MINUTES OF THE UCOAC MEETING
UC Santa Cruz, 17 May 2011

Attending: Mike Bolte (UCO Director; UCSC), Alex Filippenko (UCOAC Chair; UCB), Gabriela Canalizo (UCR), Gary Chanan (UCI), Burt Jones (UCSC), Lori Lubin (UCD, via polycom), Geoff Marcy (UCB, via polycom), Clair Max (UCSC), Ian McLean (UCLA), Jerry Nelson (UCSC), Mike Rich (UCLA), Tommaso Treu (UCSB, via polycom). Others (not UCOAC members) attending: Andrea Ghez (UCLA, via telephone), Franck Marchis (UCB, via telephone), Maureen McLean (UCSC), Connie Rockosi (UCSC), Paula Towle (UCSC), John Wareham (Lick Observatory), David Cowley (UCSC), various other people for parts of the meeting (e.g., Brad Holden, UCSC; Adam Burgasser, UCSD, via polycom).

Introduction: Alex Filippenko

Alex thanked the UCSC staff for making the meeting arrangements and everyone for attending. He said that there are a number of important issues, especially with the ongoing review of UC astronomy and astrophysics. UCOAC members should provide updates to their campus colleagues and discuss issues with them, bringing new matters to the attention of Alex and Mike.

UC Santa Cruz Campus Report: Mike Bolte

Gemini Planet Imager (GPI): GPI is the $20M high-contrast extreme AO imager commissioned for the Gemini-S telescope. The PI is Bruce Macintosh and the Project Scientist is James Graham. Assembly and integration in the "Highbay" at UCSC is going well. The last major component is a spectrometer from the UCLA IR lab.

Astronomical Coatings Lab: The upgrades to the tank, funded by NSF ATI, are almost done; the swing arm is completed, and the new pump and gate valve are ready for installation. Experiments with Solgel for broad-band antireflective coatings have been resumed and appear very promising with process controls leading to much more predictable results. For reflective silver-based coatings the quantum efficiency is as high as 80% down to 3400 Ang, and then drops precipitously at shorter wavelengths. Former UCO Director Joe Miller has been involved in these activities.

Shane Adaptive Optics (AO): Upgrades to the Shane 3-m AO system, funded with a $2M NSF MRI grant, have been slowed down by the unexpected death (in February 2011) of Chris Lockwood, an excellent and dedicated engineer who had worked on the Keck LRIS-R dewar, AO bench upgrades, NGAO, and the Shane AO. The IRCAL upgrade might get handed off to the UCLA IR Lab; this includes a new detector (Hawaii-2RG) in a LIRC refurbished dewar, improved mechanisms, and new readout electronics. The refurbished IRCAL will have a 20 arcsec field of view and will take well-sampled *J*-band spectra.

Richard Stover retirement: CCD expert and head of the UCO Detector Lab Richard Stover retired in February 2011, after several decades of outstanding service. An offer is out for a new detector specialist, although at a different level than Stover.

Nelson Award: There is a new award, the Jerry and Jocelyn Nelson Award for Innovation and Excellence, thanks to a generous gift from the Nelsons. The first recipient is Bob Kibrick, who has been absolutely crucial to UCO and has made many innovative advances to our observatories.

Lick Observatory Report: Mike Bolte

APF (Automatic Planet Finder) Update: The telescope and dome signoff occurred on December 4, 2010. The spectrometer was delivered in early January 2011, but there was a strut failure during shipping. However, disaster was averted through cautious planning, and there was a full review of the failure mode and structure; Matt Radovan did a great job. On April 12, the spectrometer was bolted to the telescope, and alignment was completed on May 11. A big team is working hard to get to the point where science can be done.

Lick Observatory (LO) Technology Development: We have several experiments underway at Lick: FIRST (Franck Marchis), a spatial heterodyne spectrometer (scanning interferometer), POLISH polarimeter (Sloane Wiktorowicz), and Villages (Laboratory for Adaptive Optics).

Mt. Hamilton Bandwidth Upgrade: A Mt. Hamilton microwave link has been established to the UCSC Extension building (UNEX), at 35 Mbits per second, nearly a factor of 4 better than the existing T1 links. The enhanced bandwidth will allow expanded remote use and enables live broadcasts for education and public outreach (EPO) programs. The project is being done with funding from Blue Oak Ranch ARI NSF, UCSC ITS, and UCO.

