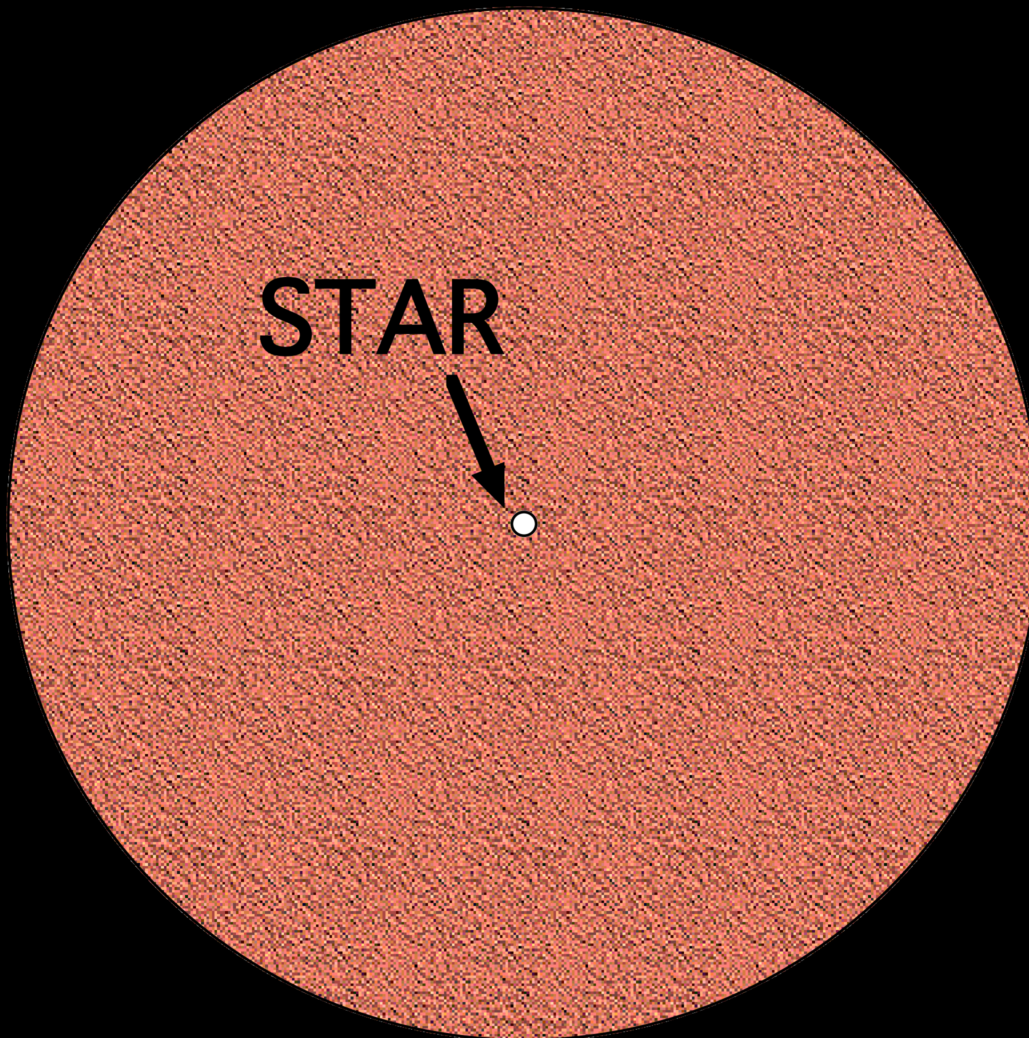
Are Dyson Spheres Illegal?



GERALD D. NORDLEY

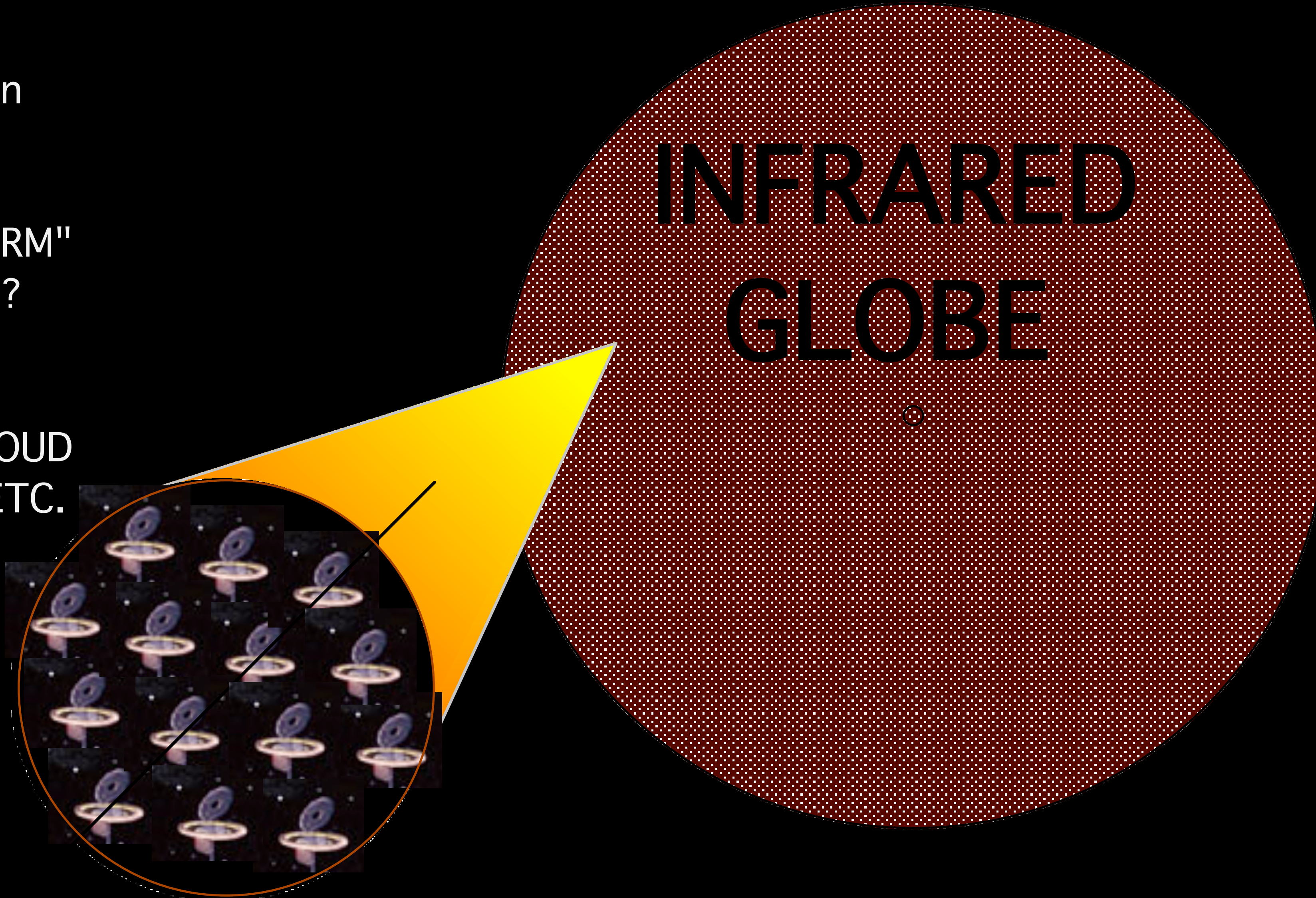
CONTACT 2018

ORIGINAL
CONCEPTS

Olaf Stapledon
"Starmaker"

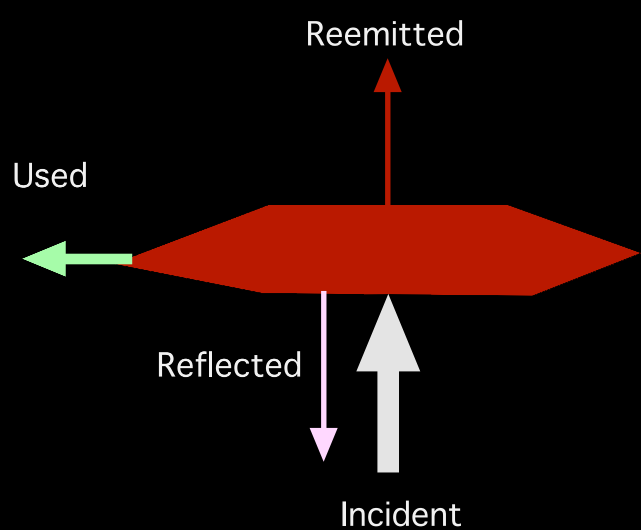
DYSON "SWARM"
Detectable??

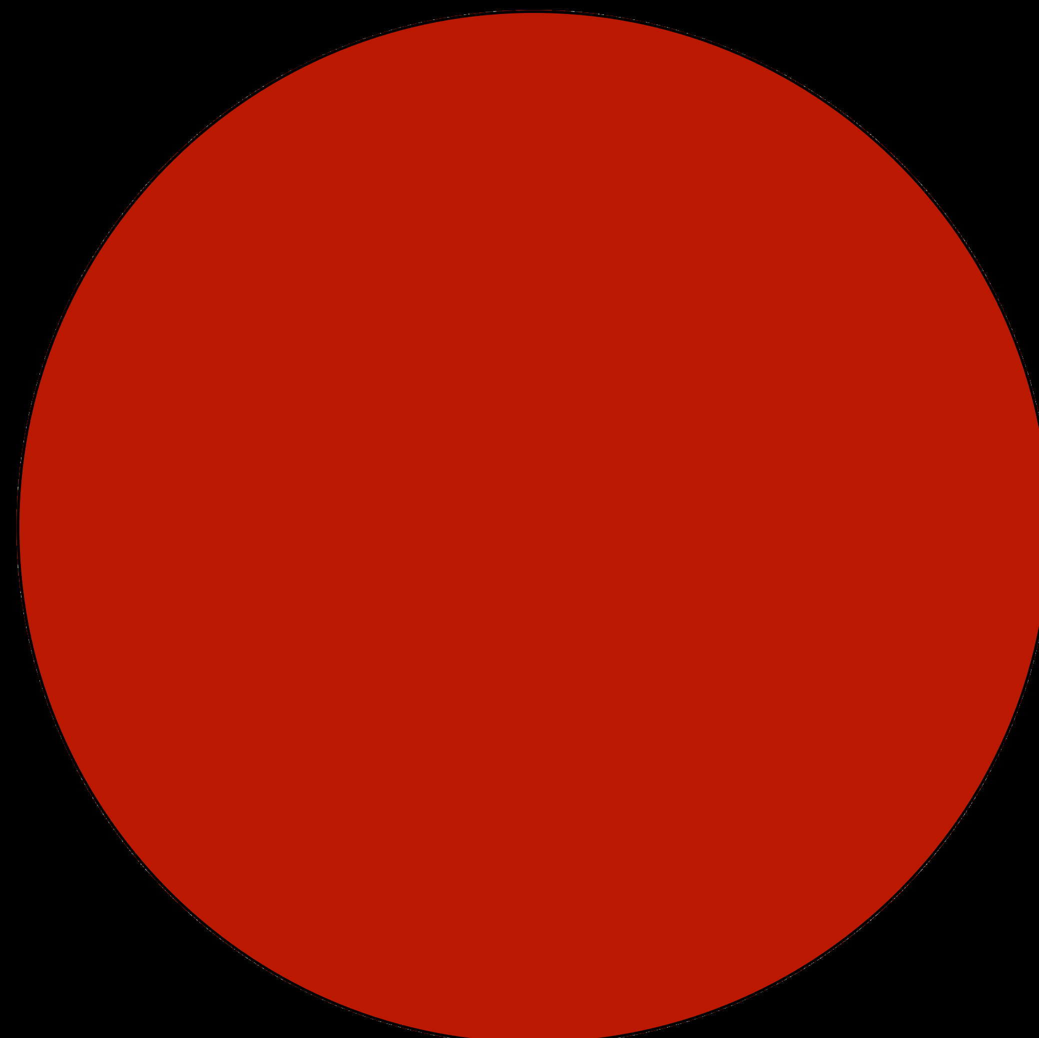
VARIANTS
BUBBLE, CLOUD
BALLOON, ETC.

