Importance of UCO Facilities (from UCO Survey 1): Excerpts on Education, Outreach, and Fund-raising

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Preface: Almost to a person, emphasis was put upon the ability of UC to attract top-notch undergrads, grads, and post-docs because of the availability of UCO facilities. We have selected some of the more detailed examples, along with references to public outreach and fundraising.

Gillian Wilson, UC Riverside

I am heavily involved in outreach, giving K-12 talks, radio and press interviews etc. See e.g., http://faculty.ucr.edu/~gillianw/publicoutreach.html

I invariably show and discuss the latest UCO findings in these outreach efforts (both results from my own and other groups).

I also utilize UCO findings in teaching my classes (at all levels from large undergraduate classes for non-science majors to specialized courses for graduate students).

Alice Shapley, UCLA

I have trained my graduate students in observations and reduction of Keck data. I have also given a Keck public lecture to local Hawaii residents.

Joshua Bloom, UC Berkeley

I brought several classes from intro astronomy courses from Cal to Mt Hamilton. Those were obviously very special moments for them in their studies, as many of them had not seen a telescope up-front nor really understood them to be scientific laboratories.

Ben Zuckerman, UCLA

I have given quite a few public lectures on astronomy in which I describe results obtained at UCO facilities.

Raja GuhaThakurta, UCSC

The training and education of young people is of vital importance to me. All of the 11 UCSC PhD students I've supervised and the 6 post-doctoral fellows at UCSC I have worked closely with have relied primarily on Keck and Lick data. This has also been true of most of the other young people I have mentored: a dozen or so UCSC undergraduates, a dozen or so graduate students and postdocs outside UCSC, and the ~ 30 high-school students in the Science Internship Program at UCSC.

The Keck Evenings with Astronomers talk series, the Mount Hamilton Music of the Spheres concert series and Summer Visitor Program, and **fundraising events** at these two observatories have given me the opportunity to develop my public speaking skills.

Bruce Macintosh, LLNL

UCSC AO lab was crucial in developing technology that enabled the Gemini Planet Imager, a $24M research instrument constructed and integrated primarily within UC.

Tomasso Treu, UCSB

UCO facilities are an integral part of my mentoring of students and postdocs. All my students, including undergraduates, get to experience the thrill of research with the best data on Earth and publish papers. I use the remote observing rooms very effectively for training purposes. I incorporate data and results from UCO facilities into my lectures and public lectures.

Jean-Luc Margot, UCLA

Outreach/mentorship enabled by UCO facilities: Training of graduate students.

Michael Rich, UCLA

Access to Keck has attracted graduate students and postdoctoral researchers to work with me, enabling me to be a mentor. Access to Keck also makes my **public presentations** more interesting and has been a factor in drawing the public to attend talks. **I believe that Keck access figured in my roughly $750,000 of NSF support received since coming to UCLA.**

The access to Keck was instrumental on my being selected to join the research team [studying globular cluster M4], and has resulted in $130,000 in funding.

Lori Lubin, UC Davis

All of my research over the past 15+ years (including for example **active grants totaling over $1M over just the past 3 years**) has involved the Keck telescopes.

Having access to the UCO facilities and the resulting observational data significantly factors into my undergraduate teaching and outreach to K-12 schools**. The UCO facilities are essential for recruitment of new faculty and graduate students.**

Mark Morris, UCLA

My research with Keck has led me to participate in outreach activities and to commit a considerable amount of time to some service activities in recent years, in support of the Keck Observatory's instrumentation and fund-raising programs.

Chris Fassnacht, UC Davis

I have been able to use data obtained with Keck and Lick to train both undergraduates and high school students (through the COSMOS program -- the California State summer school for mathematics and science http://cosmos-ucop.ucdavis.edu/main/campus_programs) in the fundamentals of research in science.

Marusa Bradac, UC Davis

The facilities attract students; graduate and undergraduate. I have presented my work in many of my classes. Furthermore I have used data from Keck for the COSMOS program, which is a K-12 summer program for extremely gifted high-school students. The students also visit Lick facilities during their stay.

Matt Richter, UC Davis

The observing workshop for students at Lick Observatory is a terrific program and provides valuable experience. I hope all my students in the future will participate.

Greg Aldering, LBL

UCO facilities have been essential in training students, not only to conduct their research while here, but also in making them competitive for the best postdoctoral and faculty positions once they graduate.

