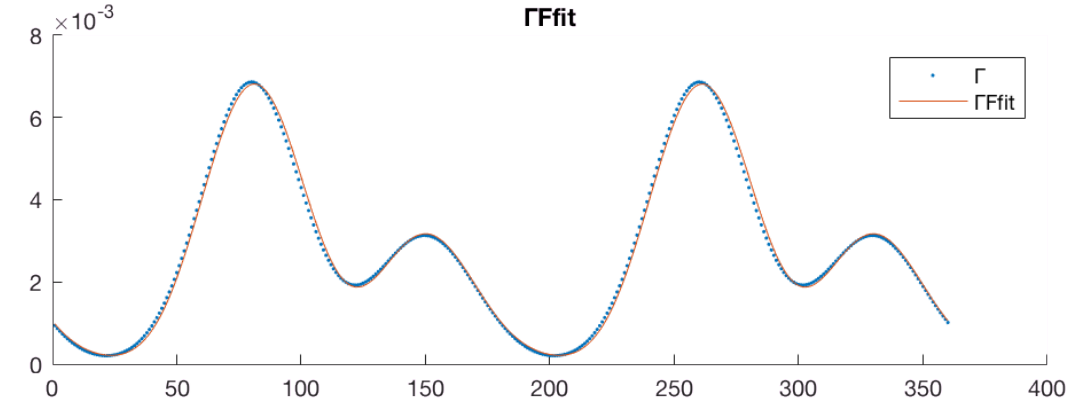
2D Fourier Series to Structural Tensor

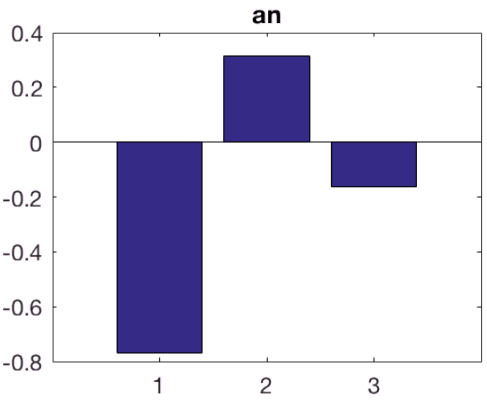
Data Generation

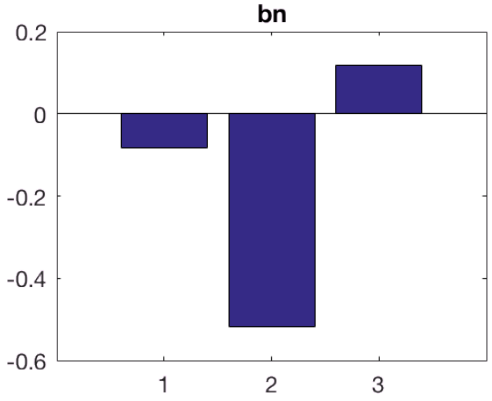
```
warning off
clear all
close all
clc

theta_full = 1:1:360;
data_raw1 = [27 33 40 48 58 70 84 101 121 144 171 203 240 283 333 392 459 537 626 728 845 978
data_raw2 = data_raw1;
data_raw2 = circshift(data_raw2',70)'/2.2;
data_raw = data_raw1 + data_raw2;
gamma = data_raw/sum(data_raw);
```

Fourier Series fit

```
fs_order = 6;
an = [];
bn = [];
for n = 2:2:(fs_order)
   an = [an compute_an(n, gamma, 2:360)];
   bn = [bn compute_bn(n, gamma, 2:360)];
end

gamma_Ffit = evalFourier(an, bn, 1, 1:360);
gamma_Ffit=gamma_Ffit/sum(gamma_Ffit); %% This is weird

figure
subplot(2,2,1:2)
hold on
plot(1:360,gamma,'.')
plot(1:360,gamma_Ffit)
legend('show','Γ','ΓFfit'); title('Fourier Series Fit');
hold off

title('ΓFfit');
subplot(2,2,3); bar(an); title('an');
subplot(2,2,4); bar(bn); title('bn');
```



