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 = 4;
nmodes = ModesSup(sel);
mode = 12;
disp("Selected waveguide:")
```

```
Selected waveguide:
```

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

```
   Size: 405x730
```

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

```
   Mode: 12
```

```

```

Waveguide Summary:

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

```
Waveguide: 405x405, mode: 12
```

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(λ):
```

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

```
-0.000032618120069393180993251591*l.^30+0.00016018385044980201965293675 8*l.^29-0.000165516382843027400149221728*l.^
```

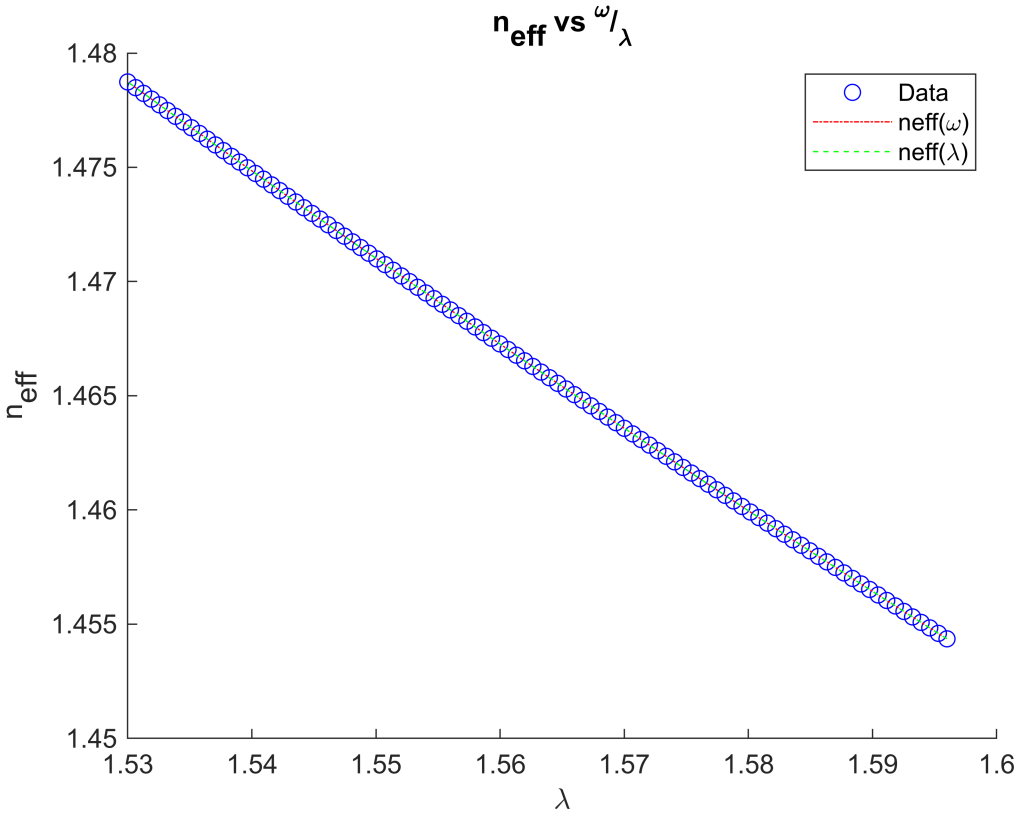
```
disp("Function neff(ω)");
```

```
Function neff(ω)
```

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

```
1.747346577041554230953220300498e-271*w.^30-7.662539294564936012074625087400e-262*w.^29+8.257018736675902781497804 71
```

```
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
```



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

```
disp("Function k(ω):");
```

```
Function k(ω):
```

```
disp(wgFundamental.kwStr);
```

```
w.*(1.747346577041554230953220300498e-271*w.^30-7.662539294564936012074625087400e-262*w.^29+8.257018736675902781497
```

```
disp("Function dk(ω)/dω:");
```

```
Function dk(ω)/dω:
```

```
disp(wgFundamental.dkwdwStr);
```

```
(1.747346577041554230953220300498e-271*w.^30*(31)-7.662539294564936012074625087400e-262*w.^29*(30)+8.25701873667590
```

```
disp("Function Vg(ω):");
```

```
Function Vg(ω):
```