New Staff on Mt. Hamilton: New staff at Lick Observatory include Eric Kovaks, Pavi Zachary, Paul Lyman, Greg Sulger, and Dave Perrin.

Possible New IR Instrumentation at Lick: Adam Burgasser (UCSD), Mariska Kriek (UCB), Mike Fitzgerald (UCLA), and some colleagues have expressed interest in updated IR capabilities at Lick Observatory. The process is as follows: Persuade the UCOAC; partner with UCO (UCSC and UCLA) to develop a compelling proposal; submit the proposal to NSF MRI, ATI, NASA, and private donors to get funding; build and commission the instrument. For several reasons, UC Santa Cruz is a particularly good institution for NSF MRI submissions; however, if at least 20% of the work is to be done at another campus, that campus must submit an MRI proposal as well.

Adam Burgasser presented a white paper on Cerberus, a possible new infrared instrument for the Lick 3-m Shane telescope. He also described it via polycom. It would be a modern, highly capable replacement for the Gemini imager. The instrument concept has

two infrared imaging channels and an optical CCD channel; simultaneous imaging is achieved using dichroics. It also includes a moderate-resolution spectroscopic capability. UCOAC members evaluated the plan and will provide advice to Adam and his team.

Lick Observatory Security: The LO policeman is a UCSC position that was eliminated in the last round of budget cuts. There is now a contract with the Santa Clara Sheriff for temporary assignment of an officer. A number of security improvements are long overdue anyway and work has started. There has been good support from the UCOP and UCSC for studies and costs.

Public Outreach: We continue to get cuts in the LO operating budget. Analysis of the visitor counts showed very few on Monday through Wednesday; so, the open times have been reduced to Thursday through Sunday from October through May (still open all days June through September). The Visitor's Gallery at the Shane telescope is being improved, and there will be self-guided tour pamphlets. Gaby Canalizo is producing a bilingual presentation for the LO Main Building display.

Mt. Hamilton Lodging and Other News: The lodging rate for observers is staying the same, for now: $75 per night in the new dorm. But there is a new category for non-observers (e.g., film crews): $114/night. There is also a "hostel" rate for hostel-like services in the old dorm: $25/night (e.g., for participants in the annual Graduate Student Workshop, which will be held again in Fall 2011); regular observers are not eligible and wouldn't want to use the old dorm anyway, because it's noisy during the day. The exterior of the main building will be painted soon, funded through a gift.

Keck Observatory Report: Mike Bolte

Keck Impact: The impact of the Keck telescopes, measured through a combination of papers and citations, continues to lead the world on a per-telescope basis, among ground-based telescopes. (The Sloan Digital Sky Survey is excluded from comparison because it was a nationally available survey open to thousands of users.)

UC-Caltech Keck Agreement: Contrary to some rumors, the UC-Caltech agreement regarding Keck does not "expire" in 2018. The relevant text from the existing Agreement is as follows: "5. Term of Agreement. This Agreement shall begin as of the Effective Date and shall continue until it is terminated (i) pursuant to paragraph 15 as a result of the default of the Institutions, or (ii) by mutual agreement of the Institutions. The Institutions expect that this or any successor Agreement shall continue as long as the W. M. Keck Observatory is useful for astronomical purposes." Also relevant is the following: "6.1 UC Contributions and Obligations. 6.1.3.2 Post-March 31, 2018 Obligations. UC shall contribute to CARA, 50% of all W. M. Keck Observatory Net Expenses incurred by CARA after March 31, 2018. ('Net Expenses' means the total of CARAs Capital Expenses and Operating Expenses, after they are offset by all non-UC and non-Caltech contributions applied to pay for or reimburse for such expenses.)"

Laser Guide Star Adaptive Optics (LGSAO): A center launch telescope for Keck II would improve the AO performance. This project is supported by NSF MRI, and it has passed its preliminary design review. First light is planned for September 2011.

Keck I AO IR Tip-Tilt: This is supported by an NSF ATI grant; it dramatically increases sky coverage and improves Strehl by decreasing the contribution of tip-tilt errors, especially in the absence of an optically bright tip-tilt star. The System Design Review is scheduled.

