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

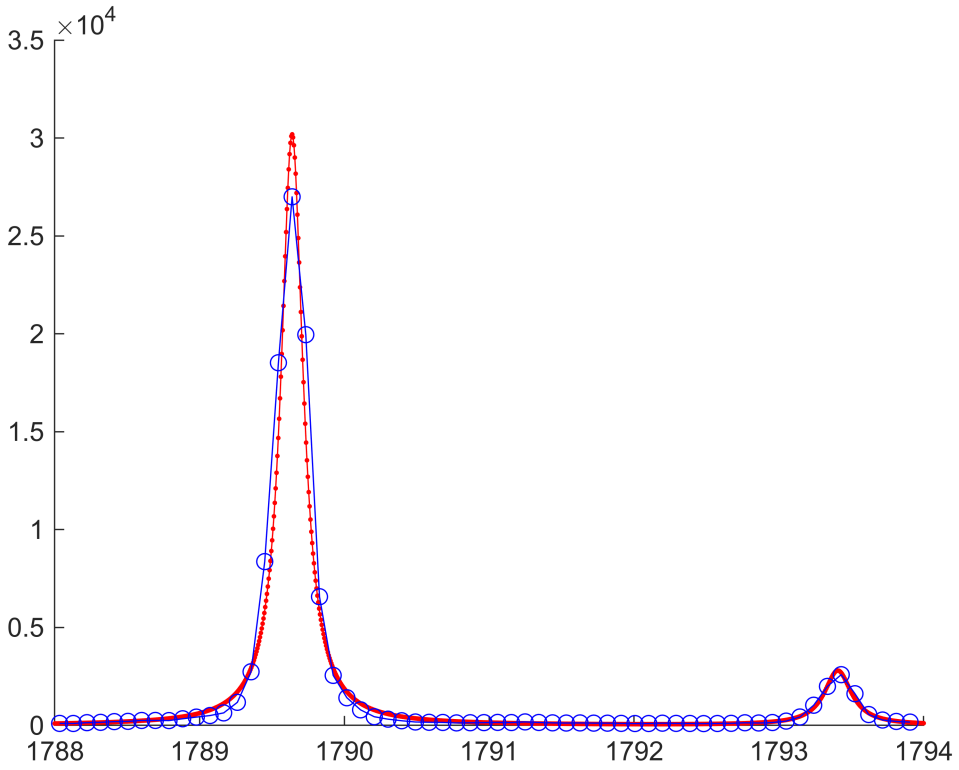
```
%
```

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

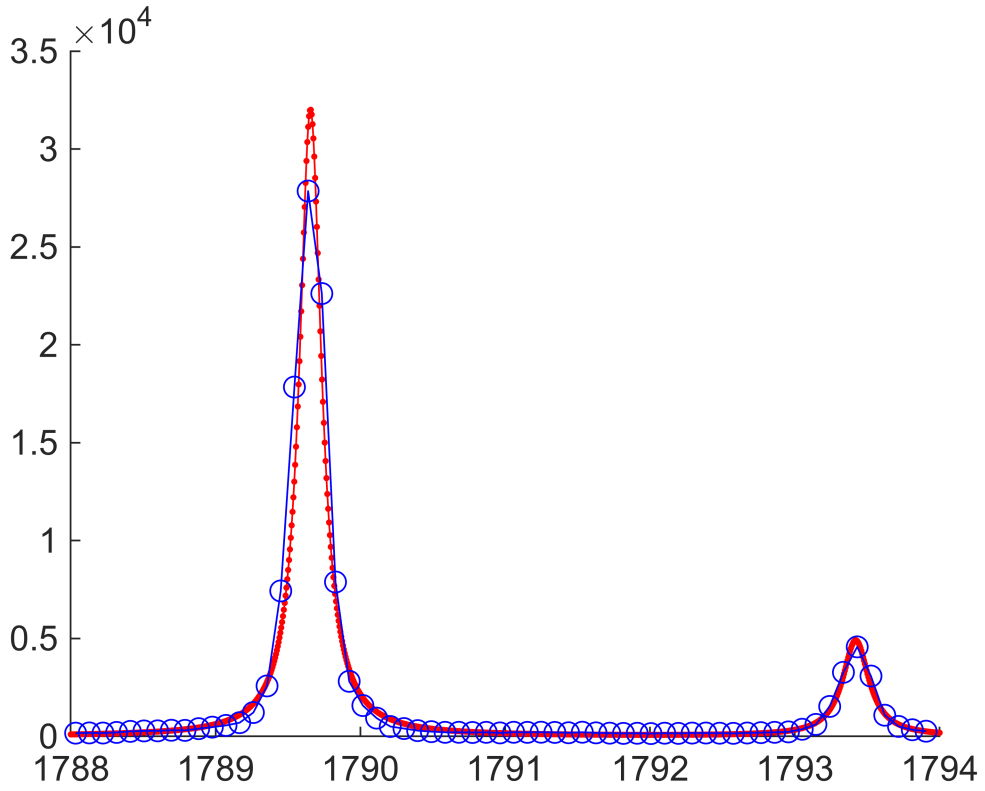
```
Erange = [1788, 1794];
Energy = linspace(Erange(1), Erange(2), 1000);

FitParams = [3000, 10, -0.7, -0.7, 3.6, 1790];

function loss = peak_sensitive_loss(yhat, y)
    delta = max(y) * 1e-3;
    loss = mean(((yhat - y).^2) ./ (abs(y) + delta) .* (y>300 | (y<300 &
yhat>300)));
end
loss_func = @peak_sensitive_loss;

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 = [2000, 0.5, -0.9, -0.8, 3.5, 1785];
    UpperBound = [3400, 3, -0.2, -0.35, 4, 1795];

    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;
    %Params0 = [1500, 3, -0.7, -0.7, 3.6, 1790];
    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);
    [FitParams, ~] = de_curve_fit(FitModel, E_data, I_data, FitParams, options);
    %}

    %[FitParams, loss] = de_curve_fit(FitModel, E_data, I_data, Params0, options);

    %{}
    best_loss = Inf;
    for it = 1:10
        options.rng_seed = it;  % Try different seeds
        Params0 = rand(1,6) .* (UpperBound - LowerBound) + LowerBound;
        [params_i, loss_hist_i] = de_curve_fit(FitModel, E_data, I_data, Params0,
options);
        if loss_hist_i(end) < best_loss
            best_loss = loss_hist_i(end);
            FitParams = params_i;
            loss_history = loss_hist_i;
        end
    end
    %}

    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(['Temperature = ', sprintf('%d', T), ' K'])
    disp(['Loss = ', sprintf('%.4g', best_loss)]);
    disp(['I0 = ', sprintf('%.4g', I0)]);
    disp(['d_{20}/d_{10} = ', sprintf('%.4g', TransAmpR)]);
    disp(['Linewidths = [', sprintf('%.4g', Linewidth(1)), ', ', sprintf('%.4g',
Linewidth(2)) ']']);
```

