In this notebook we try to find an obvious manifestation of Rydberb blockade.

Some definitions

```
Sn[N_, S_] := N * S^N / N! * Exp[-S]
Sbin[N0_, N_, S_] := N * (S / N0) ^N * (1 - S / N0) ^ (N0 - N) * N0 ! / (N ! * (N0 - N) !)
L[A_, Γ_, t0_] := A / (1 + Γ (t - t0) ^2)
G[A_, σ_, t0_] := A / (2 Pi σ) * Exp[- (t - t0) ^2 / (2 σ^2)]
```

Cooking data

Importation of the two files: Forster resonance ON and Forster OFF

Reading the files

```
col = 1 ;(*color selection*)
A25 = Import["A25.tsv"]; A26 = Import["A26.tsv"];
```

Parsing the files. We consider the sum of signal on channel P and S, as suggested by Igor

```
i = 1; f = 200;
SS = A25[[i ;; f, 12]] + A25[[i ;; f, 18]];
S1 = A25[[i ;; f, 7]] + A25[[i ;; f, 13]];
S2 = A25[[i ;; f, 8]] + A25[[i ;; f, 14]];
S3 = A25[[i ;; f, 9]] + A25[[i ;; f, 15]];
S4 = A25[[i ;; f, 10]] + A25[[i ;; f, 16]];
S5 = A25[[i ;; f, 11]] + A25[[i ;; f, 17]];

SSn = A26[[i ;; f, 12]] + A26[[i ;; f, 18]];
S1n = A26[[i ;; f, 7]] + A26[[i ;; f, 13]];
S2n = A26[[i ;; f, 8]] + A26[[i ;; f, 14]];
S3n = A26[[i ;; f, 9]] + A26[[i ;; f, 15]];
S4n = A26[[i ;; f, 10]] + A26[[i ;; f, 16]];
S5n = A26[[i ;; f, 11]] + A26[[i ;; f, 17]];
```

Creating the graphs for each number of atoms

```
GSS = ListPlot[SS, Joined → True, PlotStyle → ColorData[col, "ColorList"][[2]]];
GS1 = ListPlot[S1, Joined → True, PlotStyle → ColorData[col, "ColorList"][[3]]];
GS2 = ListPlot[S2, Joined → True, PlotStyle → ColorData[col, "ColorList"][[4]]];
GS3 = ListPlot[S3, Joined → True, PlotStyle → ColorData[col, "ColorList"][[5]]];
GS4 = ListPlot[S4, Joined → True, PlotStyle → ColorData[col, "ColorList"][[6]]];
GS5 = ListPlot[S5, Joined → True, PlotStyle → ColorData[col, "ColorList"][[7]]];

GSSn = ListPlot[SSn, Joined → True, PlotStyle → ColorData[col, "ColorList"][[2]]];
GS1n = ListPlot[S1n, Joined → True, PlotStyle → ColorData[col, "ColorList"][[3]]];
GS2n = ListPlot[S2n, Joined → True, PlotStyle → ColorData[col, "ColorList"][[4]]];
GS3n = ListPlot[S3n, Joined → True, PlotStyle → ColorData[col, "ColorList"][[5]]];
GS4n = ListPlot[S4n, Joined → True, PlotStyle → ColorData[col, "ColorList"][[6]]];
GS5n = ListPlot[S5n, Joined → True, PlotStyle → ColorData[col, "ColorList"][[7]]];
```

Analysis of the data

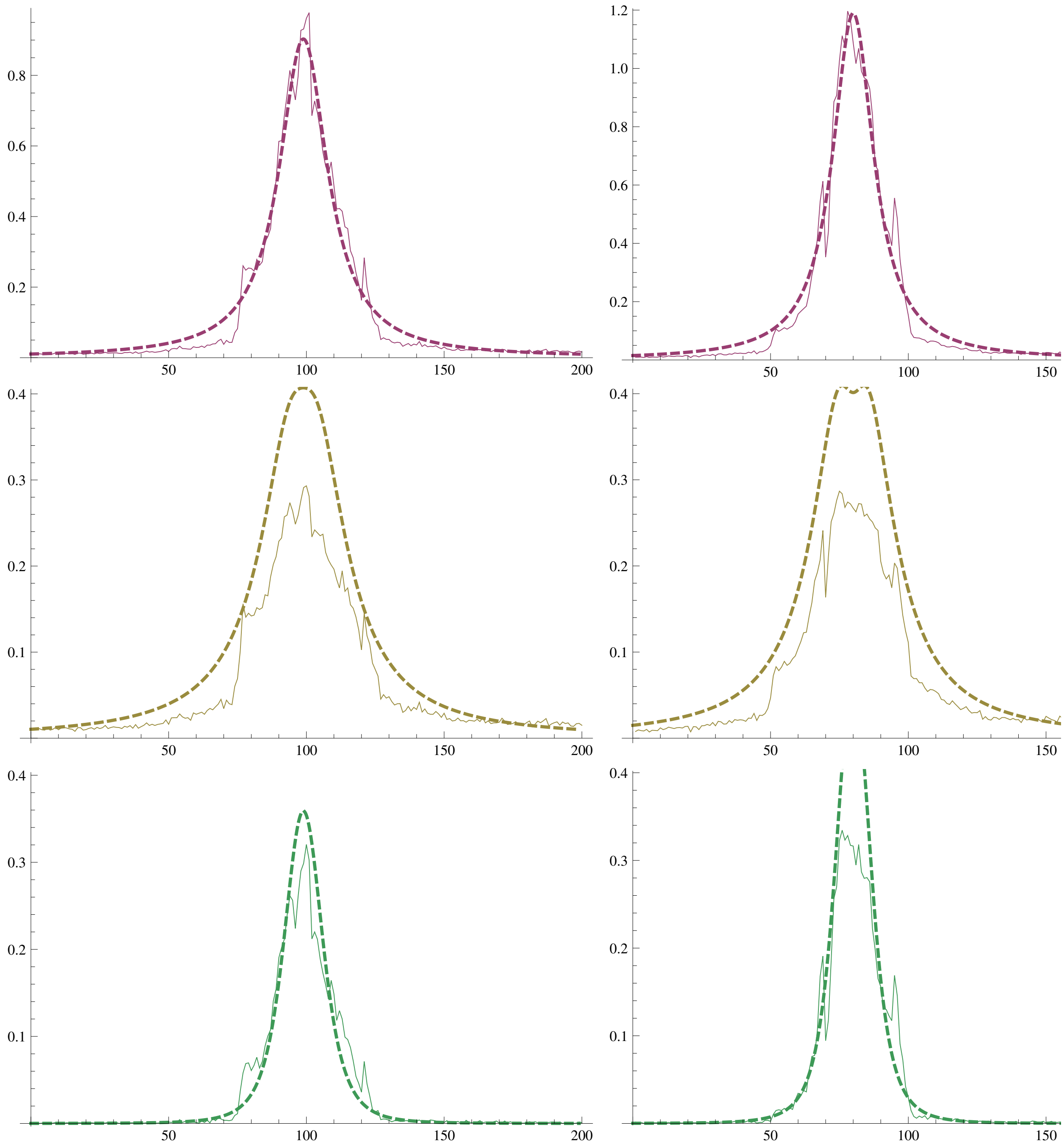
Fitting the total signal on a Lorentzian