TSIP Proposal: A TSIP proposal for KCWI (Keck Cosmic Web Imager; PI Chris Martin) and NIRES (Near IR Echellette Spectrograph; PI Keith Matthews) was submitted on September 17, 2010. It was divided as follows: 55% for KCWI Detailed Design phase and long-lead hardware purchases; 45% for the final phases of NIRES development and commissioning. The total was $2.25M, corresponding to 22 nights of telescope time. The KCWI part was approved, but the NIRES part was rejected, unfortunately.

KCWI: KCWI is an integral field spectrograph for Keck II at the Nasmyth mount, covering 0.35 to 1.0 μm and having considerable flexibility (field of view from 8" to 30" x 20"; selectable gratings R ~ 1,000 to 20,000). It is optimized for very low surface brightness targets and faint emission features, with high sensitivity (throughput > 25%) and precise sky subtraction.

UCO-UCSC is responsible for design and fabrication of the cameras. $2.4M has been secured from TSIP to date (via the two successful TSIP awards). Progress was slow until early 2011, but is now picking up; the Preliminary Design Review (PDR) is scheduled for June 15, 2011. The current cost to complete the project is $3.5M (beyond the two TSIP awards to date), and this will be updated at the PDR. Additional funds will need to be sought.

LRIS-R Upgrade Upgrade: The two new devices and cryostat are working fine, but some optimization is continuing. However, there are no spares. Possibly consider LBNL 4k x 4k device, or the Dark Energy Survey 2k x 4k spare devices.

Flexible Observing at Keck: A growing topic of discussion the past few years, highlighted at the October 2010 Strategic Planning meeting, is flexible observing at Keck. One clever idea for enabling Target of Opportunity (ToO) or cadence observing is to replace the Keck I tertiary with a deployable system. Seed money was requested and granted by the Keck Observatory for working out more detailed feasibility and cost estimates. Bolte would like to have this be part of a TSIP 2011 proposal if there is a call in 2011. A Fall 2011 ATI/MRI proposal is the other possibility.

Keck White Papers 2011: There was a call for "white papers" for new Keck instruments or upgrades. Eight white papers were submitted. The Keck SSC selected two proposals for improved red and blue throughput for DEIMOS and two concepts for more stable stellar radial velocity spectrometers.

The Future of TSIP: The President's FY12 budget had zero dollars for TSIP. Bolte, Keck Director Taft Armandroff, and Caltech Optical Observatories Director Shri Kulkarni have been in conversation with the NSF about a possible successor program.

The Future of ESI: ESI is the least used of the Keck instruments (roughly 20 nights/year). It costs about $100k/year to keep it ready for science, which isn't a huge amount but also is not negligible. There are some possible upgrades being considered such as an IFU, an R~12,000−15,000 mode, and an LBNL CCD. The decision of what to do with ESI has been tabled.

Keck Oversubscription: The Keck oversubscription rate is about 1.8 for each telescope, with some fluctuations and trends. The proposals tend not to be "padded" and are generally of very high quality, so deciding on which projects to approve is difficult.

Keck Advancement: The goals have been adjusted in the last year, although the pool of interested parties remains extraordinary. Astronomer participation is excellent; thanks to everyone who is helping.

NIRC2 Engineering Data: Franck Marchis, Mike Bolte

Marchis brought up the issue of whether NIRC2 Engineering Data should be released to the Keck community immediately. UCOAC members supported this idea, and Bolte will present it to the Keck SSC along with the UCOAC's recommendation.

UC Archive for all Keck and Lick Data: Brad Holden (and X. Prochaska, in abstentia)

Brad Holden discussed the possibility of having an archive for all UC Keck and Lick data, not just the Keck archive for a few of the existing instruments (e.g., HIRES). There are several goals: (i) Meet the requirements of new NSF guidelines; (ii) make the data easily accessible and provide long-term backup; (iii) instrument performance monitoring; (iv) semi-automated data reduction; (v) reduce duplication effort within UC; (vi) host surveys; and (viii) future archive-based science. The minimal requirements are to include a search capability, proper assignment of files to the observing program, and access control (restrict data and headers to a specific list of users that can be easily modified by the PIs and/or system administrators. The current Lick archive provides a list of files by date, telescope, and instrument (no search capabilities); the data are grouped by the observing run. Only the PI can access the files, and the data never go public. There are several possible new archive models and policy choices that will need to be evaluated and discussed.

