

# Photoluminescence: data analysis

## Load data

```
clear;
RhoData = ParsePLdata('rhodamine', 'photonE'); % Rhodamine

Temps = 10:10:290;
RubyData = cell(numel(Temps),1); % Ruby
for it = 1:numel(Temps)
    RubyData{it} = ParsePLdata('ruby', Temps(it), 'photonE');
end

RubyRoomData = ParsePLdata('rubyRtemp', 'photonE');
```

## Fit Rhodamine Data

```
%
```

## Fit Ruby Data to 4-level effective model (double lorentzian)

```
Erange = [1788, 1794];
Energy = linspace(Erange(1), Erange(2), 1000);

FitParams = [1500, 3, -0.7, -0.7, 3.6, 1790];

for Dnum = 1:29
    T = 10*Dnum;

    Idx = RubyData{Dnum}(:,1) > Erange(1) & RubyData{Dnum}(:,1) < Erange(2);
    E_data = RubyData{Dnum}(Idx,1);
    I_data = RubyData{Dnum}(Idx,2);

    LowerBound = [1400, 1e-1, -2, -2, 1, 1780];
    UpperBound = [1600, 1e1, -0.3, -0.3, 4, 1800];
    Thres = I_data(fix(numel(E_data)/2));
    loss_func = @(y_hat, y_data) mean(((y_hat - y_data).^2) .* (y_data>Thres |
(y_data<Thres & y_hat>Thres))) .* abs(max(y_data,y_hat)));

    options.lb = LowerBound;
    options.ub = UpperBound;
    options.loss_type = loss_func;

    Params0 = FitParams;
    FitModel = @(Params, Energies) RubySpec(Params(1), Params(2), [power(10,
Params(3)), power(10, Params(4))], Params(5), Params(6), T, Energies);
    [FitParams, ~] = Adam_curve_fit(FitModel, E_data, I_data, Params0, options);
```

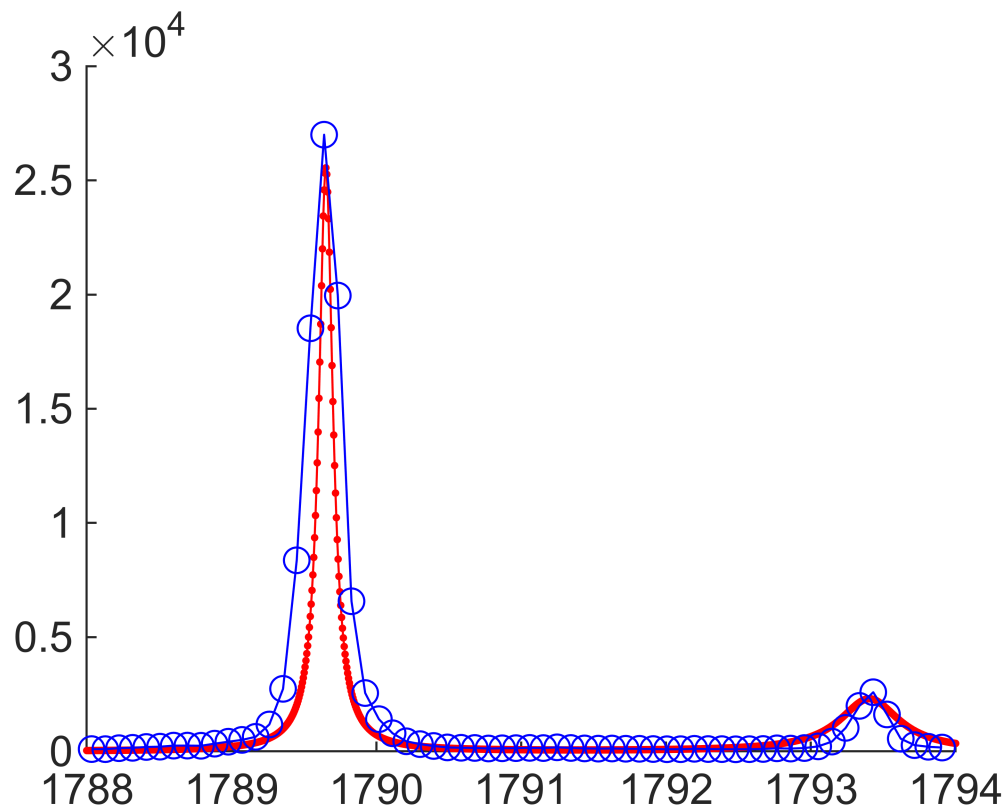
```

I0 = FitParams(1);
TransAmpR = FitParams(2);
Linewidth = [power(10, FitParams(3)), power(10, FitParams(4))];
Delta = FitParams(5);
E1 = FitParams(6);

figure;
hold on;
I_fit = RubySpec(I0, TransAmpR, Linewidth, Delta, E1, T, Energy);
plot(Energy, I_fit, '.-', 'color', 'red');
plot(E_data, I_data, 'o-', 'color', 'blue');
hold off;

disp(['I0 = ', sprintf('%.4g', I0)]);
disp(['d_{20}/d_{10} = ', sprintf('%.4g', TransAmpR)]);
disp(['Linewidths = [', sprintf('%.4g', Linewidth(1)), ', ', sprintf('%.4g',
Linewidth(2)) ']' ]);
disp(['Delta = ', sprintf('%.4g', Delta)]);
disp(['E1 = ', sprintf('%.4g', E1)]);
end

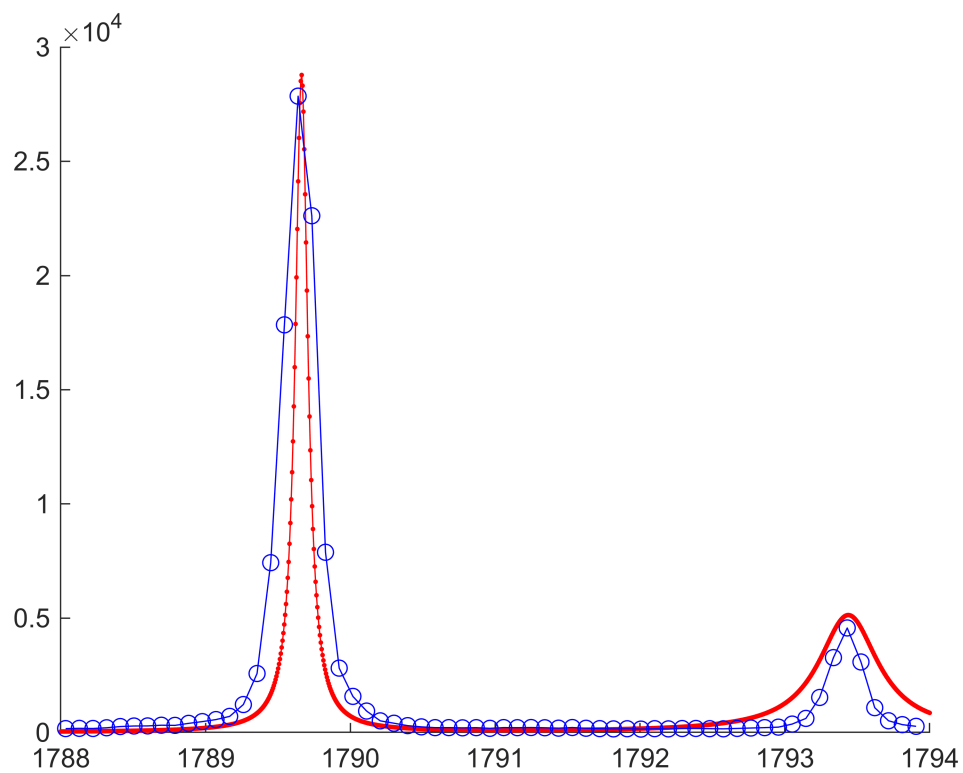
```



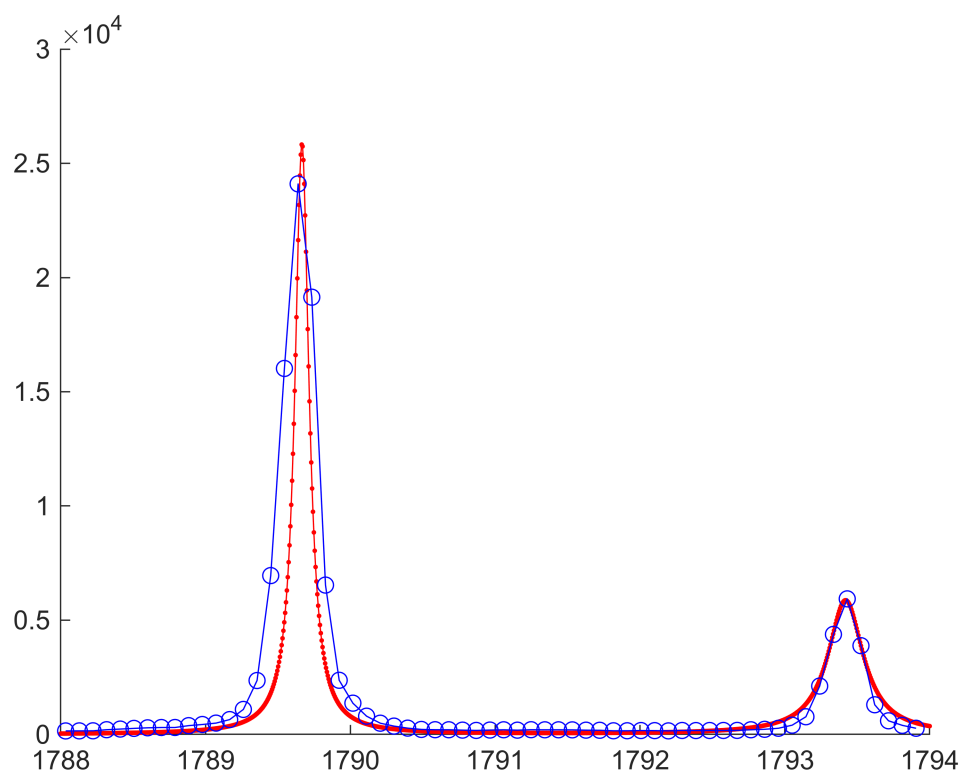
```

I0 = 1509
d_{20}/d_{10} = 5.455
Linewidths = [0.1182, 0.5012]
Delta = 3.753
E1 = 1790

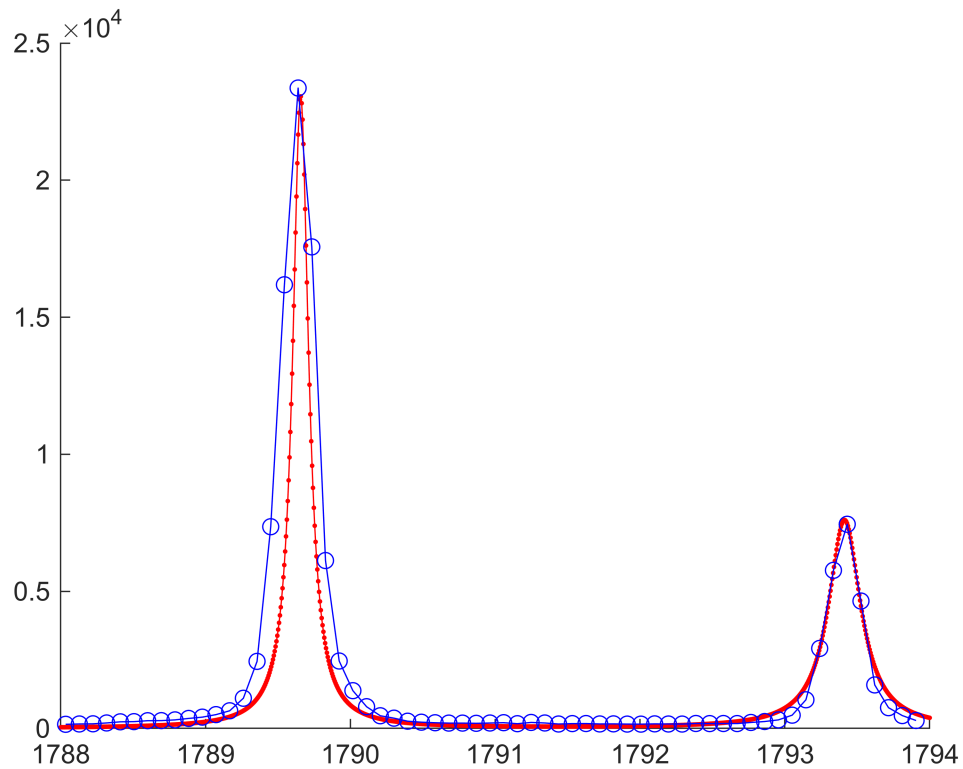
```