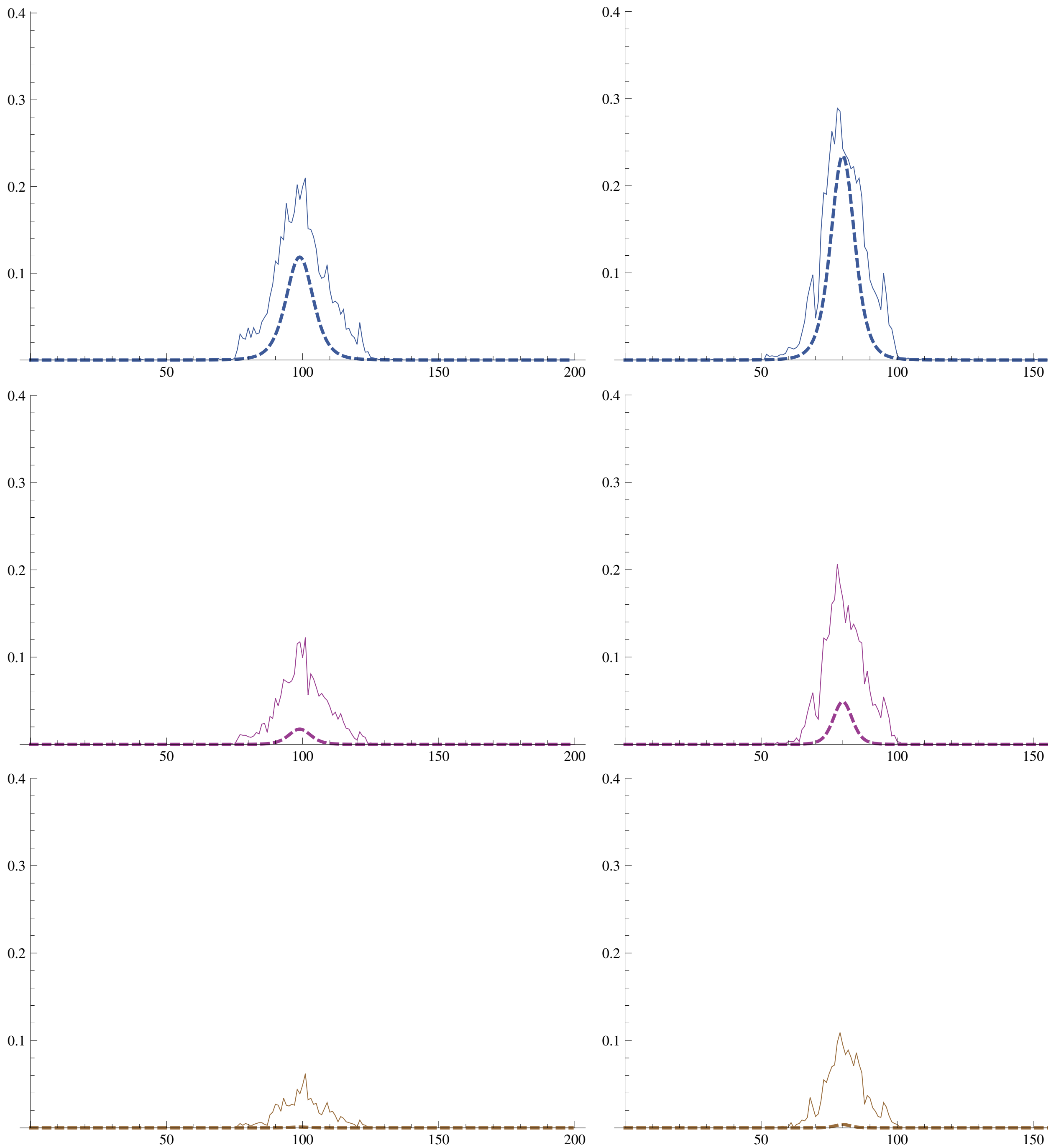
```
FSS = FindFit[SS, L[A, Γ, t0], {A, Γ, t0}, t, MaxIterations → 10 000]
FSSn = FindFit[SSn, L[A, Γ, t0], {A, Γ, t0}, t, MaxIterations → 10 000]
(*FSS=FindFit[SS,G[A,Γ,t0],{A,Γ,t0},t,MaxIterations→10000]*)
(* There is no large profit using a gaussian instead of a lorentzian *)
```

```
{A → 0.903012, Γ → 0.00874229, t0 → 98.9096}

{A → 1.18862, Γ → 0.0121193, t0 → 79.9893}
```

