


2023

Annual Report



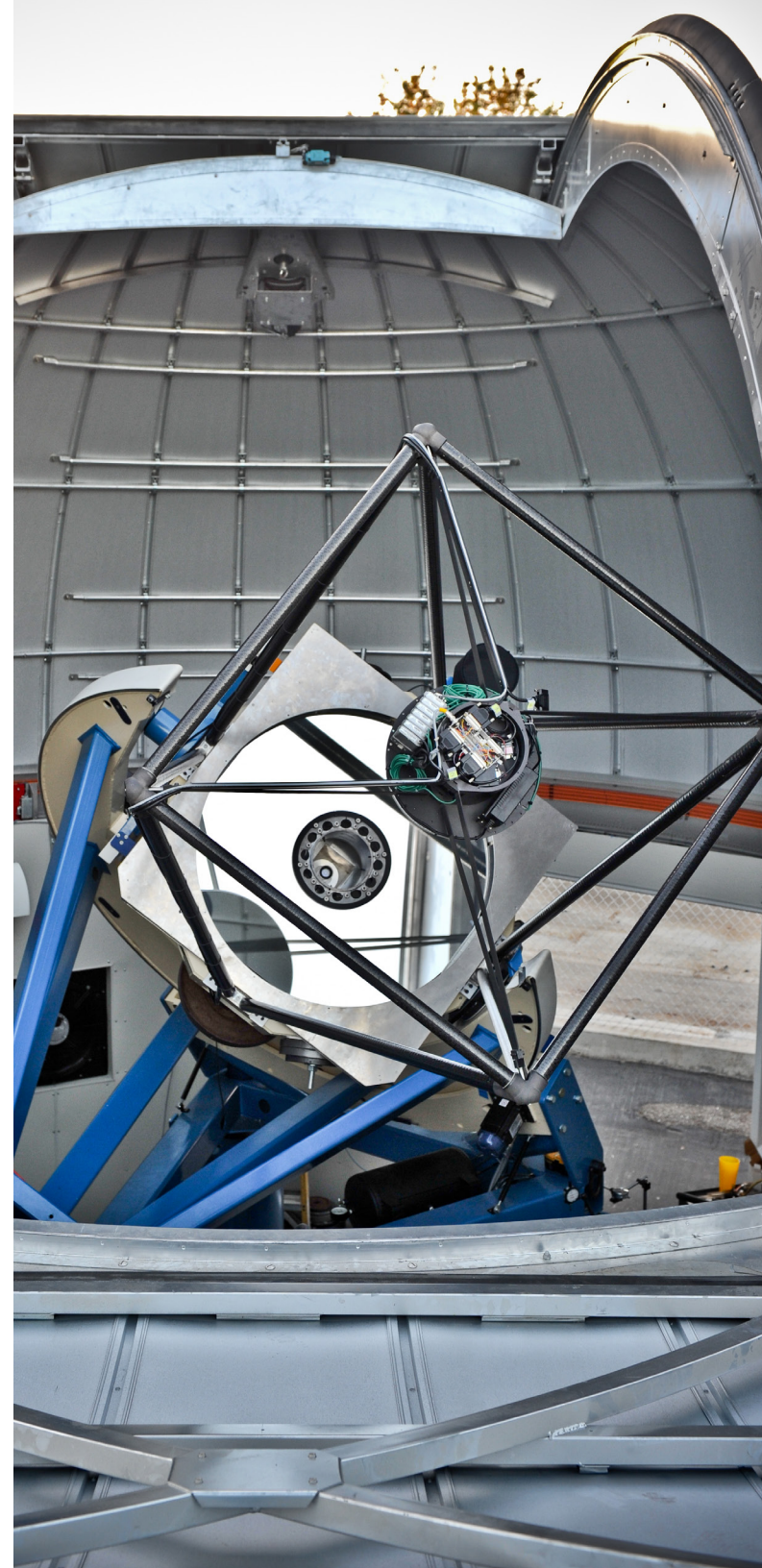
Las Cumbres Observatory saw significant achievements during the year 2023 in all areas of our operation. With our small team, we made great progress in hardware, software, science, and education.

Here we share some highlights of the past year.

Cover photo: The Milky Way illuminates LCO's Faulkes Telescope North dome on the summit of Haleakala.

Image credit: Haleakala Amateur astronomer Rakhal Kinkaid. The lava knoll where the Milky Way touches Earth is a culturally significant site.