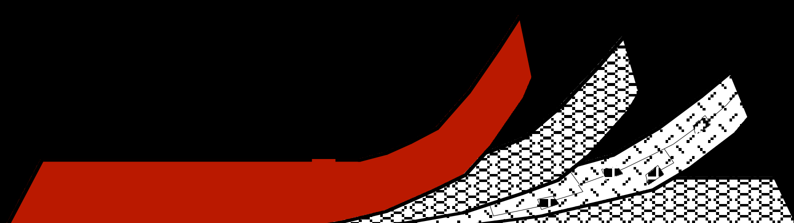


Using entire output of a star
And several planets worth of material

With advanced materials, such as graphene, a continuous sphere could be made,supported by radiation pressure.*

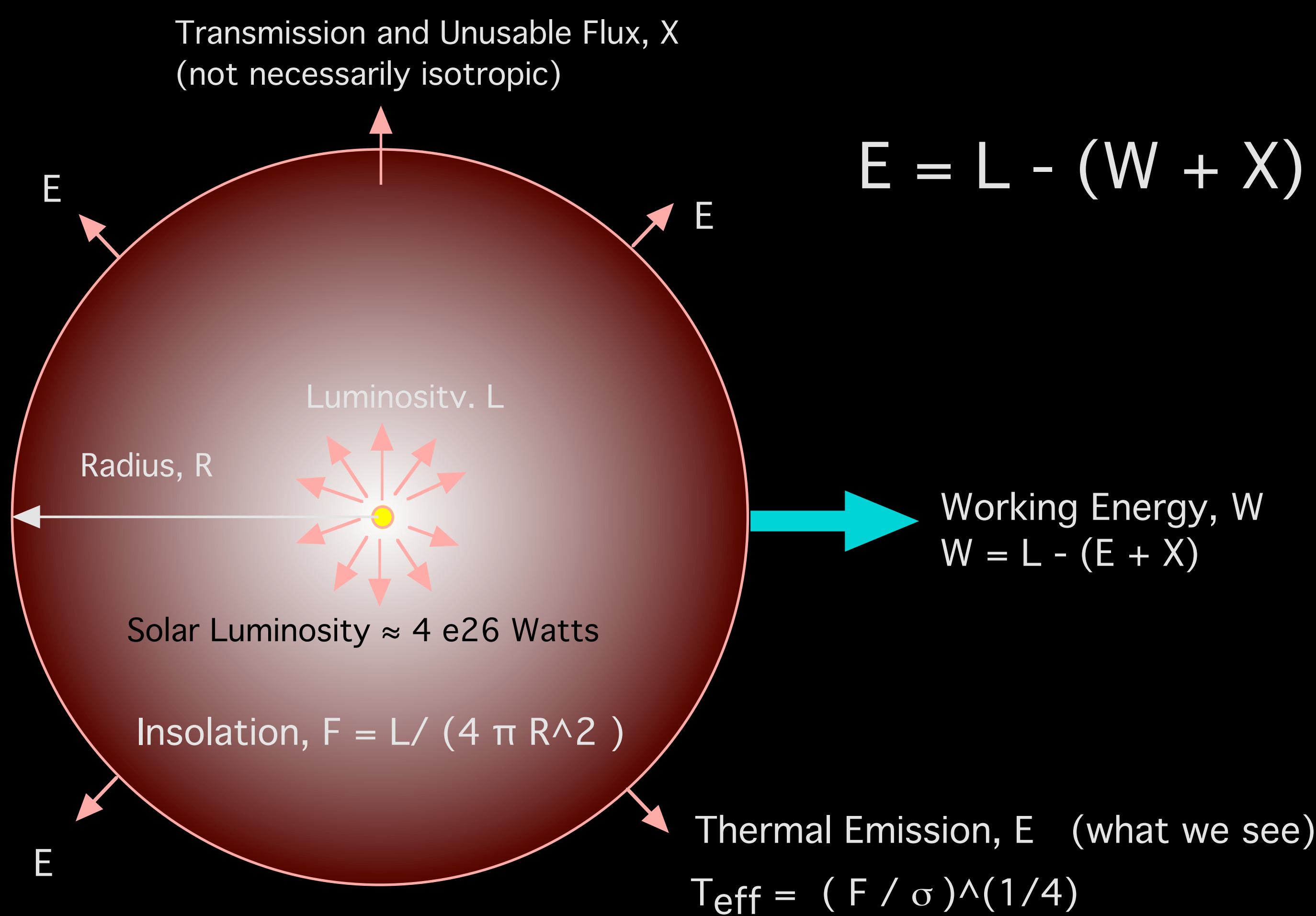


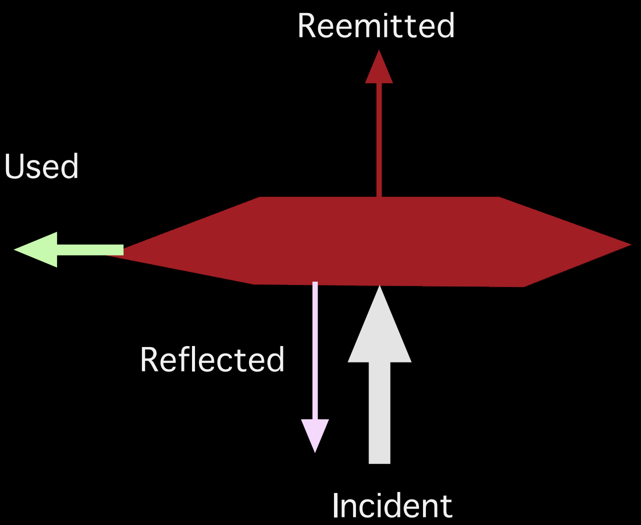




*Smart fabric could keep it centered by varying absorption.

Dyson Sphere: Gross Energy Balanc



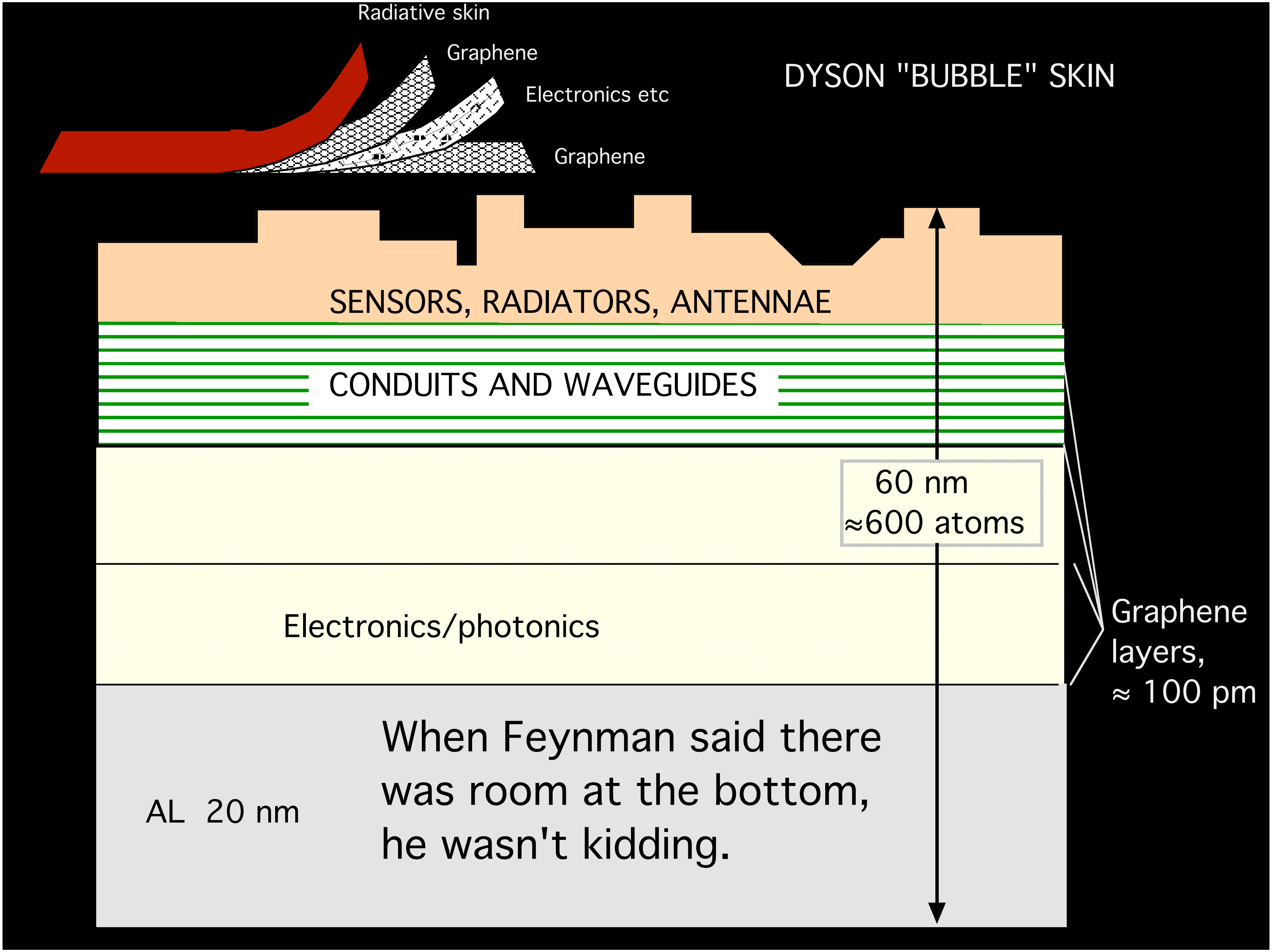


sources

Heller+17.0830 71v2 [arXiv:1704.03871v2] [astro-ph.IM]
Falker+2013 Lightweight Light Sail Propulsion Project
https://www.grafixplastics.com/grafix-plastics/plastic-film-plastic-sheet-faq/mylar_what/mylar_prop/

Levitation of a Solar Sail at 1 AU and a momentum transfer efficiency of 35%

	Mass (1m2)	wieght @1 Au	net force
	µg	µN	@ 6.84 µN
Graphene	0.38	0.0022	6.8401
Graphene-class sail	0.86	0.0051	6.8372
Graphene with 50 nm gold	965	5.7240	1.1183
Solar Statite	**1154**	**6.8423**	**0.0000**
Graphene with 100 nm gold	1930	11.4480	-4.6057
Mylar, 0.06 mil = 0.635e-5 m	4380	25.9804	-19.1381
Mylar, 0.48 mil = 2.54e-5 m	16346	96.9605	-90.1182
Mylar, 1mil = 2.54e-5 m	34055	202.0012	-195.1589
Millenium starshot chip	73000	433.0080	-426.1657



Radiative skin
Graphene
Electronics etc
Graphene
DYSON "BUBBLE" SKIN
SENSORS, RADIATORS, ANTENNAE
CONDUITS AND WAVEGUIDES
60 nm
≈600 atoms
Electronics/photonics
Graphene layers, ≈ 100 pm
AL 20 nm
When Feynman said there was room at the bottom, he wasn't kidding.