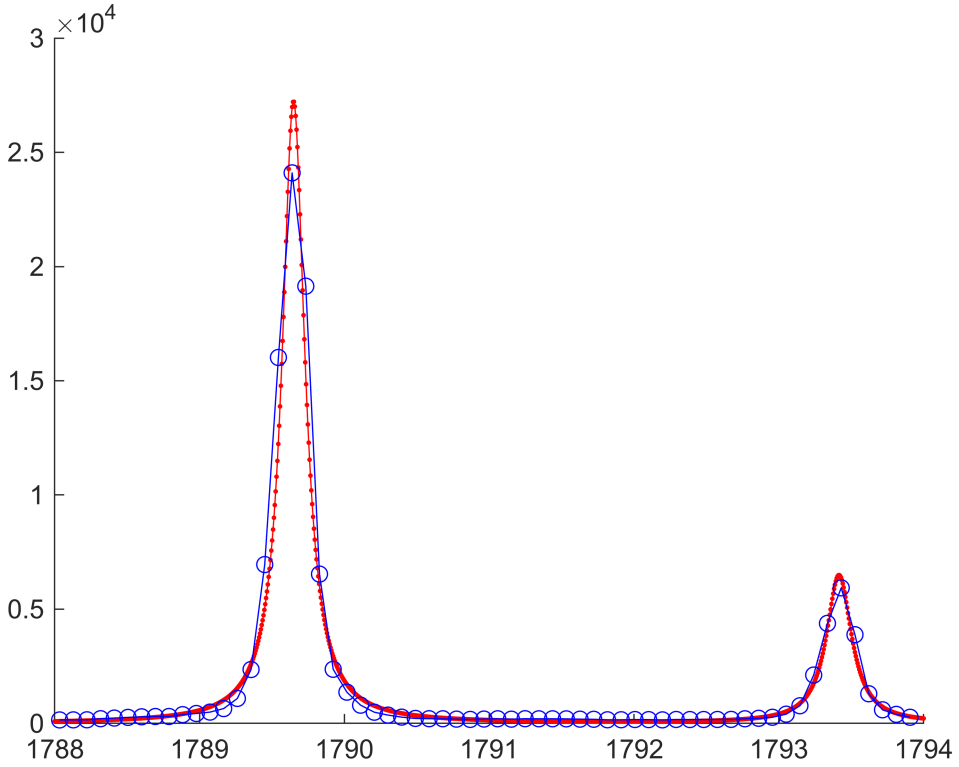
```
    disp(['Delta = ', sprintf('%.4g', Delta)]);
    disp(['E1 = ', sprintf('%.4g', E1)]);
end
```



