

University of California Astronomy & Astrophysics



Shared Facilities in Astronomy

Lick 1m 1888



Lick 3m 1959



- Since 1888 UC has combined the resources of the UC system to participate in world-leading observatories

Keck 10m 1993/1996

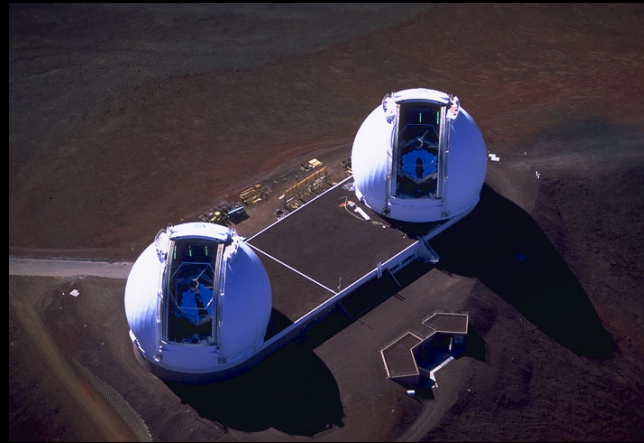


University of California Observatories

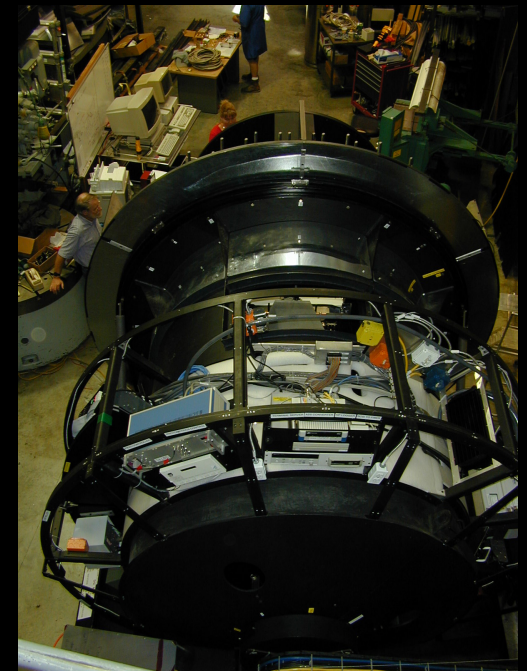
UCO is a UC Multi-Campus Research Organization with headquarters in Santa Cruz. The UCO mission is to *develop* and *manage* the astronomical optical/IR facilities for UC astronomers and to carry out forefront research in astronomy and astrophysics



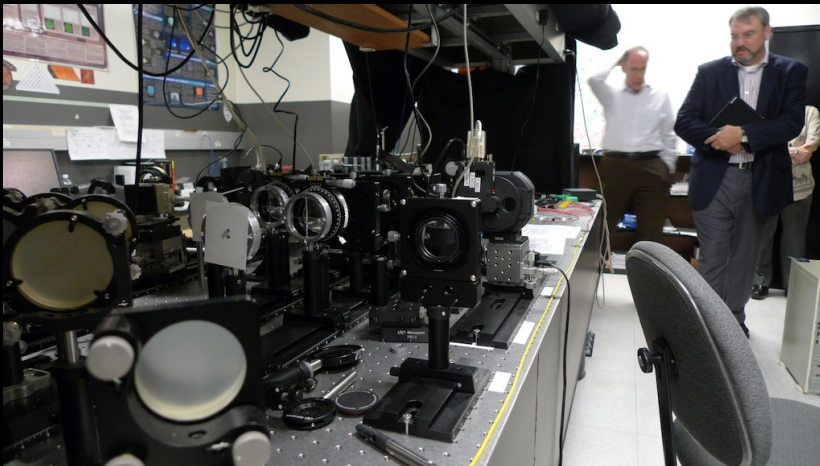
Lick Observatory



Keck Observatory



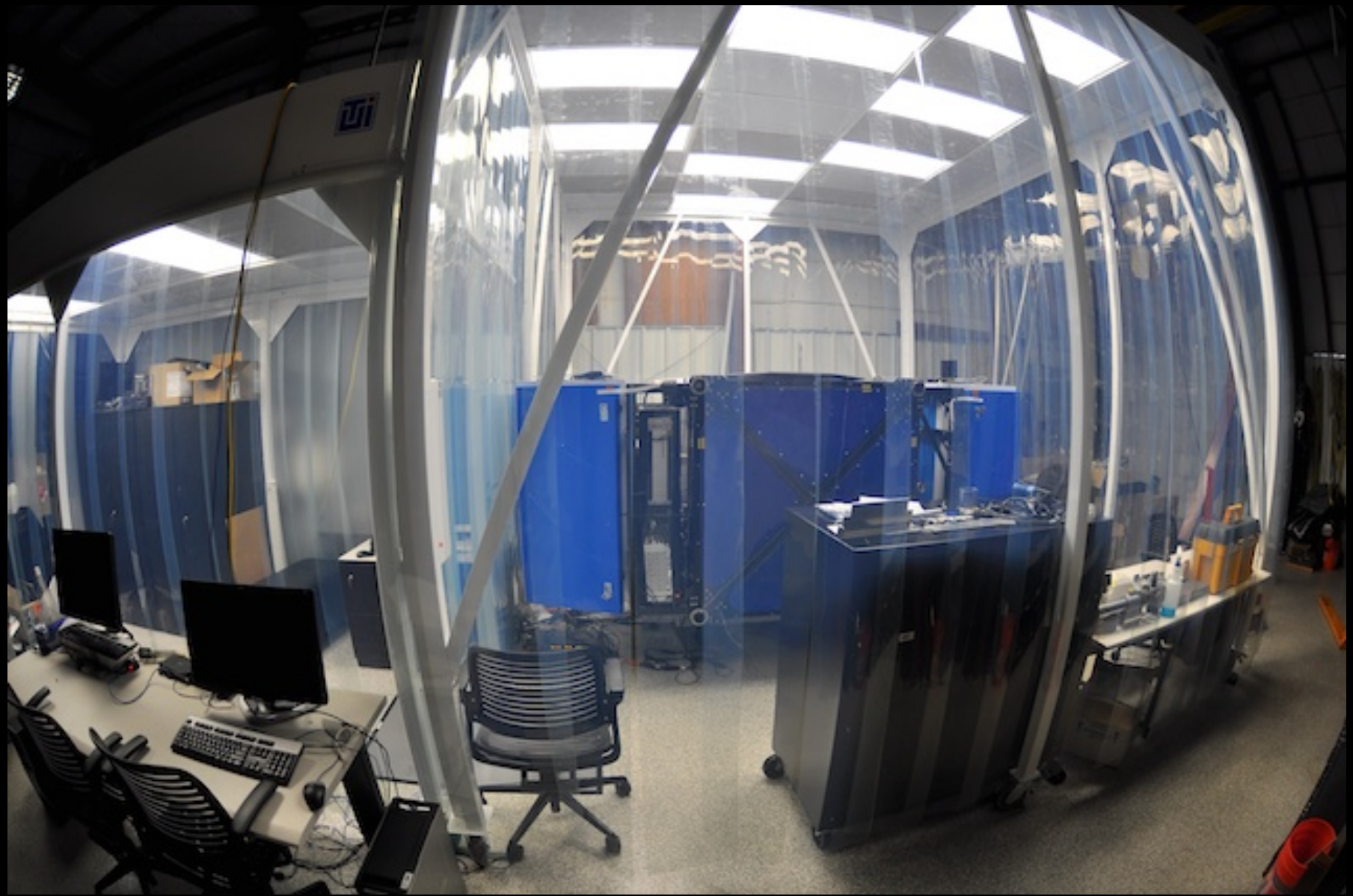
UC Santa Cruz and UCLA



- Complete facilities to equip and operate Lick Observatory
- Complete facilities to build instruments for the Keck Observatory
- Carry out relevant R&D (e.g. Laboratory for AO, Astronomical Coatings Facility)
- Scientific staff to lead and guide those efforts

Campus Facilities

- UC Santa Cruz (~80 employees)
 - Optics Laboratory
 - Laboratory for Adaptive Optics
 - Engineering Group (mechanical and electronics)
 - Instrument Shop
 - Electronics Shop
 - Detector Laboratory
 - Scientific Programming Group
 - Administrative Services
- UCLA
 - UCLA Infrared Laboratory- led by UCO Associate Director Ian McLean
- “full service” instrument facility