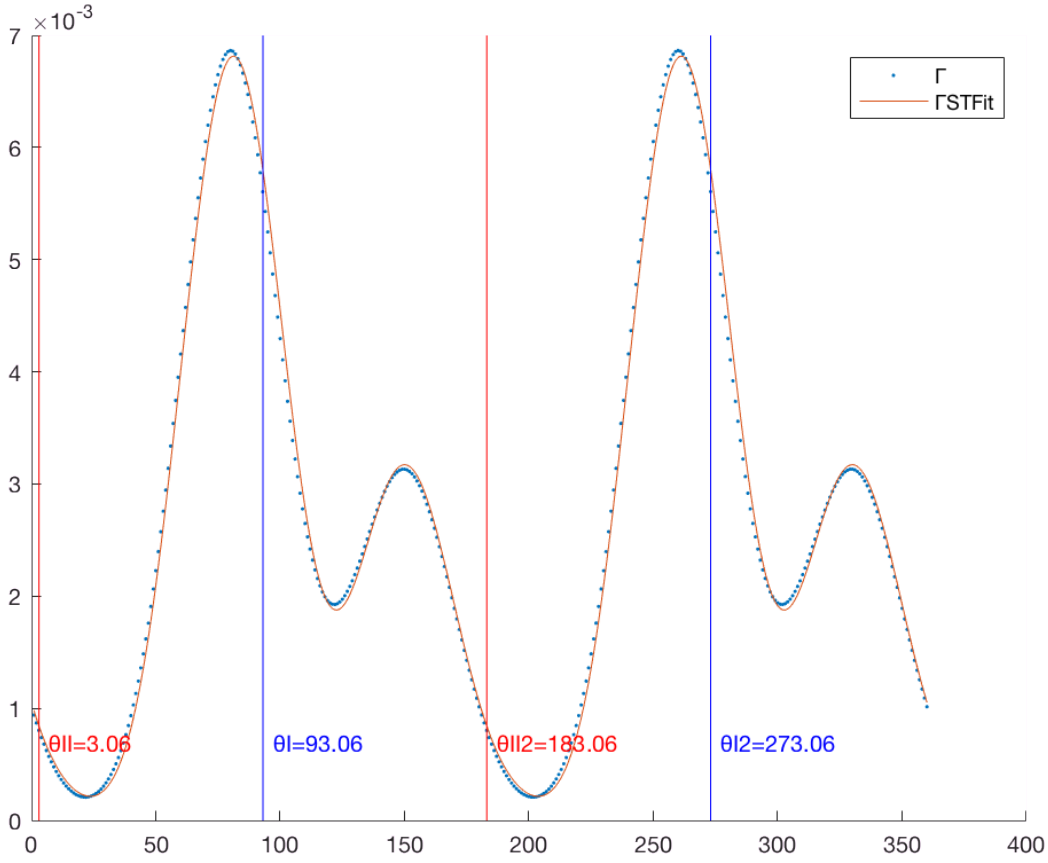




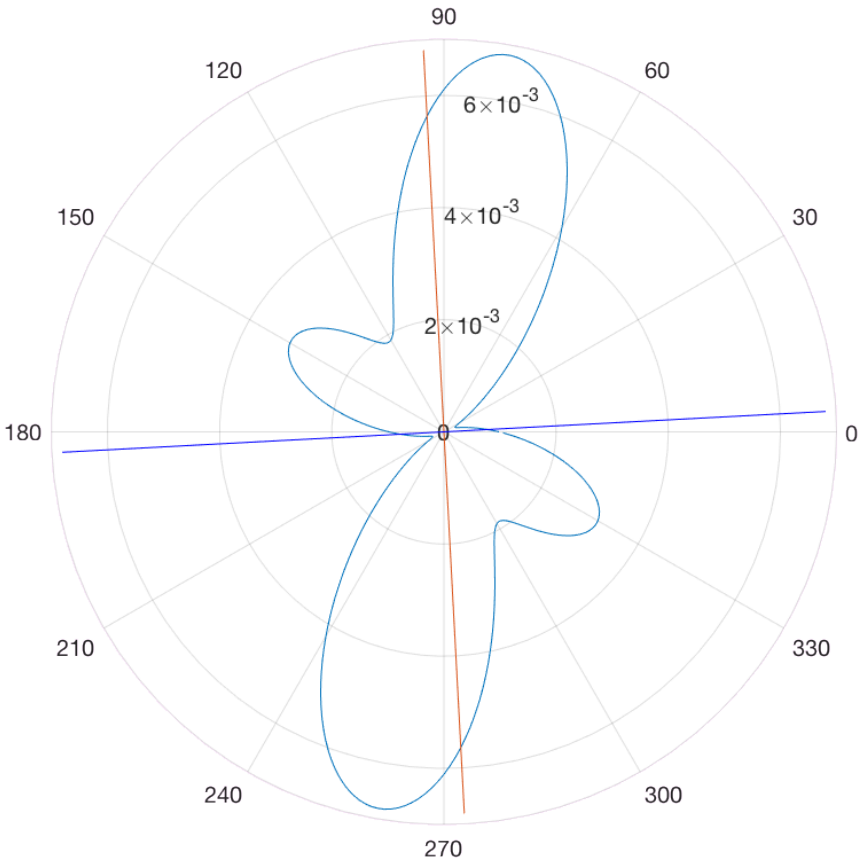
Inspection of STFit and θ derived from Dij

```
D = GenerateTensors(an,bn);
gamma_STFit = evalGammaST(D,1:360);
gamma_STFit = gamma_STFit/sum(gamma_STFit);

D_ij = D{1};
[v, d] = eig(D_ij);
theta1 = atan(v(2,1)/v(1,1)) * (180/pi) + 90;
theta2 = atan(v(2,2)/v(1,2)) * (180/pi) + 90;
```

```
figure
hold on
plot(1:360,gamma,'.');plot(1:360,gamma_STFit);
vline(theta1,'b', sprintf('θI=%.2f',theta1)); vline(theta1+180,'b', sprintf('θI2=%.2f',theta1+180
vline(theta2,'r', sprintf('θII=%.2f',theta2)); vline(theta2+180,'r', sprintf('θII2=%.2f',theta2+18
legend('show','Γ','ΓSTFit')
hold off
```

