Cover
Federal Agency and Organization Element to Which Report is Submitted: 4900
Federal Grant or Other Identifying Number Assigned by Agency: 1062976
Project Title: REU SITE: Research Experiences for Undergraduates in Astronomy at Cerro Tololo Inter-American Observatory (2012-2016)
PD/PI Name: Nicole S van der Bliek, Principal Investigator
David J James, Co-Principal Investigator
Recipient Organization: Association of Universities for Research in Astronomy, Inc.
Project/Grant Period: 10/01/2011 - 09/30/2016
Reporting Period: 10/01/2013 - 09/30/2014
Submitting Official (if other than PD\PI): N/A
Submission Date: N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions) N/A

Accomplishments
* What are the major goals of the project?

The National Optical Astronomy Observatory (NOAO) Research Experiences for Undergraduates (REU) site program at Cerro Tololo Inter-American Observatory (CTIO) offers undergraduate students the opportunity to engage in publishable-quality research projects with scientists working at the forefront of astronomy and astrophysics. The fundamental goals are to provide research opportunities to six (6) US undergraduates annually to further their careers as well as exposing them to the international aspects of astronomical investigation through their 10-week stay at CTIO in La Serena, Chile.

This award for the period 2012 to 2016 is to fund an REU summer program at CTIO in La Serena, Chile, which is offered annually to six qualified applicants. An emphasis on student selection is directed toward stronger publicity and recruitment at minority-serving institutions, as well as students from institutions lacking access to first-rate telescope facilities. REU students are hired as full-time research assistants to work with a CTIO, Southern Astrophysical Research telescope (SOAR), or Gemini-South astronomer-mentor on a research project from mid-January to mid-March. The students are hosted at CTIO for the entire 10-week duration of the program. Each REU student is guaranteed a minimum of two nights observing with the 1.5-m, 1.0-m, or 0.9-m telescopes at CTIO. Analysis of observational data products provided by the mentors and/or procured during the students' own observing runs will be closely aligned with typical syllabus material in undergraduate courses such as Observational Astronomy, Stars & Galaxies, or Principles of Astronomy allowing us to bring students' classroom and book-learning efforts in fundamental astronomy concepts into focus. All participants are encouraged to attend the American Astronomical Society winter meeting
following their program to present a poster or deliver a paper. In addition to research projects, the CTIO REU site program features seminars designed by the science staff especially for the students as well as professional colloquia given by science staff and visiting astronomers, informal lunches, and group discussions. Beyond the offices, the program includes field trips to the observatories at Cerro Pachón and at least one other major, world-class astronomical facility in Chile (e.g., the Atacama Large Millimeter Array (ALMA), Las Campanas, and Cerro Paranal) and a variety of recreational and social activities. Working and interacting on a daily basis with scientists from diverse research specialties and with students from Chile and around the globe, CTIO REU students are exposed to many different aspects of a professional career in astronomy. Such day-to-day exposure to a wide range of scientific and technical occupations in astronomy and engineering is one of the chief benefits of the CTIO REU site program.

The CTIO REU site program is a vital part of NOAO’s ongoing commitment to contribute toward the nation’s need in training our future scientists, academics, and young professionals. Our REU program also will provide its participants with valuable exposure in instrumentation, technical support, and education for those interested in a broader astronomical career. In an effort to provide opportunities for REU students representing the full spectrum of the US population, we make special, programmatic efforts in advertising to and recruiting students from minority-rich backgrounds, especially those attending minority-serving institutes. The broadest goals of the CTIO REU site program are (1) to encourage undergraduates of all demographics, including women and those of minority-rich backgrounds, to pursue careers in science, (2) to foster high levels of scientific literacy among the future Science, Engineering, and Technology (SET) workforce, (3) to stimulate general awareness of the remarkable achievements of US astronomy, and (4) to inspire interest in the future progress and welfare of US science.

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

Major Activities: The 2014 National Optical Astronomy Observatory (NOAO) Research Experiences for Undergraduates (REU) Program at Cerro Tololo Inter-American Observatory (CTIO) provided an opportunity for six US undergraduate students to participate in independent, supervised research activities in astronomy, in collaboration with members of the scientific staff. The program is supported by the rich scientific environment and research facilities of CTIO’s La Serena offices, as well as ready access to the national observatory facilities on Cerro Tololo itself. Together, these facilities provided a framework that introduced students to both the operations of a major observatory and the capabilities of a variety of optical and infrared instrumentation, all while they are actively engaged in current astronomical research. Building upon these resources, the program included an introduction to observational techniques and provided observing experiences for all of the participants. Furthermore, the program offered a unique cultural opportunity for participants to live in a foreign country and work alongside Chilean students who are doing similar research projects.

STUDENT SELECTION

Six undergraduate students from the US, selected from a total of 19 qualified applicants from US institutions, participated in the 2014 REU program at CTIO. Announcements were sent to over 800 college and university science and mathematics departments and career placement offices in the US and Puerto Rico. This promotional campaign is also targeted to the Hispanic Association of Colleges and Universities (HACU) as well as Historically Black Colleges and Universities (HBCU). The program was advertised on the CTIO REU program website (http://www.ctio.noao.edu/noao/content/REU-Program, the CTIO and CTIO REU/PIA Facebook pages, and in the NOAO Newsletter. Advertising for the 2014 program was accomplished in August 2013, as planned. Promotional activities for the 2015 CTIO REU program will start in July 2014.

SCIENCE

Each student pursued a research project guided by a professional astronomer as a mentor. The REU Site Director and the REU Student Coordinator solicited volunteers among the
CTIO, Gemini Observatory, and SOAR scientific staff, looking for active astronomers who were willing to invest their time and expertise to work with a student, and who had projects suitable for undergraduate students carrying out research in a 10-week program. There were more than enough volunteers and projects. Three REU students were mentored by CTIO staff members or visiting astronomers, and the remaining three students were mentored by Gemini Scientists. CTIO staff members also served as mentors for students participating in the CTIO Práctica de Investigaciones en Astronomía (PIA) program, a CTIO-funded annual program for two Chilean students that is run concurrently with the CTIO REU program.

WEEKLY STUDENT SEMINARS

Apart from the official CTIO colloquia, the students attended a seminar series especially designed to reflect their needs and interests. The seminars covered a broad range of topics, including lectures and workshops. Additionally, several general seminars and discussions were scheduled for the students, e.g., CTIO Director Dr. Nicole van der Bliek welcomed the students with a presentation on CTIO, NOAO, and AURA. The seminars were given by CTIO and Gemini scientific staff about once a week between January 13 and March 11. The speakers and topics from the 2013 Student Seminar Series follow:

Dr. Nicole van der Bliek (CTIO): “Welcome to CTIO”

Dr. Timothy Abbott (CTIO): “CTIO Labs and Instrument Shop”

Dr. David James (CTIO): “Telescope Designs”

Michael Warner (CTIO): “Hunting for Meteorites in the Chilean Atacama”

Guillermo Cabrera (CMM-UdeChile): “Astroinformatics”

Dr. Patrick Seitzer (U.Mich): “Space Debris”

Dr. Catherine Kaleida (CTIO): “Career Path in Astronomy and Applying for Graduate School”

Dr. Andrei Tokovinin (CTIO): “Who Studies Binary Stars and Why They Do It”

OBSERVATORY FIELD TRIPS

The REU grant provides funding for the students to visit Cerro Pachón and a three-day field trip to a site of astronomical significance. These trips allow the students to get a taste of other observatories and get acquainted with their unique telescopes, instruments, and operations. For the 2014 program, the students visited the observatories on the Chajnantor plateau, and the Cerro Tololo and Cerro Pachón mountaintops.

