



# W. M. Keck Observatory Status and Plans 2025

January 29, 2025

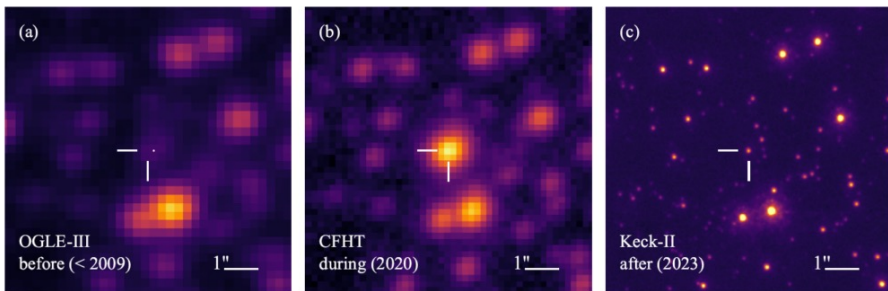
Rich Matsuda, Observatory Director



# Earth's Fate, Perhaps?



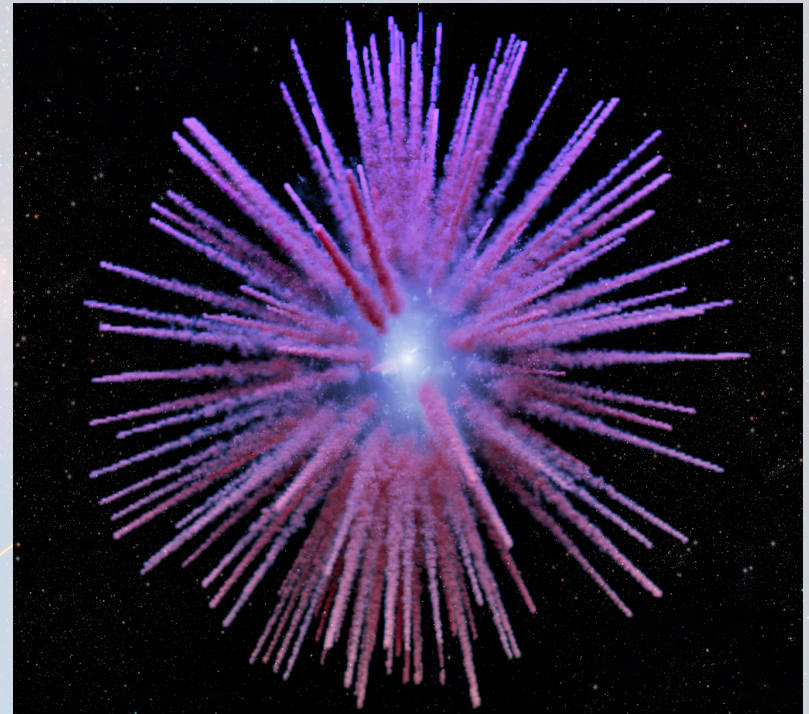
- Gravitational microlensing detection in 2020 using Korea Microlensing Telescope Network and CFHT concluded an earth-sized planet orbiting 1-2 AU from a host star half the mass of our sun about 4,000 light years away.
- Zhang (UCB/UCSD) et. al., followed up in 2023 on Keck using AO+NIRC2 to disambiguate the star.
- AO observation did not see anything there which led to conclusion that it is a white dwarf.
- What is interesting about this result is that this system looks like what earth's fate may be 8 billion years from now when our sun evolves into a red giant and then a white dwarf. Earth will migrate to a larger orbit.





# Dandelion Supernova in 3-D

- Type 1ax Supernova observed in 1181 in Cassiopeia including by Japanese astronomers.
- In 2013, the remnant nebula (Pa30) was found by amateur astronomer D. Patchick, using NASA -WISE data.
- Later, Fesen (Dartmouth) and Schaefer (LSU) discovered clumping, filaments in the remnants.
- Using the Keck Cosmic Web Imager's new red arm, Cunningham (CfA) and Calazzo (Caltech) et. al., including Chris Martin, PI of KCWI, mapped the filaments in 3 dimensions at unprecedented spatial, spectral sensitivity.



