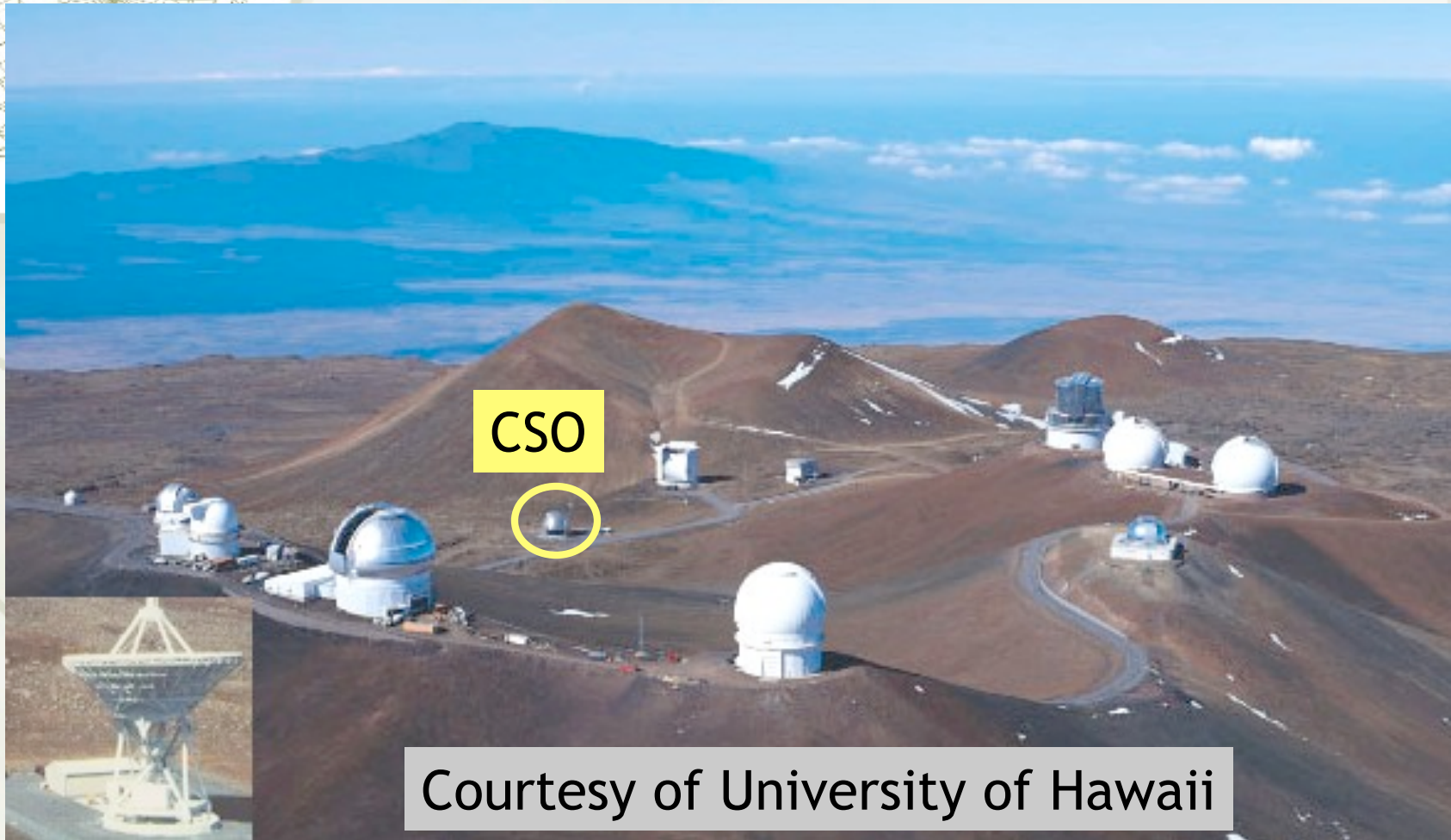


How to catch weak signal from distant astronomical objects?

Hiroko Shinnaga

Caltech Submillimeter Observatory
(CSO)

Unique Mountain Mauna Kea

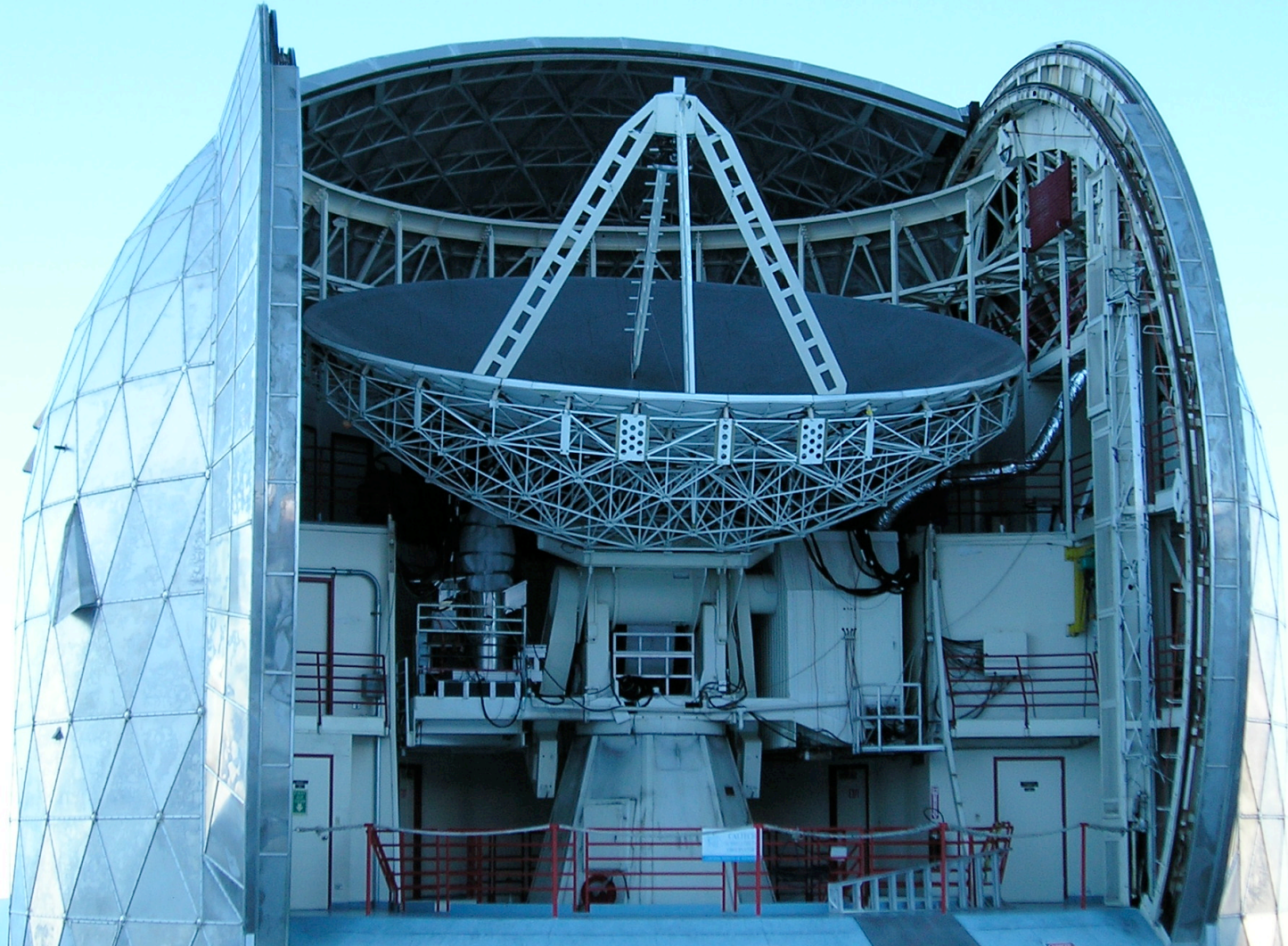


Courtesy of University of Hawaii

JTTU 2007

Hiroko Shinnaga (CSO)