The Chajnantor plateau is the site of the Atacama Large Millimeter Array (ALMA), one of the premier millimeter/sub-millimeter radio astronomy observatories in the world. ALMA is an array of 66 antennae with dishes 7-12 meters in diameter that operate combined through an interferometric network to act as one large aperture. The observatory is an hour drive from San Pedro de Atacama in Northern Chile, through some of the most arid and beautiful terrain on Earth. The REU students were fortunate to receive permission from the ALMA director to tour the site, and are among the select few who have visited, as tours of ALMA are not available to the general public. While there, the students toured the antennae and the observatory facilities, and asked questions of the observatory scientists and engineers.

This year, CTIO, Gemini, and AURA hosted a large group of students on a “Grand Tour” of AURA facilities in Chile, visiting on the mountaintops of Cerro Tololo and Cerro Pachón.
The group consisted of the 6 CTIO REU students, 2 CTIO PIA students, 2 Gemini interns from Australia, 1 Union College/CTIO Term Abroad student, and 12 students participating in a two-week data science program co-sponsored by AURA, Harvard, the University of Chile’s Center for Mathematical Modeling, and the Millennium Center for Supernova Studies. The day began on Cerro Tololo with a brief history of the site and a visit to the Blanco 4-m telescope to see the largest camera in the Southern Hemisphere, the Dark Energy Camera. The group then took a half-hour drive to Cerro Pachón, which is home to the 8.1-m Gemini Telescope and the 4.2-m SOAR Telescope. Dr. Chris Smith (CTIO) and Dr. Tom Hayward (Gemini) led exciting tours for the students, introducing the various instruments and modes of observing at each telescope. After watching the sun set slowly over the Large Synoptic Survey Telescope site, the tour culminated in watching the Gemini Multi-Conjugate Adaptive Optics system fire its five-laser constellation skyward.

CTIO REU PROGRAM EXTERNAL PROJECT EVALUATOR MID-TERM VISIT

In the CTIO REU grant proposal to the NSF, funding was requested for an external project evaluator to assist in our effort to continually improve the program. The external evaluator chosen was Dr. Isabel Hawkins, Astronomer and Project Director at the Exploratorium in San Francisco, California. Dr. Hawkins is a PhD astronomer with a wide breadth of expertise in science education, and as such is an ideal reviewer for our program. As part of this external evaluation, Dr. Hawkins visited CTIO for a week in February 2014, during the 2014 CTIO REU program. Her goal was to assess and write a mid-term report on the overall state of the program and suggest avenues for positive change over the longer term. Dr. Hawkins met with each of the REU and PIA students individually, as well as various student mentors and CTIO staff astronomers, attended all of that week’s activities with the REU/PIA students, and visited the telescopes on the mountain. Dr. Hawkins’ overall review was very positive, and her suggestions for change, especially in the area of recruitment, were extremely helpful and informative. More details of this review are attached, including the schedule of her visit to CTIO, the charge given to Dr. Hawkins in her evaluation, her response to that charge written upon completion of the visit to CTIO, and our subsequent response to her review.

PHOTOS

Photos of key activities, including the workplace and field trips, are included in the attached PDF file.

Specific Objectives:

• To guide six US undergraduate astronomy students in 10-week-long astronomy research projects

• To provide observing experience at a research-class telescope to those students

• To provide the students with practical knowledge of astronomical topics and data reduction methods and tools via approximately weekly seminars

• To expose the students to living and working in the environment of an international observatory

• To enhance the students’ understanding of astronomical instrumentation and telescope/antenna design by visiting other large observatories in Chile (Gemini, SOAR, ALMA)

• To give the students experience documenting and presenting their research to the community via weekly research meetings, the final Student Symposium, their final reports, and presentations at the AAS meeting

Significant Results:

The key result of the CTIO REU program is the research the students complete while in the
program. Participant support costs were provided for the students listed below. The students research project titles are listed along with the students' names, university affiliations, and mentors, together with abstracts of the research projects written by the students and their mentors.

**Sarah Burhart** (Arizona State University), Research Intern to Dr. Percy Gomez (Gemini)

Project Title: “An Investigation into the Dynamics in Abell 3827”

Abstract: Abell 3827 (A3827) is one of the most massive known galaxy clusters. At a relatively close redshift of 0.1, we have the unique opportunity to look at the galaxies it contains with more resolution than many others. Its unusual features include the most massive known galaxy in its core consuming up to 5 galaxies. We used GMOS data to find velocities of 27 of A3827’s galaxies, 6 of which had no previous data, and added our data to a catalog that is still growing in order to more accurately calculate the mass of this cluster and compare it with previous calculations made by our team and others. Preliminary results give a mass estimate close to that calculated by measuring gravitational lensing of the cluster, however our sample size needs to be larger in order to make a definitive conclusion.

**John Farmer** (Clemson University), Research Intern to Dr. Kathy Vivas (CTIO)

Project Title: “Probing Kinematic Substructures in the Virgo Overdensity Using Bright RR Lyrae from the La Silla QUEST Survey”

Abstract: We present analysis of 300 spectra for 215 stars in the Virgo overdensity region (−5 < δ < 10, 175 < α < 210). Photometry for these data are taken primarily from the La Silla and Venezuela QUEST variability surveys with spectra provided by SDSS Data Release 10. Radial velocities for RRLab stars are corrected using a new set of template radial velocity curves for Balmer and metallic lines given by Sesar (2012). We combine data from QUEST, the Catalina Sky Survey, LINEAR, and observations from Duffau et al. (2014) to give our full sample. A preliminary, qualitative analysis reveals evidence for confirmation of many known stellar streams, including the Sagittarius stream at 40−60kpc, the Virgo Stellar Stream at 10−30 kpc, and a new discovery by Duffau et al. (2014). Our data agrees with N-body simulations giving the position and velocity of stars in the Sagittarius stream.