Artist conception:  
W. M. Keck Observatory/Adam Makarenko



# Keck 2035 Strategic Plan



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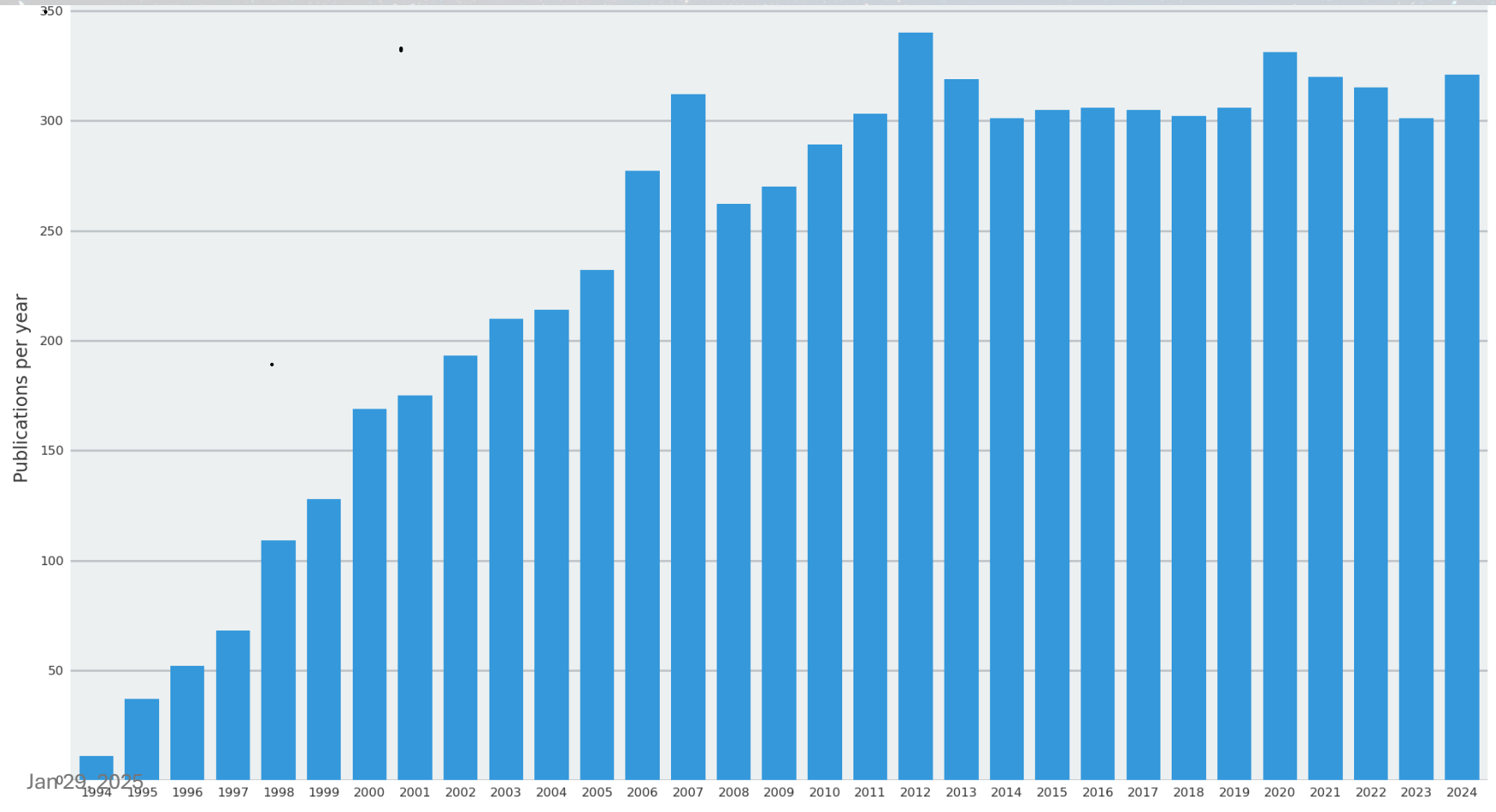
# Science