Graeme Smith, UCSC

Education: the Lick 3-m has been a huge factor in realizing my goals for the graduate students that I have supervised. My ideal is to give grad students a thorough grounding in the planning, design, and carrying out of a large multi-year observational program. I have been able to do this with my grad students, all three of whom used the Lick 3-m to obtain all or a major part of their PhD thesis data. For example, Laura Langland-Shula's entire PhD thesis on the spectroscopy of comets was a multi-year program that used the Lick 3-m exclusively and produced a major compendium of observational material for some two-dozen comments. The major result from Sarah Martell's thesis on carbon evolution among globular cluster red giants was obtained from a multi-year campaign with the Kast spectrograph on the Lick 3-m. Access to Lick has been crucial to my PhD students and I do not think they could have gotten the same observational grounding by basing their theses on much more limited amounts of Keck time.

Personally one of the most edifying things I do in **public outreach** is to lecture at the Lick summer visitor program. My lectures try in some small way to generate an appreciation for the rich history of Lick Observatory. If one were to take Lick away a major part of the outreach effort of the UC astronomical endeavor would be jeopardized. It has been an honor to work for an observatory with such a rich legacy. It is what has made my appointment at UCO/Lick truly special and unique.

Michael Fitzgerald, UCLA

UCO facilities also figure critically in the training of graduate students. Access to world-class observational facilities where students take an active part in data acquisition is essential to training observational astronomers.

Gabriela Canalizo, UC Riverside

The facilities at Mt. Hamilton have been essential in mentoring and teaching undergraduates and young graduate students. We have been able to send our incoming graduate students to workshops at Mt. Hamilton to introduce them to observational astronomy. I have used the remote observing room along with the Shane 3-meter telescope and the Keck telescopes to teach both graduate and undergraduate students how to observe. I have used these remote facilities for **public outreach** at UCR. I have taken both graduate and undergraduate students on field trips to the IR lab at UCLA. UCO facilities have also been useful in providing opportunities for our grad students that they don't have in our own campus. For example, **one of my students completed a PhD thesis in instrumentation at the adaptive optics labs at UCSC.** UCR has used footage of Mt. Hamilton and the Keck Observatory for the **Living the Promise outreach campaign**. It is obvious that the astronomy facilities capture the attention and imagination of prospective students and donors alike.

Kevin Hurley, SSL Berkeley

The education aspect has been the most important one - many students have had access to what is indisputably one of the world's best optical facilities.

David Jewitt, UCLA

I use my observing activities as a magnet in classes (e.g. ESS 9) and public lectures and it always works. People love telescopes and astronomers using telescopes. Take a look at http://www.kavlifoundation.org/2012-kavli-prize-public-laureate-lectures - KP2012PLLfor an example.

Gary Chanan, UC Irvine

All of my undergraduate researchers, graduate students, and postdocs used UCO facilities for their research. Three of these former group members are now JPL staff members, three more are TMT employees, and two others work in closely related fields.

Alex Filippenko, UCB

I have had a great time showing select undergraduates from my large introductory astronomy course how real research is done by bringing them with me to Lick on observing runs. This kind of educational experience is quite rare at universities. Moreover, over the past quarter century nearly 150 undergraduates have participated in my research group, mostly through observations at Lick: they have helped identify new supernovae, and they have taken and analyzed data, obtaining invaluable hands-on training that has served them well in their careers.

In the past few years, **the remote observing room at UCB has greatly increased the opportunity for meaningful observational experiences among undergraduate students.** They can assist with observations without seriously compromising their coursework; each student can, for example, take half of the night, depending on when his/her classes are scheduled the next day. We don't have to worry about getting them to and from Lick Observatory, and having them miss classes. We have had undergraduate students take a lot of data with the Lick Nickel and Shane telescopes. The remote observing room also allows more undergraduates, graduate students, and postdocs to help with Keck observations, since we don't have to spend a lot of money (and time) flying them out to Hawaii. The amount of effective mentorship of students has thus increased.

At the Lick Observatory Visitor's Center, I have had the opportunity to conduct significant **public outreach** by speaking once per year for the summer visitor's program, and on some other special occasions.

The Lick and Keck Observatories have been useful for my private **fundraising** efforts: I have taken various potential donors with me on observing runs, showing them how we obtain real data with the telescopes. They have been impressed with the facilities and in some cases have already donated substantial funds. I expect other such contributions in the future; it takes time to develop meaningful relationships with potential donors.

Much public outreach and education is done at Lick. Although only a minority of UC faculty now use Lick Observatory, it is important to certain faculty and other researchers, for some or all of the above reasons. A useful comparison can be made with a single, specific Keck instrument: it is generally used by only a minority of UC faculty, yet we understand its value and contribution to our overall astronomical enterprise.