UCOAC members were generally, though not unanimously, supportive of the idea. However, questions remain regarding the length of the proprietary period (currently 18 months for HIRES data) and a few other issues. It was decided that a survey will be taken of UC astronomers, much like the one a few years ago before the Keck archive was implemented. The results of the survey will be discussed at the next UCOAC meeting, with the hope of making a decision then.

UCLA IR Lab Update: Ian McLean

Currently there are four main projects, as follows.

(1) MOSFIRE, a 0.97−2.45 micron camera and multi-object spectrograph for the Keck Observatory. PI Ian McLean. It passed the pre-ship review in April. Will be shipped to Hawaii in mid-June.

(2) GPI, a 1−2.5 micron extreme AO camera and integral field spectrograph for the Gemini South 8-m telescope. The overall PI is Bruce Macintosh (LLNL); James Larkin (UCLA) is the PI for the infrared spectrograph. It is almost ready for the pre-ship review, and will be shipped to UCSC very soon.

(3) IRIS, a 1−2.5 micron AO camera and integral field spectrograph for the TMT. PI James Larkin (UCLA); Co-PI Anna Moore (Caltech). It is in the conceptual design phase; hope to start the preliminary design review phase this year (2011).

(4) FLITECAM, a 1−5 micron camera and grism spectrometer for NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA). PI Ian McLean. The pre-ship review will be in June. The first flights on SOFIA are scheduled for August 2011.

So, in summary, three major projects are coming to an end (MOSFIRE, GPI, FLITECAM). But support is still needed for previous instruments (NIRSPEC, NIRC2, and OSIRIS at Keck; Gemini is still in use at Lick, despite having been complete in 1993). For the future: IRIS is ongoing, but the limited budget is a major restriction to progress. Proposed instruments include a polarization upgrade for NIRC2 (Mike Fitzgerald), a grating upgrade for OSIRIS (James Larkin), and detector upgrades for NIRSPEC (Ian McLean). IR lab people have met with Sean Adkins at Keck on concepts for NGAO/DAVINCI. They also met with Connie Rockosi to discuss their support of the IRCAL upgrade, and with Adam Burgasser in support of Cerberus. The concern is that the UCLA IR Lab lacks a major project with sufficient funding to retain technical staff; previously there were 12 FTE, but now only 8. FY2012 will be challenging.

TMT Update: Mike Bolte

Permits: There was another round of public hearings in December 2010. There was a Board of Land and Natural Resources hearing on February 25, 2011, and the TMT permit was granted. However, a "Contested case" was also granted and is proceeding.

Reviews and Capital Costs: The project has had many detailed, extensive, and invasive reviews involving external panels drawn from observatories and major science projects throughout the world: Conceptual Design, May 2006; Cost Review, September 2006; Revised CDR and construction proposal review, June 2007; External Advisory Panel Review, September 2008; NSF GSMT Community Assessment Review, May 2009;

External Advisory Panel Review, May 2010; TMT Cost Review, January 2011. There have also been many additional reviews of major subsystems.

The capital cost of the project is now known pretty accurately: $1.152B (FY2011), including 26.2% contingency. These numbers take into account the recommendations of the January 2011 Cost Review, and they utilize a detailed schedule and "basket of commodities" escalators. The cost estimate includes the telescope, dome, associated support facilities, headquarters, three instruments, and a 120 nm wave-front error (WFE) AO system.

The January 2011 Cost Review went in great detail through the costing methodologies, cost estimate of all subsystems and contingencies and risks. It looked at trends in contingency vs. the fraction completed, for previous big projects; TMT is on the conservative extreme of the envelope. A meeting has been set up for early June between UCSB Chancellor and TMT Board Chair Yang, the TMT Project Manager, the Chair of the TMT Cost Review Committee (Jay Marx from LIGO) the UC-Astronomy Task Force and representatives from the UCOP Office of Research to review again the costing issues.

