# NOAO CURRENTS

#### August 2019 • Issue 60

AURA

# Currents

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**Astro2020 White Papers Posted:** NOAO-related white papers submitted in response to the 2020 Decadal Survey of Astronomy and Astrophysics (Astro2020) call for "Activities, Projects, and State of the Profession Considerations" (APC) white papers <u>are now posted</u>. These include white papers submitted by NOAO scientific staff as well as those from the community on NOAO-related topics. If your submission is missing, please inform us by writing to <u>currents@noao.edu</u> so we can include your white paper in the compilation.

**Special Sessions at January AAS:** The January meeting of the AAS will include NOAO-related special sessions on

- DESI Imaging and First Light Spectroscopy
- Zwicky Transient Facility (ZTF) Community Survey
- Imaging Stars: a Century of Advances in High Angular Resolution Astronomy
- Threats to Astronomy from Lighting and Satellites
- Planets, Exoplanets, and Planet Formation with Gemini Large and Long Programs

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**First Night of AEON Queue on SOAR a Success:** The Astronomical Event Observatory network (AEON), a collaboration between Las Cumbres Observatory, NOAO, SOAR and Gemini, is aimed at building an automated ecosystem of follow-up facilities for time-domain astronomy in preparation for the LSST era. The first night of queue operations, carried out this month on the SOAR telescope, was a resounding success. <u>Read more...</u>

**AEON-related Conferences:** Two upcoming conferences provide opportunities to learn more about AEON and how it can support your observing program: *Hot-wiring the Transient Universe VI* (Evanston, 19-22 Aug 2019) and the *TOM Toolkit Workshop* (Pasadena, 30 Sept – 4 Oct 2019). Materials from both workshops are expected to be available online. <u>Read more...</u>

**TripleSpec Returns with Science Verification on SOAR:** The infrared spectrometer TripleSpec 4.1, previously at the CTIO Blanco telescope, has now been successfully modified and installed on the SOAR telescope. With the instrument now

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fully commissioned as a facility instrument, prospective observers are encouraged to submit TripleSpec proposals for the 2020A semester. <u>Read more...</u>

**Data Release 8 for Legacy Surveys:** The eighth data release (DR8) of the <u>DESI</u> <u>imaging Legacy Surveys</u>, now publicly available, contains approximately 1.6 billion unique sources and includes source catalogs, images, and an interactive image viewer covering a third of the sky in three optical (g,r,z) and four mid-infrared (from WISE) bands. The data, which encompass the entire footprint of the <u>Dark Energy</u> <u>Spectroscopic Instrument (DESI)</u> survey, will be used to select DESI targets. The release also includes an image gallery of high-redshift galaxy clusters. <u>Read more...</u>

**US ELT Program News:** The US Extremely Large Telescope Program (US-ELTP) welcomes Dr. Sidney Wolff as Project Director for the AURA/NOAO US-ELTP team. This article also highlights US-ELTP-related submissions in response to the Astro2020 call for APC white papers. <u>Read more...</u>

**2019 TMT Science Forum:** Registration is now open for the 2019 Thirty Meter (TMT) Science Forum, "Science Synergies in the Era of the Thirty Meter Telescope," which will be held in Xiamen, China **4-6 November 2019**. Travel support will be available for US scientists. <u>Read more...</u>

**NEID Queue Observers Onboard at WIYN:** Two young astronomers, Eli Golub and Jessica Klusmeyer, have joined the WIYN team as queue observers for NEID, the extreme precision radial velocity spectrometer. Jessica and Eli both have physics and astronomy degrees as well as experience with astronomical observing. Shared risk observations with NEID are scheduled to begin in December 2019. <u>Read more...</u>



### NOAO at the January AAS Meeting

The following special sessions are planned for the January 2020 meeting of the American Astronomical Society.