Comparing the data with the rescaling of the total signal using the binomial distribution for each number of atom

```
N0 = 5;
(* We assume the total number of atoms in the interaction volume is N0=5 *)

GFSS = Plot[L[A, Γ, t0] /. FSS, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[2]], Thick, Dashed]];
GFS1 = Plot[Sbin[N0, 1, L[A, Γ, t0]] /. FSS, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[3]], Thick, Dashed]];
GFS2 = Plot[Sbin[N0, 2, L[A, Γ, t0]] /. FSS, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[4]], Thick, Dashed]];
GFS3 = Plot[Sbin[N0, 3, L[A, Γ, t0]] /. FSS, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[5]], Thick, Dashed]];
GFS4 = Plot[Sbin[N0, 4, L[A, Γ, t0]] /. FSS, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[6]], Thick, Dashed]];
GFS5 = Plot[Sbin[N0, 5, L[A, Γ, t0]] /. FSS, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[7]], Thick, Dashed]];

GFSSn = Plot[L[A, Γ, t0] /. FSSn, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[2]], Thick, Dashed]];
GFS1n = Plot[Sbin[N0, 1, L[A, Γ, t0]] /. FSSn, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[3]], Thick, Dashed]];
GFS2n = Plot[Sbin[N0, 2, L[A, Γ, t0]] /. FSSn, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[4]], Thick, Dashed]];
GFS3n = Plot[Sbin[N0, 3, L[A, Γ, t0]] /. FSSn, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[5]], Thick, Dashed]];
GFS4n = Plot[Sbin[N0, 4, L[A, Γ, t0]] /. FSSn, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[6]], Thick, Dashed]];
GFS5n = Plot[Sbin[N0, 5, L[A, Γ, t0]] /. FSSn, {t, 0, f - i}, PlotRange → All,
   PlotStyle → Directive[ColorData[col, "ColorList"][[7]], Thick, Dashed]];

Grid[Transpose[{{Show[GSS, GFSS, PlotRange → {0, Max[SS]}, ImageSize → Medium],
    Show[GS1, GFS1, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS2, GFS2, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS3, GFS3, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS4, GFS4, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS5, GFS5, PlotRange → {0, 0.4}, ImageSize → Medium]},
   {Show[GSSn, GFSSn, PlotRange → {0, Max[SSn]}, ImageSize → Medium],
    Show[GS1n, GFS1n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS2n, GFS2n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS3n, GFS3n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS4n, GFS4n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS5n, GFS5n, PlotRange → {0, 0.4}, ImageSize → Medium]}
  }]]
```

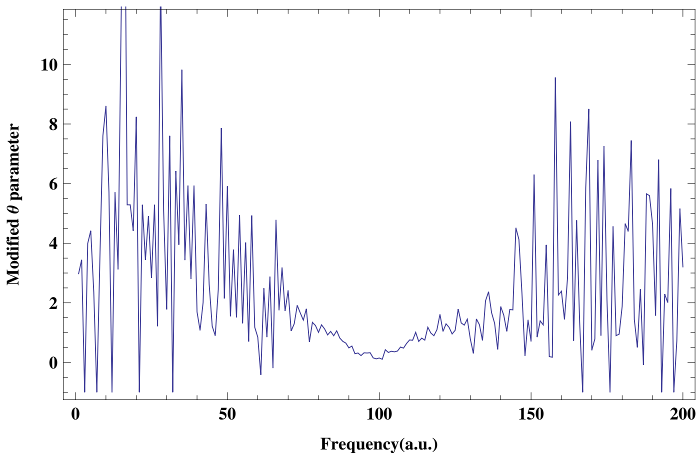

0.8
0.6
0.4
0.2
50
100
150
200
1.2
1.0
0.8
0.6
0.4
0.2
50
100
150
0.4
0.3
0.2
0.1
50
100
150
200
0.4
0.3
0.2
0.1
50
100
150
0.4
0.3
0.2
0.1
50
100
150
200
0.4
0.3
0.2
0.1
50
100
150



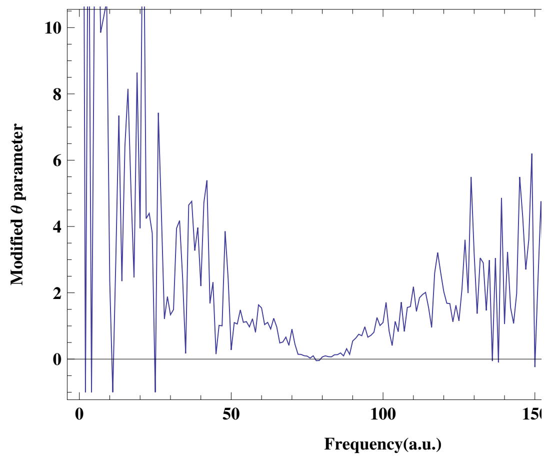
Plotting two Rydberg blockade criteria (these quantities should be always equal to zero)

```
Sbin[N0, 2, S] / Sbin[N0, 1, S] * (N0 - S) / (S * (N0 - 1)) - 1 // Simplify
(* first criterion: verification that this is really equal to zero *)
Grid[{{ListPlot[S2 / S1 * (N0 - SS) / (SS * (N0 - 1)) - 1,
    Joined → True, ImageSize → Medium, Frame → True,
    FrameLabel → {{"Modified θ parameter", None}, {"Frequency(a.u.)", None}},
    LabelStyle → Bold], ListPlot[S2n / S1n * (N0 - SSn) / (SSn * (N0 - 1)) - 1,
    Joined → True, ImageSize → Medium, Frame → True,
    FrameLabel → {{"Modified θ parameter", None}, {"Frequency(a.u.)", None}},
    LabelStyle → Bold]}, {"Forster ON", "Forster OFF"}}]
```

