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## Currents

### In this Issue...

**Outlook** ([NOAO at the Science Frontiers of New Worlds, New Horizons](#)): NOAO Director David Silva discusses the role of NOAO in enabling scientific leadership by the US community in the decade ahead. **We have created an [on-line forum to enable community discussion on this topic](#)**. We look forward to hearing from you!

**KPNO Director Search** ([Timothy Beers to Head Kitt Peak National Observatory](#)): Dr. Timothy C. Beers will join NOAO as the Associate Director for the Kitt Peak National Observatory, beginning 10 October. Beers brings to the position a broad array of experience and an international reputation for leadership.

**ReSTAR Phase 2 Update** ([Proposals Received and Reviewed](#)): NOAO received 16 proposals in response to the open solicitation for partners to collaborate on the second phase of ReSTAR activities that will strengthen the smaller aperture component of the US System. The proposals have been reviewed and NOAO is working with selected proposers in writing a funding proposal to AST/NSF.

**Blanco and Mayall LSPs** ([NOAO Community Workshops on DECam and BigBOSS](#)): NOAO is hosting community workshops on DECam (**18-19 August**) and BigBOSS (**13-14 September**), instruments that are coming to the Blanco and Mayall 4-m telescopes as part of their respective Large Science Programs. The workshops are opportunities for interested NOAO community members to provide input to NOAO on community aspirations for science with these instruments and their priorities for instrument capabilities and data pipelines.

**LSST Update** ([LSST Science Collaboration Applications Invited](#)): All interested members of the US community are invited to participate in shaping the science of the LSST through membership in LSST Science Collaborations. Applicants may request to join an existing collaboration or propose to form a new collaboration. The application deadline is **14 October**. Those proposing to form a new collaboration are asked to submit by **16 September** a letter of intent to apply.

Your input is welcome on any of these issues. Please send your thoughts to [currents@noao.edu](mailto:currents@noao.edu).

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## NOAO at the Science Frontiers of New Worlds, New Horizons

by David Silva, NOAO Director

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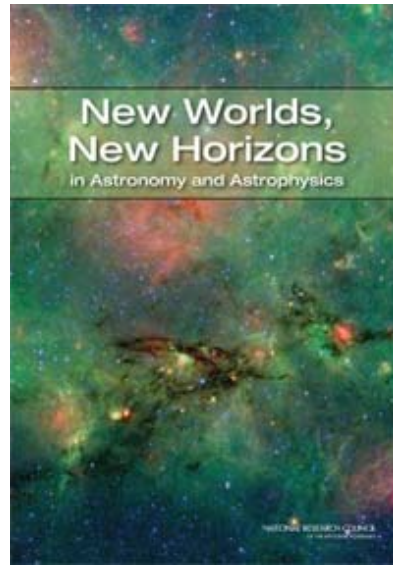
We welcome your thoughts on any aspect of this article, including your views on questions such as:

- What are our major challenges in the coming decade? (Either those of NOAO specifically or the US community in general.)
- Are we addressing these questions from the right point of view?
- What is your highest priority in the coming decade? (Or what should NOAO's priorities be?)
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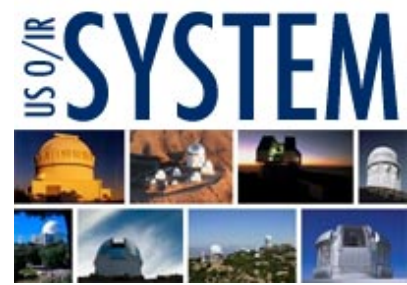
To enable community discussion, we have created an [on-line forum](#). Comments entered there will be posted immediately. Comments sent to [currents@noao.edu](mailto:currents@noao.edu) will not be posted unless requested. We look forward to hearing from you!