**Joshua Frechem** (Old Dominion University), Research Intern to Dr. Peter Pessev (Gemini)

Project Title: “Near Infrared Spectroscopy of Active Galactic Circumnuclear Regions”

Abstract: Using data from the 2.3-meter Bok telescope on Kitt Peak and the FRANKENSpect spectrograph, we aim to investigate the circumnuclear region of over twenty active galaxies in the J, H, and K passbands in order to obtain high signal to noise spectra with reasonable investment of observing time. The sample is selected to cover a wide range of AGN types of activity in luminous nearby galaxies. The primary goal of this project was to sort and process the 9,000+ spectra, including dark subtraction, flat fielding, and creation of and application of bad pixel masks. The 2-D spectra were processed to a 1-D spectra and wavelength calibrated to reveal the exact wavelength of each peak in the spectra. Using standard stars is of utmost importance so the atmospheric lines can be corrected for and the data can be used for precise analysis. With the reduced and calibrated spectra, we measure the Paschen α, β, and γ Hydrogen lines, the Brackett γ Hydrogen line and the Fell line in the near infrared emitted from the circumnuclear regions of the galaxies. These data unveil details of what the environment is like in the area surrounding the supermassive black holes that are found in the heart of each of these galaxies.
**Shane Loeffler** (University of Minnesota-Duluth), Research Intern to Dr. Catherine Kaleida (CTIO)

Project Title: “Comparing Stellar Populations across the Hubble Sequence”

Abstract: Previous work (Jansen et al., 2000, Taylor et al., 2005) has revealed trends in radial profiles of galaxies of differing morphologies in optical wavelengths. We aim to look for trends in the infrared portion of the spectrum but find that existing 2MASS data is not sufficiently deep. Herein, we expand the available data into the infrared by analyzing data taken using the Infrared Sideport Imager (ISPI) on the four meter Blanco Telescope of Cerro Tololo Inter-American Observatory (CTIO) in Chile. Images taken in the J, H, and Ks bands were reduced using standard IRAF and IDL procedures. Photometry was calibrated using stars in each image with available high quality 2MASS magnitudes (AAA quality stars). Aperture photometry was then performed on the galaxy and radial profiles of surface brightness, J-H, and H-Ks were obtained. Preliminary results for IC1639 show features in the infrared that are similar to those observed in optical wavelengths, with a smooth surface brightness drop off and flat color gradients. These trends imply what one would expect from an elliptical galaxy, a relatively homogenous stellar population, with stellar density decreasing with radius.

**Veronica Paez** (University of California-Los Angeles), Research Intern to Dr. Blair Conn (Gemini)

Project Title: “Investigating the Depth and Data of a Wide Field Survey of the Small Magellanic Cloud”

Abstract: We investigated the photometric depth of a wide field survey of the Small Magellanic Cloud (SMC) stellar halo. The aim of the survey is to search for evidence of galaxy mergers at the smallest scales. To achieve this it is crucial to understand how the data quality across the survey affects the apparent stellar density profile along different lines of sight. We explored the impact of a variety of factors on the photometric depth of the data including foreground dust extinction and employed two independent methods for determining the photometric completeness. These results will be used to help determine a global stellar density profile of the SMC, as well as show variations with azimuth and to highlight the presence of any deviations.

**Blake Pantoja** (University of Louisville), Research Intern to Dr. Djazia Ladjal (CTIO Visiting Astronomer)

Project Title: “3D Versus 1D Radiative Transfer Modeling of Planetary Nebulae”

Abstract: Planetary nebulae are the products of the fast stellar wind from the end of the AGB star phase. To date, there are many one-dimensional radiative transfer codes, and a few fully 3D codes that can model the ionization of the planetary nebulae. The limitations on 1D codes are that they can only make spherical or parallel plane models, while 3D codes take much computing power and memory to run. A pseudo 3D code such as pyCloudy can model a planetary nebula in 3D by making multiple runs of a 1D code such as Cloudy in different angles from the center of the nebula. We find that one-dimensional codes can actually give good estimates for electron temperature and density in a bipolar planetary nebula.

**Key outcomes or Other achievements:**

The students’ primary focus while in Chile was to work on their individual research projects, supervised by their respective scientific mentors and the REU Student Coordinator. The students were encouraged to work independently and to develop the skills and expertise to define the direction and scope of their projects. In addition, the REU Student Coordinator was available to any of the students who had procedural, administrative, or scientific questions.
As a capstone at the end of the program, the students were asked to write a final report on their project and to present their work in a mini-symposium. Each student gave a 10–15 minute talk, which was followed by 5 minutes for questions from the audience. The symposium took place in the AURA auditorium, and was attended by the observatories’ scientific staff and visitors. The REU students will also present their work in the form of a poster paper at the 225th meeting of the American Astronomical Society (AAS), scheduled for 4–8 January 2015.

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

**SCIENCE**

The main goal of the CTIO REU program is to provide an opportunity to carry out a research project, supervised by one of the staff astronomers at CTIO, SOAR, or Gemini and by the REU Student Coordinator. At the end of the program, the students report on their work in the form of a written report and a short presentation. The students were encouraged to work independently, but those who lacked research experience were given more direct guidance when necessary by their mentor or the REU Student Coordinator. The CTIO summer students also had the opportunity to observe on Cerro Tololo, using the Small & Moderate Aperture Research Telescope System (SMARTS) 0.9-m telescope. Thus, the students experienced the three main tasks of a professional observational astronomer: observation, analysis of results, and subsequent reporting and publication.

**OBSERVING**

As part of the CTIO REU program, the students observed on Cerro Tololo using the SMARTS Consortium’s 0.9-m telescope. The objective of the observing run was to introduce the students to observing techniques and allow them to sample different methods of observing. The observing time, eight nights in total, was requested via the regular NOAO Time Allocation procedure (program ID: 2014A-0329). This proposal was ranked highly by the Telescope Allocation Committee, receiving a grade of 9.6, where 10 was the highest grade achievable. These eight nights corresponded to two observing nights for each group of two students.

For the 2014 program, the student observing plan consisted of Target-of-Opportunity (ToO) observations of Gamma-ray bursts (GRBs), supernovae (SNe), novae, and near-earth objects (NEOs), in collaboration with Dr. Francisco Virgili of Liverpool John Moores University, Dr. Joe Masiero of California Institute of Technology/Jet Propulsion Laboratory, and Dr. Frederick Walter of Stony Brook University. Although no visible SNe or GRBs occurred during this year’s observing run, there were many other TOO targets of interest available for the students to observe. One recurrent nova (V745 Sco) went into an active phase during the observing run, and the students obtained follow-up observations of this nova. Other observations included a new nova, which is exhibiting an unusual light curve (V1369 Cen), and a variety of comet and asteroid-like NEOs. This data is currently being analyzed and prepared for publication by the collaborators listed above. A portion of the observing time was also left open for the students to image objects of their own choosing, including observations for their own research projects in some cases. The students imaged Southern Hemisphere galaxies, star clusters, and nebulae. In choosing their own targets, they learned how to determine what objects are visible in the night sky from a certain location at a certain time, how to determine appropriate exposure times, and they gained experience in deciding what filters to use to meet different scientific goals.