Note that Keck 1 had a cost overrun of 7%, but Keck 2 was under budget by 12%.

Operations Costs: The TMT operations costs are estimated to be $24.8M/year. In addition, new capabilities will cost $21M/year; these include "Science Requirements Document " instrument suite, an adaptive secondary mirror, and 85 nm WFE AO upgrade. The likely Board policy will be to obligate all partners (total) to $24.8M/year operations plus $12M/year development. This provides guaranteed funding for significant new capabilities and opportunities for partners to step up with new funds and rebalancing of telescope-time shares.

The above estimate of operations costs is based on an "enhanced," "corrected" Keck model: a task-by-task, person-by-person comparison with Keck, enhanced services for science operations, and corrected for shortcomings in the Keck model. The bottom-up estimate is coming in very close to the Keck comparison. There will be another major review on June 27−29. What about "10% of capital costs" rule of thumb? Although this figure is often brought up as a benchmark, modern observatories tend to run for significantly less and many of the costs associated with operating an observatory do not scale with telescope aperture (and therefore capital cost). Keck operations are <5% of the capital costs.

UC Share of TMT: The current partnership principle regarding shares is based on contributions to capital, contributions to operations for the first 20 years, contributions to new capabilities for the first 20 years, and an early-funding premium factor. 18−19% is the currently expected UC share for the first 20 years assuming $175M capital contribution, $6.5M/year operations = 18% of $36.8M/year (which is equal to the Keck "savings" post 2018), and a 5% premium factor. We may also have community access if NSF becomes a partner.

Partnerships: This remains a major focus of the Board. In addition to Caltech and UC, a Memorandum of Understanding (MoU) has been signed by Canada, Japan, China, and India. The work-share matrix has nearly been completed; legal agreements and corporate structure documents are in progress. The plan is to submit coordinated proposals by March 2012. NSF remains a wildcard.

Quite sensibly, China and India want to build a community of observers. One approach is to establish a vigorous program of scientific and technical exchanges and collaborations involving UC astronomers, as well as use of the Lick and Keck facilities. For example, Bolte has a Lick 3-m program with Gang Zhao, and WFOS/MOBIE engineers will visit UC Santa Cruz.

UCO Review: Mike Bolte

It has been 10 years since the last UCO review. The UC Office of the President (UCOP) established a two-committee structure: the UC-ATF (Astronomy Task Force), and a UCO Visiting Committee.

The charge to the UC-ATF, chaired by Geoff Marcy, is as follows. (1) Lead a system-wide planning effort, through one or more workshops, with broad input from the UC astronomy and astrophysics community. The effort should prioritize both current and future infrastructure needs for creating future science and education opportunities for UC. (2) Assemble a short list of the anticipated major new investments needed to support these prioritized opportunities and shared facilities in the next decade. This should include estimates of the costs, both capital investment and ongoing operations, to the extent possible today. (3) Produce, in June 2011, a report on the recommendations for the highest priority investments in facilities, operations, and other activities, with a broad astrophysics perspective on what will best serve the ten-campus UC system for research and education. (4) Propose a mechanism for ongoing assessment of future priorities by the full UC astrophysics community and for continuing accountability to the Office of the President.

Geoff Marcy and Andrea Ghez reported on the UC-ATF and its progress thus far; see below.

The UCO Visiting Committee roster is as follows. Robert Kennicutt, Chair (Institute of Astronomy, Cambridge University), Charles Alcock (Harvard-Smithsonian Center for Astrophysics), Roger Blandford (Kavli Institute for Particle Astrophysics and Cosmology, Stanford University), John E. Carlstrom (Kavli Insitute for Cosmological Physics, University of Chicago), Rolf Kudritzki (Institute for Astronomy, University of Hawaii), Marcia Rieke (University of Arizona), Anneila Sargent (Caltech), Robert Williams (Space Telescope Science Institute), and Sidney Wolff (LSST Corporation).