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

```
(3*10^8)./(1.747346577041554230953220300498e-271*w.^30*(31)-7.662539294564936012074625087400e-262*w.^29*(30)+8.25701
```

```
disp("Function d2k(ω)/dω:");
```

```
Function d2k(ω)/dω:
```

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

```
(1.747346577041554230953220300498e-271*w.^29*(930)-7.662539294564936012074625087400e-262*w.^28*(870)+8.257018736675
```

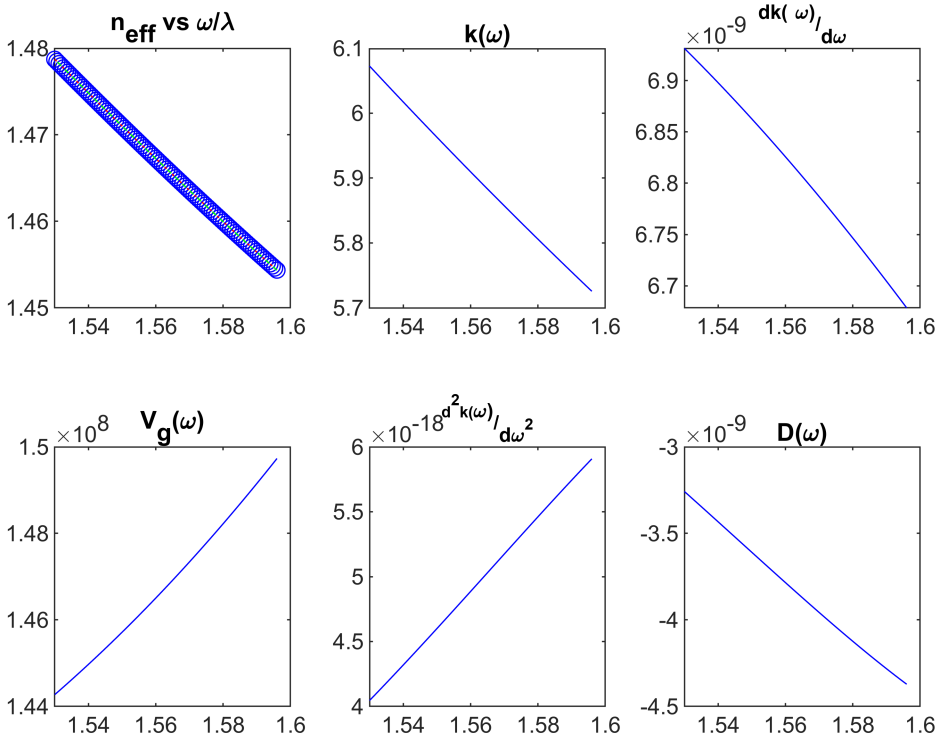
```
disp("Function D(ω):");
```

```
Function D(ω):
```

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

```
-(w.^2/(2*pi*3*10^8)).*((1.747346577041554230953220300498e-271*w.^29*(930)-7.662539294564936012074625087400e-262*w.
```

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



Superior Mode Data (530nm):

```
file = sprintf(Superior,sXs(sel),sYs(sel),ModesSup(sel));
load(SuperiorPath+file);
wgSuperior = waveguide(lambda,neff);
l = wgSuperior.lambdaData;
w = wgSuperior.omegaData;
neff = wgSuperior.neffData;
```

Ranges:

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

```
Lambda Ranges: 0.51-0.532
```

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

```
Omega Ranges: 3543149609.3118-3695991357.1645
```

Neff vs ω/λ

```
disp("Function neff(λ):");
```

```
Function neff(λ):
```

```
disp(wgSuperior.nefflStr);
```

```
-5742622197979.337890625000000000000000000000*l.^30+171800007180 23.595703125000000000000000000000*l.^29-19817629871
```

