

Nonvisible Light

- Most light is invisible to the human eye.
- Special detectors/receivers can record such light.
- Digital images are reconstructed using false-color coding so that we can see this light.



Chandra X-ray image of the Center of the Milky Way Galaxy

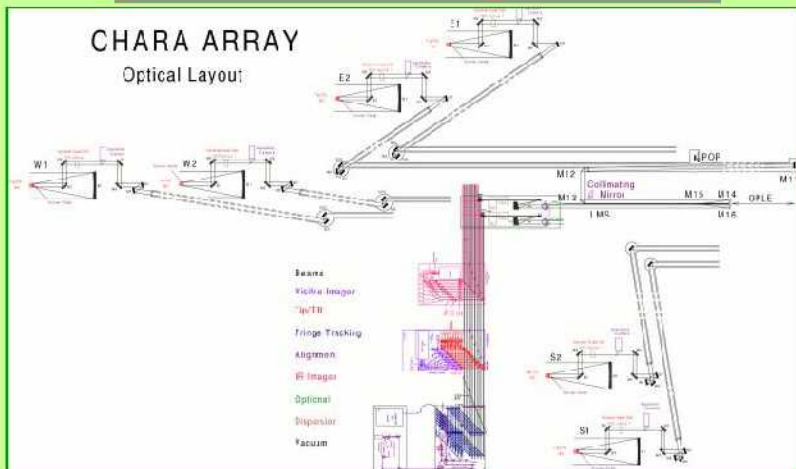
Variations: Optical Interferometry

- Observe at optical or infra-red
- Very difficult technically
 - Tolerances tiny
 - Signals very weak
 - Stars twinkle
- First arrays now coming online



Overall Optical Layout

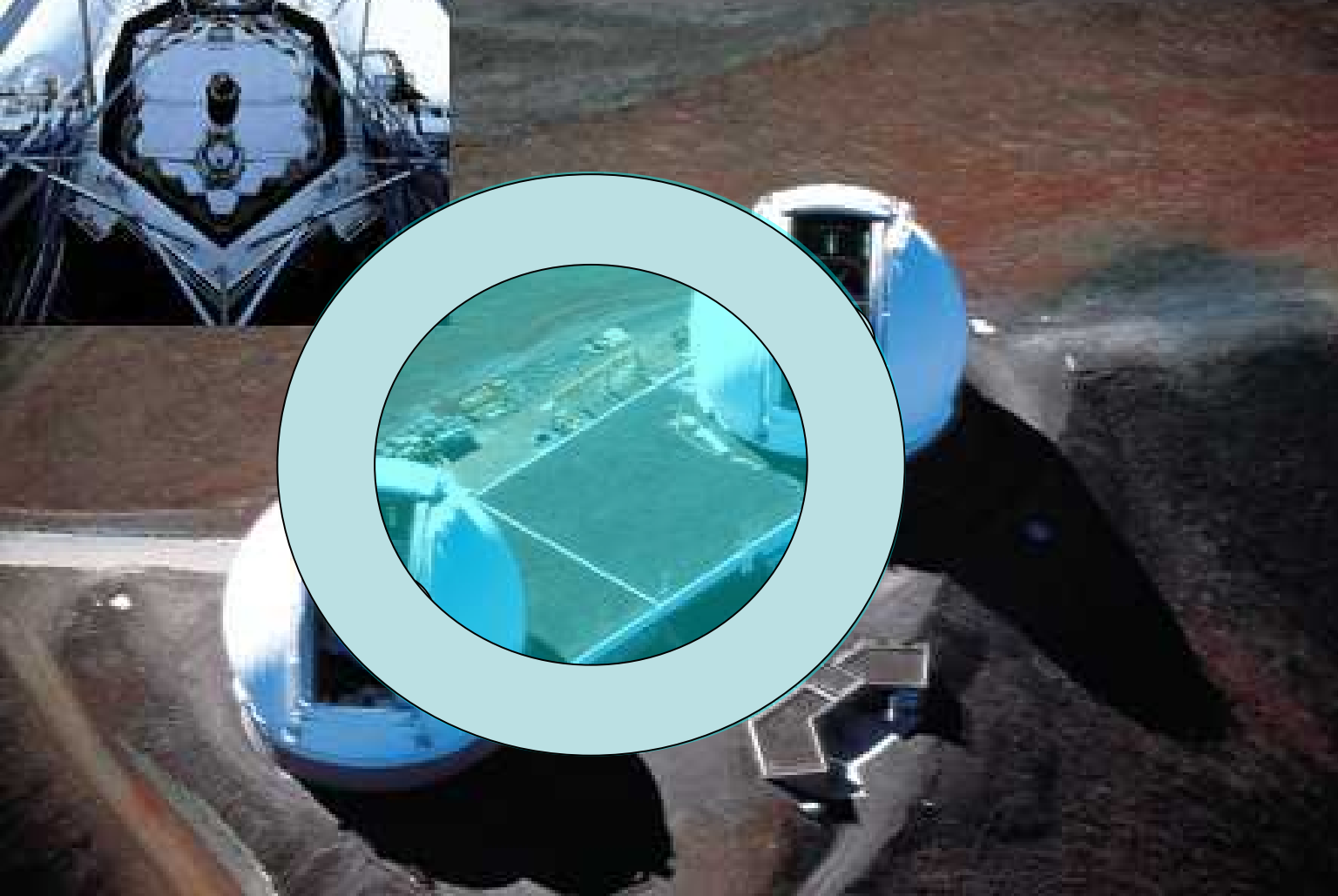
CHARA ARRAY Optical Layout



Layout on Mt. Wilson (CHARA facilities labeled in red)



10-m, multiple mirror Keck
Telescopes on Mauna Kea act as a
single telescope – an
interferometer.







Maunakea is the best place in the world for astronomical observations..



- **Clear nights usually above cloud cover**
- **Dry – low humidity**
- **Stable wind patterns**
- **Latitude allows view of northern and part of southern skies**
- **Accessible**



Maunakea (<1968 - before high school)

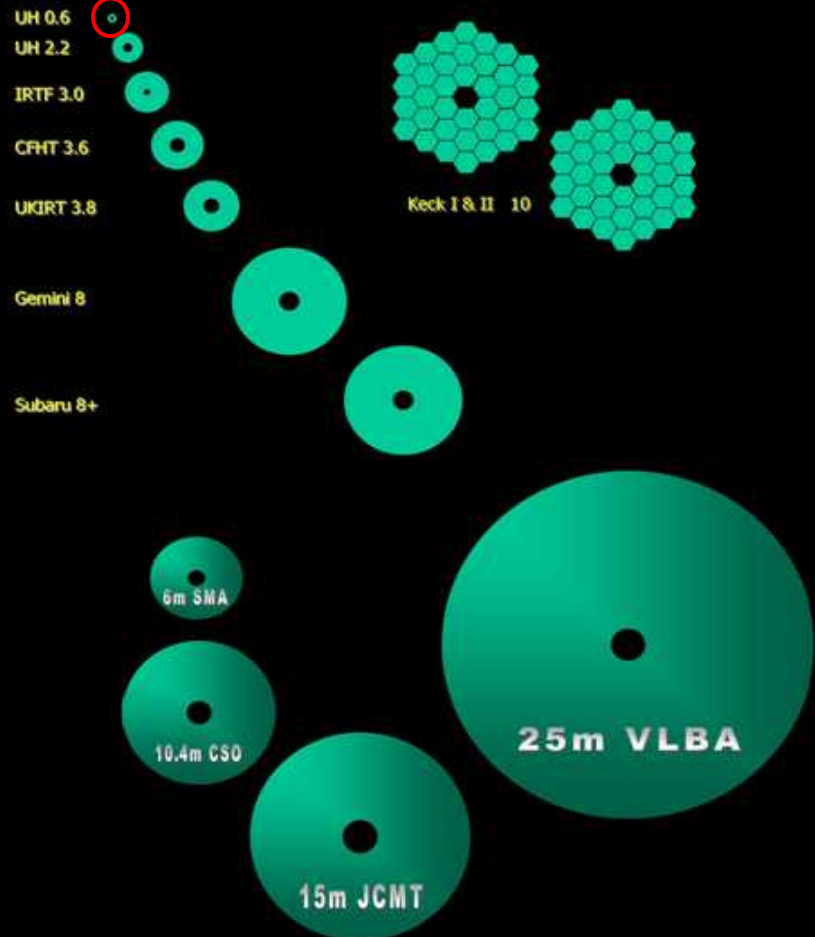




UH 24 inch

(plus students)