0



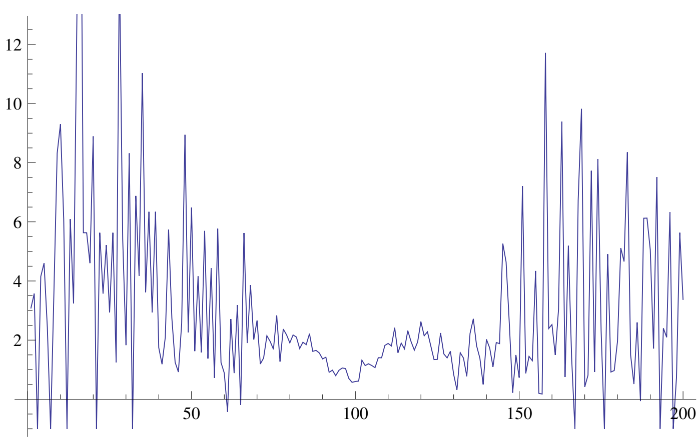
Forster ON



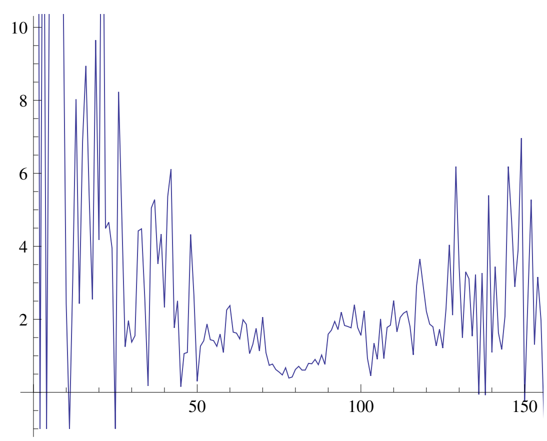
Forster OFF

```
Sbin[N0, 2, S] / Sbin[N0, 1, S]^2 * (1 - S / N0)^N0 / (1 - 1 / N0) - 1 // Simplify
(* second criterion: verification that this is really equal to zero *)
Grid[{{ListPlot[S2 / S1^2 * (1 - SS / N0)^N0 / (1 - 1 / N0) - 1, Joined → True,
    ImageSize → Medium], ListPlot[S2n / S1n^2 * (1 - SSn / N0)^N0 / (1 - 1 / N0) - 1,
    Joined → True, ImageSize → Medium]}, {"Forster ON", "Forster OFF"}}]
```

0



Forster ON



Forster OFF

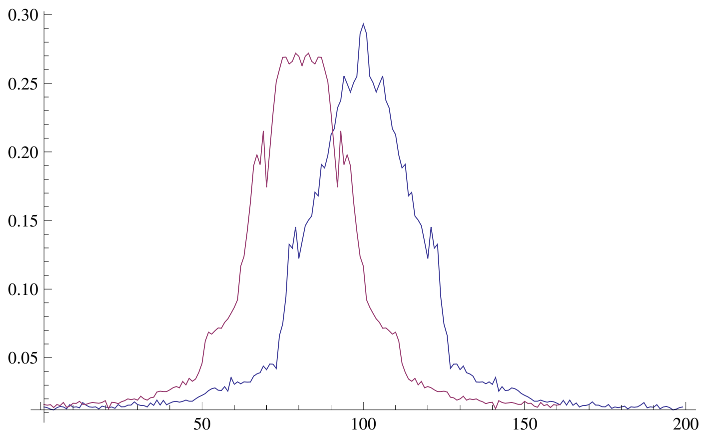
Dealing with mean data (taking the even and the odd parts of

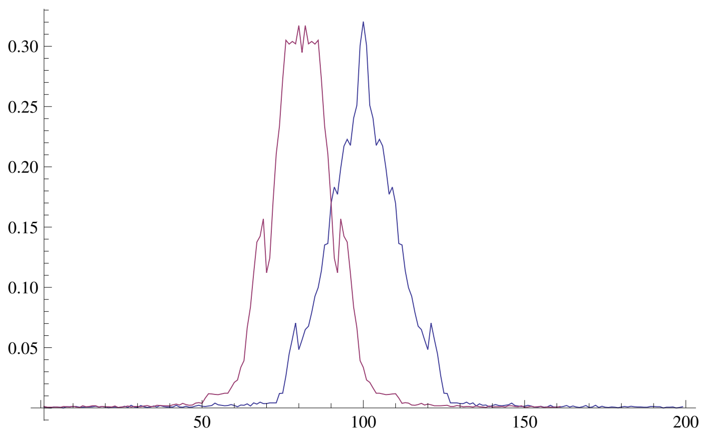
the spectra)

```
ff = 99 * 2 + 1; (* we have select the right size of the spectrum,
99 is the maximum*)
S1e = (S1[[i ;; ff]] + Reverse[S1[[i ;; ff]]]) / 2;
(*the even part is the sum of the original spectrum and the reversed spectrum*)
S2e = (S2[[i ;; ff]] + Reverse[S2[[i ;; ff]]]) / 2;
S3e = (S3[[i ;; ff]] + Reverse[S3[[i ;; ff]]]) / 2;
S4e = (S4[[i ;; ff]] + Reverse[S4[[i ;; ff]]]) / 2;
S5e = (S4[[i ;; ff]] + Reverse[S5[[i ;; ff]]]) / 2;
SSe = (SS[[i ;; ff]] + Reverse[SS[[i ;; ff]]]) / 2;

S1o = (S1[[i ;; ff]] - Reverse[S1[[i ;; ff]]]) / 2; (*the odd part is the
 difference between the original spectrum and the reversed spectrum*)
S2o = (S2[[i ;; ff]] - Reverse[S2[[i ;; ff]]]) / 2;
S3o = (S3[[i ;; ff]] - Reverse[S3[[i ;; ff]]]) / 2;
S4o = (S4[[i ;; ff]] - Reverse[S4[[i ;; ff]]]) / 2;
S5o = (S5[[i ;; ff]] - Reverse[S5[[i ;; ff]]]) / 2;
SSo = (SS[[i ;; ff]] - Reverse[SS[[i ;; ff]]]) / 2;

ffn = 80 * 2 + 1;
S1en = (S1n[[i ;; ffn]] + Reverse[S1n[[i ;; ffn]]]) / 2;
S2en = (S2n[[i ;; ffn]] + Reverse[S2n[[i ;; ffn]]]) / 2;
S3en = (S3n[[i ;; ffn]] + Reverse[S3n[[i ;; ffn]]]) / 2;
S4en = (S4n[[i ;; ffn]] + Reverse[S4n[[i ;; ffn]]]) / 2;
S5en = (S5n[[i ;; ffn]] + Reverse[S5n[[i ;; ffn]]]) / 2;
SSen = (SSn[[i ;; ffn]] + Reverse[SSn[[i ;; ffn]]]) / 2;

S1on = (S1n[[i ;; ffn]] - Reverse[S1n[[i ;; ffn]]]) / 2;
S2on = (S2n[[i ;; ffn]] - Reverse[S2n[[i ;; ffn]]]) / 2;
S3on = (S3n[[i ;; ffn]] - Reverse[S3n[[i ;; ffn]]]) / 2;
S4on = (S4n[[i ;; ffn]] - Reverse[S4n[[i ;; ffn]]]) / 2;
S5on = (S5n[[i ;; ffn]] - Reverse[S5n[[i ;; ffn]]]) / 2;
SSon = (SSn[[i ;; ffn]] - Reverse[SSn[[i ;; ffn]]]) / 2;
```

