August 2018 • Issue 54

Currents

In this Issue…

Observing Time with CHIRON Available for Exoplanet Research: NASA is purchasing 35 nights per semester of observing time with the echelle spectrometer CHIRON for use by the NOAO community for exoplanet research. Further information will be available in the 2019A NOAO Call for Proposals. Read more…

News from SOAR: Changes to the SOAR Target of Opportunity program address the demand for follow-up of gravitational wave events and other time domain observations. The SOAR Integral Field Spectrograph (SIFS) will be available to proposers in the 2019A semester. Both the SOAR Echelle Spectrograph (STELES) and TripleSpec 4.1 (formerly ARCOIRIS at the Blanco Telescope) will likely be available for science verification and early science in 2019A. Read more…

In the Time Domain: ZTF, ANTARES, and a Synoptic Follow-up System:

- The **Zwicky Transient Facility** (ZTF) is in full swing and producing hundreds of thousands of transient alerts per night. Alerts from the ZTF public survey are available daily. **NOAO proposals** for ToO follow-up programs are welcome, and the Las Cumbres Observatory (LCOGT) automated telescopes remain accessible through the NOAO TAC.
- An **ANTARES** brokering service for the ZTF alert stream will be available in or about January 2019. **Shared-risk NOAO proposals** for follow-up observing of ANTARES-filtered alerts are welcome for 2019A for science verification purposes.
- NOAO is developing a follow-up system for synoptic surveys ("Astronomical Event Observation Network" or **AEON**) that will integrate brokering, scheduling, data acquisition and reduction, and enable coordination among multiple groups to optimize resource use. AEON is a collaboration between NOAO, Gemini, SOAR, and LCOGT. Read more…

DESI Imaging Legacy Surveys DR7: The seventh data release features source catalogs from images covering more than a quarter of the sky. Catalogs include DECam photometry (g, r, and z bands) and custom mid-infrared fluxes from the WISE satellite. Potential DR7 users are invited to explore the data set via the Legacy Survey sky viewer, which allows for

In this Issue

seamless interactive zooming and panning throughout the entire data set. Read more…

Key Science Programs for US ELTs: The US Extremely Large Telescope Program, a joint initiative of NOAO, the Thirty Meter Telescope, and the Giant Magellan Telescope, aims to provide the US community with open access to significant observing time on both facilities. Key Science Programs (KSPs), which are being developed for presentation to the 2020 Decadal Survey and NSF, are a core element of the Program. To contribute to KSP development, visit the US ELT Program KSP web page. Read more…

Call for White Papers on LSST Cadence: The LSST Project has issued a call for white papers to help refine the 'main survey' and fully define the use of the 10-20% of time that is expected to be devoted to various 'mini surveys' including 'Deep Drilling mini-surveys' and 'Target of Opportunity' programs. The submission deadline is **30 November 2018**. Read more…

Workshop Report — "Searching for Dwarf Galaxy Companions in the LSST Era": To capitalize on the opportunity offered by LSST to address fundamental galaxy formation questions, NOAO and the LSST Corporation sponsored a dwarf galaxy workshop in October 2017. In addition to examining the science questions that will drive this field in the LSST era, participants also anticipated the demands that the science will place on LSST archives and tools and offered guidance on observing strategies and follow-up needs. Read more…

Newly-Coated Primary for Blanco Telescope: The realuminization of the 4-m Blanco telescope primary mirror has led to significant increases in reflectivity (10-25%). Further improvements to the thermal control of the primary are under way. Read more…

Meeting Announcement — "Extremely Big Eyes on the Early Universe": The first in a three-part series of international conferences, this meeting will review the current state of the art in studying the high redshift universe and discuss how to best use giant telescopes to go beyond. The meeting will be held **28 January — 1 February 2019** at UCLA. Registration is now open. Read more…