**WEEKLY RESEARCH GROUP MEETINGS**

A group research meeting was held each week and attended by all of the students and their mentors when they were available. At these meetings, the students presented their projects, their progress during the previous week, and their plans for the upcoming week. These presentations helped them to track their research progress and discuss issues encountered with their REU peers and mentors. These group meetings were an excellent way to ensure that substantial and steady progress was made, while at the same time allowing the students to practice their presentation skills. Over the course of the 10-week program, their presentations improved dramatically, and their confidence grew equally fast.

**SCIENTIFIC INTERACTIONS**

An essential component of the CTIO REU program is the opportunity students have for interaction with scientists, not only with the observatory staff, but also with the flow of visiting astronomers who pass through on their way to the observatory. The generally informal atmosphere at CTIO provides a climate that promotes these interactions, which take place naturally at “Staff Tea” (every Friday morning at 11 am, the CTIO and SOAR scientific staff gather to discuss science, observatory matters, and other topics of interest), at regular scientific colloquia, and in the public computer area that the students share with visiting astronomers and other
Interns. Informal meetings with various CTIO staff members and visiting astronomers while students were on the mountain typically resulted in an on-the-spot introduction to an instrument or research specialty. This year, Dr. Pat Seitzer from the University of Michigan was in La Serena for an observing run, and graciously agreed to present a seminar on his research for the students. Dr. Seitzer gave a seminar explaining the observing program he is carrying out for NASA to track space debris, thus exposing the students to yet another possible field of study for observational astronomers.

**Other**

See also “Weekly Student Seminars” and “Field Trips” in the Major Activities section.

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

**Scientific Results**

At the end of the program, the students presented their work in a mini-symposium. Each student gave a 10–15 minute talk, which was followed by 5 minutes for questions from the audience. The symposium took place in the AURA auditorium on the AURA compound in La Serena and was attended by the CTIO, Gemini, and SOAR scientific staff and visitors. The REU students also will present their work in the form of poster papers at the 225th meeting of the AAS, scheduled for 4–8 January 2015 in Seattle, Washington.

**Outreach**

Public outreach is also an important aspect of the CTIO REU program. During their time in Chile, the students were given the opportunity to participate in an outreach event with the CTIO Education and Public Outreach team. This activity was held at a school in the small fishing village of Punta de Choros to the north of La Serena, and included night sky observing and a portable planetarium show. The students helped with assembling and operating two small telescopes, and explaining objects in the night sky to the general public.

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

During the next reporting period, we will host the 2015 CTIO REU program, building and improving upon the process used in previous years. The following is a timeline of the CTIO REU program for the period from July 2014 through June 2015:

**July-August 2014:**

- Answer student inquiries about 2015 CTIO REU program
- Update CTIO REU poster website for the 2015 program and print REU posters
- Mail and Email REU recruitment posters and letters
- Identify mentors and select student projects
- Application form available for 2015 program

**September 2014:**

- Abstracts for AAS meeting are due for 2014 CTIO REU students
- Student AAS travel plans are finalized
- Submit an NOAO observing proposal for the 2015A semester for the incoming 2015 REU students

**October 2014:**

- Advertise at 2014 SACNAS National Conference
- CTIO REU application deadline
- Student Selection Committee meets
• Acceptance emails are sent out to successful students
• Reply date for first offers
• All REU positions filled by the end of October

**November 2014:**
• Advertise at 2014 AISES National Conference
• REU Student Coordinator has paired students and mentors
• Student travel plans to Chile booked
• Educational activities for the 2015 program are finalized

**December 2014:**
• Mentors and Student Coordinator help 2014 students prepare AAS posters
• NOAO awards telescope time for 2015A

**January 2015:**
• Advertise at 2015 Winter AAS Meeting
• 2014 students present at AAS Meeting
• Student Coordinator meets new students at DFW to escort them to Chile
• Official start of 2015 CTIO REU program
• Students meet their mentors and begin work on projects
• First student seminar given
• First REU weekly research meeting

**February 2015:**
• Student Observing Run (usually scheduled for 1st week of February)
• Field Trip to Cerro Pachón, including the Gemini-South and SOAR telescopes
• Field Trip to another major observatory in Chile

**March 2015:**
• Final Student Presentations in AURA Lecture Hall
• Official end of Chilean phase of the 2015 CTIO REU program
• Students depart Chile to return home

**June 2015:**
• Submit 2015 CTIO REU Annual Project Report to the NSF

**Supporting Files**

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## Products

### Books

#### Book Chapters

**Conference Papers and Presentations**


### Inventions

#### Journals

#### Licenses

#### Other Products

*Educational aids or Curricula.*

As part of the Weekly Research Meeting, the REU and PIA students participated in an Astronomy Language Exchange. At the beginning of each meeting, the students came up with astronomy-related technical terms in English to translate to Spanish, and from these suggestions compiled the beginnings of an English-Spanish Astronomy Dictionary. The intention is to continue this practice in future years' REU and PIA programs, with the aim of creating a comprehensive English-Spanish Astronomy Dictionary to post on the Web for public use.

### Other Publications

#### Patents

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Technologies or Techniques

Thesis/Dissertations

Websites

http://www.ctio.noao.edu/noao/content/REU-Program

On this website, potential students can find information about the program, and peruse the abstracts of research completed by current and past students while at CTIO. The website also contains a page that lists the publications related to work carried out during the CTIO REU summer student programs, going back to the start of the CTIO REU program in 1995. The website also has the start of an English-Spanish Astronomy Dictionary developed by the 2012, 2013, and 2014 REU/PIA groups and shows photos from each year's program, which give a good impression of the programs.

Participants/Organizations

Research Experience for Undergraduates (REU) funding

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<td>How many REU applicants were selected and agreed to participate during this reporting period?</td>
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REU Comments:

What individuals have worked on the project?

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<th>Most Senior Project Role</th>
<th>Nearest Person Month Worked</th>
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<tr>
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Full details of individuals who have worked on the project:

Nicole S van der Bliek
Email: nvdbleik@ctio.noao.edu
Most Senior Project Role: PD/PI
Nearest Person Month Worked: 0
**Contribution to the Project:** Help managing program.

**Funding Support:** AST-0950945

**International Collaboration:** Yes, Chile

**International Travel:** No

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**David J James**  
**Email:** dj@ctio.noao.edu  
**Most Senior Project Role:** Co PD/PI  
**Nearest Person Month Worked:** 0

**Contribution to the Project:** Help managing program.

**Funding Support:** AST-0950945

**International Collaboration:** Yes, Chile

**International Travel:** No

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**Catherine Kaleida**  
**Email:** ckaleida@ctio.noao.edu  
**Most Senior Project Role:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** CTIO REU Student Program Coordinator. Managed program.