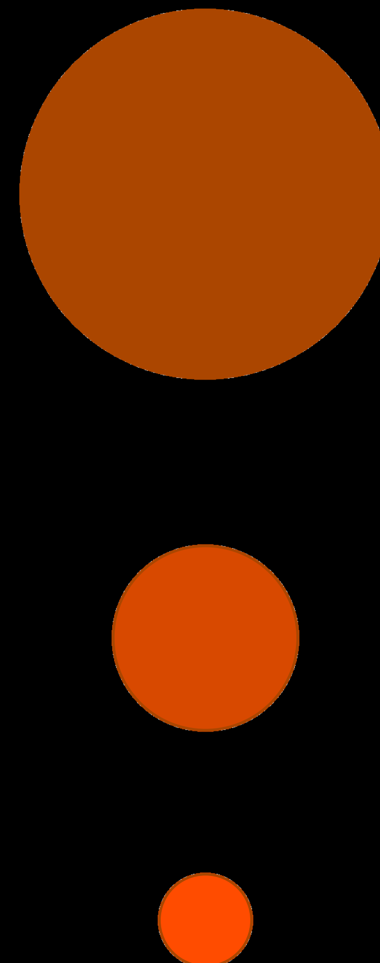
HOW BIG?

The canonical Dyson sphere is about 1 AU in radius

A smaller one could carry more weight per unit area. The force of gravity and radiation pressure both scale as the radius, but the difference between them increases inversely with the square of the radius.

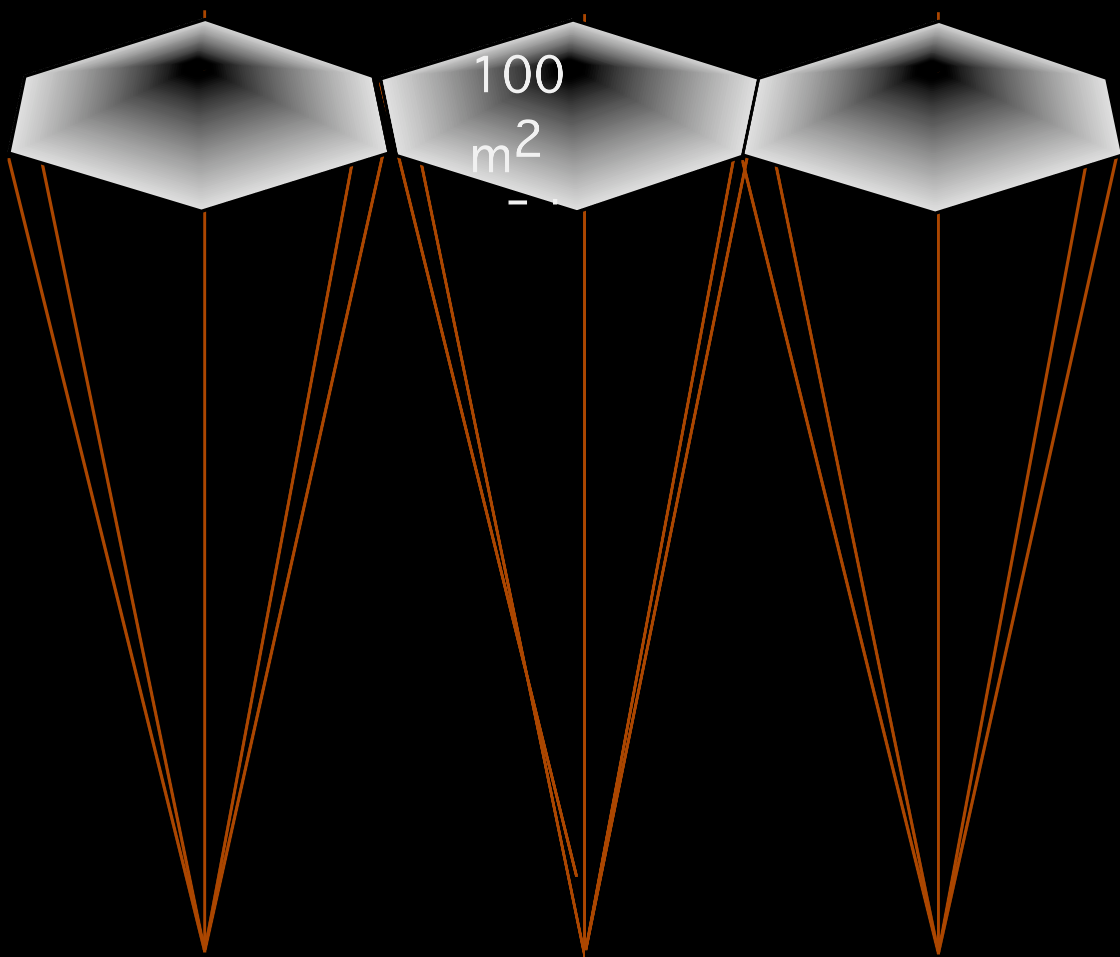
$FR = ©L/R^2$ $FG = MG/R^2$ $FR/FG = ©L/MG$ (no R!)

$\Delta F = FR - FG = ©L/R^2 - MG/R^2 = (©L - MG)/R^2$



HOW MASSIVE?

At 1 AU, the area of a Dyson sphere is about 2.81e23 square meters, which at a .001 kg per square meter would be 2.81e20 kg, about the mass of the asteroid Pallas. One would NOT have to disassemble a solar system!



Say each 1 m2 sail segment supports a gram (10^{-3} kg).

A 100 m square ($10^4 m^2$) ≈ a football field, 10 kg

A 100 km square (104 km2) (10^{10} m2) ≈ island of Hawai'i =107 kg or 10,000 metric tons.

A continuous 1AU-radius Dyson sphere could support 10^{20} kg --about the mass of Pallas, of course.

The mass of stuff on Manhattan Island has been estimated at ≈125 million tons. Say about 100 million metric tons, or about 10^{11} kg. $10^{20} / 10^{11} = 10^9$

So, it has the mass of about a billion Manhattans

HOW LONG WOULD IT TAKE TO MAKE?

This is a job for self-replicating 3-D printing technology.   The key would be a "front end" which would take raw materials and turn them into the appropriate printer stock. This development is a question of not "if" but "when."

With a nod toward near term technologies being easier to conceive than do, and also a nod to significant work being done already, a rough order of magnitude estimate of a century would seem appropriate. Not in a decade, but easily within a thousand years.

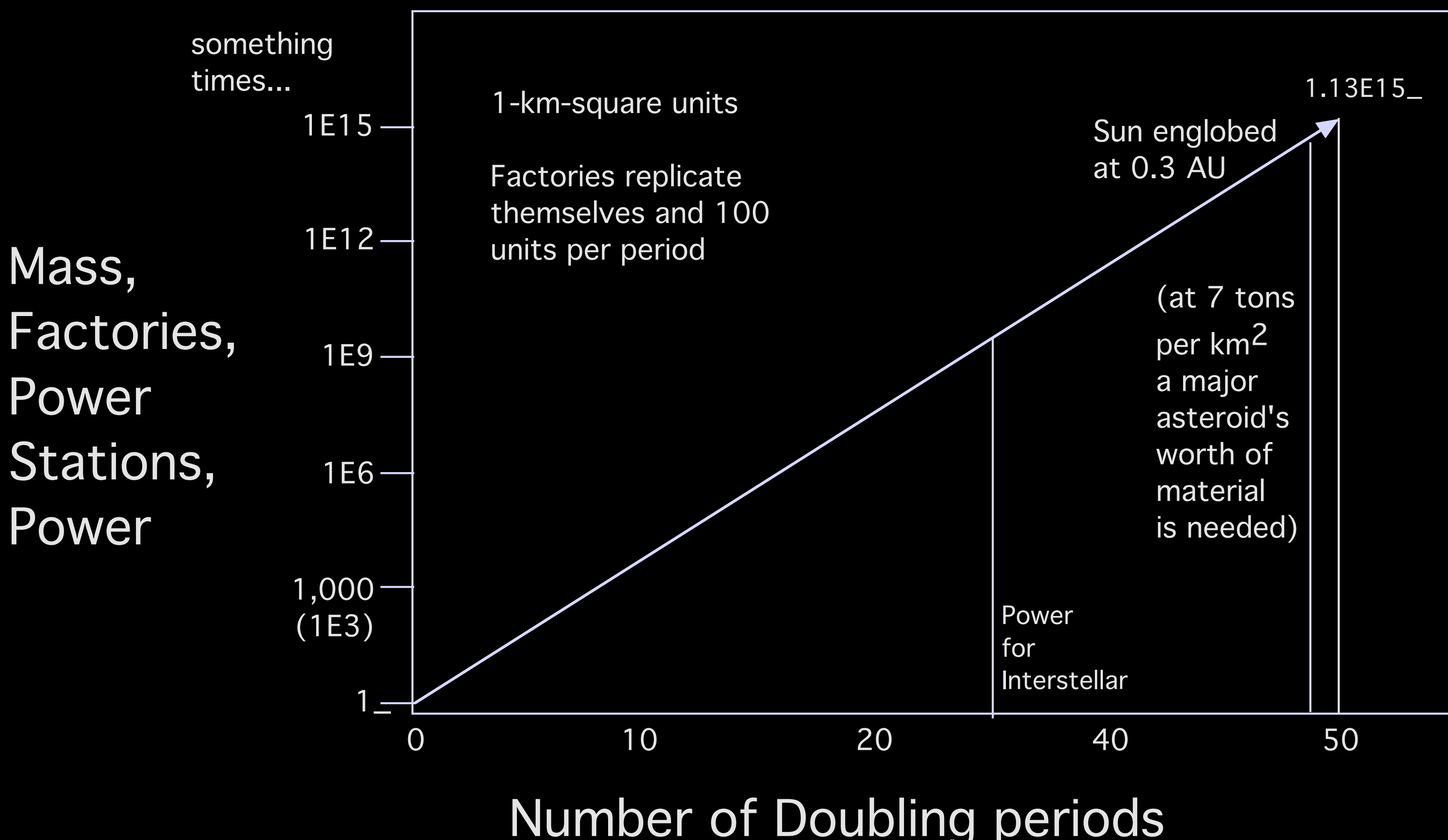
The important parameter would be the doubling period. If we somewhat arbitrarily select one year for the time needed for a "factory" to *reproduce itself* and create a 10,000-ton Dyson sphere module.

The formula is $N = 2^{(nD)}-1$ where nD is the number of doubling periods.

If the doubling period is 1 year, it takes 64.6 years.

Building a Dyson Sphere (or part of one)

with self-replicating systems



Advanced aliens (or our descendants) would smile at the above, but it is at least a demonstration of principle.

Assuming advanced aliens have birth control,
they wouldn't need it for living space. (But at billion Manhattan's per asteroid, they might not feel constrained.)