UC Astronomy

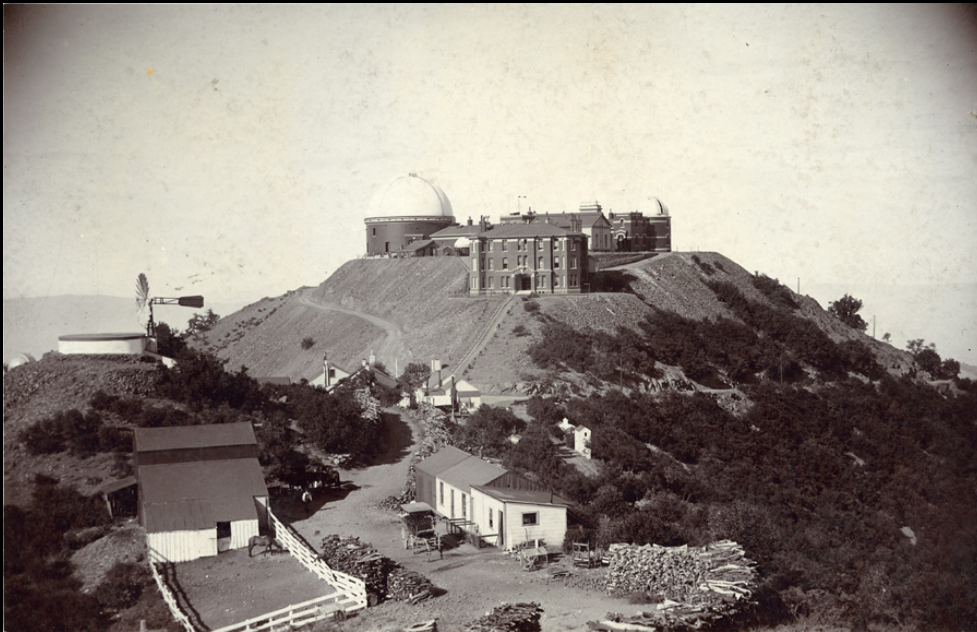


- Access to forefront observatories (Lick, Keck) has brought outstanding faculty to UC in A&A
 - 22 members of the NAS (of total UC A&A faculty ~ 100)
 - 11 Packard Fellows in the last decade
 - 33 Sloan Fellows
 - Shaw Prize (5), Gruber Prize, Bower Award, MacArthur Fellow, Kavli Prize (2), Nobel Prize, Crawford Prize, Franklin Medal and others
 - UCSC and UCB routinely ranked in top five of SI “science impact” (UCSC #1 twice)

Lick Observatory

James Lick gave a \$700k gift to build the Lick Observatory and turn it over to the University of California

- First permanently occupied mountaintop observatory in the world in 1888
- First observatory to completely embrace photography
- Immediately became premier observatory in the world

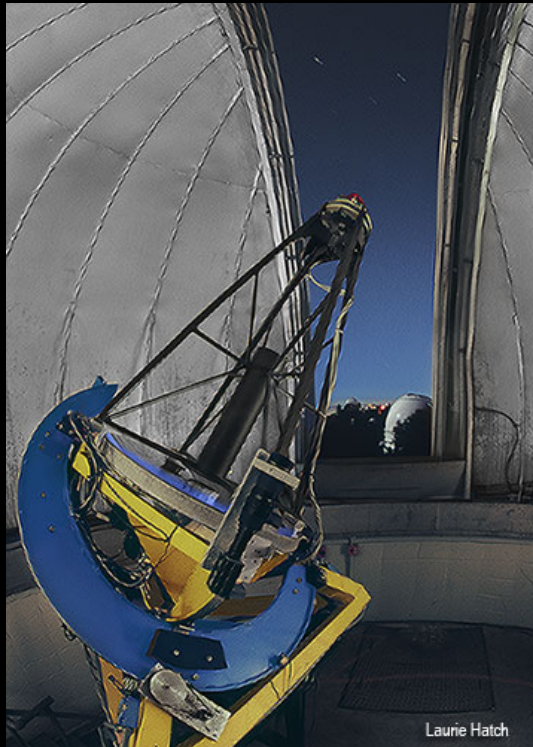


Lick Observatory 2012

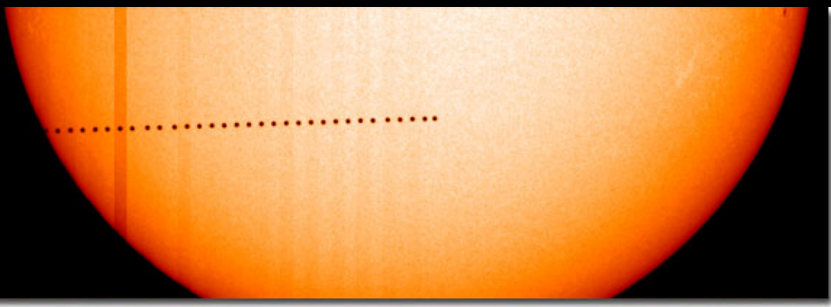


- Forefront science
 - Standalone programs
 - Support of Keck programs
- Technology development
- Undergrad/grad education in A&A
- Public outreach and education

Lick Observatory Science



- Forefront science remains the priority at Lick Observatory
- High profile programs discovering:
 - planets around other stars and
 - exploding stars (supernovae) in the nearby Universe



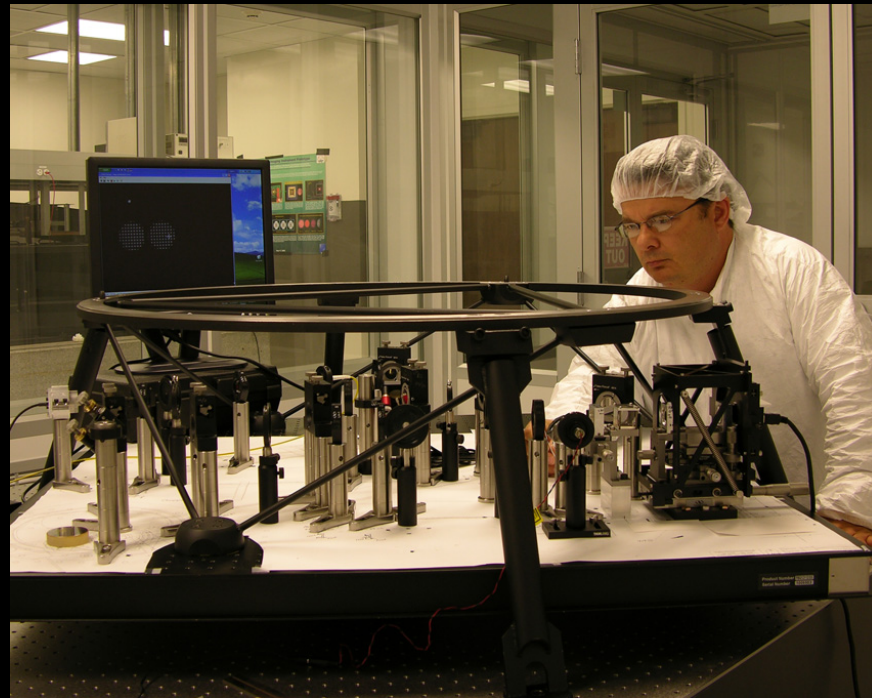
Extra-solar Planets



- Program at the 3-m started in the mid-1980s to search for planets orbiting other stars
- Largest telescope (2.4m) dedicated to the discovery of planets orbiting other stars being commissioned right now
- Major Keck program

Technology testbed

- electronic detectors
- ultra-precise radial velocity measurement techniques
- AO
- Laser guide stars