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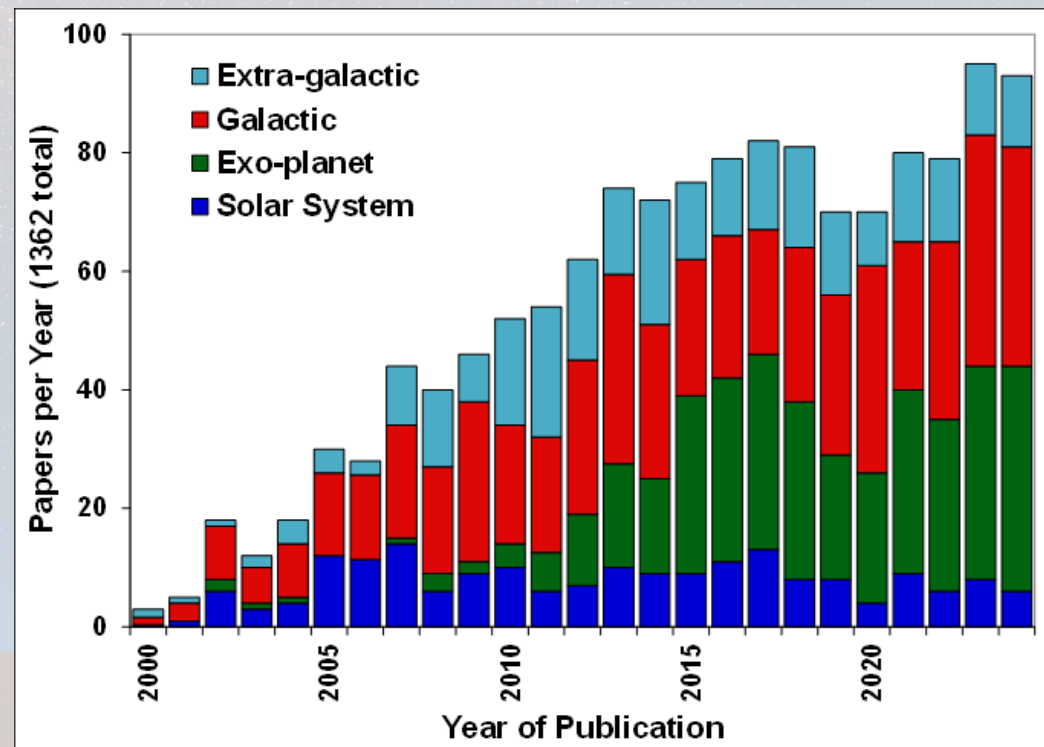


# Scientific Productivity



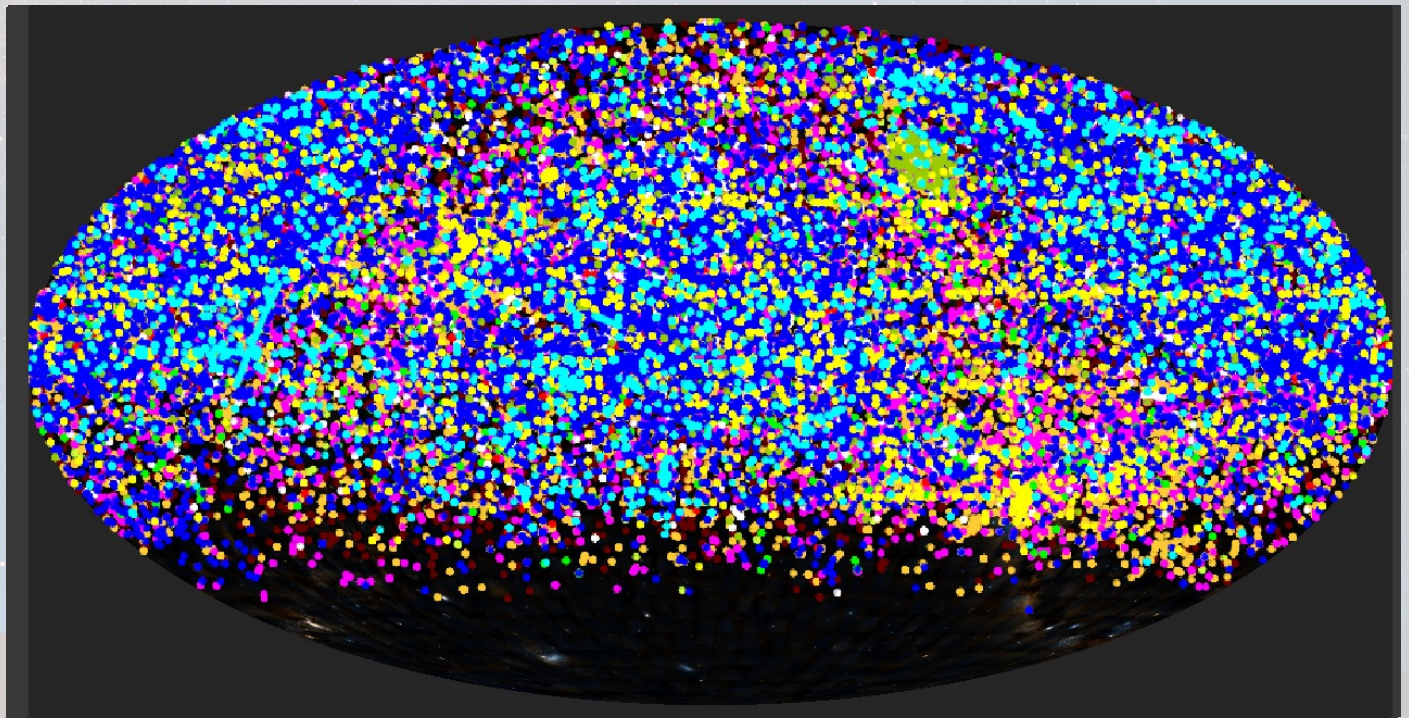
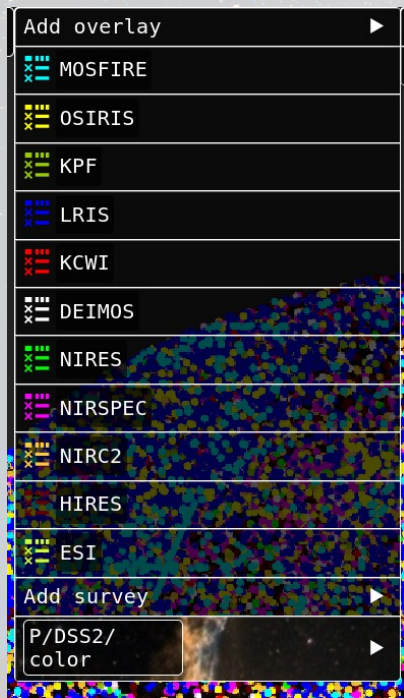