The charge to the UCO Visiting Committee is as follows. (1) Review the management of the UC Observatories and advise on how effectively UCO fulfills its stated mission, meets its goals, manages its operations, and responds to or helps set system-wide

priorities in astronomy and astrophysics research. (2) Assess the quality and performance of the UC Observatories, its current programs, collaborations, facilities, and accomplishments. (3) Assess the process by which the UC astronomy and astrophysics research community determines system-wide priorities. Evaluate how UC invests system-wide funding to address these priorities, and how well this current investment addresses UC's needs. Review and recommend an optimal way for UC to determine system-wide priorities for astronomy and astrophysics research across the multi-campus system, and how it may invest system-wide funding to address these priorities. (4) Assess the likely future requirements for UC investment in astronomy and astrophysics in the next decade and advise on what combination of resources, facilities, and funding structures will be needed to meet these requirements.

UC-ATF Report: Geoff Marcy, Andrea Ghez

Geoff Marcy summarized the charge to the UC-ATF and the UCO Visiting Committee, as given above.

The UC-ATF has 14 members: G. Marcy (UCB, Chair), S. Furlanetto (UCLA), E. Quataert (UCB), T. Tyson (UCD), C. Max (UCSC), A. Ghez (UCLA), B. Mobasher (UCR), C. Rockosi (UCSC), J. Bloom (UCB), D. Schlegel (LBNL), D. Tytler (UCSD), I. McLean (UCLA), J. Bullock (UCI), and T. Treu (UCSB).

The UC-ATF conducted a survey of UC astronomers. This was done primarily by Rebecca Stanek-Rykoff and Emily Rader (UCOP), Andrea Ghez (UCLA), Connie Rockosi (UCSC), and Tommaso Treu (UCSB). 91 responses were received (roughly a 34% response rate), from all campuses except UCSF and UC Merced. 88% of the responses were from senior researchers and tenured faculty.

TMT and Keck were identified as a priority by 90% of the respondents, followed by optical/IR instrumentation (71%), Lick Observatory (41%), LSST (20%), computational facilities (16%), and radio astronomy (11%). Furthermore, TMT and Keck were identified as the top priorities (with roughly equal weight). Within optical/IR instrumentation, there was roughly equal support for the UCSC/optical and UCLA/IR labs, and strong support for adaptive optics.

There is a broad spectrum of science priorities that can be addressed with common facilities. The main areas identified were galaxy evolution, exoplanets, and cosmology, followed by supermassive black holes, star and planet formation, and the solar system. Current UC science achievements enabled by Keck, Keck instruments, adaptive optics, and Mt Hamilton/Lick, in descending order, are as follows: exoplanets, Galactic center, dark energy, high-redshift galaxies and quasars, UC/UCO community, cosmic microwave background, supernovae and gamma-ray bursts, D/H ratio, the era of reionization, and planetary science. Current UC technical achievements enabled by system-wide support and association with National Labs are as follows, in descending order: Keck telescopes, adaptive optics, instrumentation (unspecified), and radio/mm interferometry.

The main conclusion regarding the past is that the key enablers for the main achievements of UC astronomers have been the following. (i) Science: Keck and Lick, instrumentation, and adaptive optics. (ii) Technical: system-wide support of large-scale innovative programs, association with National Labs (LBNL and LLNL), and excellent people. Of overarching importance is the interplay between the intellectual environment, shared facilities, and technological leadership.

The main conclusion regarding the future is that there is strong support for TMT, Keck, optical/IR instrumentation, and Lick. The key enablers for future achievement are (i) investment in large telescopes, (ii) a strong instrumentation program, and (iii) effective system-wide interplay between intellectual environment, shared facilities, collaborations, and technological leadership.

UCO Self-Study: Mike Bolte

UCO is preparing a major self-study for the Visiting Committee. This is actually quite useful for taking a snapshot of activities and budgets, and looking ahead to the next five to ten years. Bolte would like to involve the UCOAC, but exactly how to do so is not yet clear.

Bolte discussed the UCO budget, which is $7.48M/year from UCOP plus $0.56M/year UCSC facilities (Mt. Hamilton), plus recharges from various contracts ($0.774M in FY2010, for example). Lick Observatory (Mt. Hamilton) costs about $1.1M/year, excluding the $0.56M/year from the UCSC campus for facilities.