Telescopes

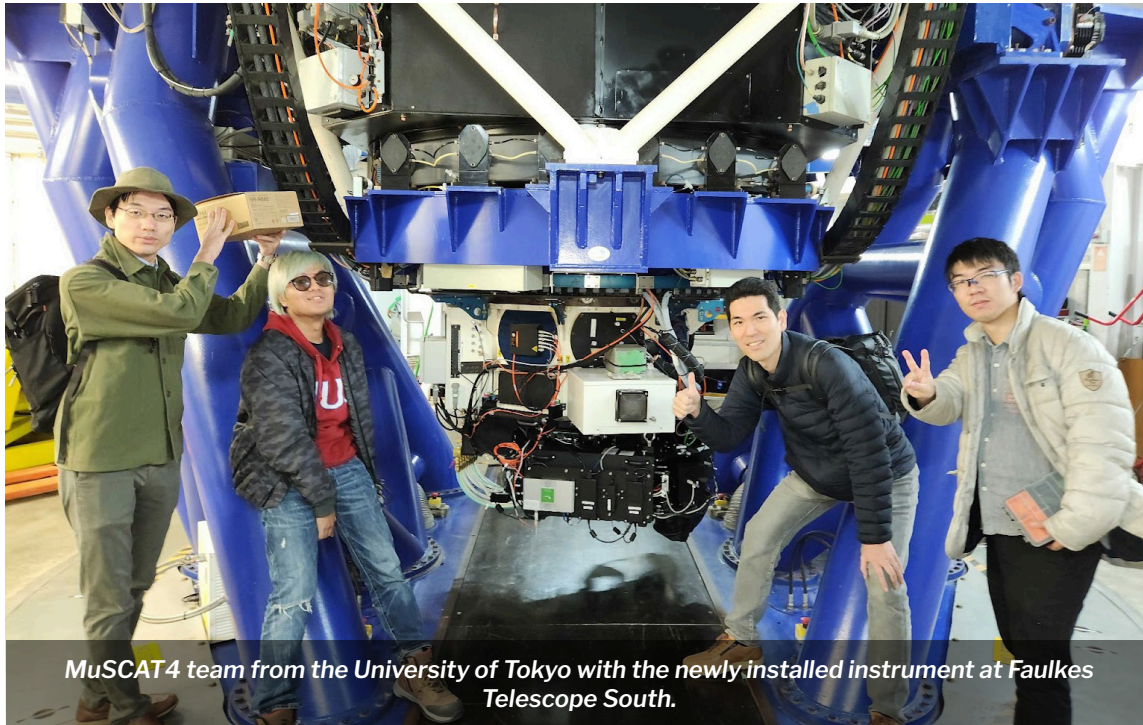


New Instrument Sees First Light at Siding Spring Observatory

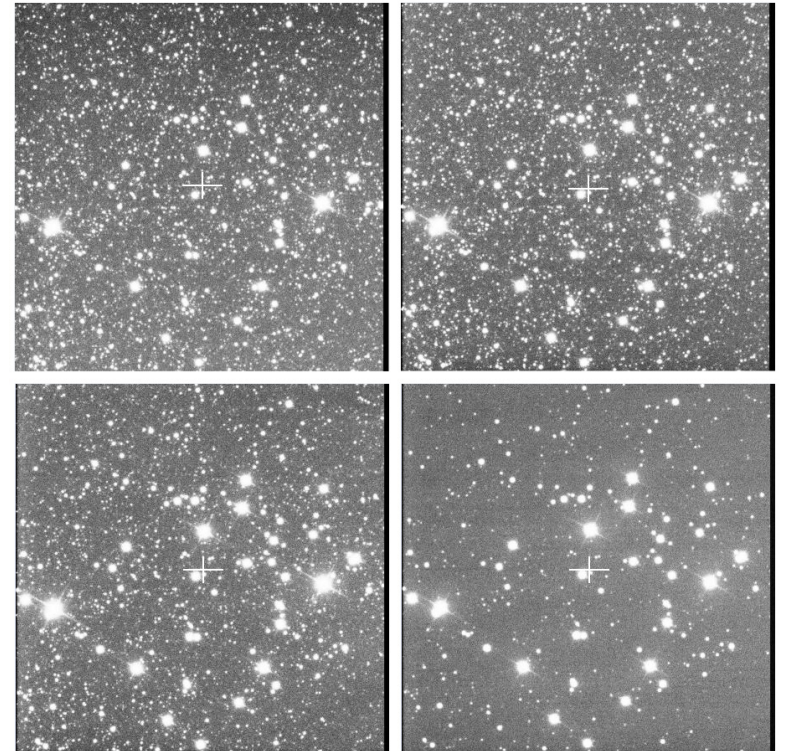
Following the successful installation of the MuSCAT3 instrument at the Haleakala Observatory, LCO experienced strong demand for the multi-channel camera and made plans to build and install another at the Siding Spring Observatory in Australia.

The [Heising-Simons Foundation](#) provided a grant of \$1.6 million to fund the new imager. MuSCAT4 was built by the same team in Japan that constructed MuSCAT3 and was successfully installed at the Faulkes Telescope South, Siding Spring Observatory, in October 2023. The new instrument was released for science observations on October 19th.

LCO is pleased that the new camera is popular for use by international scientists and multiple science papers are in preparation for publication this year.



MuSCAT4 team from the University of Tokyo with the newly installed instrument at Faulkes Telescope South.



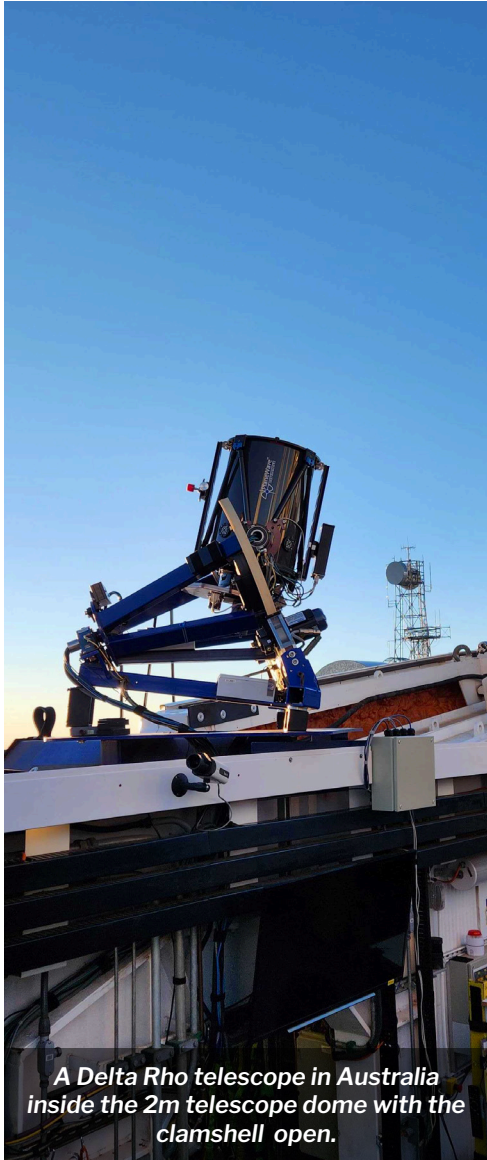
First light for MuSCAT4. All four channels, g', r', i', and z, captured an image of the open cluster NGC 6281 located in the Scorpius constellation. The field of view is 9.1' x 9.1' arcminutes.