$\lambda =$ Optical

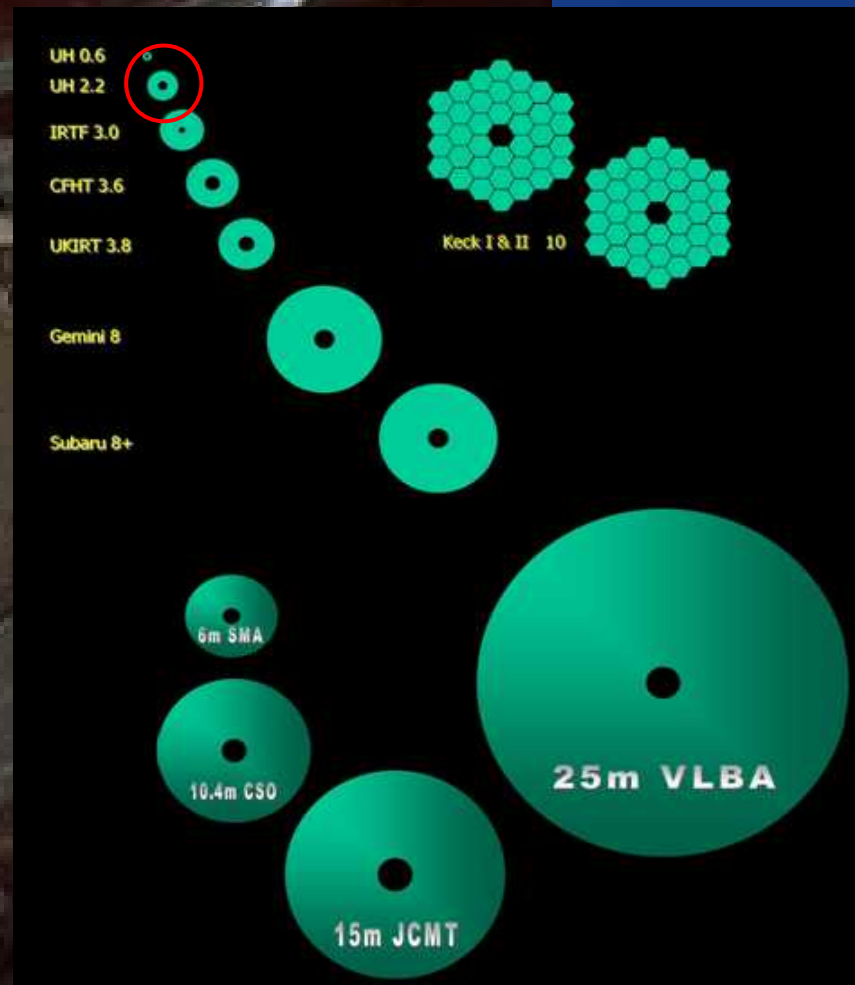


1970 - 2.2 meter telescope

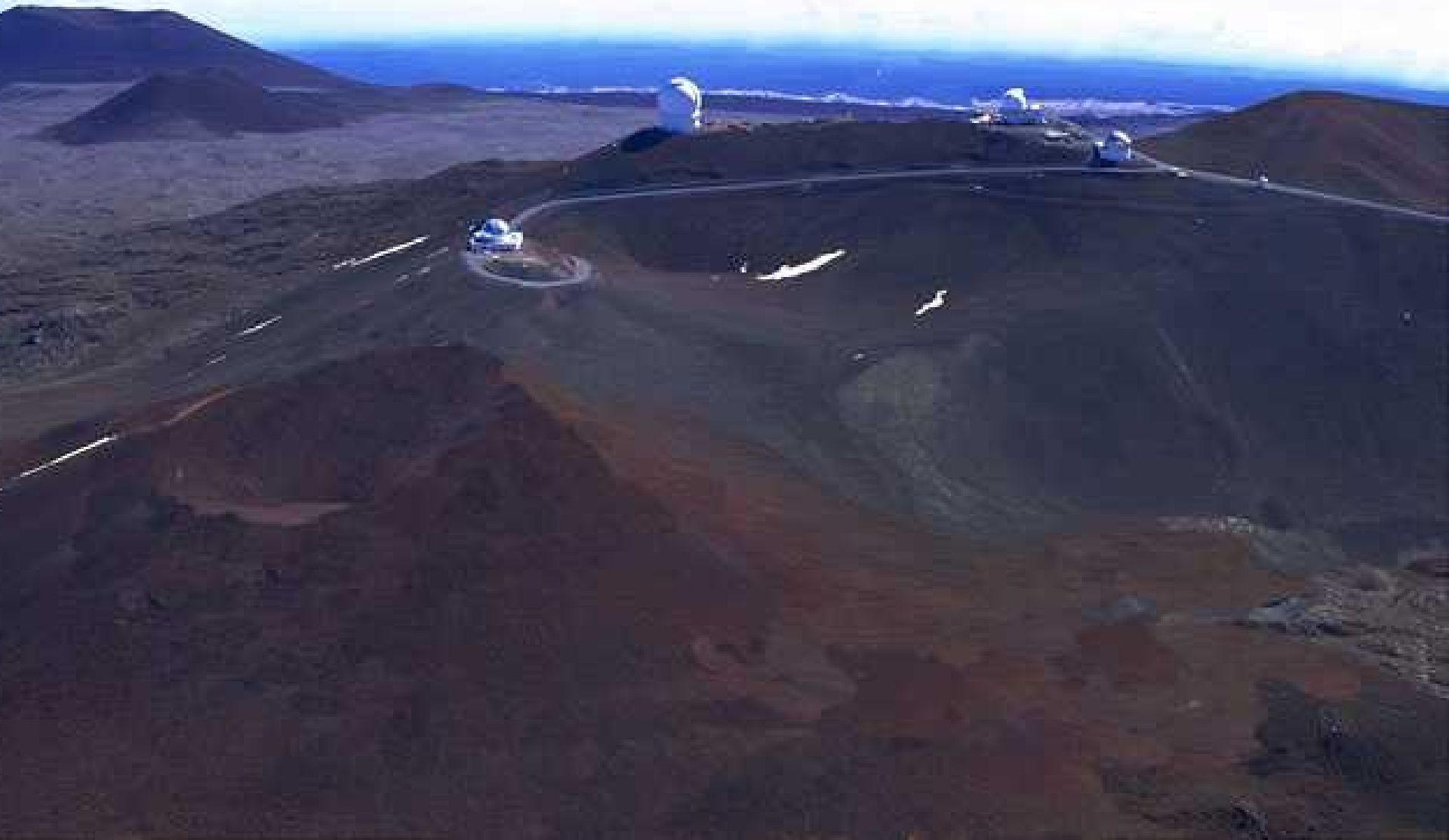


UH 2.2 meter

$\lambda =$ Optical/Infrared



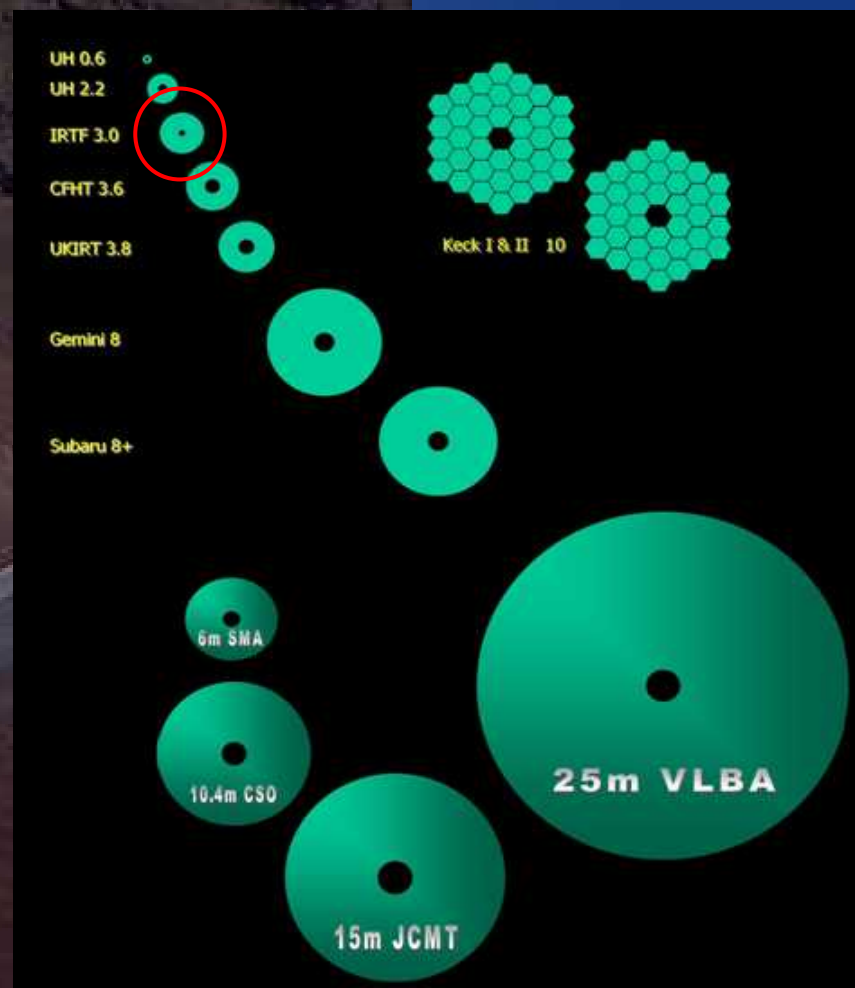
1979 – 2nd year of graduate school



IRTF