**Funding Support:** AST-0950945

**International Collaboration:** Yes, Chile

**International Travel:** Yes, United States - 0 years, 0 months, 11 days

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**Sarah Burkhart**  
**Email:** sarah.burkhart@asu.edu  
**Most Senior Project Role:** Research Experience for Undergraduates (REU) Participant  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Student Research Project

**Funding Support:** None

**International Collaboration:** Yes, Chile

**International Travel:** Yes, Chile - 0 years, 2 months, 15 days  
**Year of schooling completed:** Other  
**Home Institution:** Arizona State University  
**Government fiscal year(s) was this REU participant supported:** 2014

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**John Farmer**  
**Email:** jmfarme@g.clemson.edu  
**Most Senior Project Role:** Research Experience for Undergraduates (REU) Participant  
**Nearest Person Month Worked:** 3

**Contribution to the Project:** Student Research Project
Funding Support: None

International Collaboration: Yes, Chile
International Travel: Yes, Chile - 0 years, 2 months, 15 days
Year of schooling completed: Junior
Home Institution: Clemson University
Government fiscal year(s) was this REU participant supported: 2014

Joshua Frechem
Email: jfrec001@odu.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: Student Research Project

Funding Support: None

International Collaboration: Yes, Chile
International Travel: Yes, Chile - 0 years, 2 months, 15 days
Year of schooling completed: Junior
Home Institution: Old Dominion University
Government fiscal year(s) was this REU participant supported: 2014

Shane Loeffler
Email: loeff081@d.umn.edu
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: Student Research Project

Funding Support: None

International Collaboration: Yes, Chile
International Travel: Yes, Chile - 0 years, 2 months, 15 days
Year of schooling completed: Junior
Home Institution: University of Minnesota-Duluth
Government fiscal year(s) was this REU participant supported: 2014

Veronica Paez
Email: vmargotpaez@gmail.com
Most Senior Project Role: Research Experience for Undergraduates (REU) Participant
Nearest Person Month Worked: 3

Contribution to the Project: Student Research Project

Funding Support: None

International Collaboration: Yes, Chile
International Travel: Yes, Chile - 0 years, 2 months, 15 days
Year of schooling completed: Junior
Home Institution: University of California-Los Angeles
Government fiscal year(s) was this REU participant supported: 2014
Blake Pantoja  
Email: bmpant01@louisville.edu  

Most Senior Project Role: Research Experience for Undergraduates (REU) Participant  
Nearest Person Month Worked: 3  

Contribution to the Project: Student Research Project  

Funding Support: None  

International Collaboration: Yes, Chile  
International Travel: Yes, Chile - 0 years, 2 months, 15 days  
Year of schooling completed: Other  
Home Institution: University of Louisville  
Government fiscal year(s) was this REU participant supported: 2014  

What other organizations have been involved as partners?  
Nothing to report.  

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 main goal of this program is to allow students, mainly astronomy and physics majors, but also the occasional engineering, math, or geology major, to participate in research, get hands-on experience in observing, work in a research institute (non-university based, for a different perspective), and experience the international nature of astronomy (working in Chile, at an international observatory) alongside Chilean students. The students directly contribute to making new discoveries in the field of astronomy and frequently publish these results in peer-reviewed journals. A summary of the specific astronomical discoveries of the 2014 REU students can be found in the "Key Outcomes" section of this document.  

What is the impact on other disciplines?  
The major impact of this program on other disciplines is to help produce the next generation highly educated and skilled scientists to enter the STEM workforce.  

What is the impact on the development of human resources?  
The goal of this program is the development of young scientists who will be the astronomers of the future. Nineteen applications for the 2014 CTIO REU program were received. Of these applicants, 63% (12 out of 19) were women and 37% (7 out of 19) were men. For the 2014 REU program, 67% (4 out of 6) of the students selected were men and 33% (2 out of 6) were women.  

In order to combat the underrepresentation of certain minority groups in the sciences seen across the US, the CTIO REU program strives to have a diverse applicant pool. This year, we have seen an improvement in the representation of minority groups in the applicant pool for the CTIO REU program, as compared to previous years. Out of the 19 applicants, 10 reported themselves to be White and not of Hispanic, Latino, or Sephardic/Portuguese/Mexican, 2 reported as biracial and not of Hispanic, Latino, or Spanish origin, 1 reported mixed race and Peruvian, 1 reported as Dominican, and 1 reported Asian Indian (note that as of the 2011 National Academy of Science, National Academy of Engineering, and Institute of Medicine report “Expanding Underrepresented Minority Participation,” Asian Indians are no longer considered a group underrepresented in the sciences; for more information, see http://www.nap.edu/catalog.php?record_id=12984). Three applicants declined to answer, as this was an optional question on the application form. Thus, 38% (6/16 applicants who chose to report their racial demographic information) of this year's applicants were members of a minority group. Of the six accepted students this year, 4 were White/Caucasian and not of Hispanic, Latino, or Spanish origin, 1 was White and Spanish/Sephardic/Portuguese/Mexican, and 1 reported mixed race and Peruvian.  

While the diversity of our applicant group is improving, the underrepresentation of minorities in the sciences is still reflected in the
2014 REU applicants. We will continue our efforts to advertise heavily at historically minority-serving institutions and conferences in the US. In October 2013, the CTIO REU program sent advertisement fliers for the 2015 program to be distributed at the National Conference of the Society for Advancement of Chicanos and Native Americans in Science (the conference date was after the application deadline for the 2014 program). These fliers were distributed at the NSF-REU Chemistry Leadership Group booth by Dr. Jared Shaw of the University of California-Davis. We hope that students who attended this conference will apply for the 2015 program after seeing our advertisement flier. One change that was made to the advertising practices for the 2014 program was the posting of the internship advertisement on the CTIO and CTIO REU Alumni Facebook pages. We will continue this practice in subsequent years.

Of course, while the diversity in the 2014 REU group itself is limited to the diversity of the applicant pool, the fact that the NSF-funded REU program is run in parallel with the PIA program for Chilean students ensures a high level of diversity in the overall program and student interactions.

Geographically, the applicants were from universities in 12 states in the US: 7 from the South, 7 from the Midwest, and 3 from the West, and 2 from the Northeast. In years prior to 2012, there has been a smaller proportion of applicants from the South and Midwest, and it is gratifying to see that for two years in a row now the advertising efforts for the program are reaching those parts of the country that have been previously underrepresented in our program alumni.

The home institution size of the accepted applicants was also tabulated: 17% (1 out of 6) were from schools with fewer than 10,000 enrolled undergraduates. The CTIO REU program continues to be committed to providing astronomy research experiences to qualified applicants whose home institutions cannot provide them with similar opportunities.

The CTIO REU groups are chosen based on merit as well as how much they will benefit from the program. However, we continue to strive to have a diverse applicant pool, in order to have groups that are balanced in gender and include students from underrepresented minorities in the sciences. As such, the CTIO REU program is directly contributing to broadening participation in the science, technology, engineering, and mathematics (STEM) disciplines.

What is the impact on physical resources that form infrastructure?
Nothing to report.

What is the impact on institutional resources that form infrastructure?
Nothing to report.

What is the impact on information resources that form infrastructure?
Nothing to report.