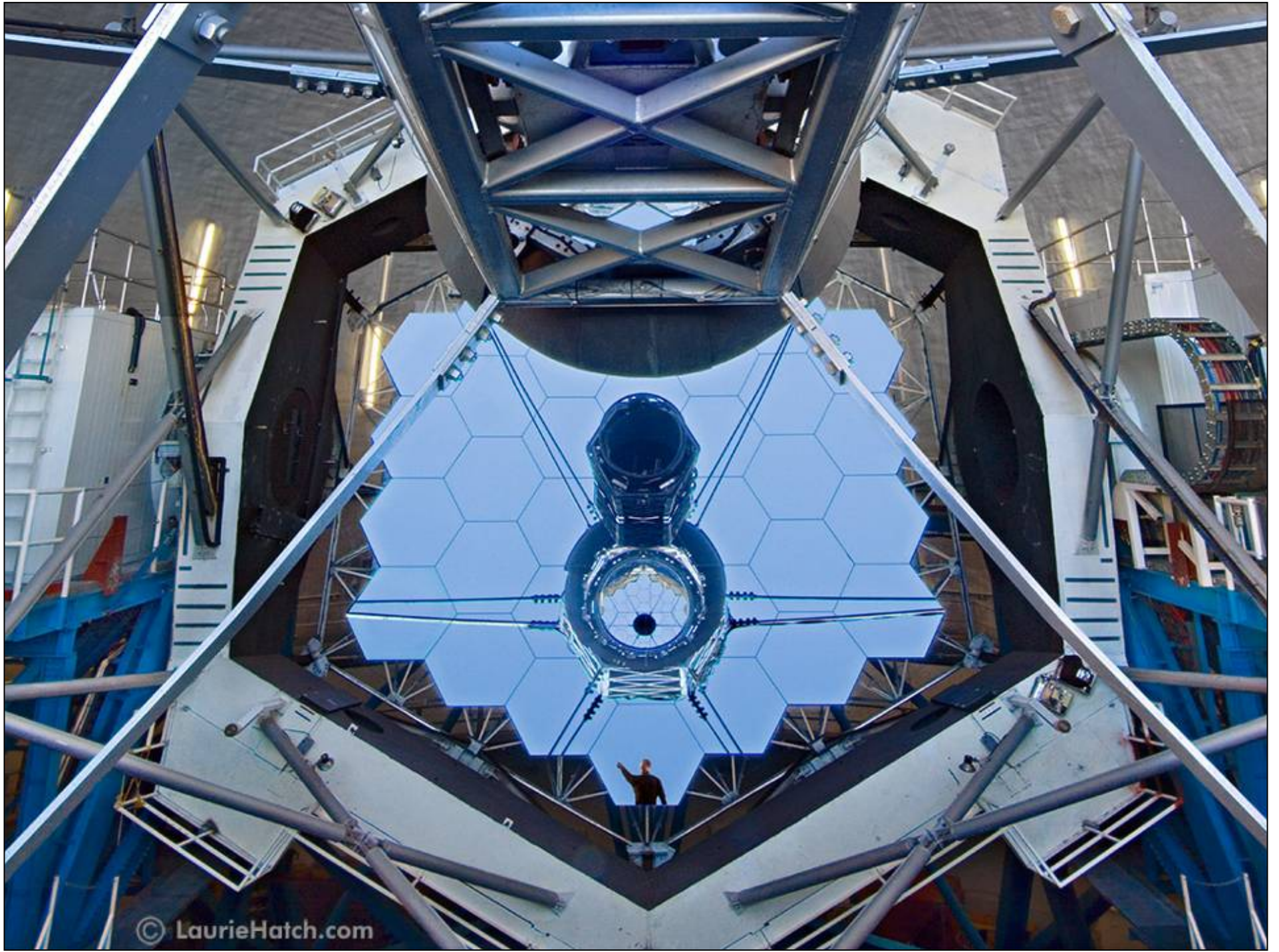
UC Astronomy: Keck Telescopes

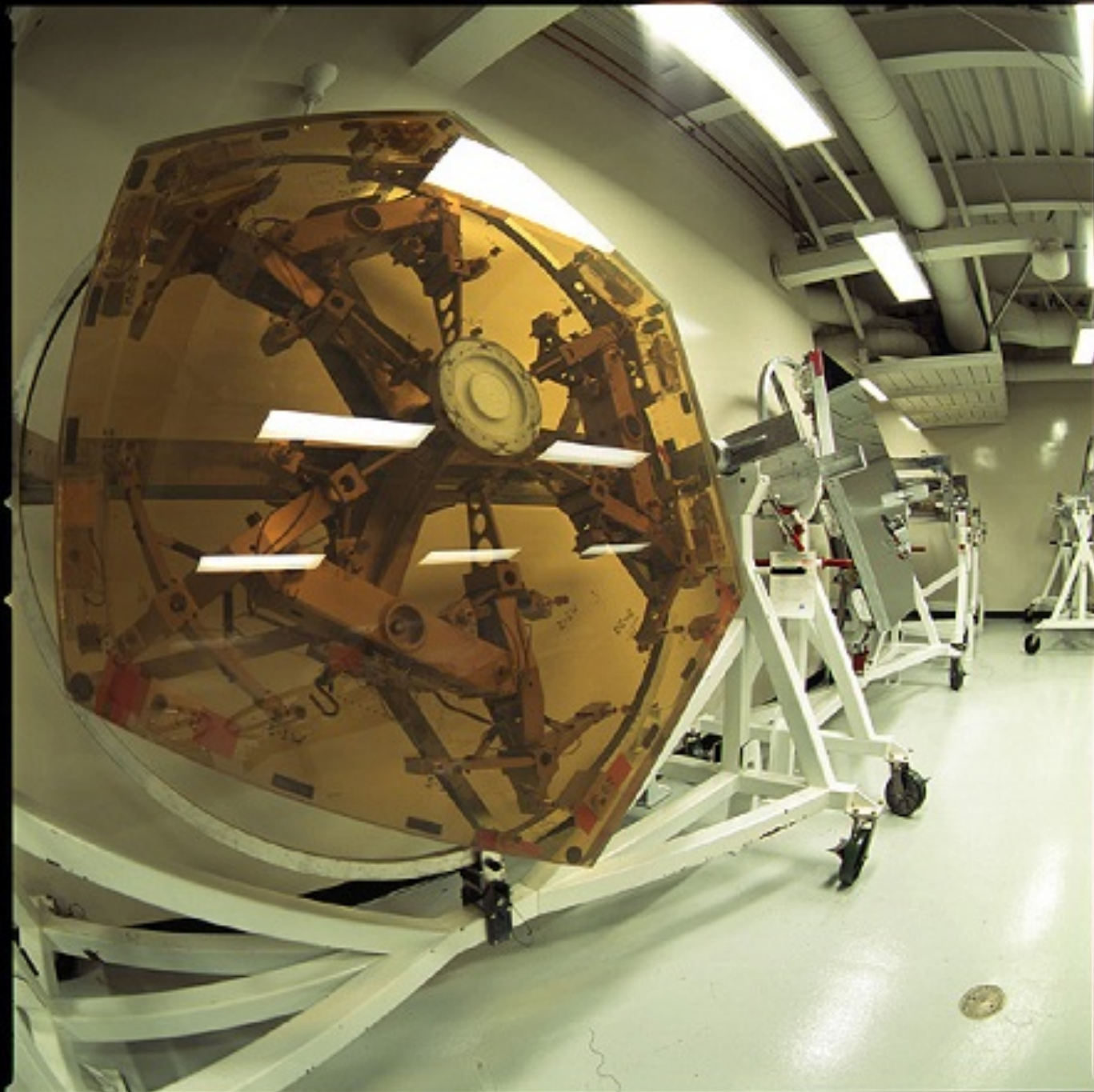


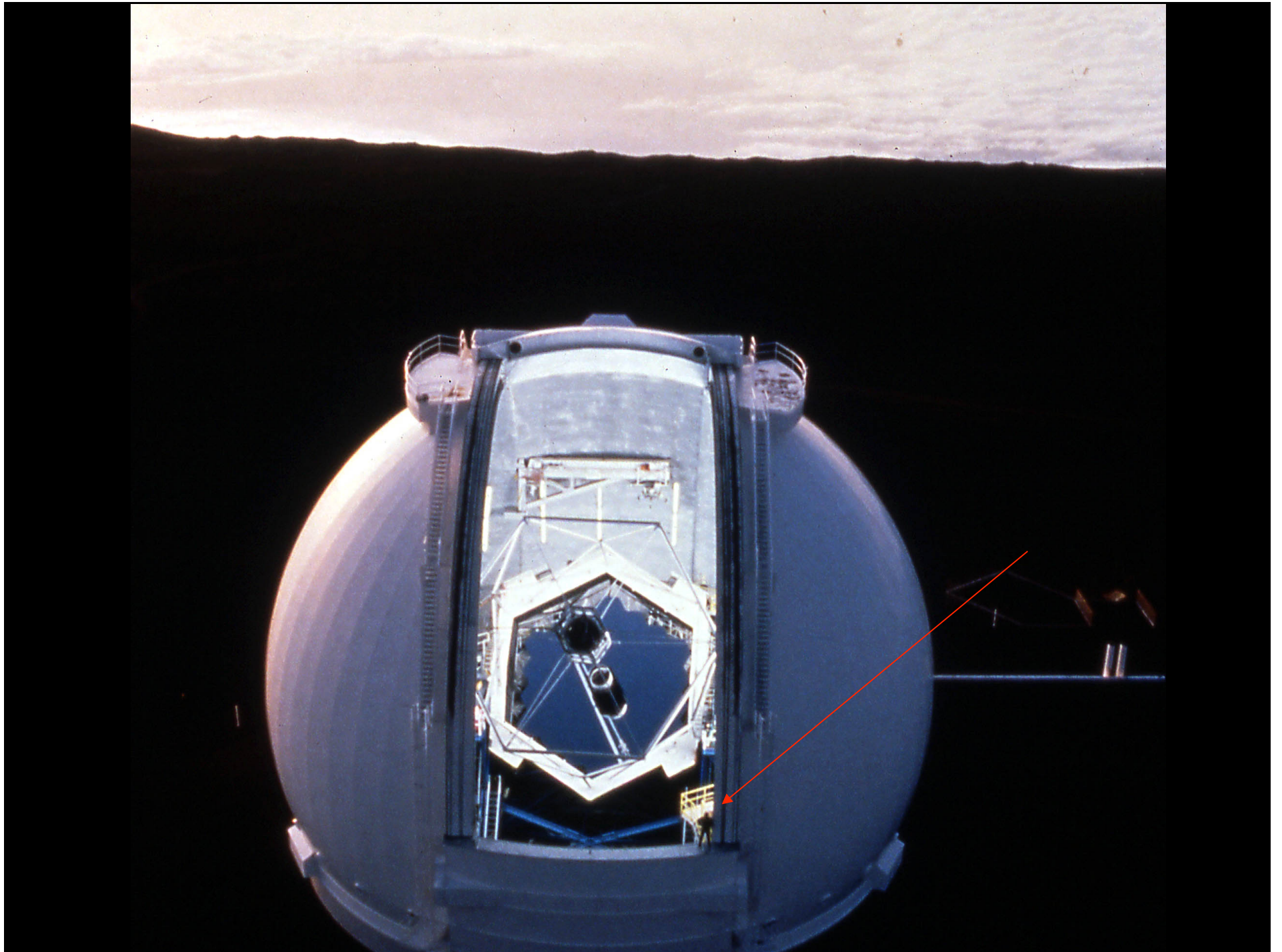
Not obvious that this would work

- Control system/precision
- Manufacturing segments

- By 1980, the Lick 3m telescope was one of many 3m-4m telescopes
- Two University of California physicists, Jerry Nelson and Terry Mast, proposed a new approach to building giant mirrors using segments that fit together and are controlled very precisely