Caltech Submillimeter Observatory



**10.4meter (34.1feet) diameter Leighton Telescope
At the Caltech Submillimeter Observatory**

Caltech Submillimeter Observatory

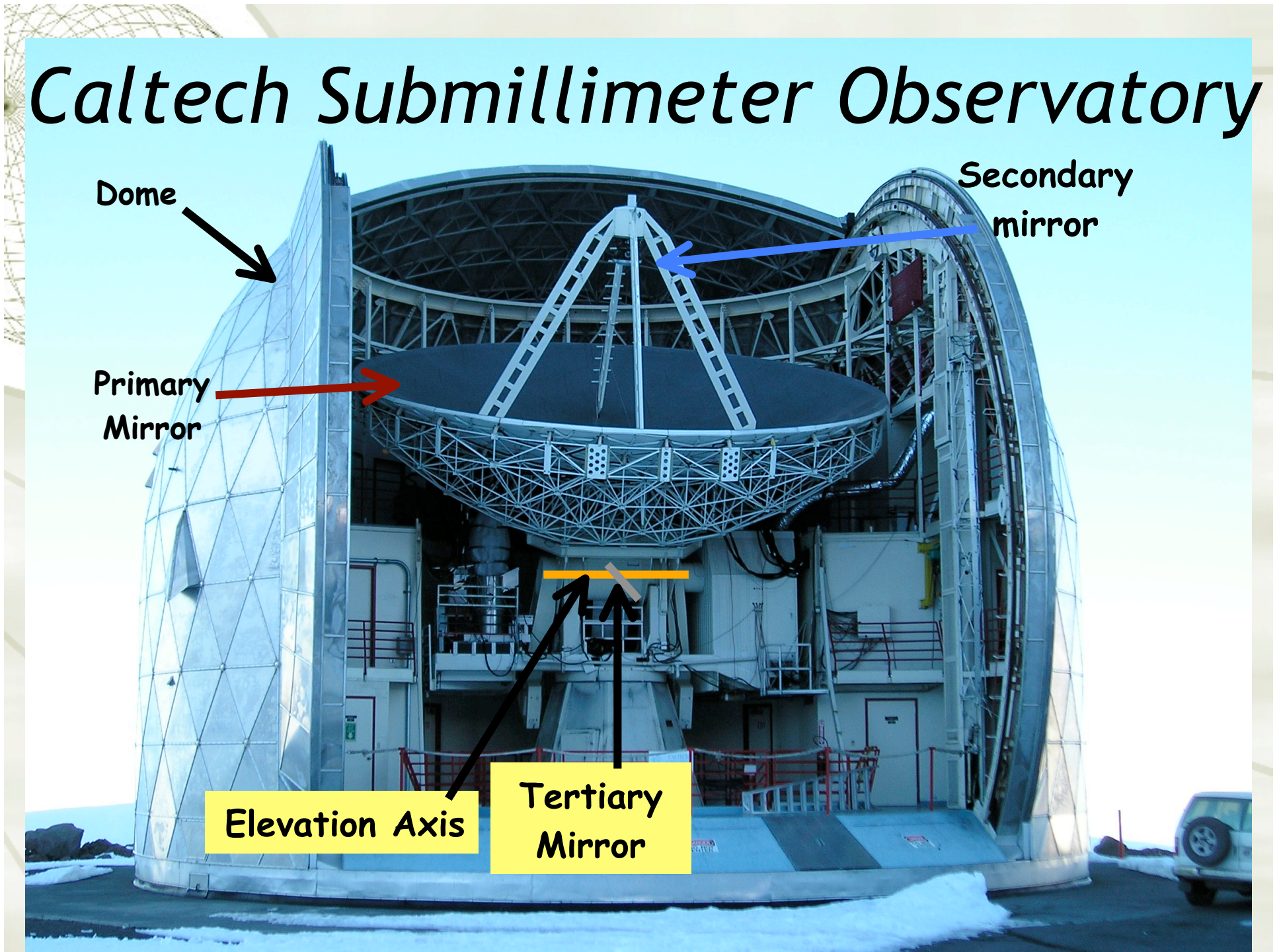
Dome

Secondary mirror

Primary Mirror

Elevation Axis

