate fellowship in astronomy at Clemson University was mailed to 40 physics programs at HBCUs and other minority institutions.

October 14-17, 2009, SACNAS Conference, Dallas, TX

PI Walter attended the annual meeting of the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS). A POCA/PAARE booth was set up that advertised the POCA/PAARE summer astronomy intern program at SC State and the POCA/PAARE graduate fellowships at Clemson University.

October 29-November 1, 2009, NSF HBCU-UP Research Conference, Washington, DC

Co-PI Smith attended the annual research conference for the NSF program, the Historically Black Colleges and Universities (HBCU) Undergraduate Program (UP). A POCA/PAARE booth was set up that advertised the POCA/PAARE summer astronomy intern program at SC State and the POCA/PAARE graduate fellowships at Clemson University.

October 2009-February 2010

PI Walter has visited a total of 5 high schools in Georgia and South Carolina to talk about physics and astronomy at SC State, the POCA/PAARE scholarships and STEM careers. He spoke to a total of 473 students and 16 teachers. Most of the students were upper classmen and nearly half of them were honors or gifted and talented students.

August 2009-February 2010

Co-PI Leising and PI Walter have directly contacted 6 underrepresented minority students who have expressed an interest in the POCA/PAARE graduate fellowship at Clemson either from contacts made at the SACNAS meeting or the summer REU program at Clemson.

December 2009-February 2010

PI Walter and Co-PI Smith have directly contacted 19 high school seniors in South Carolina, Georgia and North Carolina who have expressed an interest in attending SC State and majoring in physics. The students were provided with POCA/PAARE scholarship information.

February 2010

A packet with a cover letter, flyers and a poster describing the POCA/PAARE undergraduate astronomy internships for the summer of 2010 was mailed to 40 physics programs at HBCUs and other minority institutions.

### **Journal Publications**

E. Mayo & T. Troland, "VLA HI Zeeman Observations of the Cygnus X Regions DR 22 and ON 2", *The Astronomical Journal*, p. , vol. , (2010). In preparation,

E. Mayo, N. Abel, P. Lockett, A. Sarma & T. Troland, "VLA OH Zeeman Observations and Complete Environmental Analysis of NGC 6334 A", *The Astrophysical Journal*, p. , vol. , (2010). In preparation,

### **Books or Other One-time Publications**

Cash, Jennifer; Howell, Steve; and Walter, Don, "A Long Term Photometric and Spectroscopic Study of RV Tauri Stars", (2009). Conference Proceedings, Published  
Collection: STELLAR PULSATION: CHALLENGES FOR THEORY AND OBSERVATION: Proceedings of the International Conference. AIP Conference Proceedings, Volume 1170  
Bibliography: AIP Conference Proceedings, Volume 1170, pp. 146-148 (2009AIPC.1170..146C)

Smith, Daniel M., Jr., "City-City Correlations Lab to Introduce Galaxy-Galaxy Correlations", (2010). Conference Proceedings, Published

Collection: American Astronomical Society, AAS Meeting #215, #466.15; Bulletin of the American Astronomical Society, Vol. 41, p.508  
Bibliography: 2010AAS...21546615S

Mayo, Elizabeth and Troland, T. H., "VLA HI Zeeman Observations of the Cygnus X Region: DR 22 And ON", (2010). Conference Proceedings, Published

Collection: American Astronomical Society, AAS Meeting #215, #415.26; Bulletin of the American Astronomical Society, Vol. 41, p.265  
Bibliography: 2010AAS...21541526M

Nesmith, Eva and Cash, J., "Photometric Light Curve Analysis of RV Tauri Stars Using AAVSO", (2010). Conference Proceedings, Published

Collection: American Astronomical Society, AAS Meeting #215, #417.15; Bulletin of the American Astronomical Society, Vol. 41, p.273  
Bibliography: 2010AAS...21541715N

Durant, Patrick; Howell, S. B.; Cash, J. and Walter, D. K., "Spectral Variations of Several RV Tauri Type Stars", (2010). Conference Proceedings, Published