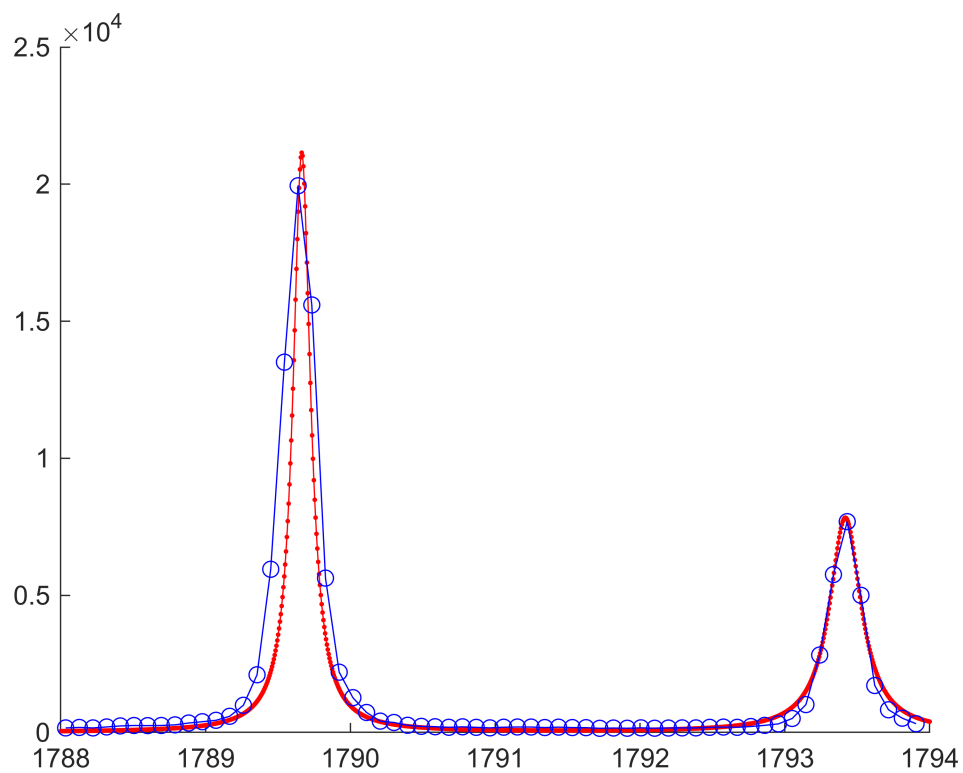
$I_0 = 1517$   
 $d_{\{20\}}/d_{\{10\}} = 2.754$   
 $\text{Linewidths} = [0.1055, 0.5012]$   
 $\Delta = 3.775$   
 $E1 = 1790$



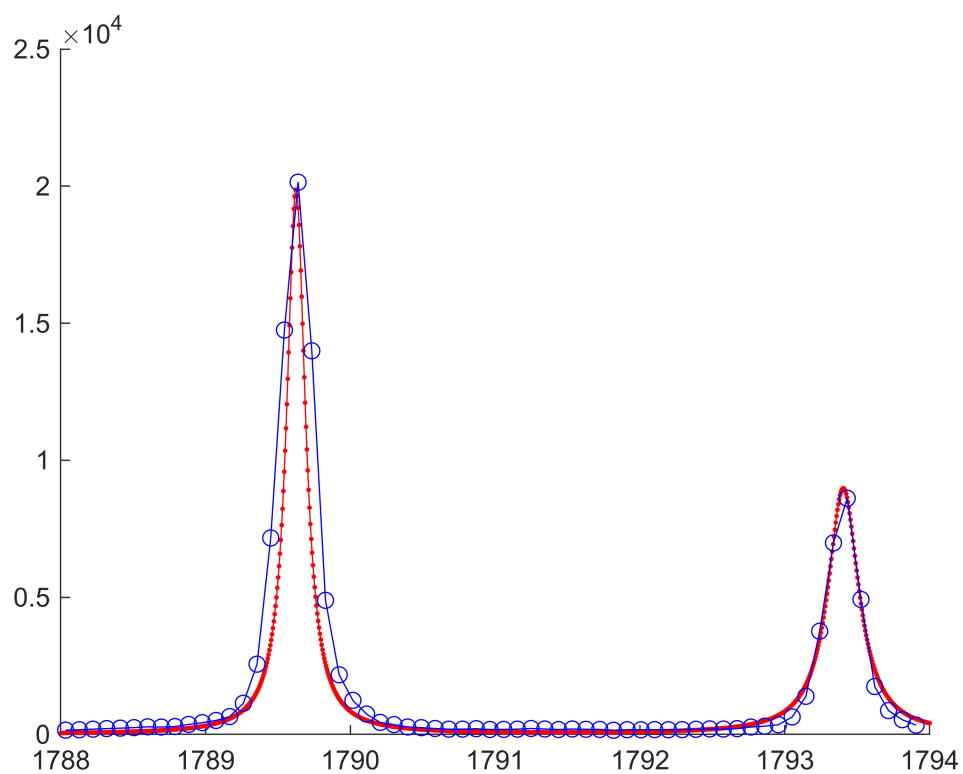
$I_0 = 1527$   
 $d_{\{20\}}/d_{\{10\}} = 1.559$   
 $\text{Linewidths} = [0.1182, 0.2961]$   
 $\Delta = 3.754$   
 $E_1 = 1790$



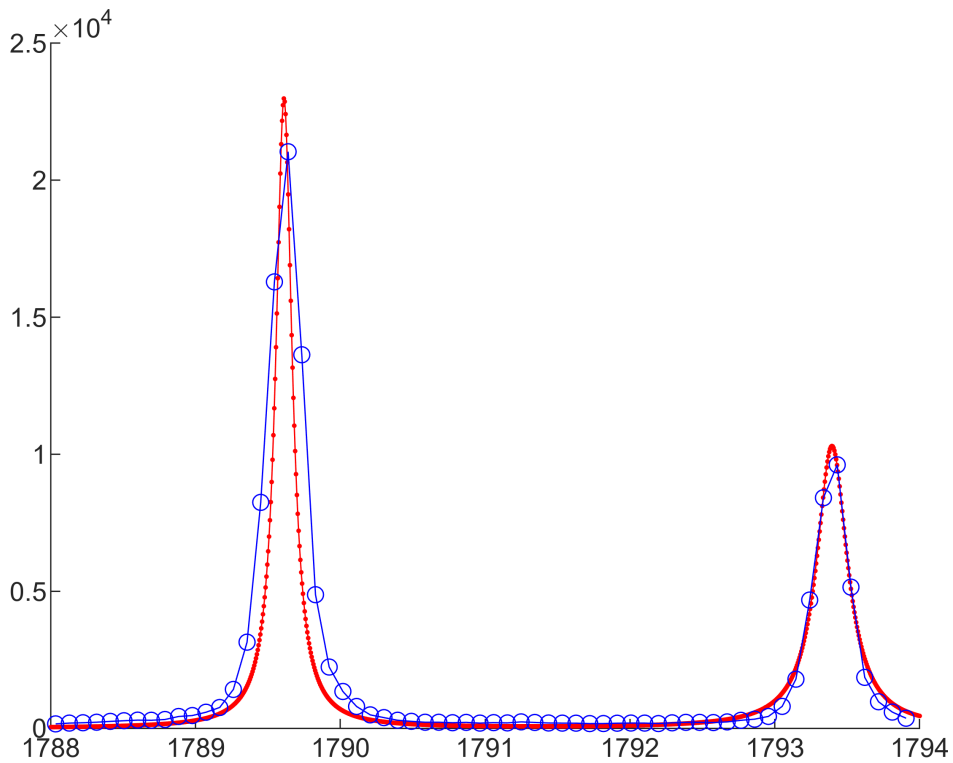
$I_0 = 1537$   
 $d_{\{20\}}/d_{\{10\}} = 1.409$   
 $\text{Linewidths} = [0.1334, 0.2702]$   
 $\Delta = 3.756$   
 $E_1 = 1790$



