

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 = 3;
nmodes = ModesSup(sel);
mode = 15;
disp("Selected waveguide:")
```

Selected waveguide:

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

Size: 475x955

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

Mode: 15

Waveguide Summary:

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

Waveguide: 475x475, mode: 19

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(λ):");
```

```
Function neff( $\lambda$ ):
```

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

$$0.000017319307674958947198444806 * l.^{30} - 0.000136783674043061947295241154 * l.^{29} + 0.000295947599398755528156412797$$

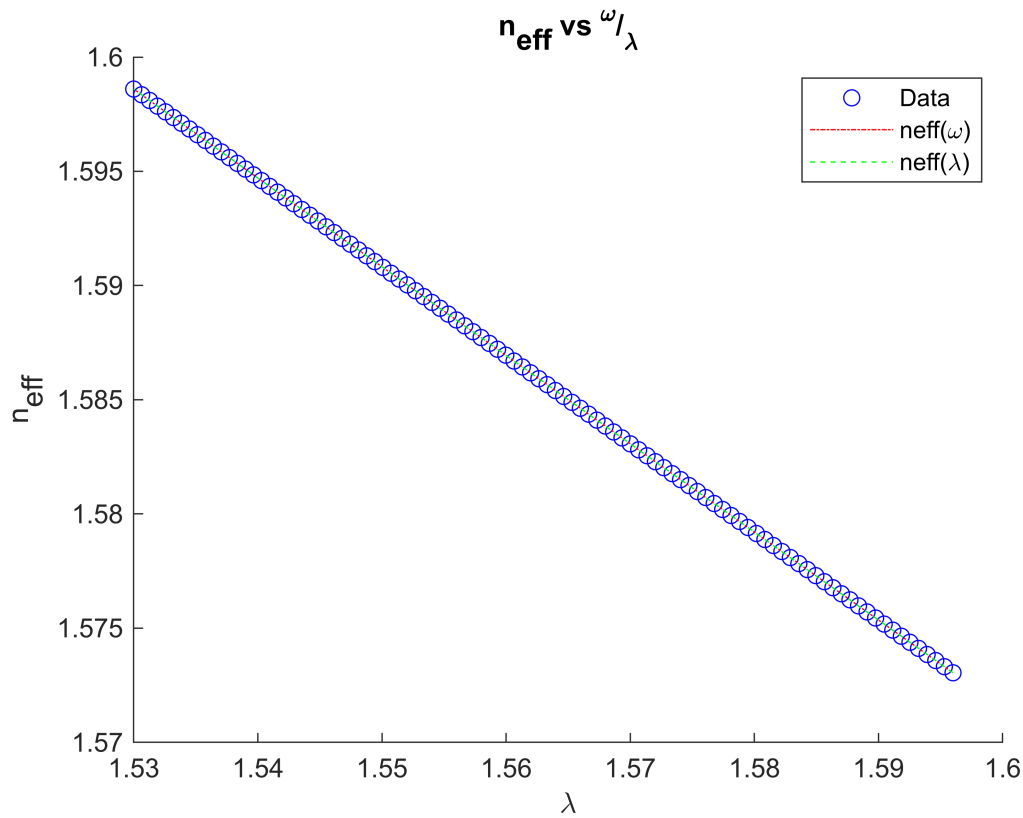
```
disp("Function neff(w)");
```

Function `neff(w)`

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

$$1.057981373733877631075077401994e-271 * w.^{30} - 4.876575195987541549652917935234e-262 * w.^{29} + 7.27533805954948753738$$

```
figure;
hold on
title("n_{eff} vs ^{\omega}/_{\lambda}");
plot(1,neff,'bo',1,wgFundamental.neffwFun(w),'r-.',1,wgFundamental.nefflFun(1),'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(wgFundamental.kwStr);
```

```
w.*(1.057981373733877631075077401994e-271*w.^30-4.876575195987541549652917935234e-262*w.^29+7.275338059549487537387
```

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

Function dk(w)/dw:

```
disp(wgFundamental.dkdwStr);
```

```
(1.057981373733877631075077401994e-271*w.^30*(31)-4.876575195987541549652917935234e-262*w.^29*(30)+7.275338059549487
```