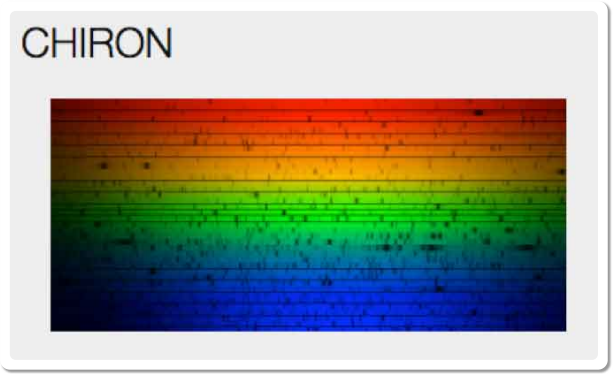
Conference presentations available online — "Science and Evolution of Gemini Observatory": At the July 2018 conference the astronomical community gathered to review recent science highlights, discuss needs in the context of Gemini's evolving capabilities, and develop strategies for the future. Presentations from the scientific program, which covered science topics, instrument themes, and panel discussions, are now available online at the conference website.

Observing Time with the CHIRON Spectrometer on the CTIO 1.5-meter Available through the NN-EXPLORE Program

Verne Smith, NOAO

Through an extension of the NASA NSF-Exoplanet Observational Research (NN-EXPLORE) Program, NASA is purchasing 35 nights per semester on the

CTIO 1.5-meter telescope with the CHIRON spectrometer beginning in semester 2019A. CHIRON is a highly stable cross-dispersed echelle spectrometer that is fiber-fed and intended primarily for precise radial velocity measurements.



The purchased time will be available for use by the NOAO community for exoplanet research through proposals submitted to NOAO and reviewed by the NOAO Telescope Allocation Committee (TAC). Further information will be available in the 2019A Call for Proposals, which will be posted on the NOAO website on 1 September 2018.

Information on CHIRON can be found at: http://www.astro.yale.edu/smarts/1.5m.html

News from SOAR: Changes to Target of Opportunity Policy, Availability of SIFS, STELES, and TripleSpec 4.1

Jay Elias, SOAR Director

The SOAR Board has **modified the ToO** policy for 2019 (both semesters) in order to address the demand for follow-up of gravitational wave events as well as the increasing demand for other time-domain observations. The revised policy, which includes the following changes, is linked from the SOAR website:

- The allocation of interrupts for gravitational-wave follow-up has been separated from the allocations for other programs, in order to ensure that the former receives high priority while retaining options for other science. In the current semester (2018B) we have several active time-domain programs for supernova follow-up and small bodies in the solar system, in addition to the follow-up of gravitational wave events.
- We will schedule a modest number of "compensation nights", to compensate scheduled observers for time lost to ToO interrupts. However, such compensation is not guaranteed.
- Scheduled observers and time domain investigators may agree to collaborate in lieu of compensation. Anyone contemplating a target of opportunity proposal for SOAR should read the policy, as it is not identical to the Blanco or Gemini policies. Examples of recent successful observations are available here (LIGO) and here (Solar System occultations).

STELES and TripleSpec 4.1 Updates. We hope to be commissioning STELES and TripleSpec 4.1 (ex-ARCOIRIS transferred from the Blanco telescope) late in the calendar year or early in 2019. This schedule is too late

to provide enough information for regular proposals for 2019A, but we anticipate scheduling some time for science verification and early science during the semester, with special calls for proposals. Further details should be announced in conjunction with the 2019A schedule, in early December. Potential proposers should check the SOAR news page at that time or contact the respective SOAR instrument scientists:

- STELES – Andrei Tokovinin (atokovinin at ctio.noao.edu)
- TSpec 4.1 – Sean Points (spoints at ctio.noao.edu)

