

Reto F3001C

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```
%Code Variables
%Sizes
sXs = [1000,930,475,405];
sYs = [325,235,955,730];

%Paths
SuperiorPath = "../Phase4V2/Sweeps/Matlab/";
FundamentalPath = "../Phase3/Sweeps/Matlab/";

%Modes
Superior = "Waveguide%i_%i_532_Mode%i";
Fundamental = "Waveguide%i_%i_1596";
ModesSup = [15,9,19,12];

warning('off','MATLAB:polyfit:RepeatedPointsOrRescale')
```

Waveguide selector:

```
sel = 1;
nmodes = ModesSup(sel);
mode = 12;
disp("Selected waveguide:")
```

Selected waveguide:

```
disp("    Size: "+num2str(sXs(sel))+ "x" +num2str(sYs(sel)));
```

Size: 1000x325

```
disp("    Mode: "+num2str(mode));
```

Mode: 14

Waveguide Summary:

```
disp("Waveguide: "+num2str(sXs(sel))+ "x" +num2str(sXs(sel))+ ", mode: "+num2str(ModesSup(sel)));
```

Waveguide: 1000x1000, mode: 15

Fundamental Mode Data (1596nm):

```
file = sprintf(Fundamental,sXs(sel)*1000,sYs(sel)*1000);
load(FundamentalPath+file);
wgFundamental = waveguide(lambda,neff);
l = wgFundamental.lambdaData;
w = wgFundamental.omegaData;
```

```
neff = wgFundamental.neffData;
```

Ranges:

```
disp("Lambda Ranges: "+num2str(min(l))+"-"+num2str(max(l))+"");
```

Lambda Ranges: 1.53-1.596

```
disp("Omega Ranges: "+num2str(min(w))+"-"+num2str(max(w))+"");
```

Omega Ranges: 1181049869.7706-1231997119.0548

Neff vs ω/λ

```
disp("Function neff( $\lambda$ ):");
```

Function neff(λ):

```
disp(wgFundamental.nefflStr);
```

$-0.000025750505326139147430292500 \cdot l.^{30} + 0.000166135621290843785071572603 \cdot l.^{29} - 0.000319608704624926799522238730 \cdot l.^{28} + 0.00053111111111111111111111111111 \cdot l.^{27} - 0.00074074074074074074074074074074 \cdot l.^{26} + 0.00095238095238095238095238095238 \cdot l.^{25} - 0.00116279069767441860465116279069 \cdot l.^{24} + 0.00137500000000000000000000000000 \cdot l.^{23} - 0.00158888888888888888888888888889 \cdot l.^{22} + 0.00180392156862745098039215686274 \cdot l.^{21} - 0.00202020202020202020202020202020 \cdot l.^{20} + 0.00223809523809523809523809523809 \cdot l.^{19} - 0.00245714285714285714285714285714 \cdot l.^{18} + 0.00267735091263526814159292035398 \cdot l.^{17} - 0.00289863013698630136986301369863 \cdot l.^{16} + 0.00312098765432098765432098765432 \cdot l.^{15} - 0.00334451811023622043010752688172 \cdot l.^{14} + 0.00356923076923076923076923076923 \cdot l.^{13} - 0.00379503795037950379503795037950 \cdot l.^{12} + 0.00402192982456140350877192982456 \cdot l.^{11} - 0.00425000000000000000000000000000 \cdot l.^{10} + 0.00447923076923076923076923076923 \cdot l.^{9} - 0.00470952380952380952380952380952 \cdot l.^{8} + 0.00494076923076923076923076923077 \cdot l.^{7} - 0.00517297297297297297297297297297 \cdot l.^{6} + 0.00540612244897959183673469387755 \cdot l.^{5} - 0.00564021739130434782608695652174 \cdot l.^{4} + 0.005875265822705442177287564165816888261 \cdot l.^{3} - 0.00611127819548872149122807017544 \cdot l.^{2} + 0.00634825396825396825396825396825 \cdot l.^{1} - 0.00658618881118881118881118881119$

```
disp("Function neff( $\omega$ ):");
```

Function neff(ω)