What is the impact on technology transfer?
Nothing to report.

What is the impact on society beyond science and technology?
One of the unique characteristics of the CTIO REU program is that it offers the opportunity to live and work in an international setting at an observatory in a foreign country. The US students work alongside Chilean students who participate in the parallel PIA program, and the cultural experience these young astronomers obtain is as invaluable to their growth into successful astronomers as the research projects themselves.

Changes/Problems

Changes in approach and reason for change

For the 2014 program, changes were made to strengthen sensitivity to and training pertaining to harassment issues for all student interns at CTIO. These changes included a presentation and discussion dedicated to harassment issues at the beginning of the program, together with an online anti-harassment training program. We also have implemented an individual check-in meeting between each student and the Student Coordinator at the 4th week of the program, to give students a private opportunity to express any issues that have come up. These additional activities bring to the students’ attention the broad range of issues involved, help them to recognize issues of this nature at an early stage, and help prepare them to deal with and report such issues.
with confidence. The online training was given in English to the REU students and in Spanish to the PIA students, in order to make sure that all details of the training are clearly understood.

We will be adding some additional recruitment strategies for the 2015 program, based on the suggestions given by the CTIO REU Program External Evaluator, Dr. Isabel Hawkins. Please see attached documents for details about these changes.

**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.

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**Special Requirements**

Responses to any special reporting requirements specified in the award terms and conditions, as well as any award specific reporting requirements.

Nothing to report.
The 2014 CTIO REU Program in Photographs

Figure 1: The 2014 CTIO REU students pose for a photo with La Serena in the background shortly after arrival at the CTIO offices in Chile. From left to right: Blake Pantoja, Josh Frechem, Sarah Burkhart, Veronica Paez, John Farmer, and Shane Loeffler.
The 2014 CTIO REU Program in Photographs

Figure 2: The REU and PIA students pose with the 570 megapixel Dark Energy Camera (black cylinder at top middle) on the Blanco 4-m telescope on Cerro Tololo, during the “Grand Tour” of telescopes on Cerro Tololo and Cerro Pachon. From left to right: Piera Soto (PIA), Blake Pantoja (REU), Shane Loeffler (REU), Josh Frechem (REU), John Farmer (REU), Sarah Burkhart (REU), Alexander Contreras (PIA), and Veronica Paez (REU).
The 2014 CTIO REU Program in Photographs

Figure 3: REU student Sarah Burkhart points at the bright star she used to re-acquire the telescope pointing during the student observing run on the SMARTS 0.9-m telescope on Cerro Tololo.
The 2014 CTIO REU Program in Photographs

Figure 4: The REU/PIA students and external program evaluator Dr. Isabel Hawkins examine meteorites collected in the Atacama Desert, after the Weekly REU/PIA Student Seminar entitled “Hunting for Meteorites in the Chilean Atacama” by Michael Warner. From left to right: Dr. Isabel Hawkins (Exploratorium), Piera Soto (PIA), Blake Pantoja (REU), Michael Warner (CTIO), Shane Loeffler (REU), Sarah Burkhart (REU), and Veronica Paez (REU).
Figure 5: The REU and PIA students visit the Atacama Large Millimeter Array (ALMA), the premier site for millimeter/sub-millimeter radio astronomy observations. From left to right: Josh Frechem (REU), Vaishali Parkash (Union College/CTIO), Sarah Burkhart (REU), Naru Sadakuni (Gemini), Peter Pessev (Gemini), Pascale Hibon (Gemini), Piera Soto (PIA), Blake Pantoja (REU), Veronica Paez (REU), Alexander Contreras (PIA), and Shane Loeffler (REU).
To: Isabel Hawkins  
From: Catherine Kaleida, Nicole van der Bliek, Steve Heathcote  
CC: David James, Chris Smith  

March 4, 2014  

Review of the CTIO REU program  

Since 1995 CTIO has successfully run a REU summer student program, funded by the NSF. In the last renewal proposal, AST- 1062976, CTIO proposed to invite an external reviewer to assess the CTIO REU program. This would include a mid-term visit at CTIO, to perform a program assessment and write a mid-term report, addressing the overall state of the program, and suggesting avenues for positive change over the longer term. CTIO invited me to be the external reviewer in August of 2013. I visited CTIO during the week of February 17-21, 2014 to assess the program.  

The specific charge given to me by the CTIO/REU program leadership for the mid-term review is to address three broad questions that emerge from the primary goals of the program. During my week-long visit, I was able to interact with the students and attend all of the REU research-related activities along with the students and CTIO staff.  

Question 1.  

As the name implies, the NSF REU programs aim at providing a research experience for undergraduate students. Hence, the research projects take a central role in the CTIO REU program.  

Q1. Does the CTIO REU program offer the students a valuable research experience, with quality projects and sufficient supervision?  

Answer from I. Hawkins:  

CTIO, a world class astronomy research facility, provides the students with valuable and unique opportunities for research. The student projects span a variety of current research topics, in great measure because the CTIO staff works at the vanguard of astrophysics investigation. The mentors are dedicated and thrive on the interaction with the students, who make significant contributions to the mentors’ research. The REU Coordinator provides day-to-day support by answering student questions and facilitating the student/mentor interactions during weekly research meetings. During these gatherings, the students present their progress on their projects, get feedback from mentors, and troubleshoot problems together. The students and mentors also meet on a regular basis outside of these meetings.  

The research experience of the students is enhanced by a hands-on observing run using the 0.9m telescope on the mountain. Their participation in this observing run early in the 10-week internship makes their work on data reduction very meaningful and contextual.
They also learn to reduce data using a variety of computer languages and astronomical packages such as IRAF and IDL. The students are integrated into all the research activities at CTIO, including science colloquia, talks by other students working on Gemini and other projects, and the informal and popular “Science Tea” where astronomers share and discuss the latest discoveries.

All of the students are preparing the results of their research for presentation at the 2015 Winter AAS in Seattle. For a few of the students, their REU experience is likely to result in refereed publications.

The REU program at CTIO is providing the students with meaningful and robust research experiences in the form of hands-on observing, data reduction, presentations to peers, mentors, and other staff, and broader dissemination of their results at the AAS and in some cases, publications.

It is inevitable that, due to busy schedules, at times the mentors are away on travel for observing runs or conferences. These instances are few, and when needed, the role of the REU Coordinator serves to provide additional support and to ensure remote communication between mentors and students.

CTIO Response:

The CTIO REU program will continue to provide research opportunities on current topics in astronomy, with mentors drawn from the active research staff at CTIO, SOAR, and Gemini-South, and with support in guiding the students by the CTIO REU Student Coordinator. Participation in the student observing run on the 0.9-m, weekly CTIO Science Teas, and seminars and talks by staff members, visiting astronomers, and other students will also continue to be integral parts of the CTIO REU experience. Thank you for your positive comments.

Question 2.

