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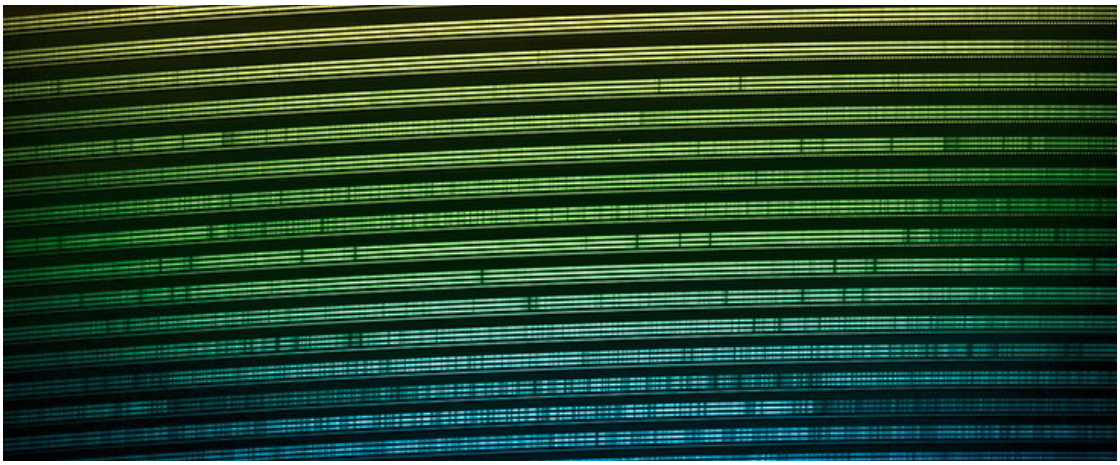
noirlab2110 — Organization Release

MAROON-X Embarks on its Exoplanet Quest

Powerful new instrument at Gemini North helps measure properties of nearby exoplanet

4 March 2021



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Astronomers using the recently installed instrument MAROON-X on Gemini North have determined the mass of a transiting exoplanet orbiting the nearby star Gliese 486. As well as putting the innovative new instrument through its paces, this result, when

combined with data from the TESS satellite, precisely measures key properties of a rocky planet that is ideal for follow-up observations with the next generation of ground- and space-based telescopes.

The exoplanet-hunting instrument MAROON-X(https://www.gemini.edu/instrumentation/maroon-x) has obtained its first scientific result from its new home at the 8.1-meter Gemini North(https://noirlab.edu/public/programs/gemini-observatory/gemini-north/) telescope, part of the international Gemini Observatory(https://noirlab.edu/public/programs/gemini-observatory/), a program of NSF's NOIRLab [1]. Shipped from the University of Chicago in mid-2019, the instrument arrived at Gemini in a collection of wooden packing crates. Despite exhausting 12-hour shifts in the thin air at an altitude of 4300 meters (14,000 feet), the MAROON-X team successfully constructed and installed the instrument in a six-month process known as commissioning. The assembled instrument takes advantage of Gemini North's location on Maunakea in Hawai'i — one of the best observing sites on the planet.

"*It's been an intense six-month stretch*," explained Jacob Bean, head of the University of Chicago team behind MAROON-X. "*We've spent ten years developing the instrument and with MAROON-X now installed on Gemini we will start to get real insights into habitable worlds around other stars.*"

The technical core of MAROON-X lies at the end of a bundle of fibers trailing from behind the main mirror of Gemini North to a small room several floors below. Inside this temperature-controlled room and encased in a vacuum chamber, a collection of high-precision optical devices forms the spectrometer(https://en.wikipedia.org/wiki/Optical_spectrometer) at the heart of MAROON-X. This spectrometer measures variations in the light from distant stars to detect the subtle influence of orbiting worlds — making MAROON-X an outstanding exoplanet hunter [2].

MAROON-X's first science result determined the mass of the newly discovered rocky planet Gliese 486 b(https://en.wikipedia.org/wiki/Gliese_436_b), which orbits Gliese 486(https://en.wikipedia.org/wiki/Gliese_436), a star smaller and dimmer than our own Sun [3]. The planet has a mass roughly three times that of the Earth, but has a similar density. The composition of this newly discovered exoplanet is not its only distinguishing feature — its relative closeness to Earth makes it an ideal candidate for observations with the next generation of astronomical technology.

