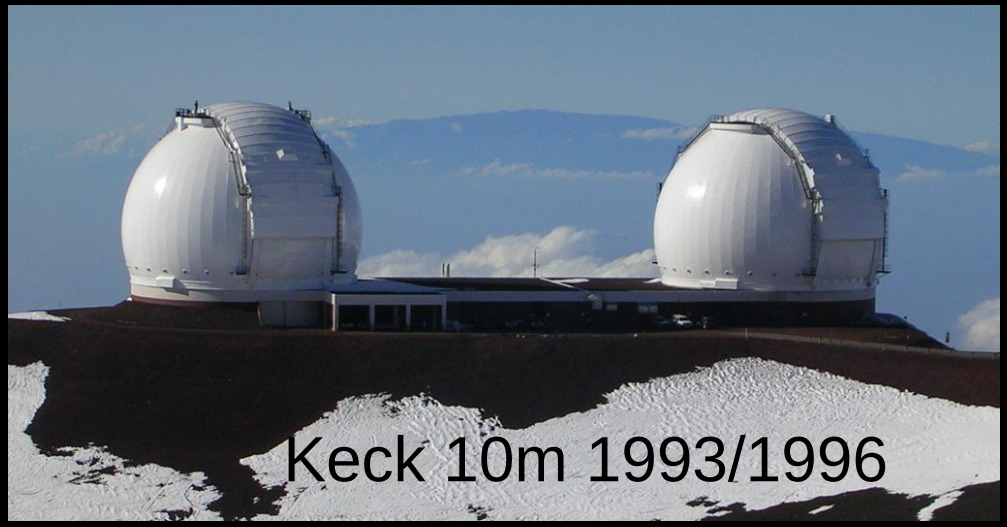
University of California Astronomy & Astrophysics

Shared Facilities in Astronomy

Lick 3m 1959

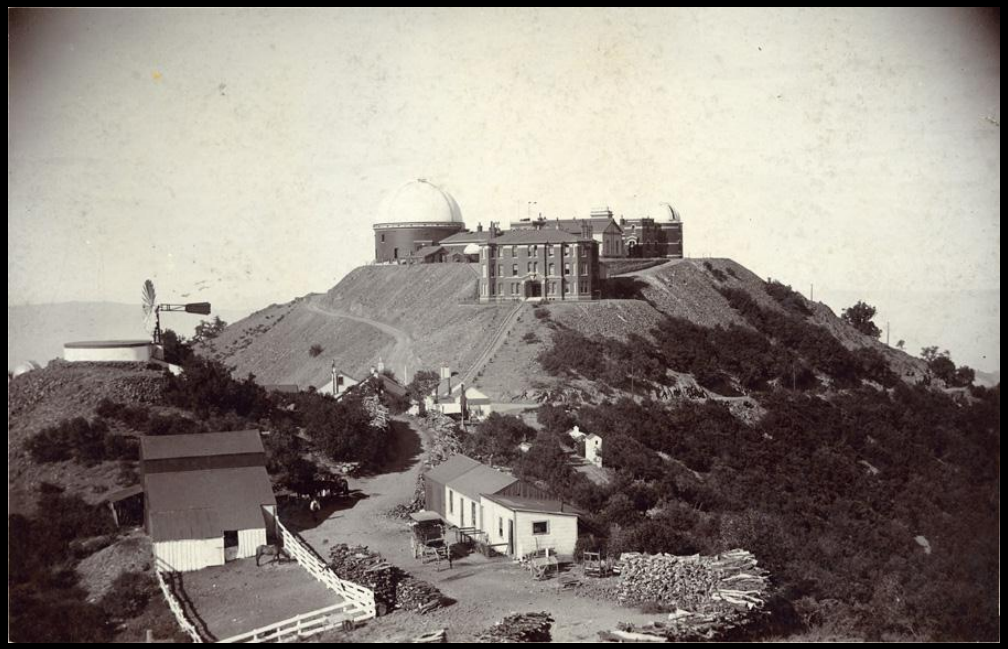
Lick 1m 1888

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



Keck 10m 1993/1996

Lick Observatory

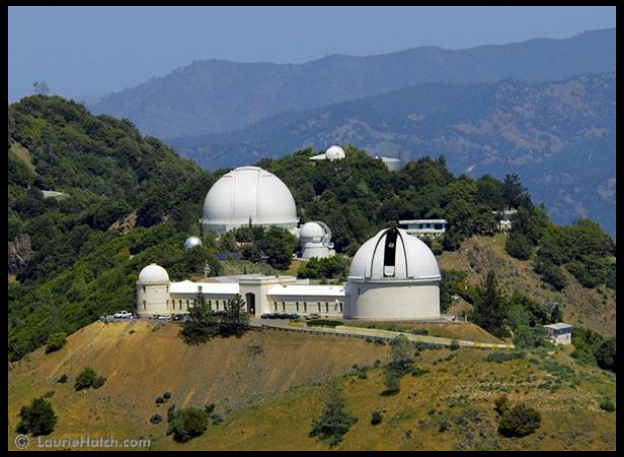


James Lick gave a $700k gift to build the Lick Observatory and turn it over to the University of California

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

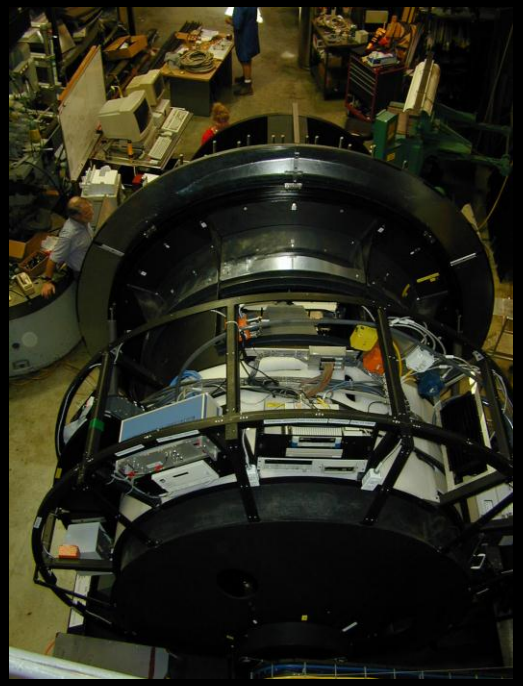
University of California Observatories

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

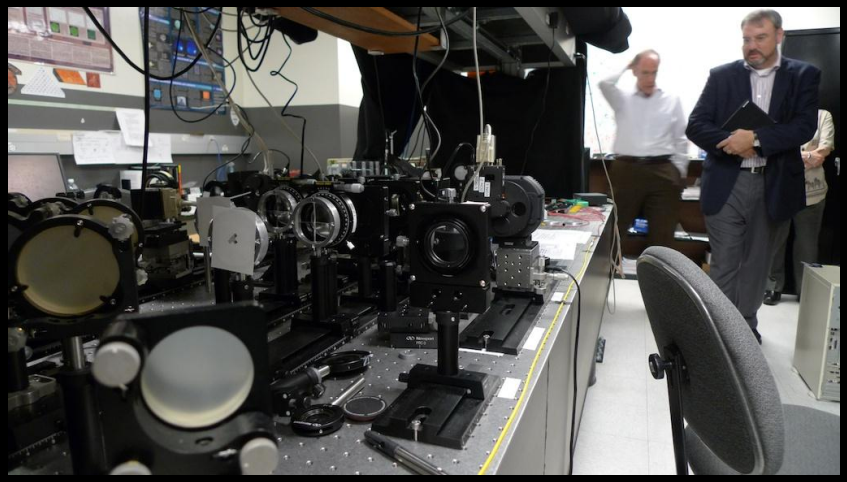
Keck Observatory



UC 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,Crawfoord Prize, Franklin Medal and others
  - UCSC and UCB routinely ranked in top five of SI “science impact” (UCSC #1 twice)