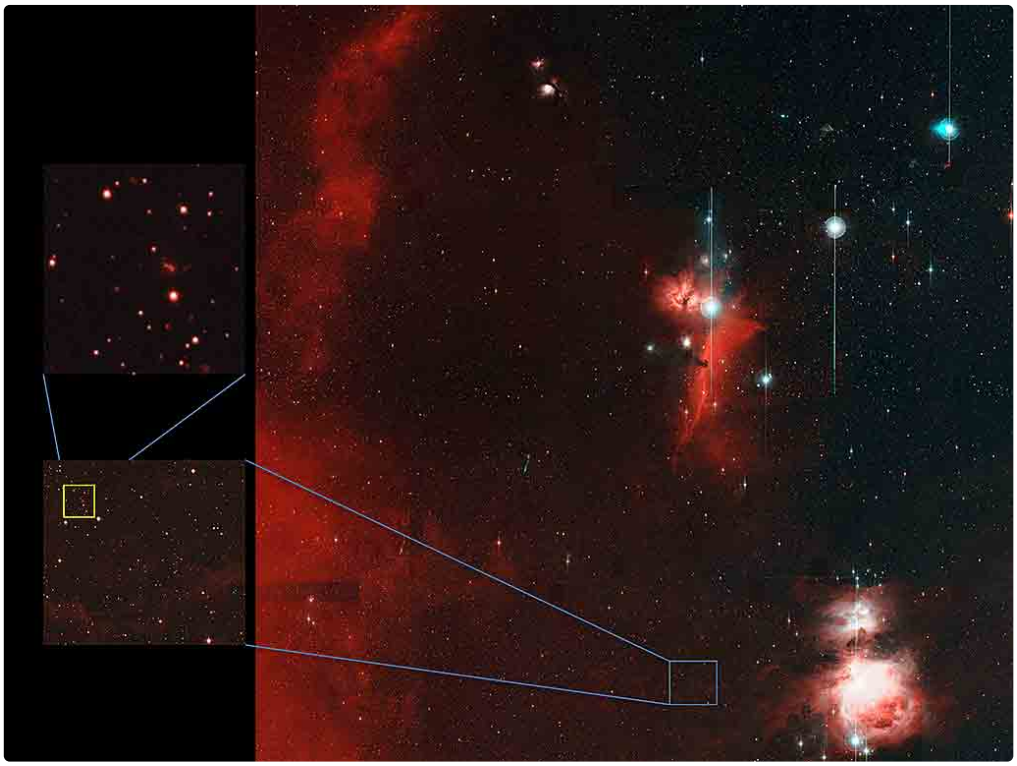
SIFS Availability. The SOAR Integral Field Spectrograph is available to users through the regular proposal process. Because it requires additional support, the total amount of time available is limited, but in fact this time is undersubscribed, especially for NOAO users. SIFS is a functional, commissioned instrument, and users have received reduced data. At this point, four papers are either submitted or in the late stages of preparation. More time is scheduled for 2018B.

Investigators interested in spectroscopy of complex, high-surface brightness objects are invited to consider whether SIFS may meet their needs. Further information is available at the SIFS instrument page. Several reports on the operation of the instrument and on data reduction are now available, and updates will be posted as additional gratings are commissioned.

In the Time Domain: ZTF Community Survey and Alerts, ANTARES Event Brokering, and the Astronomical Event Observatory Network

Stephen Ridgway NOAO), Cesar Briceno (CTIO), Bryan Miller (Gemini) and Rachel Street (LCOGT)

The Zwicky Transient Facility (ZTF), which achieved first light a few months ago, is now in full swing and producing up to hundreds of thousands of transient alerts per night. The survey is being carried out on the Palomar 48-inch Schmidt telescope using a 47 square degree camera (a mosaic of 16 CCDs with 6Kx6K pixels each). A public-private project supported in part by a National Science Foundation Mid-Scale Innovations Program award, ZTF can survey 3750 deg^2 per hour to a median depth of R=20.5. A first-light image is reproduced here.



ZTF first light composite image. Right: the full field of view encompassing the belt of Orion. Left: Successive zooms.

The ZTF Public Surveys

Thanks to the MSIP award, 40% of time on ZTF is spent on two public surveys: an **all-northern-sky survey** with a pair of visits in g and r every 3 nights, and a **Galactic Plane survey** with nightly visits in g and r.

Transient alerts from the public survey are available now on a daily basis. Pending operation of a community broker, daily alert archives are provided for download (ATEL #11685; see https://ztf.uw.edu/alerts/public/). The ZTF team is also operating a filter to select bright transients for possible supernovae, announcing favorable events via the Transient Name Server (TNS), and in some cases undertaking classification spectroscopy, also to be reported to TNS. ZTF moving object alerts are also being fed to the Minor Planet Center. Las Cumbres Observatory (LCOGT) is now offering an alert server for ZTF, MARS (Make Alerts Really Simple), with user-specifiable filtering capability.

The first ZTF object catalog and image data release is expected at the end of the first survey year (about June 2019).