Ten New Delta Rho Telescopes in Operation

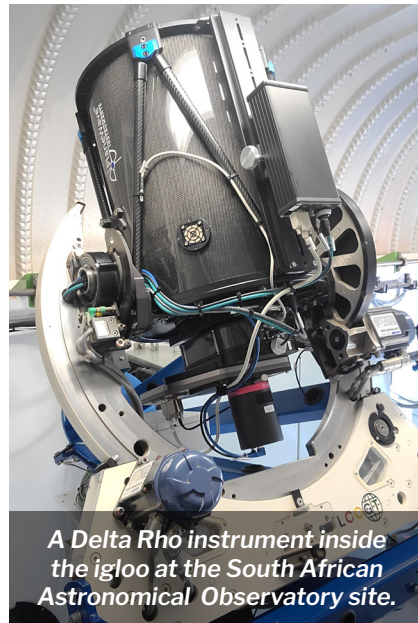
LCO's education program [Global Sky Partners](#) makes telescope time available to students, particularly from underrepresented communities and the developing world, via partner organizations. Our network of ten 0.4-meter telescopes is the backbone of our education program. Over 1300 hours of telescope time were provided in 2023. With a grant from the [Moore Foundation](#), the network of education telescopes has been upgraded, which has improved the reliability of the network and the quality of the images.

The upgraded telescopes are Planewave Delta Rho 35cm instruments. A prototype in Hawai'i was successfully commissioned in 2022. We now have eight Delta Rho telescopes in operation and the last two are being installed in Chile in March of 2024.

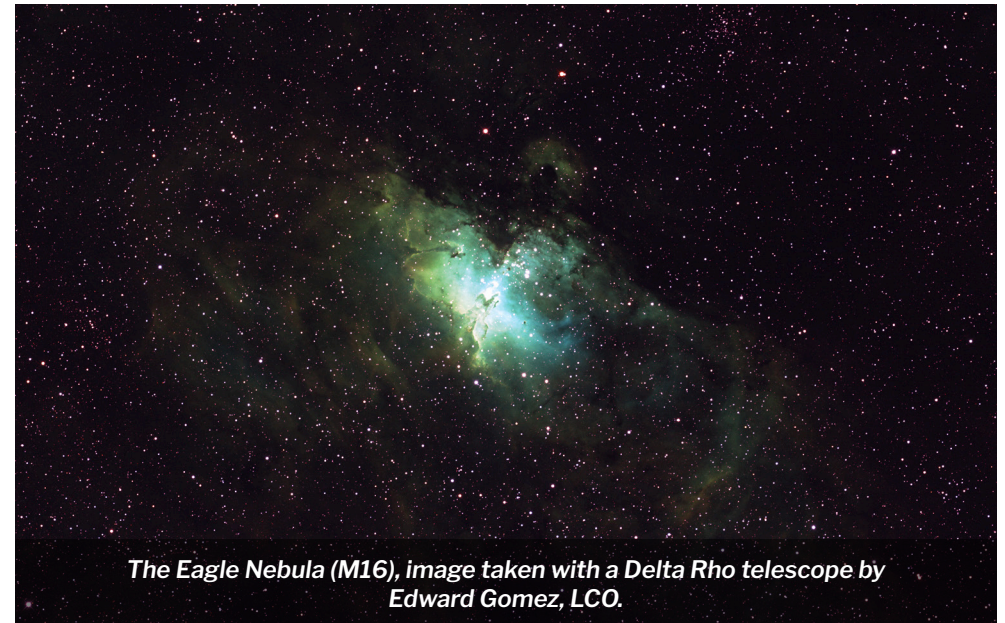
All of the 2024 Global Sky Partners have transitioned to using the new telescopes seamlessly. The partners are very happy with how the transition was handled and, most importantly, with the superior data quality now offered by the LCO education network.



A Delta Rho telescope in Australia inside the 2m telescope dome with the clamshell open.



A Delta Rho instrument inside the igloo at the South African Astronomical Observatory site.



The Eagle Nebula (M16), image taken with a Delta Rho telescope by Edward Gomez, LCO.



Software

Observatories Software Workshop

LCO Senior Scientist [Dr. Rachel Street](#) and software engineers William Lindstrom, Joey Chatelain and Matt Daily hosted a workshop last September at an astronomy conference in Croatia.

The workshop was given for the operators of international telescope facilities who will participate in the follow-up of discoveries from the [Rubin Observatory](#) when it comes online in 2025. This workshop reviewed software capabilities for time-domain astronomy using these data sources.

LCO presented live demonstrations of our software products developed in-house, the [TOM Toolkit](#) and the [Observatory Control System](#). LCO makes these tools available to the astronomy community and offers workshops such as this one to assist scientists in their uses and applications.

The workshop was a hybrid event, attended by 15 people in-person and up to 15 people online, who joined via a Zoom channel set up for the event. The event was advertised to the whole Rubin community, and particularly to representatives of observatories. Several observatory teams sent a representative in person.

A questionnaire sent to all workshop participants gave positive reviews of the workshop content, presentation, and organization. The Rubin team also expressed their appreciation for the workshop, and the LCO team are very grateful to the organizers of the conference for enabling this workshop to take place.



Attendees at the workshop in Croatia.

"Observatories around the world will be crucial in truly characterizing the nature of the amazing discoveries that Rubin will make."