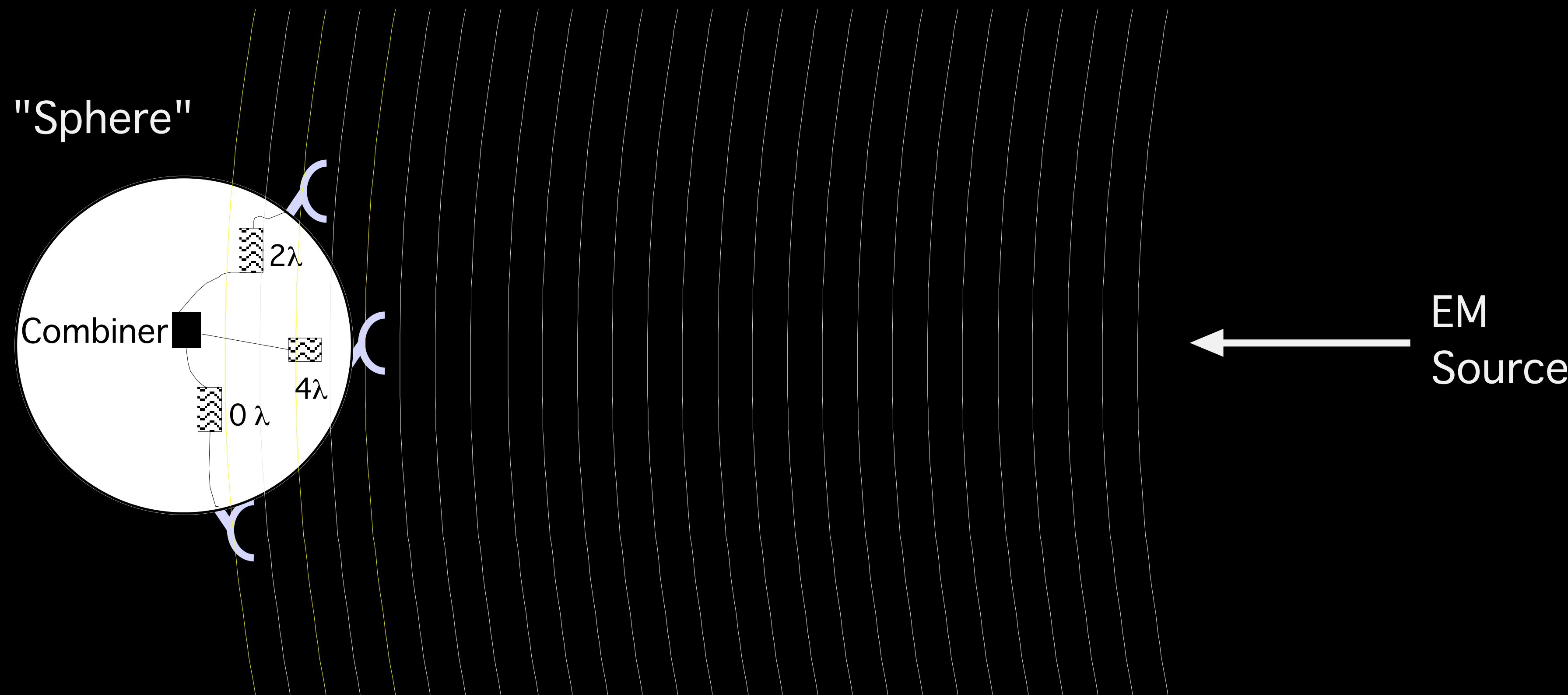
So why build one?

(1) To make a really big "phased array" antenna

(2) To get a really huge amount of energy

(3) To hide something?

Synthetic aperture / radio interferometry / etc.



Signals are delayed so that the signal from each wave front of a particular frequency from the same direction reaches the combiner at the same time A Source even slightly in a different direction won't be amplified much, because its wave fronts will be out of phase. The VLBI can discern the movements of continents within millimeters.

RESOLVING POWER

The resolving power of an array (or a solid telescope) is given, approximately, by:

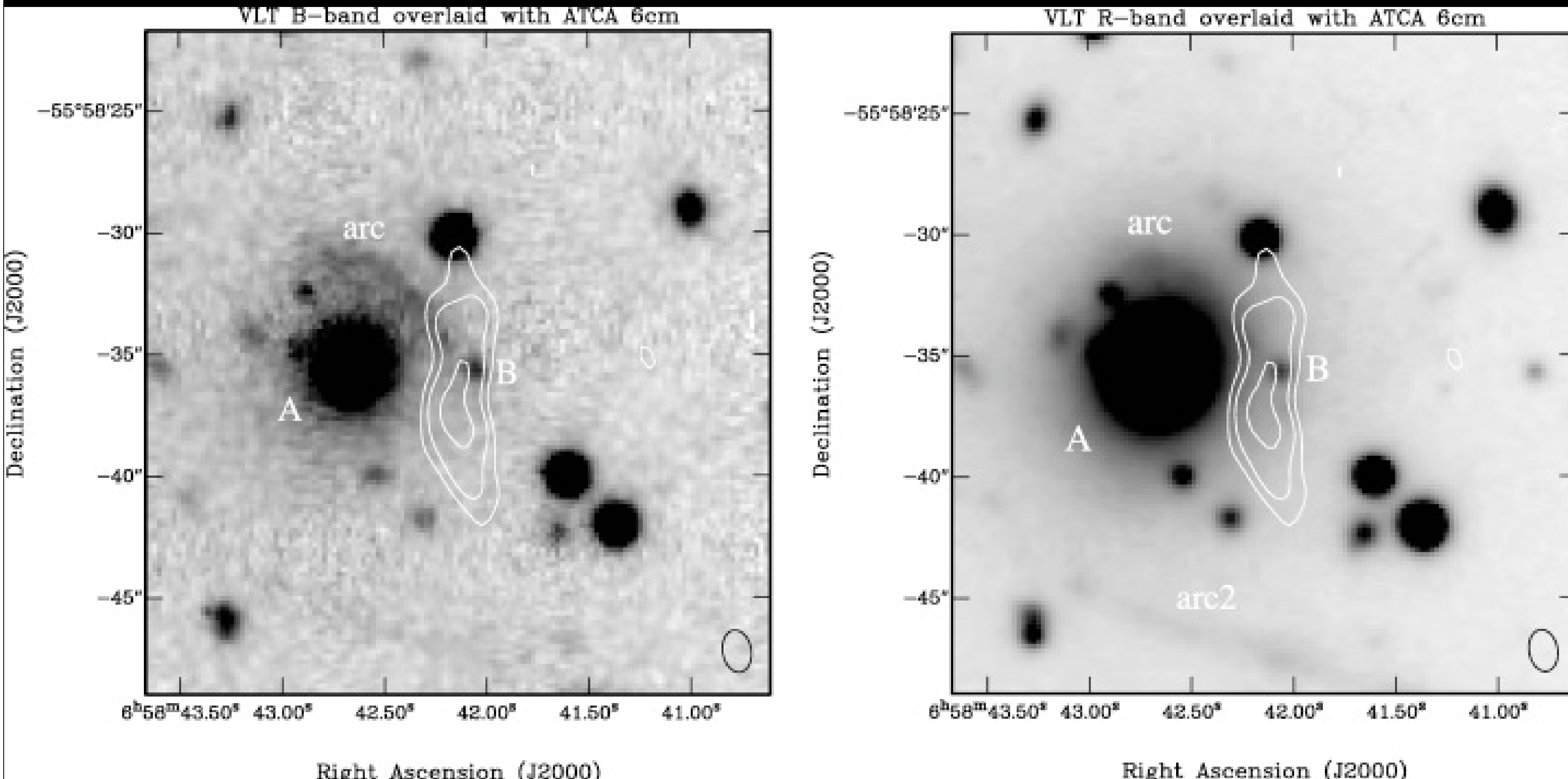
$$R = 1.22\,\lambda\,/D$$

where λ is the wavelength, and D is the dimension of the array (diameter, arm length, etc.) and R is the approximate diffraction limited angular resolution, half power beam width, pixel size, etc.

1 milliarcsecond (mas) is about the apparent angular diameter of Proxima Centauri

Very Large Telescope (VLT) in UV-IR
8.2 m (Unit) /130 M (VLTI)
50 mas / 1 mas

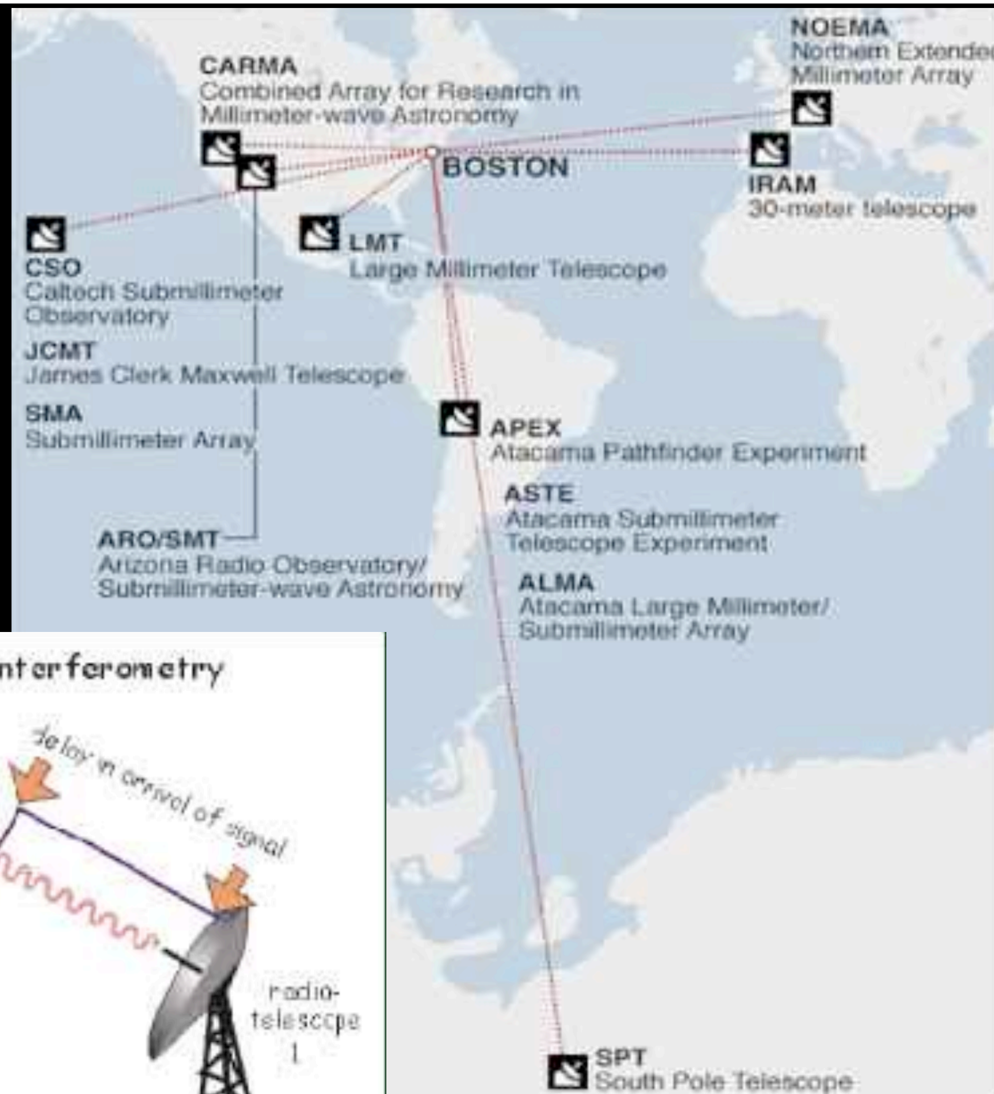
Typical max baseline 8.4 km,
resolution at 3 mm, 10 mas
1.2 λ/D = 10.3 mas

