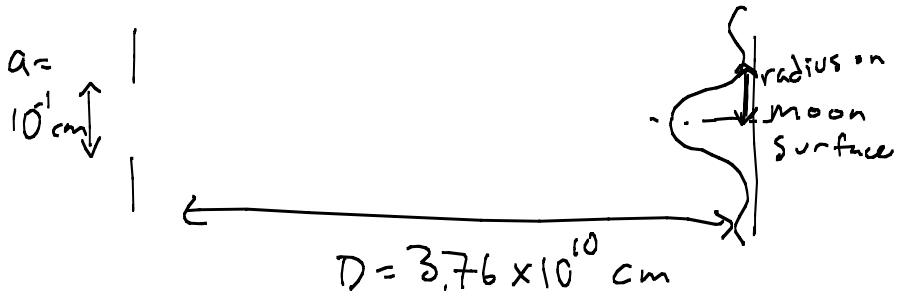
(1)



$$R = D\frac{\lambda}{a}$$

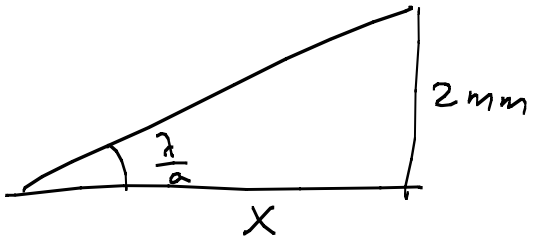
$$= 3.76\times10^{10}\ \frac{10.6\times10^{-4}\text{ cm}}{10^{-1}\text{ cm}}$$

~ 4000 Km!

Diameter ~ 8000 Km

Irradiance: $\frac{2\text{ KW}}{\pi R^2} \simeq 4\times10^{-18}\ \frac{\text{Kw}}{\text{cm}^2} = 4\times10^{-15}\ \frac{\text{W}}{\text{cm}^2}$

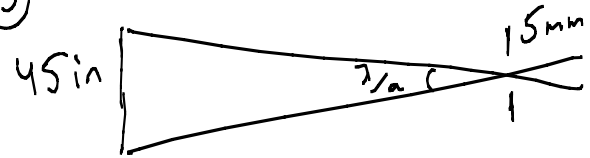
(2)



$$\tan\frac{\lambda}{a} = \frac{2\text{ mm}}{x}$$

$$x = \frac{2\text{mm}}{\tan\frac{\lambda}{a}} = \frac{2\text{mm}}{\tan\frac{6.328\times10^{-5}\text{ cm}}{2\times10^{-1}\text{ cm}}} = 632.1\ \text{cm}$$

(3)



$$\sin\frac{\lambda}{a} = \frac{45\text{ in}}{L} \rightarrow L = \frac{45\text{ in}}{\sin\frac{5.5\times10^{-5}}{5\times10^{-1}}} = 4.1\times10^{5}\text{ in}$$

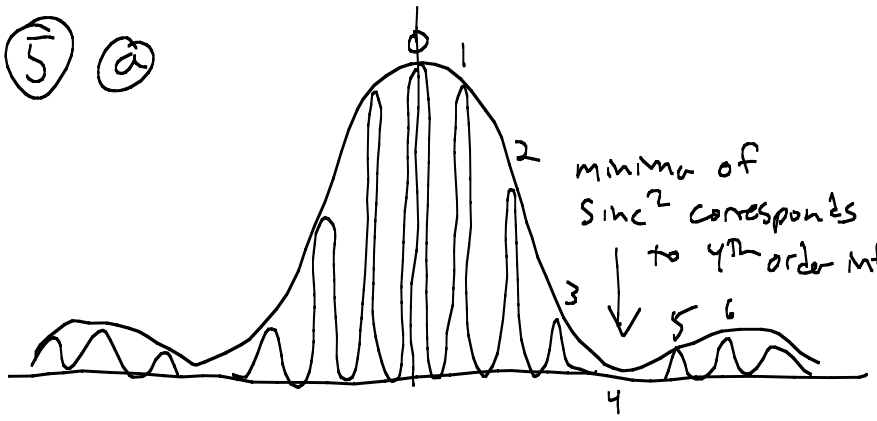
~ 6.46 miles

(4) see above:

$$\frac{1\,mm}{\sin\frac{5.5\times10^{-5}}{2\times10^{-1}}} < L < \frac{1\,mm}{\sin\frac{5.5\times10^{-5}}{7\times10^{-1}}}$$

$$\sim 363\,cm < L < \sim 1272\,cm$$

(5) (a)



$$4\cdot\frac{\lambda}{d} = \frac{\lambda}{a}$$

$$d = 4a = 0.4\ mm$$

(b) $\left(\frac{\sin\alpha}{\alpha}\right)^2 \quad \alpha = \frac{k\theta a}{2}$

1st: $\theta = \frac{\lambda}{d}$

$$\alpha = \frac{2\pi \cancel{\times} a}{\cancel{2\times} d} = \frac{\pi a}{d} = \frac{\pi}{4}$$

$$\left(\frac{\sin\frac{\pi}{4}}{\pi/4}\right)^2 = 0.81057$$

2nd: $\alpha = \frac{\pi}{2}$ $\left(\frac{\sin\frac{\pi}{2}}{\pi/2}\right)^2 = 0.40528$

3rd: $\alpha = \frac{3\pi}{4}$ $\left(\frac{\sin\frac{3\pi}{4}}{3\pi/4}\right)^2 = 0.090063$

Octave: The script calculates the intensity on a screen due to single-slit diffraction, see below for one way to handle arbitrary apertures:

```
function data=diffraction2(aperture)

%aperture is an array of lengths, in the format
%[transparent1 opaque1 transparent2 opaque2 transparent3....]
%example input:
%aperture=1e-3; %single-slit, width 10 microns
%aperture=[1e-3 2e-3 1e-3]; %double slit, each 10 microns, with 20 microns opaque
                                %between them (30 micron spacing)
%aperture=[1e-3 2e-3 1e-3 2e-3 1e-3]);% three-slit diffraction

for ii=1:length(aperture)
 aa(ii)=sum(aperture(1:ii));
end

lambda=6.33e-5;

D=100;
k=2*pi/lambda;
xs=-20:0.1:20;
ii=1;
for x=xs
  E=0;
  for y=0:lambda/2:sum(aperture)
        if ceil(min(find(sign(y-aa)-1))/2)~=min(find(sign(y-aa)-1))/2
              d=sqrt(D^2+(x-y)^2);
              E=E+e^(i*k*d);
        end
  end
  I(ii)=abs(E)^2;
  ii=ii+1;
end
plot(xs,I)
data=[xs' I'];
```