Plotting the even parts for 1 and 2 atoms (these graphs are even)

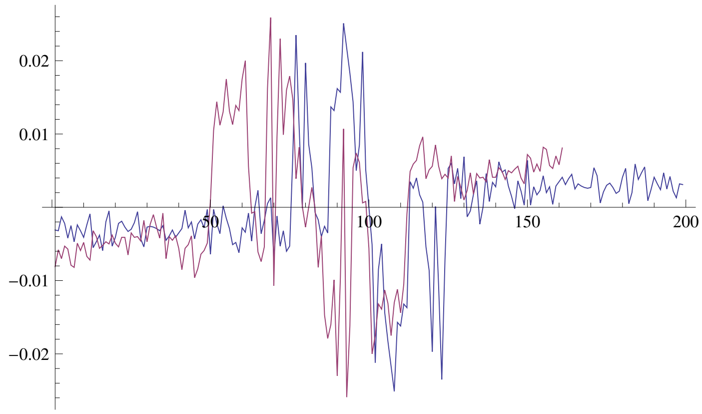
```
ListPlot[{S1e, S1en}, PlotRange → All, Joined → True]
ListPlot[{S2e, S2en}, PlotRange → All, Joined → True]
```

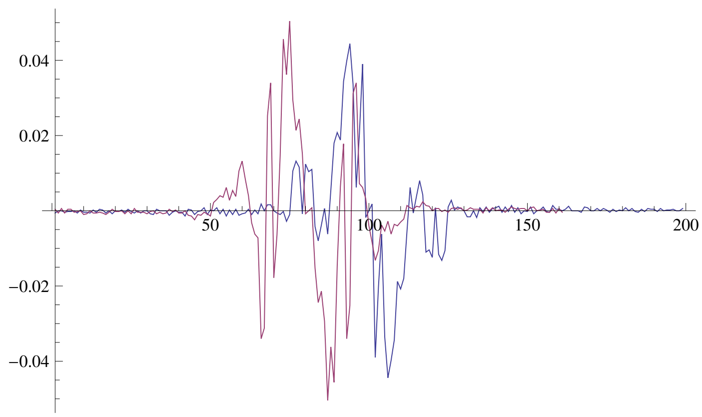




Plotting the odd part for 1 and 2 atoms (the graph must be null)

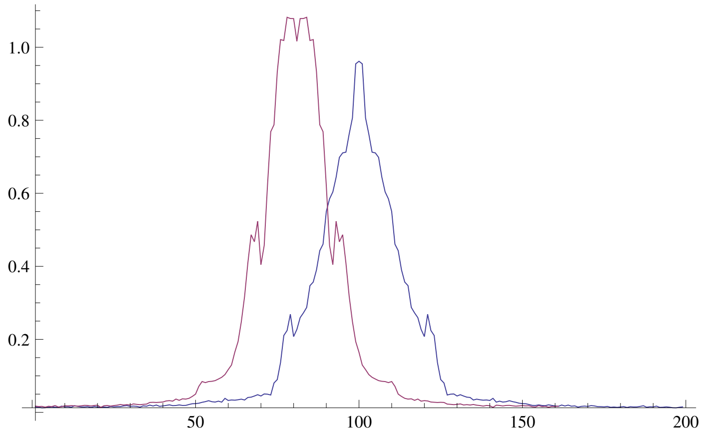
```
ListPlot[{S1o, S1on}, PlotRange → All, Joined → True]
ListPlot[{S2o, S2on}, PlotRange → All, Joined → True]
```

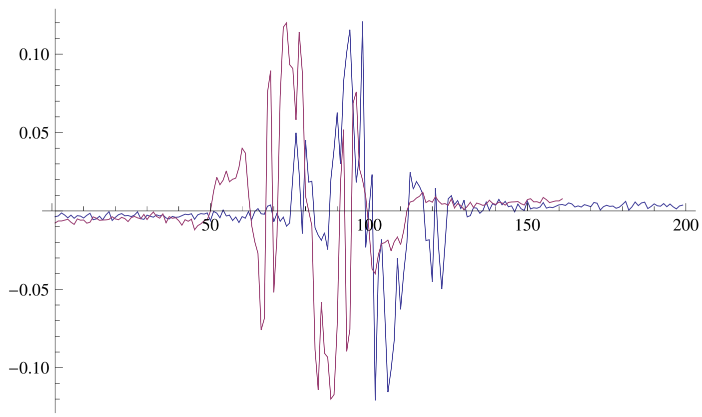




Plotting the even and the odd part for the total signal (Forester ON and OFF)

```
ListPlot[{SSe, SSen}, PlotRange → All, Joined → True]
ListPlot[{SSo, SSon}, PlotRange → All, Joined → True]
```