"*The proximity of this exoplanet is exciting because it will be possible to study it in more detail with powerful telescopes such as the upcoming James Webb Space Telescope and the various Extremely Large Telescopes such as the GMT (https://www.gmto.org/)and TMT(https://www.tmt.org/),*" explained Trifon Trifonov, lead author of the paper reporting this discovery. "*Within the next few years, we hope to use transit spectroscopy to search for signs of an atmosphere and possibly determine this planet's surface composition.*"

MAROON-X was developed to find and characterize exactly this type of exoplanet — rocky worlds around nearby stars whose atmospheres are suitable for follow-up investigation using future instruments. As well as next-generation telescopes, MAROON-X was designed to work alongside NASA's Transiting Exoplanet Survey Satellite (TESS(https://www.nasa.gov/tess-transiting-exoplanet-survey-satellite)). In the case of Gliese 486 b, the team combined MAROON-X measurements of the exoplanet's mass with the planetary radius measured by the TESS mission to find the density of Gliese 486 b — revealing it to be a rocky super-Earth.

"*MAROON-X provides a new, valuable addition to Gemini's visiting instrument program. Demonstrating exciting precision and sensitivity, it is available for use by the astronomical community to discover and characterize new worlds,*" said National Science Foundation Division of Astronomical Sciences Program Officer Martin Still.

MAROON-X's capabilities are already popular amongst the astronomical community, with a surge of requests for observation time following the instrument's commissioning. Four long observation campaigns have already been completed despite the impact of COVID-19, as MAROON-X can be operated fully remotely. In fact, the observations of Gliese 486 b were some of the first observations obtained with Gemini North after it restarted operations(https://noirlab.edu/public/announcements/ann20002/) in May 2020. Even without astronomers on site, the capabilities of Gemini and MAROON-X have been impressive — the instrument can detect exoplanets around stars that are 150 times fainter than those visible to the naked eye.

"*This result demonstrates the unprecedented capability of MAROON-X*," concluded Jacob Bean. "*This is only our first result, and as we find more we will determine what kinds of rocky planets are out there, ultimately helping us learn more about the formation and evolution of the Earth.*"

Notes

[1] MAROON-X is a visitor instrument at Gemini North. The Gemini Visiting Instrument program allows the observatory to respond to the emerging needs of the astronomical community by hosting instruments developed by astronomers themselves. This program gives astronomers the opportunity to use specialized instruments for their scientific needs while sharing a diverse range of instruments with the wider astronomical community.

[2] Astronomers can measure the mass of an exoplanet by observing its host star, as the vast majority of exoplanets cannot be directly imaged. Instead, astronomers measure the tiny movements of host stars as they are tugged back and forth by the gravitational attraction of an orbiting planet; the more massive the exoplanet, the more the host star will be tugged to and fro. MAROON-X measures this stellar motion by capturing incredibly precise shifts in the star's spectrum.

[3] The convention for naming exoplanets is to take the name of the parent star and add a lower case letter as a suffix, starting with the letter b. As this exoplanet is the first to be discovered orbiting the star Gliese 486, it takes the name Gliese 486 b.

More information

This research was published in the paper *A nearby transiting rocky planet ideal for atmospheric investigation* to appear in the journal *Science*.

The team was composed of T. Trifonov (Max-Planck-Institut für Astronomie), J. A. Caballero (Centro de Astrobiología), J. C. Morales (Institut de Ciències de l'Espai and Institut d'Estudis Espacials de Catalunya), A. Seifahrt (The University of Chicago), I. Ribas (Institut de Ciències de l'Espai and Institut d'Estudis Espacials de Catalunya), A. Reiners (Institut für Astrophysik, Georg-August-Universität), J. L. Bean (The University of Chicago), R. Luque (Instituto de Astrofísica de Canarias and Universidad de La Laguna), H. Parviainen (Instituto de Astrofísica de Canarias and Universidad de La Laguna), E. Pallé (Instituto de Astrofísica de

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NSF's NOIRLab(https://noirlab.edu) (National Optical-Infrared Astronomy Research Laboratory), the US center for ground-based optical-infrared astronomy, operates the international Gemini Observatory(https://www.noirlab.edu/public/programs/gemini-observatory/) (a facility of NSF(https://www.nsf.gov/), NRC–Canada(http://www.nrc-cnrc.gc.ca/eng/solutions/facilities/gemini.html), ANID–Chile(http://www.conicyt.cl/astronomia/oficina-gemini-chile/), MCTIC–Brazil(https://www.gov.br/mcti/pt-br), MINCyT–Argentina(http://www.geminiargentina.mincyt.gob.ar/), and KASI–Republic of