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

Function Vg(w):

```
disp(wgFundamental.vgwStr);
```

```
(3*10^8)./(1.057981373733877631075077401994e-271*w.^30*(31)-4.876575195987541549652917935234e-262*w.^29*(30)+7.275338059549487
```

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

Function d2k(w)/dw:

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

```
(1.057981373733877631075077401994e-271*w.^29*(930)-4.876575195987541549652917935234e-262*w.^28*(870)+7.275338059549
```

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

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

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

```
-(w.^2/(2*pi*3*10^8)).*((1.057981373733877631075077401994e-271*w.^29*(930)-4.876575195987541549652917935234e-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)");
```



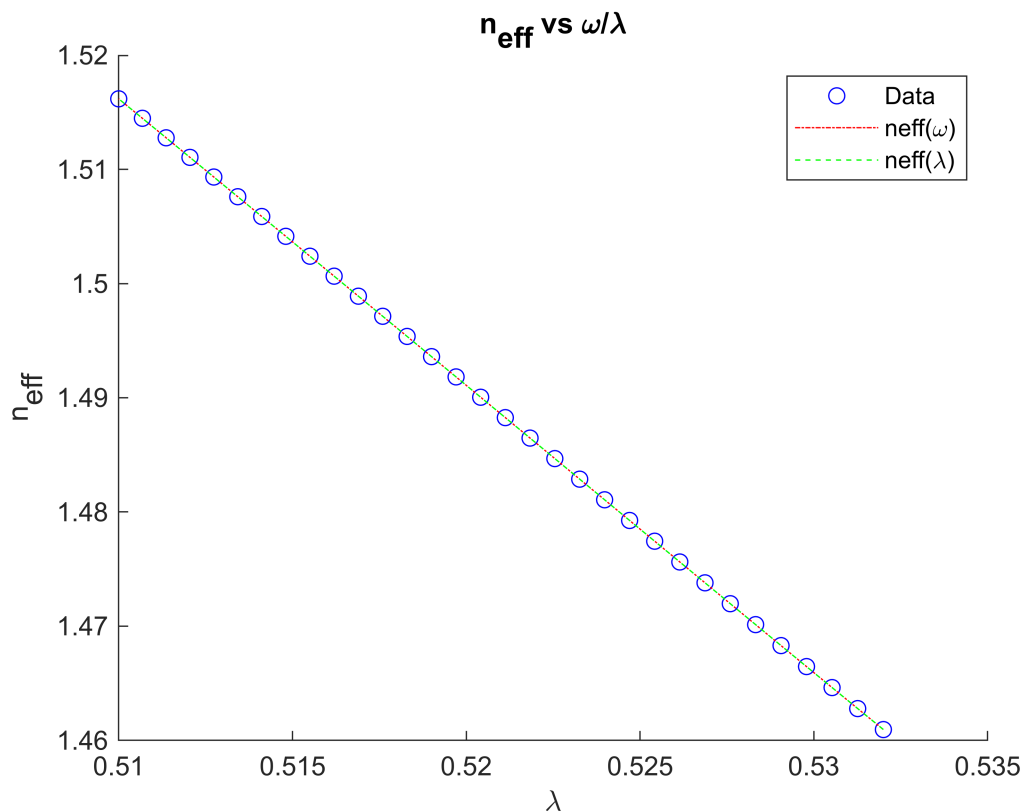
```
disp("Function neff(w):");
```

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

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

```
-2.362815545505330443363793346491e-283*w.^30+4.037432829134895234866074040568e-270*w.^29-4.537593124006705593524901
```

```
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.*(-2.362815545505330443363793346491e-283*w.^30+4.037432829134895234866074040568e-270*w.^29-4.53759312400670559352
```

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

Function dk(w)/dw:

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

```
(-2.362815545505330443363793346491e-283*w.^30*(31)+4.037432829134895234866074040568e-270*w.^29*(30)-4.53759312400670
```

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

Function Vg(w):

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

```
(3*10^8)./(-2.362815545505330443363793346491e-283*w.^30*(31)+4.037432829134895234866074040568e-270*w.^29*(30)-4.53759312400670
```

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

Function d2k(w)/dw2:

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

```
(-2.362815545505330443363793346491e-283*w.^29*(930)+4.037432829134895234866074040568e-270*w.^28*(870)-4.53759312400670
```