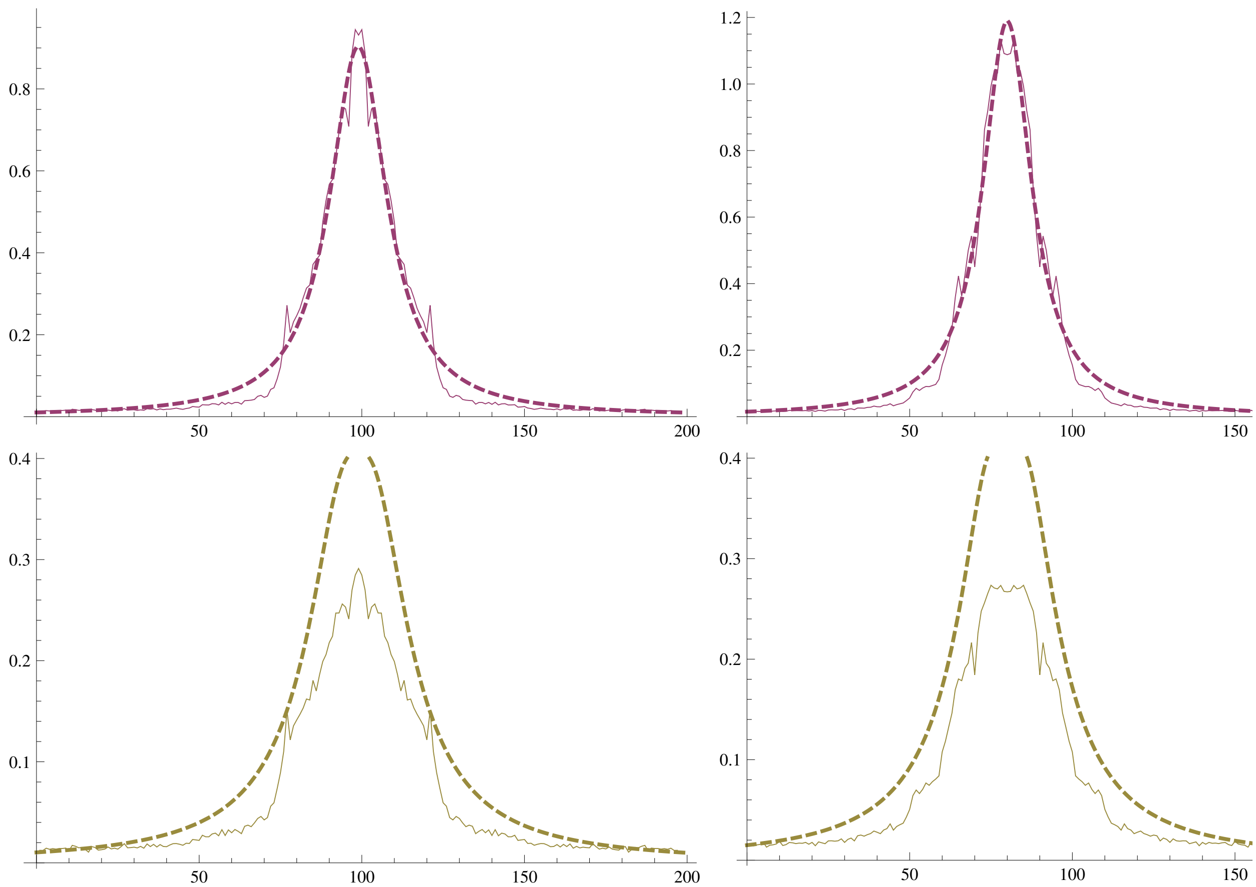


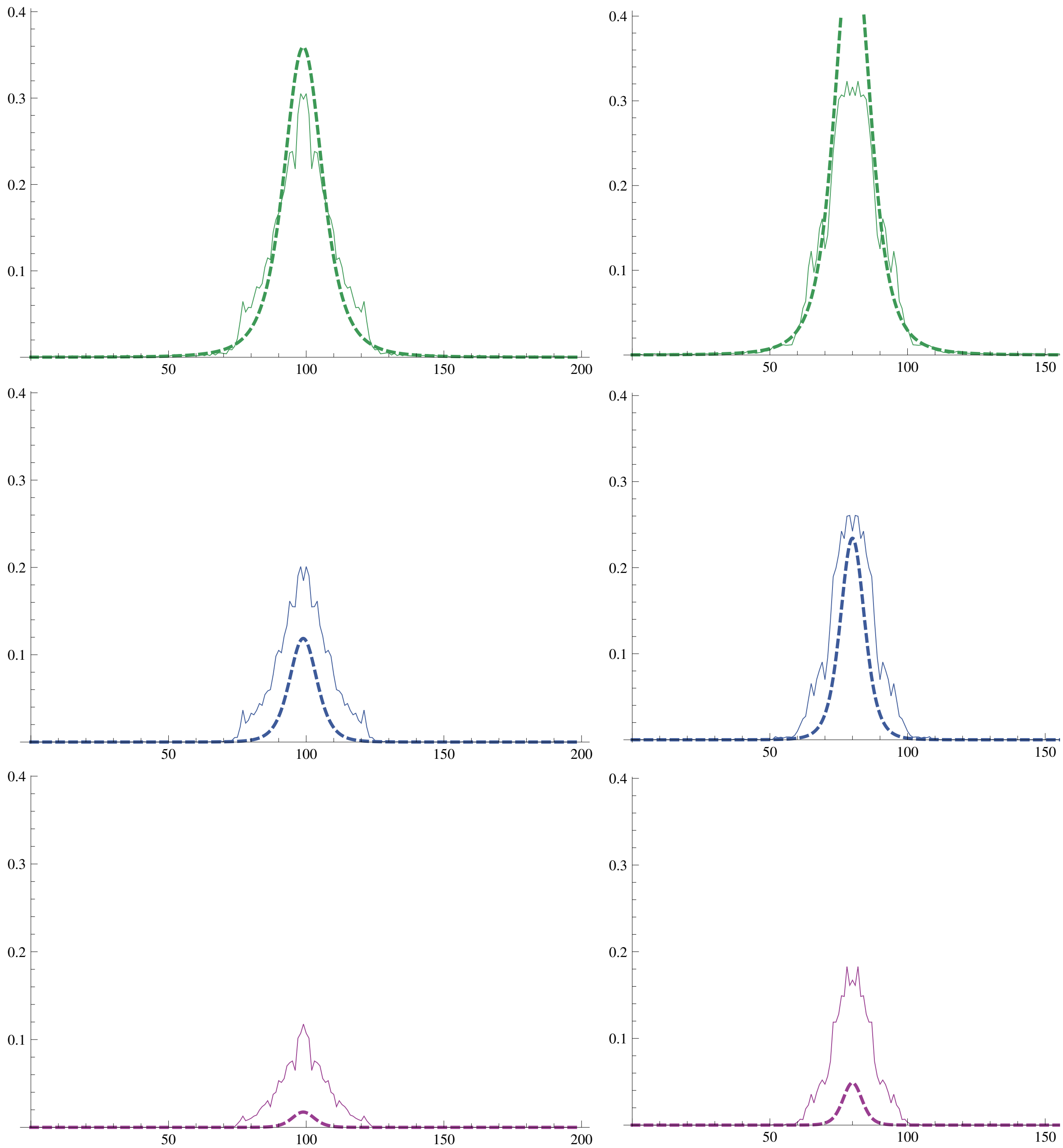


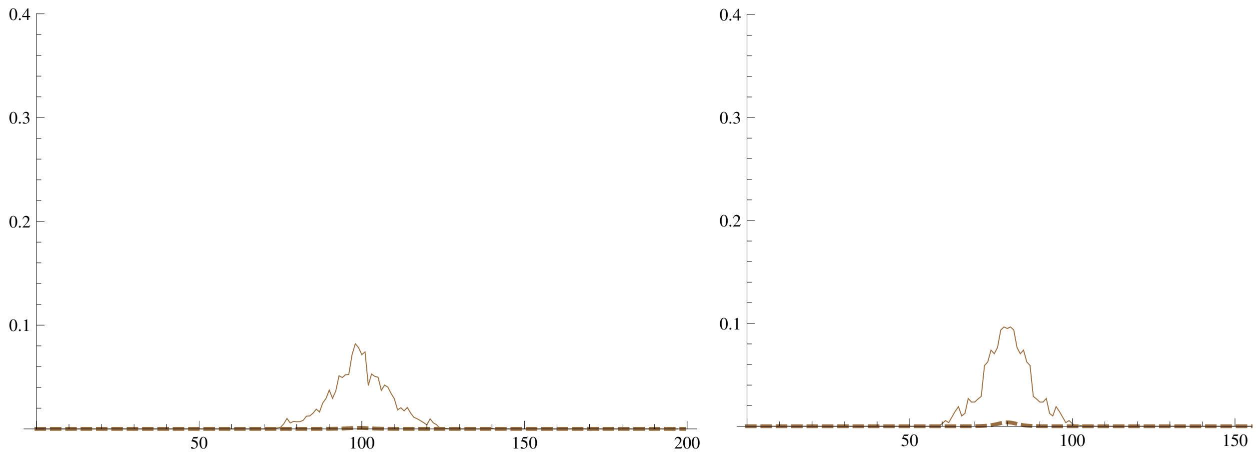
Comparing the even part of the data with the rescaling of the total signal using the binomial distribution for each number of atom (

```
GSSe = ListPlot[SSe, Joined → True, PlotStyle → ColorData[col, "ColorList"][[2]]];
GS1e = ListPlot[S1e, Joined → True, PlotStyle → ColorData[col, "ColorList"][[3]]];
GS2e = ListPlot[S2e, Joined → True, PlotStyle → ColorData[col, "ColorList"][[4]]];
GS3e = ListPlot[S3e, Joined → True, PlotStyle → ColorData[col, "ColorList"][[5]]];
GS4e = ListPlot[S4e, Joined → True, PlotStyle → ColorData[col, "ColorList"][[6]]];
GS5e = ListPlot[S5e, Joined → True, PlotStyle → ColorData[col, "ColorList"][[7]]];

GSSen = ListPlot[SSen, Joined → True, PlotStyle → ColorData[col, "ColorList"][[2]]];
GS1en = ListPlot[S1en, Joined → True, PlotStyle → ColorData[col, "ColorList"][[3]]];
GS2en = ListPlot[S2en, Joined → True, PlotStyle → ColorData[col, "ColorList"][[4]]];
GS3en = ListPlot[S3en, Joined → True, PlotStyle → ColorData[col, "ColorList"][[5]]];
GS4en = ListPlot[S4en, Joined → True, PlotStyle → ColorData[col, "ColorList"][[6]]];
GS5en = ListPlot[S5en, Joined → True, PlotStyle → ColorData[col, "ColorList"][[7]]];
```

```
Grid[Transpose[{{Show[GSSe, GFSS, PlotRange → {0, Max[SS]}, ImageSize → Medium],
    Show[GS1e, GFS1, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS2e, GFS2, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS3e, GFS3, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS4e, GFS4, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS5e, GFS5, PlotRange → {0, 0.4}, ImageSize → Medium]},
   {Show[GSSen, GFSSn, PlotRange → {0, Max[SSn]}, ImageSize → Medium],
    Show[GS1en, GFS1n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS2en, GFS2n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS3en, GFS3n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS4en, GFS4n, PlotRange → {0, 0.4}, ImageSize → Medium],
    Show[GS5en, GFS5n, PlotRange → {0, 0.4}, ImageSize → Medium]}
  }]]
```