$D = 3.0 \text{ m}$

$\lambda = \text{Infrared}$

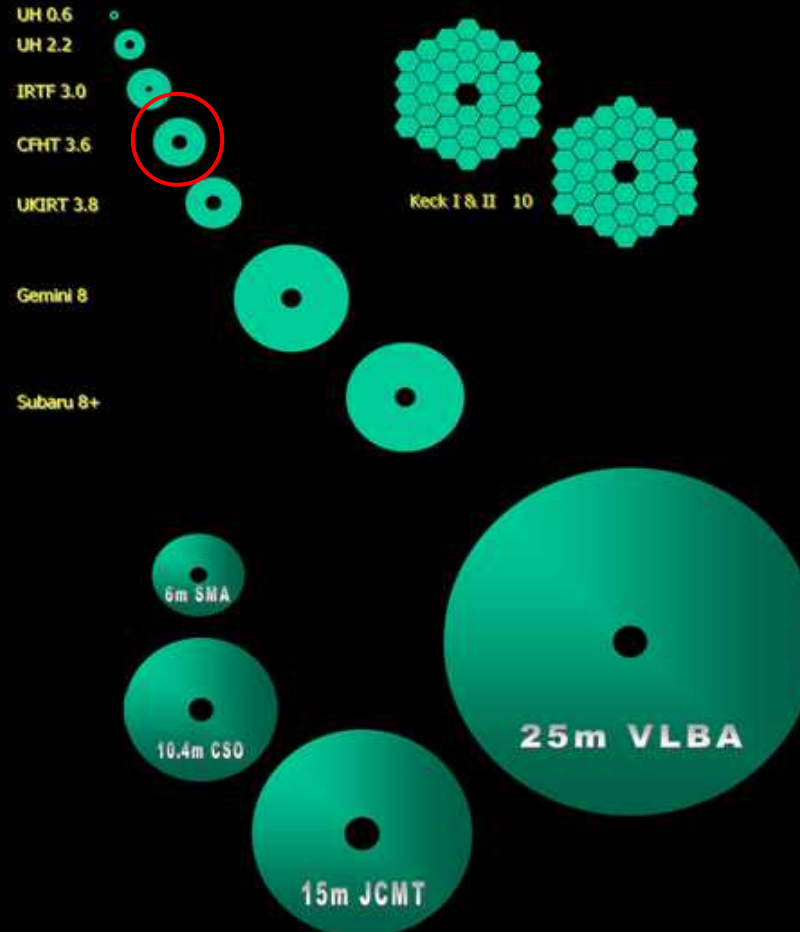




CFHT

$D = 3.6 \text{ m}$

$\lambda = \text{Optical/Infrared}$

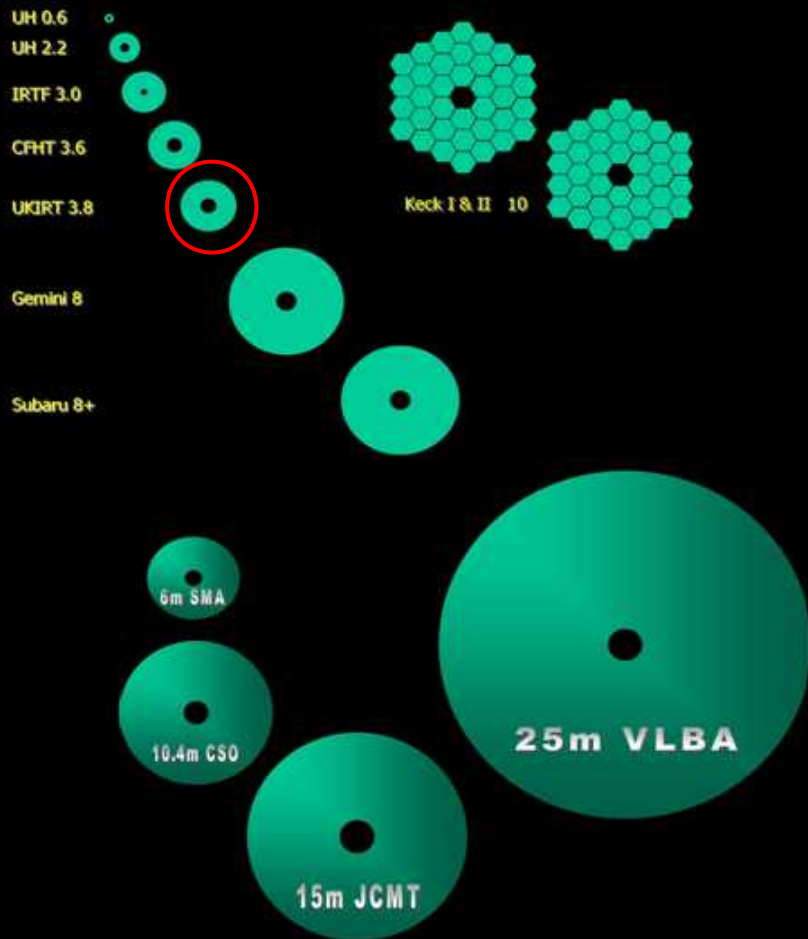




UKIRT

$D = 3.8 \text{ m}$

$\lambda = \text{Infrared}$