Proposals for ToO follow-up programs on NOAO facilities are invited and welcome. As a reminder, **access to the LCOGT automated telescopes is available via the NOAO TAC** for the next few years, also thanks to NSF MSIP support.

ANTARES Event Brokering

The NOAO Community Science and Data Center continues development of the ANTARES transient broker service. An initial ANTARES brokering service for the ZTF alert stream is currently being commissioned, with a release date anticipated during January 2019. This service will begin with simple filters and

deploy more complex filtering capabilities in subsequent semesters, with the goal of operating full-featured and scalable implementation in advance of the arrival of the alert stream from the Large Synoptic Survey Telescope (LSST).

Community engagement is welcome in the continuing development of ANTARES. Shared-risk proposals for follow-up observing of ANTARES-filtered alerts on NOAO-scheduled facilities are welcomed for science-verification purposes. For details, please see the NOAO 2019A call for proposals.

Connecting the Time Domain Ecosystem

A number of community reports (e.g., the Elmegreen report "Optimizing the US Ground-based OIR System" and the Kavli Futures symposium "Maximizing Science in the Era of LSST") have studied the requirements for follow-up of major synoptic surveys and have highlighted the urgent need for systems that integrate brokering, scheduling, follow-up data acquisition, and data reduction, with the capability of coordination among multiple scientists and between collaborations in order to optimize facility use.

NOAO has initiated development of such an integrated follow-up system, initially to connect alerts from ANTARES to follow-up observing programs employing resources available through the NOAO TAC. This project (dubbed AEON, for "Astronomical Event Observation Network") is a collaboration between NOAO and LCOGT, SOAR and Gemini. In the first phase (release date TBD), the SOAR Goodman spectrograph will be offered via the LCOGT dynamic scheduling service for a fraction of the available nights each semester. Extension to Gemini will follow, and the project can scale to additional facilities. Further details are available in a poster overview.

The ZTF Community Science Advisory Committee

The ZTF Community Science Advisory Committee, which advises the ZTF PI (Shri Kulkarni), welcomes your input and advice at any time. Are you using ZTF alerts? We would like to hear about your experience. Are you not using ZTF alerts even though you would like to? Why not? What data products are you most eager to access?

To provide your input, please contact the committee: Marcel Aguerros (Columbia University), Todd Boroson (LCOGT), Mukremin Kilic (University of Oklahoma), Juna Kollmeier (Carnegie Observatories), Maryam Modjaz (NYY), Marc Pinsonneault (Ohio State University), and Stephen Ridgway (NOAO).

The next major tasks of the CSAC will be to encourage community utilization of ZTF data, aggregate feedback, and advise the project on the evolution of the community survey strategy moving into the second half of the survey. The 2019 AAS meetings will be an opportunity for discussion, and the discussion venue will be announced in these pages.

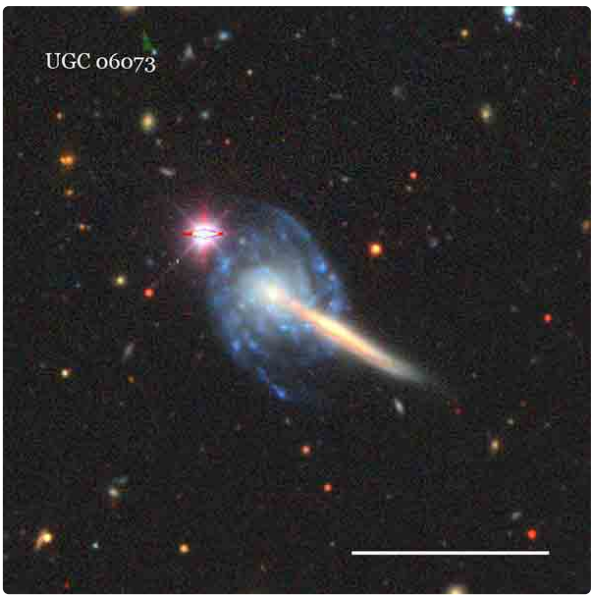
DESI Imaging Legacy Surveys Publish Seventh Data Release

Aaron Meisner, Arjun Dey & Stephanie Juneau (NOAO), on behalf of the DESI imaging Legacy Surveys team

The DESI imaging Legacy Surveys team announces the publication of its seventh data release (DR7), featuring source catalogs from images covering more than a quarter of the sky. The images were obtained using the Dark Energy Camera (DECam) on the 4-m Blanco Telescope at the Cerro Tololo Inter-American Observatory in Chile. This new DECam Legacy Survey (DECaLS) DR7 data set will help enable target selection for the upcoming Dark Energy Spectroscopic Instrument (DESI), while also providing a much deeper multi-purpose successor to the Sloan Digital Sky Survey imaging catalog over a similar footprint.