The upcoming [NSF Astronomy Portfolio Review](#) will use the 2010 Decadal Survey report, [New Worlds, New Horizons in Astronomy and Astrophysics](#) (NWNH), as a guide in making decisions about NSF strategic investment over the next 10 years. In particular, the NSF review seeks to determine "...the critical capabilities needed to make progress..." at the NWNH Science Frontiers as well as "...what combination of new facilities and programs plus existing – but evolved – facilities and programs will best deliver those capabilities within strict budgetary constraints".

How does the current [NOAO Long-Range Plan](#) (LRP) measure up? Our LRP describes how NOAO and the research community it serves will have major leadership roles over the next 5 years and beyond in providing, operating and utilizing unique capabilities and facilities for the three NWNH Science Objectives: Cosmic Dawn, New Worlds, and Physics of the Universe. These concepts and designs are the result of decade-long planning and optimization, completed in concert with NSF support and community input from a wide variety of sources including the [ReSTAR](#) (Renewing Small Telescopes for Astronomical Research), [ALTAIR](#) (Access to Large Telescopes for Astronomical Instruction and Research), and [Future of NOAO](#) committees. Indeed, because of that close engagement with the community-at-large and NSF, NOAO is now well positioned to provide and enable scientific leadership in the decade ahead.



## NOAO and the O/IR System Today



Today, NSF MPS Astronomy invests directly [about \\$60M](#) in the [US OIR System](#) through NOAO, Gemini, Telescope System Instrumentation Program (TSIP), and a variety of other programs (e.g., new facility design and development, Sloan-III research programs). Additional investment comes from the NSF Astronomy grants program. The NSF investment leverages a large investment of non-NSF funding

from private, state, national and international sources (e.g., partnerships such as WIYN, SOAR, Gemini, Keck, and LSST, to name only a few). As a result, it enhances a world-best OIR system and enables a rich scientific harvest in terms of highly cited breakthrough papers (e.g., the accelerating universe), number of papers published, number of early career scientists supported, and levels the playing field for all qualified researchers through open access. An increased emphasis on large, rich, open survey datasets in the years ahead can only improve that return-on-investment, as foreshadowed by the [enormous scientific return-on-investment](#) from the Sloan Digital Sky Survey (SDSS).

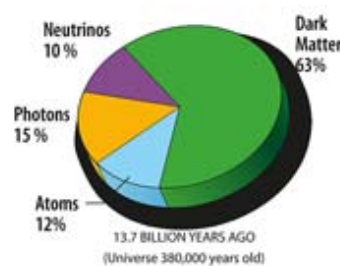
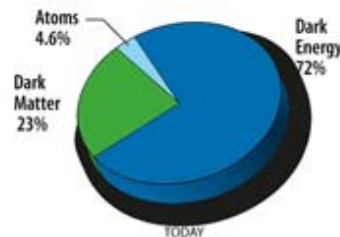
Enabled by NSF investment, NOAO, Gemini, and other US OIR System facilities provide access via peer review to more than 1500 scientists per year from small undergraduate teaching colleges, large public and private universities, and major DOE and NASA centers. The Dark Energy Survey (DES), the Big Baryonic Oscillation Spectroscopic Survey (BigBOSS), and the Large Synoptic Survey Telescope (LSST) Science Collaborations have or will engage hundreds more researchers, many from the US and international physics communities. As an ensemble, this research community is extraordinarily diverse, reaching all of the groups considered to be under-represented in the allied STEM fields by NSF, especially during the critical early-year phases when young scientists are establishing their independence and preparing to compete in the academic or commercial marketplace for jobs.

### Key areas of scientific leadership: 2020

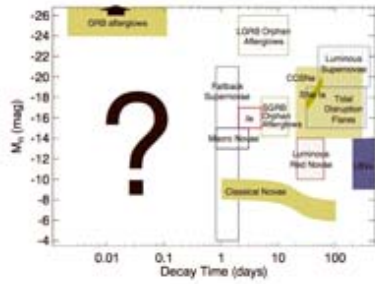
Cost-efficient stewardship of previous Federal investment, broad and open engagement with the community-at-large, and building on past success while embracing new scientific frontiers have well prepared NOAO to lead and to enable scientific leadership in the decade ahead. It is no accident that the NOAO Long-Range Plan is already well aligned with NWNH. It is a result of close engagement over many years with an active community of researchers at the scientific frontiers.