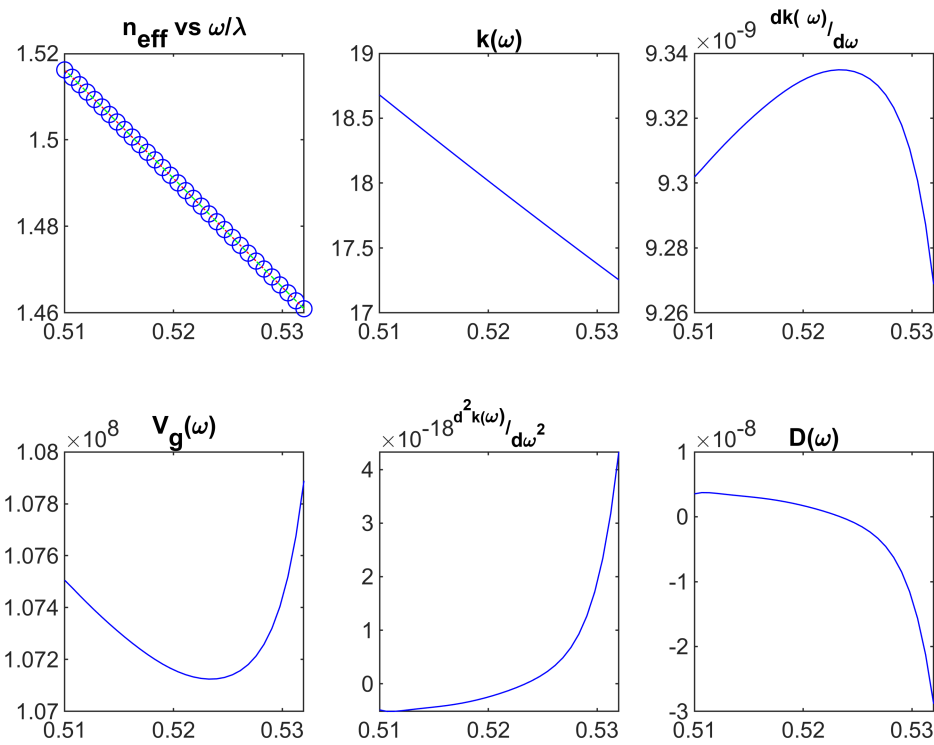
```
disp("Function D(w):");
```

Function D(w):

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

```
-(w.^2/(2*pi*3*10^8)).*((-2.362815545505330443363793346491e-283*w.^29*(930)+4.037432829134895234866074040568e-270*w.^28*(870)-4.53759312400670
```

```
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

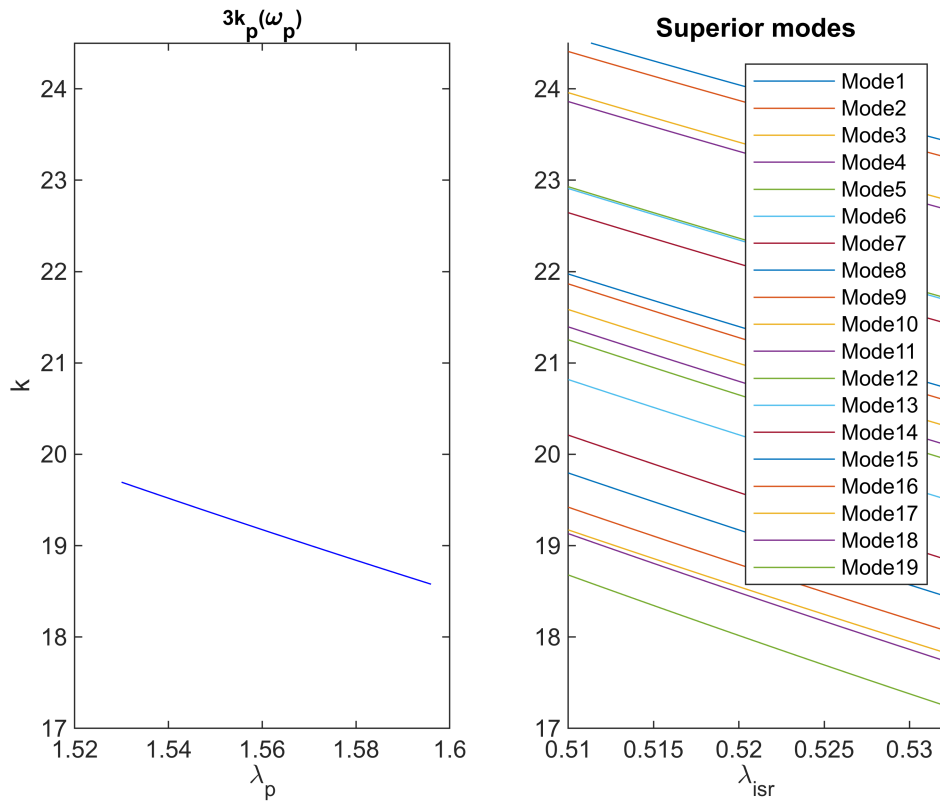
```
file = sprintf(Fundamental,sXs(sel)*1000,sYs(sel)*1000);
load(FundamentalPath+file);
wgFundamental = waveguide(lambda,neff);
l = wgFundamental.lambdaData;
w = wgFundamental.omegaData;
neff = wgFundamental.neffData;
figure;
subplot(1,2,1)
plot(l,wgFundamental.kwFun(w).*3,'b');
leg = {};
title("3k_p(\omega_p)"); 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 15