Collection: American Astronomical Society, AAS Meeting #215, #417.14; Bulletin of the American Astronomical Society, Vol. 41, p.273  
Bibliography: 2010AAS...21541714D

Lalmansingh, Jared and Leising, M., "Modeling the Hard X-ray Spectrum of a Type Ia Supernova", (2010). Conference Proceedings, Published

Collection: American Astronomical Society, AAS Meeting #215, #430.10; Bulletin of the American Astronomical Society, Vol. 41, p.357  
Bibliography: 2010AAS...21543010L

### Web/Internet Site

**URL(s):**

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

**Description:**

This serves as the main project website and is currently under major renovation as a result of a transition to a new SC State physics area website (also under construction) and a hardware upgrade to the server.

A link to our summer REU program can be found at:

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

An additional website containing educational products from previous work and new work under this award include:

<http://physics.scsu.edu/~dms/cosmology/home2.html>

and

[http://physics.scsu.edu/~dms/cosmology/LSS\\_Lab.html](http://physics.scsu.edu/~dms/cosmology/LSS_Lab.html)

### Other Specific Products

**Product Type:**

**Teaching aids**

**Product Description:**

"Large Scale Structure of the Universe for Nonscience Majors" is a modification of the laboratory exercise discussed in last year's annual report entitled "Galaxies and the Size of the Universe". The lab leads students through the determination of distances to stars, and distances to galaxies, using data from the web. Students compare these distances to the earth-sun distance, then they compare star distances to galaxy distances. Part two of the non-science majors lab requires students to download data from the Sloan Digital Sky Survey (SDSS) website to make a wedge plot ( $3 \text{ degrees} < \text{dec} < 3 \text{ degrees}$ ) of LSS out to  $z = 0.05$ , and to comment on the structure.

**Sharing Information:**

The results of the use of the lab were presented at the January 2010 meeting of the American Astronomical Society as a poster entitled "City-City Correlations Lab to Introduce Galaxy-Galaxy Correlations" (American Astronomical Society, AAS Meeting #215, #466.15; Bulletin of the American Astronomical Society, Vol. 41, p.508 Publication Date: 01/2010)

This lab is used at SC State each semester in the course, Physical Science 153, Earth and Space Science Laboratory. It is also used for the graduate level physics course for students working on their masters degree in education, P 507, which is taught once every two years. It is also used in teacher workshops for the K-12 community.

The lab has been demonstrated to our POCA partners at Clemson University and will be demonstrated to colleagues at other institutions, presented at a future national meeting, posted for distribution on our SCSU PAARE website and incorporated into an interactive museum exhibit in Year 3 of the project.

**Product Type:**

**Teaching aids**

**Product Description:**

"Large Scale Structure of the Universe for STEM Majors" is the latest version of the exercise entitled "Large Scale Structure of the Universe" in last year's annual report.

The LSS lab for STEM majors consists of the lab for non-science majors (see above) plus a third part on calculating and understanding the correlation function. Students are supplied data on the distances between cities including night time images from space of the United States, and instructed in calculating the correlation function. They then plot the correlation function and compare its interpretation to the interpretation of a correlation function for SDSS galaxies.

**Sharing Information:**

The results of this lab were presented at the January 2010 meeting of the American Astronomical Society as a poster entitled "City-City Correlations Lab to Introduce Galaxy-Galaxy Correlations" (American Astronomical Society, AAS Meeting #215, #466.15; Bulletin of the American Astronomical Society, Vol. 41, p.508 Publication Date: 01/2010)

Currently the lab is used at SCSU each fall term in the course, Physics 223, General Physics Lab III. Additionally it is used with the POCA summer astronomy interns as an exercise in their study of cosmology.

The lab has been demonstrated to our POCA partners at Clemson University and will be demonstrated to colleagues at other institutions, presented at a future national meeting, posted for distribution on our SCSU PAARE website and incorporated into an interactive museum exhibit in Year 3 of the project.