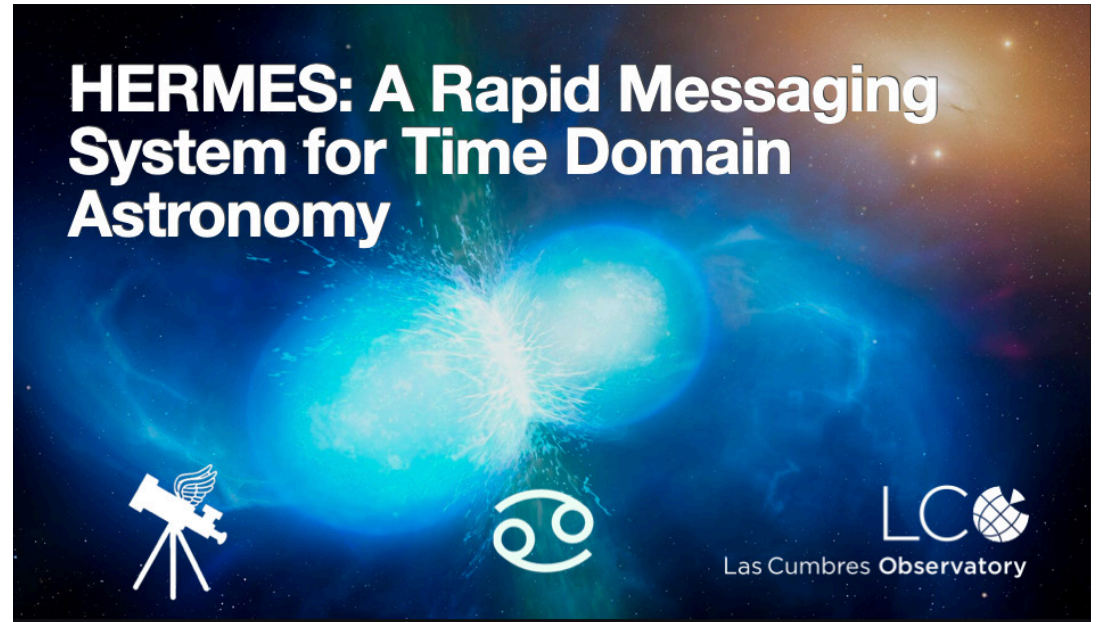
- Dr. Rachel Street
Senior Staff Scientist, LCO

Observing in the Big Data Era: LCO develops HERMES

Over the past year, Las Cumbres has conceptualized and built a new messaging service for astronomy, HERMES, to bring multi-messenger astrophysics communication and collaboration tools into the 21st century. Connecting a gravitational wave event to its corresponding electromagnetic emission requires rapid coordination between instruments around the world. To that end, LCO has worked as part of the Scalable Cyber Infrastructure for Multi-Messenger Astrophysics (SCIMMA) to develop a backbone for communication between the gravitational-wave observatories and classical telescopes.

This year, we have leveraged that experience to bring these benefits to a broader community. Individual university scientists may not have the resources to set up a complex alerting system but still have access to telescope resources and contribute to the search for electromagnetic counterpart searches. To connect with this group, we developed the tool called HOP-Enabled Rapid Message Exchange Service, or HERMES. This provides a webpage to which any amateur or professional astronomer can report observations.

We provide an easy-to-use interface that then disseminates the information to the entire scientific community. The system we designed marries both human and machine-readable information so that the messages can be acted on automatically when necessary while the human provides a broader context for their observations. Together, we will find the next kilonova!



Science



LCO Astronomers Study the Largest Gamma Ray Burst Ever Seen

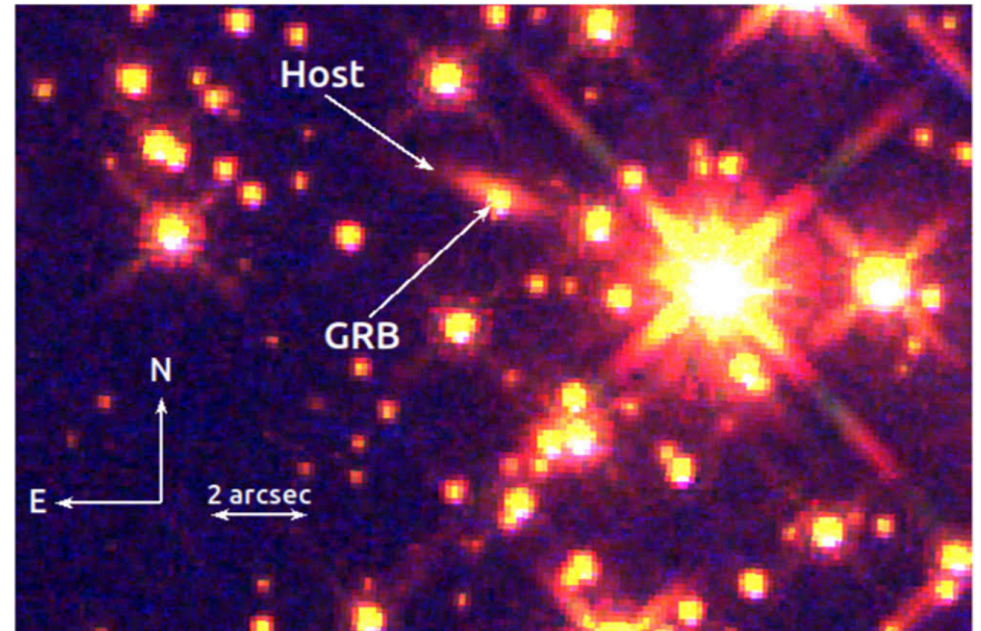
On October 9, 2022, space-based detectors picked up the signal of the brightest Gamma Ray Burst ever detected. The event, [GRB 221009A](#), is 70 times brighter than anything previously recorded. Teams of scientists around the world have been studying the data in an effort to describe this extraordinary event.

In late March, a [study](#) was published in the *Astrophysical Journal Letters* detailing the search for a supernova signal in GRB 221009A. The study includes data from optical telescopes around the world, including the LCO observatory in Maui.

The head of the Global Supernova Project, Dr. Andy Howell and a group of scientists that includes present and former LCO postdoctoral researchers and graduate students contributed to the project. The paper concludes that the data do not present a clear sign of a supernova, while the possibility does exist of a supernova that occurred at an energy level too low to be detected.