# Adaptive Optics Science Papers





# KOA Sky Map



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# Major Instrumentation Project Summary

- **KPF:** Thermal stability improvements including cryocooler installation.
- **KCWI (new red arm):** Stable operations - Cryocooler upgrade in progress.
- **DEIMOS Upgrade:** Commissioning in FY25.
- **SCALES:** In assembly and test. Delivery late CY2025.
- **HISPEC:** In final design. Delivery in 2026.
- **LRIS-2:** Preliminary design review April 2025.
- **Liger:** Seeking funding for full construction.
- **WFI:** Seeking funding for preliminary design.



# SCALES – Slicer Combined with Array of Lenselets for Exoplanet Spectroscopy

- PI Andy Skemer at UCSC
- Keck 2, AO - Designed for direct imaging and integral field spectroscopy of exoplanets
- 2-5 $\mu$ m, R = 50 (low res), ~4,000 (med res)
- Cryostat delivered - good vacuum
- First cool down successfully completed
- A series of cooldowns to test mechanism operation at temperature and under vacuum are scheduled.
- Preship review Fall 2025.
- Shipment and install end-2025.
- arXiv:2208.10721v1





# HISPEC – High-resolution Infrared Spectrograph for Exoplanet Characterization

- Fiber-fed high-resolution spectrograph fed by HAKA AO in Keck II
- 1-2.5 $\mu\text{m}$ ,  $R=100,000$
- Designed for TMT (MODHIS)
- Detailed designs for the spectrograph opto-mechanical mechanisms complete
- Detector selection in progress
- Data reduction pipeline and calibration plan is a major focus
- Have secured all funding with 30% contingency
- Delivery in 2026