NOAO strives to broaden participation in the workforce, in particular amongst the technical and scientific staff and running a program like the REU program offers an excellent opportunity to contribute in this area beyond the NOAO workforce.

Q2. Are the recruitment and selection processes adequate to select a diverse group (in all respects)?

Q2 Answer from I. Hawkins:

The primary student recruitment strategies currently in use include: sending fliers and informational letters announcing the CTIO REU opportunity to 800 physics and astronomy departments at colleges and universities in the US, including Historically Black Colleges and Universities (HBCUs) and face-to-face recruitment efforts at AAS. In addition to these strategies, I have the following suggestions for recruitment, especially to reach more minority candidates. Integrating the CTIO and KPNO REU recruitment efforts could be beneficial and cost effective for both programs, so I suggest that you consider aligning the recruitment aspect of the two REU programs.
Contact colleagues who work at institutions with diverse student populations so that they may point out the CTIO/REU opportunity to qualified students on a more personal level. Additionally, these contacts can share the fliers and informational letters with faculty who teach introductory astronomy at their institutions, since many minority students from other majors take these classes.

The contacts I suggest are:

Dr. Paul Etzel (San Diego State University) – for recruiting Latino students from their astronomy department
http://mintaka.sdsu.edu/faculty/etzel/
Email 1: etzel@sciences.sdsu.edu
Email 2: pbetzel@mail.sdsu.edu
Phone: +1 619 594 6169

Dr. Ramón (Ray) López (University of Texas, El Paso) – for recruiting Latino students from their department; also involved in Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) and National Society of Hispanic Physicists (NSBP)
http://bio.sacnas.org/beta/pdf/lopez_ramon_H.pdf
Email: relopez@utep.edu

Dr. Keivan Stassun (Vanderbuilt University and Fisk University) – for recruiting Latino and Black students from both universities, also involved in NSHP, NSBP
http://astro.phy.vanderbilt.edu/~stassuk/about.htm
Phone (Vanderbilt): 615-322-2828
Phone (Fisk): 615-329-8887
Email: keivan.stassun@vanderbilt.edu

Dr. Charles McGruder (Western Kentucky University) – for recruiting Black students from their astronomy department, also involved in NSBP
http://www.wku.edu/physics/staff/charles_mcgruder
Phone: (270)745-5277
Email: charles.mcgruder@wku.edu

Dr. Jesus Pando (DePaul University) – for recruiting Latino/Black students from their astronomy department, also involved in SACNAS
http://newsl ine.depaul.edu/Pages/PhysicistJesusPando.aspx
Email: j pando@ depaul.edu

Extending the face-to-face recruitment efforts to minority-serving professional societies such as: SACNAS (Society for the Advancement of Chicanos and Native Americans in Science), AISES (American Indian Science and Engineering Society), American Indian Higher Education Consortium (AIHEC), and the joint meeting of the National Society of Black Physicists/National Society of Hispanic Physicists. Make contact with leadership and outreach personnel of the societies to present about the program at outreach sessions or other venues at the meeting; write articles in their newsletters to members; suggest that a link to your REU webpage be included as in the resource section of their webpages; send
Submit articles about the successes of the CTIO/REU program, with student profiles, to the editors of the Astronomical Society of the Pacific’s Mercury Magazine and the Winds of Change magazine, which is published quarterly by the American Indian Science and Engineering Society (AISES). As the premier nationally-distributed magazine published with a single-minded focus on career and educational advancement of Native People, this magazine will reach potential REU candidates who are Native American.

◆ Invite your REU alumni to serve as ambassadors for the program and take them to SACNAS/AISES, etc. to represent the program along with CTIO and/or KPNO staff.

◆ In addition to sending flyers to HBCUs, include Hispanic Serving Institutions (HSIs) and Tribal Colleges and Universities (TCUs).

◆ Advertise in Environmental Engineering, Geology, and other Engineering Departments in addition to Physics/Astronomy Departments.

Q2 CTIO Response:

For the 2015 CTIO REU program we will implement these suggestions, as well as continuing with the previously used advertisement methods of fliers and face-to-face recruitment at the AAS Winter meeting. Thank you for your helpful suggestions. The following new recruitment practices will be implemented:

◆ The CTIO REU Student Coordinator will personally email each of the suggested contacts above to recruit students from diverse student bodies, and send directly to these contacts the link to the CTIO REU webpage and the program advertisement flier in PDF form.

◆ We will also specifically ask that the advertisement poster be sent to all professors currently teaching introductory astronomy courses at each university we advertise to, so that they may share information about our program with their students, to reach minority students with an interest in astronomy, but currently in ancillary fields to astronomy (e.g. engineering, geology, environmental science).

◆ The CTIO REU Student Coordinator will contact the Kitt Peak REU Student Coordinator each year, to distribute recruitment materials for the CTIO REU Program, and decide which meetings each will attend that year to advertise for both programs at as many minority-serving professional society meetings as possible.

◆ The CTIO REU Student Coordinator will personally contact the leadership, outreach personnel, and student societies of the minority-serving professional societies SACNAS, AISES, AIHEC, NSBP, and NSHP. In these
emails the Student Coordinator will:
• Send recruitment materials (poster and cover letter)
• Request opportunities to advertise about the CTIO REU program
• Explore ways to make the most effective use of limited travel opportunities to achieve face-to-face contact with the various minority communities
• Send the newsletter article we write each year for the NOAO newsletter and to ask if they can include it in their society newsletter
• Ask that the CTIO REU program webpage be linked in the resource section of their webpages

◆ The CTIO student coordinator will work with REU program student alumni and the NOAO Education and Public Outreach team to profile REU program student alumni and distribute this article to Mercury Magazine and Winds of Change Magazine.

◆ Advertisement fliers will be sent to Hispanic Serving Institutions (HSIs) and Tribal Colleges and Universities (TCUs), as well as flyers to HBCUs

◆ Advertisement fliers will be sent to Environmental Engineering, Geology, and other Engineering Departments in addition to Physics/Astronomy Departments.

Question 3.

The CTIO REU program differs from other REU programs (opposite season, combined with PIA program, at a world-class astronomical facility, and the day-to-day running of the program is taken care of by the CTIO Student Coordinator, a postdoctoral fellow).

Q3. Could you comment on this?

Q3 Answer from I. Hawkins:

The CTIO REU internship experience is outstanding and without par in many respects compared to other REU programs. Two aspects are extremely attractive and provide students with unique opportunities: to be part of an international community in a world-class astronomical facility, and to spend ten weeks immersed in a different country and culture.