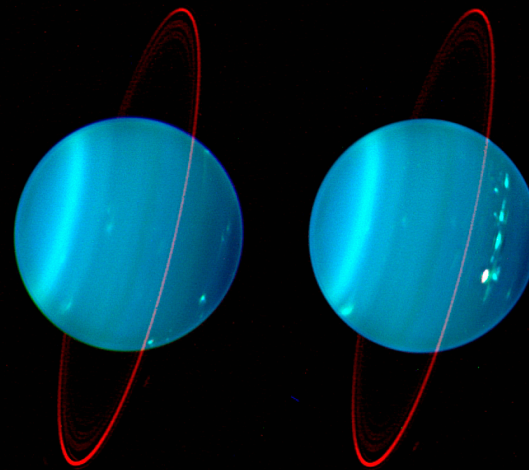
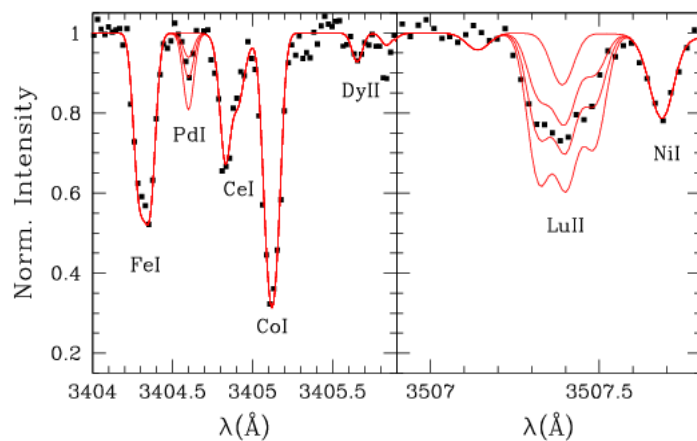




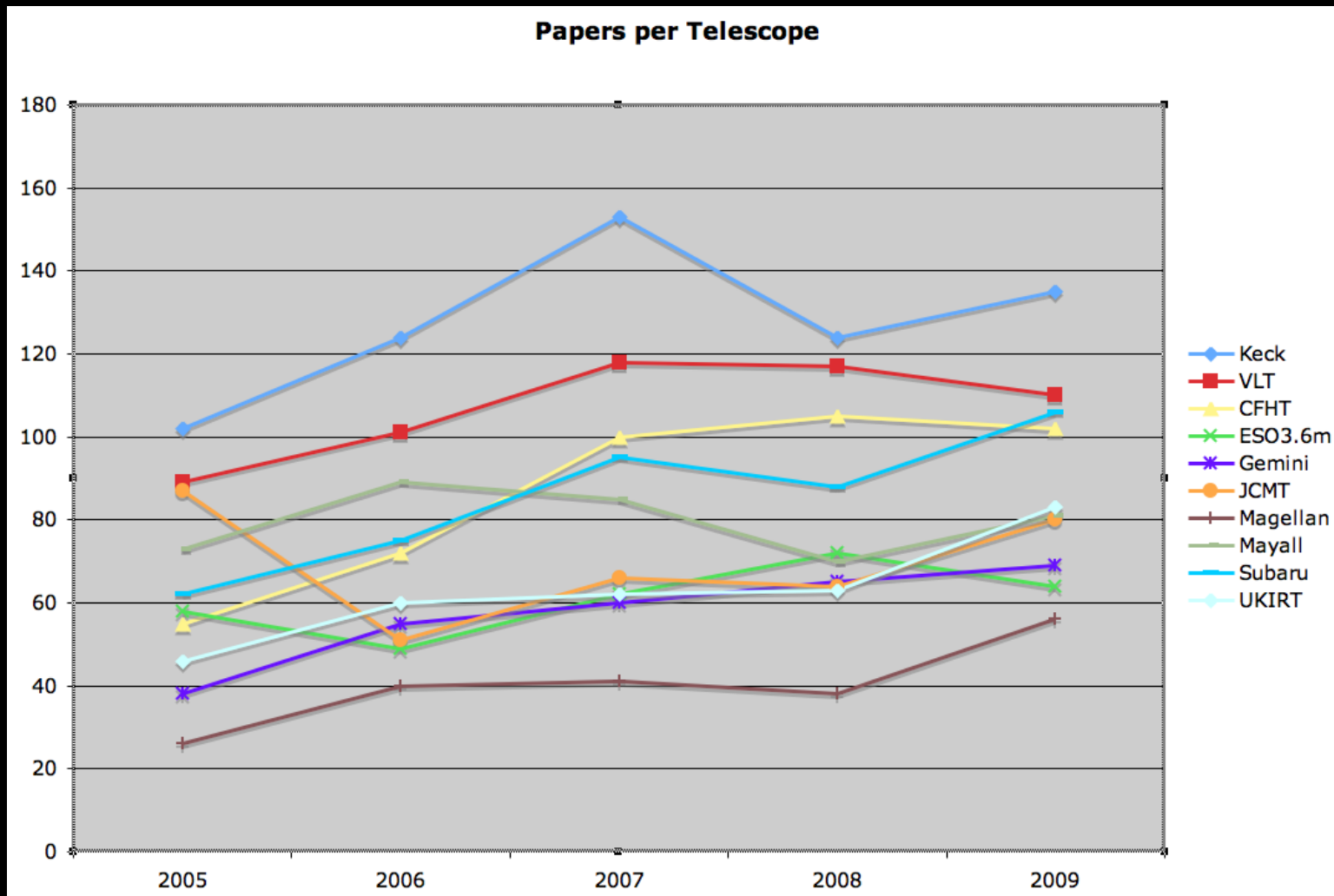


For its first decade, the Keck Observatory was the undisputed world-leading facility in optical/IR astronomy:

- Acceleration of the expansion of the Universe
- Majority of the known extra-solar planets
- Nature of gamma-ray bursts
- The determination of the history of star formation over cosmic time
- The abundance of D/H in the early Universe and verification of hot Big Bang nucleosynthesis



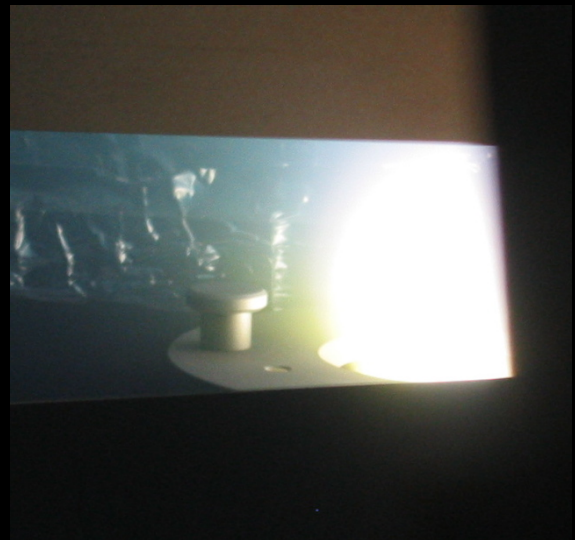
Although we compete with countries and consortia of countries, Keck remains on top in terms of productivity