Its current version is still in transition and is posted at:  
[http://physics.scsu.edu/~dms/cosmology/LSS\\_Lab.html](http://physics.scsu.edu/~dms/cosmology/LSS_Lab.html)

**Product Type:**

**Teaching aids**

**Product Description:**

"A Statistical Comparison of the Large Scale Structure of the Universe" is the working title for this significant enhancement of the "Large Scale Structure of the Universe for STEM Majors" lab (see above). In this new lab, which is still under development, students will calculate error bars on the correlation function data for cities by using the jackknife statistical technique used by cosmologists. Students will compare interpretation of these errors to error bars on the SDSS correlation function data.

**Sharing Information:**

This lab will be piloted in Year 3 with the summer REU students at SC State and in the fall of 2010 in the P 223 course. It will also be demonstrated to colleagues at other institutions and presented at a national meeting.

**Product Type:**

**Teaching aids**

**Product Description:**

"A 3D Visualization of the Large Scale Structure of the Universe" is a demonstration application of the LSS labs discussed elsewhere in this report. The visualization is under development using the software package Mathematica. The intention is to enable a user to rotate or zoom in and out of the data plots from LSS to get a visual understanding of the structure of the Universe based on SDSS data.

**Sharing Information:**

This application will be piloted in Year 3 of the project in both the non-science majors lab and the one for STEM majors. Additionally, it will

be used in our museum display on cosmology being developed in Year 3. Once satisfactory results are achieved, it will be installed in an interactive display in the SC State campus museum and planetarium. Additionally, it will be demonstrated to colleagues at other institutions and presented at a national meeting.

### Contributions

#### **Contributions within Discipline:**

Year 2 contributions within the discipline include:

Mayo's work on better understanding the role magnetic fields play in star formation is a contribution that is nearly ready for submission to peer review. We anticipate the submission of two articles within the next few months. See the publications section for more details.

Work that will advance the field's understanding of RV Tauri stars is being prepared by Cash, Howell and Walter for publication and will be ready to submit for peer review by the end of the summer of 2010. See the Findings section for more details.

Advancing the field's understanding of the role that NuSTAR can play in the detection of Type Ia supernovae is being prepared by Leising. It is anticipated this work will be submitted for peer review during Year 3 of the project.

Smith's work on laboratory exercises in cosmology for nonscience majors and STEM majors will be ready for web posting and possibly other means of dissemination during Year 3 of the project.

#### **Contributions to Other Disciplines:**

##### **Contributions to Human Resource Development:**

Year 2 of the SC State PAARE project has provided opportunities for research, teaching and mentoring in astronomy at SCSU, a Historically Black College/University located in rural South Carolina with an enrollment of approximately 4,200 students. Over 90% of the student population is African-American.

While the faculty and curriculum were largely in place at SC State prior to the award, the PAARE project allowed the faculty and students to participate in astronomical activities on a scale not previously possible. Partners, Clemson University and NOAO, have strongly embraced the concept of partnering, providing SCSU with access to people and resources previously unavailable. In turn, SCSU has been given the opportunity to contribute to the research and education activities of the partners.

A total of seven (7) SC State students were supported under this award in Year 2. All seven students are Black or African-American. Three of the students were female and four were male. Six of the seven students participated in research and travel. The seventh student became a physics major with an astronomy option late in Year 2. She has received scholarship money in Year 2 and will get her first research experience during the summer of 2010.

Two of the seven students received scholarships while two others had full scholarships through other means, but did receive POCA/PAARE stipend funds for their participation during the summer and academic year. Three of the seven students did not receive scholarships because they have not chosen the physics major with an astronomy option, but these three students did receive stipends.

A total of four SCSU faculty members (Cash, Mayo, Smith, Walter) have received support in Year 2. They have been able to enhance their professional development and skills through travel, training and having funds to upgrade their research and educational resources. Additionally, Cash, Smith and Walter have received summer salaries and release time during the academic year. This has been critical to the success of the project since SCSU is not a research institution and faculty members typically teach four courses per semester for a total of eight courses within the academic year.

Finally, through the outreach activities described elsewhere in the report, 473 high school students and 16 teachers have been exposed to physics and astronomy and the POCA/PAARE program at SC State. To quote one high school student 'I knew about your marching band and football team, but I didn't know SC State had programs like astronomy and nuclear engineering.'