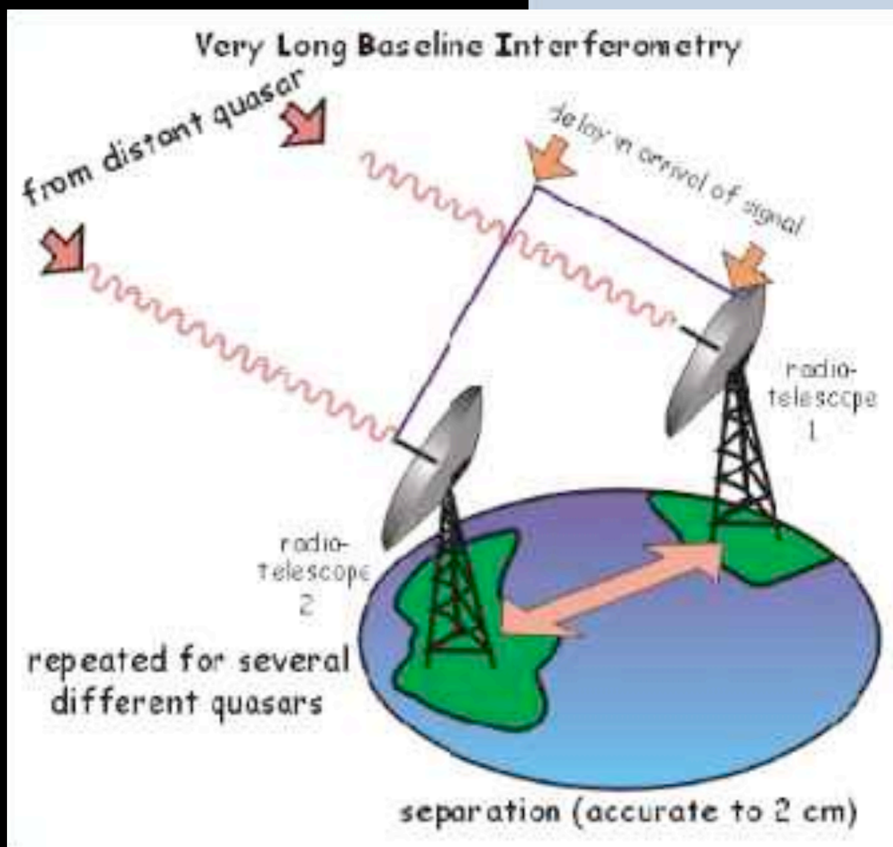


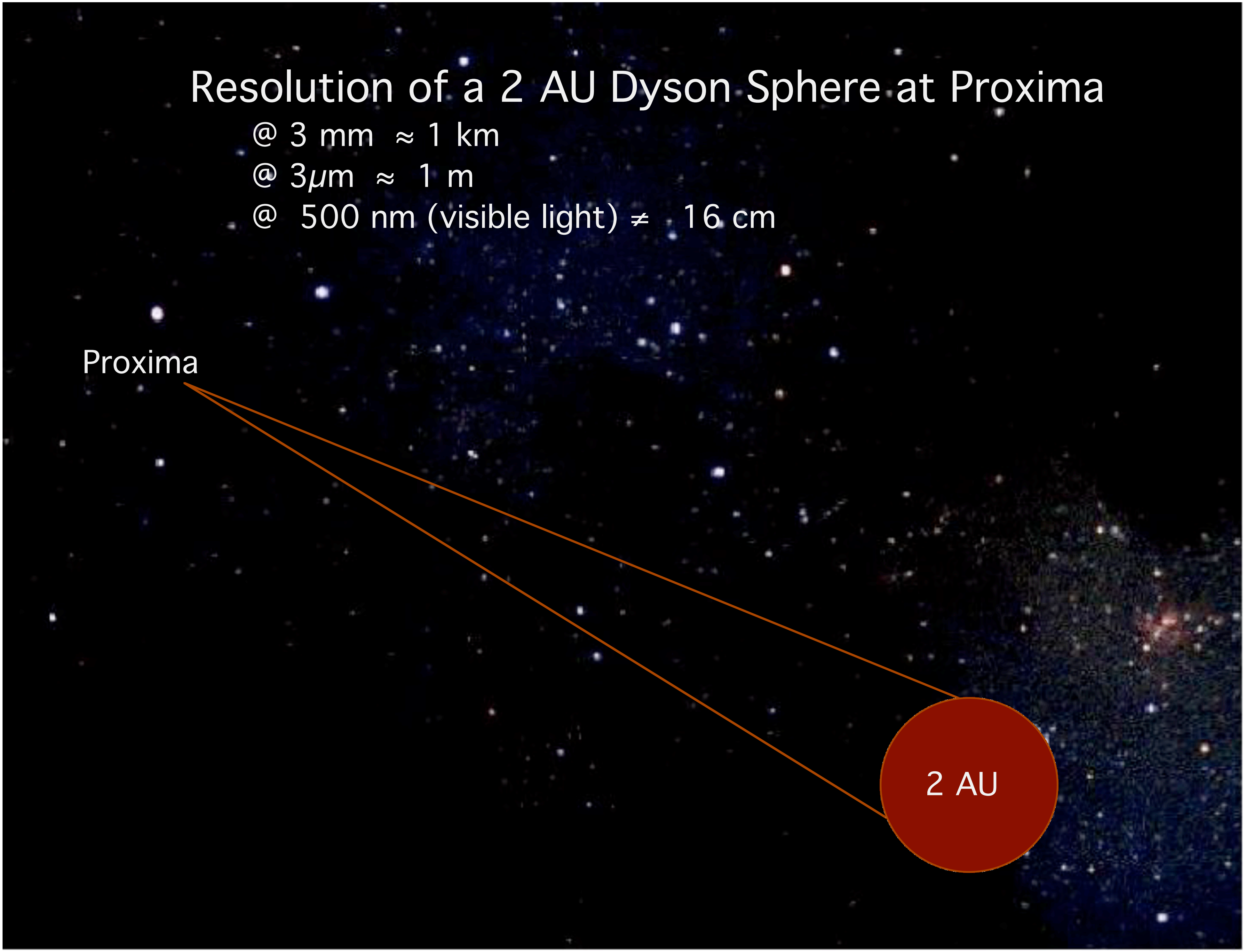
ESO Image Caption

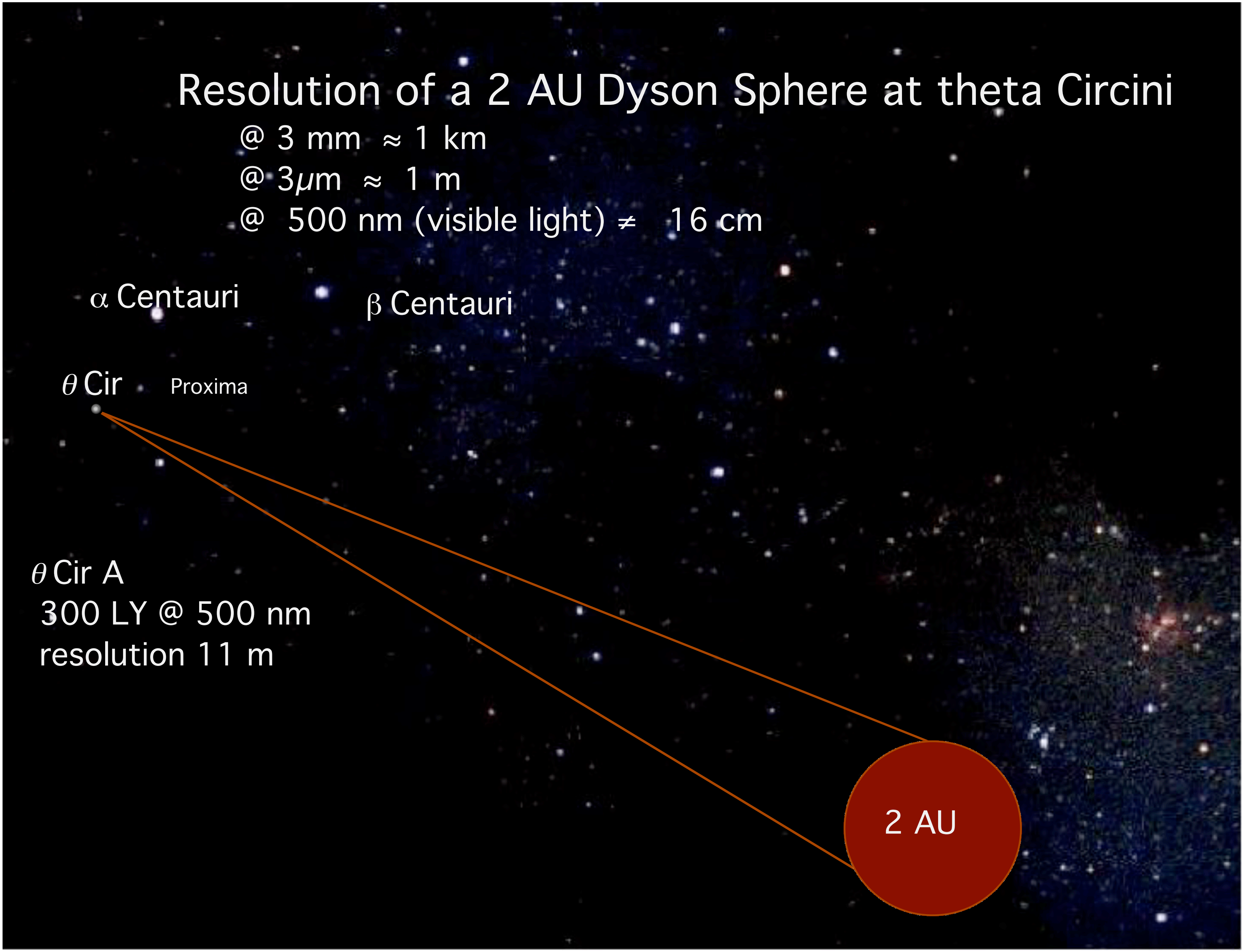
Figure 4: A high-resolution 4800-MHz contour map overlaid on VLT B-band (left) and R-band (right) images; the measured seeing was 0.75 arcsecond FWHM. Galaxy A is a cluster member, while faint galaxy B is the brightest object that falls within the radio source envelope. Two possible gravitational lens arcs associated with galaxy A are marked. Contours are at 0.2, 0.4 and 0.8 mJy beam" 1, and the rms noise of the image is . The radio beam is shown in the lower right-hand corner of each image.