Kim Griest, UCSD

Even though I mostly work as a theorist **I ask all my students to train at Lick so they understand modern astronomical data. This makes them much more valuable as scientists and helps them get good jobs at top research institutions.**

Aaron Barth, UC Irvine

The **summer visitor programs at Lick Observatory** have been an absolutely outstanding way to connect with an audience of Californians who are excited about both the science done in UC and the historical aspects of Lick Observatory. Speaking to these audiences and meeting with visitors to Lick is always one of the high points of my summers.

Sandra Faber, UCSC

UCO facilities provide world-leading data in astronomy, a subject that entrances the public imagination. Astronomical leaders have the privilege of automatically being catapulted into the public eye. It has been extremely rewarding to have a second career in becoming a public spokesperson on behalf of astronomy and UC.

David Koo, UCSC

UCO facilities also helped me to initiate the NSF Science and Technology proposals from UCSC that led to the Center for Adaptive Optics.

Tammy Smecker-Hane, UC Irvine

Access to Lick Observatory has been critical for the development of my graduate students and postdocs, too. Of my last three Ph D students, one used combined Lick and Keck observations, one solely used Keck observations, and one used observations at another US national observatory. My last two post-doctoral students routinely used Lick to pursue independent research projects that were key to developing their professional portfolio and attracting subsequent job offers.

Michael Gregg, LLNL

A**ccess to UCO facilities has played an important part in obtaining both time with the Hubble Space Telescope and also funding from the National Science Foundation.** In grant and observing proposals, I invariably make a case that original or supporting observations can be carried out with UCO telescopes and instrumentation. **Because of the preferred access to UCO facilities that UC researchers enjoy, it is a much more powerful argument [in grant proposals] than promising to carry out observations with national observatory facilities. This gives UC researchers a significant advantage in proposing for funding and space-based observatory time.**

Malkan, Matthew, UCLA

Observing at Keck and Lick observatories, and working with the data they produced, has generated unique educational opportunities for hundreds of students I've mentored, either one-on-one or in small groups (from high school, to college and graduate school, in the physical sciences, and in other areas of studies as well). **Many of these students have now gone on to highly successful careers as leaders in astrophysics, and other sciences.**

If we include the chance to explain the science of astronomy to the wider public through the mass media in a broad definition of 'outreach', then **UCO facilities played the staring role in almost all of my successful science advocacy efforts in newspapers, magazines, radio, film and TV.** Although the amount of science communicated in these efforts was of course far smaller than in the direct work with students, the total number of people who saw it has been in the millions.

James Bullock, UCLA

Our access to Keck and other facilities also **helps us to attract great students and (importantly) independently supported postdocs, who bring their prestigious fellowships here partly because of the access we have.**

I recently supervised a PhD thesis of a student who wanted to do pure observational work, and my access to Keck allowed me to do this. This student (Erik Tollerud) ended up being the best student I have worked with in my career, and he ended up getting a Hubble Fellowship based on the Keck-DEIMOS observational work he did here. He is well on track to be a successful, impactful scientist -- all because of the facility access we had here.

Brian Siana, UC Riverside

…Most importantly, initial investigations with Keck have been used to obtain data and money from the Hubble Space Telescope, resulting in ~$600k in funds over the last four years.

The Keck observatory is enormously important in training the next generation of astronomers on state-of-the-art instrumentation. Furthermore, the high profile research has resulted in a large number of requests for public talks.

Elinor Gates, UCSC

The opportunities to do **public education and outreach** are extensive as part of my career at UCO. I help plan the public summer programs at Lick Observatory and design new outreach opportunities, such as the Lick Observatory Teacher's Institute. I also host tours of the facility for college classes and other groups as well as train volunteers to assist with all our public programs. My goals for teaching are also satisfied by the planning and teaching of the graduate student Observational Astronomy Workshop. Public education, both in California and beyond, is enhanced by the film crews that I have hosted that create documentaries about astronomy and the research done at Lick that are filmed at Mt. Hamilton.

The accessibility of the Mt. Hamilton facilities to the public and UC community for education and research at all levels is unparalleled. The ability to do hands-on observing training for undergraduate and graduate students with a large variety of instruments, or host talks for the general public, or try new types of instrumentation on the Shane and Nickel telescopes, in one facility is really remarkable and I'm often participating in any of these listed activities for a breadth of experience that I don't think I could have gotten anywhere else.