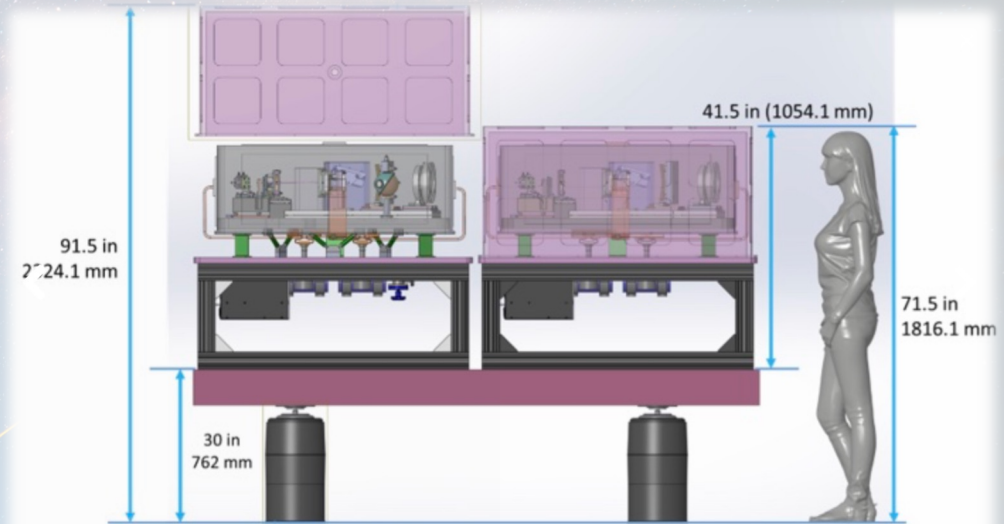


Figure: The two HISPEC cryostats housing the blue spectrograph (0.98-1.33 $\mu\text{m}$ ) and red spectrograph (1.49-2.46 $\mu\text{m}$ ).

# Adaptive Optics Leadership



Dr. Peter Wizinowich  
Retiring EMERITUS



Dr. Antonin Bouchez  
New Head of AO Development



# Keck AO Strategy

## Keck 1 Telescope

## Keck 2 Telescope

Today

**Keck 1 AO**  
OSIRIS Imager & IFS

*General-purpose  
AO systems*

**Keck 2 AO**  
NIRC2 imager  
NIRSPEC spectrometer  
KPIC fiber-feed

2025-2027

**KAPA Laser Tomography AO**  
Higher Strehl with high sky coverage  
Liger imager & IFS

*AO system  
specialization*

**HAKA Extreme AO**  
Higher contrast around bright stars  
SCALES imager & IFS  
HISPEC fiber-fed spectrometer

**'IWA**  
IR Pyr. WFS

Keck 1 AO Facility

2028-2035

**Keck 1 Adaptive  
Secondary Mirror**

Enables

*Adaptive  
telescopes*

**Single-Conjugate AO**  
for Nasmyth instruments (eg.  
KPF)

**Ground-Layer AO**

Image quality improvement for multi-  
object spectrometers

LRIS2 multi-object spectrometer  
MOSFIRE multi-object spectrometer

**Visible Multi-Conjugate AO**

Diffraction-limited in the visible

Liger Imager & IFS  
Visible Imager & IFS

↑ Innovations can be implemented  
on operational systems

**High Contrast Testbed**

Developing the next generation of  
exoplanet characterization technology



# Organizational Health

The background of the slide is a photograph of a night sky filled with stars and the Milky Way galaxy. In the foreground, two large white telescope domes are visible on a dark, silty hill. A thin yellow line originates from the left dome and extends diagonally upwards towards the right side of the frame.

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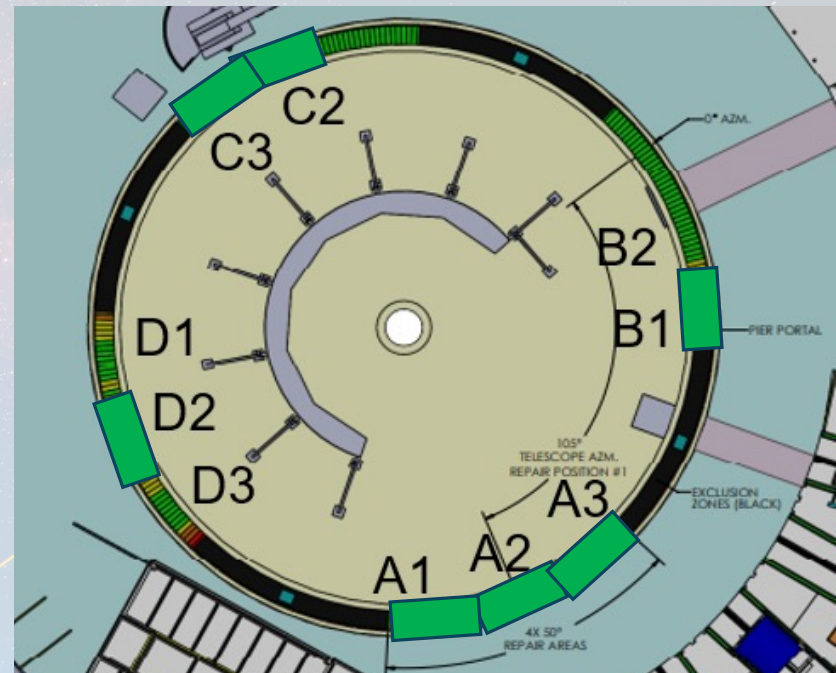