**The characterization of dark energy and dark matter in the early universe** will more accurately constrain the development of structure, the essential precursor to formation of galaxies and all that they contain. Over time, NOAO scientists and facilities have played fundamental roles in the discovery of “missing mass” in stellar systems, giant luminous arcs in clusters, the accelerating universe, and hence the roles of dark matter and dark energy in the evolution and mass-energy budget of the universe. From that foundation comes our current scientific and technical involvement in three major new surveys: the [DES](#) at the Blanco 4-m (2012 – 2017), [BigBOSS](#) at the Mayall 4-m (2017 – 2021), and [LSST](#) (2019 – 2028). These surveys will provide the community with the essential data foreseen in NWNH and other national planning reviews, such as the [DOE HEPAP Particle Astrophysics Scientific Assessment Group](#) and the NASA [Beyond Einstein: From Big Bang to Black Holes](#)

reviews. Given likely launch delays in ESA’s Euclid and NASA’s WFIRST, DES and BigBOSS will be the foremost dark energy characterization experiments of this decade. They will also provide massive, rich, open datasets for investigating a host of modern problems in astrophysics by a large research community beyond the parent DES, BigBOSS, and LSST science collaborations.



WMAP constraints on the content of the Universe (credit: NASA/WMAP Science Team)



Discovery space for cosmic transients (from The LSST Science Book, adapted from Rau 2008).

Among other things, the **exploration and characterization of the time domain** will catalog the vast majority of asteroids potentially hazardous to life on Earth, reveal new classes of exploding stars, detect numerous microlensing events throughout the Local Group, and find rare events such as stellar disruptions by central black holes in distant galaxies. NOAO and Gemini facilities are already heavily used for follow-up observations of time-variable objects found by such facilities as SWIFT, Palomar Transient Factory, and Catalina Sky Survey. DES and

(dramatically) LSST will each increase the number of transient triggers and the pressure for follow-up support from 4-m and 8-m class facilities. Using lessons learned from today's projects, NOAO is leading the development of instruments and processes needed by community investigators for LSST follow-up observations using capabilities located throughout the US OIR System, both north and south of the equator. NOAO is also deeply involved in LSST science and technology development activities, again preparing for our role in supporting LSST operations and scientific exploitation towards the end of this decade.

**Exoplanet characterization and the study of their parent stars** will reveal the composition of exoplanet atmospheres and the extent of the habitable zones of their parent stars. The Gemini Planet Imager (GPI) will become available during this LRP period and will allow scientists to characterize dozens of Jovian class planets, through a combination of key projects and PI-class investigations. Meanwhile, the precise determination of the physical properties of hundreds of parent stars identified by NASA Kepler and other missions and surveys will be possible using the new generation of optical (Mayall/KOSMOS, Blanco/COSMOS, Gemini/GHOS) and near-IR (Gemini/FLAMINGOS-2, Blanco/TripleSpec) spectrographs that will be deployed during this LRP period.

**In-depth knowledge of the nature of stellar populations in our Milky Way and its numerous dwarf satellites** will be a major arena of exploration enabled by BigBOSS on the Mayall. As has been amply demonstrated by SDSS and the community exploitation of its stellar spectra (obtained during grey and bright time when the primary dark time project could not be executed), well-understood massive samples of medium-resolution spectra allow us to determine the basic parameters describing the stars (temperature, surface gravity, and metallicity), as well as characterize their  $[\alpha\text{-element}/\text{Fe}]$  and  $[\text{C}/\text{Fe}]$  ratios. An essentially unlimited number of interesting stellar targets from the SDSS and PanSTARRS photometric catalogs will already be in place in the era of BigBOSS. Accurate radial velocities from BigBOSS, coupled with exquisite parallax distances and proper motions to be obtained with the Gaia mission (which will not obtain radial velocities for stars fainter than 16th magnitude, while BigBOSS will be able to deliver quality spectra to fainter than 20th magnitude), will enable full space motions to be determined for truly enormous numbers of stars. This powerful combination of six-dimensional phase-space