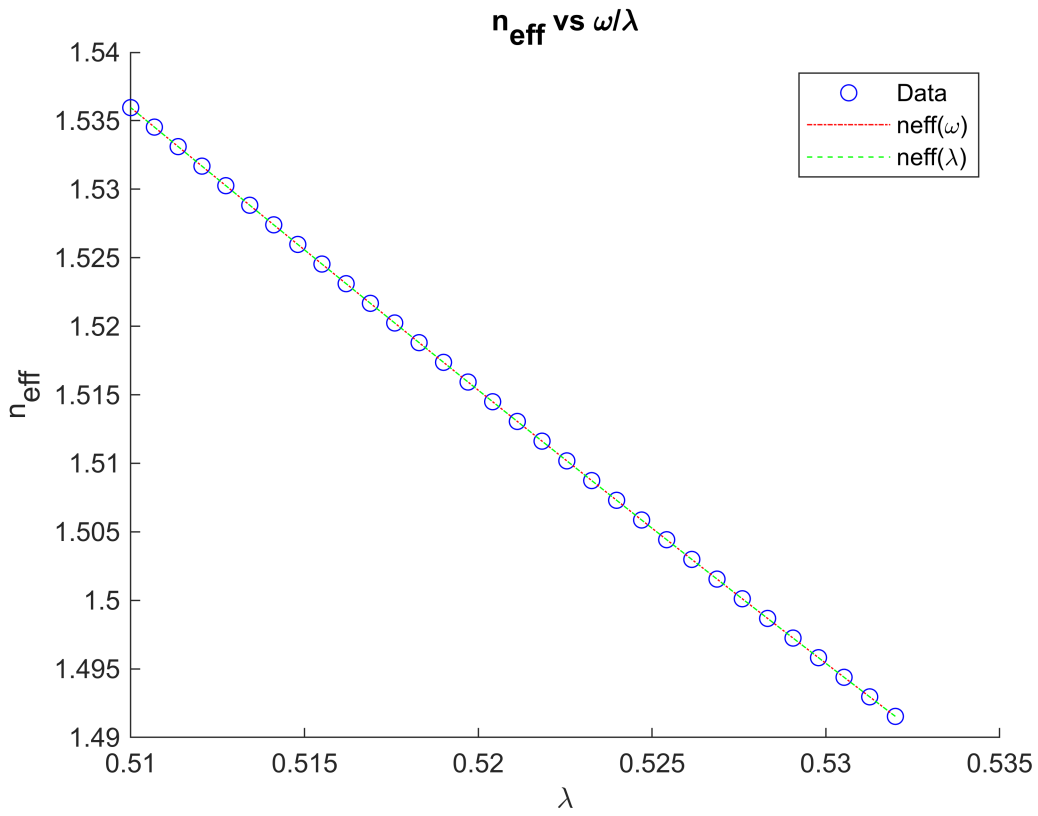
```
disp("Function neff(ω):");
```

```
Function neff(ω):
```

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

```
8.37202700942782282480165330285 7e-283*w.^30-8.7753379570191592964774100245 64e-273*w.^29+2.7332871505694742104750348 9
```

```
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(ω):");
```

```
Function k(ω):
```

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

```
w.*(8.37202700942782282480165330285 7e-283*w.^30-8.7753379570191592964774100245 64e-273*w.^29+2.733287150569474210475 0
```

```
disp("Function dk(ω)/dω:");
```

```
Function dk(ω)/dω:
```

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

```
(8.372027009427822824801653302857e-283*w.^30*(31)-8.77533795701915929647741002456 4e-273*w.^29*(30)+2.73328715056947
```

```
disp("Function Vg(ω):");
```

```
Function Vg(ω):
```

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

```
(3*10^8)./(8.372027009427822824801653302857e-283*w.^30*(31)-8.77533795701915929647741002456 4e-273*w.^29*(30)+2.73328
```

```
disp("Function d2k(ω)/dω2:");
```

```
Function d2k(ω)/dω2:
```

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

```
(8.372027009427822824801653302857e-283*w.^29*(930)-8.77533795701915929647741002456 4e-273*w.^28*(870)+2.73328715056944
```