```
disp(wgFundamental.neffwStr);
```

$1.257200516898534797702455388523e-271 \cdot w.^{30} - 5.939522598070244281054868243553e-262 \cdot w.^{29} + 8.1727800593564165816888261 \cdot w.^{28} - 1.257200516898534797702455388523e-271 \cdot w.^{27} + 5.939522598070244281054868243553e-262 \cdot w.^{26} - 8.1727800593564165816888261 \cdot w.^{25} + 1.257200516898534797702455388523e-271 \cdot w.^{24} - 5.939522598070244281054868243553e-262 \cdot w.^{23} + 8.1727800593564165816888261 \cdot w.^{22} - 1.257200516898534797702455388523e-271 \cdot w.^{21} + 5.939522598070244281054868243553e-262 \cdot w.^{20} - 8.1727800593564165816888261 \cdot w.^{19} + 1.257200516898534797702455388523e-271 \cdot w.^{18} - 5.939522598070244281054868243553e-262 \cdot w.^{17} + 8.1727800593564165816888261 \cdot w.^{16} - 1.257200516898534797702455388523e-271 \cdot w.^{15} + 5.939522598070244281054868243553e-262 \cdot w.^{14} - 8.1727800593564165816888261 \cdot w.^{13} + 1.257200516898534797702455388523e-271 \cdot w.^{12} - 5.939522598070244281054868243553e-262 \cdot w.^{11} + 8.1727800593564165816888261 \cdot w.^{10} - 1.257200516898534797702455388523e-271 \cdot w.^{9} + 5.939522598070244281054868243553e-262 \cdot w.^{8} - 8.1727800593564165816888261 \cdot w.^{7} + 1.257200516898534797702455388523e-271 \cdot w.^{6} - 5.939522598070244281054868243553e-262 \cdot w.^{5} + 8.1727800593564165816888261 \cdot w.^{4} - 1.257200516898534797702455388523e-271 \cdot w.^{3} + 5.939522598070244281054868243553e-262 \cdot w.^{2} - 8.1727800593564165816888261 \cdot w.^{1} + 1.257200516898534797702455388523e-271 \cdot w.^{0}$

```
figure;
hold on
title("n_{eff} vs  $\omega/\lambda$ ");
plot(l,neff,'bo',l,wgFundamental.neffwFun(w),'r-.',l,wgFundamental.nefflFun(l),'g--');
legend(["Data","neff(\omega)","neff(\lambda)"]);
xlabel("\lambda");
ylabel("n_{eff}");
hold off
```



```
disp(wgFundamental.d2kwdw2Str);
```

```
(1.257200516898534797702455388523e-271*w.^29*(930)-5.939522598070244281054868243553e-262*w.^28*(870)+8.172780059356
```

```
disp("Function D(w):");
```

```
Function D(w):
```

```
disp(wgFundamental.DwStr);
```

```
-(w.^2/(2*pi*3*10^8)).*((1.257200516898534797702455388523e-271*w.^29*(930)-5.939522598070244281054868243553e-262*w.
```

```
subplot(2,3,1);  
plot(1,neff,'bo',1,wgFundamental.neffwFun(w),'r-.',1,wgFundamental.nefflFun(1),'g--');  
title("n_{eff} vs \omega/\lambda");  
subplot(2,3,2);  
plot(1,wgFundamental.kwFun(w),'b');  
title("k(\omega)");  
subplot(2,3,3);  
plot(1,wgFundamental.dkwdwFun(w),'b');  
title("^{dk(\omega)}/{d\omega}");  
subplot(2,3,4);  
plot(1,wgFundamental.vgwFun(w),'b');  
title("V_g(\omega)");  
subplot(2,3,5);  
plot(1,wgFundamental.d2kwdw2Fun(w),'b');  
title("^{d^2k(\omega)}/{d\omega^2}");  
subplot(2,3,6);  
plot(1,wgFundamental.DwFun(w),'b');  
title("D(\omega)");
```



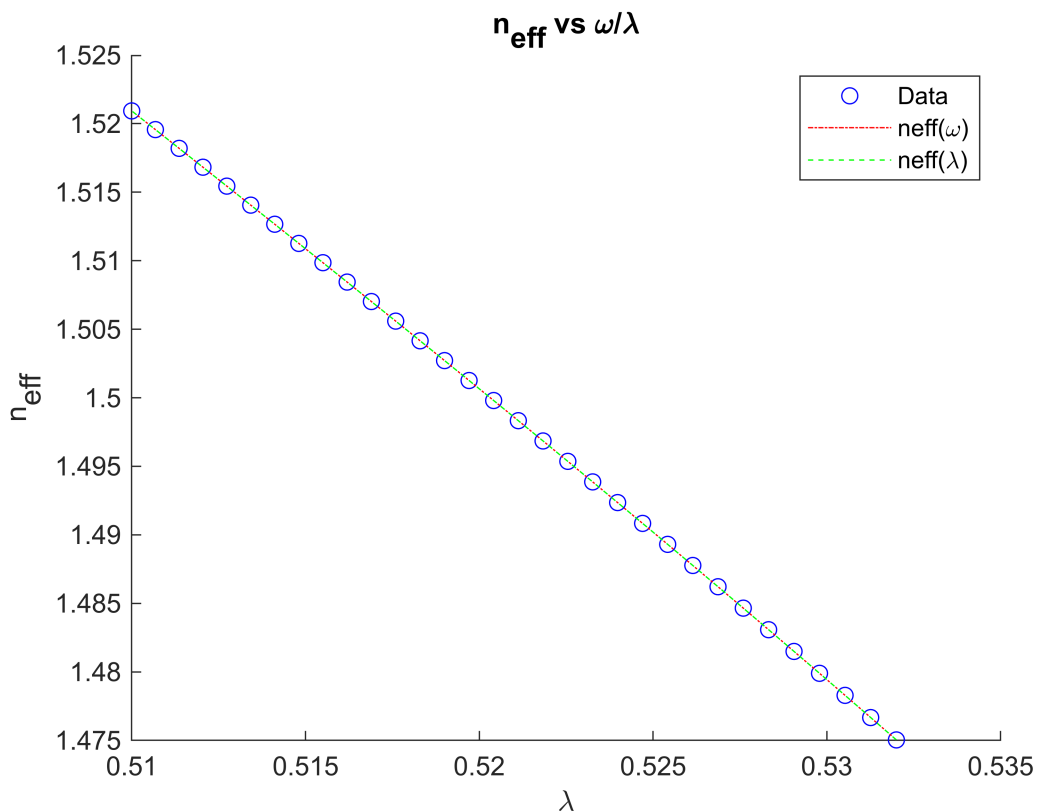
```
disp("Function neff(w):");
```