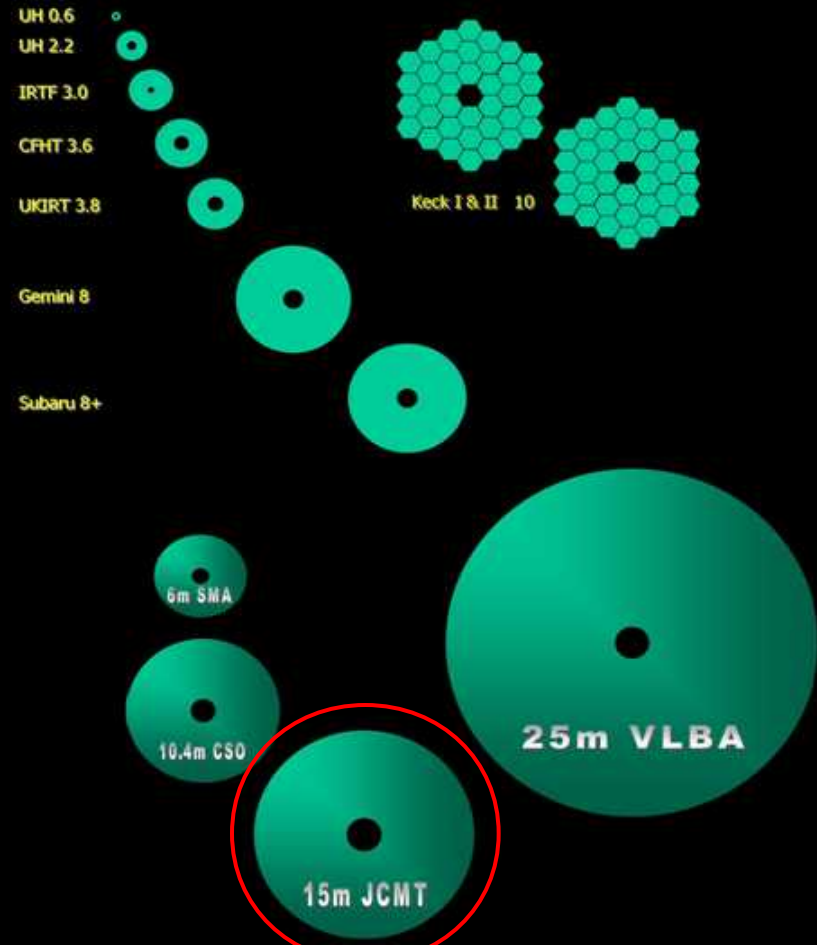
1987 – post-doctoral position



JCMT

$D = 15 \text{ m}$

$\lambda = \text{Millimeter} / \text{Submm}$

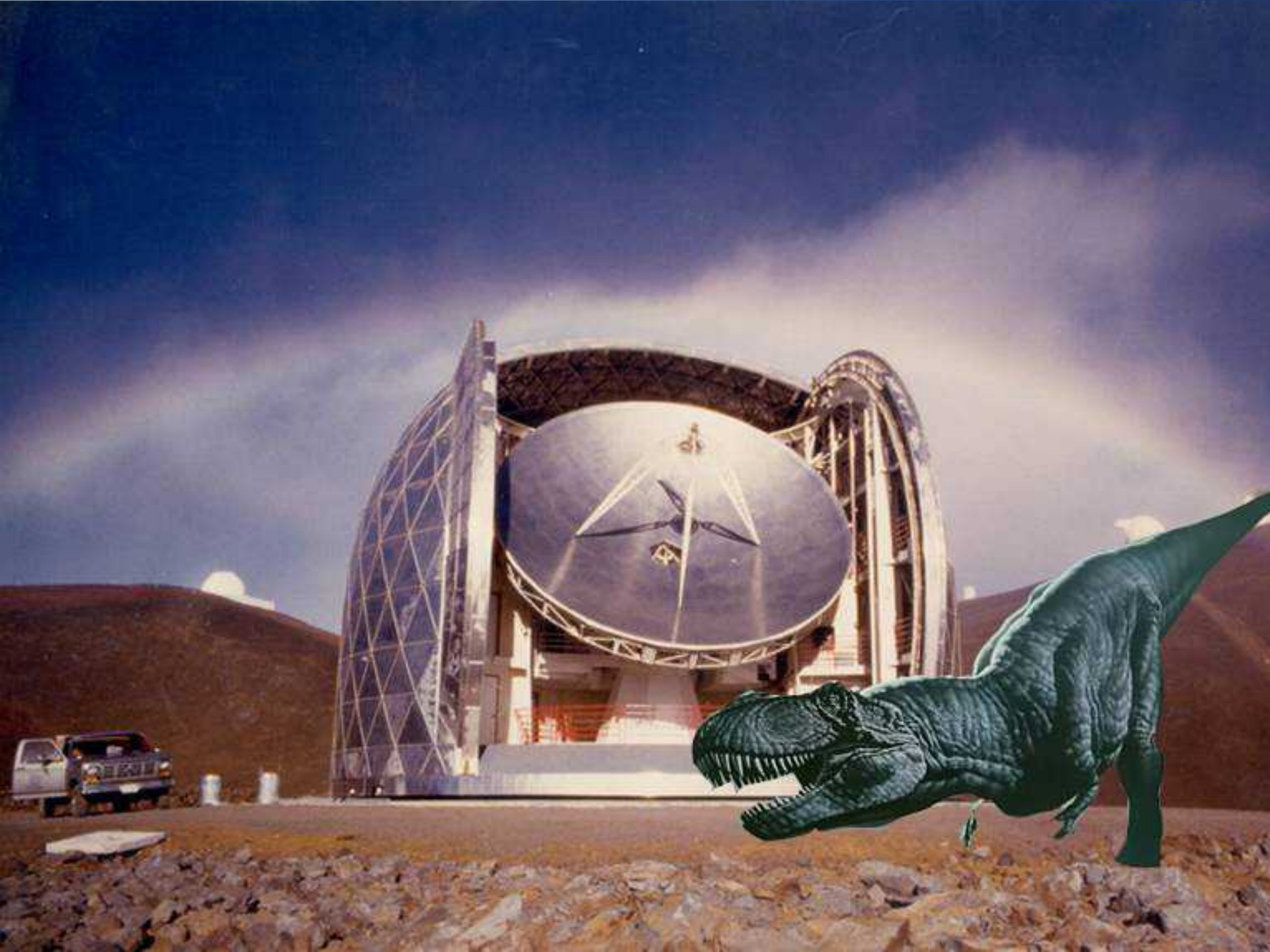


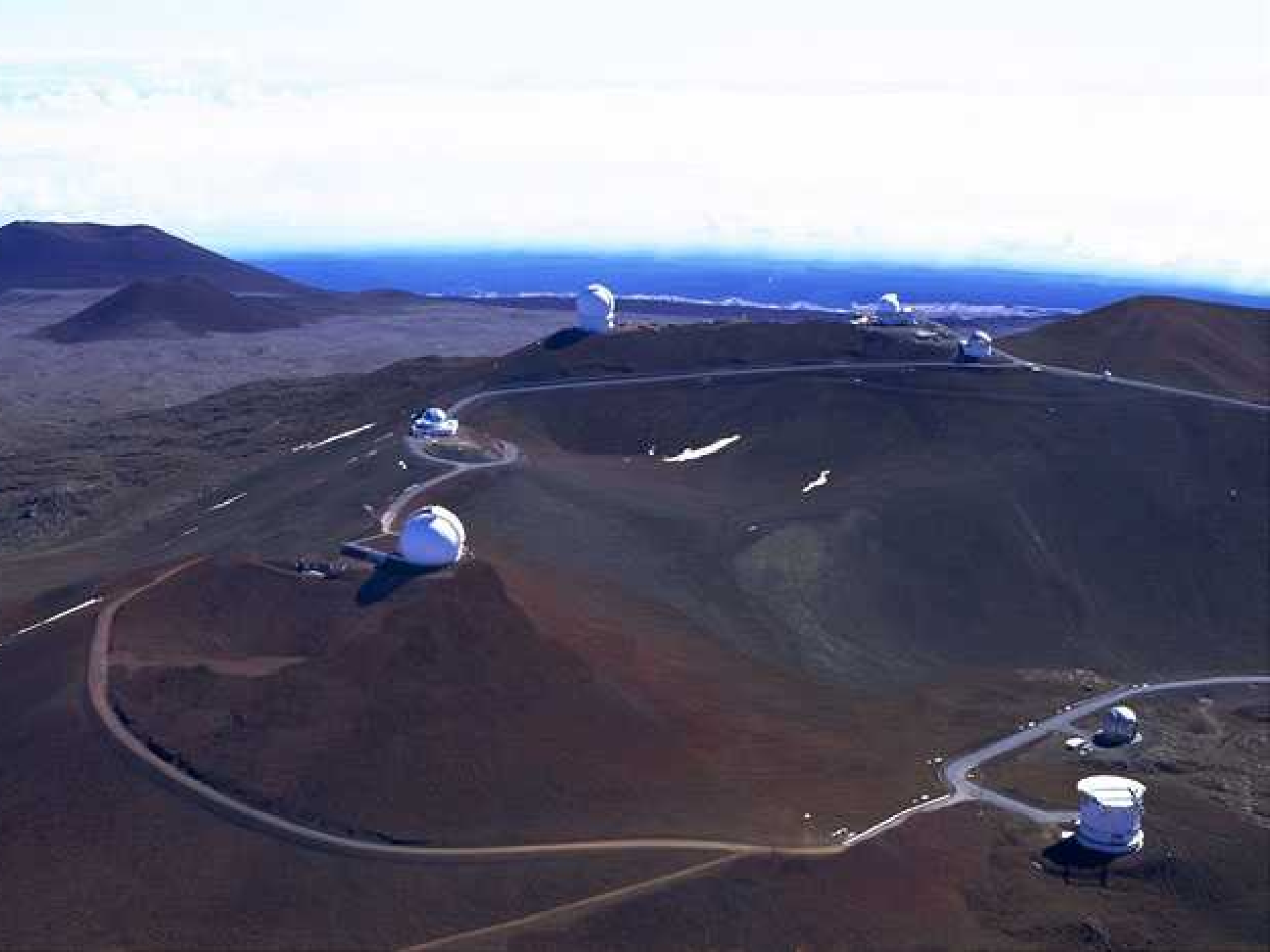
Caltech Submillimeter Observatory