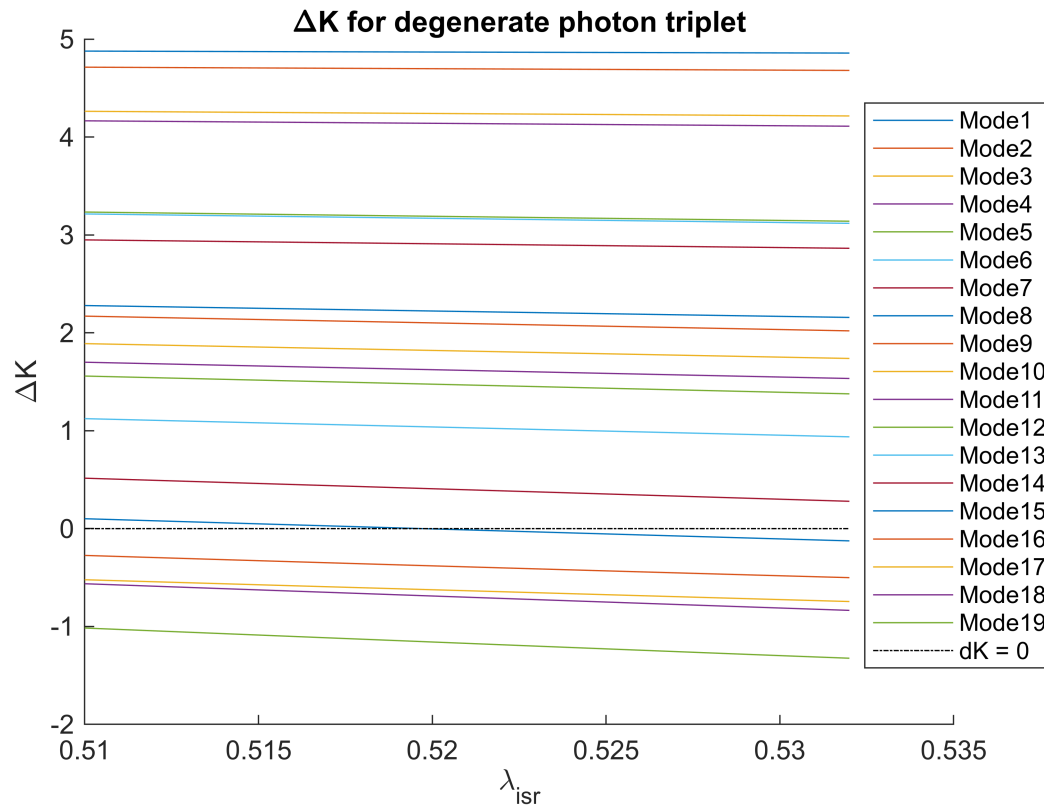
```

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 475x955 with $\lambda_i = 1.53$