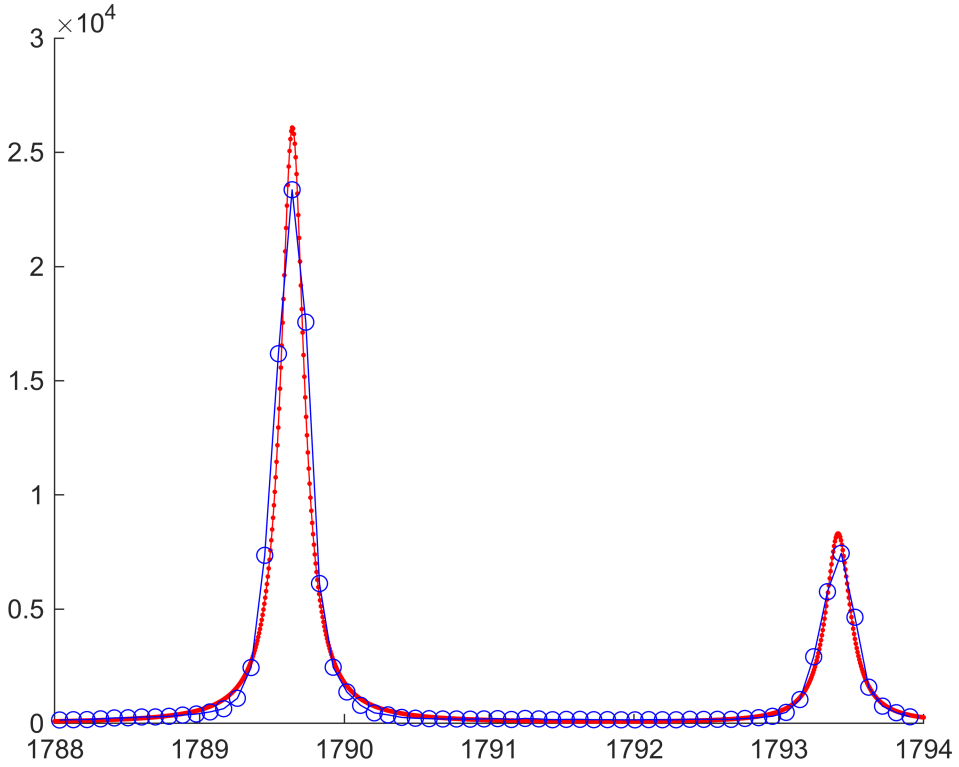

```
Loss = 84.09
I0 = 2800
d_{20}/d_{10} = 2.994
Linewidths = [0.1855, 0.2272]
Delta = 3.768
E1 = 1790
```



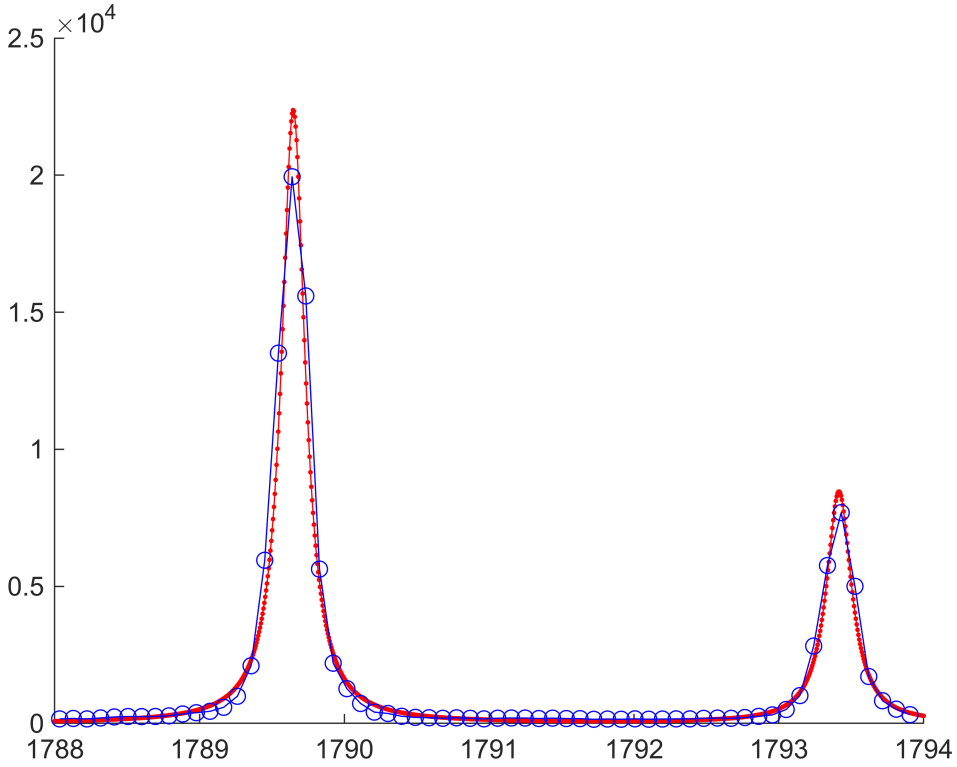

```
Loss = 73.82
I0 = 2960
d_{20}/d_{10} = 1.274
Linewidths = [0.1849, 0.2209]
Delta = 3.765
E1 = 1790
```