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

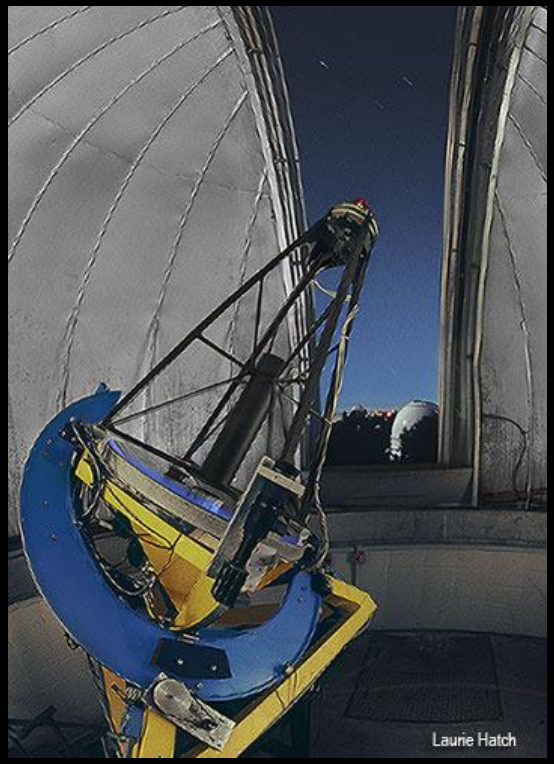
Campus Facilities

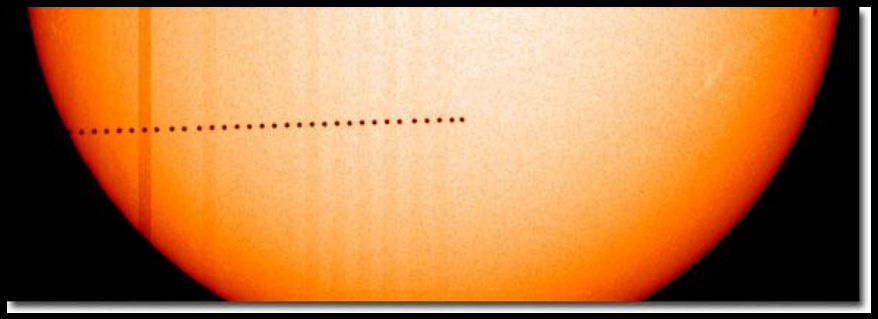
- UC Santa Cruz (~80 employees)
  - Optics Laboratory
  - Laboratory for Adaptive Optics
  - Engineering Group (mechanical and electronics)
  - Instrument Shop
  - Electronics Shop
  - Detector Laboratory
  - Scientific Programming Group
  - Administrative Services
- UCLA
  - UCLA Infrared Laboratory-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

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:
  - exploding stars (supernovae) in the nearby Universe
  - planets around other stars

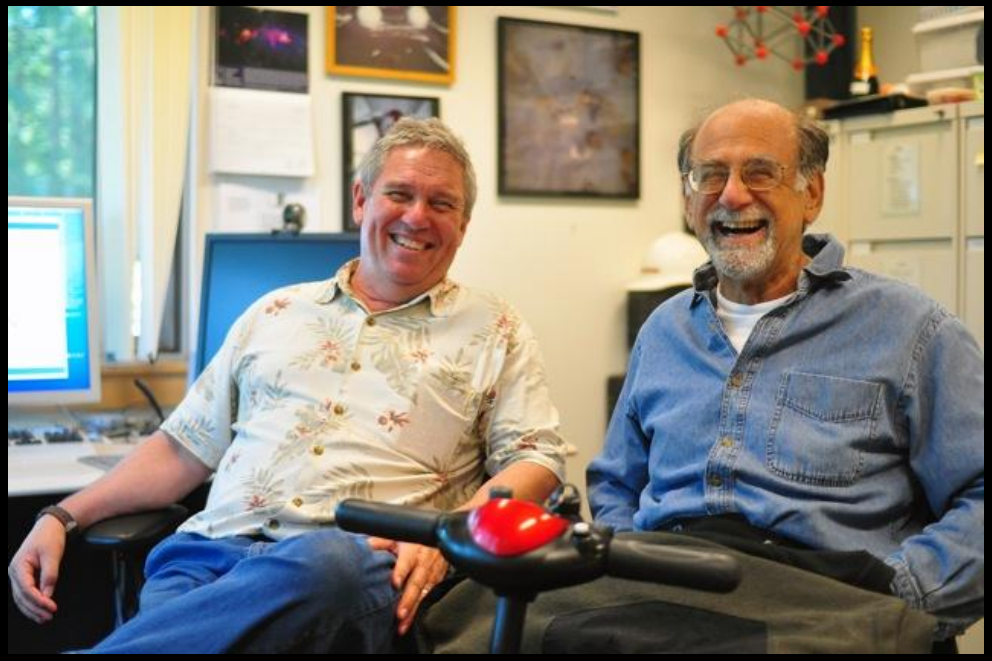
Extra-solar Planets

- 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

Adaptive Optics

- First Laser AO Science Instrument for astronomy (1996)
- Lick Site also serves as a Technology testbed
  - AO component technology, methods
  - Laser guide stars