The accessibility of Lick Observatory's telescopes to researchers and students throughout UC is enhanced with the remote operations capabilities. The Nickel telescope, in particular, can be used by undergraduates from their home campus to get experience with modern telescopes and instruments that is hard to achieve anywhere else. **Having a shared UC astronomical facility, e.g. Lick Observatory on Mount Hamilton, gives students and researchers access to better telescopes and instruments than would otherwise be**

possible and opens up modes of observation, such as time domain astronomy, that are simply not possible with the national telescopes or the largest telescopes (e.g. Keck).

David Tytler, UCSD

Delighted with the remote observing capability that I have used with great success for teaching. Have used data from Keck to mentor many undergraduates and graduate students.

Naveen Reddy, UC Riverside

As mentioned above, aside from the necessity of Keck to my research, the access to Keck has enabled us to attract some of the top graduate students and postdocs. **It also gives us, as faculty, and the students, a large amount of visibility throughout the international astronomical community.**

Jean Turner, UCLA

An aspect of teaching that is very important to me is the broadening of the field to include underrepresented minorities, people who do not have easy access to higher education or even to the idea of advanced degrees. This used to be mostly women but now the underrepresented groups among young people are Latino or African-American, Native American or Pacific Islander. Working on Keck data has been an exciting way for these undergraduate and graduate students to get involved in the field at a very early stage. **I have had a number of students from underrepresented groups,** including female, Latino, Latino-Persian, Korean, and African-American students, most of whom have worked on Keck data, either on summer projects or as independent study projects. All of these students have gone on to graduate school in physics, astrophysics, or engineering. My current undergraduate student is African-American, and he is working on Keck data from NIRSPEC. His work has revealed a genius for analysis that will be instrumental in his getting to graduate school. Once these students get to graduate school, they are on the way to becoming role models for future generations of students like themselves. **This broadens the pool of scientists, good for science and good for a diverse state like California.**

It is obvious but bears mentioning that training Ph.D. scientists is good for California and for its economy. Among my former students are engineers, managers, faculty, and mission scientists. Without the facilities of UCO we would not be nearly as good at training students in cutting-edge science.

Imke de Pater, UC Berkeley

I have used research results in education, public outreach, etc. Have had a fair number of press releases, and newsworthy items over the years.

James Larkin, UCLA

Every one of my six graduate student PhD's have observed at Lick and Keck observatory and have used at least 75% of the available instruments at some point. This is crucial training and has allowed my two most recent graduate students win prize postdoctoral fellowships and in one case a recent professorship. I have given many public talks including those in K-12 institutions. All of those presentations involve my research and instrument development within the UCO facilities. I've hosted 6 REU students all of whom have depending on UCO facilities.

Bradford Holden, UCSC

The attraction of working with both Mt. Hamilton and Keck observatory attract high quality students and prize fellowship winning post-doctoral scientists. Because of the exciting of the data and facilities, I have been able to work with an advanced undergraduate (now working to become a science teacher in the local school system), multiple graduate students and a series of prize fellows.

The attraction of these facilities also means that I have given **public presentations** to local astronomy clubs and to undergraduate focused local universities.

Michael Jura, UCLA

From January 1, 2010, a total of $350k has been awarded to our research program.

Garth Illingworth, UCSC

I am very supportive of value of outreach. **Our facilities and research are largely publicly-funded and we have a broad responsibility to ensure that the public shares in the excitement of discoveries, and that we use this excitement to enhance interest in science education and to help strengthen support for science and technology education and R&D both within California and nationwide.** The enthusiasm of graduate students and undergraduates for carrying out research programs using data from a cutting edge facility, namely "the world's best optical telescope", has been very valuable for UC's visibility as a leading educational/research center. The excitement engendered by being involved at the forefront is infectious!

Dan Lubin, UCSD

The program I have just started, related to terrestrial climate change, should have significant societal impact beyond astrophysical research, in that it will help clarify the role of the Sun as compared with the known role of industrial greenhouse gas emissions in changing climate throughout the rest of the century. There has been much misinformation fed to the public from the climate change "skeptic" organizations, and rigorous science is necessary to help clarify the issue for the public.

The Mount Hamilton Visitor's Center is an excellent venue for public outreach and communication of science. I am currently working on material for public display there. **The Mount Hamilton staff is a very highly talented and dedicated team of professionals.**

David Lai, UCSD

In terms of outreach, in the past I have been involved in UC based summer programs for high school students. We were able to employ data taken directly with the Nickel telescope for some of the projects undertaken. This proved invaluable in giving the students a hands-on feel for the actual scientific discovery process.

Michael Cooper, UC Irvine

UCO facilities also form the focus of nearly all of my proposals for research funds.