Milky Way over CTIO. (Credit: K. Don & NOAO/AURA/NSF)

information with chemical abundances, sometimes referred to as Galactic Archaeology, will provide detailed knowledge of the early stages of galaxy formation and chemical evolution at a level of detail not approachable by any other means.

These scientific opportunities will be enabled by well-established scientific and technological collaborations between NOAO and university-based groups (e.g. Ohio State, Cornell, our WIYN, SOAR, and SMARTS partners, etc.), other US-led observatories (e.g. Gemini, Keck, and other operators of 3 – 10-m class telescopes), other US national science centers (Fermi National Accelerator Laboratory, Lawrence Berkeley National Laboratory, National Center for Supercomputing Applications, SLAC), foreign institutions (e.g. Laboratório Nacional de Astrofísica, Brazil), major international science collaborations (e.g., LSST, DES, BigBOSS) and – especially – our dynamic and world-leading user community.

Finally, experience teaches us a fundamental lesson. **Unknown unknowns**, sudden and unexpected breakthroughs, sometimes called [black swans](#) – impossible to predict but often the most important – will emerge in the coming decade. The discovery of the ubiquitous presence of dark matter and dark energy are the quintessential illustrations of this lesson. Because such discoveries are unpredictable, NOAO deploys excellent general-purpose instruments (including the Dark Energy Camera and the BigBOSS instrument) and then through an open access process unleashes creative minds to use those instruments for exploration. A strong national observatory dedicated to open-access research and affiliated with other strong US-dominated facilities such as Gemini maximizes the likelihood that the right mind, regardless of who they are or where they work, will connect to the right capability to make those big leaps forward.

### **NOAO and the US O/IR System tomorrow**

NOAO embraces the strong evolution implied by NWNH as necessary to maintain scientific leadership within constrained budgets. Indeed, our publicly available planning and implementation documents since the 2006 Senior Review have anticipated such evolution (e.g., the [Future of NOAO committee report](#)) and helped NOAO and the community it serves to prepare for continued scientific leadership as we move forward together.

By 2015, NOAO sees a strong US OIR national observatory that is organized around an LSST under construction, the US share of Gemini (at least 65%), and large survey machines at the Mayall and Blanco 4-m telescopes. Major, wide-field surveys at the Blanco, Mayall, and (by 2020) LSST will provide massive, rich data sets that can be used to address a broad range of research topics on an open-access basis. As also suggested by NWNH, NOAO believes that closer organizational ties between Gemini, NOAO, and LSST would minimize annual cost while maximizing scientific return-on-investment.

Through that enhanced national observatory, individual investigators and small teams would have access via peer review to more than 350 nights per year on 8-m class telescopes and more than 500 nights per year on 4-m class telescopes with a broad range of work horse instruments. While such access is independently valuable, it will also be important as a resource to interpret observations done at other wavelengths by other facilities. In many cases it will be impossible, without the OIR data, to develop a complete physical understanding of the observed phenomena.

That strong national observatory will not exist in isolation. It will be embedded within a strong US OIR System consisting of a broad range of non-Federal observatories from 3-m to 10-m in aperture. Continued Federal investment in instrumentation and community access to these facilities through ReSTAR and TSIP, as well as eventually the Mid-Scale Initiatives program recommended in the NWNH

report, would be a very cost-effective way to maintain US scientific leadership across a broad geographical landscape, especially when combined with investment from state governments, private foundations, and private individuals. This is especially true given the unfortunate possibility that the Giant Magellan Telescope (GMT), Thirty Meter Telescope (TMT), and James Webb Space Telescope projects will not reach scientific fruition until after 2020 and operations support for HST is currently uncertain beyond 2015.