Tertiary Mirror





5116 2007

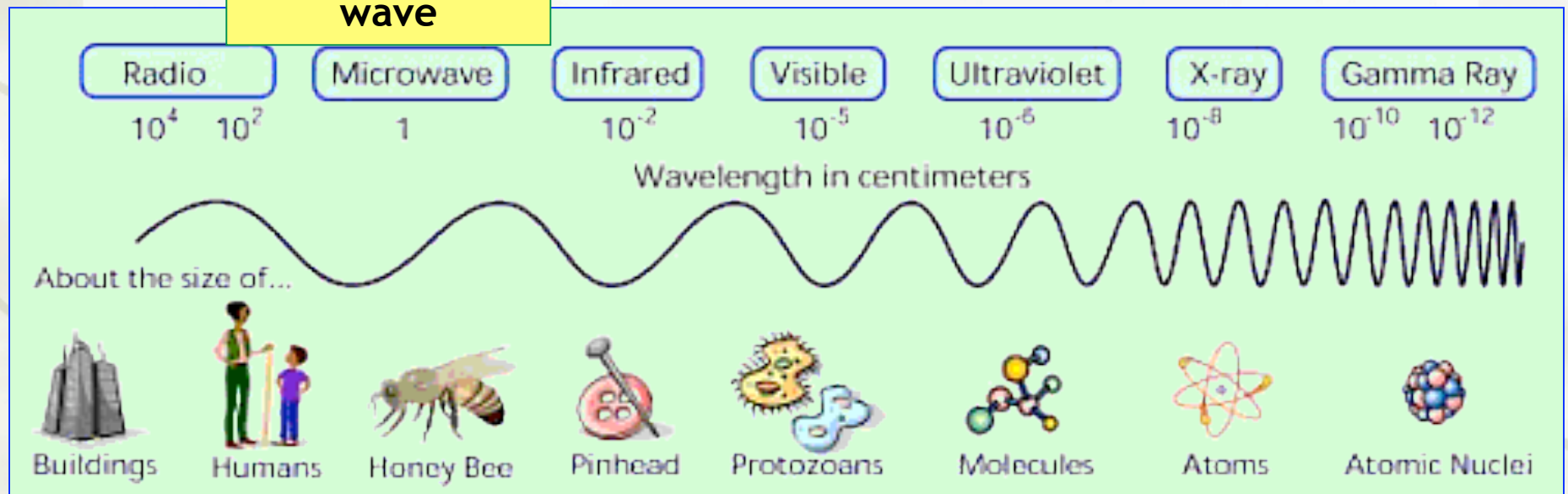


Courtesy of Univ.Hawaii

Light / Radio wave

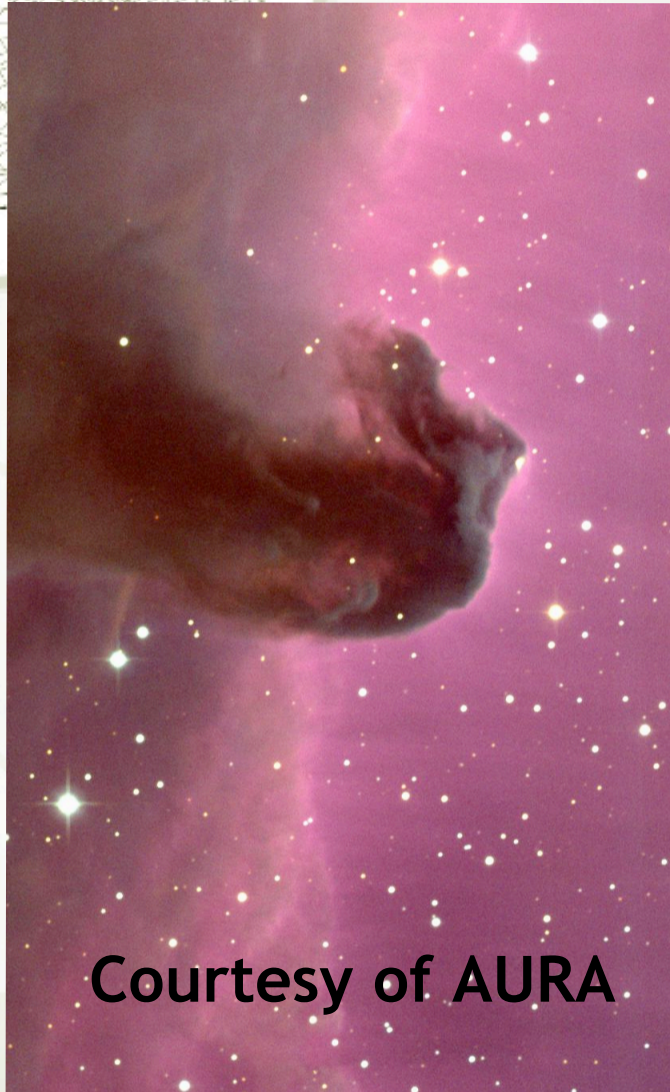
★ Electromagnetic Wave

Submillimeter
wave

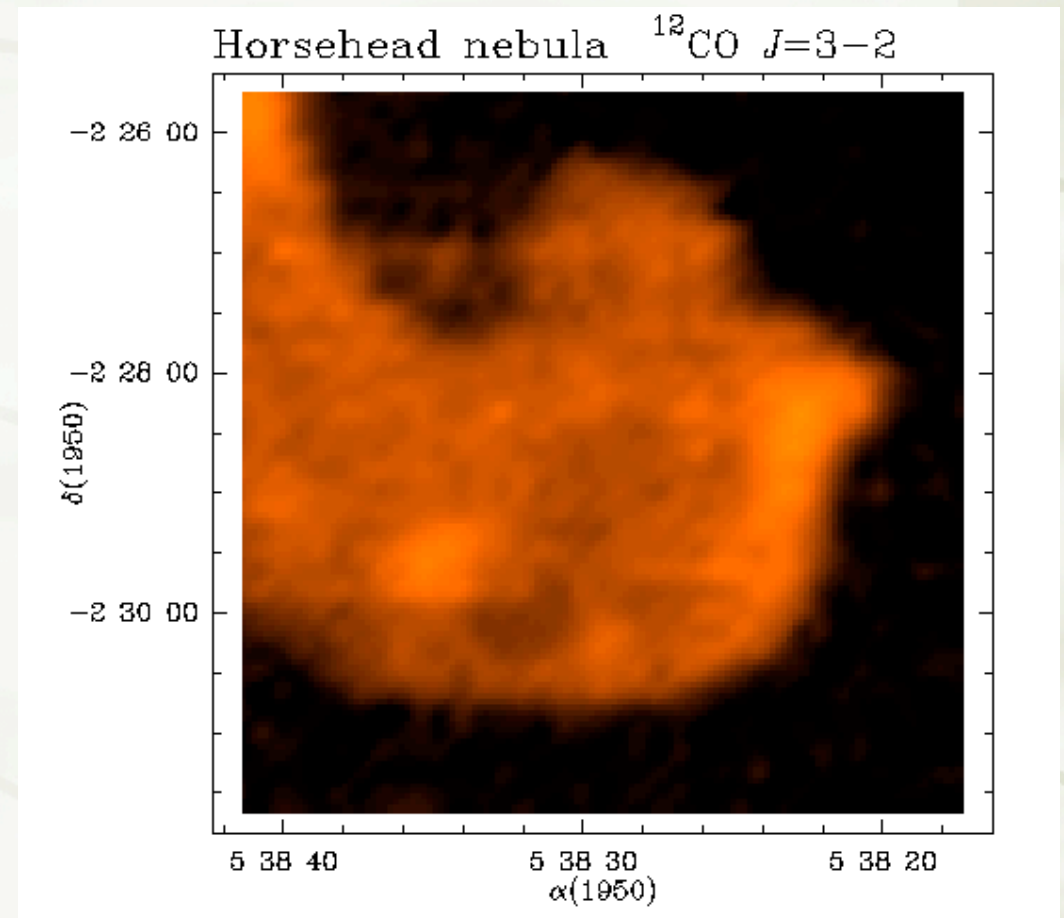


(Courtesy of NASA Imagers)