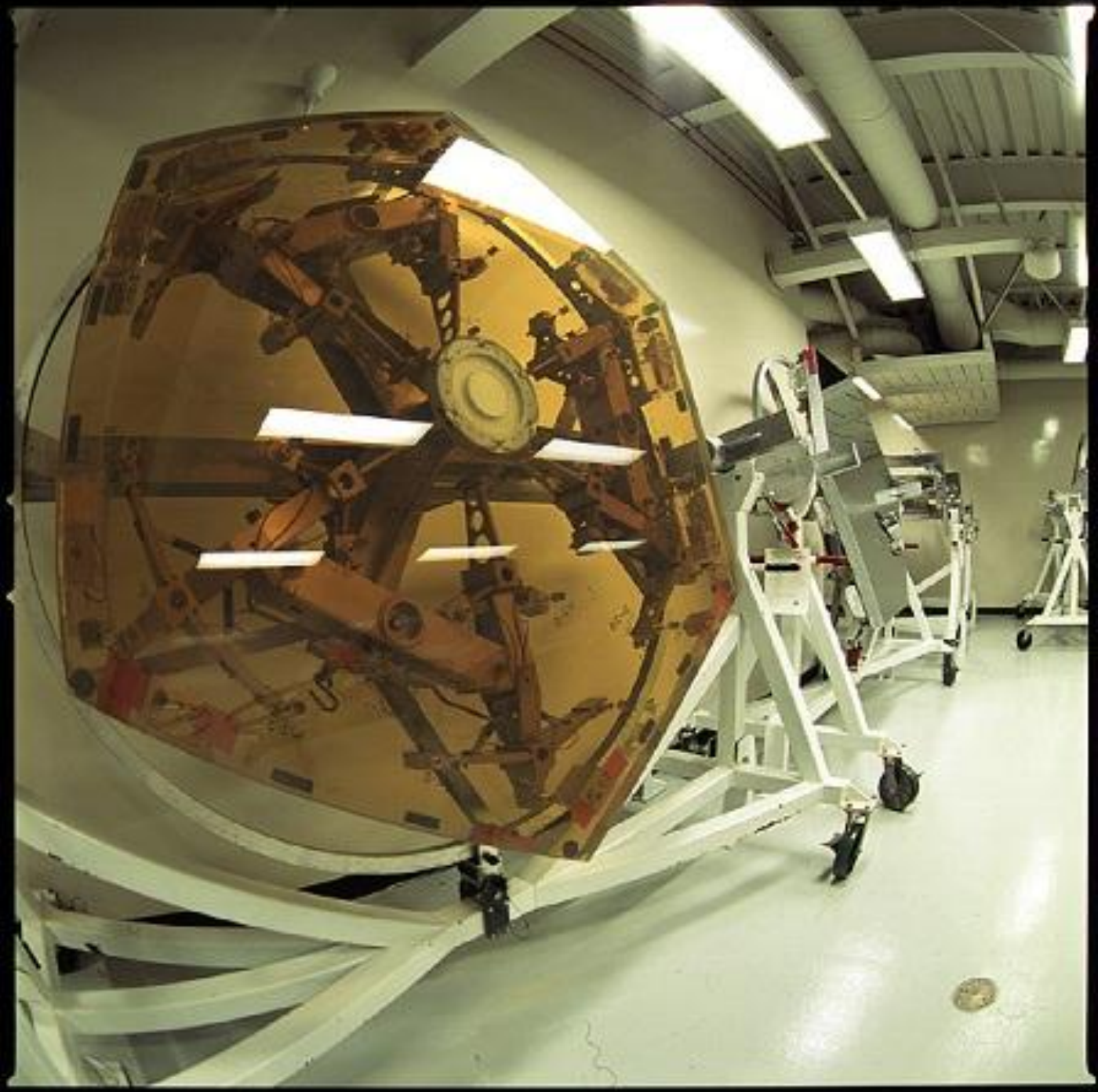
UC Astronomy: Keck Telescopes

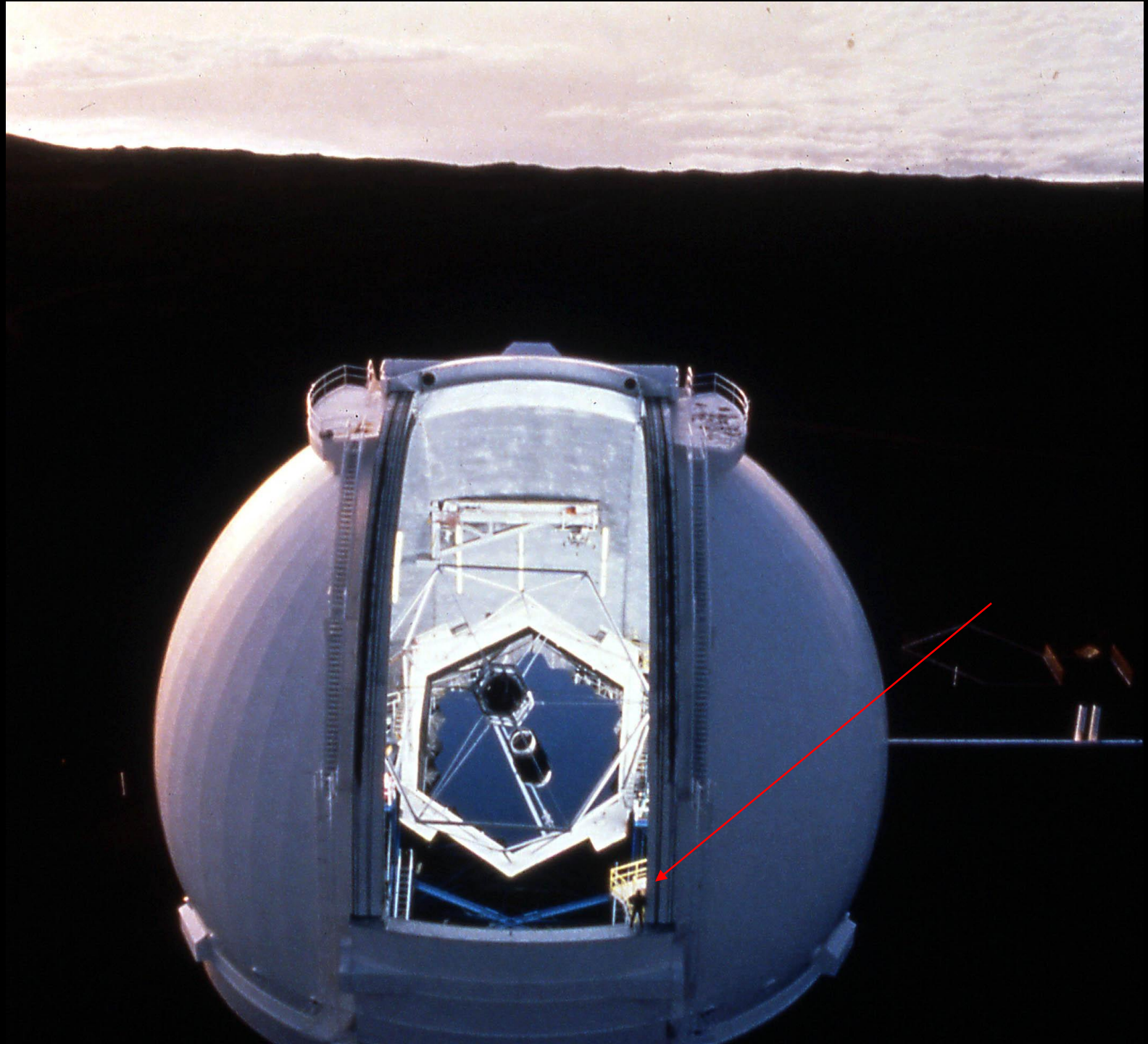


Not obvious that this would work
- Control system/precision
- Manufacturing segments