DECaLS DR7 consists primarily of DECam optical measurements in the g, r and z passbands. Through an innovative "forced photometry" approach, the DECaLS source catalog includes, for each source, custom mid-infrared fluxes measured from the all-sky survey conducted by the WISE satellite. The DECaLS source positions are tied to the high-fidelity astrometry provided by the Gaia spacecraft.

DECaLS DR7 is the result of major observational and computational efforts by the Legacy Surveys team. Beginning in 2014, more than 40 observers from 17 institutions collected roughly 120 nights of DECaLS data. In total, DECaLS DR7 processed over 40,000 DECam exposures, corresponding to approximately 70 trillion pixels of input. The entire DESI imaging data set now includes 1.2 billion unique sources, from which DESI will select approximately 30 million to study in further detail. The data were processed at the National Optical Astronomy Observatory in Tucson, Arizona and the National Energy Research Scientific Computing Center in Berkeley, California.

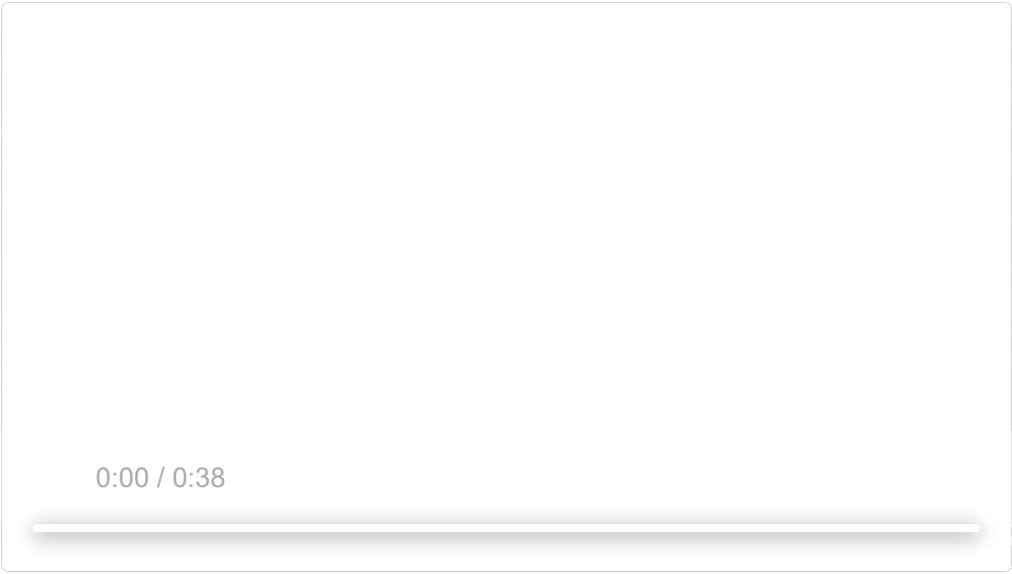


An image of the interacting galaxy pair UGC 6073 (also known as Arp 198) from the Legacy Surveys' Data Release 7 Gallery. The system lies at a distance of 125 Mpc from the Milky Way in the constellation of Leo. The white horizontal scale bar represents one arcminute.

The Legacy Surveys team is committed to open data practices, and plans its next data release (DR8) for January 2019. DR8 will for the first time jointly process DECam

data together with more northerly images from the Kitt Peak-based Mayall z-band Legacy Survey (MzLS) and Beijing-Arizona Sky Survey (BASS), filling out the entire DESI spectroscopic footprint. DESI's footprint is currently covered by the combination of Legacy Surveys DR6 and DR7. An overview of the full DESI imaging effort is provided in Dey et al. (2018).

