Homework 2.3

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1 Problem a

We did it

2 Problem b

Calculations are listed below in appendix a. Our divergence angle w_0 and w_0' is $\theta = 0.0055$.

3 Problem c

The fundamental (Gaussian) is simply just the single dot of the laser and is TEM mode 00, I have not included a picture of this below. However, it is easy to tell that the figures below are in eigenmodes of free space. We can thing of TEM modes as rows or columns. You can add rows and columns as modes starting at 00. Then the laser creates new modes the modes are created vertically or horizontally, like previously stated adding to columns or rows. Also, these modes have to stay symmetric.

4 Problem d

We are able to tell that the figures below are not in eigenmodes of free space. This is simply because they do not look like normal modes we expect to see. These superposition of TEM modes are easy to distinguish from a normal mode for the reason that they take on a strange shape. When observing the superposition they tend to flicker and have weird characteristics to them. This is a result of two energies competing for a specific TEM mode. Thus, this is how we determined that they are in a superposition.

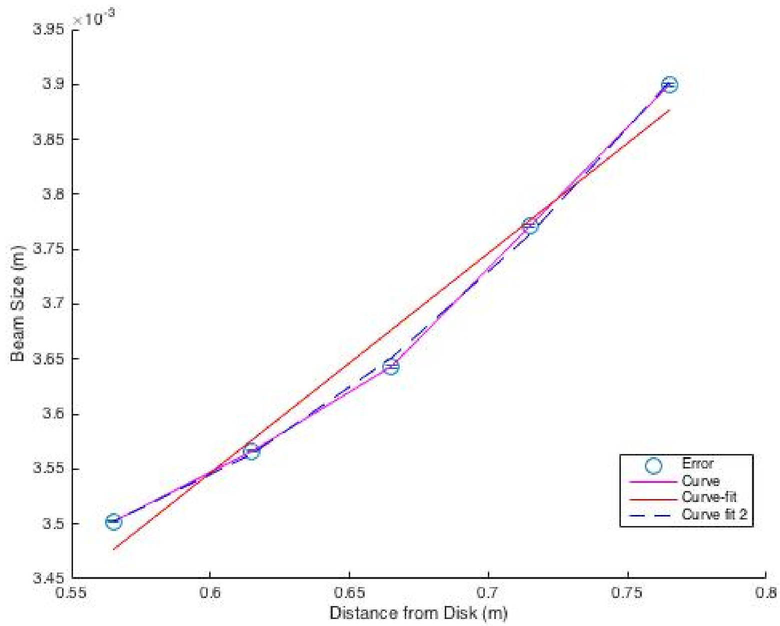

Figure 1: Curve-fit

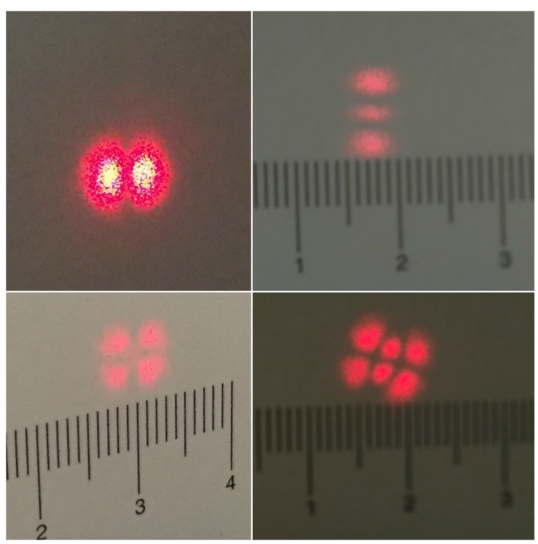

Figure 2: Top left: TEM 10, top right: TEM 02, bottom left: TEM 11, bottom right: TEM 21.

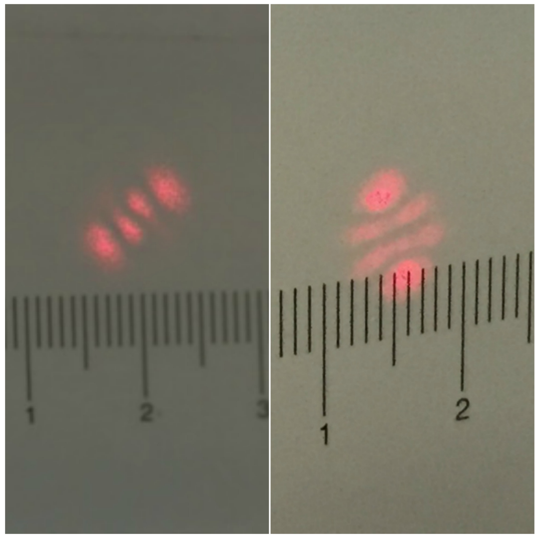

Figure 3: superposition

5 Problem e

Skip

6 appendix a

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%2.3 Fourier Optics and Lasers

Diam = 0.098; %meters
Rev = 0.06; %seconds
RiseTime = [ 680*(10^-06) 640*(10^-06) 630*(10^-06) 610*(10^-06) 590*(10^-06) ];
FallTime = [ 840*(10^-06) 830*(10^-06) 790*(10^-06) 780*(10^-06) 775*(10^-06) ];
Error = (10^-06)* [ 1 1 1 1 1]; %seconds
AvgTime = (RiseTime + FallTime) / 2;
Circ = pi*Diam;
BeamSizeRise = (Circ*RiseTime)./(Rev);
BeamSizeFall = (Circ*FallTime)./(Rev);
BeamSizeAvg = (Circ*AvgTime)./(Rev);
DTot = 0.765; %From Ouput Coupler to Disk in meters
Dist = [ 0.765 0.7150 0.6650 0.6150 0.5650]; %meters
Theta = atan(BeamSizeAvg/Dist)
P = polyfit(Dist,BeamSizeAvg,1);
P2 = polyfit(Dist,BeamSizeAvg,2);
Y = (Dist.^2*P2(1))+(Dist.*P2(2))+P2(3);
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```
YY = (((Dist).*P(1))+P(2));

figure(1);
hold on
errorbar(Dist, BeamSizeAvg,Error,'o','markersize',10);
plot(Dist,BeamSizeAvg,'m');
plot(Dist,YY,'r');
plot(Dist,Y,'b--');
ylabel('Beam Size (m)');
xlabel('Distance from Disk (m)');
legend('Error','Curve','Curve-fit','Curve fit 2')
hold off
```