Househead Nebula



Courtesy of AURA

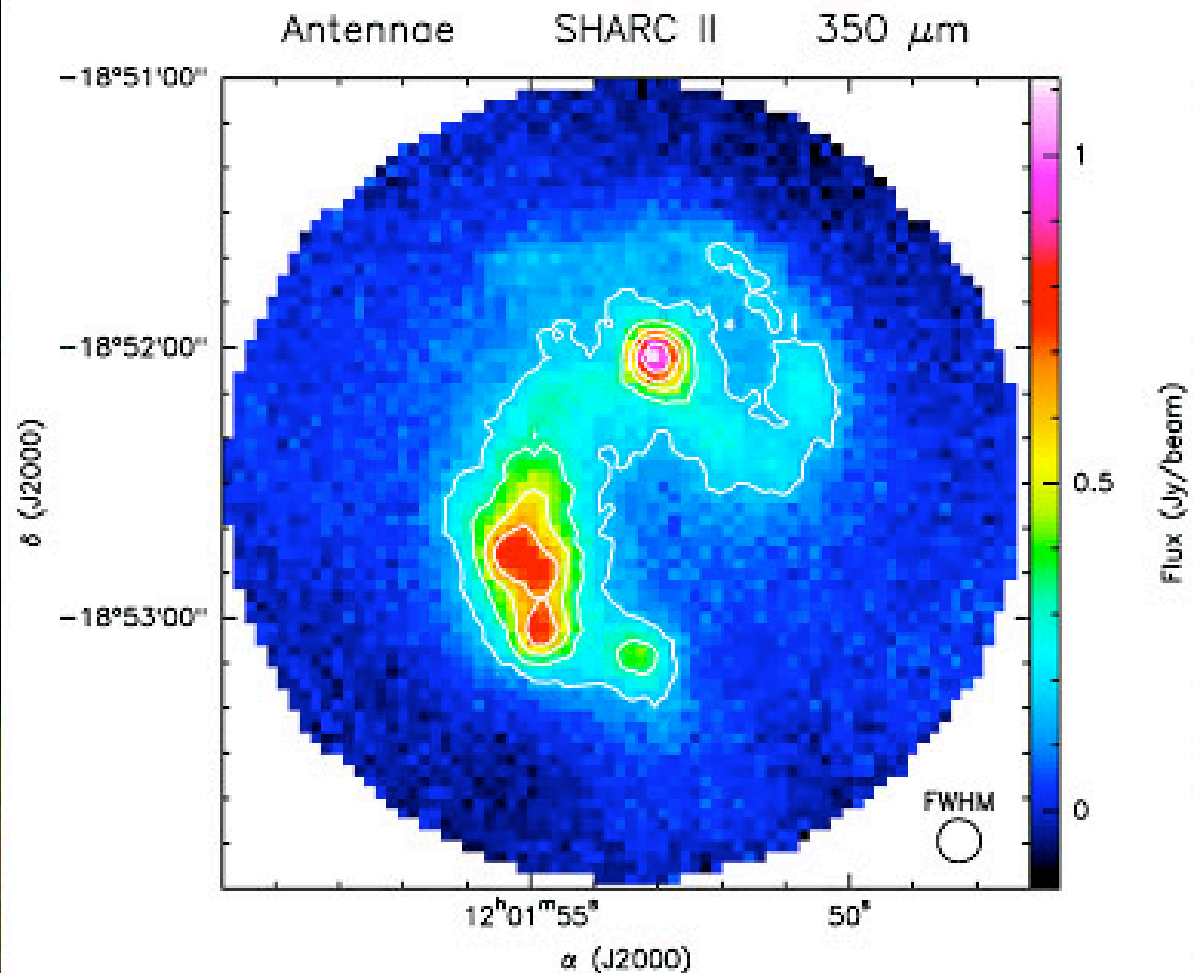


roko Shinnaga (CSO)

Colliding Galaxies Antennae



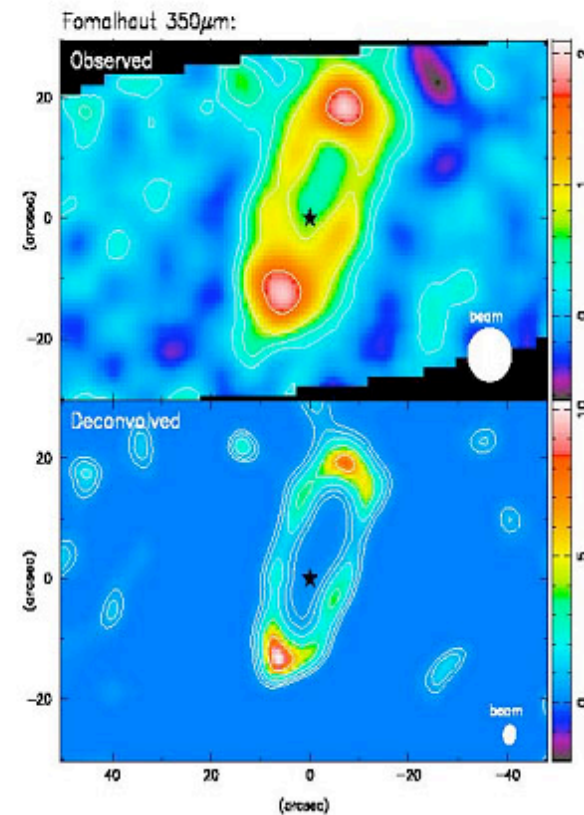
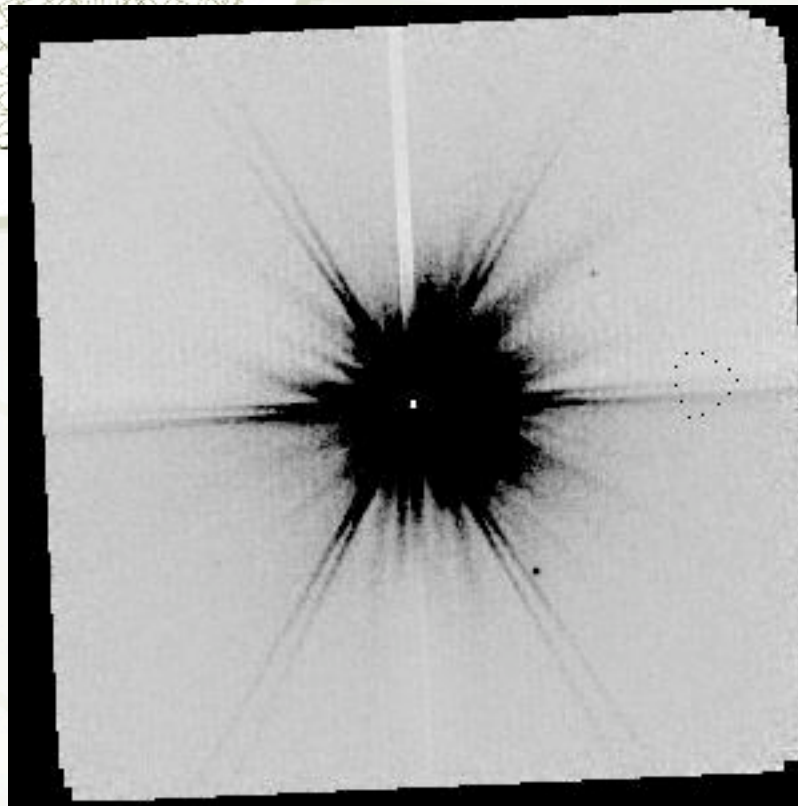
Courtesy of NASA