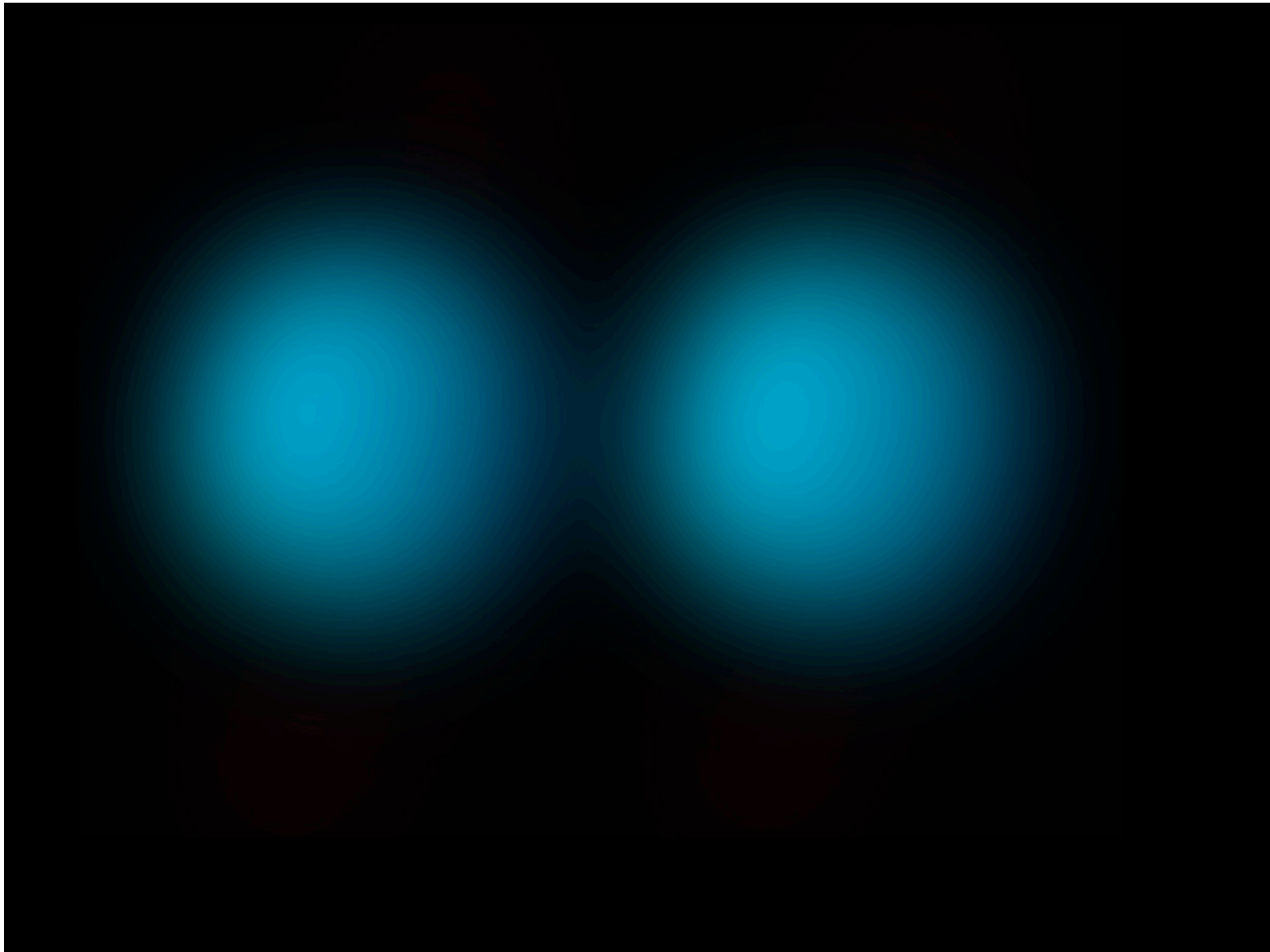
Keck Instruments

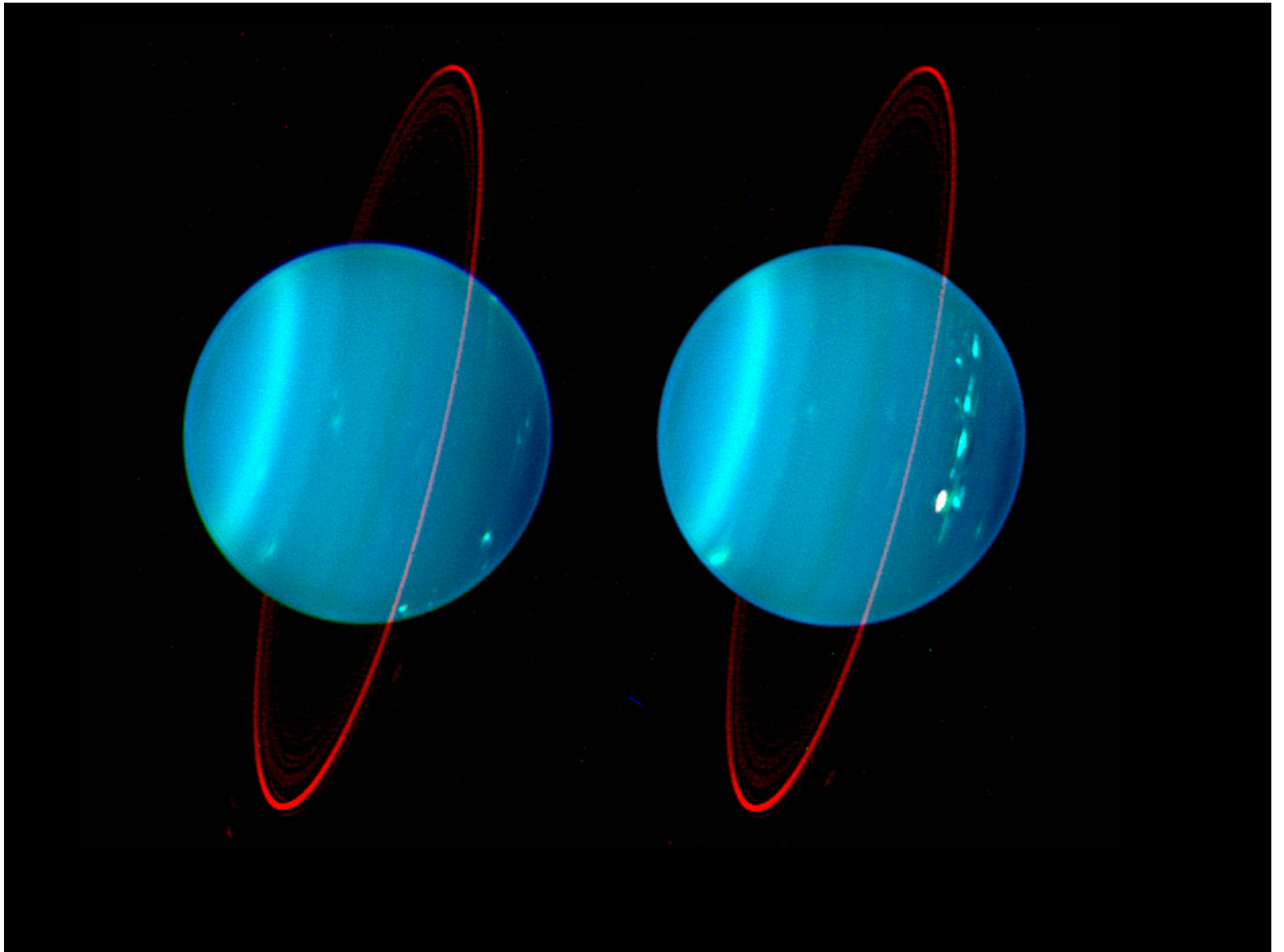


- Instruments for the Keck Telescopes are large and expensive (\$4M - \$12M)
- Three have been built in Santa Cruz, two at UCLA, along with numerous major upgrades and other observatory components