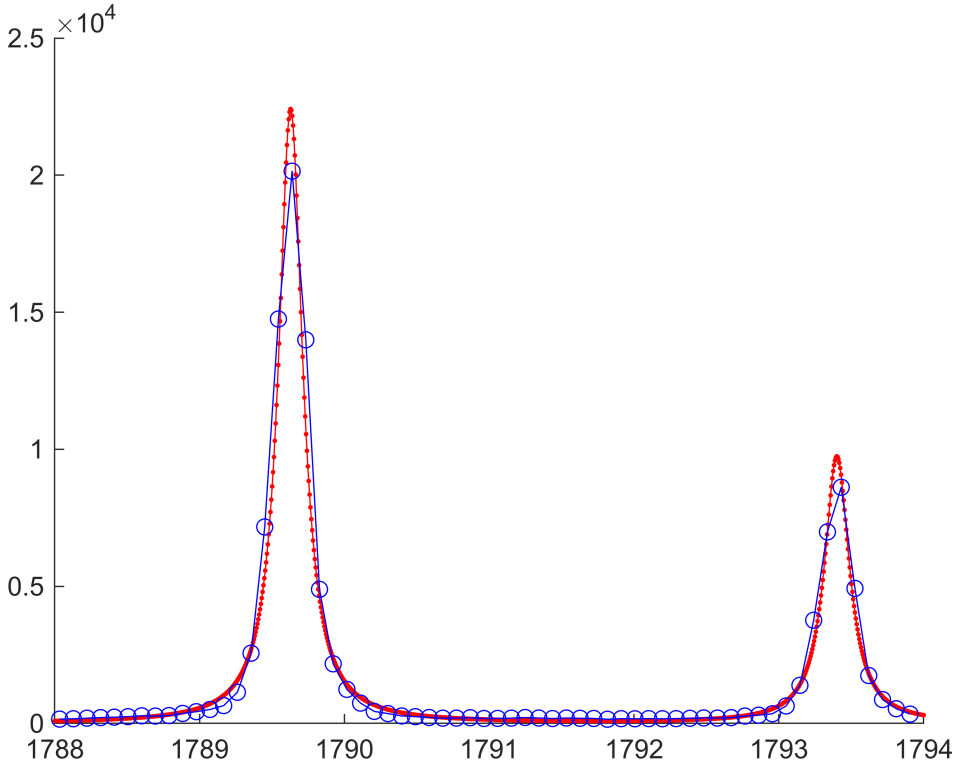

```
Loss = 67.12
I0 = 2589
d_{20}/d_{10} = 1.065
Linewidths = [0.1902, 0.2111]
Delta = 3.767
E1 = 1790
```



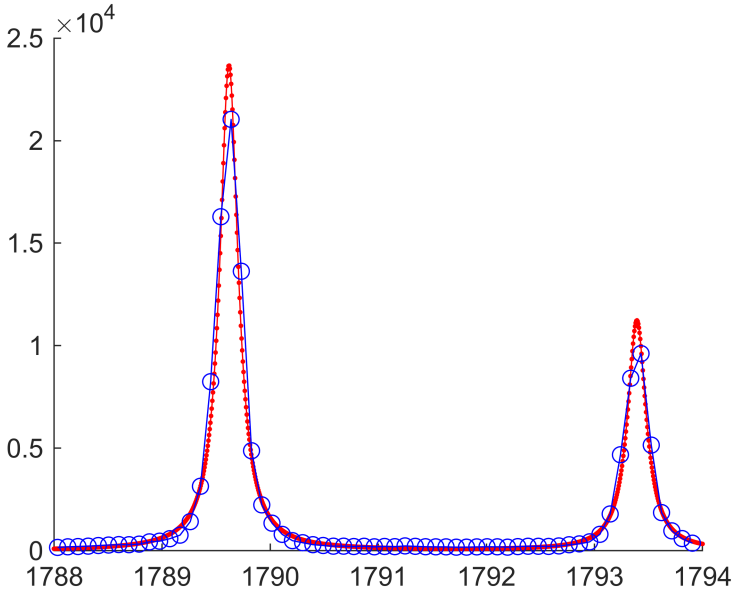

```
Loss = 66.38
I0 = 2533
d_{20}/d_{10} = 1.008
Linewidths = [0.1942, 0.2076]
Delta = 3.768
E1 = 1790
```