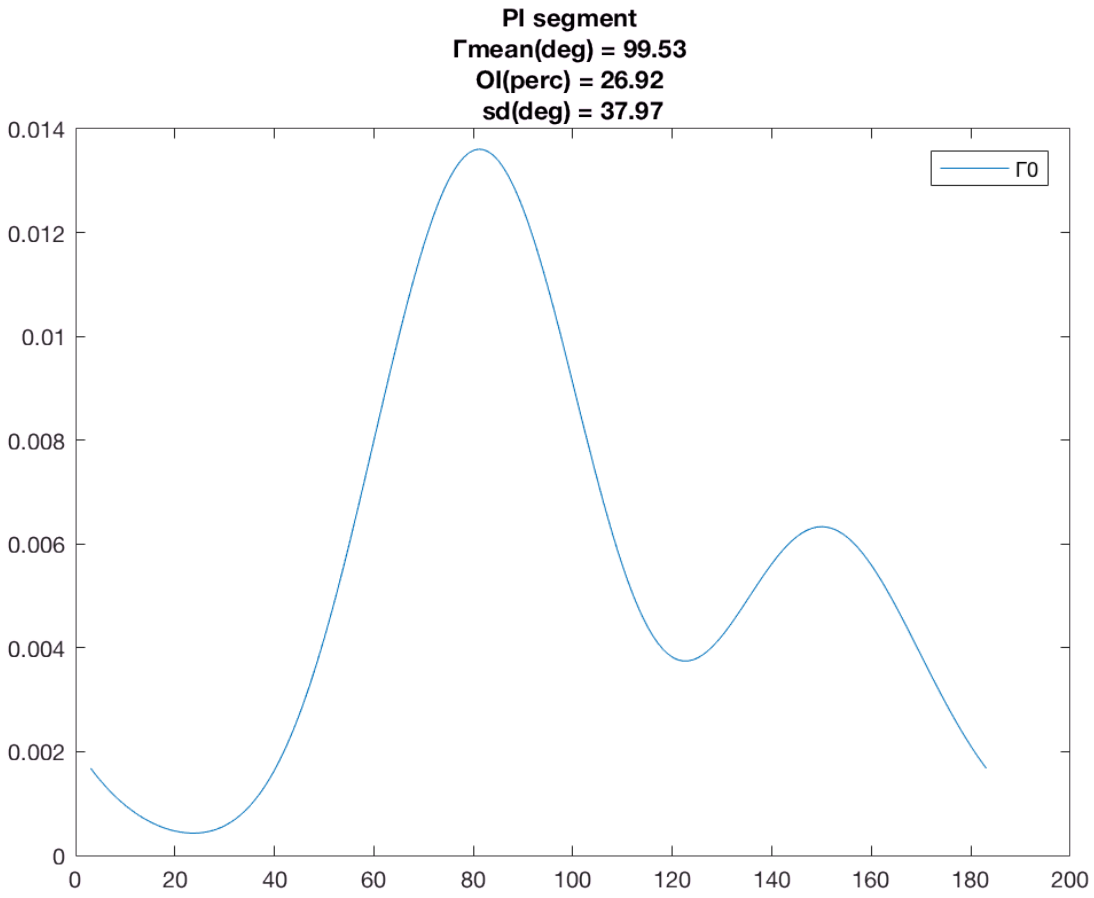



```
figure
polarplot(0:pi/180:(2*pi-pi/180), gamma_STFit)
hold on
rho=[-max(gamma_STFit) max(gamma_STFit)];
theta=[theta1*pi/180 theta1*pi/180];
polarplot(theta,rho);
theta=[theta2*pi/180 theta2*pi/180];
polarplot(theta,rho,'b');
hold off
```