Taking part of an REU internship from January – March allows students to continue their research or partake of another internship opportunity during the Northern Hemisphere summer, where they can continue to hone their research skills. From a cultural and diversity standpoint, being at CTIO offers both the REU and PIA (Chilean) students the chance to interact with each other in an authentic activity with a common purpose – astrophysics research. It is a win-win opportunity for both sets of students, and everyone I interviewed felt very strongly that having a multi-cultural group of peers was exciting and beneficial to themselves and to the program.
The day-to-day management of the CTIO REU program has traditionally been done by a CTIO postdoctoral fellow. This has worked well, particularly when the personality and capabilities of the fellow are synergistic to the goals of the program and responsive to the needs of the students. The current REU Coordinator is extremely energetic and dedicated to the well-being of the students and to the progress of their research projects. Long term, however, I believe it would benefit the CTIO REU program to have a permanent Ph.D. staff position take care of the day-to-day coordination. This would provide continuity and would ensure that the lessons learned from prior efforts lead to continual improvement. A permanent staff position would also allow for sustained coordination of certain aspects of the program with the KPNO counterpart, particularly in the area of recruitment and program evaluation of impact.

**Q3 CTIO Response:**

The CTIO REU program will continue to operate in coordination with the PIA program for Chilean students for the duration of the current REU grant, providing a unique, international, REU opportunity in the January-March timeframe.

We recognize the advantages that the continuity of a permanent PhD level staff member would bring to the role of Student Coordinator. NOAO management will evaluate this within the context of the observatories overall mission and the available funding profile, as we develop the next REU proposal.

The CTIO REU program would like to thank Dr. Isabel Hawkins for sharing her insight and expertise, and the National Science Foundation for providing the support to fund this evaluation.
CTIO REU 2014 External Evaluator Itinerary (Version 02/17/14)
Dr. Isabel Hawkins, February 16-22

Room Abbreviations: MCR=Main Conference Room, ALH=AURA Lecture Hall, LIB=Library Extension

➢ Sunday, February 16th
  → 18:10, Arrive in La Serena on LA306
  → 20:00, Dinner with Katie Kaleida, REU program Student Coordinator, discuss itinerary and evaluator questions

➢ Monday, February 17th
  → 10:30-11:00, Get settled in Office#6
  → 11:00-12:00, Gemini Student Final Presentations (ALH)
  → 12:00-12:30, Meet-and-Greet with students (LIB)
  → 13:00-14:00, Lunch with NOAO-South Director Steve Heathcote and Katie Kaleida
  → 14:00-15:00, Break
  → 15:00-15:45, Tour La Serena facilities with Katie Kaleida, Go over REU program documentation sent on Feb. 12th (Office#6)
  → 15:45-18:00, Meeting with students (Office#6)
    • 15:45-16:00, Margot Paez (REU)
    • 16:00-16:15, Joshua Frechem (REU)
    • 16:15-16:30, Shane Loeffler (REU)
    • 16:30-16:45, Piera Soto (PIA)
    • 17:00-17:15, John Farmer (REU)
    • 17:15-17:30, Alexandar Contreras (PIA)
    • 17:30-17:45, Blake Pantoja (REU)
    • 17:45-18:00, Sarah Burkhart (REU)
→ ~19:30, Dinner with Head of AURA in Chile Chris Smith

➢ Tuesday, February 18th
→ 09:00-11:00, Discussion of recruitment and student selection (Office#6)
→ 11:00-11:15, Break
→ 11:15-11:30, Meet with student Vaishali Parkash (Union College Term Abroad Student) (Office#6)
→ 11:30-13:00, Discussion of program preparation, program activities (Office#6)
→ 13:00-14:00, Spanish/English Lunch at Casa 13 with Students
→ 14:00-15:00, Discussion of student/mentor, student/student interactions (Office#6)
→ 15:30-17:30, Student Research Meeting: Midterm Presentations (MCR)
→ 19:00, Dinner with Katie Kaleida, discussion of student research quality

➢ Wednesday, February 19th
→ 09:00-11:00, Free time for meetings, further discussion, writing report draft
→ ~11:00-18:00, Tour Cerro Tololo telescopes with David James and ~2-3 students
  • Get mealcards from Ximena before leaving.
  • Tentative Schedule:
    • 11:00, Leave La Serena
    • 13:00, Arrive Cerro Tololo
    • 13:00-14:00, Small break and then lunch
    • 14:00-16:00, Tour telescopes
    • 16:00, Leave Tololo

Written by Catherine Kaleida, REU/PIA Student Coordinator, Version 02/17/14
• 18:00, Arrive La Serena
  • Time TBD, Dinner with Peter Pessev

➢ Thursday, February 20th
  → 09:00-11:00, Discussion of student research quality (continued), post-program assessment, evaluation of program impact (Office#6)
  → 11:00-13:00, Free time for meetings, writing report draft
  → 13:00-14:00, Lunch with Nicole van der Bliek
  → 14:00-15:30, Free time for meetings, writing report draft
  → 15:30-16:30, REU/PIA Weekly Student Seminar Series (MCR)
    • “Hunting for Meteorites in the Chilean Atacama” by Michael Warner (MCR)
  → 16:30-17:30, Free time for meetings, writing report draft

➢ Friday, February 21st
  → 09:00-11:00, Free time for meetings, writing report draft
  → 11:00-12:00, CTIO Science Tea (LIB)
  → 12:00-13:00, Free time for writing report draft, preparing for afternoon debriefing to REU program team
  → 13:00-14:00, Lunch
  → 14:00-15:00, Free time for writing report draft, preparing for afternoon debriefing to REU program team
  → 15:00-~17:00, Debriefing from Dr. Isabel Hawkins with the REU program team (Room TBD, probably MCR or Office #6)
  → 19:30-21:30, Dinner with students
    • 2 options: Tia Coco in Peñuelas (fish), or a BBQ/Potluck at Casa 8
➢ Saturday, February 22nd
   ➔ ~10:00-16:00, Tour La Serena Archeological Museum and Japanese Garden
      • have lunch downtown
   ➔ 18:40, Leave La Serena on LA307
8 August, 2013

Attention: Dr. Isabel Hawkins
Astronomer and Project Director
The Exploratorium
Piers 15/17
San Francisco, CA 94111-1456
USA

Dear Dr. Hawkins,

We would like to formally invite you to the Cerro Tololo Inter-American Observatory (CTIO) offices in La Serena, Chile, in order to serve as the external program evaluator for the CTIO Research Experiences for Undergraduates (REU) program, which is supported by the National Science Foundation under grant AST-1062976. As the midpoint of CTIO REU grant award period will be in 2014, we would like to cordially invite you to visit CTIO during the week of February 17-21, 2014. We will provide funding for you to come to La Serena for a week to review the REU program while the 2014 program is in session, including travel costs, lodging, and per diem.

Upon completion of your week at CTIO, we ask that you write a mid-term report based on that visit. The report should address the overall state of the program, and suggest avenues for positive change over the longer term. This report should be a maximum of 3-4 pages in length.

Thank you for providing your expertise to assist in our continued effort to improve our program over time.

Sincerely,

Catherine Kaleida
Postdoctoral Research Associate
Director of Student Programs
Cerro Tololo Inter-American Observatory
La Serena, Chile
ckaleida@ctio.noao.edu
http://www.ctio.noao.edu/noao/content/student-programs-and-internships
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