Potential DR7 users are encouraged to explore the data set via the Legacy Survey sky viewer, which allows for seamless interactive zooming and panning throughout the entire data set (see image below). The DECaLS DR7 gallery highlights objects drawn from Halton Arp's *Atlas of Peculiar Galaxies* (see image above).

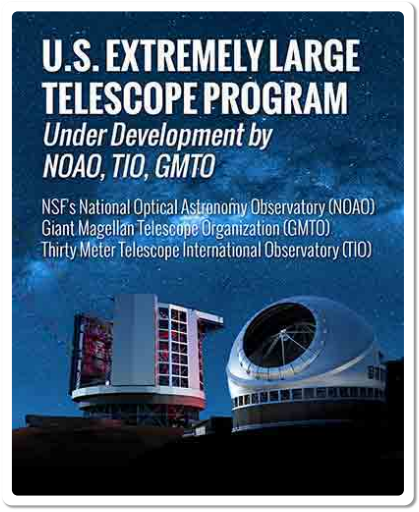


Click the image to play an animation that illustrates the online sky viewer tool as it zooms in to a cluster of galaxies, and then back out to a wider field of view. You can also view the visualization in HD.

The DR7 data products are available through [1] the Legacy Survey website; [2] the NOAO Science Archive; and [3] the NOAO Data Lab. The NOAO Science Archive provides access to both the DR7 raw and calibrated images. The NOAO Data Lab provides tools to access databases containing the catalogs. The Data Lab tools enable complex user queries and analyses of the data using a Jupyter Notebook server, a Simple Image Access (SIA) service and a TAP handle (which allows, for example, users to connect to the databases via tools such as TOPCAT). Example Jupyter Notebooks are also provided. Data Lab also provides opportunities for combined analyses using other datasets (such as Dark Energy Survey (DES) DR1, the NOAO Source Catalog (NSC), and Gaia DR2). Precomputed tables that crossmatch Legacy Surveys to other catalogs are provided by Data Lab for these purposes. User feedback can be communicated via the Data Lab Helpdesk or email (datalab@noao.edu). A comprehensive list of Legacy Surveys acknowledgments is available from Data Lab.

Key Science Programs for the US Extremely Large Telescope Program

Mark Dickinson, NOAO



In the coming decade, Extremely Large Telescopes (ELTs) with 20-m to 40-m primary mirror diameters will peer out into the Universe with unprecedented sensitivity and angular resolution, enabling scientific investigations beyond the reach of present-day observatories. While many discoveries will be made with relatively short ELT observations, other problems will require substantial investments of observing time, perhaps using multiple instrument capabilities, perhaps in conjunction with other astronomical facilities, in order to systematically investigate and answer forefront astronomical questions.

The US ELT Program, a joint initiative of NOAO, the Thirty Meter Telescope (TMT) International Observatory, and the Giant Magellan Telescope (GMT) Organization, aims to provide the US astronomical community with open access to significant shares of observing time for both GMT and TMT. This two-hemisphere model will provide all-sky coverage and more diverse observatory capabilities, enabling integrated science programs that go beyond the reach of a single telescope.

Key Science Programs (KSPs) are a core element of the US ELT Program that is being developed for presentation to the 2020 Decadal Survey and the National Science Foundation. KSPs will address questions of fundamental scientific importance that may require tens to hundreds of observing nights with GMT, TMT, or both observatories working in concert, taking advantage of their combined view of the full sky, or of their complementary instrumental capabilities. It is envisioned that KSPs will follow open collaboration models that encourage broad, diverse participation by observers, data scientists and theorists throughout the US research community. Smaller-scale, focused research projects will also be an important component of the overall science programs for these observatories, as richly illustrated by the existing detailed science cases for GMT and TMT. However, the present effort is directed towards the development of larger-scale concepts for frontier research programs, led by US community scientists, that can achieve exceptional advancements in humanity's understanding of the cosmos.

NOAO and its US ELT Program Advisory Committee have invited members of the US astronomical community to develop KSP concepts. To date, more than 200 scientists have responded to this invitation. Their interests span the range from our solar system to cosmology. NOAO is now organizing these participants into thematic groups that will consider forefront problems in their area of expertise, formulate and prioritize KSP concepts, identify and quantify the ELT capabilities required, and then elaborate these ideas as detailed observing and analysis plans in advance of a workshop to be held in Tucson in mid-November.