$D = 10.4 \text{ m}$

$\lambda = \text{Infrared}$







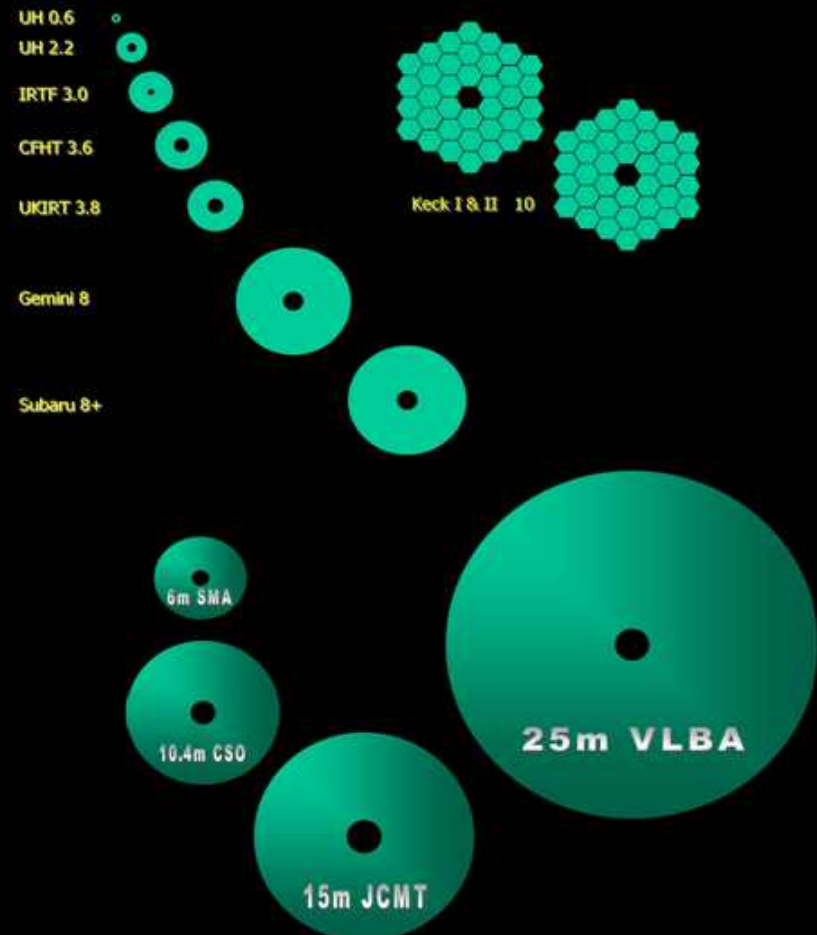


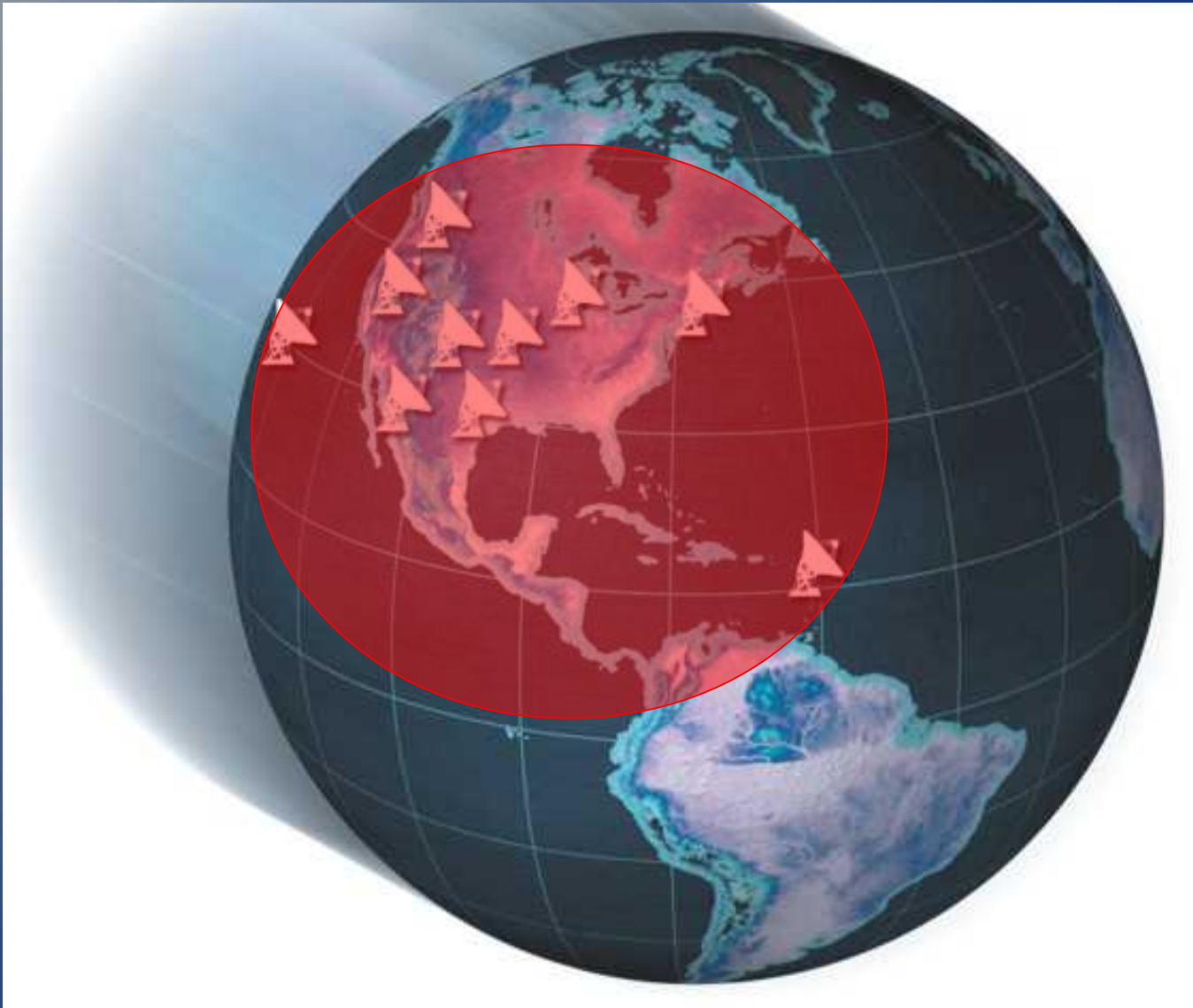


VLBA

$D = 25 \text{ m}$

$\lambda = \text{cm}$



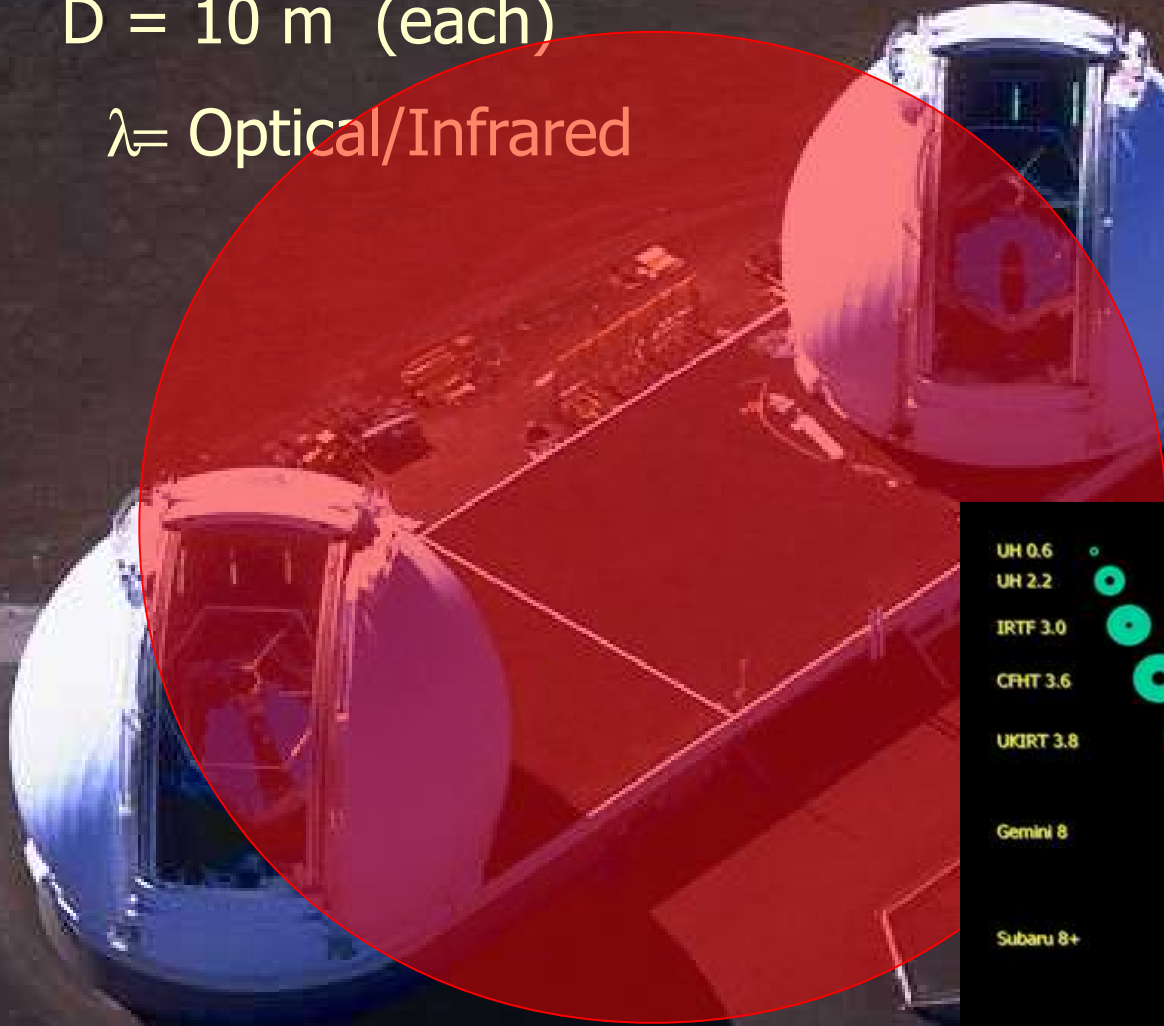




Keck I & II

$D = 10 \text{ m}$ (each)