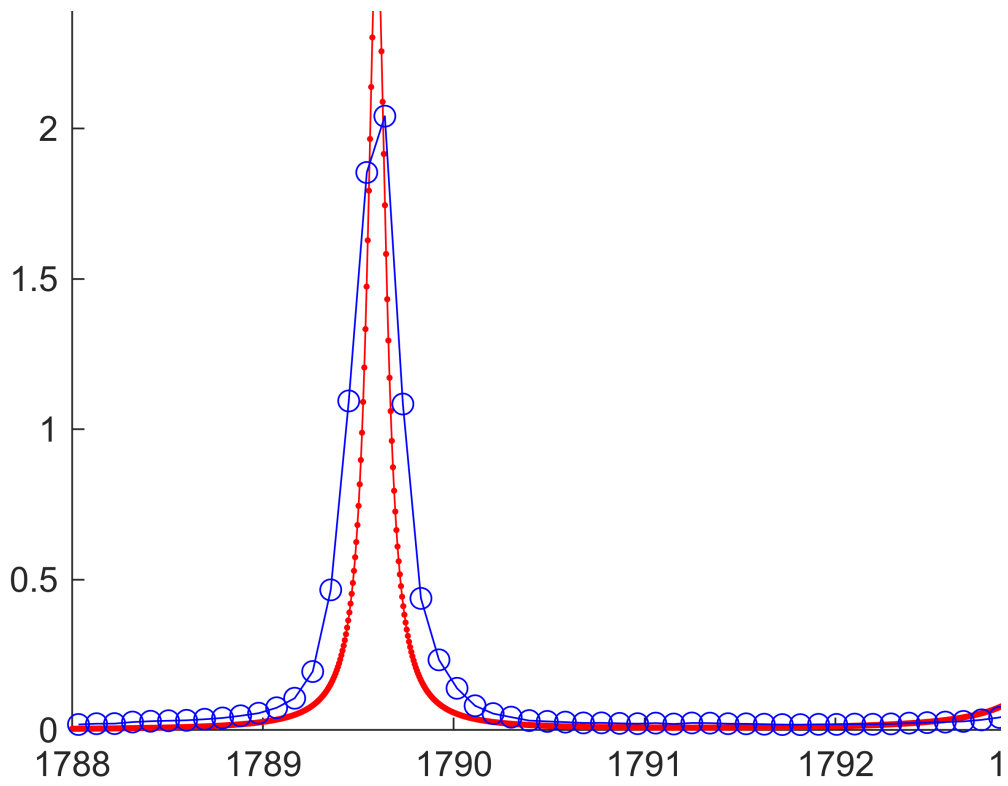
$I_0 = 1547$   
 $d_{\{20\}}/d_{\{10\}} = 1.268$   
 $\text{Linewidths} = [0.1464, 0.2659]$   
 $\Delta = 3.753$   
 $E_1 = 1790$



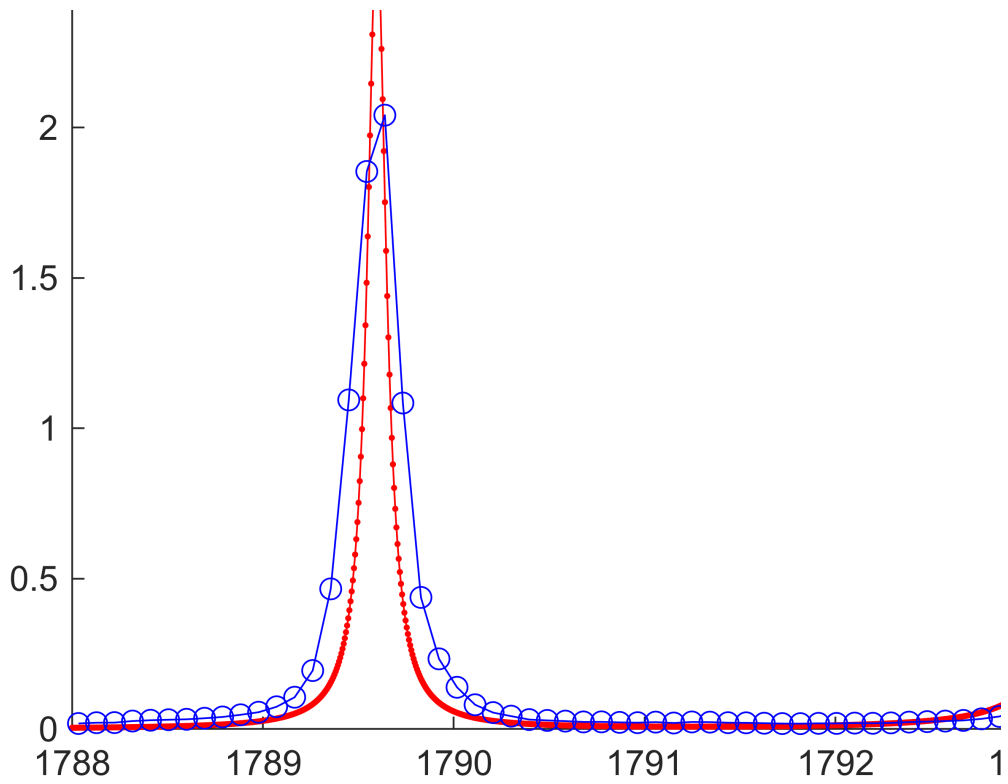
$I_0 = 1557$   
 $d_{\{20\}}/d_{\{10\}} = 1.245$   
 $\text{Linewidths} = [0.1566, 0.2589]$   
 $\Delta = 3.779$   
 $E_1 = 1790$



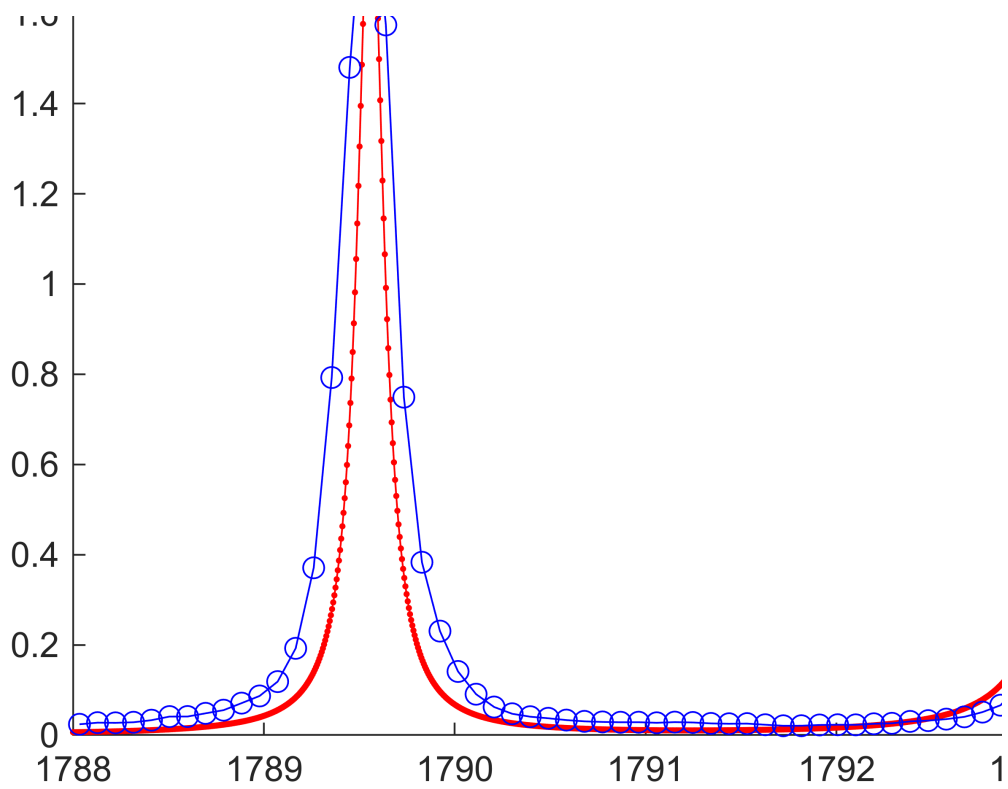
$I_0 = 1567$   
 $d_{\{20\}}/d_{\{10\}} = 1.262$   
 $\text{Linewidths} = [0.1364, 0.2587]$   
 $\Delta = 3.784$   
 $E_1 = 1790$



$I_0 = 1577$   
 $d_{\{20\}}/d_{\{10\}} = 1.29$   
 $\text{Linewidths} = [0.119, 0.2783]$   
 $\Delta = 3.774$   
 $E1 = 1790$

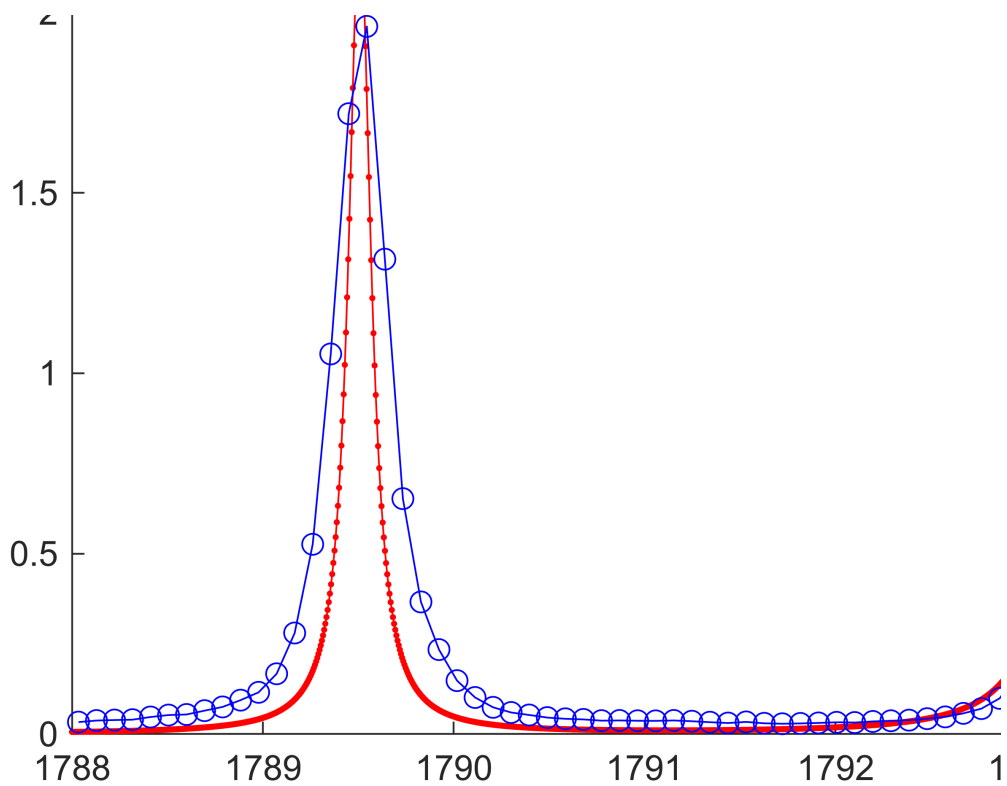


$I_0 = 1587$   
 $d_{\{20\}}/d_{\{10\}} = 1.247$   
 $\text{Linewidths} = [0.1196, 0.2782]$   
 $\Delta = 3.774$   
 $E_1 = 1790$