"This is what Las Cumbres Observatory was built for – when something happens in the sky, we can point our telescopes immediately and follow that exciting event around the clock. And the results are interesting – how can the GRB that is the brightest of all time in Gamma Rays not produce a bright supernova? Maybe the star collapsed to make a black hole and the supernova was a dud. We'll be scratching our heads over this for a long time."

- Dr. Andy Howell
Senior Staff Scientist, LCO
Adjunct Faculty, UCSB



Combined Hubble Space Telescope images of the GRB 221009A field, observed on 2022 December 4. Note the clear appearance of an underlying host galaxy, with a disk-like shape. Image Credit: *The Astrophysical Journal Letters* (2023)

LCO Data Confirm the Success of NASA's DART Mission



Graphic of the over three dozen telescopic facilities in space and around the globe that were planned to observe the Didymos asteroid system in support of DART's global observation campaign after impact.

Chile: Las Cumbres Observatory Global Telescope Network (LCOGT). South Africa: Las Cumbres Observatory Global Telescope Network (LCOGT). Image Credit: NASA/ Johns Hopkins APL/Nancy Chabot/Mike Halstad.

The NASA [Double Asteroid Redirection Test](#) mission — the first test mission for NASA's [Planetary Defense Coordination Office](#) — launched a spacecraft in November of 2021 with the aim to crash into the binary near-Earth asteroid system [Didymos](#). The DART impact with the smaller asteroid Dimorphos occurred on September 26, 2022. The goal of the mission was to alter the period of Dimorphos in its orbit. Analysis of data taken since the impact has shown that the experiment was a great success. A paper published 2023 March 1 in the journal [Nature](#) documents the full scope of the experiment and the ongoing research.

LCO scientists [Dr. Tim Lister](#), Dr. Joey Chatelain, and Dr. Edward Gomez are coauthors on this paper. Data from LCO telescopes, along with two others in Chile and planetary radar observations from Goldstone, CA, were used to measure the new period of Dimorphos after the DART impact. Dr. Lister was busy over the months following the DART impact continuing to observe Didymos and Dimorphos and the still present plume of ejecta to gain more insights into Dimorphos's properties and the effect of the impact.

"It's been a great privilege to be involved with and contribute to such an important mission for planetary defense. Having LCO telescopes in both Chile and South Africa allowed us to compare with other telescopes in Chile and also capture parts of Dimorphos's orbit that other telescopes could not. LCO's extensive telescope network in the Southern Hemisphere was important in being able to measure the period change so soon after the impact."

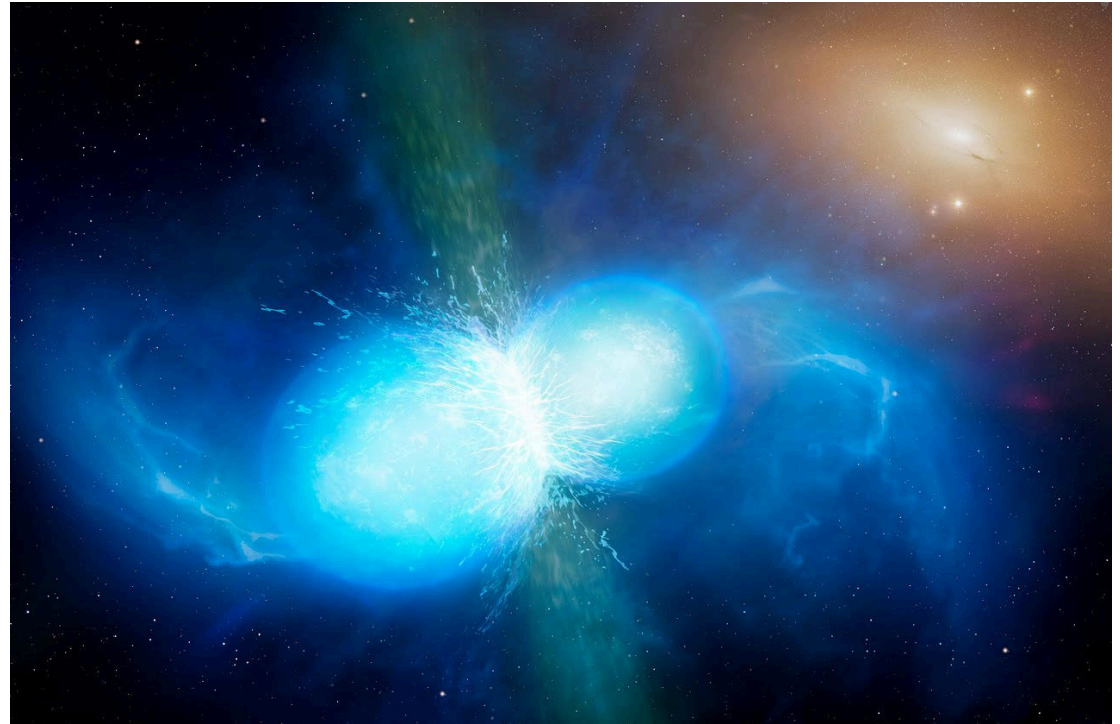
- Dr. Tim Lister
Senior Staff Scientist, LCO

UC Santa Barbara and Las Cumbres Observatory partner to lead the future of multi-messenger astronomy

Multi-messenger astrophysics (MMA) brings together different “messengers”, or ways of studying the universe, such as photons, gravitational waves and high-energy particles. By combining these different data points, MMA can probe questions in fundamental physics through astrophysics. For example, gravitational waves from the first and, to date, only known merger of two neutron stars – a kilonova – detected by the LIGO-VIRGO-Kagra Collaboration provided astronomers insight into how the heaviest elements in the universe were synthesized.

To develop communications infrastructure to coordinate and connect multi-messenger astrophysics research across the globe, the National Science Foundation (NSF) approved a proposal by the National Center for Supercomputing Applications (NCSA) and the Scalable Cyberinfrastructure to support Multi-Messenger Astrophysics (SCIMMA). Researchers from UC Santa Barbara and the Las Cumbres Observatory (LCO) in Goleta, are among the principal scientists leading this effort.