#### **Contributions to Resources for Research and Education:**

##### **Contributions Beyond Science and Engineering:**

**Conference Proceedings**

**Special Requirements**

**Special reporting requirements:** None

**Change in Objectives or Scope:** None

**Animal, Human Subjects, Biohazards:** None

**Categories for which nothing is reported:**

Contributions: To Any Other Disciplines

Contributions: To Any Resources for Research and Education

Contributions: To Any Beyond Science and Engineering

Any Conference

**Figure 1**

**Summer 2009 PAARE Interns at SC State  
Osei Julien (left) and Keisha Jamison (right) examine SDSS data with Dr. Smith.**



**Figure 2**

**SC State Summer 2009 PAARE Interns (l. to r.)  
Osei Julien, Jared Lalmansingh and Graham Davis.**



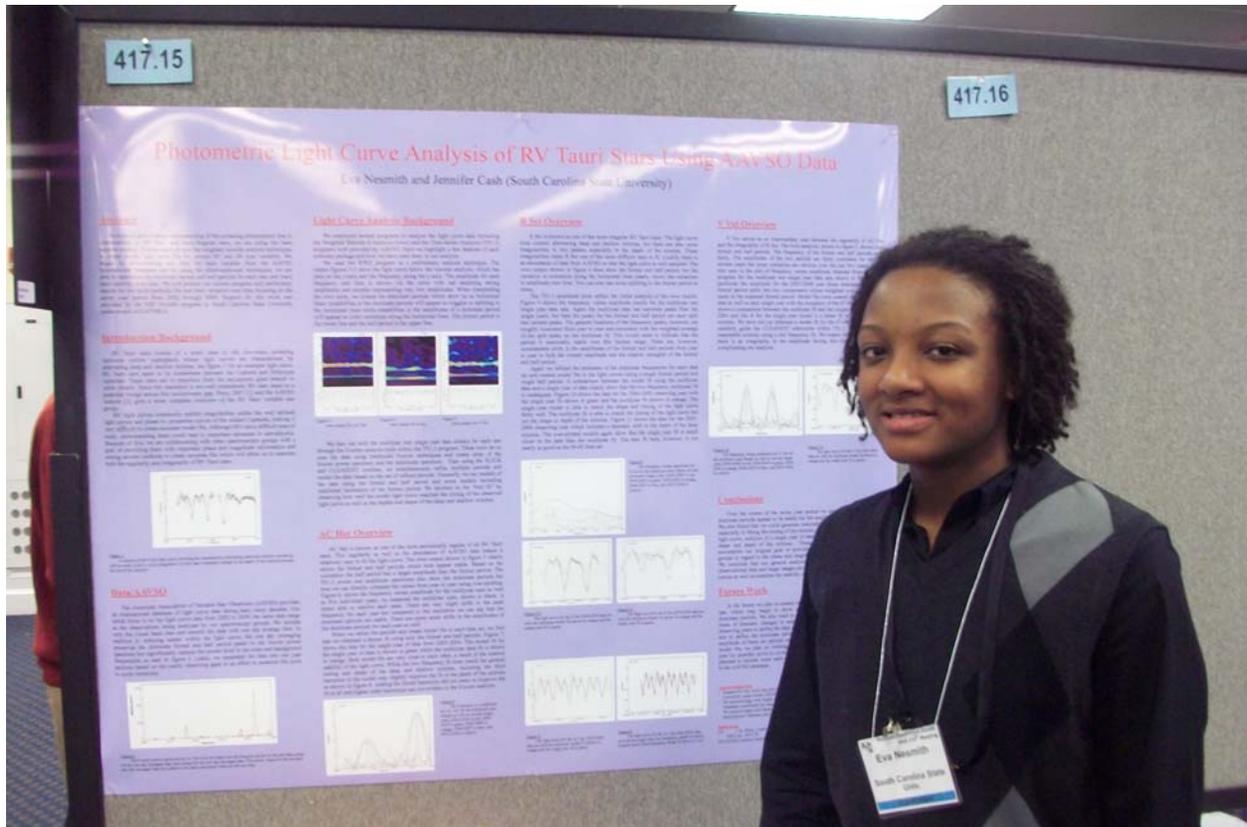
**Figure 3**

**Summer 2009 PAARE interns and faculty from SC State confer with their counterparts during a visit to the campus of Clemson University.**



Figure 4

SC State PAARE undergraduate Eva Nesmith presents her poster at the January 2010 meeting of the American Astronomical Society.