Planetary Scale Arrays Already Exist

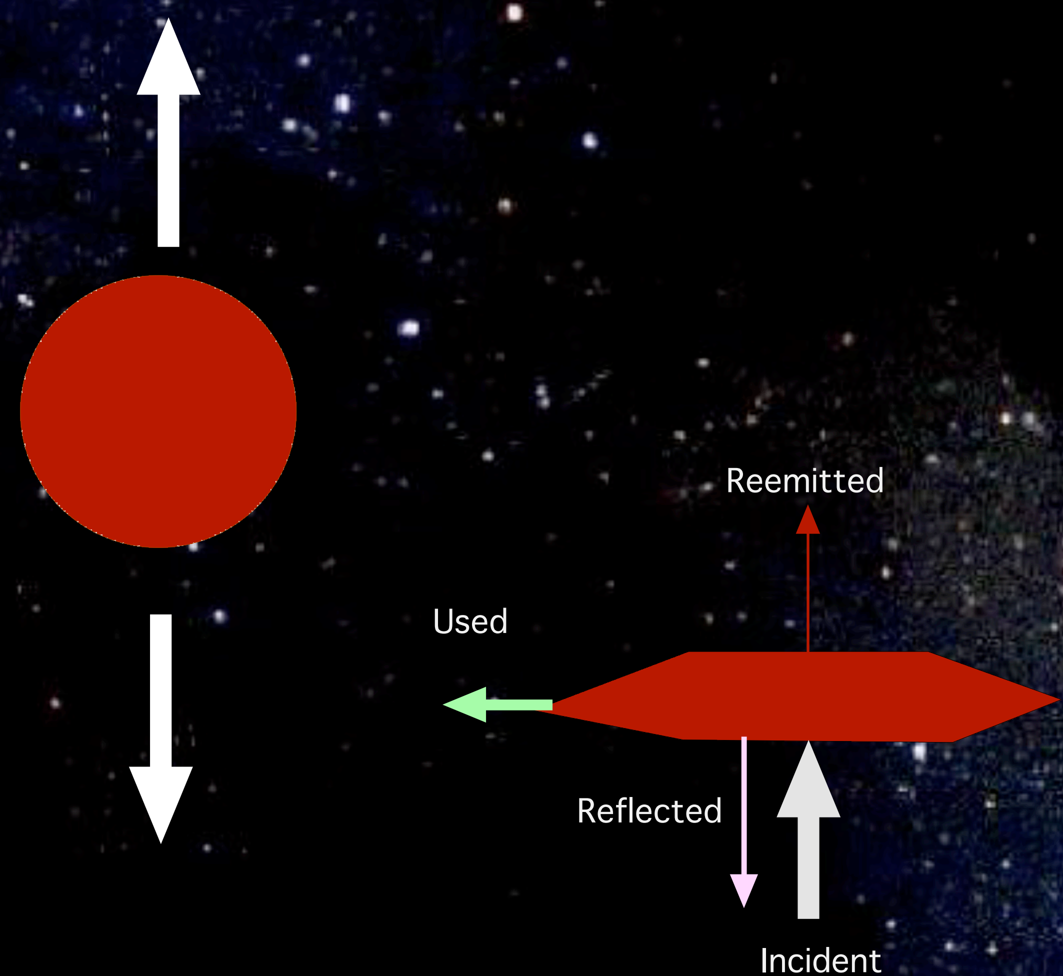




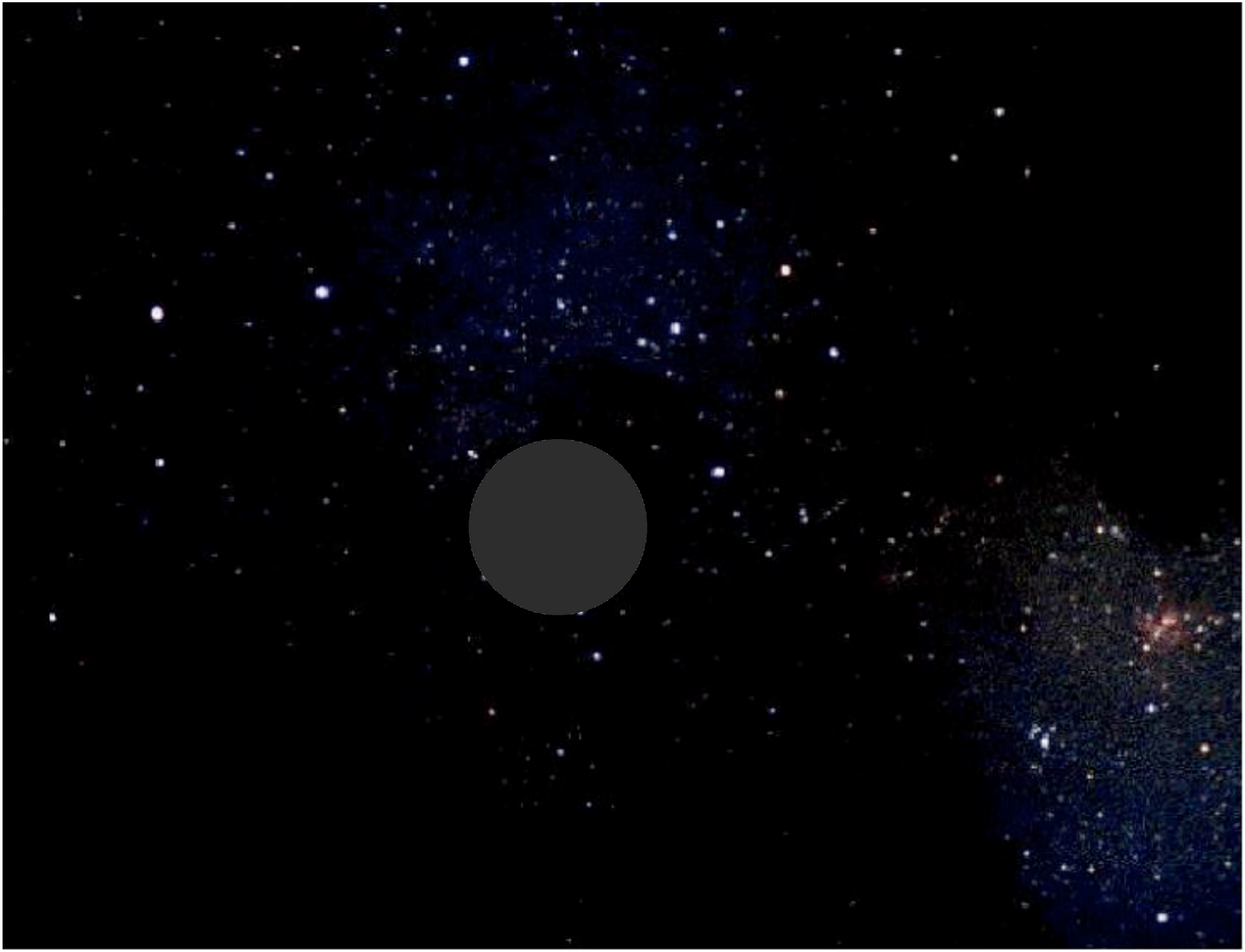

Resolution of a 2 AU Dyson Sphere at Proxima
@ 3 mm ≈ 1 km
@ 3μm ≈ 1 m
@ 500 nm (visible light) ≠ 16 cm
Proxima
2 AU


Resolution of a 2 AU Dyson Sphere at theta Circini
@ 3 mm ≈ 1 km
@ 3μm ≈ 1 m
@ 500 nm (visible light) ≠ 16 cm
α Centauri
β Centauri
θ Cir
Proxima
θ Cir A
300 LY @ 500 nm
resolution 11 m
2 AU

How to Hide a Dyson Sphere




Now it's there

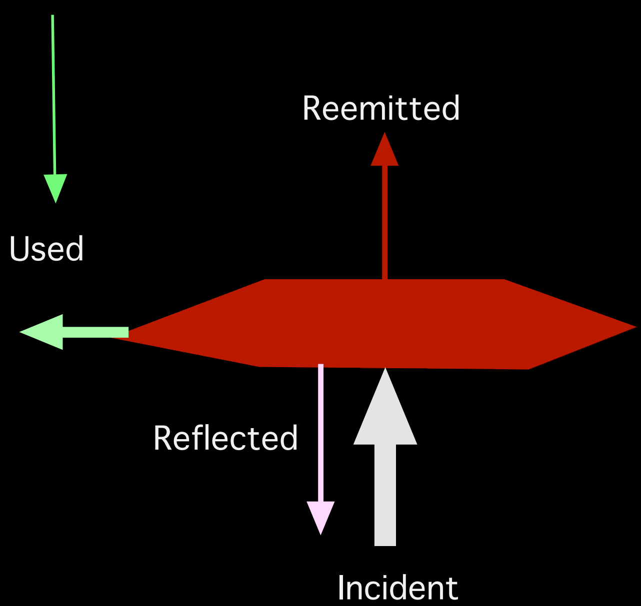


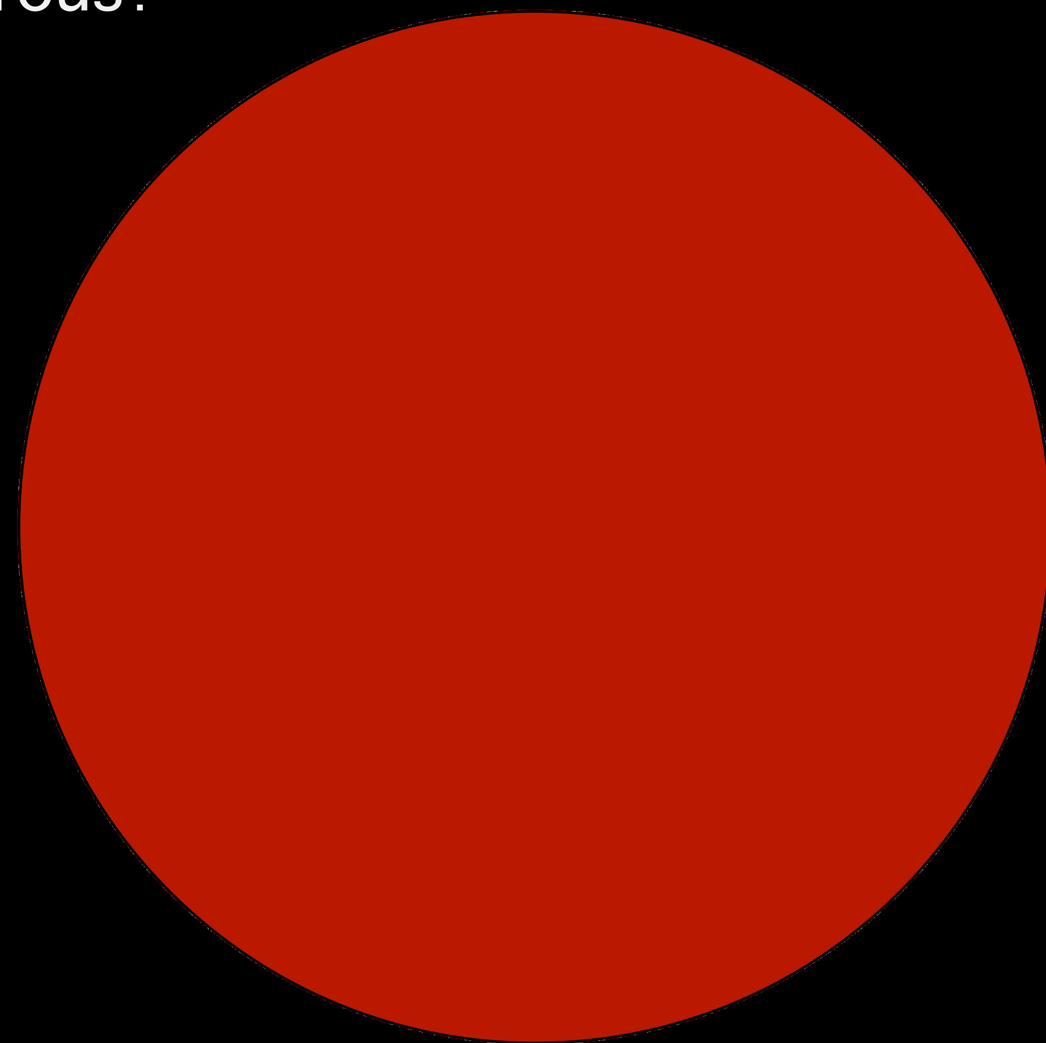

Now it's not
(black circle)

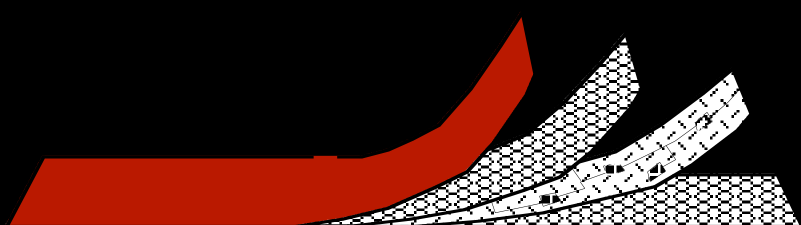

Now it's not
(no circle)
photo from Uluru by Gerald Nordley 1999

Are Dyson Spheres Dangerous?