PI segment stats

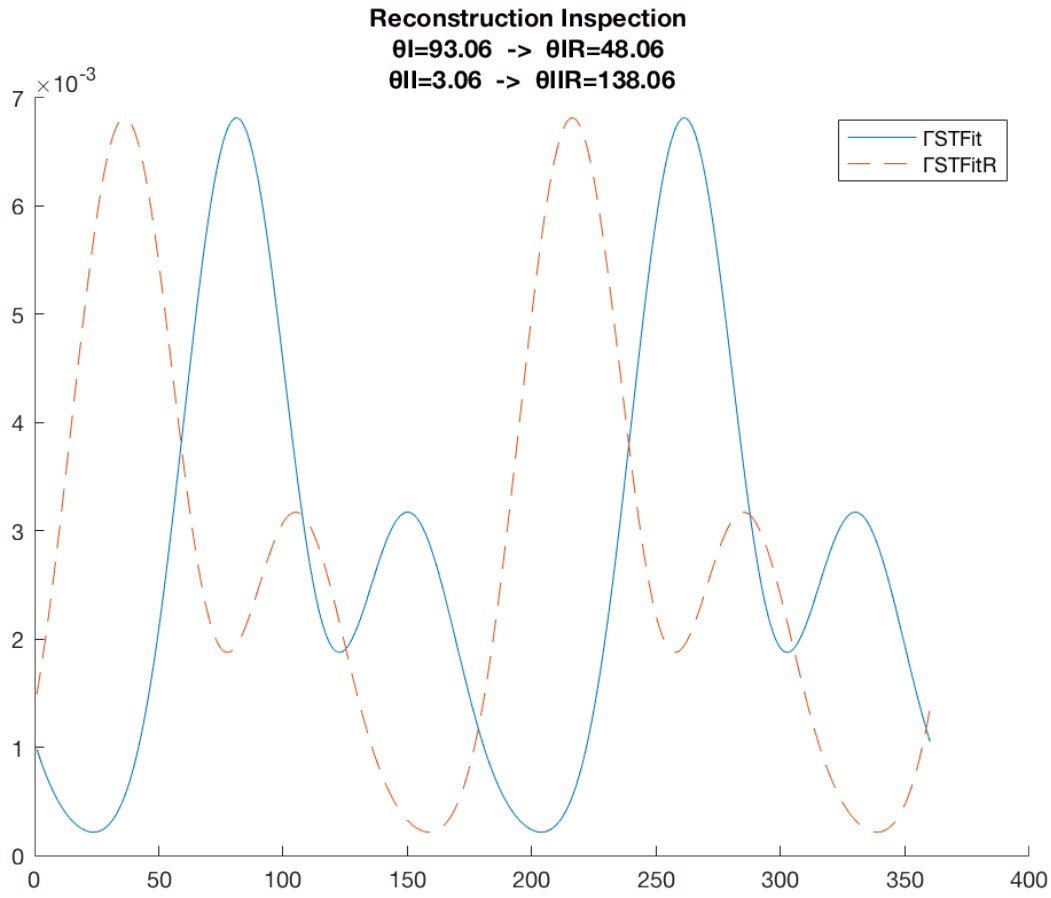
```
piSeg = theta2:1:(theta2+180);
gamma_Ffit_pi = evalFourier(an, bn, 2, piSeg);
gamma_Ffit_pi=gamma_Ffit_pi/sum(gamma_Ffit_pi); %% This is weird

mean = compute_mean(gamma_Ffit_pi, piSeg);
var = compute_var(gamma_Ffit_pi, piSeg, mean);
sd = sqrt(var);
syms x
sdMax = double(sqrt((1/180) * int(x^2, x, -90, 90)));
OI = 100*(1-sd/sdMax);

figure
plot(piSeg,gamma_Ffit_pi)
legend('show','Γ0','ΓFfit'); title(sprintf('PI segment \nΓmean(deg) = %.2f \nOI(perc) = %.2f \nsd(de
```