The existing suite of capable workhorse instruments is being augmented in the next three years by world-leading capabilities including ultra-wide-field optical imaging (Blanco, WIYN), multi-object near-IR spectroscopy (LBT, Magellan, Keck, Gemini), ground-layer correction (LBT, SOAR), arc-minute scale adaptive optics imaging and multi-object spectroscopy (Gemini-S), and very high-Strehl, very high-contrast imaging (Gemini-S). Much of this investment has come from NSF, in whole or part.

### Towards a decade of excellence

Since the 2005-2006 Senior Review, NOAO has laid a strong foundation for leadership at the NWNH Science Frontiers through support from NSF and continuous engagement with a broad set of scientists in the national and international community. We look forward to a decade where NOAO, Gemini, and the rest of the US OIR System work together with an expanded research community as well as NSF and other funding sources to build on existing infrastructure in a cost effective manner to enable transformational science.



NOAO Long Range Plan cover

We welcome your thoughts on any aspect of this article, including your views on questions such as:

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### Timothy Beers to Head Kitt Peak National Observatory

Dr. Timothy C. Beers will join NOAO as the Associate Director for the Kitt Peak National Observatory (KPNO), beginning 10 October 2011. As Kitt Peak Director, Beers will be responsible for the suite of research facilities on Kitt Peak. These

include the Mayall 4-m telescope, the WIYN 3.6-m telescope, and several smaller facilities. Kitt Peak also hosts tenant observatories and provides services to several of them. In addition to these responsibilities, the Kitt Peak Director also works closely with the NOAO Director and the other Associate Directors in developing and implementing the NOAO strategic plan.

Beers brings to the position a broad array of experience and insight. He is currently University Distinguished Professor in the Department of Physics and Astronomy at Michigan State University as well as co-founder and Associate Director of the Joint Institute for Nuclear Astrophysics (JINA), an NSF-funded Physics Frontier Center that brings together the work of nuclear physicists and astronomers at MSU, the University of Notre Dame, and The University of Chicago.



Dr. Timothy C. Beers

Beers led JINA's participation in SEGUE: The Sloan Extension for Galactic Understanding and Exploration, a medium-resolution spectroscopic survey of 240,000 stars in the Galaxy, as well as the SEGUE-2 continuation of this program which obtained spectra for more than 120,000 additional stars. He and his group developed the stellar parameter estimation software pipeline for the survey, an effort that produced publicly-available abundance estimates for over 400,000 stars, a first for such large samples.

In announcing Beers' selection to the NOAO staff, NOAO Director David Silva commented, "Tim is an accomplished scientist with an international reputation for leadership. His enthusiasm and talent for working with large data sets will be a valuable asset as NOAO moves into the era of the Dark Energy Survey, Big Baryonic Oscillation Survey (BigBOSS), and the Large Synoptic Survey Telescope (LSST). At the same time, as a long-time user of facilities at Kitt Peak, Cerro Tololo and many other observatories, he understands the needs of individual investigators. Tim has been a tireless advocate for a strong national observatory in many venues, including as co-chair of the Future of NOAO committee in early 2009. He is joining NOAO at a moment of great opportunity."

Commenting on his new position, Beers added, "My very first observing run was riding the prime focus on the KPNO 4-m telescope, and I have had some 75 runs on NOAO telescopes in the years since. In that time I developed a deep-felt admiration for the efforts of the many people who strive to make NOAO the best it can possibly be, sometimes during periods of difficult budgetary constraints. As I look forward to working with the NOAO family, I know I will need to have the support of the entire US astronomical community to help take us all to an even brighter future."