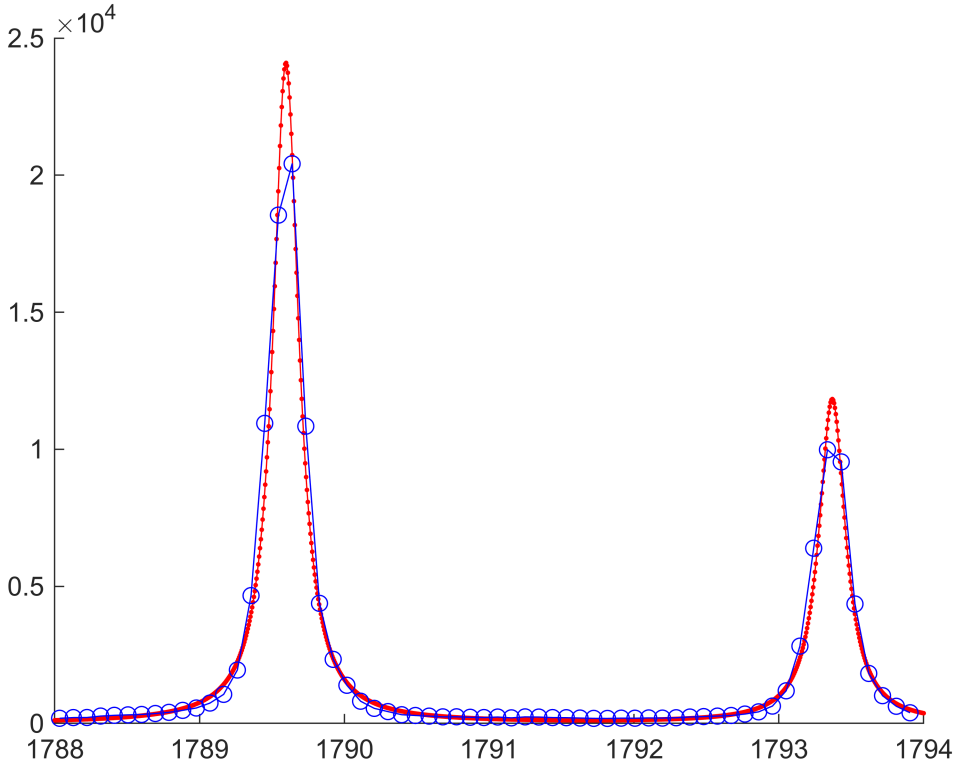

```
Loss = 51.59
I0 = 2208
d_{20}/d_{10} = 0.9836
Linewidths = [0.1974, 0.2109]
Delta = 3.768
E1 = 1790
```



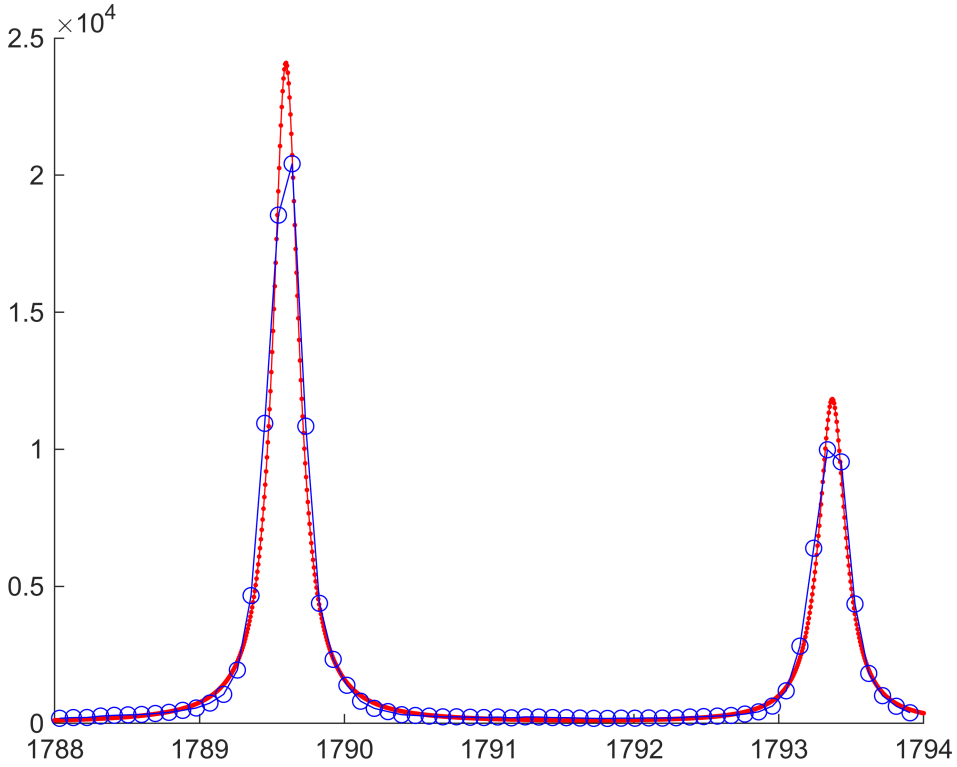

```
Loss = 46.57
I0 = 2259
d_{20}/d_{10} = 0.968
Linewidths = [0.2016, 0.2098]
Delta = 3.772
E1 = 1790
```