Bolte summarized the UCO Keck in-kind contributions. These consist of the following: (i) academic staff and faculty do not charge time to Keck projects, (ii) “warranty” on UCO-delivered instruments with associated support [examples: CCD support, DEIMOS, flexure-compensation system, slit-mask software, remote diagnosis of all hardware and software problems including upgrades, split cost for many repair missions (Keck hard costs, UCO salary costs)], (iii) reviews, (iv) cost-capped projects, and (v) proposal preparation support. Time-card data are easy to generate and accurate, but other level-of-effort estimates are less accurate.

Regarding instrumentation and UCO, it is clear that new capabilities are required to stay out in front, but building quality instruments for 10 m telescopes is challenging. Although the infrastructure is increasingly dated, UCO has built a program that is first-rate at designing and delivering 10 m instruments and major upgrades. Lick Observatory (Mt. Hamilton) is also remaining scientifically productive and a number of younger faculty are interested in pursuing new IR instruments.

The peak of the Keck instrument era was a few years ago but is not over: (i) UCO is doing the red and blue camera design and construction for KCWI; (ii) a deployable tertiary for rapid deployment of instruments on Keck 1 is next on the SSC priority list; (iii) SHREK; (iv) for NGAO, the UCO LAO is absolutely key; (v) there will be major detector upgrades for IR and optical instruments; (vi) with MOSFIRE commissioned,

NIRSPEC2 will be optimized for high-resolution 1-5 μm work; (vii) a multi-object, wide-field, R ~ 15,000 spectrometer might be built; and (viii) other possible projects (there are many ideas being considered in the Keck astronomical community).

With a significant effort and some expenditure of resources, two TMT first-light instruments are being led out of UC. The total budget is $90M for the combined WFOS and IRIS, but both projects have been very underfunded thus far. We are currently not able to fully carry out the design and fabrication; TMT funding will solve the personnel problem, but infrastructure updating is more difficult. There will be intense competition among the partners for second-generation instruments; excellence and experience are two important factors to our advantage.

Bolte discussed the governance of UCO. Advisory committees are crucial to UCO and UC astronomy: (i) Time Allocation Committees make the decisions regarding Lick and Keck time; (ii) policy decisions are made by the UCOAC; (iii) future directions are discussed in detail and extensively in the UCOAC; (iv) the Keck SSC and TMT SAC are the deciding bodies for Keck and TMT scientific priorities and strategic plans; and (v) ad hoc committees set up as required. The Director's office is responsible for implementing the consensus wishes of the community. Overall, it is a good system.

There is clear synergy between Keck and TMT. The Keck-TMT combination on Mauna Kea will be extremely powerful: science programs, technology programs, and workforce. Keck provides pathfinder science and technologies; AO is the key example. There will be complementary capabilities: wider-field science at Keck, large programs at Keck, high-performance AO. The anticipated timescale is for TMT first light to be in 2019, and fully instrumented by around 2029.

What will be the role of Lick Observatory (Mt. Hamilton) in the TMT era, with a transition in the next 5-10 years? We would like to find a partner or endowment for the public outreach program and establish a K-12 component. The Barth et al. active galactic nuclei reverberation mapping program, Filippenko's long-term supernova studies, Marcy's exoplanet work and (more recently) the Kepler exoplanet program, and other major or long-term projects demonstrate the potential science value of owning a facility. We currently have four instrument-demonstration programs underway. Remote access and robotic facilities can be very cost effective for research and undergraduate/graduate education programs.

Some final concluding themes: The Lick and Keck Observatories are the laboratory facilities for astronomy and astrophysics in the UC system. There are great efficiencies in centralizing the resource, and by combining 10-campus resources we can work at the world-class level. However, centralization of the astronomy and astrophysics resources makes them stand out in a budgetary sense and reduces any one campus's sense of ownership; this puts a target on the back of UCO central funding, and diminishes the apparent support for the endeavor. It is essential to get the context right! UCO expenditures always need to be justified in the context of the system-wide University, but subtle linkages are important and the efficiencies of a centralized program mean there

will be a center of weight and activities for UCO. We have a great investment in physical and *human* capital, and by all of the standards usually applied to academic programs the payoff has been outstanding. Let's "make no small plans"; we can take the example of the Keck Observatory as a model for the future.

The open meeting was adjourned at 4 pm, and an Executive Session was held.

These minutes were provided by UCOAC Chair Alex Filippenko.