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## **ReSTAR Phase 2 Proposals Received and Reviewed**

As reported in the [last issue of Currents](#), NOAO has been engaged in a selection process to identify collaborators for the second three-year phase of ReSTAR, our program to build a more capable and robust system of smaller aperture telescopes. The first phase of ReSTAR, funded at \$6.9M in FY09-10 by the NSF, is nearing completion. This successful program has provided three years of open access to the Palomar Hale 200-inch telescope, two modern optical spectrographs for the NOAO 4-

m telescopes, a near-infrared spectrograph for SOAR, and two instrument upgrades (new focal planes and controllers for Mosaic 1 at the Mayall, and the Hydra South fiber spectrograph at the Blanco).

Phase 2 of ReSTAR enhances community participation and concentrates on new facilities, operations modes, and capabilities that the US OIR community has not had open access to in the past.



Proposals were due 1 February, and NOAO received 16 proposals from individuals or groups that wished to collaborate. The diversity of ideas in the proposals was considerable: they included open access to facilities, instrumentation development, and improvements to or new features for existing instruments. Some respondents addressed bold new scientific opportunities in proposing new capabilities in areas such as wide-field infrared imaging and follow-up to time-domain discoveries. The budgets of all the proposals totaled about \$24M, demonstrating that there is no dearth of innovation or interest among the users and operators of the smaller aperture component of the US System.

The proposals were reviewed by a committee that included both NOAO staff and external members. The latter were drawn in large part from existing NOAO oversight or advisory committees, including the NOAO Users Committee and the ReSTAR committee. The committee forwarded their recommendations to the NOAO Director, who approved this suite of elements for Phase 2. NOAO is now working with each of the selected groups to create a composite proposal of approximately \$10M that will be submitted to the NSF in early FY12.

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## NOAO Community Workshops on DECam and BigBOSS

As previously announced via email, NOAO is hosting community workshops on DECam and BigBOSS, instruments that are coming to the Blanco and Mayall 4-m telescopes as part of their respective Large Survey Programs.

### Seeing the Big Picture

The [first workshop \(18-19 August 2011\)](#) focuses on [DECam](#), a high-performance prime-focus imager for the Blanco telescope at CTIO. It is being built as part of the Dark Energy Survey (DES) Project by the DES Consortium, a Fermilab-led collaboration of scientists from institutions in the US, UK, Spain and Brazil. A facility instrument, DECam will be available to the NOAO community starting in early 2012.



**Seeing the Big Picture**  
DECam Community Workshop  
18-19 August 2011, Tucson, AZ

The workshop provides an opportunity for interaction between the DECam collaboration and members of the NOAO community who are interested in using the instrument to further their science goals. The workshop discussions will give the DECam team an overview of the community interest in DECam, input that will be used in optimizing commissioning, operations and data reduction. The workshop is also an opportunity for prospective DECam users to meet and form collaborations based on their common or complementary interests.

Further details on the workshop are available at the [DECam workshop homepage](#), where presentations from the meeting will be archived for the benefit of those



unable to attend the workshop. Questions regarding the workshop may be directed to the organizing committee chair David James ([djj@ctio.noao.edu](mailto:djj@ctio.noao.edu)).

## Highly Multiplexed Spectroscopy with BigBOSS on the Mayall Telescope

The [BigBOSS workshop](#) will be held on **13-14 September 2011**. As described in [previous issues of Currents](#), [BigBOSS](#) is a highly-multiplexed, moderate resolution ( $R=5000$ ) spectrograph with broad wavelength coverage (3800-10600Å). It has the unique ability to provide simultaneous spectroscopic observations of up to 5000 targets spread over a three-degree diameter field of view. The instrument has been proposed for the Kitt Peak Mayall telescope by a large international collaboration that is led by the Lawrence Berkeley National Laboratory and includes 16 US institutions (universities and national laboratories) as well as international partners.