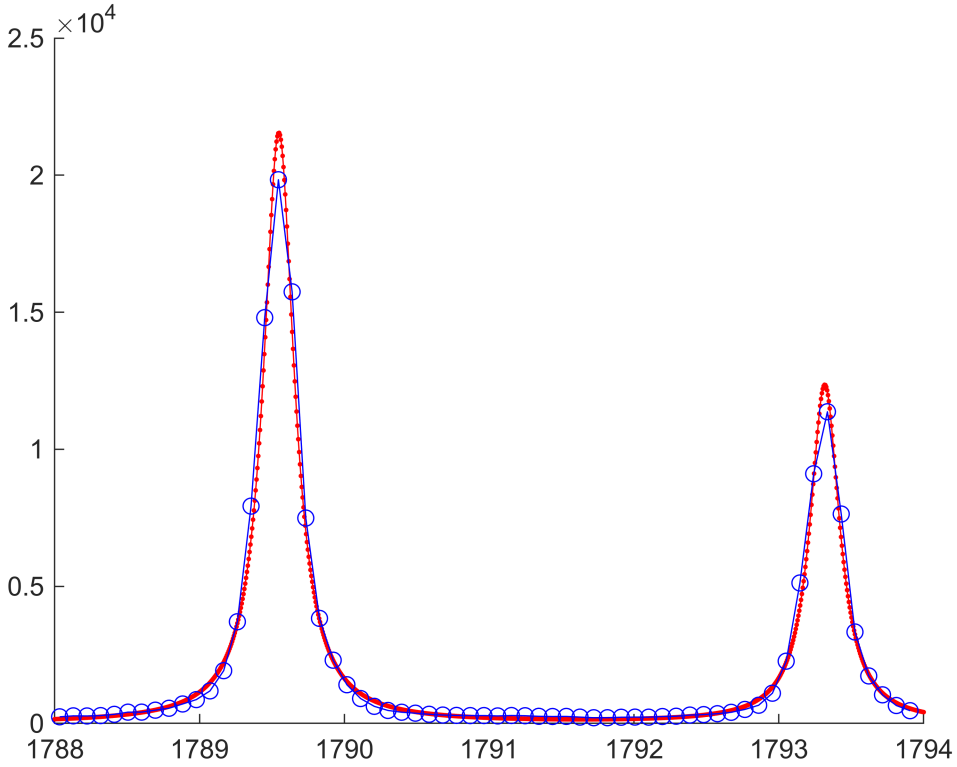

```
Loss = 41.99
I0 = 2431
d_{20}/d_{10} = 0.9494
Linewidths = [0.2054, 0.2089]
Delta = 3.773
E1 = 1790
```



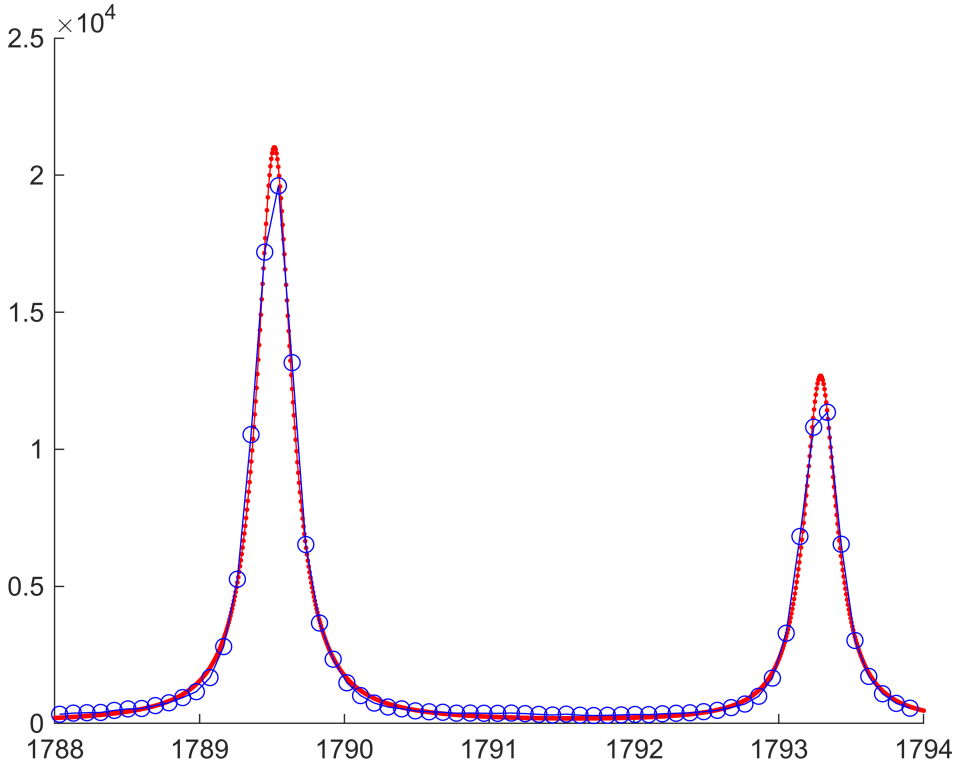

```
Loss = 34.83
I0 = 2588
d_{20}/d_{10} = 0.9383
Linewidths = [0.2149, 0.2231]
Delta = 3.772
E1 = 1790
```