```
Function neff(w):
```

```
disp(wgSuperior.neffwStr);
```

```
4.393310814495142809142406236547e-282*w.^30-2.360636067323359288727349250688e-272*w.^29-8.36820973776158960097829387
```

```
figure;  
hold on  
title("n_{eff} vs \omega/\lambda");  
plot(l,neff,'bo',l,wgSuperior.neffwFun(w),'r-.',l,wgSuperior.nefflFun(l),'g--');  
legend(["Data","neff(\omega)","neff(\lambda)"]);  
xlabel("\lambda");  
ylabel("n_{eff}");  
hold off
```



Subfunctions (k, dw, Vg, d2w, D)

```
disp("Function k(w):");
```

```
Function k(w):
```

```
disp(wgSuperior.kwStr);
```

```
w.*(4.393310814495142809142406236547e-282*w.^30-2.360636067323359288727349250688e-272*w.^29-8.36820973776158960097829387
```

```
disp("Function dk(w)/dw:");
```

Function dk(w)/dw:

```
disp(wgSuperior.dkwdwStr);
```

```
(4.393310814495142809142406236547e-282*w.^30*(31)-2.360636067323359288727349250688e-272*w.^29*(30)-8.36820973776158
```

```
disp("Function Vg(w):");
```

Function Vg(w):

```
disp(wgSuperior.vgwStr);
```

```
(3*10^8)./(4.393310814495142809142406236547e-282*w.^30*(31)-2.360636067323359288727349250688e-272*w.^29*(30)-8.3682
```

```
disp("Function d2k(w)/dw2:");
```

Function d2k(w)/dw2:

```
disp(wgSuperior.d2kwdw2Str);
```

```
(4.393310814495142809142406236547e-282*w.^29*(930)-2.360636067323359288727349250688e-272*w.^28*(870)-8.368209737761
```

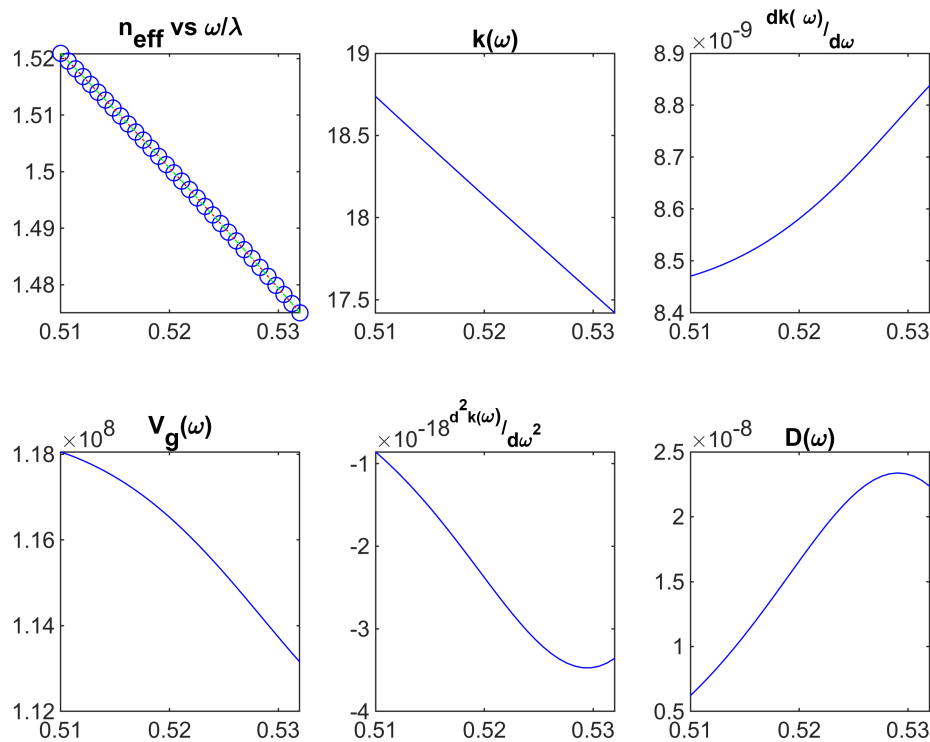
```
disp("Function D(w):");
```

Function D(w):

```
disp(wgSuperior.DwStr);
```

```
-(w.^2/(2*pi*3*10^8)).*((4.393310814495142809142406236547e-282*w.^29*(930)-2.360636067323359288727349250688e-272*w.
```

```
subplot(2,3,1);  
plot(1,neff,'bo',1,wgSuperior.neffwFun(w),'r-.',1,wgSuperior.nefflFun(1),'g--');  
title("n_{eff} vs \omega/\lambda");  
subplot(2,3,2);  
plot(1,wgSuperior.kwFun(w),'b');  
title("k(\omega)");  
subplot(2,3,3);  
plot(1,wgSuperior.dkwdwFun(w),'b');  
title("^{dk(\omega)}/{d\omega}");  
subplot(2,3,4);  
plot(1,wgSuperior.vgwFun(w),'b');  
title("V_g(\omega)");  
subplot(2,3,5);  
plot(1,wgSuperior.d2kwdw2Fun(w),'b');  
title("^{d^2k(\omega)}/{d\omega^2}");  
subplot(2,3,6);  
plot(1,wgSuperior.DwFun(w),'b');  
title("D(\omega)");
```



Load Waveguide Simple:

```
file = sprintf(Fundamental,sXs(sel)*1000,sYs(sel)*1000);
load(FundamentalPath+file);
wgFundamental = waveguide(lambda,neff);
file = sprintf(Superior,sXs(sel),sYs(sel),mode);
load(SuperiorPath+file);
wgSuperior = waveguide(lambda,neff);
```

K's comparing

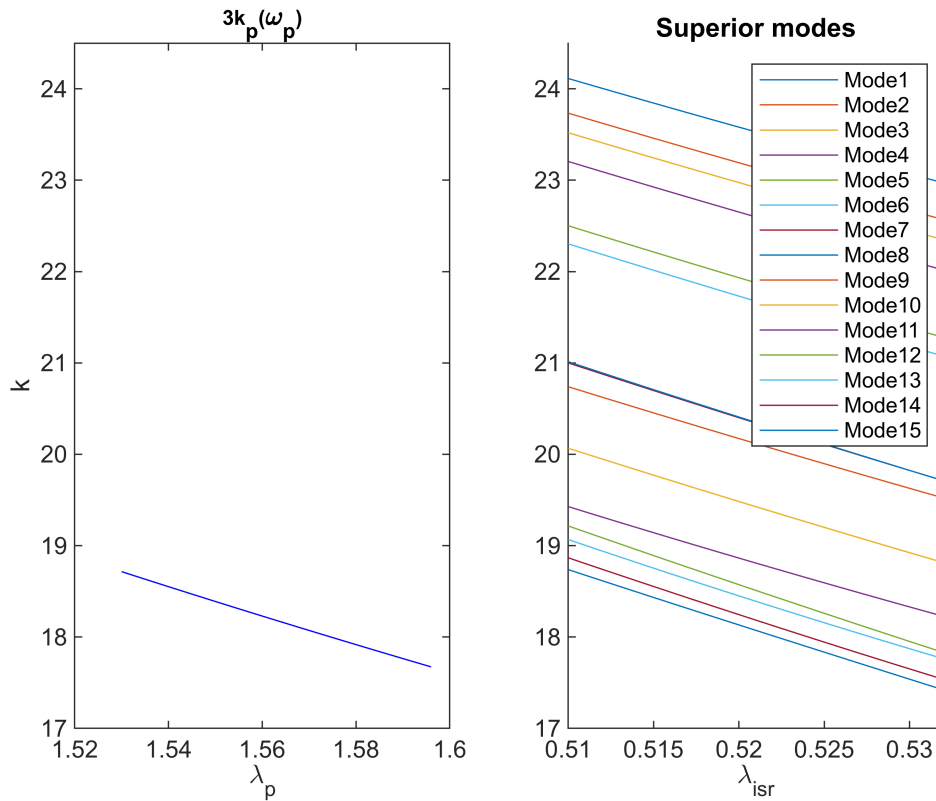
```
file = sprintf(Fundamental,sXs(sel)*1000,sYs(sel)*1000);
load(FundamentalPath+file);
wgFundamental = waveguide(lambda,neff);
l = wgFundamental.lambdaData;
w = wgFundamental.omegaData;
neff = wgFundamental.neffData;
figure;
subplot(1,2,1)
plot(l,wgFundamental.kwFun(w).*3,'b');
leg = {};
title("3k_p(\omega_p)"); xlabel("\lambda_p"); ylabel("k");
```