- 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

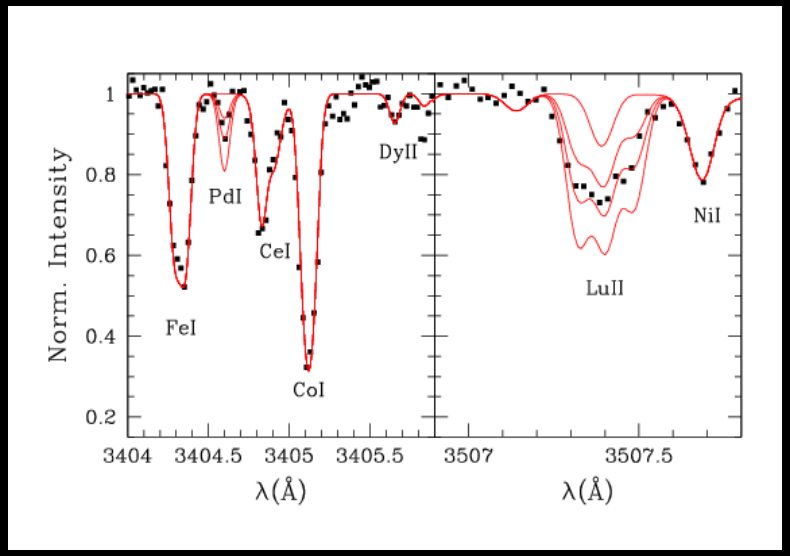

© LaurieHatch.com

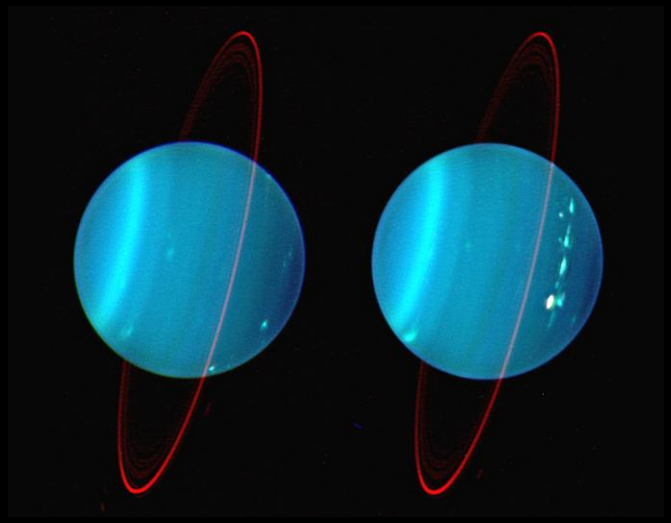




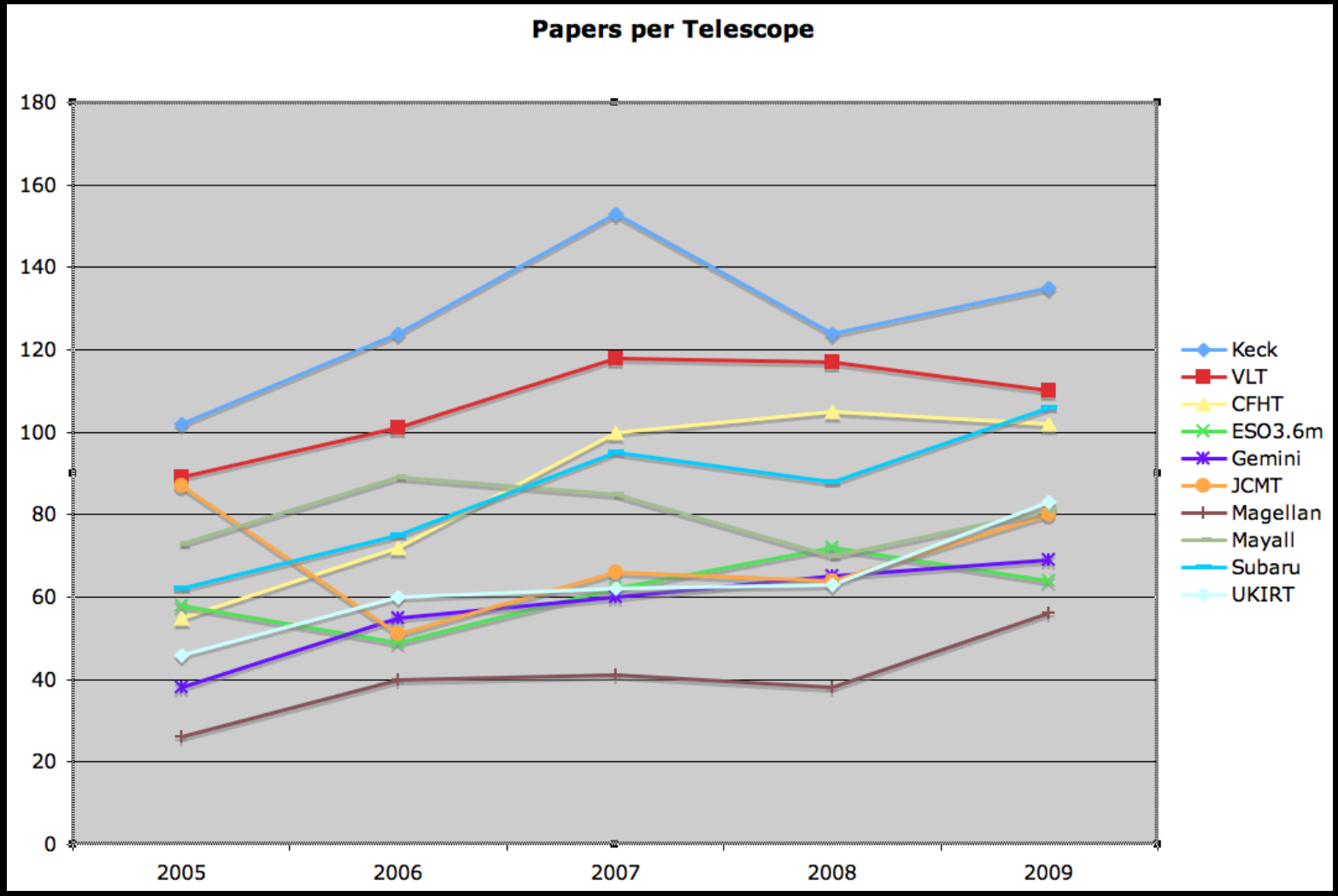
For its first decade, the Keck Observatory was the undisputed world-leading facility in optical/IR astronomy:

- 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



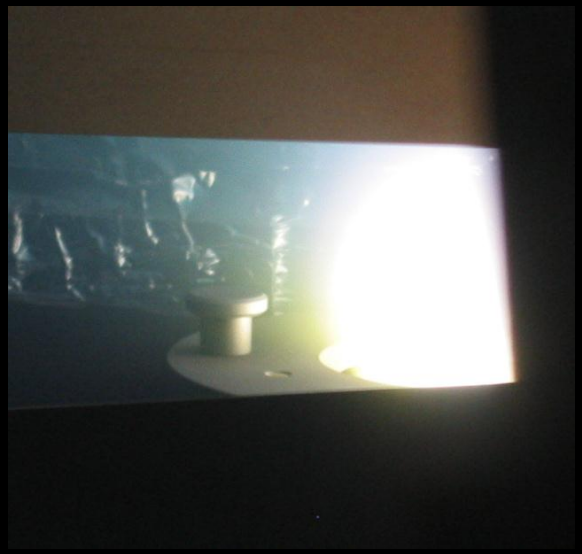


Although we compete with countries and consortia of countries, Keck remains on top in terms of productivity

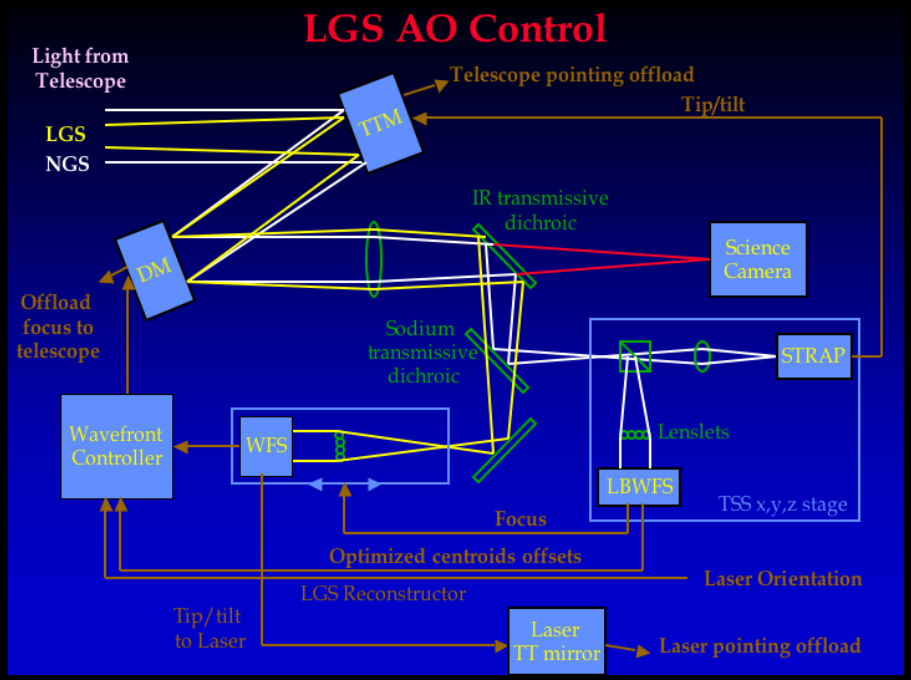


Keck Instruments

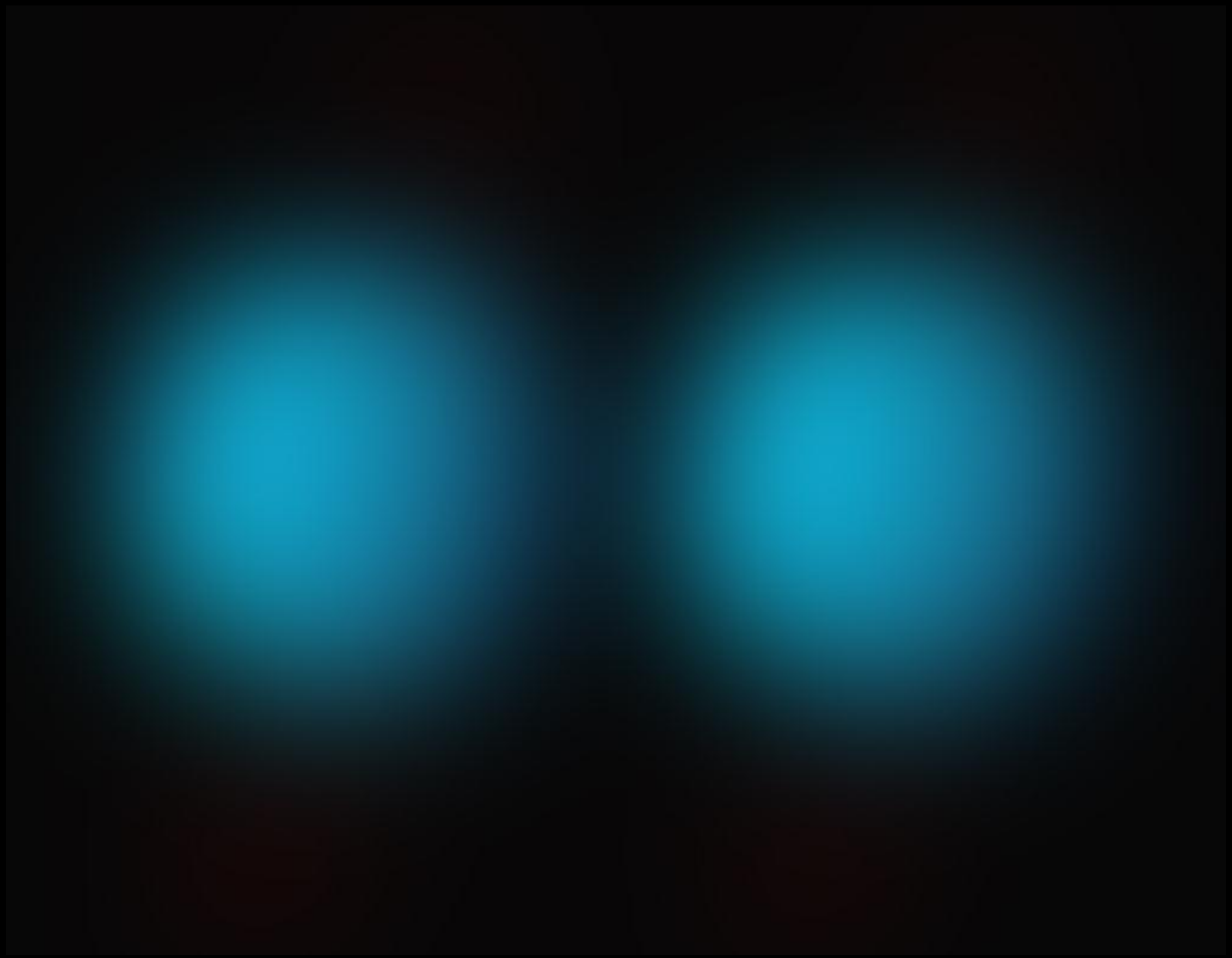
- Instruments for the Keck Telescopes are large and expensive ($4M - $12M)
- Three have been built in Santa Cruz, two at UCLA, along with numerous major upgrades and other observatory components