The full story of this partnership appears in [The Current](#) of UC Santa Barbara.



Multi-messenger astronomy enabled scientists to observe merging neutron stars for the first time in 2017 (artist's impression). Image Credit: University of Warwick/Mark Garlick

LCO Data Confirm the Discovery of an Earth-Size Exoplanet



LP 791-18d, illustrated here, is an Earth-size world about 90 light-years away.
Image Credit: NASA's Goddard Space Flight Center/Chris Smith (KRBwyle)

A paper published in the scientific journal [Nature](#) describes the discovery of a world beyond our solar system, the Earth-size exoplanet LP 791-18d. This planet provides a so-far unique opportunity to investigate a temperate earth-size planet in a system with a sub-Neptune size planet.

A research group based at the University of Montreal found and studied the planet using data from NASA's [Transiting Exoplanet Survey Satellite \(TESS\)](#) and [Spitzer Space Telescope](#), as well as a suite of ground-based observatories, including the Las Cumbres Observatory network of 1-meter telescopes.

Las Cumbres Observatory provides critical follow-up data to time-sensitive astronomical discoveries.

“Las Cumbres Observatory is very happy to be able to contribute to another exciting result from NASA missions.”

*- Dr. Lisa Storrie-Lombardi
President & Director of LCO*

LCO detects planetary collision in distant solar system, revealing new cosmic object

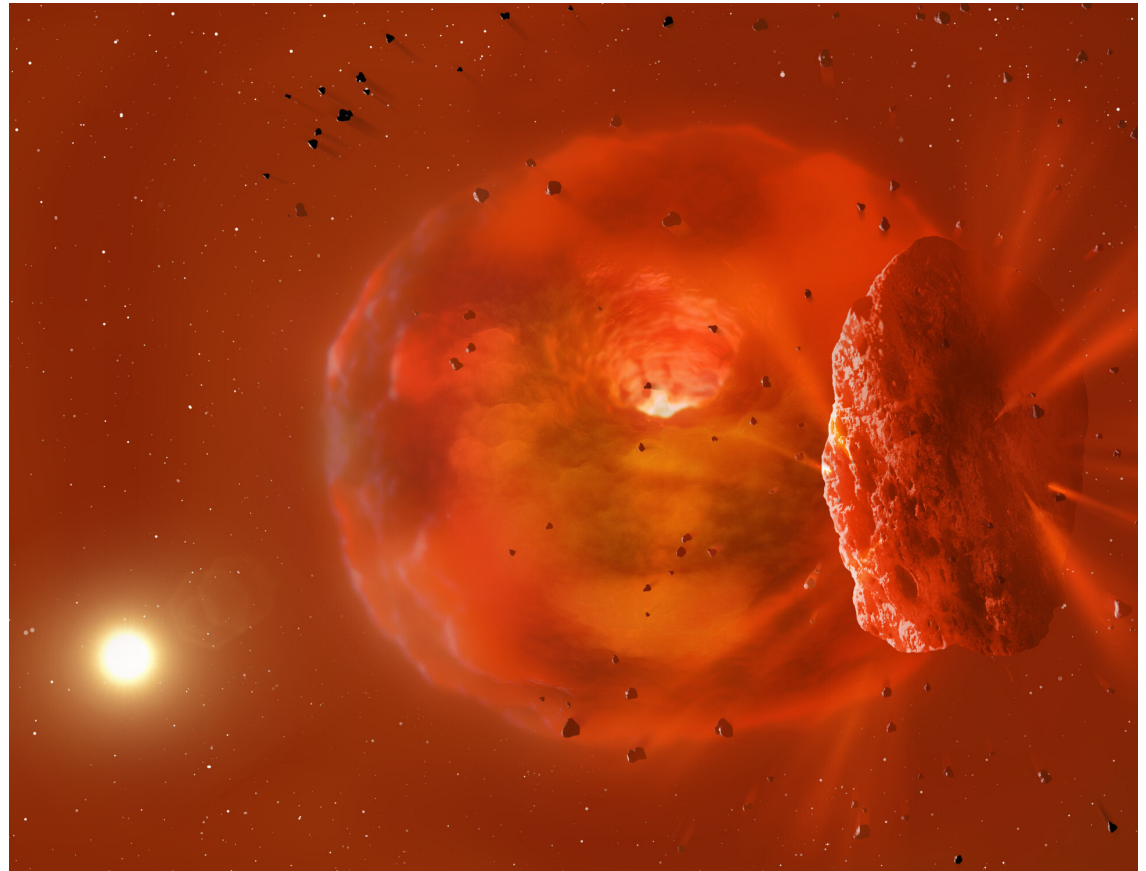
Astronomers have for the first time observed the collision of two ice-giant planets in a distant solar system, a process they believe planet Earth underwent when it was just a few million years old leading to the creation of our moon.

The international team, which included an LCO scientist, Education Director [Dr. Edward Gomez](#), says the collision has revealed the signature of a new type of astronomical object - a synestia, which is composed of a cloud of molten and vaporised rock and shaped like a doughnut.

Their findings, published in [Nature](#), have shown that the synestia resolves the mystery of a star fading unexpectedly, revealing how the fading occurred after a collision between two planets orbiting the distant star.

"After the alert, we decided to take a longer look at this star with the LCO global telescope network. This revealed the light from the star was dimming in an wholly unexpected way."