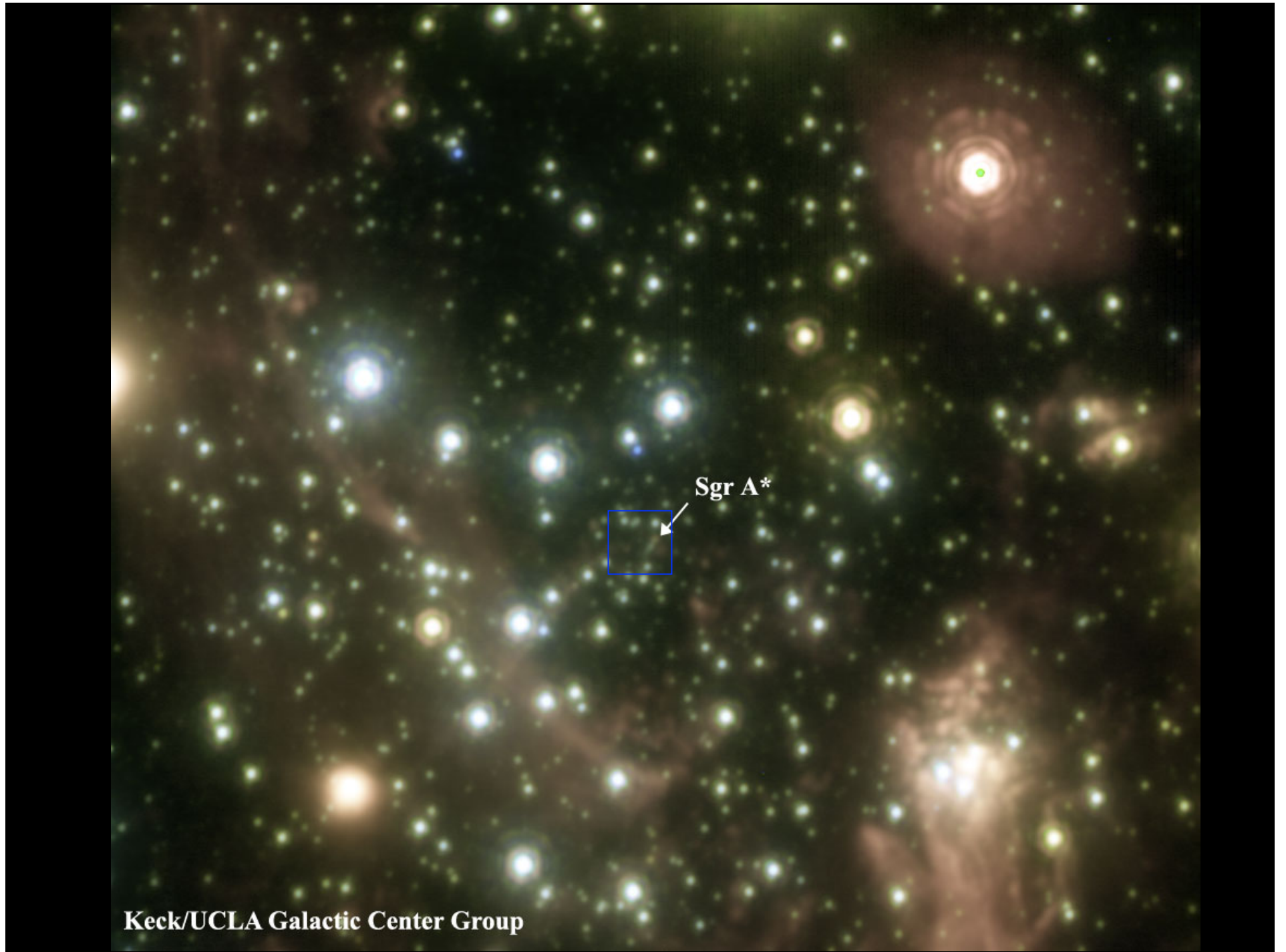








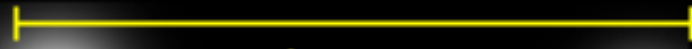




Sgr A*

Keck/UCLA Galactic Center Group

1992

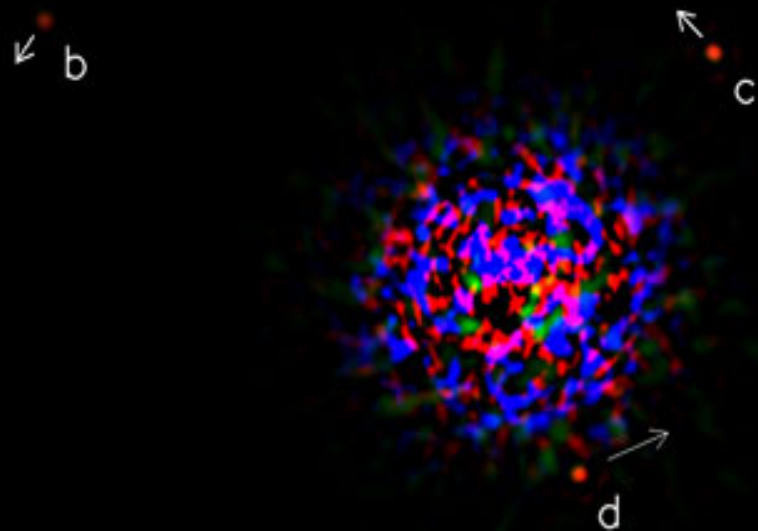


10 light days



Courtesy of Andrea Ghez, UCLA

HR 8799



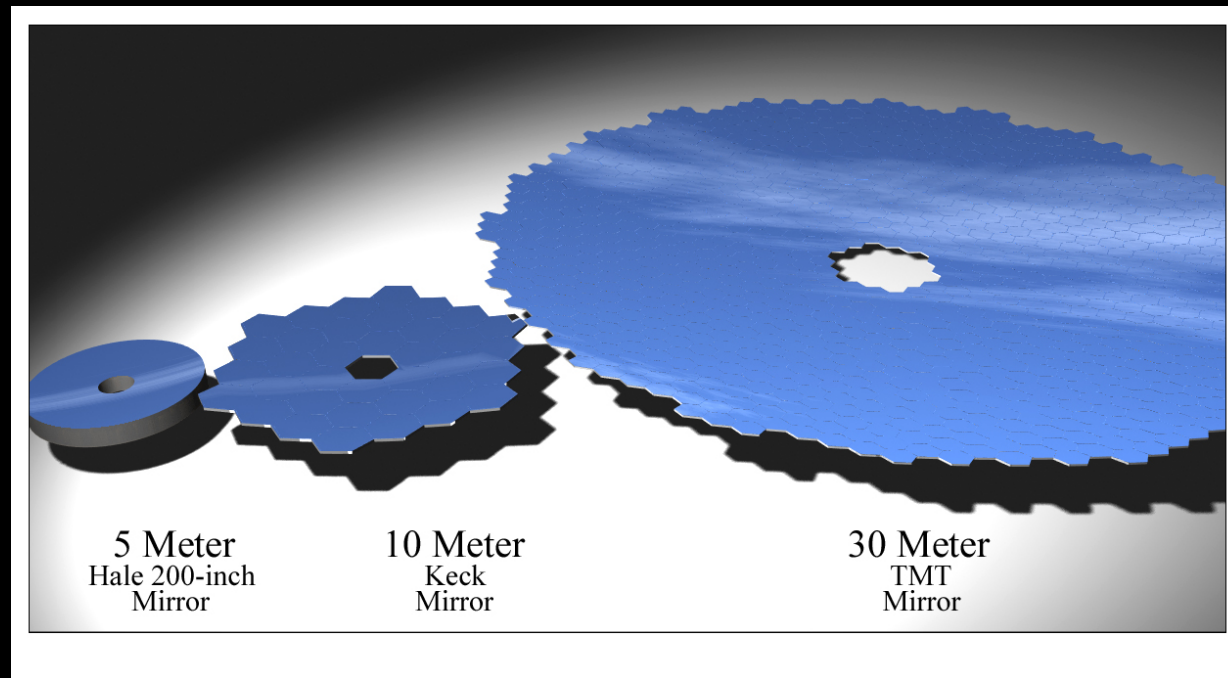
0.5"
—
20 AU

UC and Adaptive Optics



- UC and UCO have led the way in AO for astronomy
- 3m laser-guide star AO first to be put in use
- Keck is (by far) the leader in AO science productivity
- \$9.3M gift from the Moore Foundation for the Lab for Adaptive Optics at Santa Cruz
- \$40M NSF Science and Technology Center at UCSC

Thirty Meter Telescope (TMT)



- UC and Caltech initiated a project in 1999 to build a Keck style segmented primary 30m in diameter: 492 1.45m segments
- **Nine times** the light collecting area of a Keck Telescope, **Twelve times** higher spatial resolution than the Hubble Space Telescope

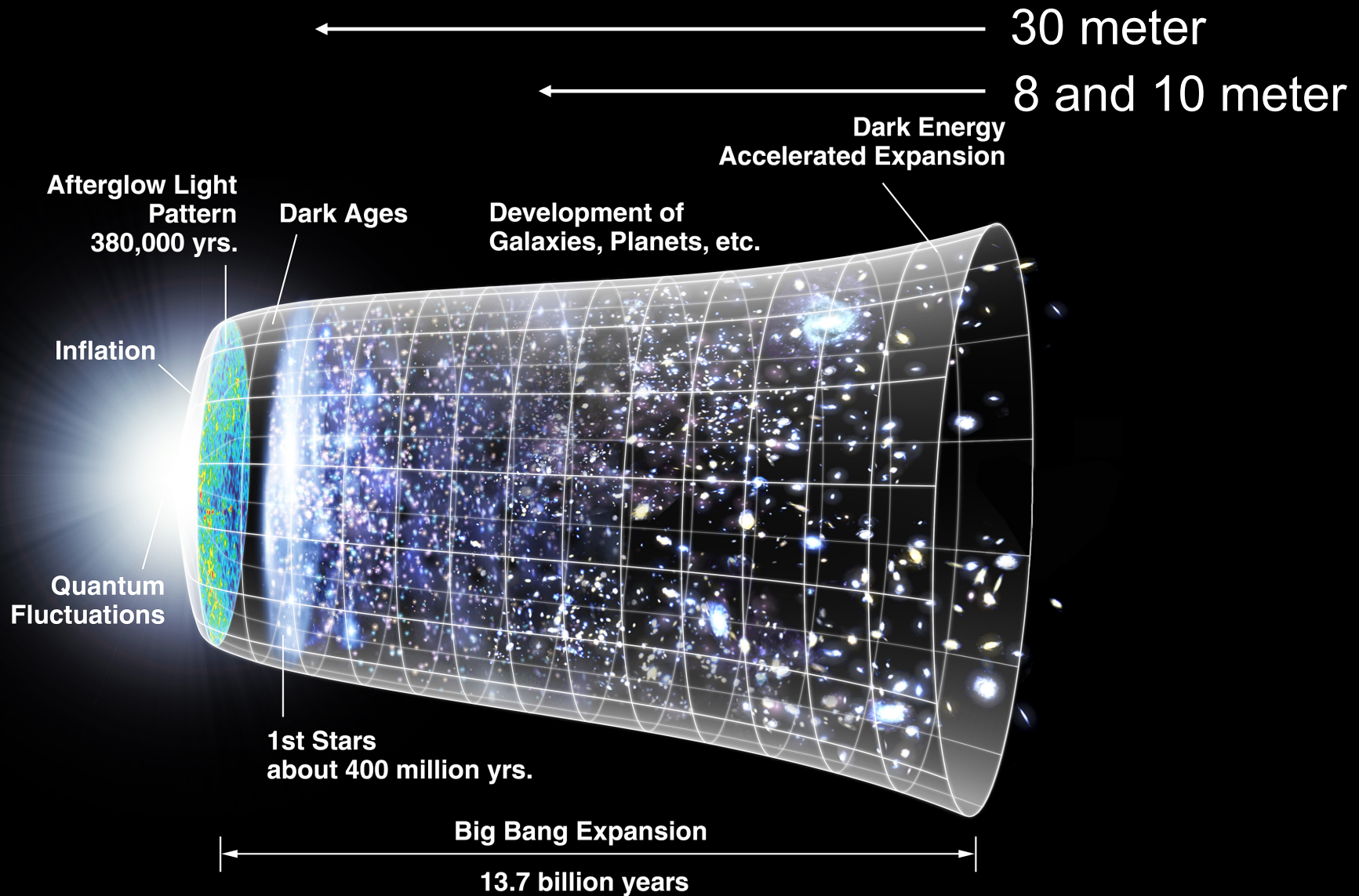


TMT Science



TMT light gathering power and very high spatial resolution will revolutionize studies in the areas of:

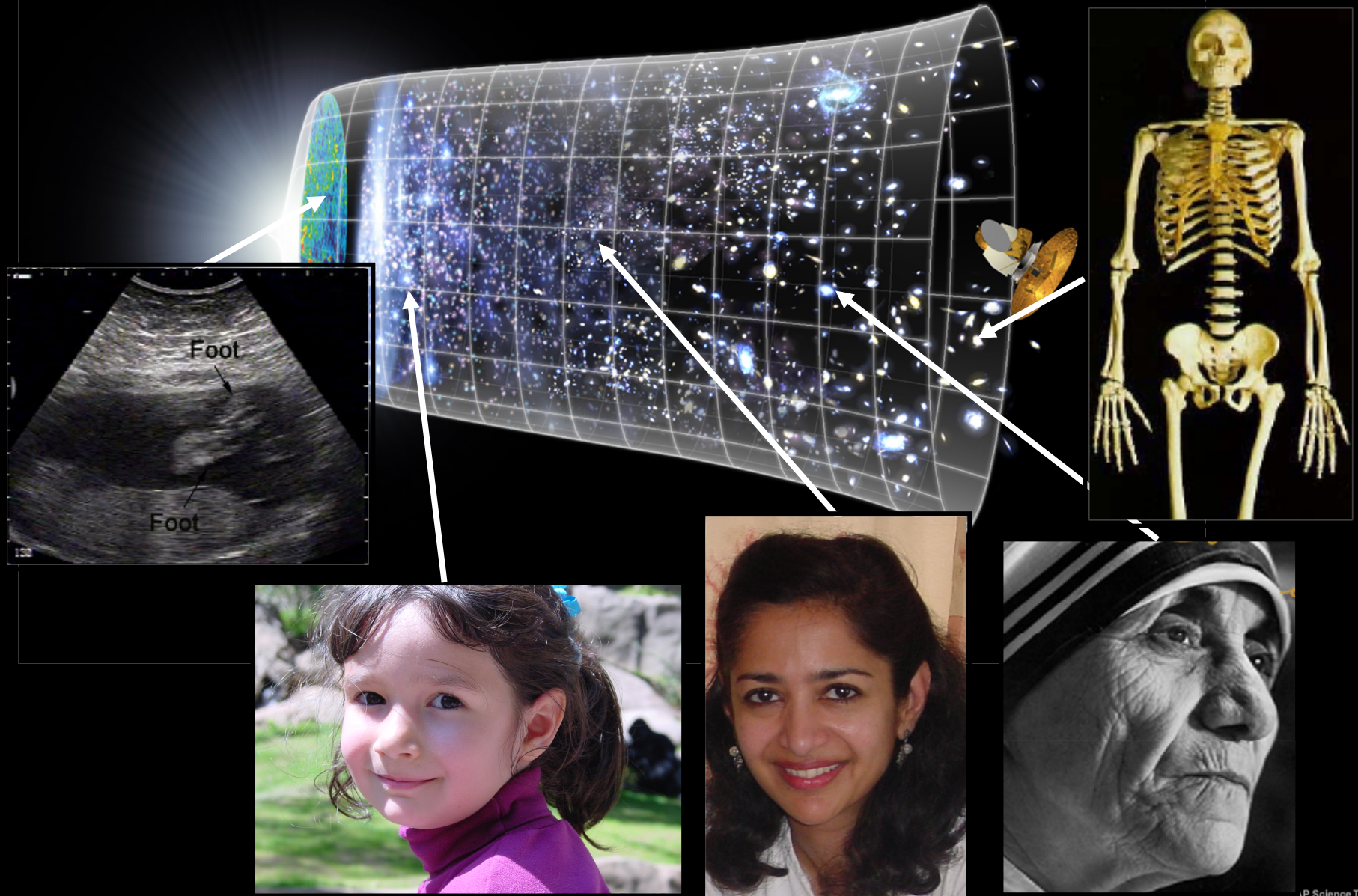
- the first epoch of star formation in the Universe
- the assembly and evolution of galaxies
- the discovery and characterization of extra solar planets
- fundamental physics of dark matter and dark energy



The TMT will extend studies back to the era of the first stars and galaxy

Using Telescopes as Time Machines

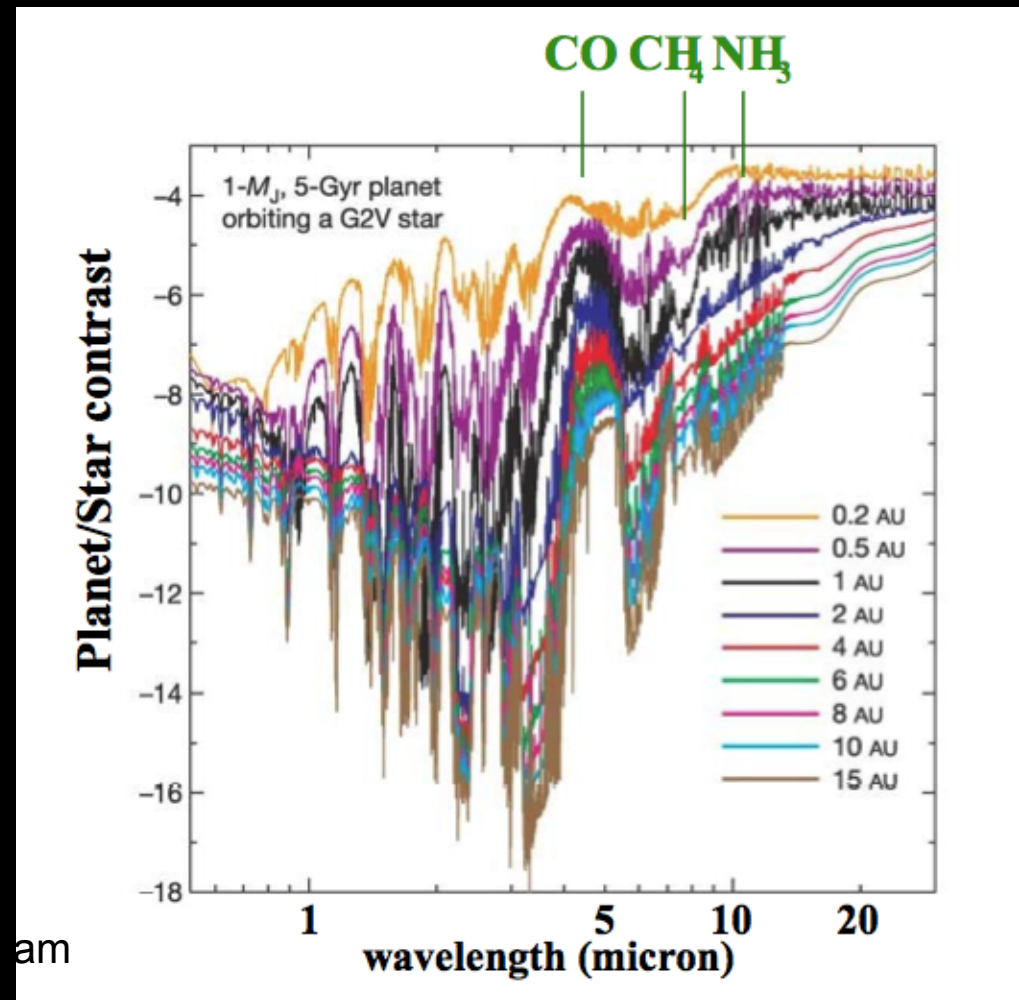
(for some reason, my wife hates this slide)