Compute Tensors in new Coordinate system

```
thetaR = 45;
Q = [cosd(thetaR) sind(thetaR); -sind(thetaR) cosd(thetaR)];
for i = 1:length(D)
    D_R{i} = rotateTensor(D{i}, i*2, Q);
end
gamma_STFitR = evalGammaST(D_R,1:360);
gamma_STFitR = gamma_STFitR/sum(gamma_STFitR);
```

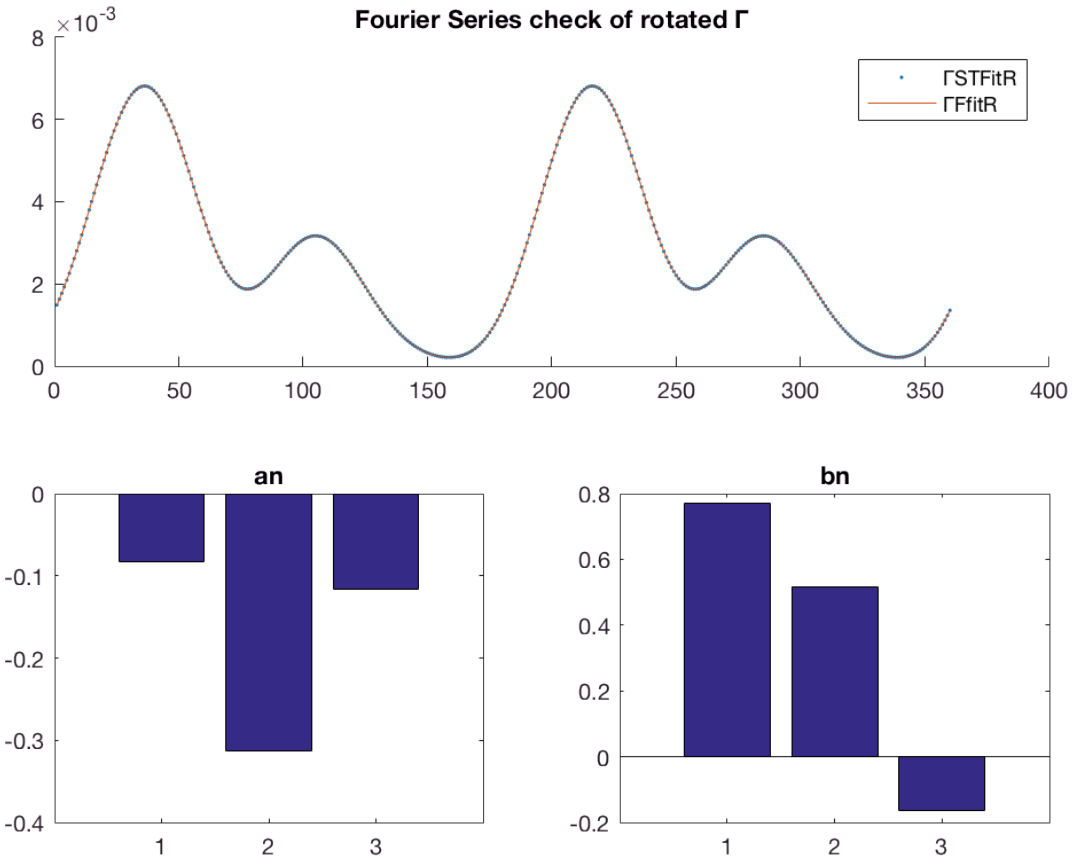
```
D_ij = D_R{1};
[v, d] = eig(D_ij);
theta1R = atan(v(2,1)/v(1,1)) * (180/pi) + 90;
theta2R = atan(v(2,2)/v(1,2)) * (180/pi) + 90;

figure
hold on
plot(1:360,gamma_STFit)
plot(1:360,gamma_STFitR,'--')
legend('show','ΓSTFit','ΓSTFitR')
title(sprintf('Reconstruction Inspection \nθI=%.2f  ->  θIR=%.2f \nθII=%.2f  ->  θIIR=%.2f',theta1
hold off
```