**Highly Multiplexed Spectroscopy with BigBOSS on the Mayall Telescope**  
13-14 September 2011, Tucson, AZ

In hosting the workshop, NOAO aims to understand the broader astrophysical impact of the proposed instrument and community aspirations for its use. The workshop will provide opportunities for the NOAO community to learn about the capabilities of the BigBOSS instrument; share their aspirations for the science they hope to do with it; and have an impact on the prioritization and preservation of instrument capabilities, observing modes and data pipeline deliverables. The workshop will also provide an opportunity for interested researchers to meet and form collaboration networks based on common interests in science projects with BigBOSS and to interact directly with members of the BigBOSS Collaboration.

For further details on the workshop, please see the [BigBOSS workshop homepage](#), where presentations from the workshop will also be archived. Questions regarding the workshop may be directed to Arjun Dey ([dey@noao.edu](mailto:dey@noao.edu)).

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## Science Collaboration Opportunities with the Large Synoptic Survey Telescope

The Large Synoptic Survey Telescope (LSST) invites the US astronomy and physics communities to take part in shaping the science of the LSST through membership in LSST Science Collaborations. Applicants may request to join an existing collaboration or propose to form a new collaboration.

**What is the LSST?** Over the course of ten years, the LSST will perform a six-wavelength, multi-epoch optical survey of half the visible sky, providing major new opportunities for studies of dark energy and dark matter via studies of gravitational lensing, distant supernovae, and the large-scale distribution of galaxies. The LSST will also enable large surveys that explore the structure and stellar populations of the Milky Way, search for faint solar system objects, and detect optical transients, among other topics.



The LSST camera with its six filters (ugrizy). Five are in the filter wheel at any given time. (2011) (Image credit: Todd Mason, Mason Productions Inc. / LSST Corporation)

The LSST will cover the sky with an unprecedented combination of speed and depth. The Astronomy and Astrophysics Decadal Survey (Astro2010) ranked the LSST as the top priority for large-scale ground-based programs. More information about the LSST and its science goals can be found at <http://www.lsst.org>.

The Science Collaborations are opening their membership to the US science community to help develop and document the science opportunities provided by the LSST, finalize the design of the system and observing strategy, undertake end-to-end simulations, commission instrument and data management systems, and ultimately perform science analyses. The collaborations are intended to work closely with the LSST construction project, although they are autonomous ventures.

Those who wish to join an existing collaboration, or initiate a new collaboration, are invited to submit proposals. These will be reviewed by an independent panel of astronomers and physicists coordinated by NOAO, with input from the collaborations on applications specific to their group. Further details and information are available at: [http://www.noao.edu/lst/collab\\_prop/Scicollab.htm](http://www.noao.edu/lst/collab_prop/Scicollab.htm).

Please read the guidelines carefully. Successful applicants must demonstrate a commitment to helping to develop the LSST observational program. The application deadline is **14 October 2011**. Those proposing to form a new collaboration are requested to submit a letter of intent to apply that briefly describes the scientific topic and proposed membership. Please send letters of intent to [mhartman@noao.edu](mailto:mhartman@noao.edu) by **16 September 2011**. Questions may be addressed to Tod R. Lauer at [lauer@noao.edu](mailto:lauer@noao.edu).

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## Contact Us

Did something interesting, inspiring, or surprising happen on a recent observing run? Please tell us about it! Is there a topic that you would like to see covered in a future *Currents*? If you are planning a regional astronomy meeting or department internal symposium, would you like someone from NOAO to give a presentation on our new program? Please contact us at [currents@noao.edu](mailto:currents@noao.edu). We look forward to hearing from you!

*Currents* is a sparkplug for communication between NOAO and our community. It provides updates—and solicits community input—on NOAO observing opportunities and NOAO programs and policies on a more rapid timescale than is possible with the *NOAO Newsletter*.

NOAO is the national center for ground-based nighttime astronomy in the United States and is operated by the Association of Universities for Research in Astronomy (AURA), Inc. under cooperative agreement with the National Science Foundation.

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