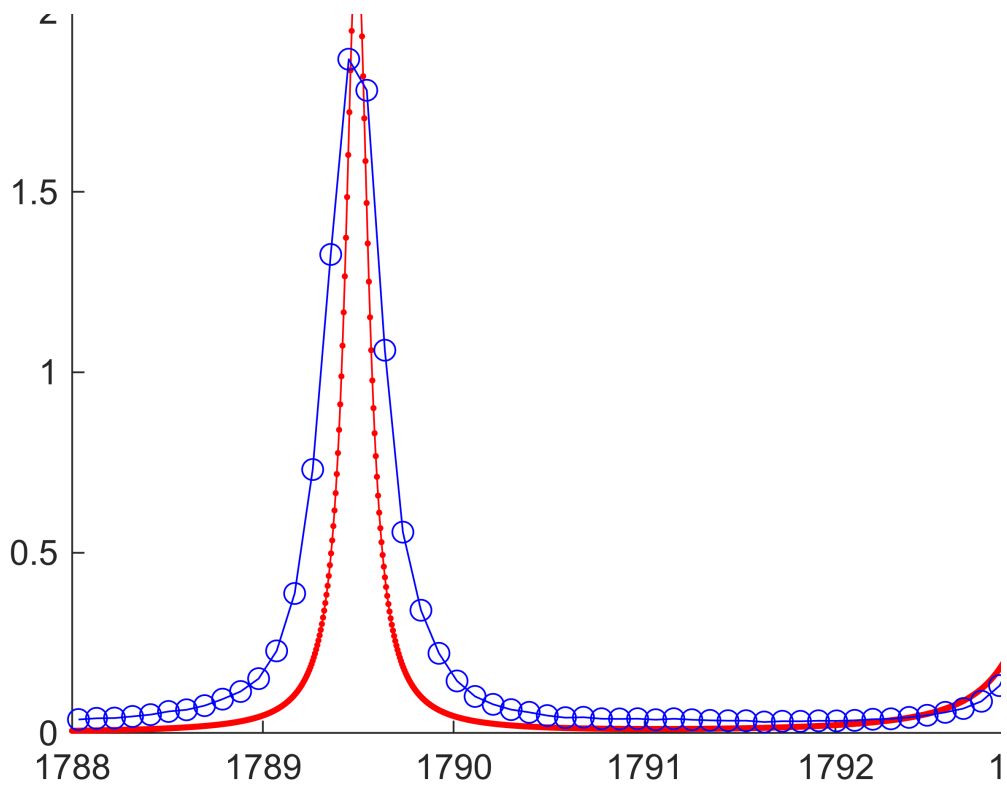


$I_0 = 1597$   
 $d_{\{20\}}/d_{\{10\}} = 1.288$   
 $\text{Linewidths} = [0.1652, 0.2958]$   
 $\Delta = 3.759$   
 $E_1 = 1790$

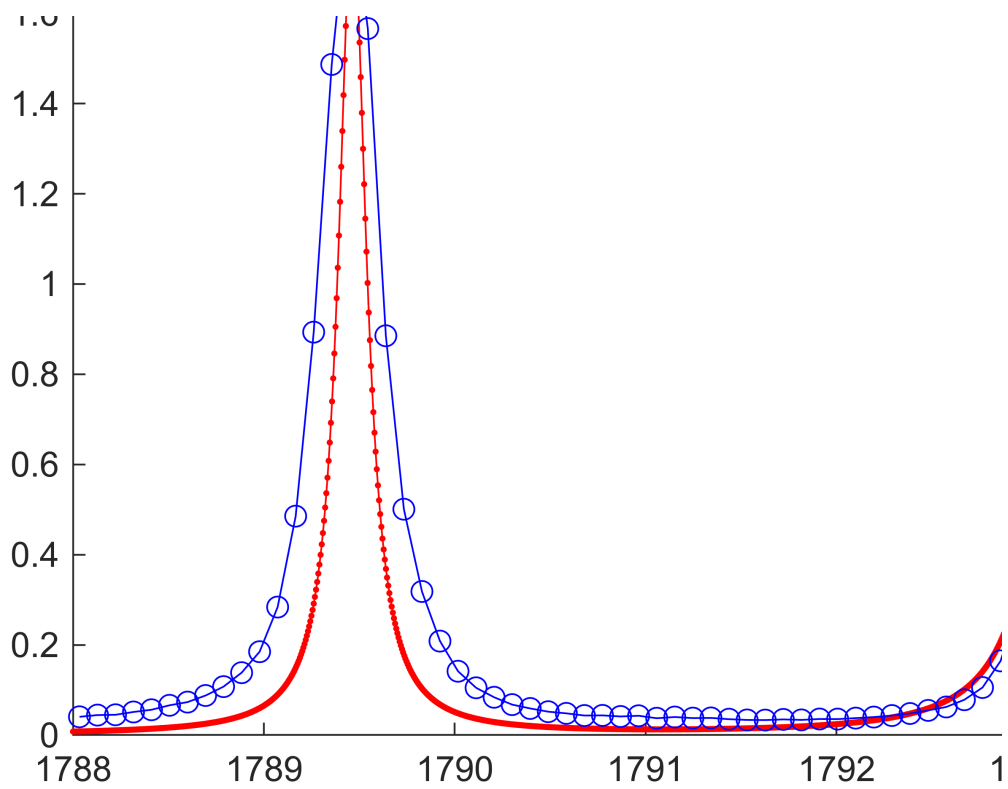




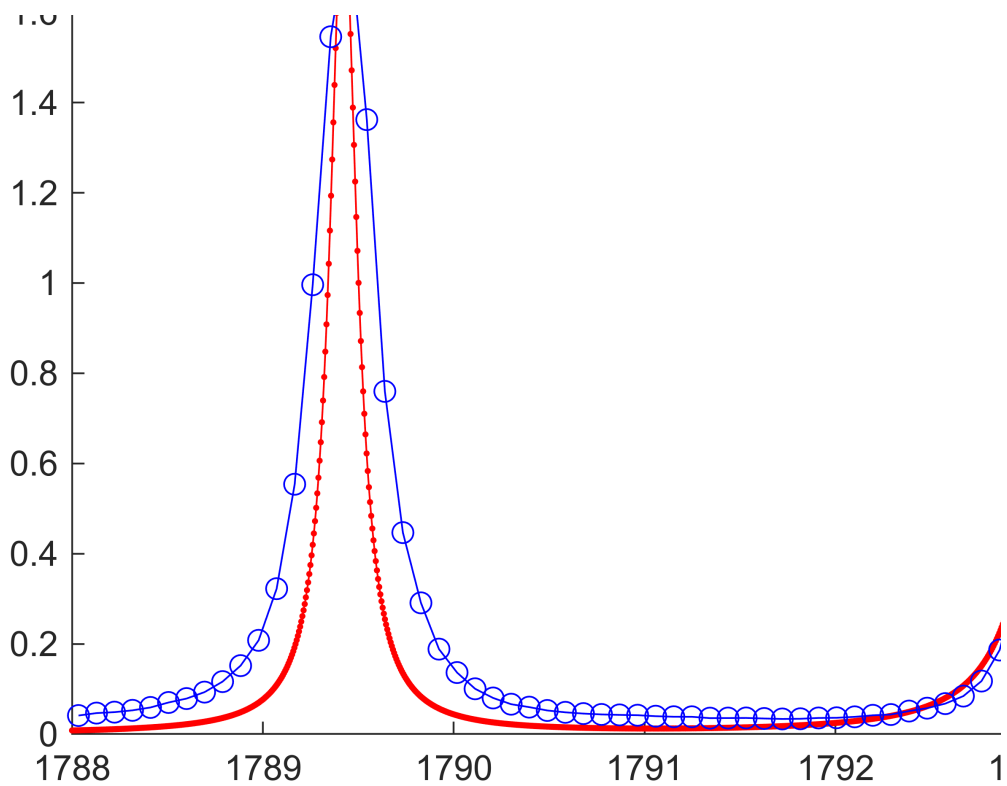
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.316$   
 $\text{Linewidths} = [0.1427, 0.3053]$   
 $\Delta = 3.783$   
 $E_1 = 1790$