**Figure 5**

**SCSU PAARE undergraduate Patrick Durant (left) discusses his poster during the January 2010 meeting of the American Astronomical Society.**



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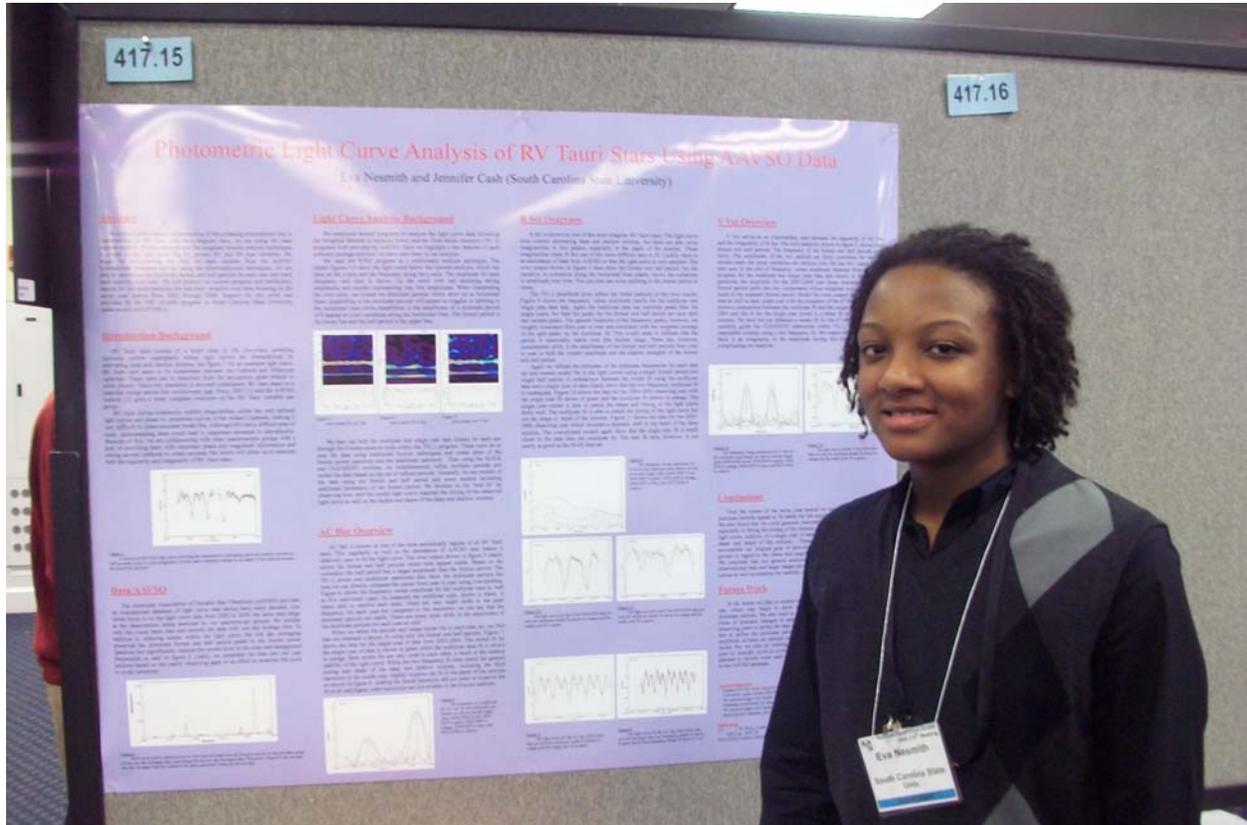
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