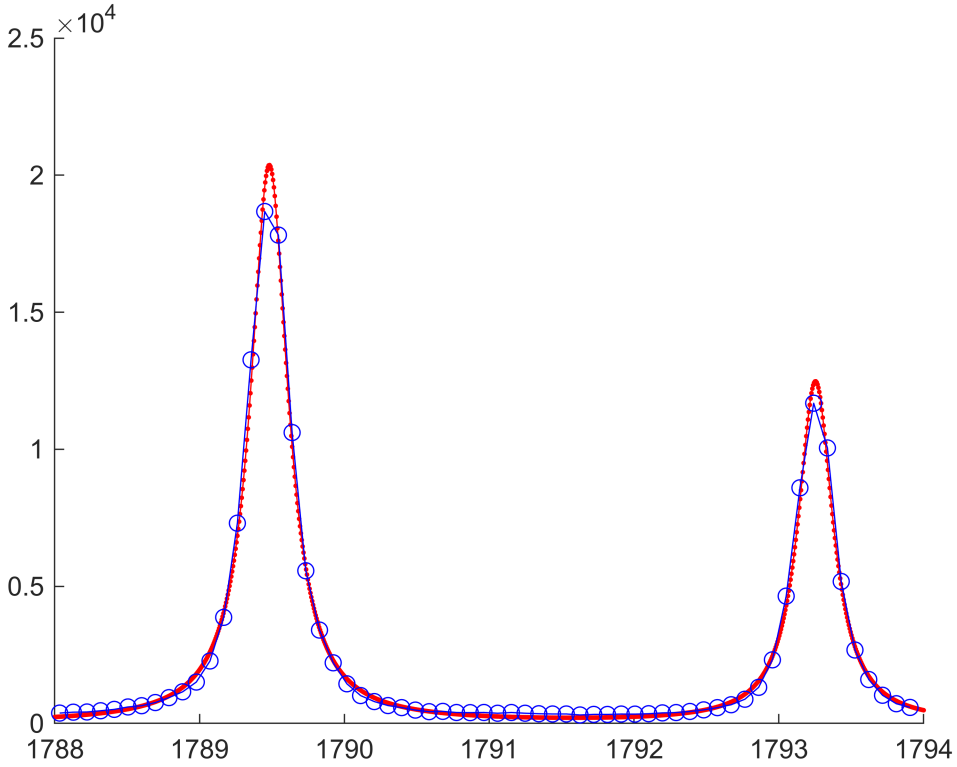

```
Loss = 34.83
I0 = 2588
d_{20}/d_{10} = 0.9102
Linewidths = [0.2149, 0.2231]
Delta = 3.772
E1 = 1790
```



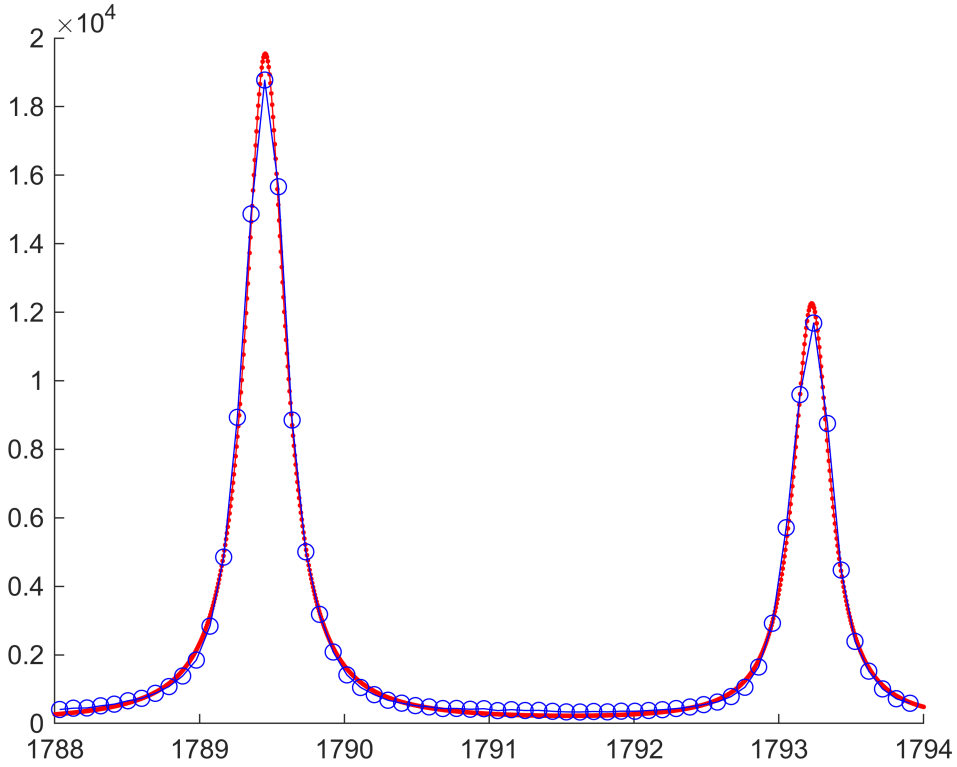

```
Loss = 23.09
I0 = 2781
d_{20}/d_{10} = 0.9226
Linewidths = [0.2583, 0.2479]
Delta = 3.77
E1 = 1790
```