The KSP ideas developed through this process will serve as *exemplars* that illustrate the research potential of TMT and GMT for the US community and define the required scope of federal investment for a US ELT Program. Undoubtedly, astronomy will continue to evolve rapidly during construction of GMT and TMT, in part thanks to new discoveries from facilities such as JWST,

TESS and LSST. Consequently, the KSPs that will eventually be executed by TMT and GMT will be determined in a future peer-review proposal process prior to and during science operations.

If you would like to contribute to Key Science Program development, please visit the US ELT Program web site KSP web page and register using the on-line form.

Call for White Papers on LSST Cadence Optimization

Zeljko Ivezic, Lynne Jones, and Tiago Ribeiro,
For the LSST Project and LSST Science Advisory Committee

The NOAO science community is invited to play a key role in defining the Observing Strategy for LSST.

The LSST Project has issued a call for white papers to help refine the 'main survey' and fully define the use of the 10-20% of time that is expected to be devoted to various 'mini surveys' including 'Deep Drilling mini-surveys' and 'Target of Opportunity' programs.

The call solicits science-driven input for observing strategy properties such as:

- the sky coverage
- per-bandpass imaging depth
- temporal coverage and
- various detailed observing constraints

The submission deadline is **30 November 2018**. Details are available in the Call for White Papers on LSST Cadence Optimization.

Background: The LSST Science Requirements Document (SRD) places minimal constraints on the observing strategy, recognizing that science evolves and that the initial (by now more than a decade old) survey strategy would have to be redefined closer to first light. With LSST first light expected in 2020 and the LSST operations phase starting in 2022, now is the time to undertake the final planning for the initial LSST observing strategy. While the existing candidate baseline survey strategy has been defined primarily by the LSST Project, the final planning must be undertaken hand-in-hand with the community. There are no specific limitations on what kind of science programs will be considered, except that the four primary LSST science themes (for a

brief introduction, please see ls.st/os9) must remain the cornerstones of the LSST survey.

Questions? An open, searchable resource for asking questions is available on LSST Community. Team members will monitor and respond in a timely manner to questions posted there. In addition, there is a mailing list available (email: lsst-survey-strategy at lists.lsst.org) to contact the survey strategy team in case of specific questions and/or concerns. Messages posted to the mailing list are broadcasted to the survey strategy team and archived. The same list will be used for white paper submission.

Workshop Report: Searching for Dwarf Companions of the Milky Way and Beyond in the LSST Era

Keith Bechtol (LSST), Knut Olsen and Steve Ridgway (NOAO)

LSST will dramatically increase the sensitivity to faint galaxies and halo substructures, making it possible to address fundamental questions about galaxy formation in regimes that are currently unexplored. To capitalize on this opportunity, NOAO and the LSST Corporation jointly sponsored a workshop in October 2017 to bring together a critical mass of specialists in dwarf galaxy studies to examine the science questions and resource needs for this field in the LSST era.

The workshop presentations and report are available at the meeting website.

Because the workshop was devoted almost entirely to discussion, with very few prepared presentations, the slides are brief. However, all participants contributed to the workshop report, which effectively captures the in-depth and fast-moving discussion.

The report covers the following major areas:

- What will be the big dwarf galaxy questions in the LSST era?
- Successes and challenges of recent dwarf galaxy searches
- LSST data products and services for dwarf galaxy science
- What measurements will we need?
- Catalog-based search techniques
- Pixel-based search techniques
- Beyond the Milky Way
- Addressing dwarf galaxy problems with LSST
- Ongoing and future surveys and their relationship to LSST

Advice to LSST. In addition to the science focus of the workshop, attendees were invited to develop advice to LSST data management with respect to the demands that dwarf galaxy science will place on LSST archives and tools, as well as guidance on observing strategies and follow-up needs. The

recommendations, which include the following, have potential value for other LSST science.