### **DESI Imaging and First Light Spectroscopy**

### Arjun Dey, NOAO

The Dark Energy Spectroscopic Instrument (DESI) consists of imaging surveys over 16,000 square degrees (see the related data release article in this issue) followed by 3600-9800 angstrom spectroscopy of 35 million galaxies and quasars that aims to probe the role of dark energy in the expansion history of the universe. This special session will provide an overview of the DESI instrument and feature talks on the DESI Legacy Imaging Survey and DESI targeting; maximizing the legacy of WISE infrared imaging for DESI and beyond; first light tests of DESI targets; commissioning the 5000 DESI fiber robots; the DESI instrument and performance; and initial data from the DESI spectrographs.



DESI in bloom. All ten "petals," each of which holds 500 fiber-positioning robots, were recently installed in the DESI instrument at the Mayall telescope on Kitt Peak.

### Splinter Session on the Zwicky Transient Facility Community Survey

Steve Ridgway, NOAO (for ZTF and its Community Science Advisory Committee)

The Zwicky Transient Facility is engaged in a 3-year survey of the transient sky. As part of the MSIP funding agreement with NSF, the survey includes both private and public observing programs. The public survey, utilizing 40% of available on-sky time, provides immediate broadcasts of transient alerts and timely publication of cumulative catalogs. In a planned splinter session at the January AAS meeting, the ZTF project, in collaboration with the ZTF Community Science Advisory Committee, will present the status of the community survey and provide information about Data Release 2 (expected in December 2019). We will discuss a new survey element, begun on 18 July 2019, that shadows the on-going TESS mission fields with daily visits. Participants are invited to bring ideas and join the discussion on the disposition of ZTF community survey time during the next 12 months.

### Imaging Stars: a Century of Advances in High Angular Resolution Astronomy

Gail Schaefer (CHARA) & Steve Ridgway (NOAO)

This session will commemorate the first interferometric measurement in 1920 of a stellar diameter by Albert Michelson and Francis Pease. Invited speakers will include Doug Gies, Andrea Dupree, John Monnier, Gioia Rau and Daniel Huber. There will be an associated poster session. A website for the event (http://www.chara.gsu.edu/workshops/aasspecial-session-2020) will be updated as schedule and other details become available. We remind readers that access to the CHARA Array, supported by Georgia State University and partially funded by the NSF MSIP program, is available through the NOAO TAC.



CHARA maintains a small interferometry museum at its site on Mt Wilson, where you can see <u>the original</u> <u>optical support beam</u> used by Michelson and Pease to adapt the 100" telescope to observe with 20 foot aperture separation. (Image credit: Gail Schaefer)

### Threats to Astronomy from Lighting and Satellites

#### Constance Walker, NOAO

The commercial world has plans to deploy potentially thousands of low-Earth orbit satellites, outnumbering all previously launched satellites. As members of the astronomical community, we need to understand the impact of these plans on our field, as well as possible solutions, and how to work collaboratively with designers, deployers, and policy-makers at this new, largely unregulated frontier of space. Join us at this special session, held by the AAS Committee on Light Pollution, Radio Interference and Space Debris, where you can discuss these and related issues with a panel of experts.



on 25 May 2019. The diagonal lines are trails of reflected light left by some of the 60 recently launched Starlink satellites as they passed through the field of view. Note that the satellite density declined in the days after launch, compared to that seen here. The satellites also diminished in brightness as they reached their final orbital altitude. (Image credit: Victoria Girqis/Lowell Observatory)

# Planets, Exoplanets, and Planet Formation with Gemini Large and Long Programs

#### Letizia Stanghellini (NOAO), Ken Hinkle (NOAO), and Alison Peck (Gemini)

Science from Gemini Large and Long Programs (LLP) will be showcased in a focused meeting organized by the US NGO, in collaboration with Gemini. This Splinter meeting will focus on science from mature LLPs in the field of planets and their formation. Speakers will be selected from PIs and co-Is of these programs, and other experts in the field. Talks will present the science results along with data analysis strategies.