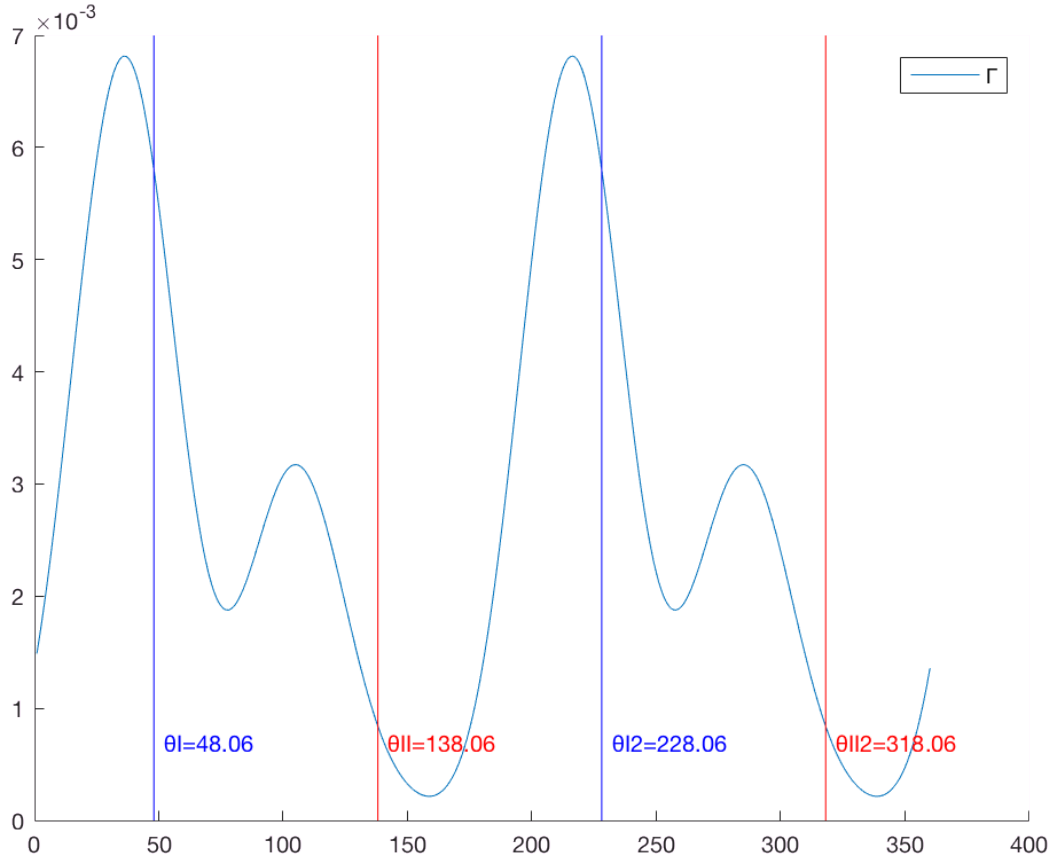
Fourier Series check of rotated \Gamma

```
coeffs_R = ComputeCoefficientsFromTensors(D_R);

an = coeffs_R(1:2:length(coeffs_R));
bn = coeffs_R(2:2:length(coeffs_R));

gamma_Ffit_R = evalFourier(an,bn,1,1:360);
gamma_Ffit_R = gamma_Ffit_R/sum(gamma_Ffit_R);
```