$\lambda = \text{Optical/Infrared}$



UH 0.6

UH 2.2

IRTF 3.0

CFHT 3.6

UKIRT 3.8

Gemini 8

Subaru 8+

6m SMA



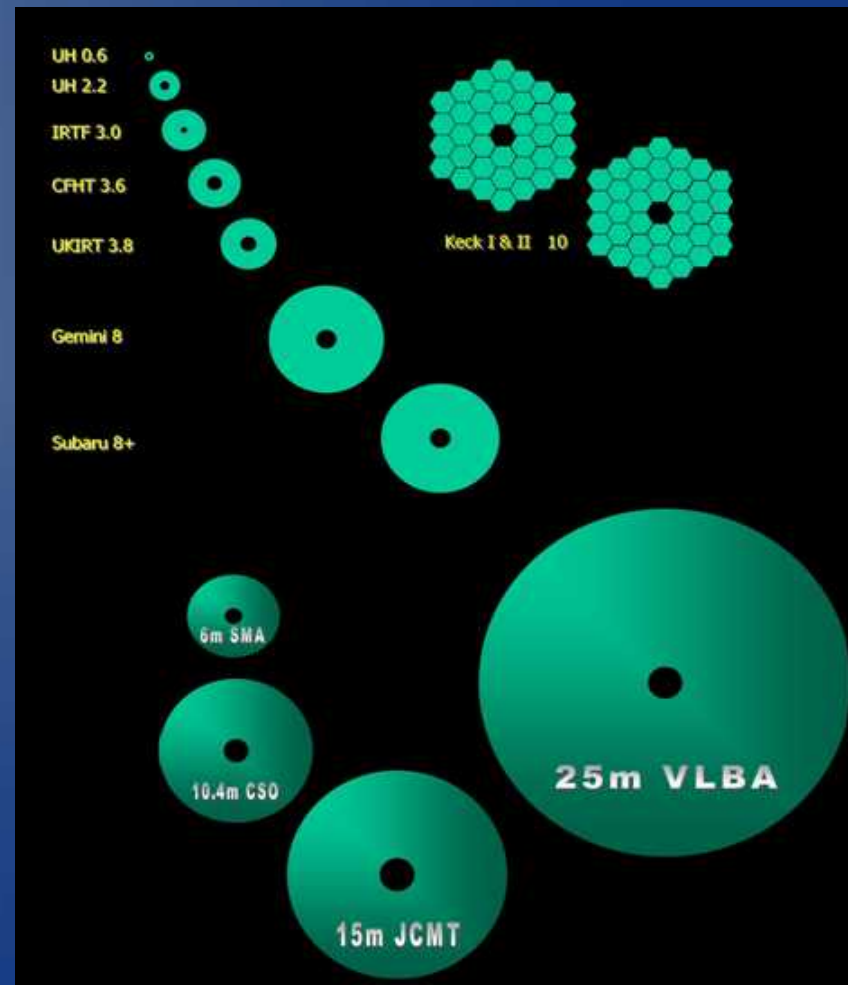
Keck I & II 10

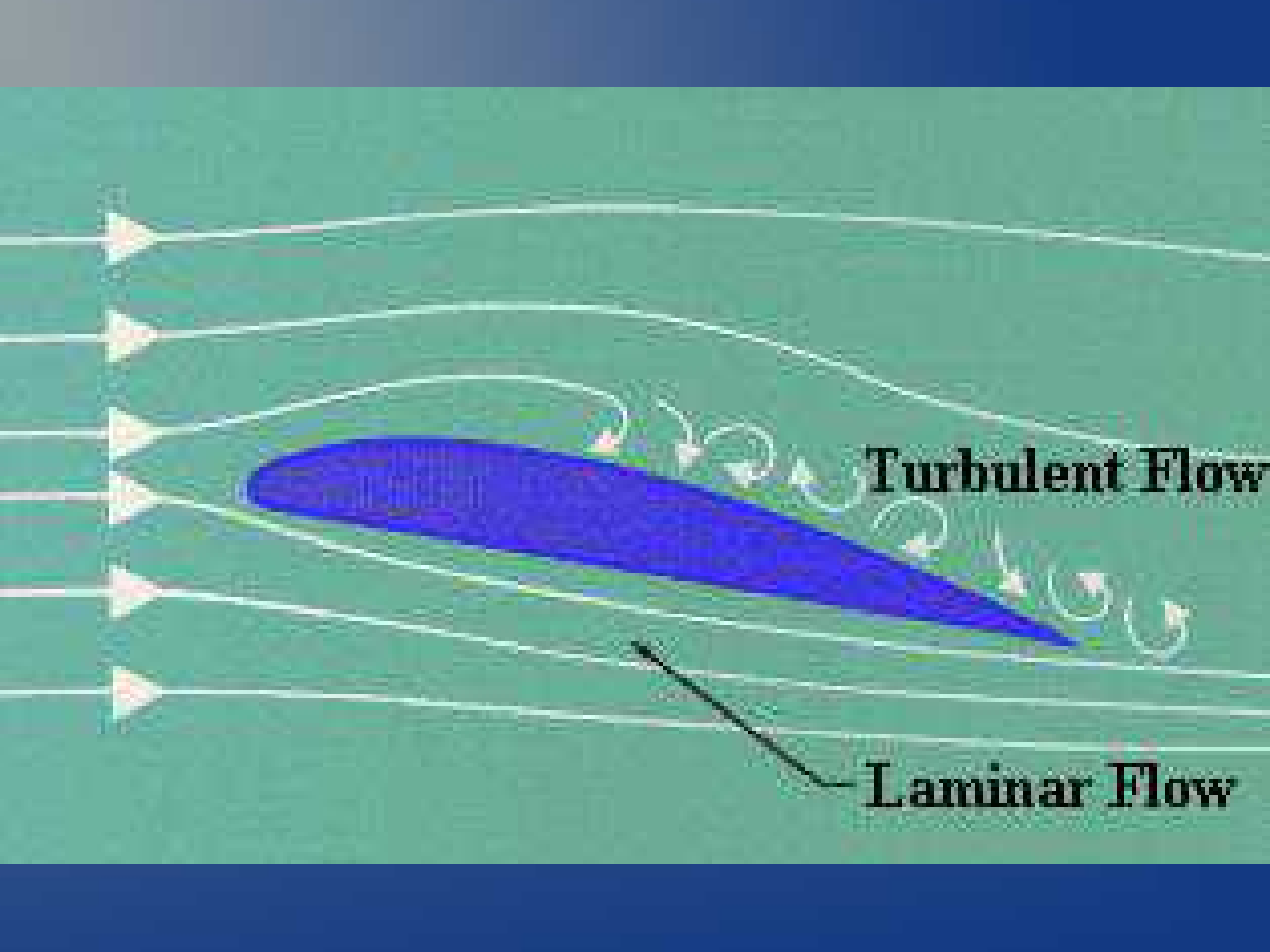


Gemini

D = 8 m

λ = Optical/IR





Turbulent Flow

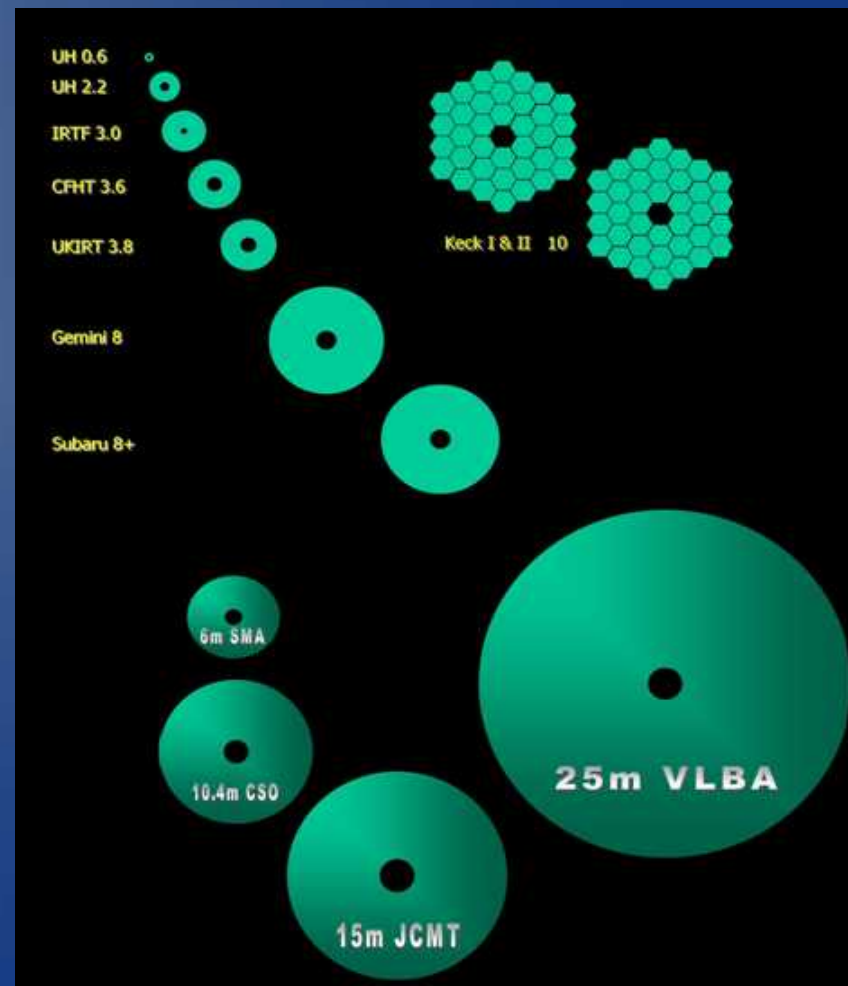
Laminar Flow



Gemini

D = 8 m

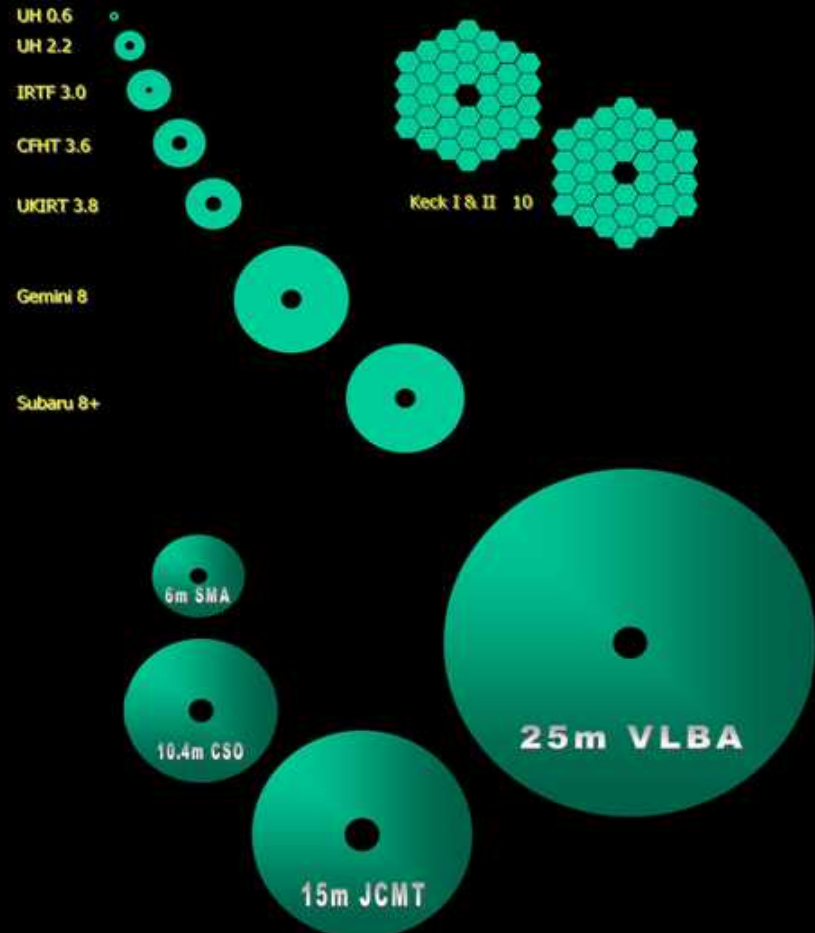
λ = Optical/IR

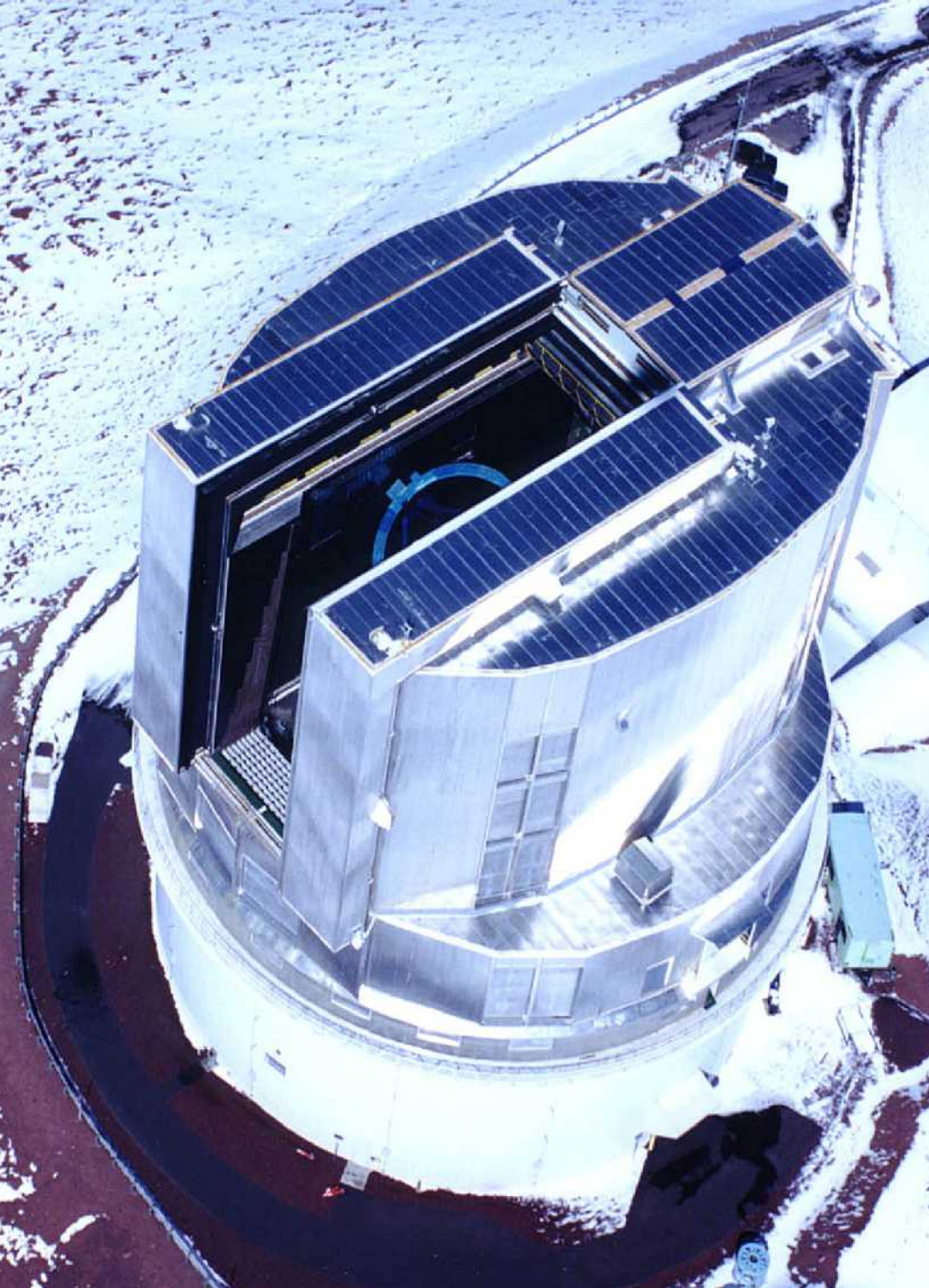


Subaru

D = 8+ m

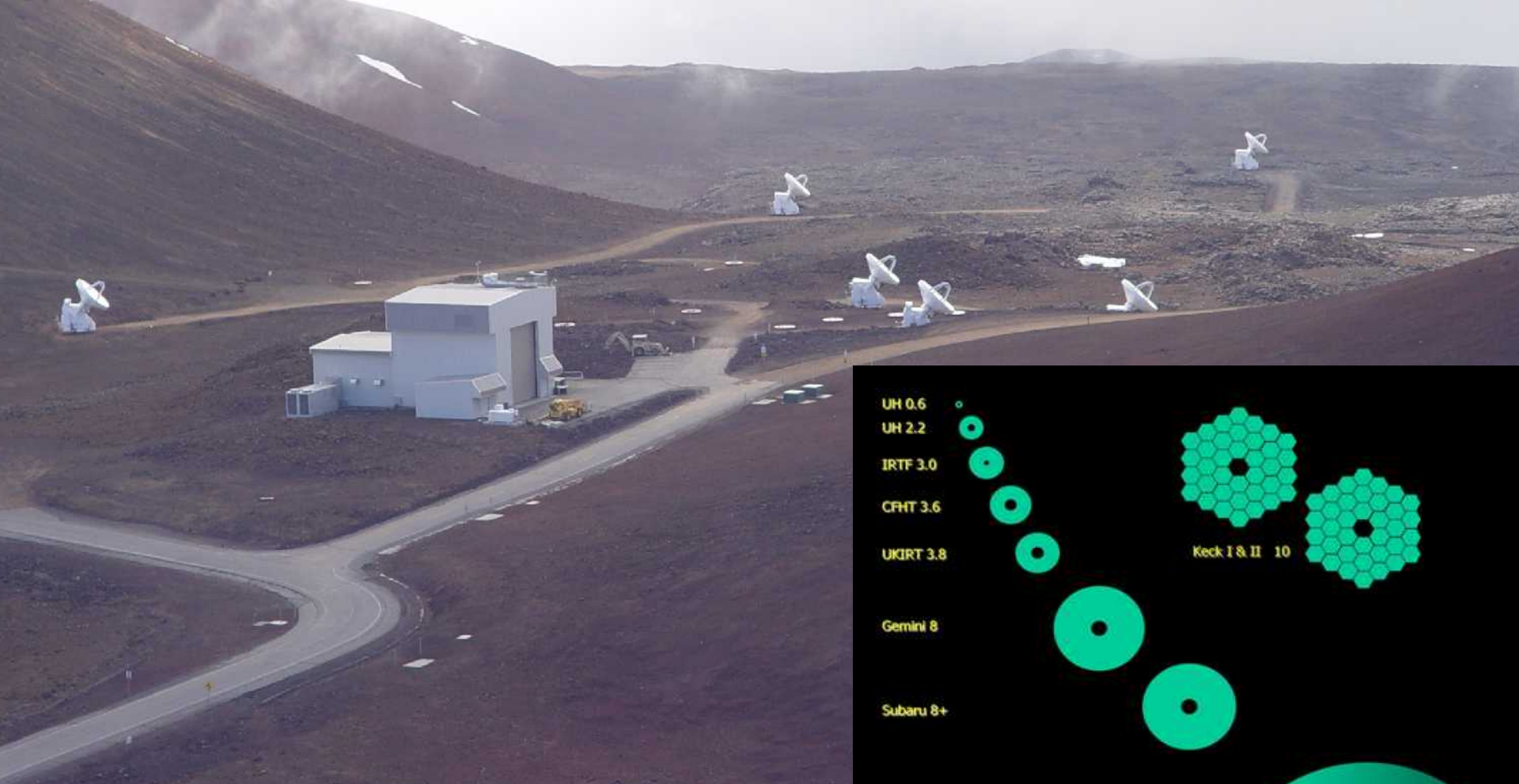
$\lambda =$ Optical/Infrared





2001 – UPR \Rightarrow IfA

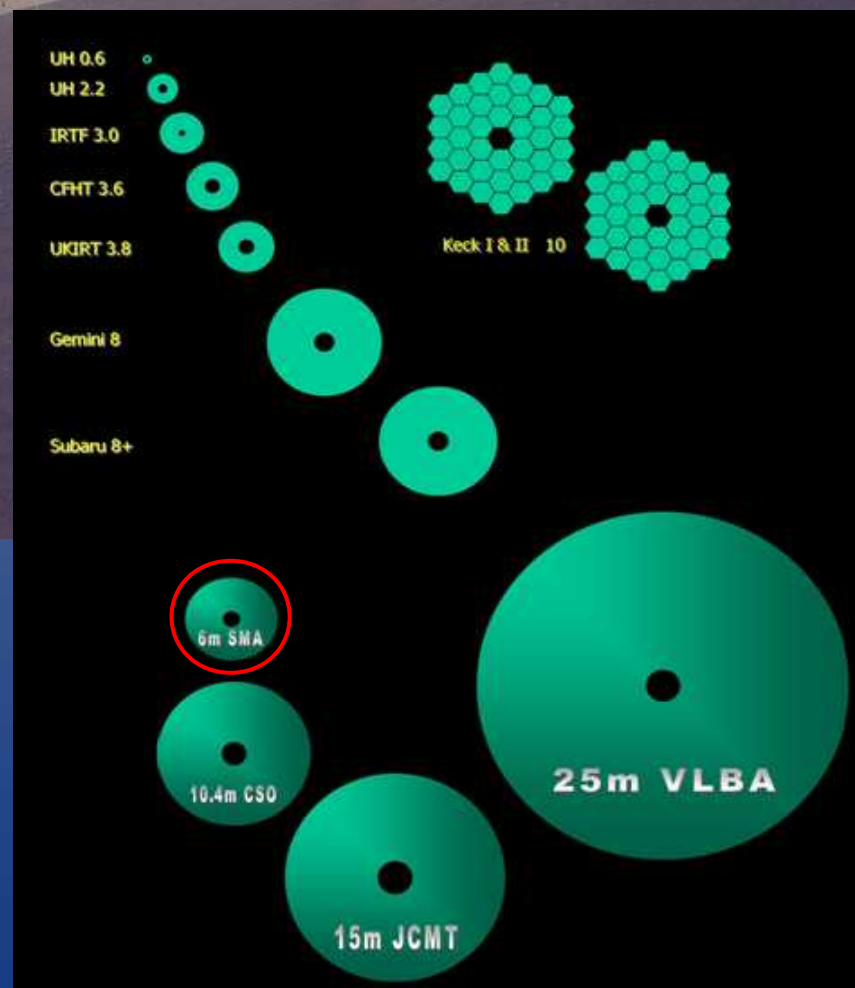




SMA

$D = 6 \text{ m}$ (each)

$\lambda = \text{Submillimeter}$



Maunakea today



Optical and Infrared Telescopes

UH 0.6-m Telescope	0.6 m	Optical	UH	1968
UH 2.2-m Telescope	2.2 m	Optical/Infrared	UH	1970
NASA Infrared Telescope Facility (IRTF)	3.0 m	Infrared	NASA	1979
Canada-France-Hawaiïi Telescope (CFHT)	3.6 m	Optical/Infrared	Canada/France/UH	1979
United Kingdom Infrared Telescope (UKIRT)	3.8 m	Infrared	United Kingdom	1979
W. M. Keck Observatory (Keck I)	10 m	Optical/Infrared	Caltech/ Univ. of California/NASA	1992
W.M. Keck Observatory (Keck II)	10 m	Optical/Infrared	Caltech/ Univ. of California/NASA	1996