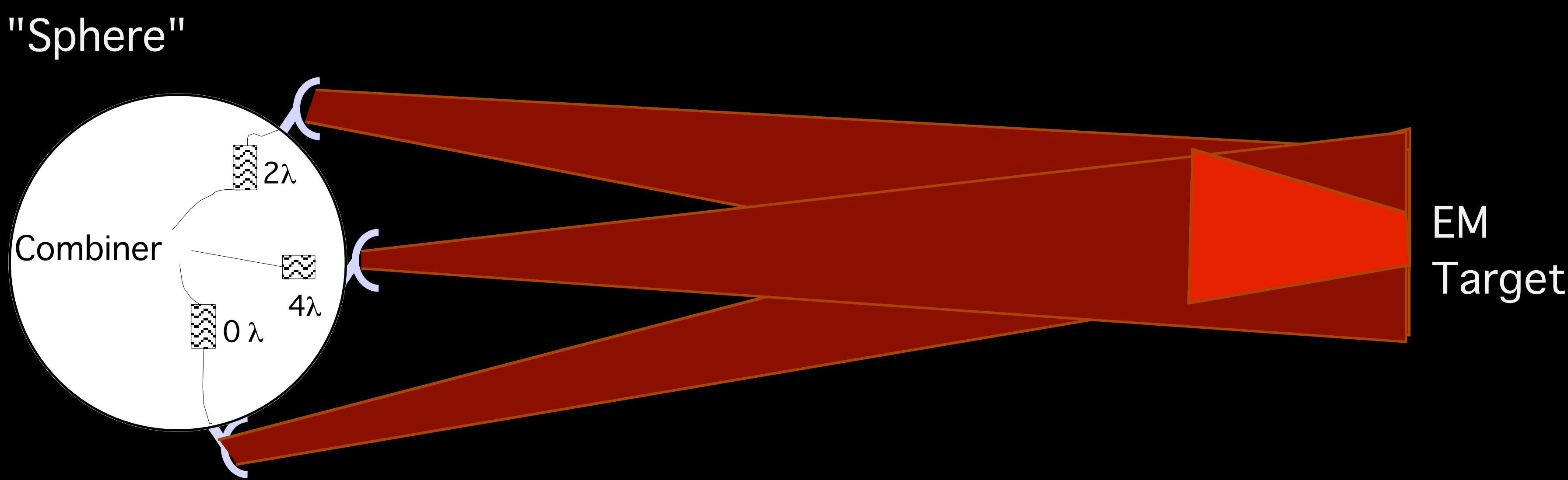
A ≈ Complete Dyson Sphere would be able to intercept and use a significant fraction of the star's output.





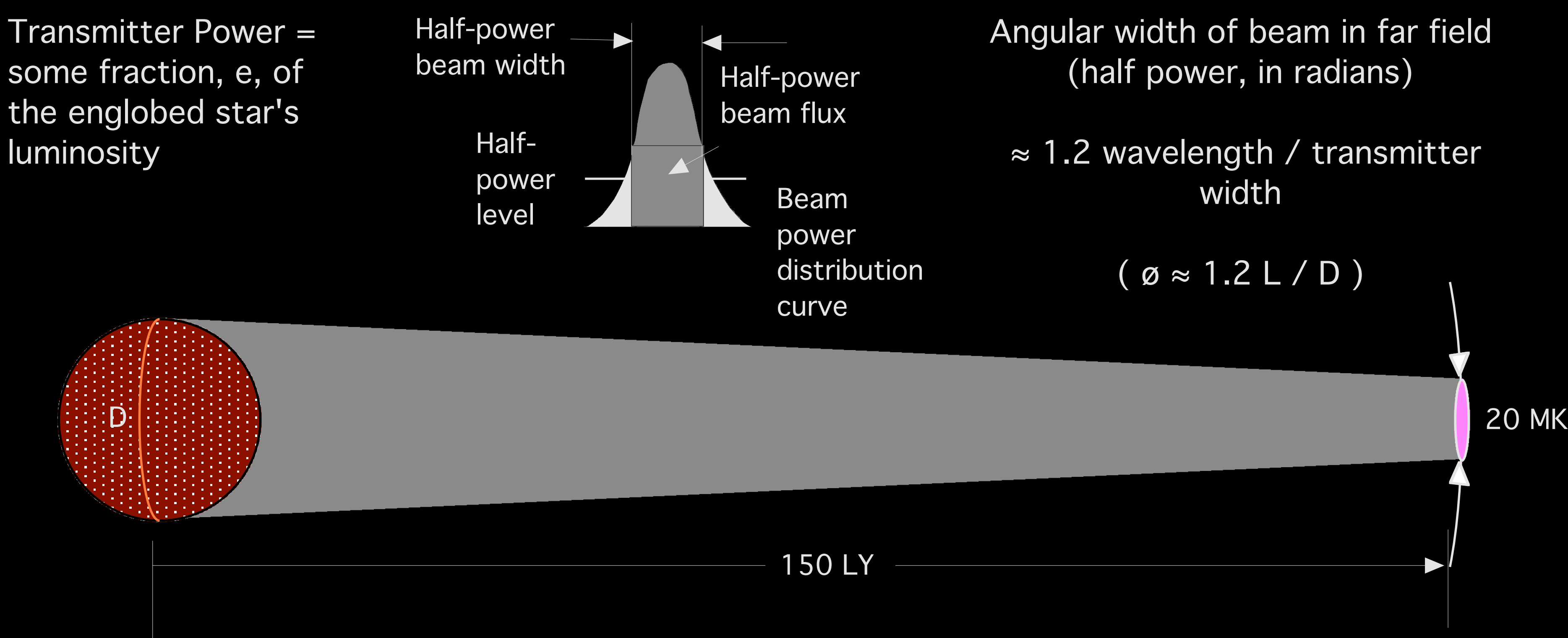


The same equation used for reception governs Transmission as well.



Signals are sent [icon] so that the signal from each antenna wave front of a particular frequency constructively interferes when it reaches the reaches the target.

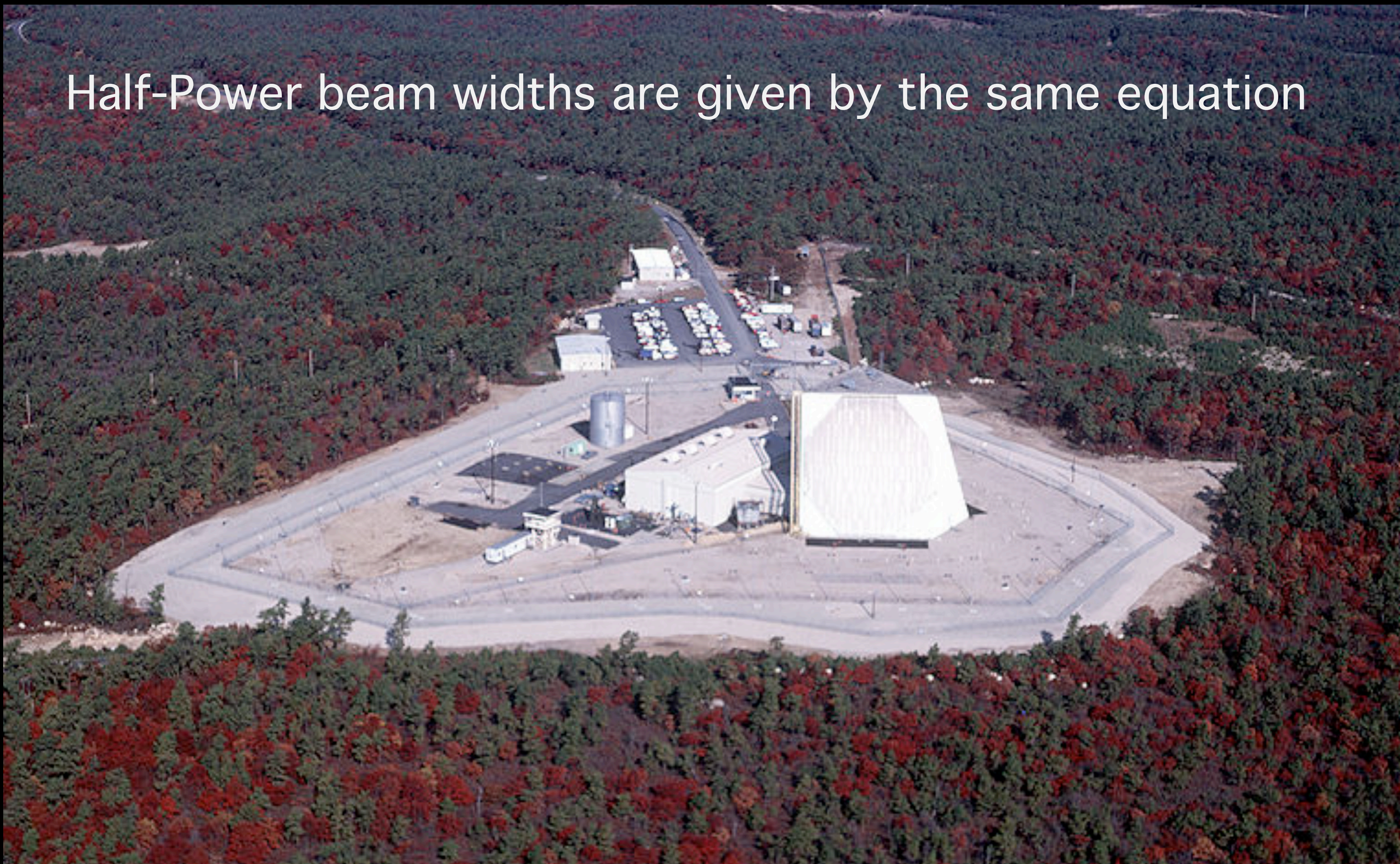
Dyson Sphere Array Resolution and Beam Power



For a star of the Sun's Luminosity at 150 LY, englobed by a Dyson sphere with a radius or 0.3 AU and covered by an array of masers:

The spot size for a 5μm wavelength is about 100 m radius
The irradiance is about 4,000,000 trillion (4 e18) suns
The effective temperature is about 20 million kelvins

Phased Array Radar Transmitters
have been operational since the



Only a Small Fraction of a Dyson Sphere is needed for Interstellar Flight

Array width: 10,000 km

Array length 55,000,000 km

arc length 30 deg

55,000 trillion square meters

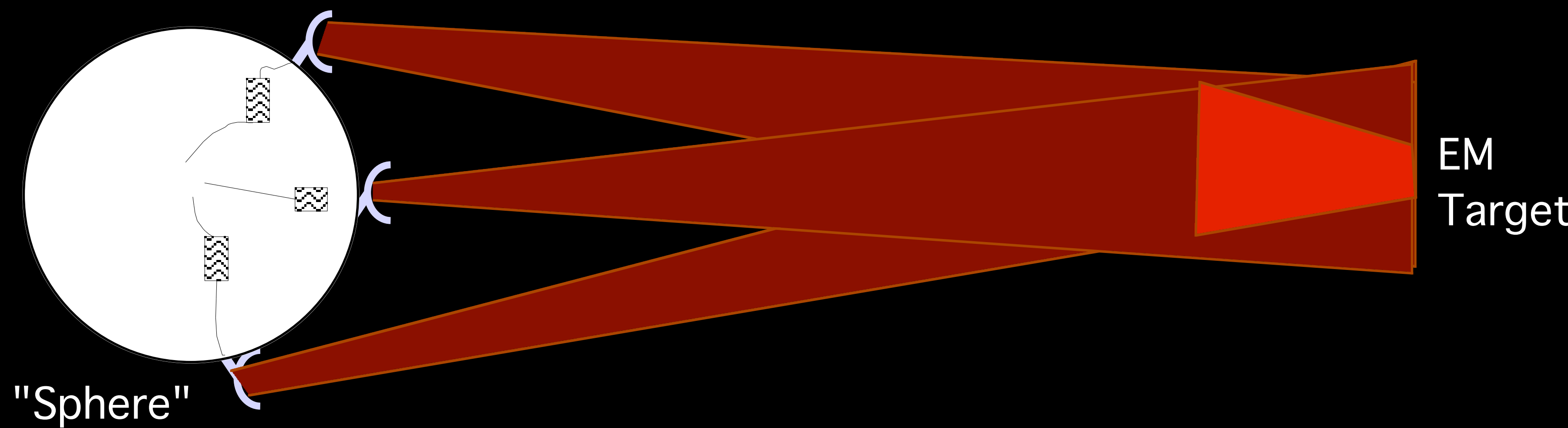
(3.75 millionths of a Dyson sphere)

Power collected 550 million TW

Enough to send 38,600 starships to .86 c each year

Needed to build: 40 years & mass of a 250-km asteroid

Consider a significant fraction of a star's output focused on a spot a few kilometers in radius--tens of light-years away!