# First Night of AEON Queue Operations on SOAR a Success!

Cesar Briceno, Jay Elias (NOAO)

The <u>Astronomical Event Observatory Network</u> (AEON), a collaboration between <u>Las</u> <u>Cumbres Observatory</u> (LCOGT), NOAO, <u>SOAR</u> and <u>Gemini</u>, is aimed at building an ecosystem of world-class telescope facilities for the follow up of transients and timedomain astronomy, in preparation for the <u>LSST</u> era. The night of 6 August 2019 set a milestone for the project, as the first of <u>20 nights</u> <u>scheduled on the SOAR telescope this semester in AEON-queue mode</u>. The night was successful, with a total of 10 different targets studied under excellent observing conditions. Additional queue-scheduled observing nights are anticipated at a rate of 3-4 per month for the remainder of the 2019B semester.

Over this semester, SOAR's AEON-scheduled queue will carry out observations that have been approved through the standard NOAO TAC process. The approved programs, eight regular programs and four Target-of-Opportunity programs, pursue diverse science cases, ranging from the characterization and study of Near Earth Objects, microlensing events, young supernovae, RR Lyrae stars in ultra-faint dwarf galaxies, solar-like pre-main sequence stars, to the follow up of Galactic transients and gravitational wave events.

AEON builds on the infrastructure of the existing network of small telescopes run by LCOGT to incorporate 4-m and 8-m class telescopes. The underlying idea is to create an integrated "follow-up" ecosystem, as outlined in the figure below.

SOAR's Goodman instrument is currently available through the AEON queue in a subset of modes: imaging with the VR, SDSS-g, SDSS-r, SDSS-i filters, and spectroscopy with the red camera, 400 line grating and 1 arcsecond slit. Users can submit their targets at any time during the semester, through the LCOGT Observing Portal or with custom software that connects to LCOGT via their API. On an AEON night, the observing schedule is downloaded from LCOGT and executed by software that runs both the telescope and the Goodman instrument; guide star and on-slit target acquisition (for spectroscopic observations) are the only steps still carried out manually. Users can obtain the status of their observations and retrieve their raw data





through the <u>LCOGT Observing Portal</u>. Data reduction can be carried out in an automated way using the <u>Goodman Spectroscopic Data Reduction Pipeline</u>. Further information on <u>observing with AEON</u> is available at the <u>LCOGT-AEON web site</u>.

SOAR intends to expand the range of Goodman configurations available in queue mode and to eventually add additional instruments such as <u>TripleSpec 4.1</u>. The underlying objective is to provide flexible observing in an era of complex observing requirements ranging from large survey programs to focused time-domain programs.

**To learn more:** Interested SOAR-AEON users, including those affiliated with other SOAR partners, are invited to consult future issues of *Currents* and calls for the proposals for additional opportunities and information. Updates on available instruments or observing configurations for the 2020A semester will be provided when the NOAO call for proposals is issued in early September. We are also very much interested in including programs from other SOAR partners in the AEON queue. Developing the AEON Network will be a major topic of discussion at the upcoming <u>TOM Toolkit Workshop</u> (see related article below). Further information on the current status and related matters at the <u>SOAR AEON page</u>.

SOAR's success in reaching this milestone is due to the effort of a many people, including Diego Gomez and Omar Estay of NOAO and Jon Nation, Elizabeth Heinrich, and Mark Bowman of Las Cumbres Observatory. Queue operations also rely on the

skill and efficiency of the regular SOAR operators. Funding for much of this work was provided by supplementary funding from the National Science Foundation.

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

# **Opportunities in the Time Domain – AEON Observing and AEON-related Conferences**

Steve Ridgway (NOAO) for the AEON Consortium

NOAO, SOAR, GEMINI and Las Cumbres Observatory are collaborating on the development of AEON, the Astronomy Event Observing Network. An important element of AEON functionality will be its compatibility with Target and Observation Manager (TOM) systems. Project participants representing AEON and TOM development will be present at



the conference *Hot-wiring the Transient Universe VI* (Evanston, 19-22 Aug 2019). There will be a web page for participants to post their slides, and some sessions may be streamed. For additional information, please see <u>https://sites.northwestern.edu/hotwired6/</u>.

The *TOM Toolkit Workshop* (Pasadena, 30 Sept – 4 Oct 2019) will provide an interactive introduction to building and customizing TOMs. The workshop will also provide support for a number of observing programs. While the application window for the workshop is now closed, and successful applicants will be notified shortly, the organizers expect to post all training materials and contributed slides to the web. Details can be found at <u>https://lco.global/workshops/tom-toolkit-community-workshop/</u>.