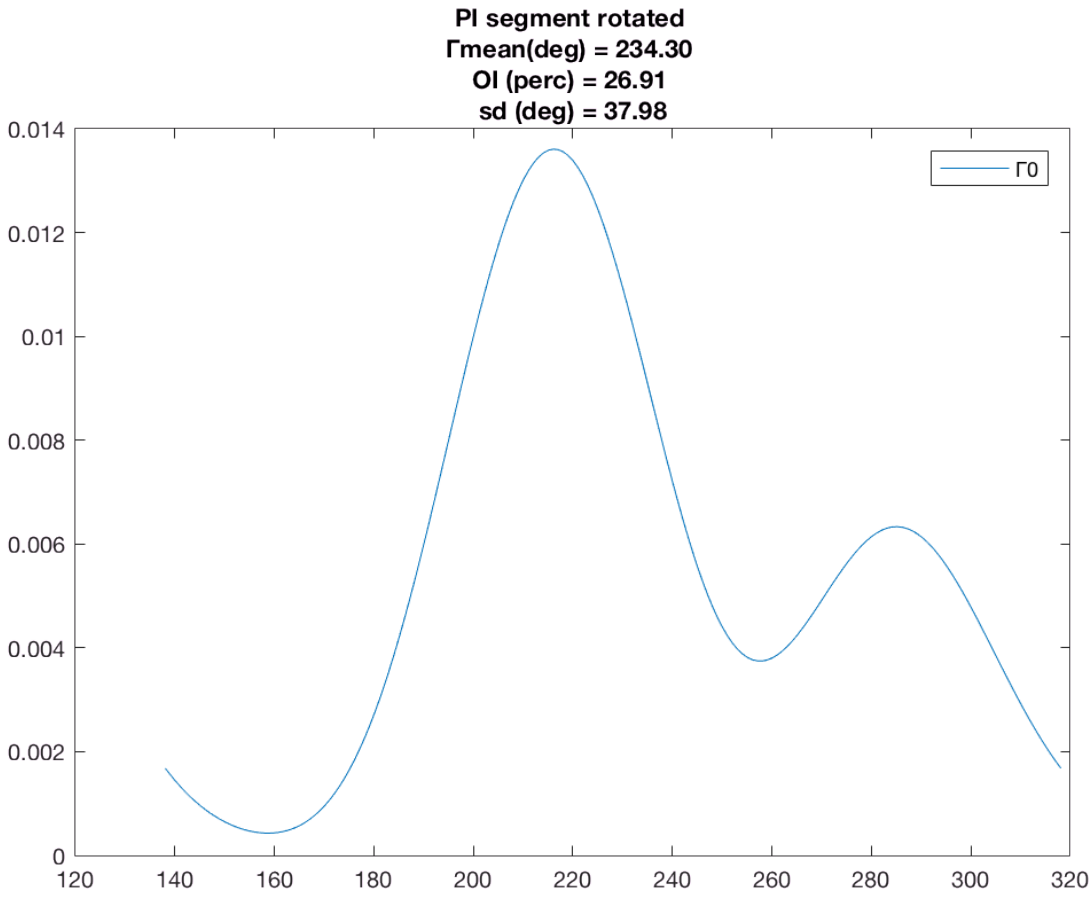
```
figure
subplot(2,2,1:2)
hold on
plot(1:360,gamma_STFitR,'.')
plot(1:360,gamma_Ffit_R)
legend('show','ΓSTFitR','ΓFfitR'); title('Fourier Series check of rotated Γ');
hold off

subplot(2,2,3); bar(an); title('an');
subplot(2,2,4); bar(bn); title('bn');
```




```
figure
hold on
plot(1:360,gamma_STFitR);
vline(theta1R,'b', sprintf('θI=%.2f',theta1R)); vline(theta1R+180,'b', sprintf('θI2=%.2f',theta1R
vline(theta2R,'r', sprintf('θII=%.2f',theta2R)); vline(theta2R+180,'r', sprintf('θII2=%.2f',theta2
legend('show','Γ','ΓSTFitR')
hold off
```




```
piSeg = theta2R:1:(theta2R+180);
gamma_Ffit_pi_R = evalFourier(an, bn, 2, piSeg);
gamma_Ffit_pi_R=gamma_Ffit_pi_R/sum(gamma_Ffit_pi_R); %% This is weird

mean = compute_mean(gamma_Ffit_pi_R, piSeg);
var = compute_var(gamma_Ffit_pi_R, piSeg, mean);
sd = sqrt(var);
syms x
sdMax = double(sqrt((1/180) * int(x^2, x, -90, 90)));
OI = 100*(1-sd/sdMax);

figure
plot(piSeg,gamma_Ffit_pi_R)
legend('show','ΓO','ΓFfit'); title(sprintf('PI segment rotated \nΓmean(deg) = %.2f \nOI (perc) = %.2
```


PI segment rotated
Γmean(deg) = 234.30
OI (perc) = 26.91
sd (deg) = 37.98
Γ0
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
120
140
160
180
200
220
240
260
280
300
320