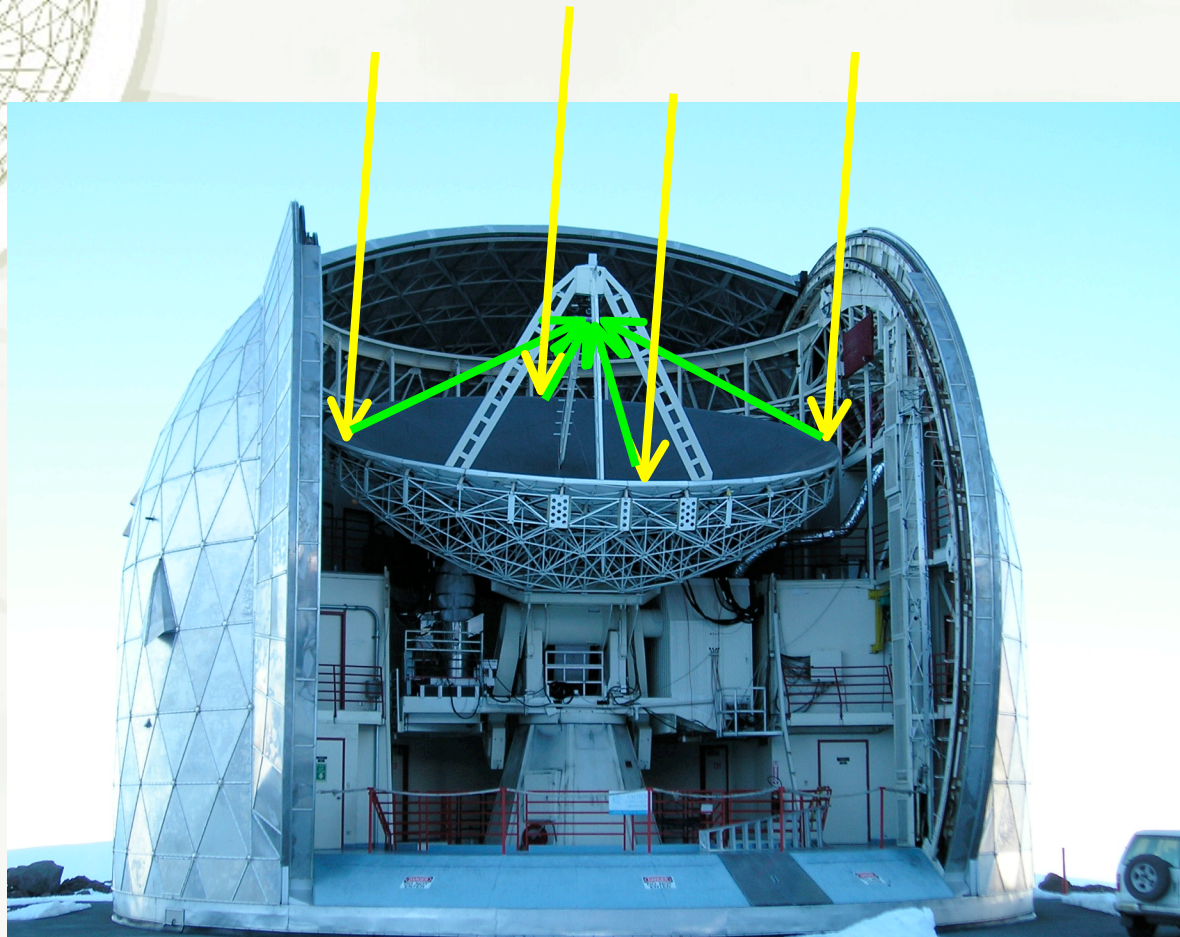
60 million light years (19Mpc) away

Formalhaut (a nearby star)

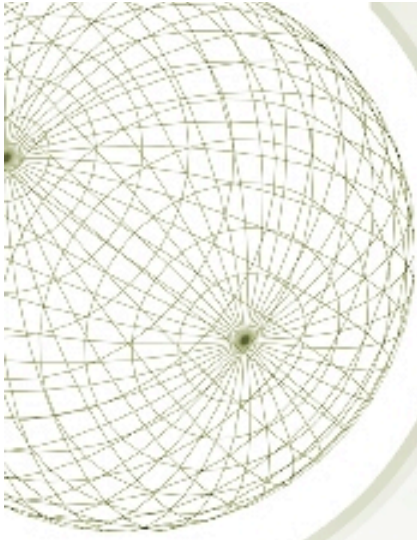
SHARC II: Marsh et al. (2005)