# Pier Repair – 6.5 Week Shutdown, March 2025

Major initiative to address degradation of K1 pier

2 or more shutdowns planned

Keck II does not have same issue



Downtime #1 areas of repair



A night sky photograph of Maunakea. Two large white observatory domes are visible on the dark, silty slopes of the mountain. The sky is a deep blue, filled with countless stars and the prominent, glowing band of the Milky Way galaxy stretching across the upper half of the frame. A thin, bright yellow line, possibly a laser guide star or a meteor, cuts diagonally across the sky from the lower left towards the upper right. The overall scene is serene and awe-inspiring, capturing the beauty of the natural world and human scientific endeavor.

# Hawai'i Community Relations

Jan 29, 2025



# New Governance of Maunakea

- Mauna Kea Stewardship and Oversight Authority (MKSOA) established by the State of Hawai'i in 2022.
  - “Mauna Kea has come to symbolize a rigid dichotomy between culture and science, often leading to **polarization** between stakeholders on Mauna Kea and local communities.”
  - “...for the purpose of fostering a **mutual stewardship paradigm** in which ecology, the environment, natural resources, cultural practices, education, and science are in balance and synergy.”
  - “**support of astronomy** ...is a policy of the state.”
- Authority will develop a management plan that balances astronomy development with other interests.
- Five-year transition ending in 2028 for MKSOA to assume stewardship responsibilities from the University of Hawai'i and the State Dept. of Land and Natural Resources.
- Existing master and subleases remain in effect, expiring in 2033. MKSOA authorization will be required for observatories to operate beyond 2033.
- WMKO Director Matsuda is current astronomy representative on board –
  - Objective: build strong relationships and mutual understanding so that astronomy may work in close collaboration with MKSOA and local community on future of astronomy post-2033.



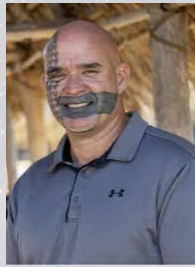
# MKSOA Board



John Komeiji, Chair  
Business/Finance



Neil Hannahs  
Land Management



Kalehua Krug  
Education



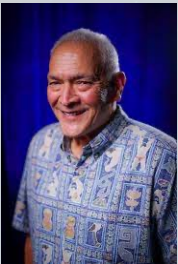
Rich Matsuda  
Observatories



Pomai Bertelmann  
Lineal Descendant



Lanakila Mangauil  
Cultural Practitioner



Paul Horner  
Senate Appt



Dr. Noe Noe Wong-Wilson  
House Appt



Ryan Kanaka'ole  
First Deputy, DLNR



Dr. Kimo Alameda  
Mayor, Hawaii County



Benjamin Kudo  
Former UH Regent



Dr. Bonnie Irwin  
Chancellor, UH-Hilo  
(non-voting member)

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## MUTUAL STEWARDSHIP



Authority Members presentation to A  
Astronomical Society Meeting in Seat

## MĀLAMA 'ĀINA (env.)



West Hawai'i Beach  
Cleanup

Maunakea Forest  
Restoration Project



## PILINA (relationships)

First Nations Futures  
Program

WHEA Stu  
with Lead

Food Truc



Respect for  
Maunakea

## LEADERSHIP



Hawai'i-  
Grounded in  
a Global  
Context

## HAWAI'I GROUNDED



'Oli welcome  
@ Keck Science Meeting

Keck Kalihiao  
May Day 2023, Lei Making



Fostering  
Connection

## ENGAGEMENT



West Hawai'i  
Explorations  
Academy  
Career Fair

Parker School Visit





# WMKO in 2035

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# Our Aim in 2035

- **We play a vibrant and essential role scientifically** in the era of the ELTs, JWST, Roman, Rubin and with future missions like the Habitable Worlds Observatory on the horizon.
- **We drive technological advancement** in instrumentation and AO, leveraging innovation of Caltech, UC, and our other scientific partners.
- **Keck nights are highly sought-after**. Superb conditions on Maunakea, Keck's unique capabilities, and great staff support enable leading-edge discoveries.
- **We have a strong relationships built on trust with the local community**, sustaining our long-term future on Maunakea. We have a new lease. The community views us as good stewards and a valuable community partner. There is a strong workforce pipeline for Hawai'i residents into jobs at Keck.
- **Our operations are highly effective and efficient**. We are financially sound, the facilities are well-maintained, and it is a highly desirable place to work. We have a great workplace culture.