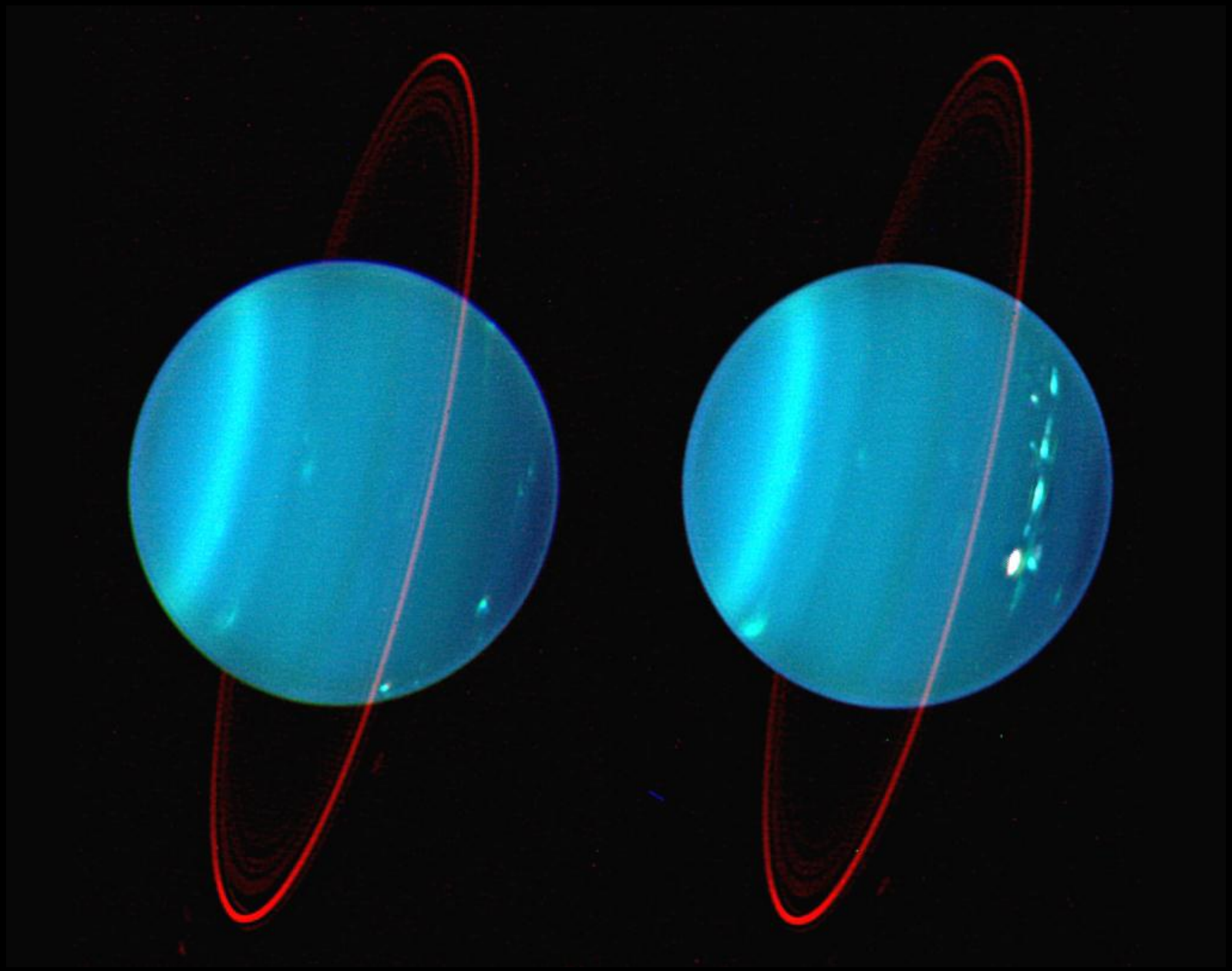


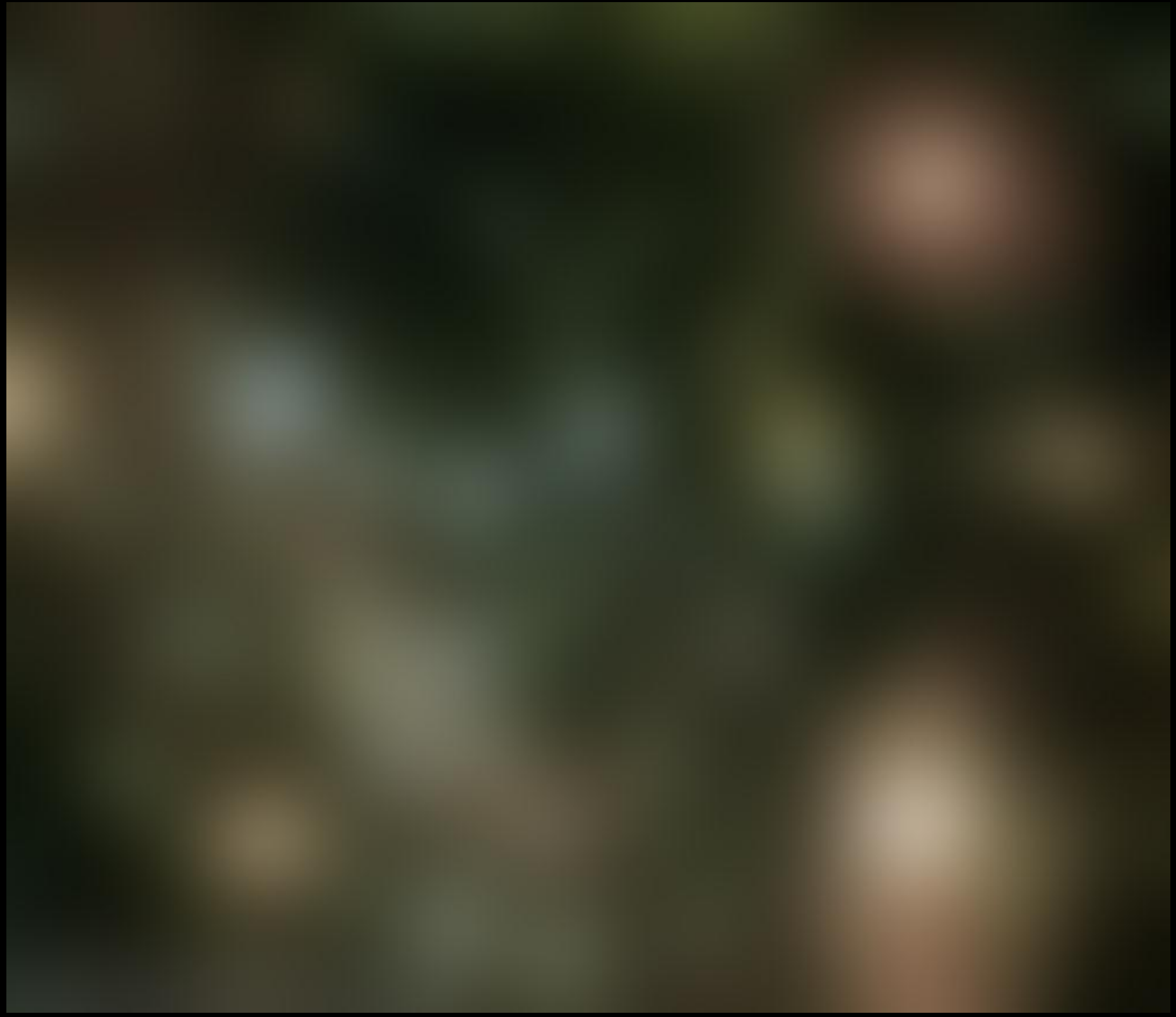
A Word about Adaptive Optics

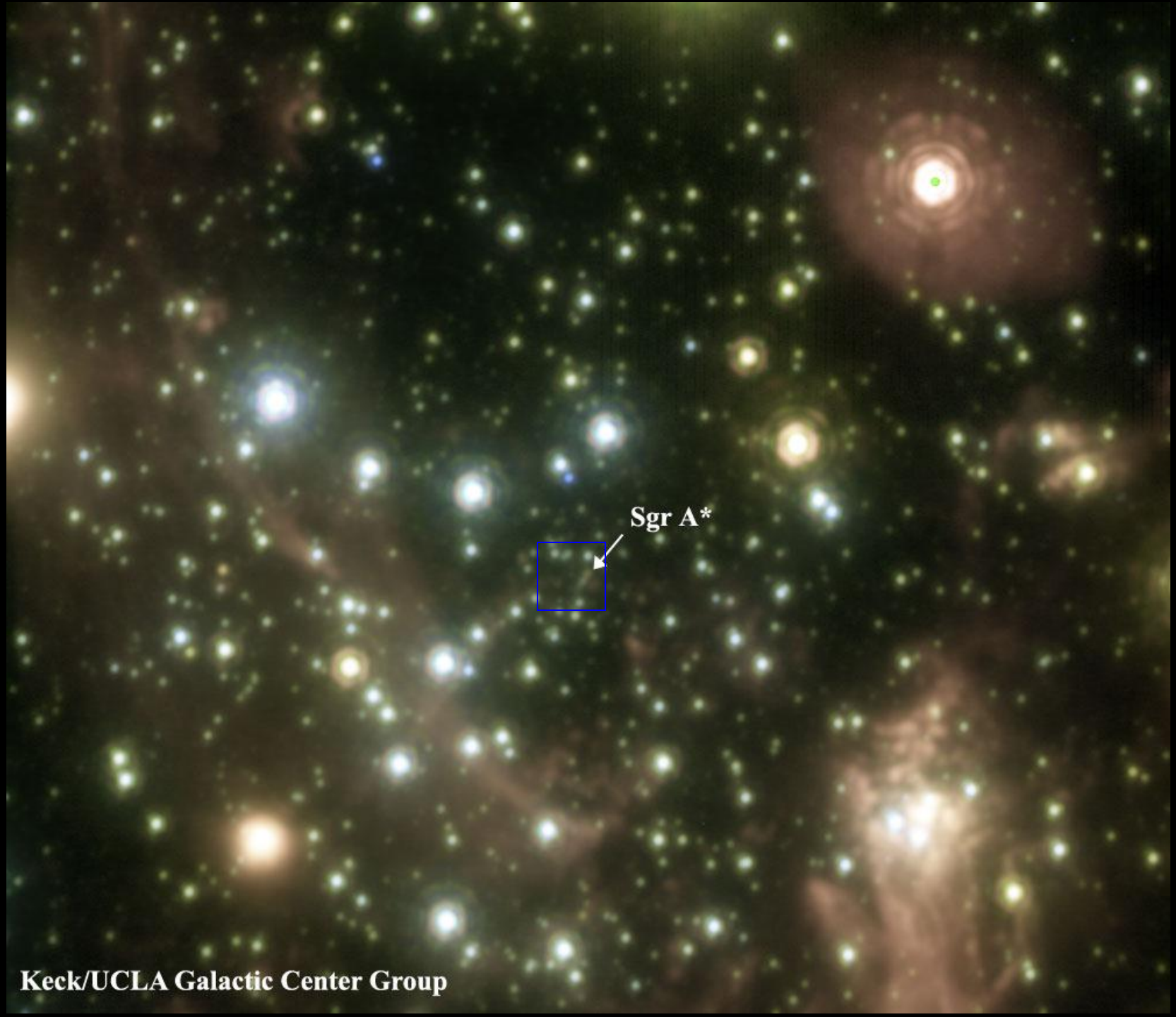


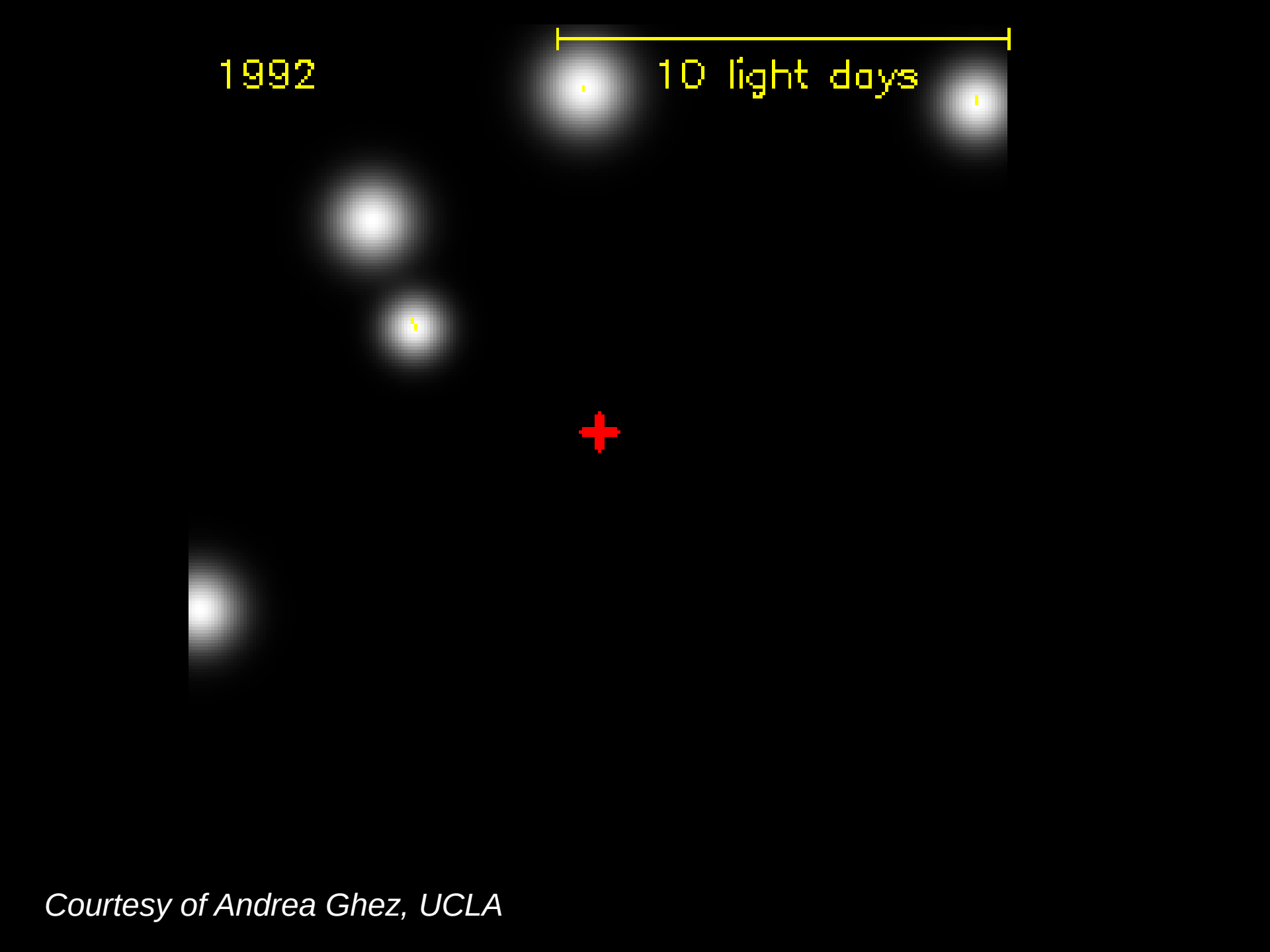
- By measuring atmospheric blurring many times per second, the blurring can be corrected using a feedback loop and “deformable mirror”
- Need a bright source of light and sometimes we make our own using a laser