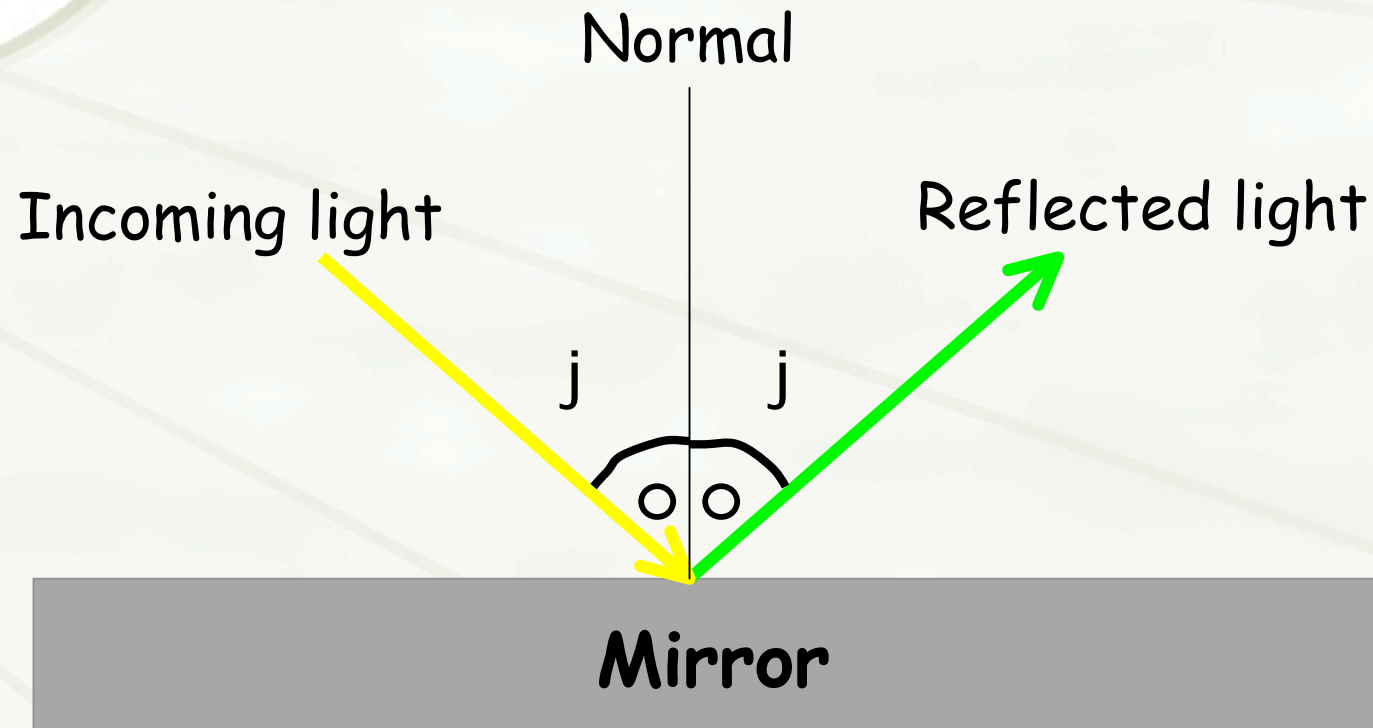
Reflection of light/radio wave



**10.4meter (34.1feet) diameter Leighton Telescope
At the Caltech Submillimeter Observatory**

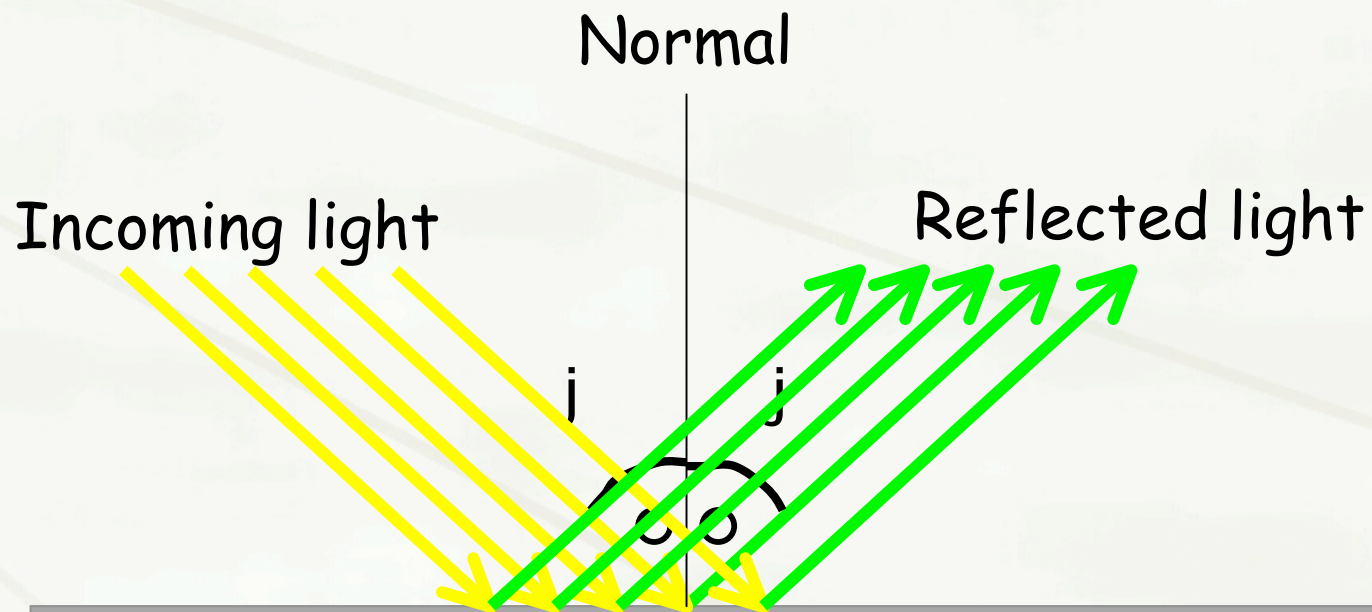


Reflection of light/radio wave



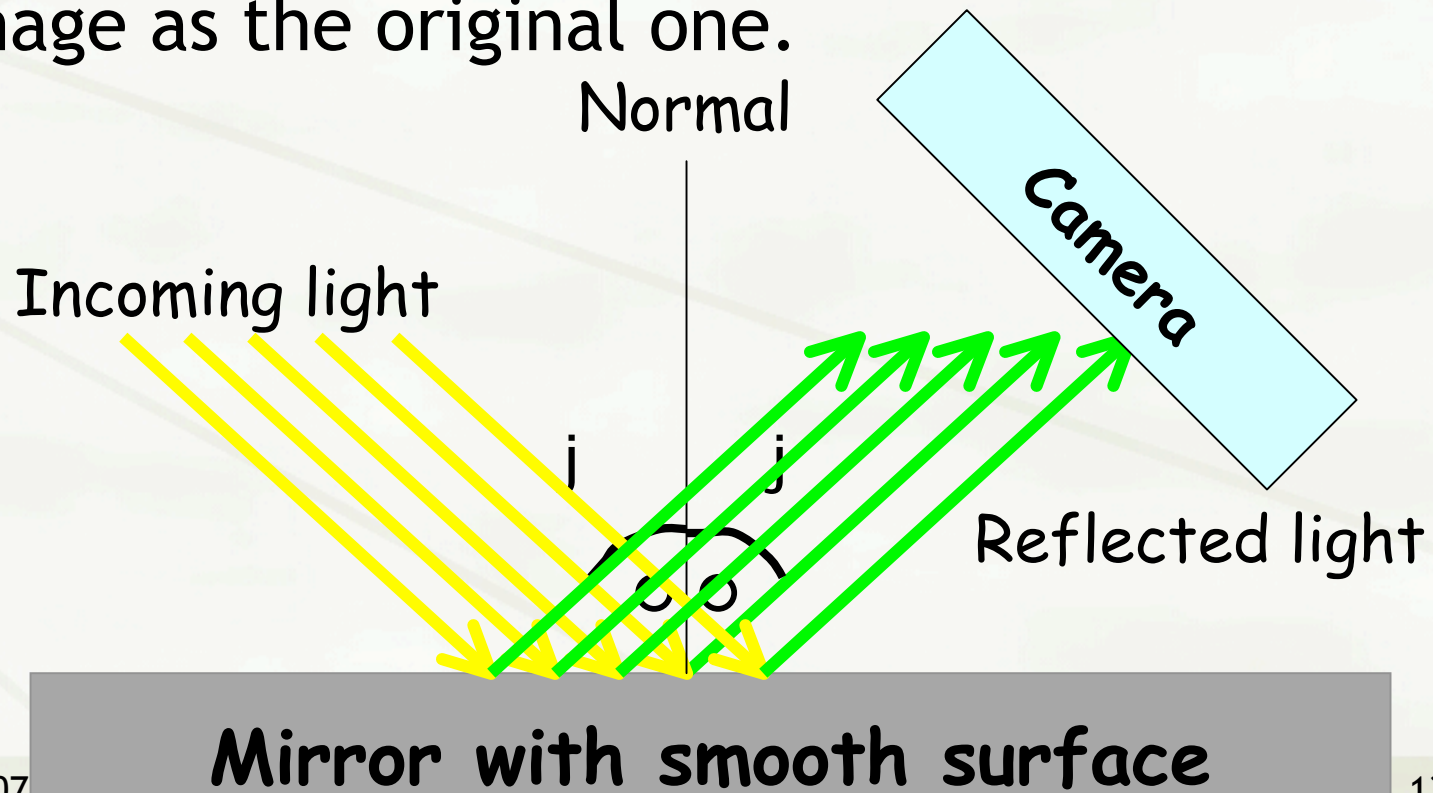
Reflection of light/radio wave

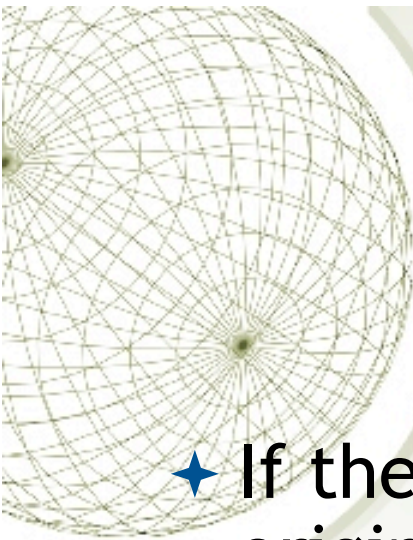
- ★ If the surface of the mirror is smooth, the reflected image would have the same image as the original one.