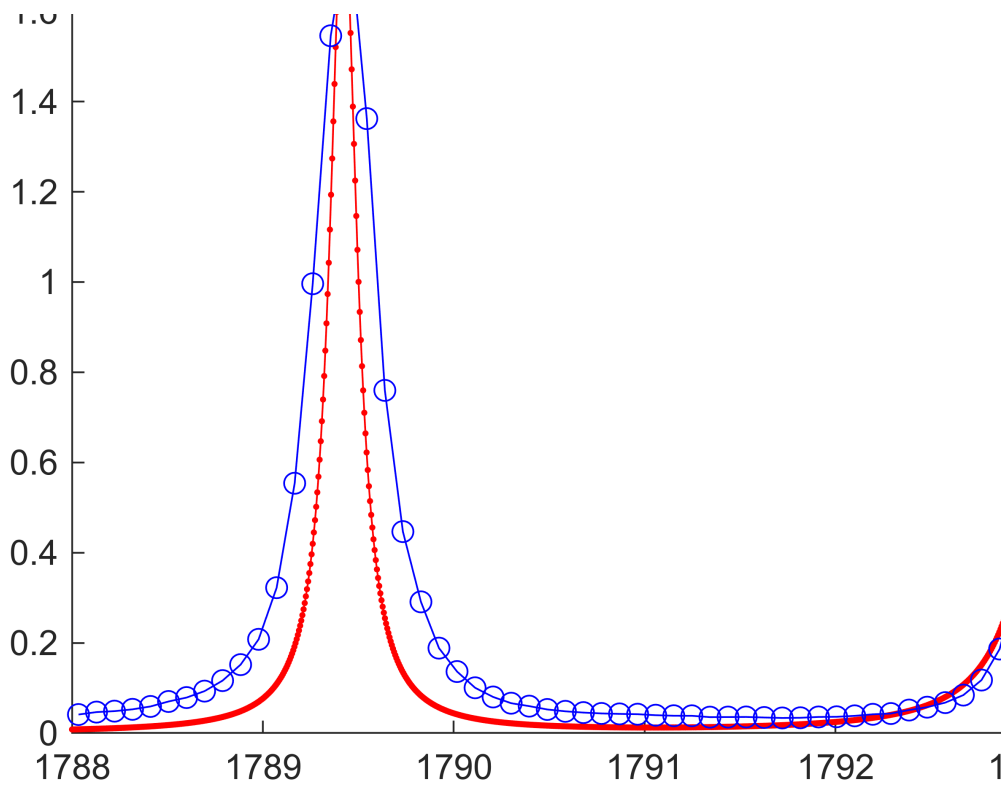
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.332$   
 $\text{Linewidths} = [0.1451, 0.3292]$   
 $\Delta = 3.763$   
 $E_1 = 1789$



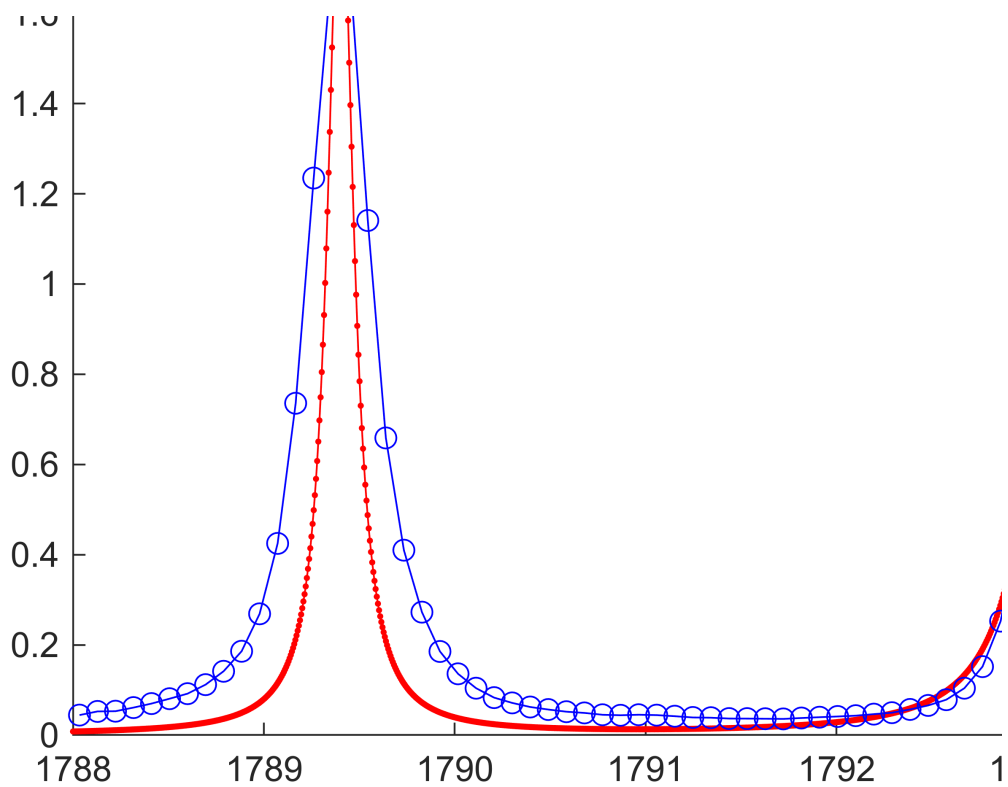
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.324$   
 $\text{Linewidths} = [0.1769, 0.339]$   
 $\Delta = 3.765$   
 $E_1 = 1789$



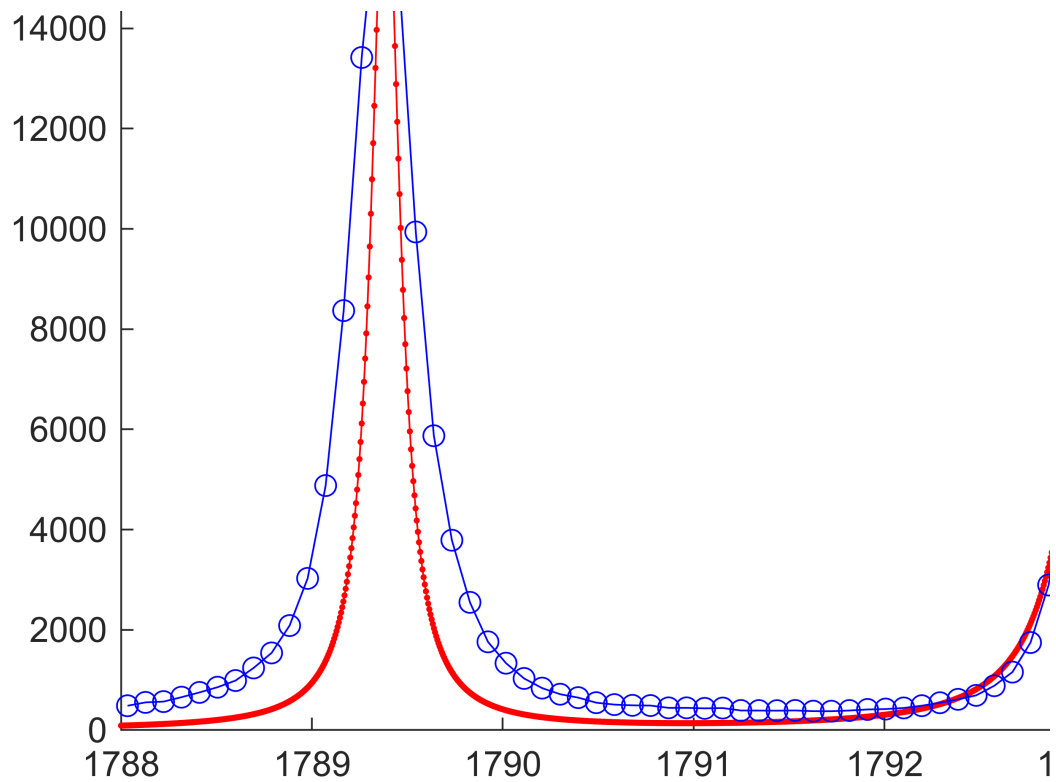
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.295$   
 $\text{Linewidths} = [0.1734, 0.3446]$   
 $\Delta = 3.786$   
 $E_1 = 1789$



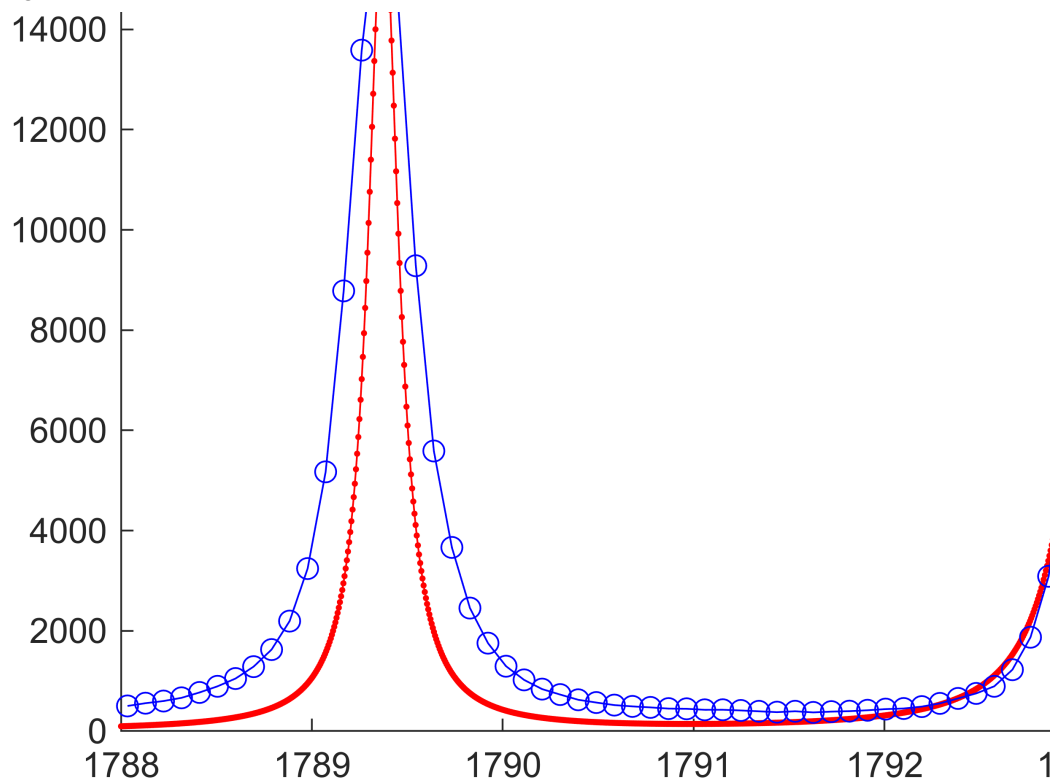
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.281$   
 $\text{Linewidths} = [0.1734, 0.3446]$   
 $\Delta = 3.786$   
 $E_1 = 1789$