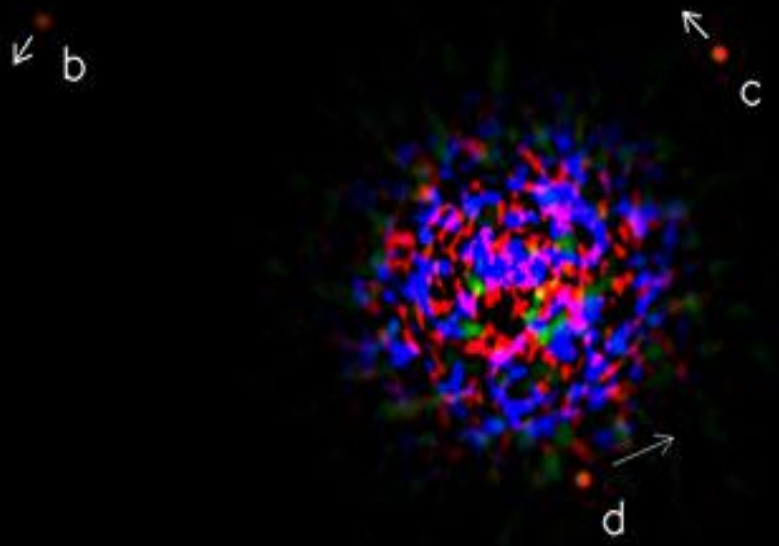



Sgr A*
Keck/UCLA Galactic Center Group



Courtesy of Andrea Ghez, UCLA

HR 8799



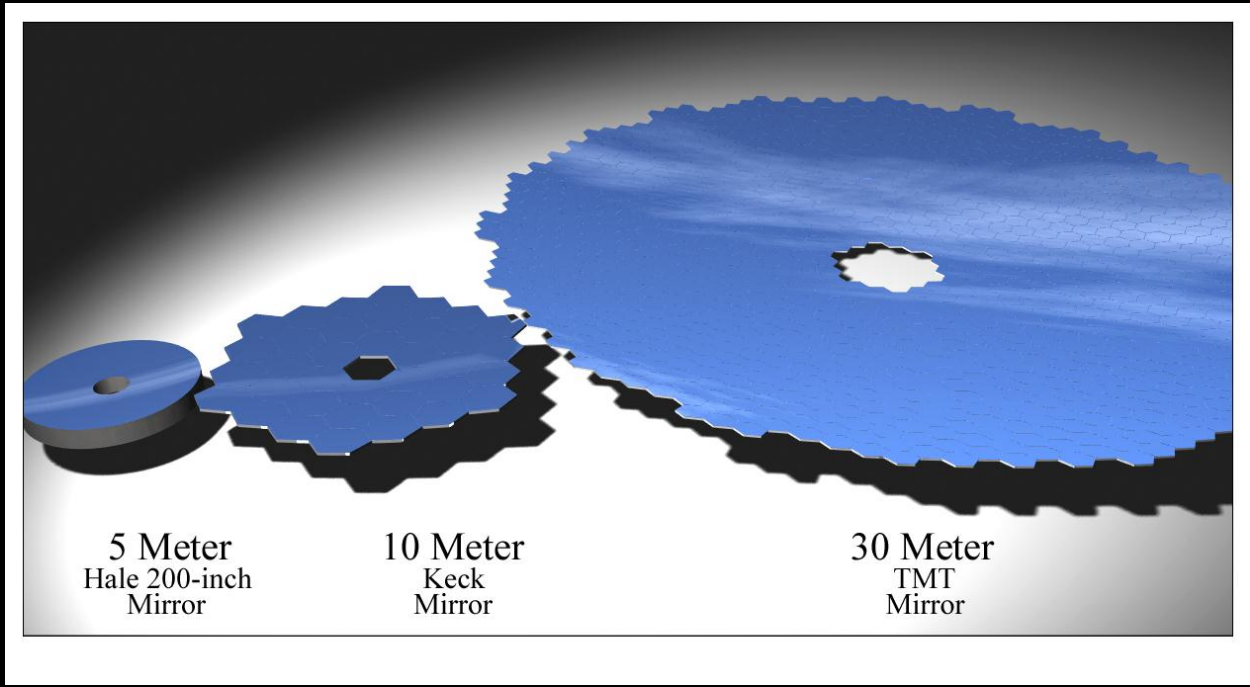
0.5''