Reflection of light/radio wave

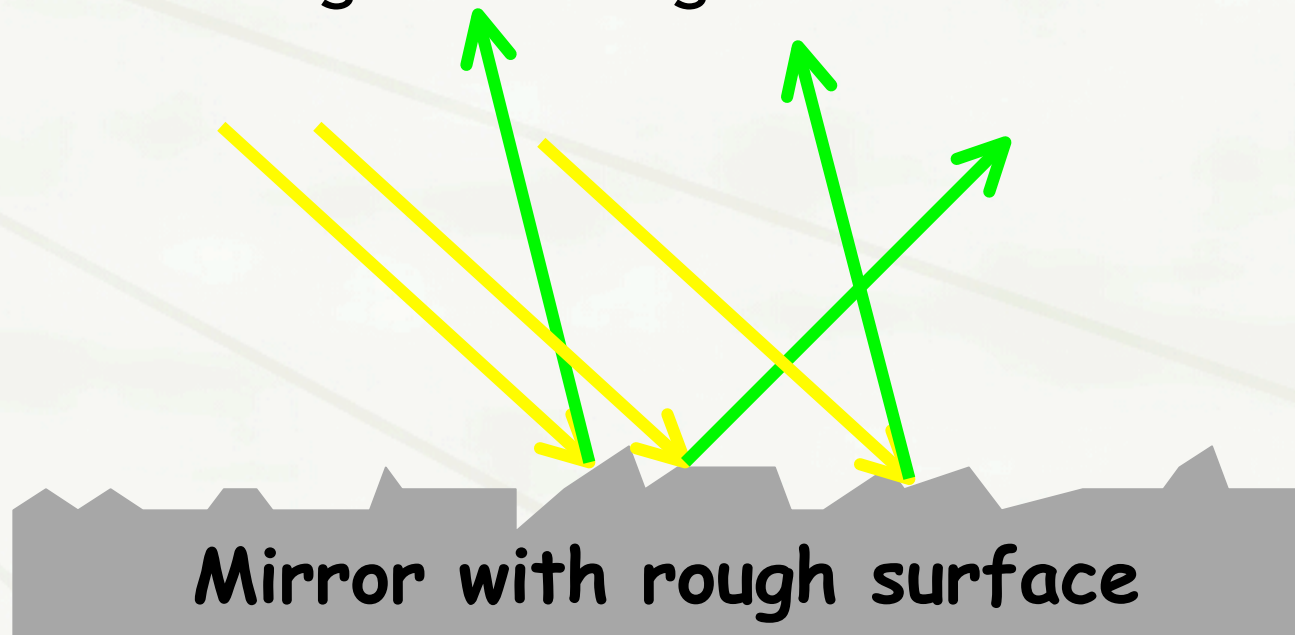
- ★ If we place a camera where reflected light passes through, we'll see the same clear image as the original one.





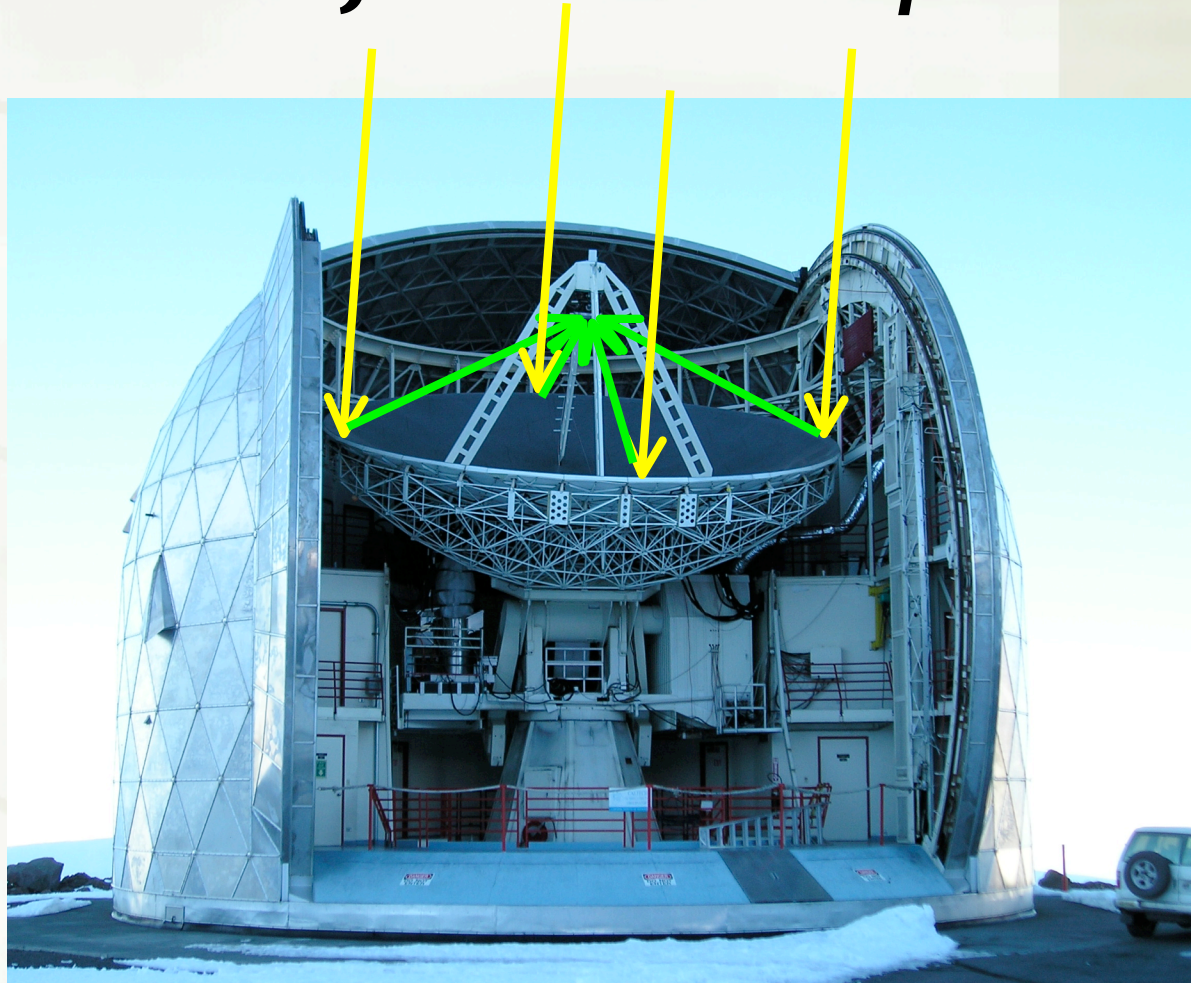
Reflection of light/radio wave

- ★ If the surface of the mirror is rough, the original image would be distorted. Reflected light would go various directions.