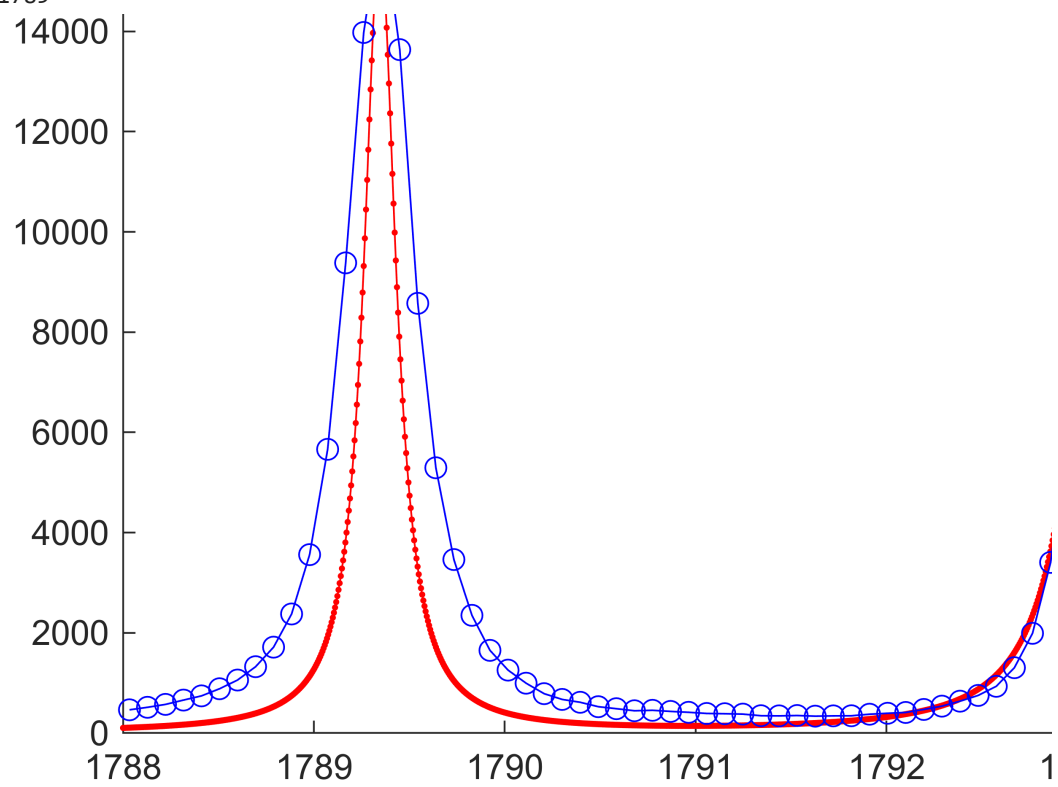
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.305$   
 $\text{Linewidths} = [0.1628, 0.3641]$   
 $\Delta = 3.772$   
 $E_1 = 1789$



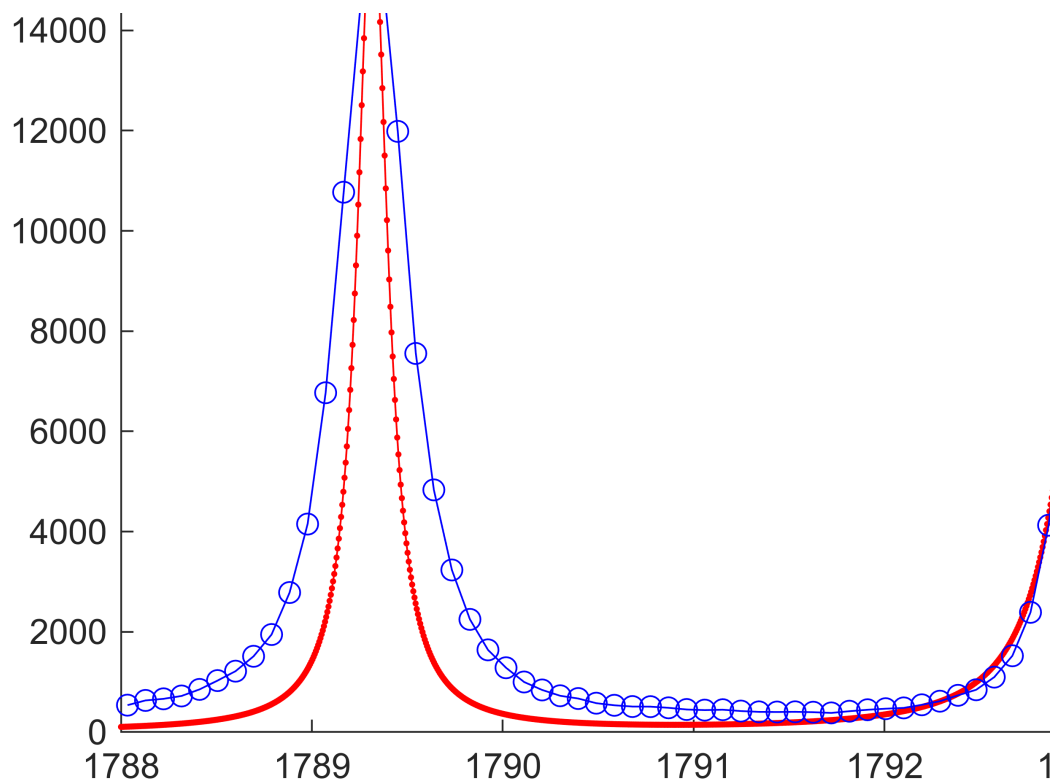
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.294$   
 Linewidths = [0.1812, 0.3734]  
 $\Delta = 3.764$   
 $E_1 = 1789$



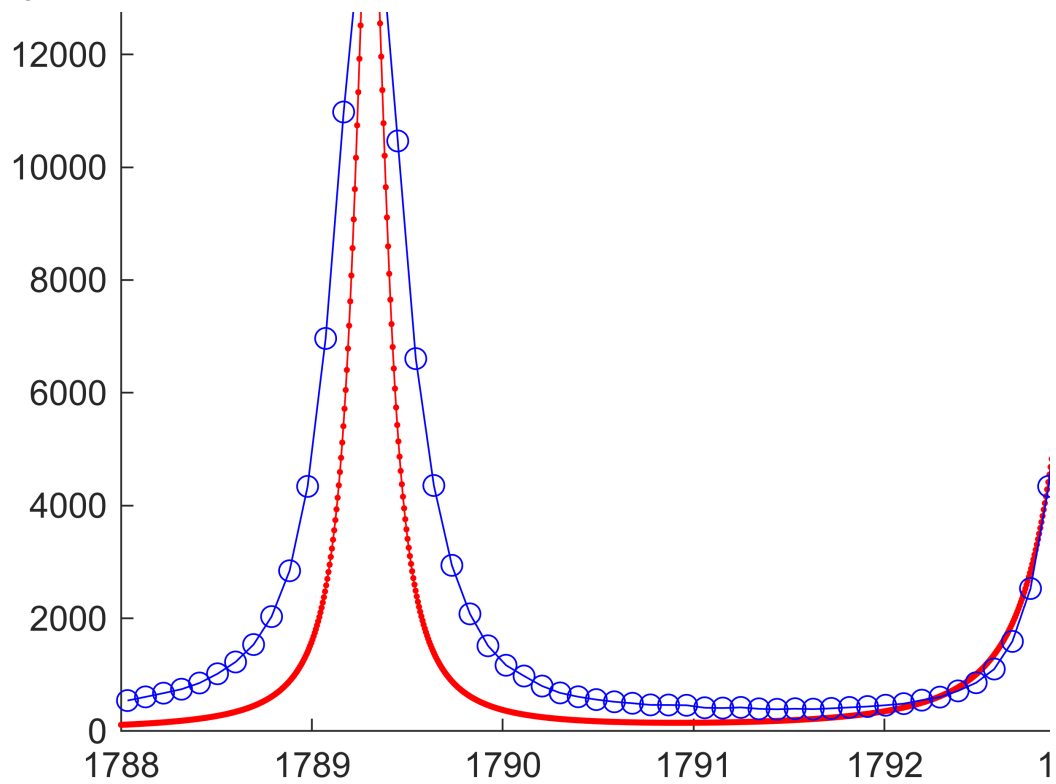
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.279$   
 $\text{Linewidths} = [0.1945, 0.3772]$   
 $\Delta = 3.765$   
 $E_1 = 1789$



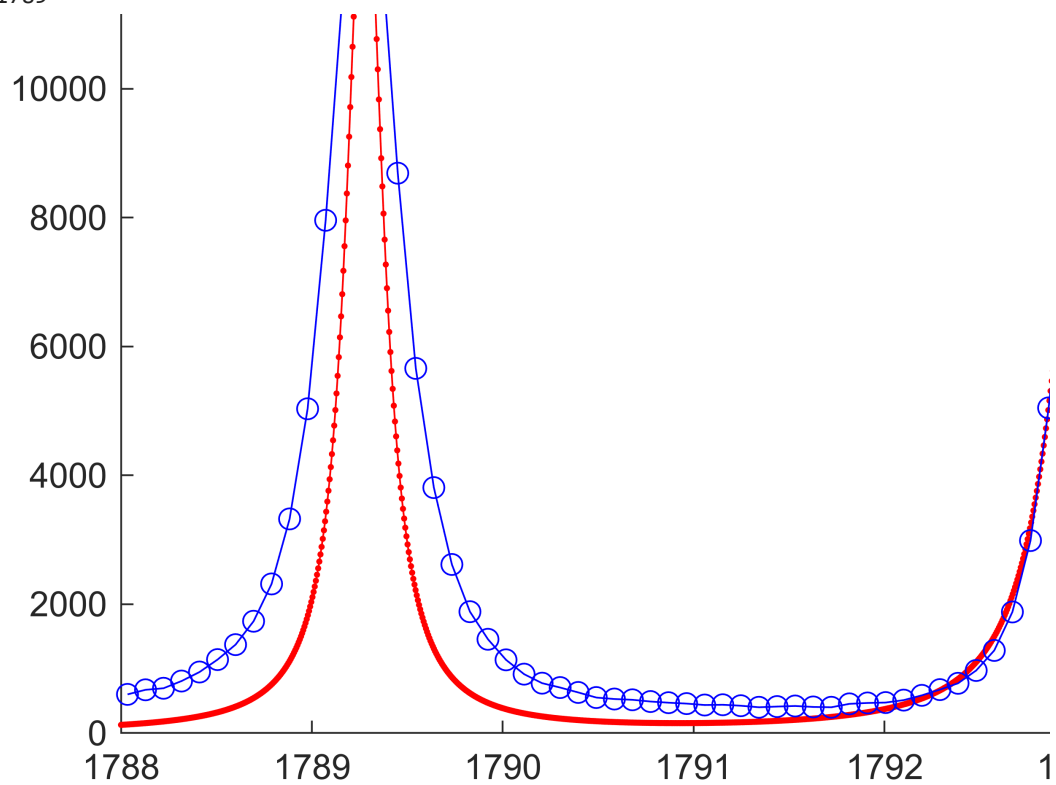
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.269$   
 $\text{Linewidths} = [0.2031, 0.38]$   
 $\Delta = 3.78$   
 $E_1 = 1789$