*- Dr. Edward Gomez
Education Director, LCO
Astrophysicist and paper co-author*



*Artist impression of a doughnut-shaped cloud that was formed after two ice giant planets collided.
Image Credit: Mark Garlick*

LCO Scientists Share the Secrets of an Important Supernova



Supernova SN2023ixf in the Spiral Galaxy M101. Image Credit: BJ Fulton for LCO

On May 19, the amateur Japanese astronomer Koichi Itagaki discovered a supernova in the Spiral Galaxy M101, 21 million light-years away. The event, named SN2023ixf, is the closest to Earth in five years and the second found in M101 in the past fifteen years. Mr. Itagaki alerted his professional colleagues, who immediately trained telescopes on the event. Dr. Andy Howell of Las Cumbres Observatory, who is the head of the Global Supernova Project, directed LCO's network of telescopes to image SN2023ixf as its light continued to fade.

The Global Supernova Project was designed by Dr. Howell for exactly this situation. With early and continuous data from the event, members of the Global Supernova Project have already made interesting discoveries about SN2023ixf. Two former graduate students of Dr. Howell, Dr. Griffin Hosseinzadeh and Dr. Daichi Hiramatsu, both published papers detailing unusual features of the supernova.

"We built Las Cumbres Observatory, and the Global Supernova Project, precisely to study supernovae at a moment's notice, and to be able to study them around the clock," adds Dr. Howell. "It is incredibly rewarding to see it all pay off with observations we could not have obtained at a more traditional facility of a single telescope at a single location. I'm also very happy that we could work together with fellow amateur astronomers to piece together the puzzle. People, around the world, no matter their cultural background, appreciate the night sky. Yet we can all come together to find out new things about the lives and deaths of stars."

*- Dr. Andy Howell
Senior Staff Scientist, LCO
Adjunct Faculty, UCSB*



Education






Global Sky Partners



A student from the Stanford Online High School Global Sky Partner presenting their research. Image Credit: Stanford Online High School

The primary aim of the [Global Sky Partners](#) program is to inspire, educate and provide authentic scientific experiences through the use of the LCO robotic telescope network. Through this opportunity, LCO aims to inspire audiences in underrepresented communities and the developing world, reaching audiences who would not normally be able to take part in programs involving professional scientific equipment. In 2023 we supported 25 Global Sky Partner projects which had an impact in 40 countries across the globe.

From Partners offering mentoring, workshops and training programs, with a total audience size of ~13,000 individuals:

-  **13%** of the audience were from disadvantaged or underrepresented communities or developing world countries with a further **79%** being from mixed representation
-  **51%** of the audience were mentored in publication quality research projects
-  **40%** of the audience took part in workshops and teacher training
-  **74%** of the audience were high school students
-  **19%** of the audience were teachers.

Students in these projects published 24 papers in peer reviewed journals, and presented 18 talks at professional astronomy conferences.

The programs these partners led directly served a total audience of ~15,600 individuals, which increases to ~58,300 individuals when you include students whose teachers were involved. The program used 1060 hours of observing time on the LCO educational network of 0.4-meter telescopes.

Global Sky Partners is supported by the [Simons Foundation](#) and the [Gordon and Betty Moore Foundation](#).

Brazilian Partner Project Reaches 3,000 Students

LCO: Imagens de Céu Profundo (LCO: Deep Sky Images), a member of LCO's [Global Sky Partners](#) program, is a 3-year joint project with the International Astronomical Search Collaboration and the Brazilian Ministry of Science, Technology, & Innovations (MCTI). The program currently reaches teachers in all 26 states of Brazil.

Participants in the project are trained by astronomers and image processing specialists to select astronomical targets, plan observations and process raw observational data to create high resolution color images using professional data processing and visualization tools.

After the training, students are organized into teams of between 10-20 for observing campaigns. The students initially make observations with LCO and produce color images as part of their curriculum, moving on to advanced topics such as asteroid observing, later in the year. In 2022-2023 there were four project campaigns. The program estimated it had reached 3,000 students during 2022-2023.

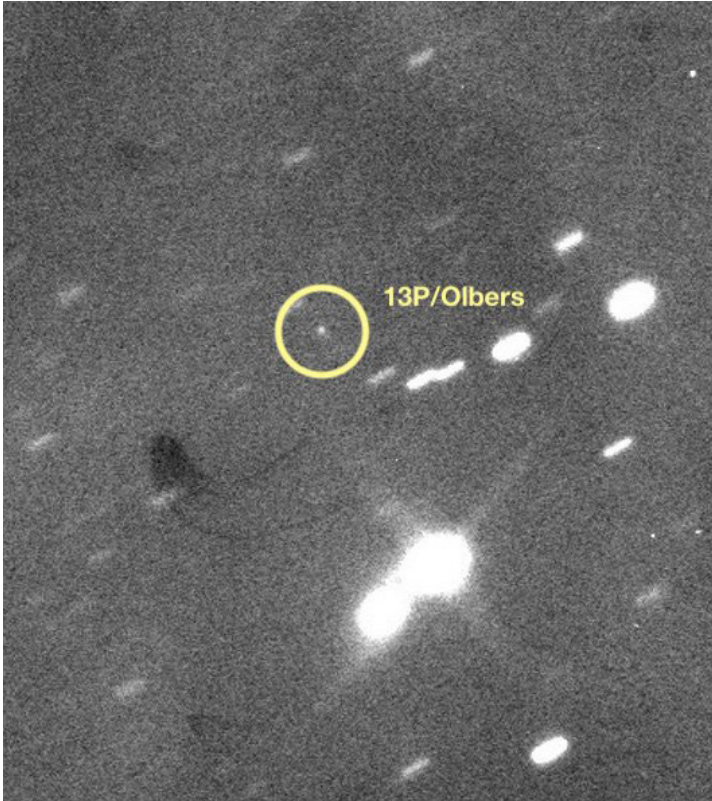


*Students from the LCO: Deep Sky Images partner program.
Image Credit: LCO: Deep Sky Images*



*The program participants were invited to an award ceremony in Brasília in October 2023. The audience is composed entirely of teachers and students from the program.
Image Credit: LCO: Deep Sky Images*

Alan Hale Recovers Comet with LCO Telescopes



Comet 13P/Olbers recovery image(s) from August 24. This is a stack of the two exposures with combined exposure time of 20 minutes. Image Credit: Alan Hale

With observations from the Las Cumbres Observatory global network of telescopes, Dr. Alan Hale located the Comet 13P/Olbers, which was last seen in 1956. Comet 13P/Olbers is a Halley-type comet discovered on March 6, 1815, by Heinrich Wilhelm Olbers at Bremen, Germany.