The first AEON-mode observations are being conducted this semester on the SOAR telescope. The first night of observations, on 6 August 2019, was a resounding success, as described above.

### **TripleSpec Returns: Science Verification on SOAR**

Sean Points (NOAO) & Jay Elias (SOAR/NOAO)

The infrared spectrometer TripleSpec 4.1, previously installed on the CTIO Blanco telescope, has now been successfully modified and installed on the SOAR telescope, where it can take advantage of the telescope's image quality and potentially be scheduled with greater flexibility (see the accompanying AEON article in this issue). Updates on the recommissioning have been provided in previous issues of *Currents*, most recently in March of this year.

Here we report on the two science verification (SV) runs in April and June 2019. During the SV runs, conducted over six nights, 92 objects were observed as part of 11 scientific programs. The observations characterized nearby ultra-cool dwarfs, measured the metallicities of brown dwarfs, and the accretion rate of a classical T Tauri star, among other goals. The data are now being reduced using the Spextool pipeline that was modified for use at SOAR by Katelyn Allers. The figure to the right shows the reduced TSpec4.1 spectum from 0.94 microns to 2.5 microns of ESO-Ha 2429, a classical T Tauri star (PI – Tina Armond, UFSJ, Brazil).

With TripleSpec now considered to be a fullycommissioned facility instrument, prospective TripleSpec observers are encouraged to submit proposals for the 2020A semester. Documentation on the instrument can be found on the <u>SOAR TSpec pages</u>.

The modifications to the instrument were performed by Cornell University (Terry Herter, PI), with special thanks to Chuck Henderson who ably supported the on-site work and got to experience a major earthquake in exchange. The modifications to the data pipeline were made by Katelyn Allers (Bucknell University). NOAO support was provided by Marco Bonati, Jose Piraces, Nicole David and the SOAR day crew.



# Data Release 8 of the Legacy Surveys

Legacy Surveys Imaging Team

The eighth data release (DR8) of the <u>DESI Legacy Imaging Surveys</u> is now publicly available. DR8 contains approximately 1.6 billion unique sources and includes source catalogs, images, and an interactive image viewer covering a third of the sky in three optical (g,r,z) and four mid-infrared (from WISE) bands. These data encompass the entire footprint of the upcoming <u>Dark Energy Spectroscopic</u> <u>Instrument</u> (DESI) survey and will be used for the selection of DESI spectroscopic targets. The DESI instrument is in the process of being installed on the Mayall 4-m telescope on Kitt Peak; instrument commissioning will begin in October and the science surveys will begin next year.

The Legacy Surveys combine, in a systematic way, data from the following ground-based optical surveys: (1) the Dark Energy Camera Legacy Survey (DECaLS); (2) the Mayall zband Legacy Survey (MzLS); (3) the Beijing-Arizona Sky Survey (BASS); and (4) publicly available images from the Dark Energy Survey (DES). DECaLS and DES were conducted using the Dark Energy Camera (DECam) on the 4-m Blanco Telescope at the Cerro Tololo Inter-American Observatory in Chile. The BASS and MzLS surveys were carried out with Steward Observatory's 90" Bok Telescope and NOAO's 4-m Mayall Telescope at the Kitt Peak National Observatory in Arizona. In addition, DR8 contains mid-infrared photometry from 5-



The Legacy Surveys z-band depth and coverage map from the DR8 release seen in an equatorial projection. The solid grey line traces the Galactic plane. See <u>here</u> and <u>here</u> for more details. (Credit: Dr. Dustin Lang) years worth of imaging by the <u>WISE satellite</u>. The <u>DR8 grz photometry</u> is homogeneously flux calibrated to the natural AB system of the three instrument+telescope combinations used for the surveys. The DR8 astrometry is tied to Gaia Data Release 2, resulting in astrometric residuals smaller than +/- 30 milliarcseconds.