$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.273$   
 $\text{Linewidths} = [0.1921, 0.3955]$   
 $\Delta = 3.782$   
 $E_1 = 1789$

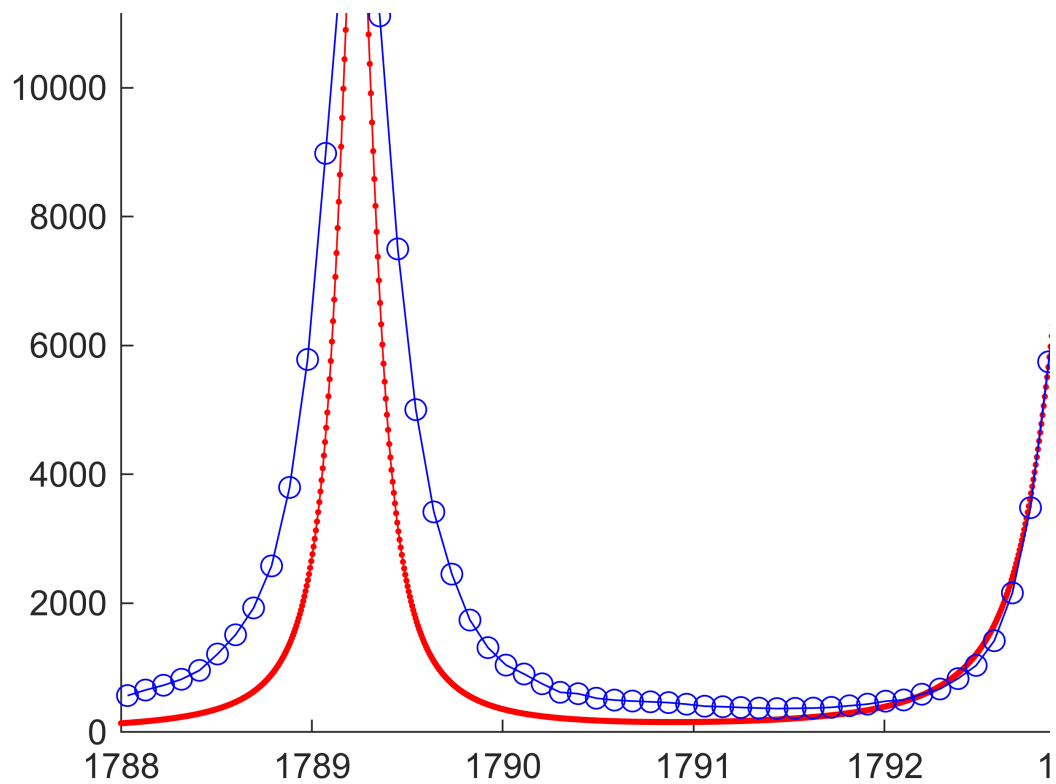


$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.234$   
 $\text{Linewidths} = [0.205, 0.4032]$   
 $\Delta = 3.776$   
 $E_1 = 1789$

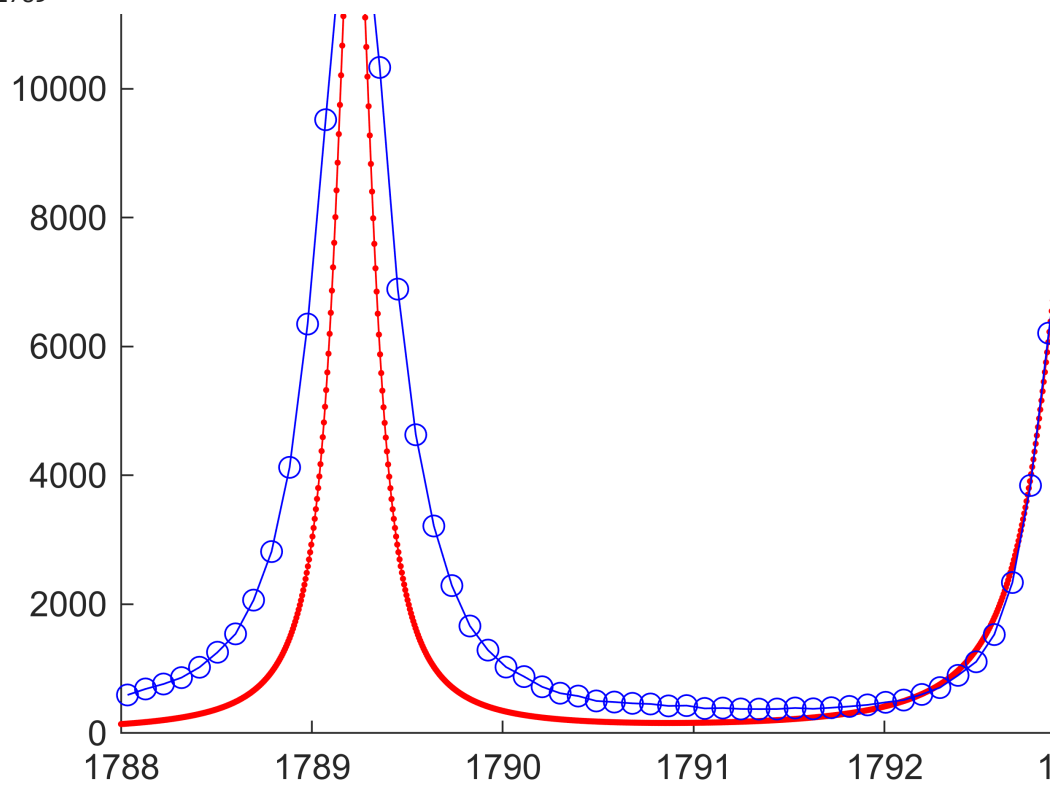


$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.213$   
 $\text{Linewidths} = [0.2305, 0.4133]$   
 $\Delta = 3.775$   
 $E_1 = 1789$

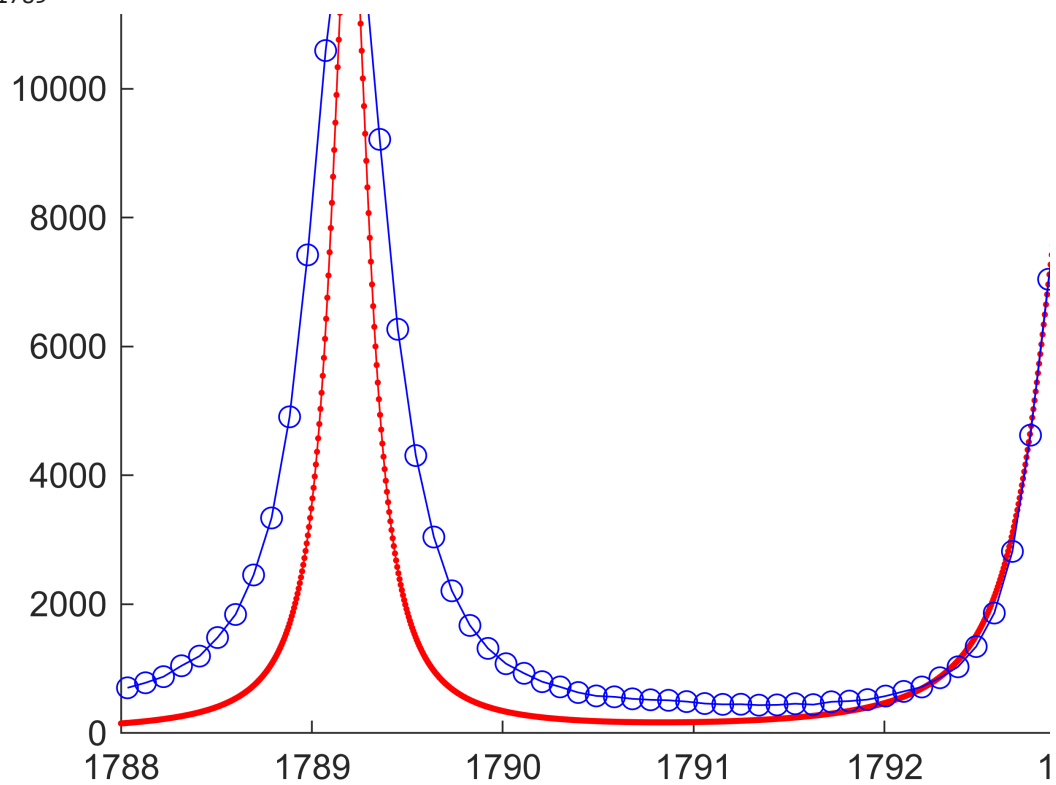




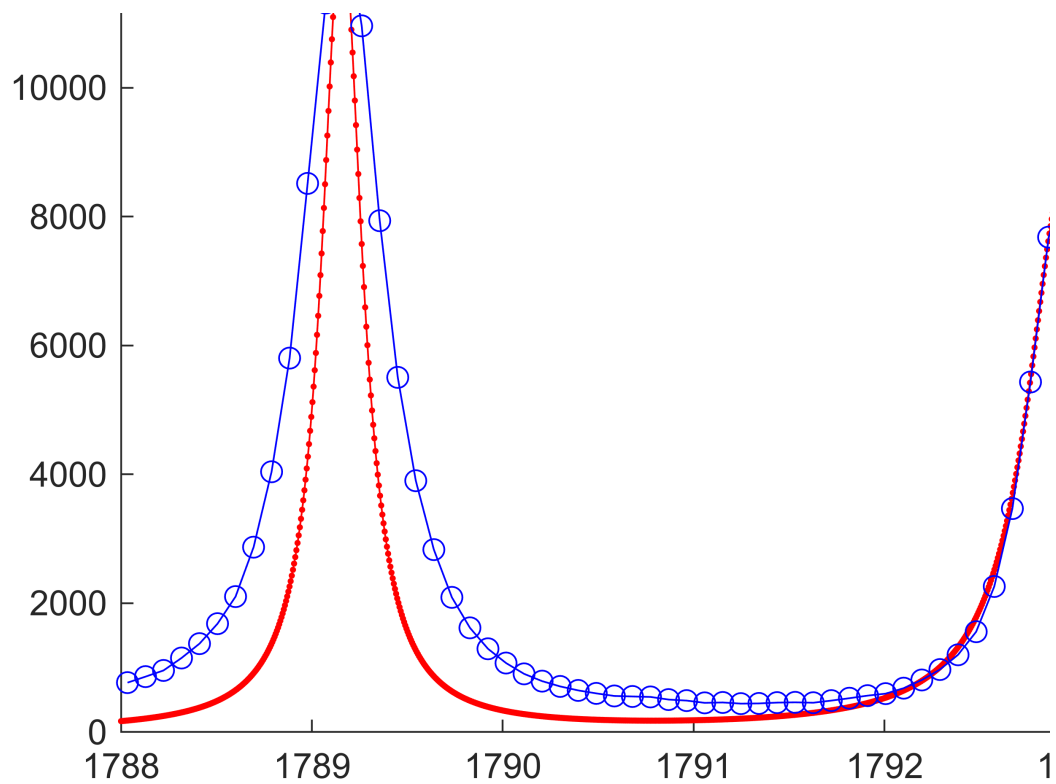
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.205$   
 $\text{Linewidths} = [0.2336, 0.4203]$   
 $\Delta = 3.787$   
 $E_1 = 1789$