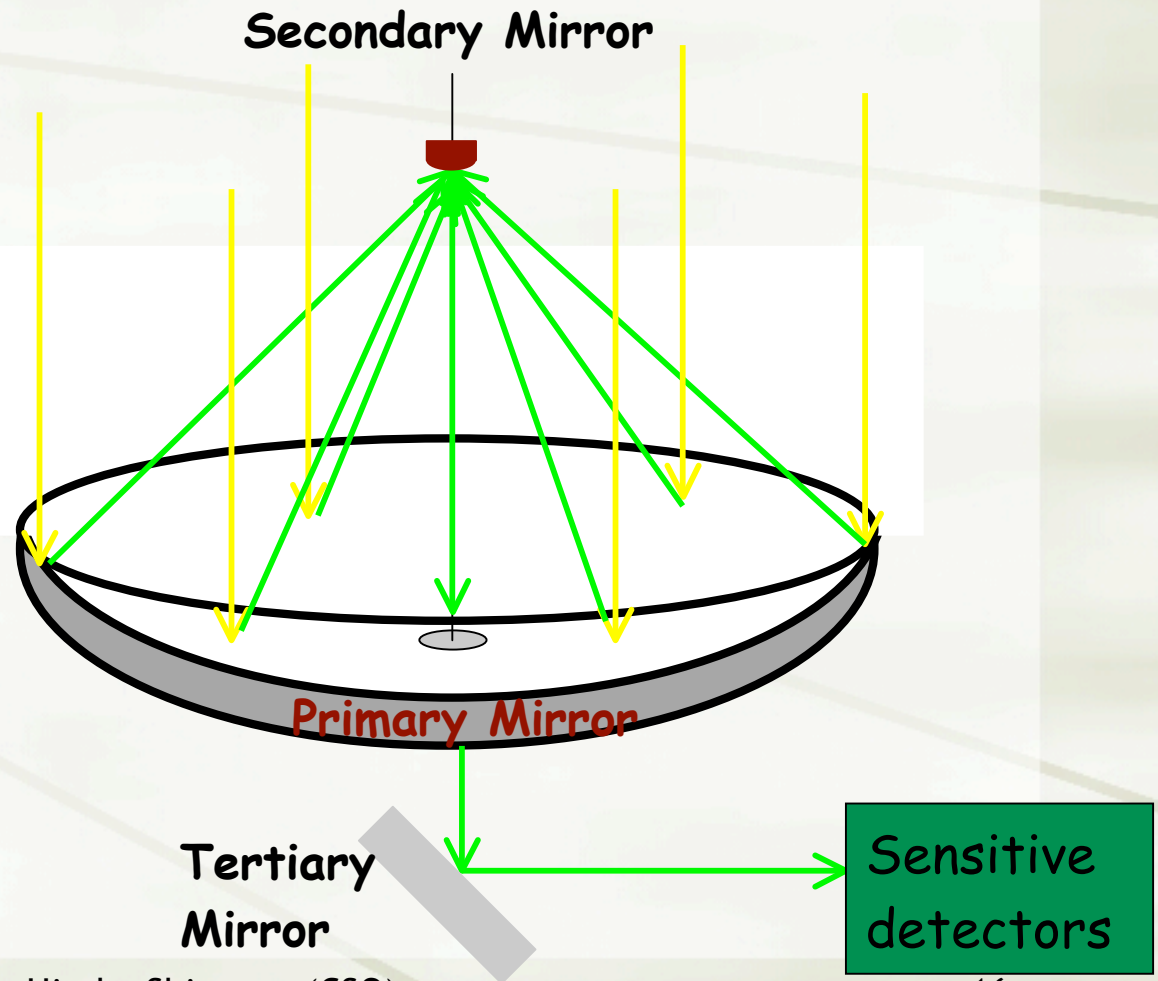
Role of a telescope

- ★ Collecting lights/radio waves traveled many years from distant objects in the Universe



Role of a telescope

★ Light/radio wave captured by the primary mirror will be guided to the sensitive detectors





DISA SURFACE OPTIMIZATION SYSTEM

INI TIME 04:01:44 02/09/06		8 -9.7		9 -9.7		9 -0.8		T THERM (um)	
SET TIME 04:17:13 02/09/06		9 -26.9		0 -26.3		1 -23.4		P SET L (um)	
SET ZA 45.00		+17.2		+16.6		+22.6		ERROR (um)	
8 -6.9		7 -7.9		7 -0.6		7 +2.5		7 +5.2	
8 -14.5		5 -18.6		4 +6.5		3 +11.9		2 +18.5	
+7.6		+10.7		-7.1		-9.4		-13.2	
8 -6.8		7 +1.6		6 +0.3		6 -0.3		6 +2.1	
7 -16.7		0 +3.5		9 +1.1		8 -0.2		7 +4.2	
+9.9		-1.9		-0.8		-0.1		-2.2	
8 -6.6		6 +1.9		6 -1.7		6 -7.9		6 -3.6	
6 -19.1		4 +7.3		3 -2.5		2 -20.0		1 -5.6	
+12.6		-5.3		+0.8		+12.1		+2.0	
8 -5.1		5 +3.8		5 +2.0		5 -8.6		5 -4.4	
5 -0.7		7 +9.2		6 +4.6		4 -7.5		3 +13.0	
-4.4		-5.4		-2.6		+7.6		+3.2	
8 -9.8		4 +2.1		4 +6.5		4 -0.7		4 -8.0	
4 -30.7		9 +6.4		8 +20.5		7 -4.0		6 -16.5	
+20.9		-4.2		-13.9		+3.3		+8.5	
4 -6.6		3 +5.2		3 +1.5		3 -4.2		3 -9.6	
0 -20.8		9 +23.8		8 +8.7		7 -6.7		6 -23.7	
+14.2		-18.6		-7.1		+2.5		+14.1	
3 -9.3		2 +7.3		2 +0.6		2 -9.9		2 -10.5	
0 -22.1		9 +17.9		8 +2.2		7 -22.9		6 -19.4	
+12.7		-10.6		-1.6		+12.9		+8.9	
8 -6.7		2 +0.9		2 +4.6		1 +5.0		1 -1.8	
3 -17.5		1 +2.9		0 +14.1		9 +12.0		8 -4.1	
+10.7		-2.0		-9.5		-6.9		+2.3	
8 -6.9		1 +3.8		1 +6.7		1 +2.4		1 -2.9	
2 -11.4		3 +8.6		2 +22.9		1 +9.4		0 -4.9	
+4.5		-4.8		-16.2		-7.0		+2.0	
8 -0.7		0 -5.1		0 -7.6		0 -3.8		0 +1.8	
1 +2.3		6 -10.0		5 -13.3		4 -8.1		3 +5.8	
-3.0		+4.8		+5.7		+4.3		-4.0	
0 -5.1		0 -7.6		0 -3.8		0 +1.8		0 +0.9	
6 -10.0		5 -13.3		4 -8.1		3 +5.8		2 +2.3	
+4.8		+5.7		+4.3		-4.0		-1.4	
8 -7.8		7 -1.6		7 -1.1		7 +2.1		7 -3.6	
0 -15.0		9 -3.4		8 -0.4		7 +10.9		6 -5.2	
+7.2		+1.8		-0.7		-8.8		+1.6	
RESTORAL (um)		8 -7.8		7 -1.6		7 -1.1		7 +2.1	
MEAN +1.1 RMS 8.3		0 -15.0		9 -3.4		8 -0.4		7 +10.9	
		+7.2		+1.8		-0.7		-8.8	

Role of instruments

- ★ Instruments will capture the light/radio wave from astronomical object.
- ★ By placing various types of detectors or cameras, one can study the objects with various different aspects.