Sun's power ≈ 3.8×10^{26} Watts

at ≈ 50 LY and 3 mm, the half-power spot is ≈11,000 km

If one gets 10% of the Sun's power on the spot, that's ≈4×10^{17} W/m2

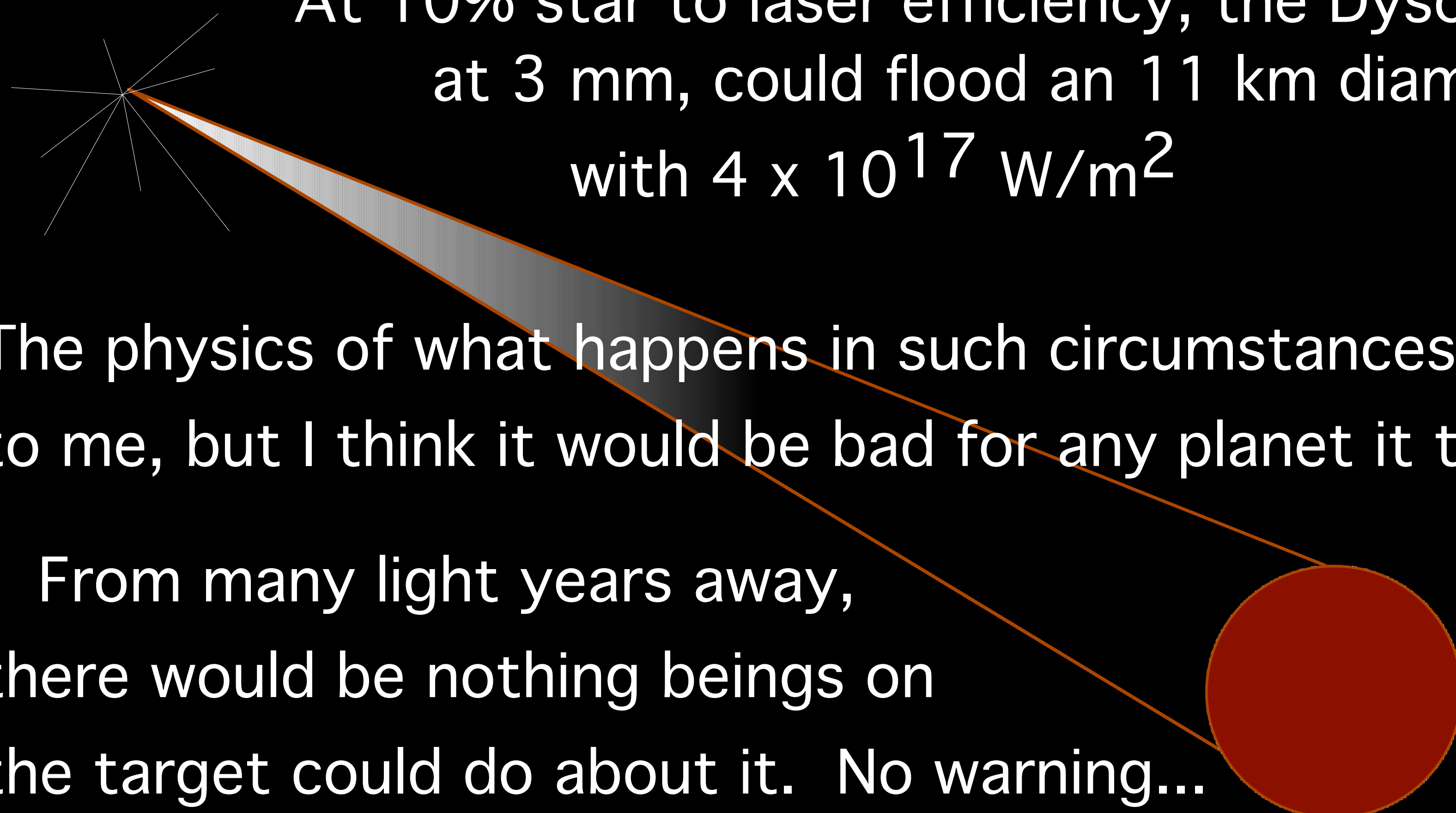
For comparison, the national ignition facility will put about 4×10^{19} W/m2, on a 2 mm diameter target, but only for a brief pulse. At 3μm wavelength, the continuous Dyson sphere beam would exceed the NIF pulse power

by a factor of ≈ 4000!!

That's very intense

One would expect nuclear reactions.

China's 100 PW laser is said to "rip apart" space at 10^{17} W.
At 10% star to laser efficiency, the Dyson sphere
at 3 mm, could flood an 11 km diameter spot
with 4×10^{17} W/m^2



The physics of what happens in such circumstances is unclear to me, but I think it would be bad for any planet it touches.

From many light years away,
there would be nothing beings on
the target could do about it. No warning...

We don't see any Dyson spheres. Why?

We could be the first beings to conceive of them.

There may be no reasonable use for that much power, which we will realize when we're a century or to more advanced.

Anyone who can build on might also be able hide one; they could divert unused radiation out its poles, or somesuch, so as not to worry us.

Or the ancients of the universe may have decided that they aren't to be allowed. Imagine [insert dictator name] with a Dyson sphere!

photo from Uluru by Gerald Nordley 1999

If Dyson Spheres were illegal, could we draw the attention of the authorities if we started making one? In the astronomical time scale, whether humanity's ability to make a Dyson sphere comes in a hundred years or a thousand is immaterial. It is too easy to imagine us, or evolved beings like us, making these things.

Or some other galaxy disrupting technologies....

An aside: Just because something feels mind-blowing or galaxy disrupting does not make physically impossible. One actually has to do the numbers. Fairly. Be rigorous about the logic. Feelings were not evolved for this.

photo from Uluru by Gerald Nordley 1999

Contemplating the near Infinite

...I believe that man is not the most perfect being but one, rather that as there are many degrees of beings his inferiors so there are many degrees of being superior to him. Also, when I stretch my imagination through and beyond our system of planets, beyond the visible fixed stars themselves into that space that is every way infinite, and conceive it filled with suns like ours, each with a chorus of worlds forever moving around him, then this little ball on which we move seems, even in my narrow imagination, to be almost nothing... --Benjamin Franklin

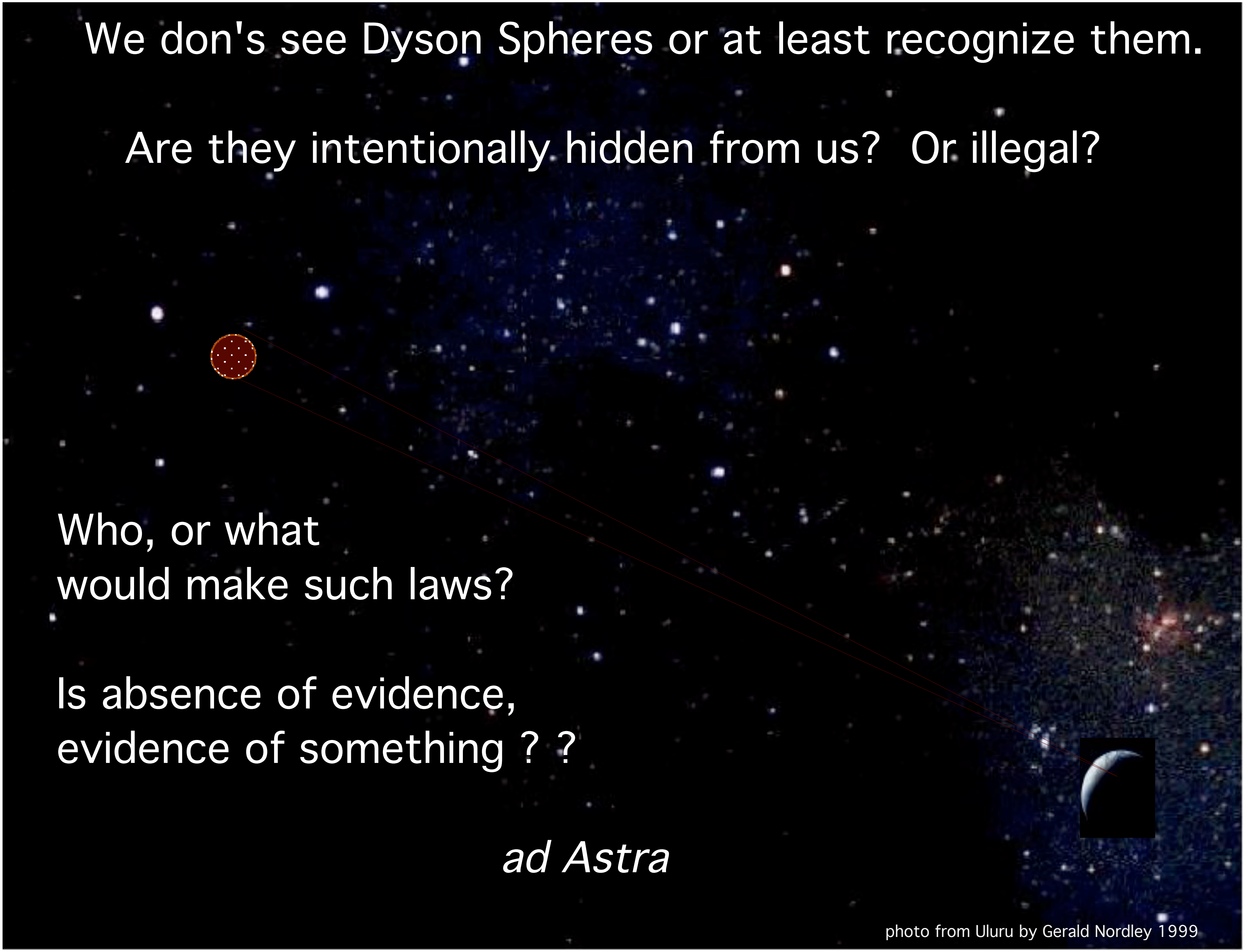
Proxima

2 AU

Freeman Dyson

Olaf Stapledon

photo from Uluru by Gerald Nordley 1999


We don's see Dyson Spheres or at least recognize them.
Are they intentionally hidden from us? Or illegal?
Who, or what
would make such laws?
Is absence of evidence,
evidence of something ? ?
ad Astra
photo from Uluru by Gerald Nordley 1999