```

ylim([17 24.5]);
subplot(1,2,2)
hold on
for i = 1:nmodes
    file = sprintf(Superior,sXs(sel),sYs(sel),i);
    load(SuperiorPath+file);
    wgSuperior = waveguide(lambda,neff);
    l = wgSuperior.lambdaData;
    w = wgSuperior.omegaData;
    plot(l,wgSuperior.kwFun(w));
    leg(end+1) = {"Mode"+num2str(i)};
end
legend(leg);
ylim([17 24.5]);
title("Superior modes"); xlabel("\lambda_{isr}");
hold off

```



Find degenerate photon that allow momentum and energy conservation

```

size=50;

lpLim = [min(wgFundamental.lambdaData) max(wgFundamental.lambdaData)];
lpLim = [min(wgSuperior.lambdaData) max(wgSuperior.lambdaData)];
lp = linspace(lpLim(1),lpLim(2),size);

```

```

wp = 2.*pi.*3.*10.^8./lp;
ws = wp./3;
leg = {};

file = sprintf(Fundamental,sXs(sel)*1000,sYs(sel)*1000);
load(FundamentalPath+file);
wgFundamental = waveguide(lambda,neff);

figure
hold on

dk0s = [];

for i = 1:nmodes
    file = sprintf(Superior,sXs(sel),sYs(sel),i);
    load(SuperiorPath+file);
    wgSuperior = waveguide(lambda,neff);
    %Nota w 10^8 es 10^14

    dk = wgSuperior.kwFun(wp)-(3*wgFundamental.kwFun(ws));

    if(min(dk)<=0 && max(dk)>=0)
        dk0s = [dk0s i];
    end

    plot(lp,dk);
    leg(end+1) = {"Mode"+num2str(i)};
end

if ~isequal(dk0s,[])
    strDk0s = sprintf('Modo %i,',dk0s);
    strDk0s = "Modos con dK=0: "+strDk0s(1:end-1);
else
    strDk0s = "Ningun modo con dK=0";
end