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

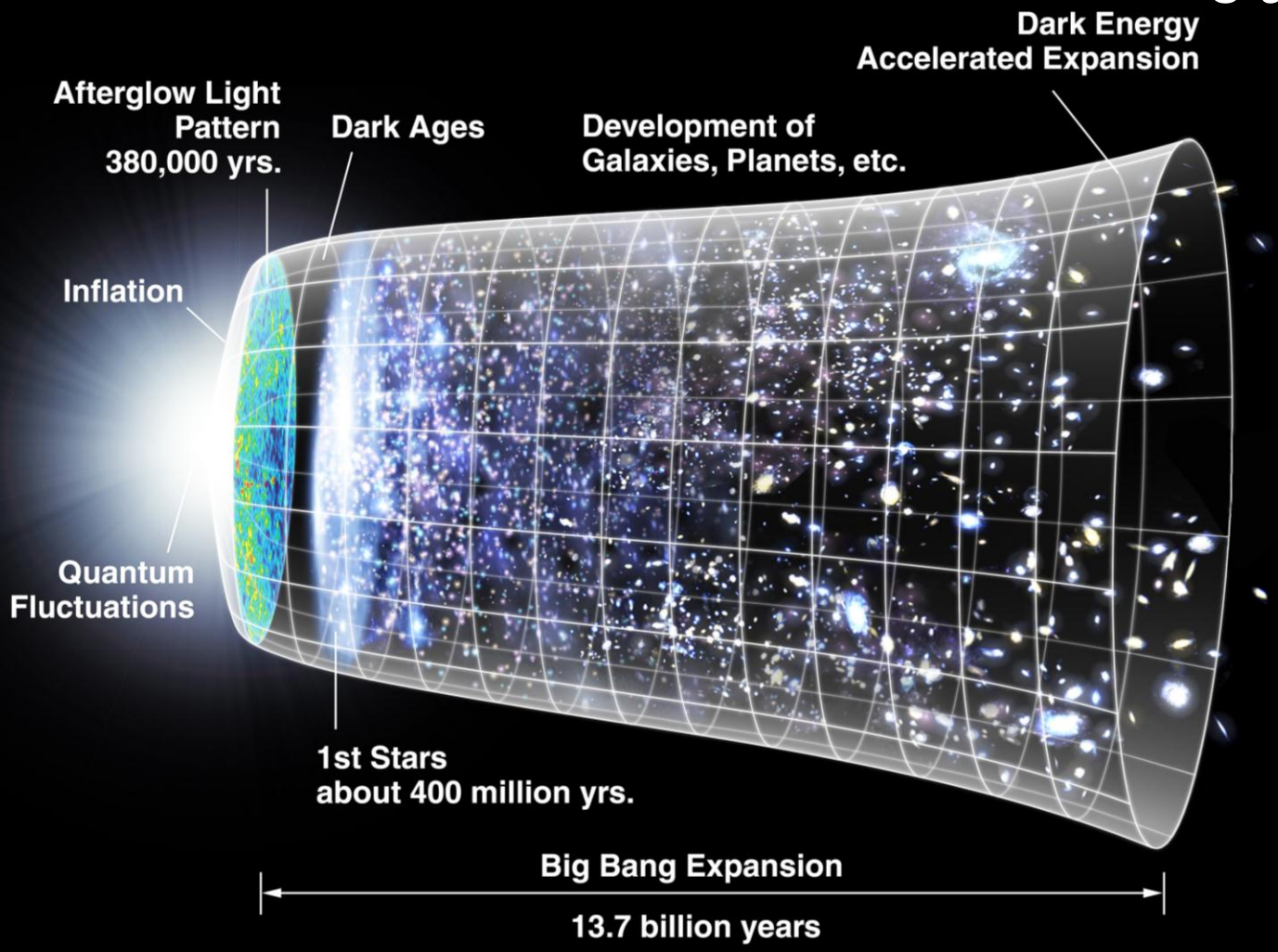
TMT Science

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

30 meter

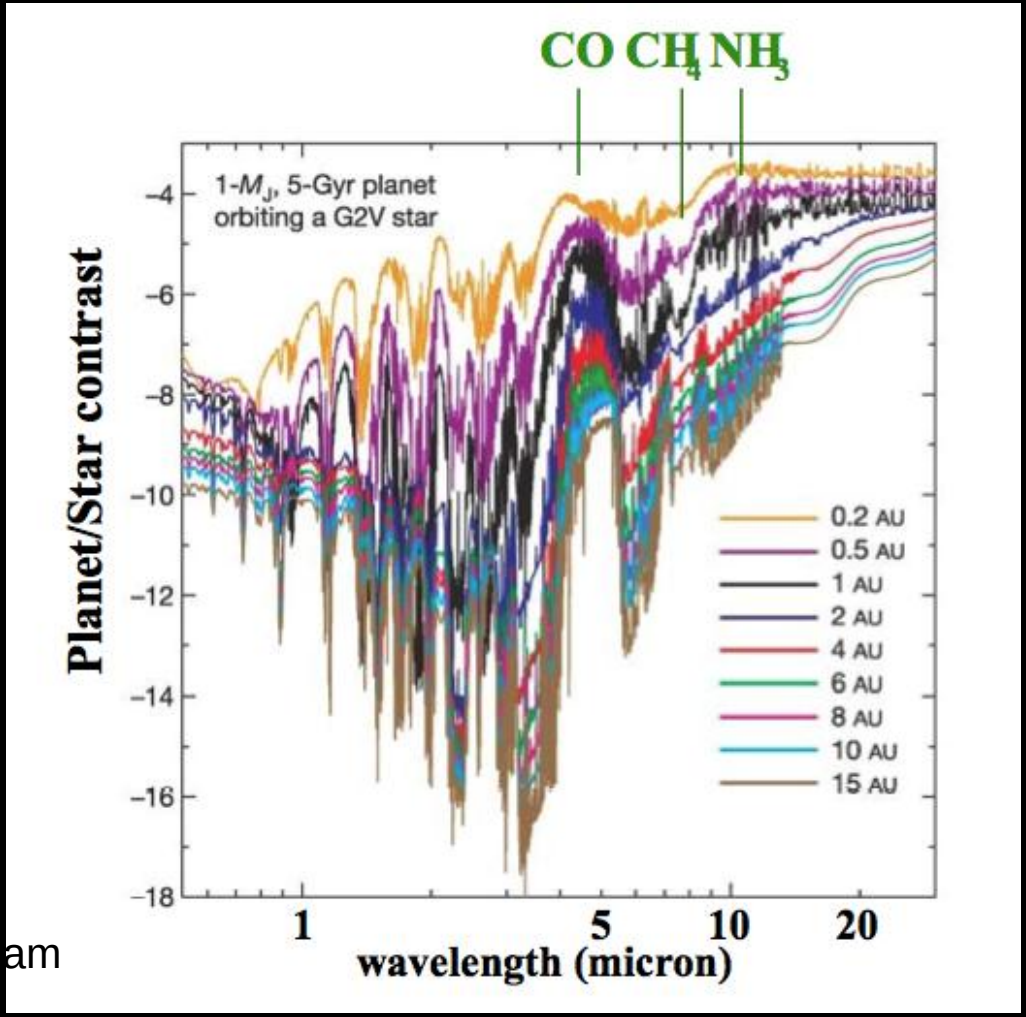
8 and 10 meter



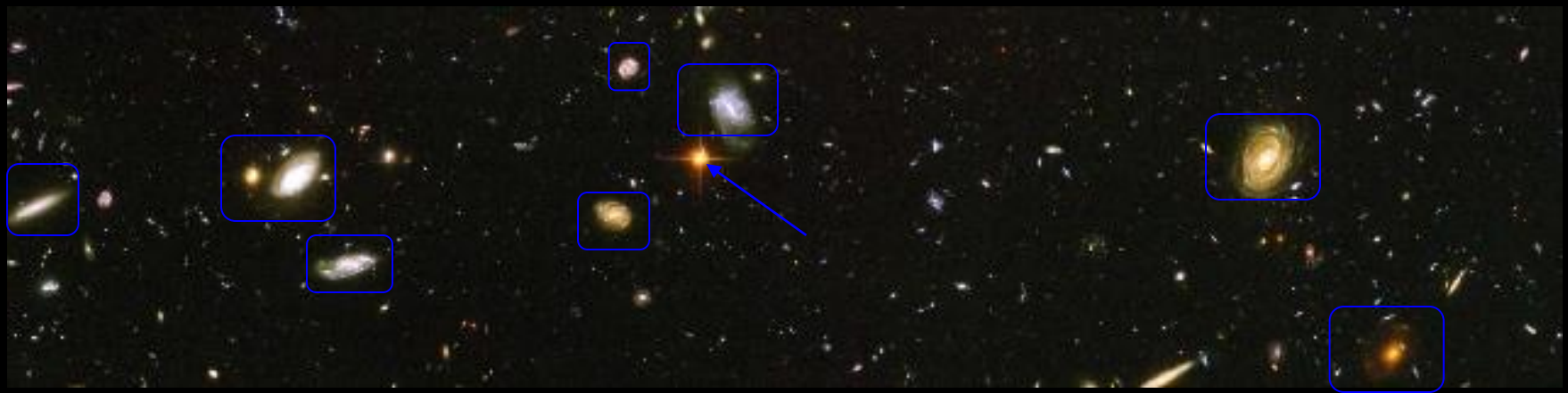
The TMT will extend studies back to the era of the first stars and galaxy

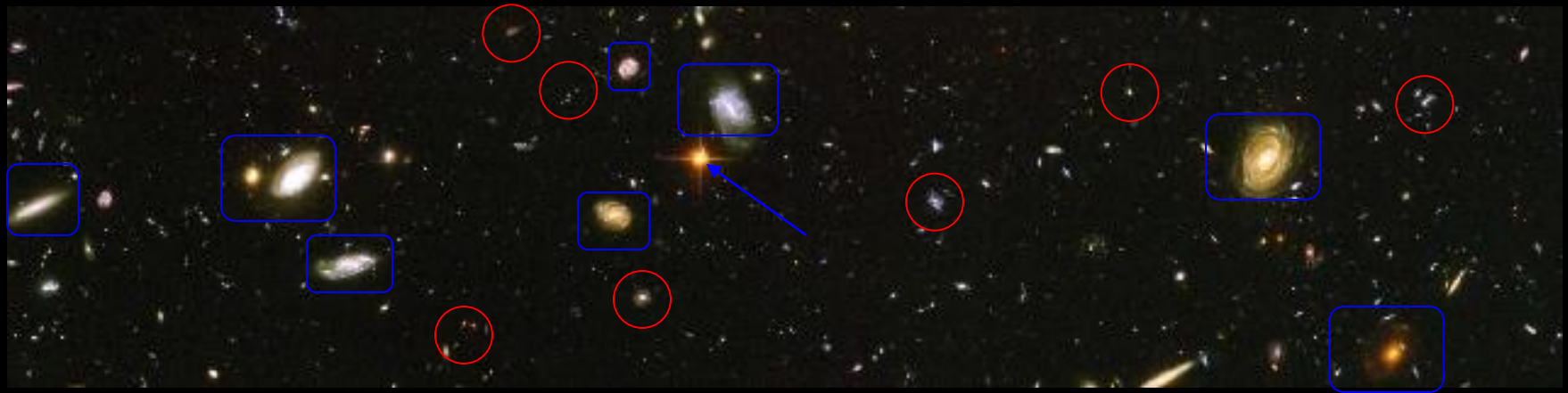
Characterization of Extrasolar Planets
- Atmospheres of massive planets

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



am





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