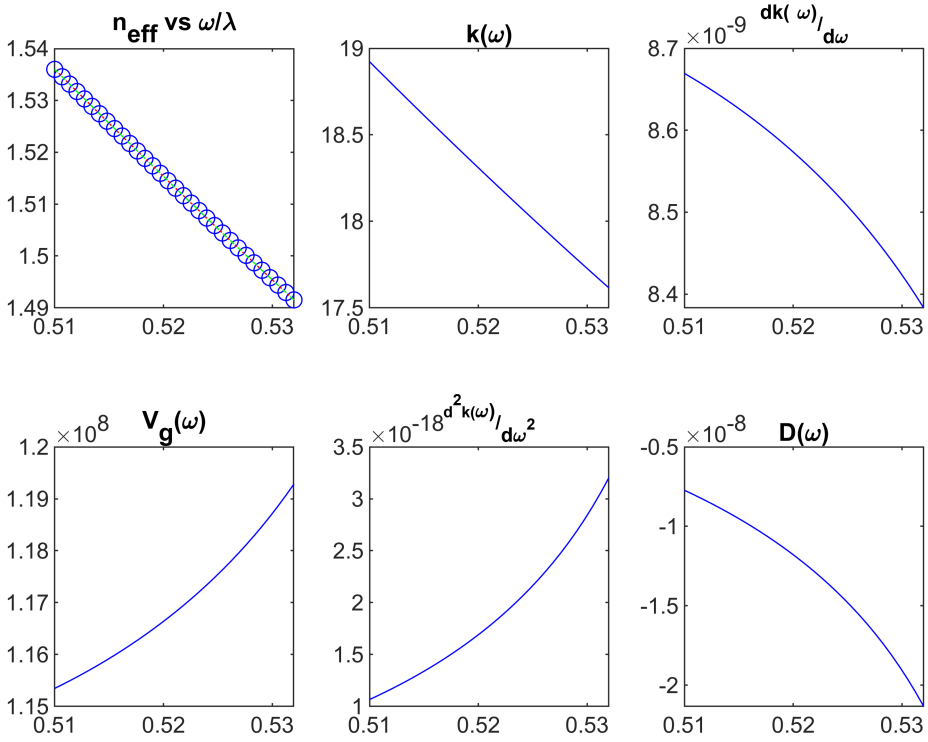
```
disp("Function D(ω):");
```

```
Function D(ω):
```

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

```
-(w.^2/(2*pi*3*10^8)).*((8.372027009427822824801653302857e-283*w.^29*(930)-8.77533795701915929647741002456 4e-273*w.^
```

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



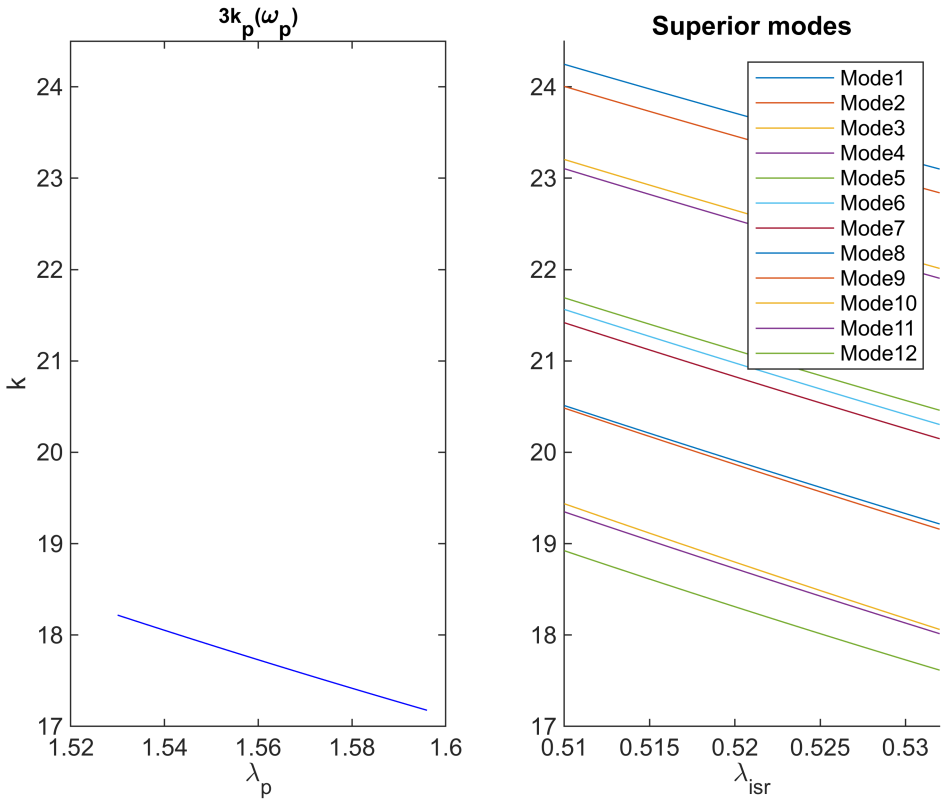
Load Waveguide Simple:

```
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
```