- **Detection of the faintest extended sources** with pixel-based techniques usually progresses by modeling all sources in the image that are detected by conventional means and subtracting the models or masking contaminated pixels, leaving a nominally "blank" image. The targets of interest will remain as subtle variations in the residual "background". They can be detected, e.g., by binning, convolution with typical models, or visual inspection. It is particularly important that this analysis should be applied to individual dithered images, prior to stacking!
- Study of dwarf galaxies would benefit from several **cadence optimizations**, which are recommended for simulation individually and together:
  - Twice the nominal *u*-band exposure time
  - Increased survey sky coverage
    - With either the nominal (WFD) cadence or a ten times less frequent cadence (tuned to deliver proper motions and RR Lyr classifications)
    - Extension to south celestial pole
    - Extension to within 10 degrees of the Galactic plane
    - Extension to +20 degrees declination
- Finally, not surprisingly, dwarf galaxy science joins the many other science programs that would benefit greatly from a **massively-multiplexed spectroscopic facility** for LSST follow-up.

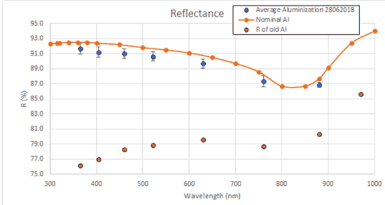
A Newly-Coated Primary Mirror for the Blanco Telescope

Tim Abbott and Roberto Tighe, CTIO

The V. M. Blanco 4-m telescope primary mirror was realuminized on 28 June 2018, for the first time since 2011 and subsequent to the installation of DECam in 2012. The resulting surface is excellent, with 25%, 15%, and 10% improvement in the reflectivity in g, r, and i, respectively. While the long period between coatings is not optimal, the reflectivity and scattering have nevertheless been quite stable for several years as a result of our program of CO2 snow cleanings every week and wet washes every 3 months. We have now established a much-improved procedure for telescope disassembly, mirror realuminization, and reassembly, and we anticipate its timely repetition in the future. Further improvements to the thermal control of the primary are now under way.

Final cleaning of the stripped mirror before installation in the coating chamber.

Inspecting the newly coated primary mirror as it is removed from the coating chamber.



Reflectometry of the primary mirror before and immediately after realuminization on 28 June 2018. The error bars reflect the amplitude of variation of reflectivity across some minor imperfections in the new coat.

Meeting Announcement — "Extremely Big Eyes on the Early Universe"

28 January – 1 February 2019, University of California, Los Angeles
https://conferences.pa.ucla.edu/early-universe-2019/
Early registration deadline: **28 September 2018**

Registration is now open for the conference "Extremely Big Eyes on the Early Universe," to be held at the University of California, Los Angeles, CA from 28 January to 1 February 2019. This will be the first installment of a three-part international conference series:

1. University of California, Los Angeles, USA, 28 January – 1 February 2019
2. Kavli Institute for the Physics and Mathematics of the Universe, Tokyo, Japan, 25-29 March 2019
3. Accademia dei Lincei, Rome, Italy, 9-13 September 2019

In the next decade, the commissioning of Extremely Large Telescopes (20-40m class) will allow us to see the high redshift universe using new eyes of unprecedented power. By themselves or in combination with other facilities, these new eyes will have the potential to transform our understanding of the formation and early evolution of galaxies and black holes, first light and cosmic reionization, as well as the evolution of the intergalactic and circumgalactic media.

The Big Eyes conferences will bring together an international group of experts to review the current state of the art in the study of the high redshift universe

and to discuss how best to use giant telescopes to learn about it. These meetings will address the following questions:

- What potentially transformative observations will be enabled by giant telescopes? What capabilities are required?
- What are the key synergies between giant telescopes and other facilities? What are the areas and topics where a concerted effort will yield far superior results than the sum of all parts?
- What theoretical or observational work is needed in preparation for first light? What are the limitations in our understanding that need to be overcome?
- What calculations are required in order to make testable predictions and interpret the results of future astronomical observations?

It is extremely important to consider these questions now, while the plans for giant telescopes can still be influenced, and there is still sufficient time to carry out preparatory theoretical and observational work that will be needed to make the most of the large investments in these facilities.

For more information and the registration form, please visit: https://conferences.pa.ucla.edu/early-universe-2019/

Contact Us

We welcome your input on this issue of *Currents*. Please contact us at currents@noao.edu. We look forward to hearing from you!

(An earlier version of this page referred to Las Cumbres Observatory by the acronym LCO. This has been updated to LCOGT to avoid confusion with Las Campanas Observatory.)

Currents is a spark plug 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.