As in previous releases, the survey can be perused using the <u>Imagine Sky Viewer</u>, created by team member Dr. Dustin Lang. With the Sky Viewer, users can compare the Legacy Surveys imaging with other imaging data sets (e.g., SDSS, WISE, etc.) and overlay user catalogs. A streamlined version of the viewer is <u>available here</u>.

DR8 also includes an <u>image gallery</u>, created by team member Dr. John Moustakas, of highredshift galaxy clusters selected from the SDSS redMaPPer/v6.3 cluster catalog.

DR8 is the result of major observational and computational efforts by the Legacy Surveys team. DECaLS (PIs Drs. David Schlegel and Arjun Dey) was conducted over 196 observing nights, spread over 248 calendar nights between August 2014 and March 2019. Fiftyseven observers from 22 institutions took part in the observing campaign. MzLS (PI Dr. Arjun Dey) was carried out over 398 nights spread over 428 calendar nights between April 2015 and February 2018. Ninety-one observers from 34 institutions took part in the observing campaign. BASS (PIs Drs. Xu Zhou and Xiaohui Fan) was conducted over 335 nights spread over 387 calendar nights between January 2015 and March 2019. Thirty observers from 9 institutions took part in the observing campaign. 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 overview of the full DESI imaging effort is provided in <u>Dey et al. (2019)</u>. The DR8 data products are available through [1] the <u>Legacy</u> <u>Survey website</u>; [2] the <u>NOAO Science</u> <u>Archive</u>; and [3] the <u>NOAO Data Lab</u>. The NOAO Science Archive provides access to both the DR8 raw and calibrated images. The NOAO Data Lab provides tools to <u>access databases</u> containing the catalogs. The Data Lab tools enable complex user queries and analyses of



<u>A screenshot</u> from the <u>DR8 Imagine Sky Viewer</u> at the location of <u>UGC 8440</u>.



An image of the z~0.44 high-redshift cluster RMJ014656-092952 from the Legacy Surveys DR8 image gallery showing the cluster galaxies and a nearly complete Einstein ring from a gravitationally-lensed background galaxy. The white scale bar represents 15 arcseconds. (Credit: Dr. John Moustakas)

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 <u>Dark Energy Survey (DES) DR1</u>, the <u>NOAO Source Catalog (NSC</u>), and <u>Gaia DR2</u>). Precomputed tables that crossmatch Legacy Surveys to other catalogs are provided by Data Lab for these purposes. User feedback can be communicated via the <u>Data</u> <u>Lab Helpdesk</u> or email (<u>datalab@noao.edu</u>). A comprehensive list of <u>Legacy Surveys</u> <u>acknowledgments</u> is available from Data Lab.

The Legacy Surveys Imaging Team is: Stephen Bailey, Arjun Dey, David Herrera, Stephanie Juneau, Martin Landriau, Dustin Lang, Aaron Meisner, John Moustakas, Adam Myers, Eddie Schlafly, David Schlegel, Frank Valdes, Benjamin Weaver, Christophe Yeche, and Mark Zhang



### News from the US Extremely Large Telescope Program

Mark Dickinson (NOAO)

The <u>US Extremely Large Telescope (ELT) Program</u> (US-ELTP) is a collaboration between NOAO, the Giant Magellan Telescope (GMT) and the Thirty Meter Telescope (TMT) to enable the whole US astronomical community to carry out research using these next-generation observatories with 25% or greater share of open-access observing time. The Program has recently welcomed a Project Director and submitted white papers in support of the upcoming Decadal Survey.

**Welcome Sidney Wolff.** The Association of Universities for Research in Astronomy (AURA) is pleased to welcome Dr. Sidney Wolff as Project Director for the AURA/NOAO US-ELTP team. Dr. Wolff has previously served as Director of NOAO, Gemini, and LSST, and brings extensive experience with new initiatives in ground-based optical/infrared astronomy.