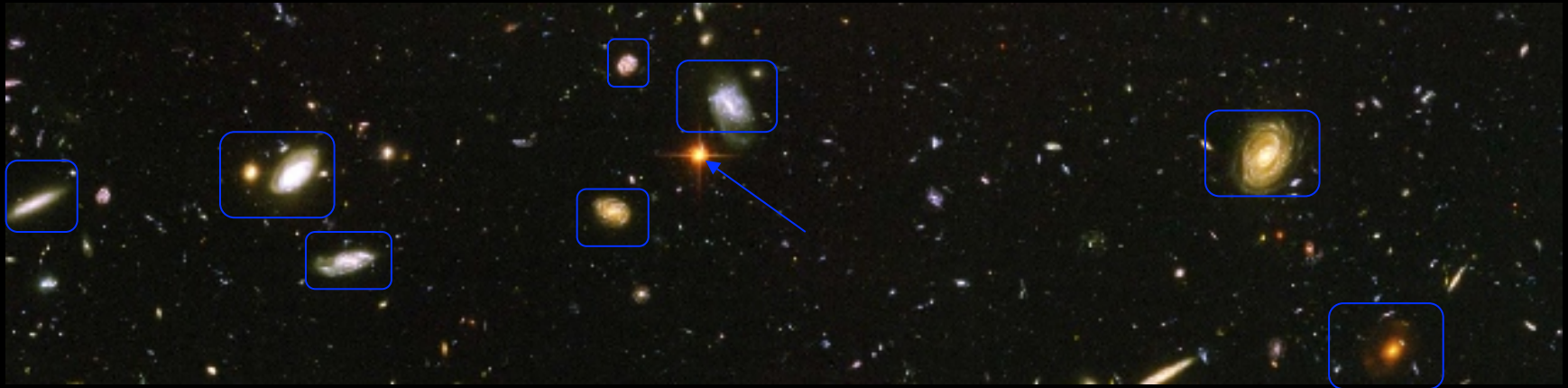
Characterization of Extrasolar Planets

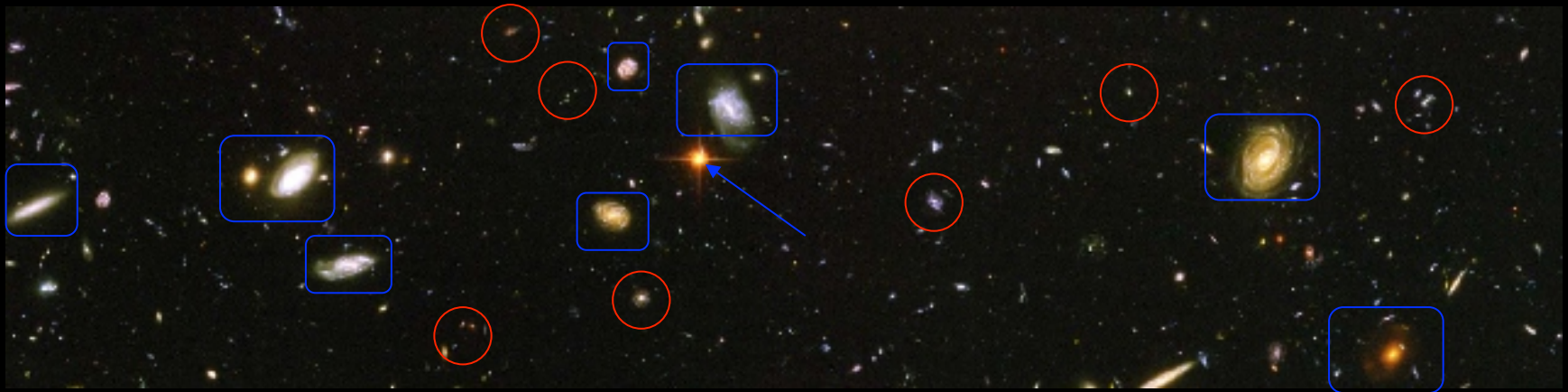
- Atmospheres of massive planets

- With 30m telescope will have the light grasp and contrast to obtain *spectra* of extra-solar planets









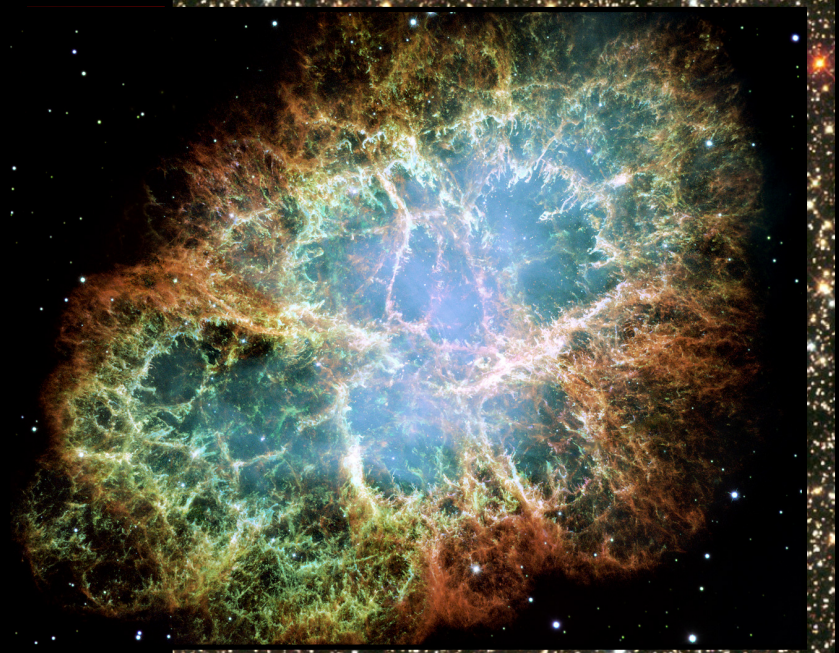
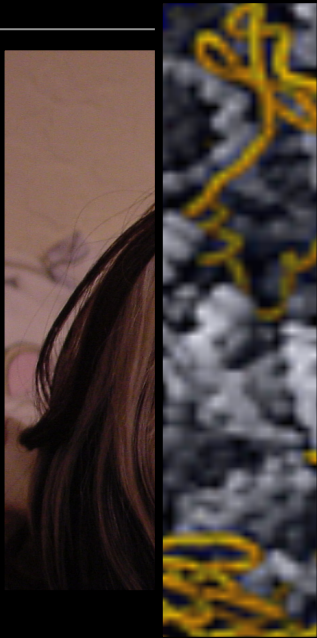
TMT 2012



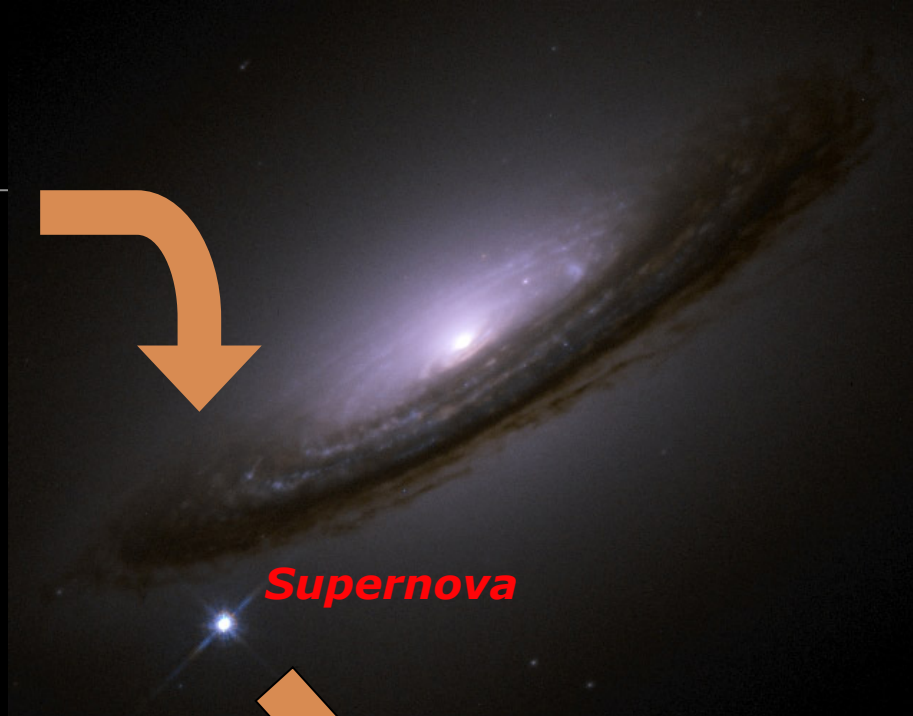
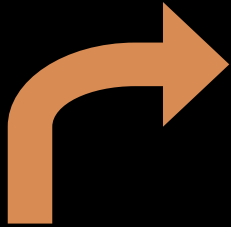
Site will be Mauna Kea.
Long and complex
process nearing
completion.

- \$1.152B (FY2011)
- Moore Fnd gift to UC of \$25M for Design Development
- MF pledge \$100M to UC, UC match of \$50M
- Canada, Japan, China and India have all selected TMT and joint proposal is being developed for 2012 submission to cover capital and 20 years of operations
- Completion date 2020

TMT and our place in the Cosmos



New stars



Supernova



Interstellar Gas

Heavy elements



Ejecta



At Home in the Milky Way



Wally Pacholka

“False Kiva” by Wally Pacholka