Korea(http://kgmt.kasi.re.kr/kgmtscience)), Kitt Peak National Observatory (KPNO(https://www.noirlab.edu/public/programs/kitt-peak-national-observatory/)), Cerro Tololo Inter-American Observatory (CTIO(https://www.noirlab.edu/public/programs/ctio/)), the Community Science and Data Center (CSDC(https://www.noirlab.edu/public/programs/csdc/)), and Vera C. Rubin Observatory(https://www.noirlab.edu/public/programs/vera-c-rubin-observatory/) (in cooperation with DOE(https://www.energy.gov/science/office-science)'s SLAC(https://www6.slac.stanford.edu/) National Accelerator Laboratory). It is managed by the Association of Universities for Research in Astronomy (AURA(https://www.aura-astronomy.org/)) under a cooperative agreement with NSF(https://www.nsf.gov/) and is headquartered in Tucson, Arizona. The astronomical community is honored to have the opportunity to conduct astronomical research on Iolkam Du'ag (Kitt Peak) in Arizona, on Maunakea in Hawai'i, and on Cerro Tololo and Cerro Pachón in Chile. We recognize and acknowledge the very significant cultural role and reverence that these sites have to the Tohono O'odham Nation, to the Native Hawaiian community, and to the local communities in Chile, respectively.

Links

- Research paper(https://science.sciencemag.org/lookup/doi/10.1126/science.abd7645)
- Photos of Gemini North(https://noirlab.edu/public/images/archive/search/?adv=&subject_name=Gemini%20North)
- MAROON-X webpage(https://www.gemini.edu/instrumentation/maroon-x)

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Add translation(/public/admin/releases/releaseproxy/add/?source=noirlab2110)

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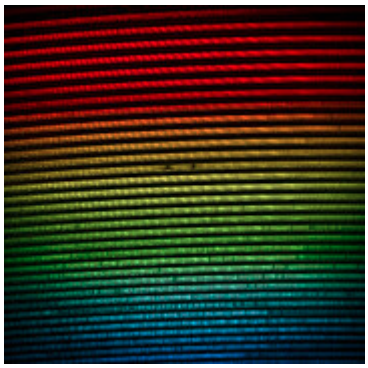
About the Release

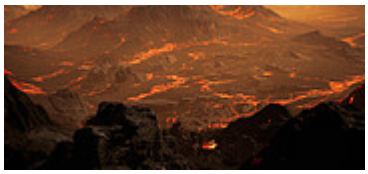
Release No.:	noirlab2110
Facility:	Gemini North(https://noirlab.edu/public/programs/gemini-observatory/gemini-north/)
Instruments:	MAROON-X

Images



(/public/images/noirlab2110a/)
PR Image noirlab2110a(/public/images/noirlab2110a/)
Colorized 2D spectra of Gliese 486 (visible light)

(/public/images/noirlab2110b/)
PR Image noirlab2110b(/public/images/noirlab2110b/)
Colorized 2D spectra of Gliese 486 (near-infrared)



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PR Image noirlab2110c(/public/images/noirlab2110c/)
Artist's impression of the surface of Gliese 486 b

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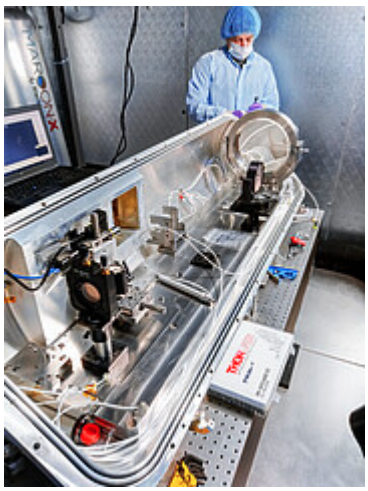
PR Image noirlab2110d(/public/images/noirlab2110d/)
MAROON-X arrives at Gemini North



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PR Image noirlab2110e(/public/images/noirlab2110e/)
Assembling MAROON-X

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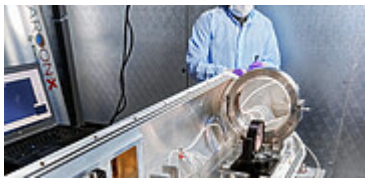
PR Image noirlab2110f(/public/images/noirlab2110f/)
MAROON-X assembled

Videos



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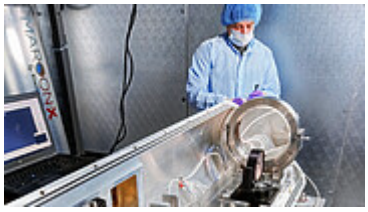
CosmoView Episode 23: First Science From MAROON-X



(/public/videos/noirlab2110b/)
PR Video noirlab2110b(/public/videos/noirlab2110b/)
CosmoView Episodio 23: First Science From MAROON-X

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