**Astro2020 White Papers.** The 2020 Decadal Survey of Astronomy and Astrophysics (Astro2020) recently solicited white papers on "Activities, Projects, and State of the Profession Considerations" (APC). Members of the US-ELTP collaboration submitted several white papers in response to this call. These include:

- <u>The US Extremely Large Telescope Program (S. Wolff et al.)</u> An overview of the US ELT Program and the TMT and GMT observatories.
- <u>Multiwavelength Astrophysics in the Era of the ngVLA and the US ELT Program</u> (<u>A. Beasley, S. Wolff et al.</u>) This white paper discusses scientific programs that are uniquely possible using the combination of unparalleled sensitivity and high angular resolution of TMT/GMT, operating at optical and infrared wavelengths, together with that of the Next Generation Very Large Array (ngVLA), operating at 1.2 to 116 GHz. The white paper also examines issues raised by the costs of building and operating flagship facilities, and strategies that can maintain the health of the US astronomical community and its international leadership.
- <u>Observatory Operating Costs and Their Relation to Capital Costs (R. Goodrich</u> <u>et al.)</u> This white paper examines the relationship between operating and

construction costs for modern ground-based observatories, with projections for the next generation of giant segmented mirror telescopes.

Additional APC white papers submitted by members of the community discuss a variety of initiatives and technical considerations for ELT instrumentation, particularly in regard to the study of extrasolar planets. Lists of APC and science white papers relevant to the US ELT Program are available at the <u>NOAO US-ELTP</u> web site.

### Science Synergies in the Era of the Thirty Meter Telescope: The 2019 TMT Science Forum

Xiamen, China, 4-6 November 2019 https://conference.ipac.caltech.edu/tmtsf2019

Registration is now open for the <u>2019 Thirty</u> <u>Meter Telescope (TMT) Science Forum</u>, which will be held in Xiamen, China **4-6 November 2019**. The Forum is the prime opportunity to learn about the Thirty Meter Telescope, to receive updates on its design and construction, to discuss its science capabilities, and to become involved in shaping the observatory's future.

This year's Forum will discuss science synergies between the TMT and space- and ground-based facilities operating in the 2030s,



with an emphasis on facilities with strong involvement from China. These facilities include the Square Kilometer Array (SKA), the Five-hundred meter Aperture Spherical Telescope (FAST), The Chinese Space Station Telescope (CSST), Einstein Probe and the enhanced X-ray Timing and Polarimetry Mission (eXTP).

The TMT Forum will consider transformative science with the TMT and its suite of instruments throughout all domains of astrophysics, from our immediate solar neighborhood to the most distant galaxies, keeping in mind the synergetic, multi-wavelength approach, to address fundamental questions about the nature of our universe. Special emphasis will be given to the operational and data-archive requirements that will enable major contributions of the TMT in the field of multi-messenger astronomy.

Obtaining a visa to travel to China may take a considerable amount of time, so be sure to start the process soon. Visa information is available at <a href="https://conference.ipac.caltech.edu/tmtsf2019/page/visa">https://conference.ipac.caltech.edu/tmtsf2019/page/visa</a>.

Travel support funding will be available for US scientists. Please see <u>https://conference.ipac.caltech.edu/tmtsf2019/page/UStravel</u> for more information.

# **NEID Queue Observers Onboard**

NN EXPL

Partnership for Exoplanet Discovery and Characterization

Heidi Schweiker (WIYN/NOAO)

Two young astronomers, Eli Golub and Jessica Klusmeyer, joined the WIYN team this month as queue observers for NEID, the extreme precision radial velocity spectrometer. NEID is being developed as part of <u>NN-EXPLORE</u>, a NASA-NSF partnership that aims to provide the astronomical community with a state-ofthe-art spectrograph dedicated to highprecision Doppler observations of exoplanets around nearby stars. Shared risk observations with NEID are scheduled to begin in December 2019.

Jessica and Eli both have physics and astronomy degrees as well as experience with astronomical observing. Jessica recently



NEID Queue Observers Jessica Klusmeyer (left) & Eli Golub

received her Masters degree at Wesleyan, where she completed her thesis research on "A Deep Search for Five Molecules in the Debris Disk of 49 Ceti". Eli has been working as a Field Observational Astronomer through the University of Virginia, where he observed occultations of KBOs, asteroids and planetary satellites. Eli and Jessica will play major roles in bringing NEID into stable and productive operation. They will also assist with WIYN observing in general.

### **Contact Us**

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

*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.

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