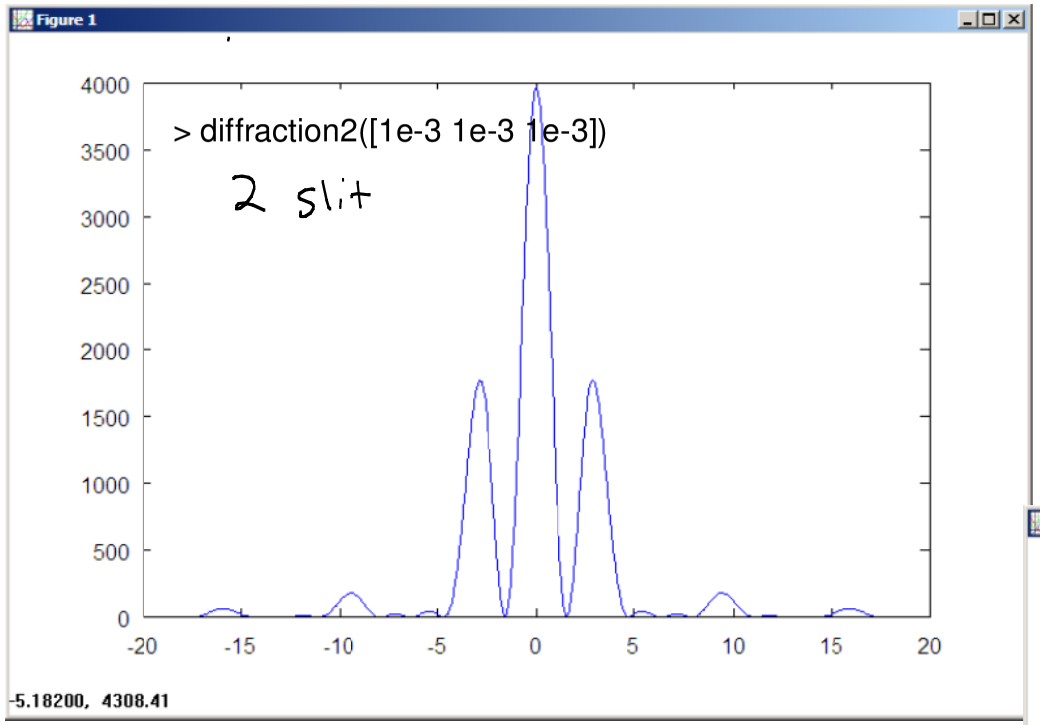


Figure 1
> diffraction2([1e-3 1e-3 1e-3])
2 slit
4000
3500
3000
2500
2000
1500
1000
500
0
-20
-15
-10
-5
0
5
10
15
20
-5.18200, 4308.41

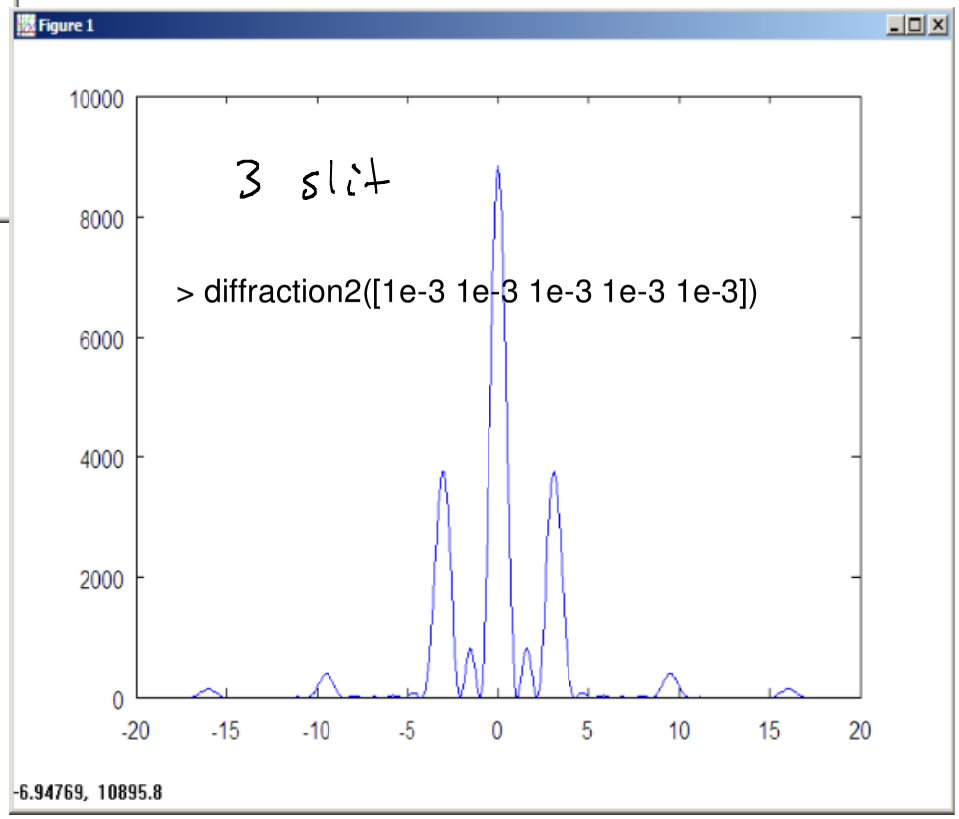


Figure 1
3 slit
> diffraction2([1e-3 1e-3 1e-3 1e-3 1e-3])
10000
8000
6000
4000
2000
0
-20
-15
-10
-5
0
5
10
15
20
-6.94769, 10895.8