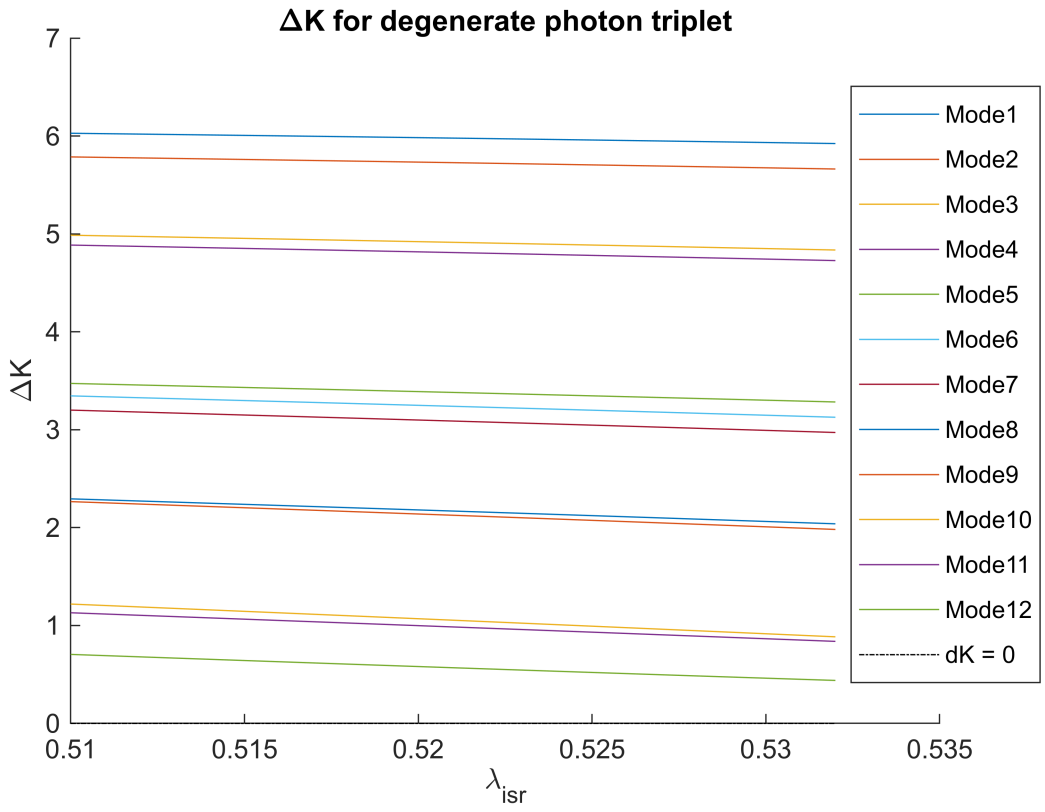
Find degenerate photon that allow momentum and energy conservation

```
size=50;

lphLim = [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)
```

```
Ningun modo con dK=0
```

```
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);

lphLim = [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.kw
    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))
```