Dr. Hale is best known for the co-discovery of Comet Hale-Bopp in 1995 and he continues his exploration of space from the Earthrise Institute, which he founded in New Mexico in 1993.

He is also a member of LCO's [Global Sky Partners](#) program, sharing his expertise with the education partners on solar system projects as a volunteer advisor.

He first began searching for Comet 13P in October 2022, utilizing the telescopes of LCO, which he accesses through the Global Sky Partners program. In mid-June 2023, the comet emerged into the morning sky and he was making observation attempts on a biweekly basis.

On August 24, Dr. Hale took two 10-minute exposures with one of the 1.0-meter telescopes at the Siding Spring Observatory in Australia. When examining these images, he spotted a faint moving object near the predicted path of the comet. Using this information, he successfully detected images of the comet on exposures that had been taken on August 13 at the LCO observatory in South Africa.

Based upon its behaviour during previous returns, Comet Olbers should reach a peak brightness, 7th magnitude, when near perihelion in June 2024.

“The pre-recovery images are very weak, and I’m not surprised I failed to notice them at the time. Since then I have obtained follow-up images of the comet on several occasions using LCO telescopes at both facilities... Indeed, it was the unique nature of LCO that made the recovery, and especially the confirmation, feasible.”

- Dr. Alan Hale
Earthrise Institute

Educational Resources

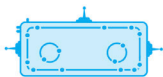
Our in-house education team produces and supports educational resources for the wider community. [SpaceBook](#) is one of our most used resources, containing information on a whole range of topics within astronomy. We have added videos to some of the most popular pages to further engage with that audience. The Stellar Parallax page now includes a video which has been watched over 220,000 times.

We developed [Serol's Cosmic Explorers](#) as an interactive web adventure for children and young people aged 8 and up. There are 3 missions which allow the audience to explore the Universe using LCO's 0.4-meter telescopes in a highly intuitive way. As well as these missions, there are educational resources and a video game. Serol's Cosmic Explorers is free for anyone with computer and internet access. In 2023, Serol's Cosmic Explorers website was shortlisted for a [Lovie Award](#) in the Education category.

[Ada's Adventures in Science](#) is a comic book series which tracks the life of an aspiring young scientist called Ada, written by our Education Director, Edward Gomez, and illustrated by the artist Laura Sorvala. These stories promote the idea that anyone can be involved in the excitement of science, they just need to ask questions. In 2018, 15,000 copies of Ada's story have been delivered to 20 countries. During 2023 we have continued creating new translations of this comic book, which is now available in 18 languages, and is completely open access.

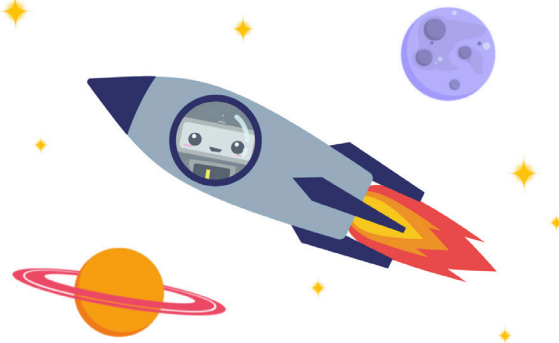
[About Serol](#)
[Movies](#)
[Education](#)
[Missions](#)
[Game](#)
[Telescopes](#)

[Login](#)
[Register](#)

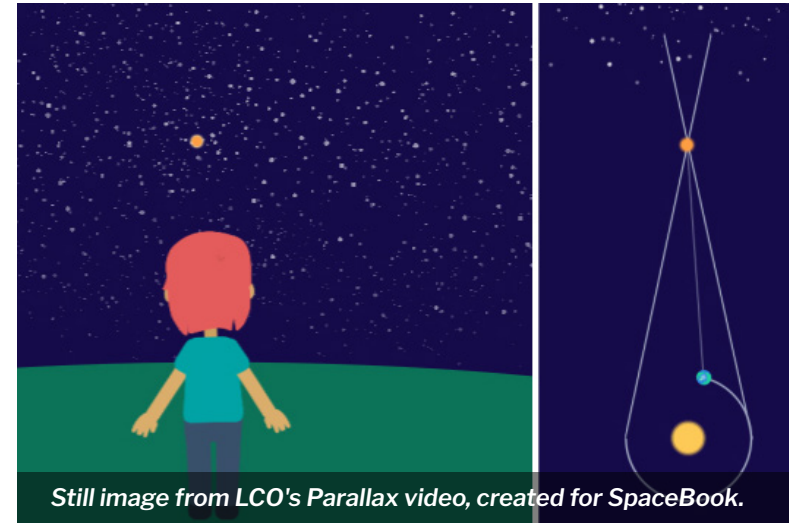


Serol's Cosmic Explorers

Explore the Universe with robotic telescopes, for children and adults from 8 years and up, for free!



Serol's Cosmic Explorers website.



Still image from LCO's Parallax video, created for SpaceBook.



Multiple language versions of Ada's Adventures in Science comic books preparing to be shipped around the world.

About LCO

Las Cumbres Observatory (LCO) is a nonprofit corporation based in Goleta, California, dedicated to advancing worldwide understanding of the Universe through science and education with its global network of fully robotic optical telescopes. LCO began its mission in 2005 and has been operating a global network continuously since May of 2014. The network currently consists of twenty-five telescopes, located at seven sites of high astronomical quality, which together serve as a single integrated observatory. The observatory is leading the future of time domain astronomy with observations that capitalize on the network's unique capabilities.

To learn more about our observatory, please visit [our website](#).