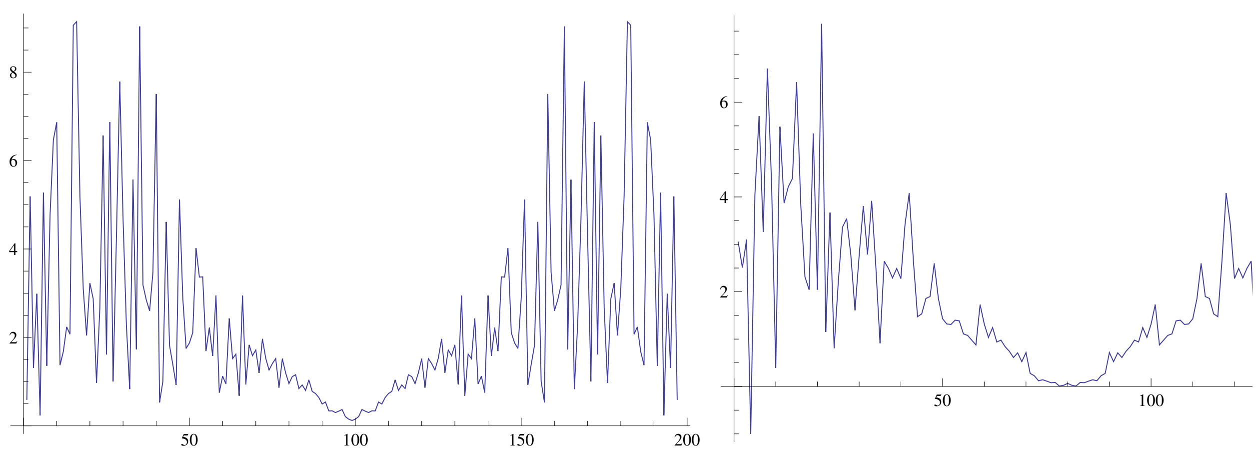



0.4
0.3
0.2
0.1
50
100
150
200

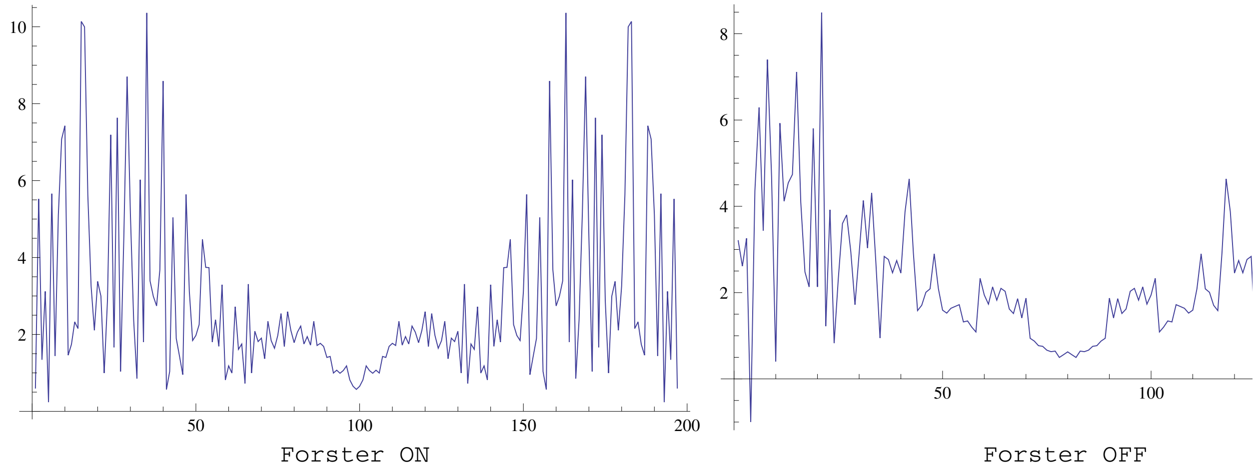


Plotting the two previous Rydberg blockade criteria with the even part of the spectra

```
Grid[{{ListPlot[S2e / S1e * (N0 - SSe) / (SSe * (N0 - 1)) - 1, Joined → True,
    ImageSize → Medium], ListPlot[S2en / S1en * (N0 - SSen) / (SSen * (N0 - 1)) - 1,
    Joined → True, ImageSize → Medium]}, {"Forster ON", "Forster OFF"}}]
```

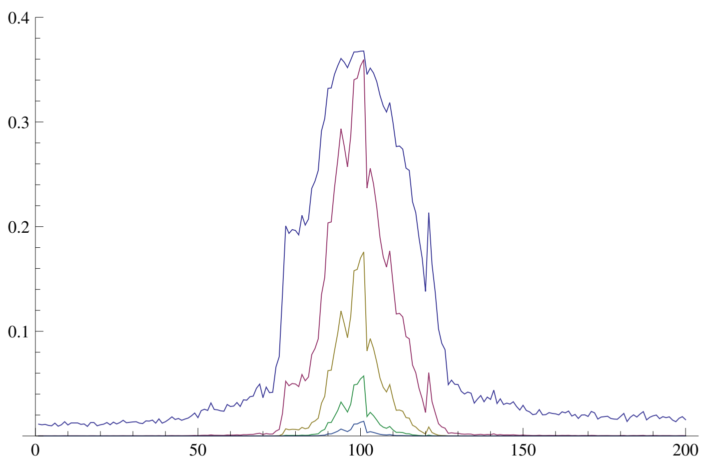


```
Grid[{{ListPlot[S2e / S1e^2 * (1 - SSe / N0) ^N0 / (1 - 1 / N0) - 1, Joined → True,
    ImageSize → Medium], ListPlot[S2en / S1en^2 * (1 - SSen / N0) ^N0 / (1 - 1 / N0) - 1,
    Joined → True, ImageSize → Medium]}, {"Forster ON", "Forster OFF"}}]
```



Reproducing the graph on the poster

```
ListPlot[Table[N * SS^N * Exp[-SS] / N!, {N, 1, 5}], Joined → True, PlotRange → {0, 0.4}]
```



```
ListPlot[Table[N * SSn^N * Exp[-SSn] / N!, {N, 1, 5}],
 Joined → True, PlotRange → {0, 0.6}]
```