disp(strDk0s)

```

Modos con dK=0: Modo 14,Modo 15

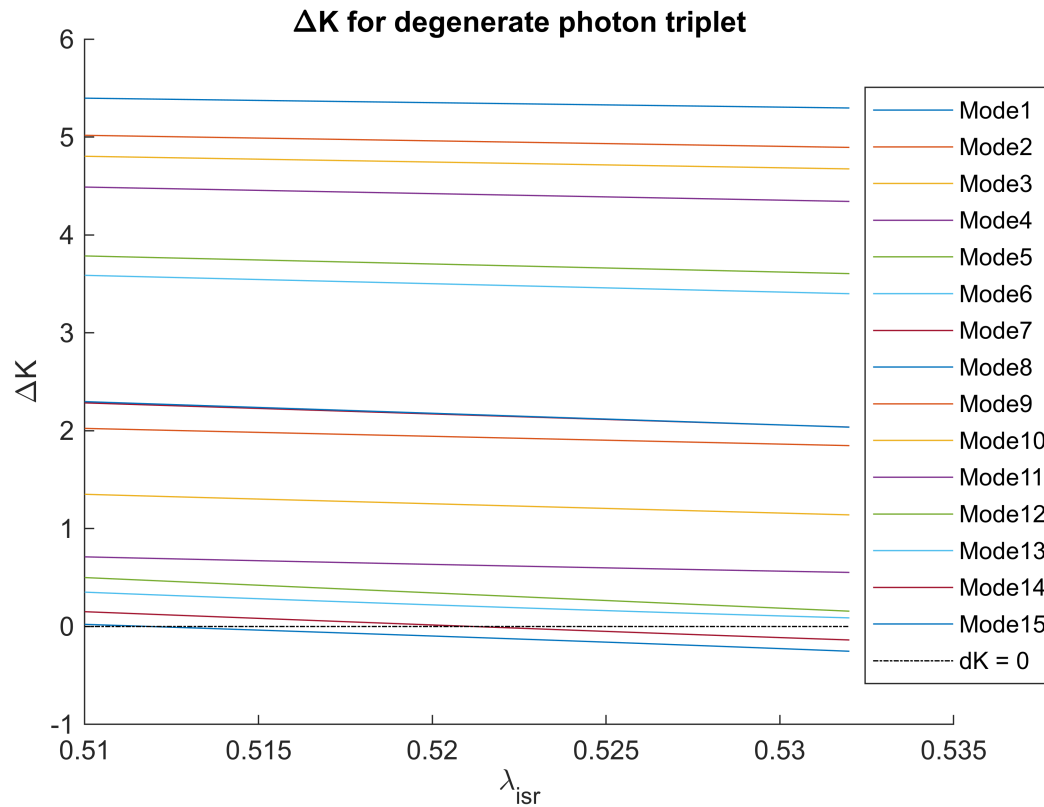
```

plot([lpLim(1),lpLim(2)],[0,0],'k-.')
leg(end+1) = {"dK = 0"};

legend(leg);
title("\DeltaK for degenerate photon triplet");
ylabel("\DeltaK"); xlabel("\lambda_{isr}");

legend("Position", [0.8256,0.15841,0.16964,0.70952])

```



Phase Matching

```

switch nmodes
case 15
    m = 5;n = 3;
case 9
    m = 3;n = 3;
case 19
    m = 5;n = 4;
case 12
    m = 4;n = 3;
end

file = sprintf(Fundamental,sXs(sel)*1000,sYs(sel)*1000);
load(FundamentalPath+file);
wgFundamental = waveguide(lambda,neff);

lpLim = [min(wgFundamental.lambdaData) max(wgFundamental.lambdaData)];
lpLim = [min(wgSuperior.lambdaData) max(wgSuperior.lambdaData)];
li = 1.53;
size=50;

wp = linspace(2.*pi.*3.*10.^8./lpLim(1),2.*pi.*3.*10.^8./lpLim(2),size);
dw = linspace(1e8,-1e8,size);

```

```
[WP,DW] = meshgrid(wp,dw);
wi = (2.*pi.*3.*10.^8./li);
wr = DW+(WP-wi)/2;
ws = WP-wi-wr;
```

```
disp("Pump wavelength: "+num2str(lpLim(1))+ "-" + num2str(lpLim(2)));
```

Pump wavelength: 0.51-0.532

```
disp("Photon wavelength: "+num2str(lphLim(1))+ "-" + num2str(lphLim(2)));
```

Photon wavelength: 1.53-1.596

```
figure
for i = 1:nmodes
    file = sprintf(Superior,sXs(sel),sYs(sel),i);
    load(SuperiorPath+file);
    wgSuperior = waveguide(lambda,neff);
    %Nota w 10^8 es 10^14
    DK = wgSuperior.kwFun(WP)-(wgFundamental.kwFun(wi)+wgFundamental.kwFun(wr)+wgFundamental.kwFun(ws));
    subplot(m,n,i)
    contour(2.*pi.*3.*10.^8./wp,dw.*10^6,DK,[0 0],'b','LineWidth',2);
    title("M "+num2str(i));
    ylabel("\omega");
end
sgtitle("Waveguide "+num2str(sXs(sel))+ "x" + num2str(sYs(sel))+ " with \lambda_i = "+num2str(li))
```

Waveguide 1000x325 with $\lambda_i = 1.53$