Subaru	8 m	Optical/Infrared	Japan	1999
Millimeter/Submillimeter Telescopes				
Gemini Northern 8-m Telescope	8 m	Optical/Infrared	Canada/Chile/Argentina/Brazil	1999
Caltech Submillimeter Observatory (CSO)	10.4 m	Millimeter/Submillimeter	Caltech/NSF	1987
James Clerk Maxwell Telescope (JCMT)	15 m	Millimeter/Submillimeter	United Kingdom/Canada/Netherlands	1987
Submillimeter Array	Eight 6-m antenn	Submillimeter	Smithsonian Astro-physical Observ./ Taiwan	2001
Other Facilities				
Very Long Baseline Array	25 m	Centimeter	National Radio Astronomy Observatory	1992

Who is employed by the IfA?

About ¼ are locals

Type of Personnel	Mānoa	Maui	Hawaīi	Total	Hawaiian
Tenure/Tenure-Track Faculty	31	1	3	35	1
Non-Tenure-Track Faculty	9	0	2	11	0
Postdoctoral Fellows	7	0	0	7	0
Graduate Students	27	0	0	27	1
Technical Support (incl. MKSS)	21	13	47	81	3
Administrative Support	26	3	6	35	6
TOTAL	121	17	53	196	11

Possible Job Opportunities:

Astronomer

Telescope Operator

Engineers (electrical, environmental, mechanical, etc.,)

Technicians

Computer Programmers (software, hardware)

Administrators

Office staff

Travel agent

Possible fields of study on the mountains:

Geology (study of geological features)

Archaeology (study of Ancient Sites)

Volcanology (study of volcanoes)

Botany (plants)

Anthropology (study of ancient civilizations people)

Meteorology (weather)

Biology (land & in the lake)

Entomology (study of insects)

High Altitude Physician

EMT (emergency medical technician)

Maintenance (road grader, snow plow, heavy equipment operator, road

clearance etc)

Ranger (malama)

Cultural Resource

Interpretive Guide

Support services (Chef, housekeepers, hotel management)

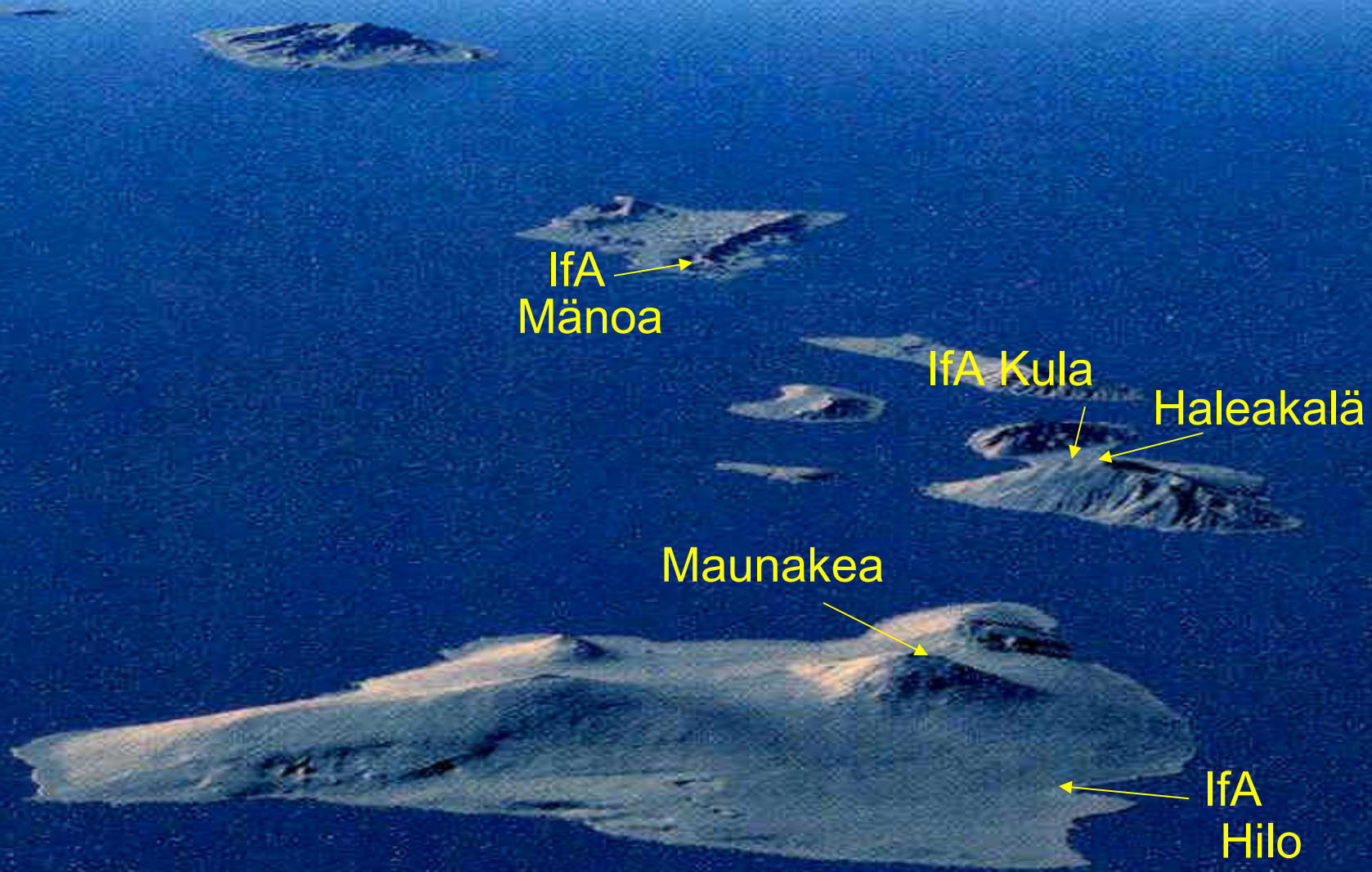
Conservation & Forestry (Department of land & Natural Resources)

Game Management (Department of land & Natural Resources)

And probably many more...

Currently ~ 600 – 800 jobs in/around astronomy. With the new IfA projects, anticipate 2-3 times more jobs in the next 10-20 years.

Where are they employed?



MONEY MAGAZINE's top ten jobs:

- 1. Software Engineer**
- 2. College professor**
- 3. Financial adviser**
- 4. Human Resources Manager**
- 5. Physician assistant**
- 6. Market research analyst**
- 7. Computer IT analyst**
- 8. Real Estate Appraiser**
- 9. Pharmacist**
- 10. Psychologist**



Maunakea
today



Maunakea
today



Maunakea
tomorrow?