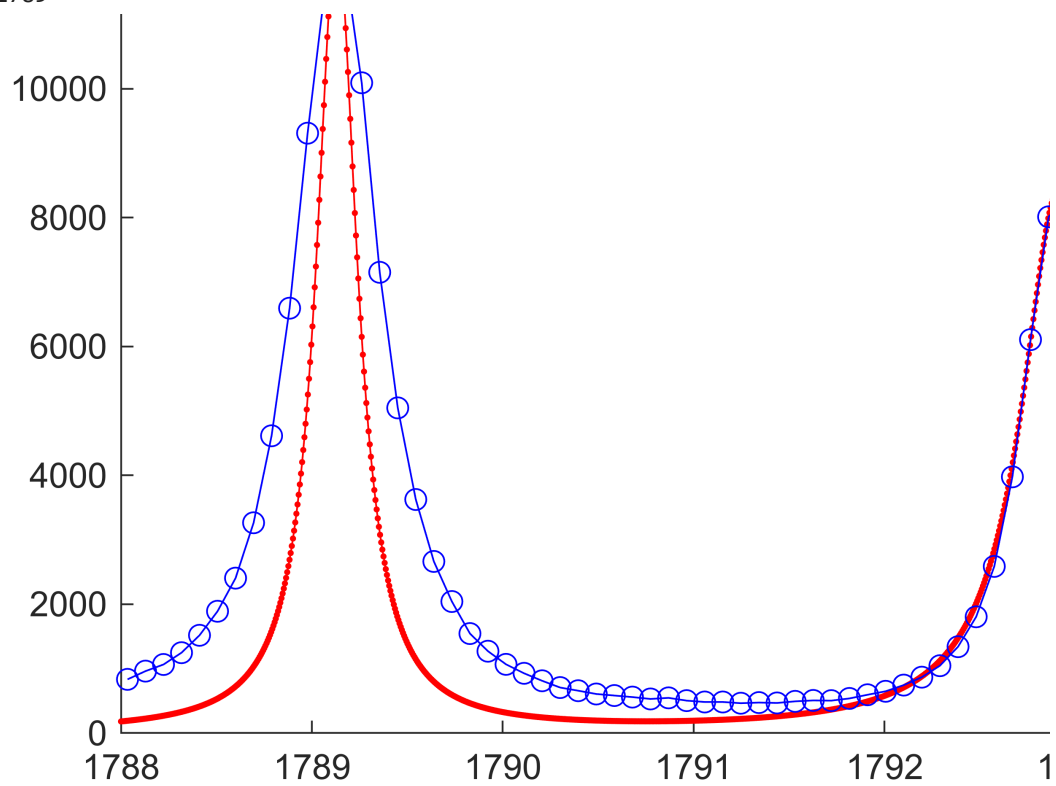
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.2$   
 $\text{Linewidths} = [0.2327, 0.4291]$   
 $\Delta = 3.785$   
 $E_1 = 1789$



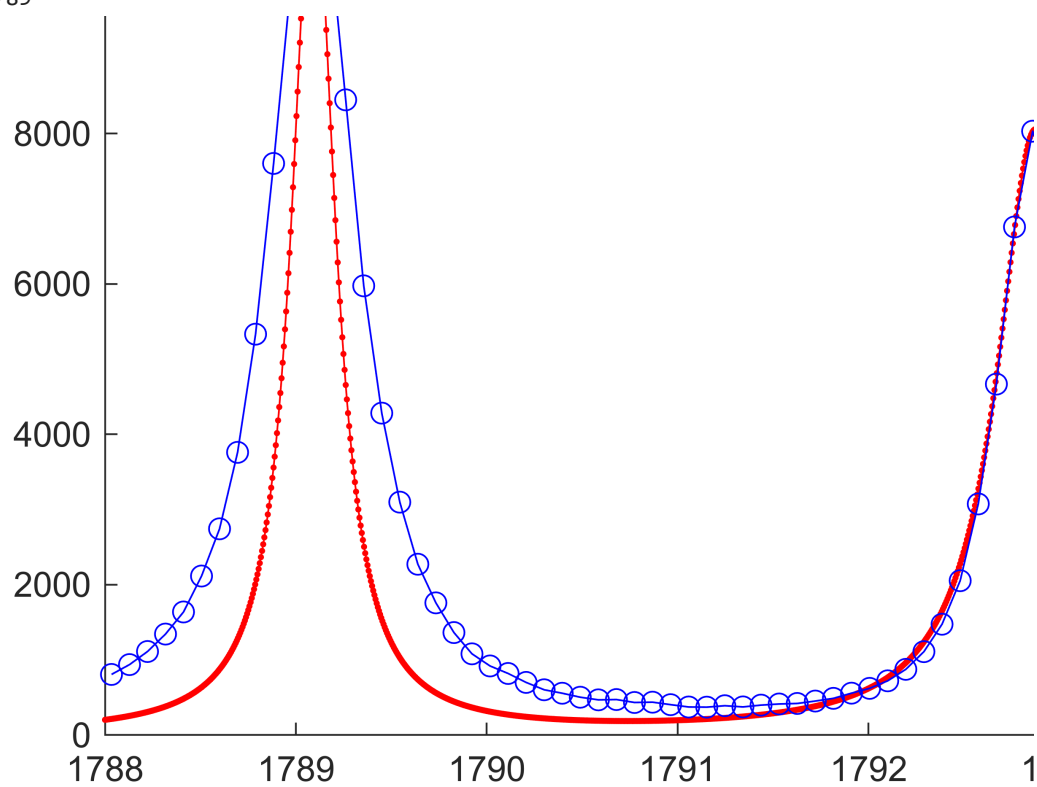
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.216$   
 $\text{Linewidths} = [0.2407, 0.4458]$   
 $\Delta = 3.777$   
 $E_1 = 1789$



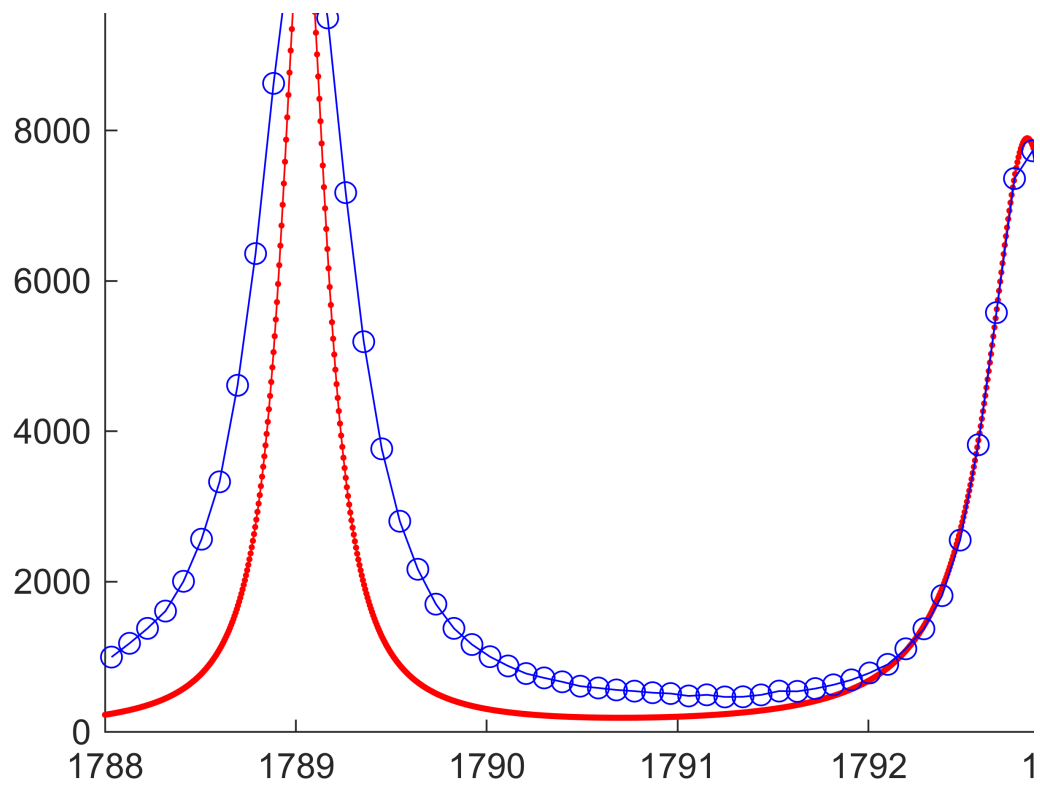
$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.222$   
 $\text{Linewidths} = [0.2557, 0.4707]$   
 $\Delta = 3.785$   
 $E_1 = 1789$



$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.228$   
 $\text{Linewidths} = [0.2597, 0.4857]$   
 $\Delta = 3.787$   
 $E_1 = 1789$



$I_0 = 1600$   
 $d_{\{20\}}/d_{\{10\}} = 1.206$   
 $\text{Linewidths} = [0.2765, 0.4945]$   
 $\Delta = 3.784$   
 $E_1 = 1789$



$I_0 = 1600$   
 $d_{20}/d_{10} = 1.199$   
 $\text{Linewidths} = [0.2894, 0.5012]$   
 $\Delta = 3.791$   
 $E_1 = 1789$