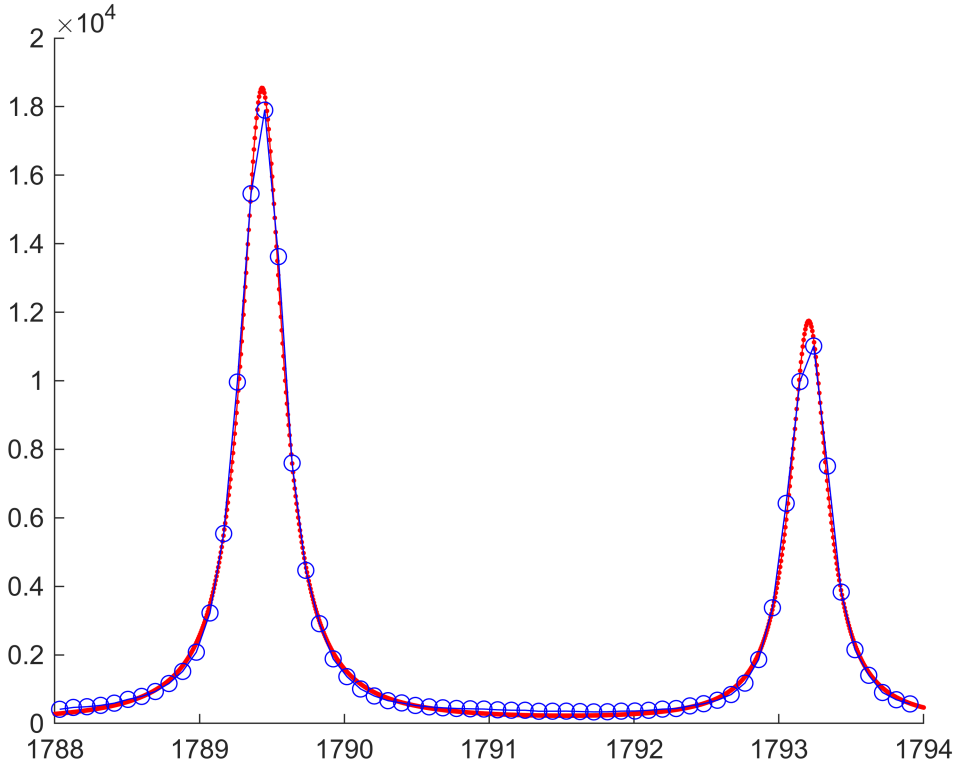

```
Loss = 24.83
I0 = 3045
d_{20}/d_{10} = 0.9174
Linewidths = [0.2899, 0.272]
Delta = 3.772
E1 = 1790
```



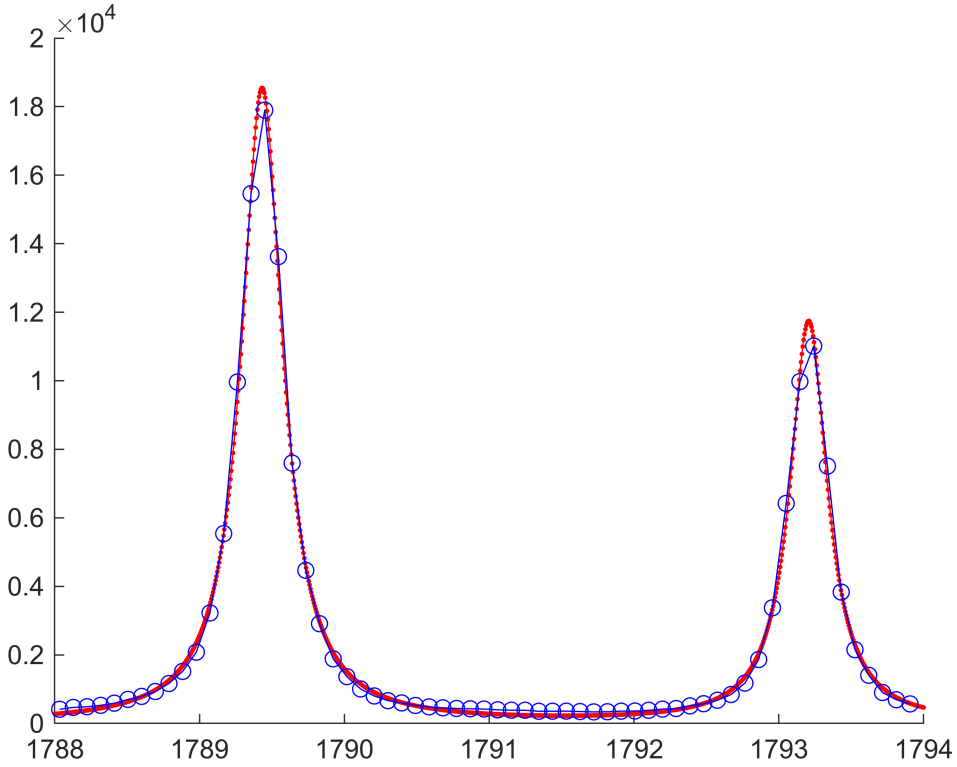

```
Loss = 22.71
I0 = 3185
d_{20}/d_{10} = 0.9057
Linewidths = [0.313, 0.2915]
Delta = 3.771
E1 = 1789
```



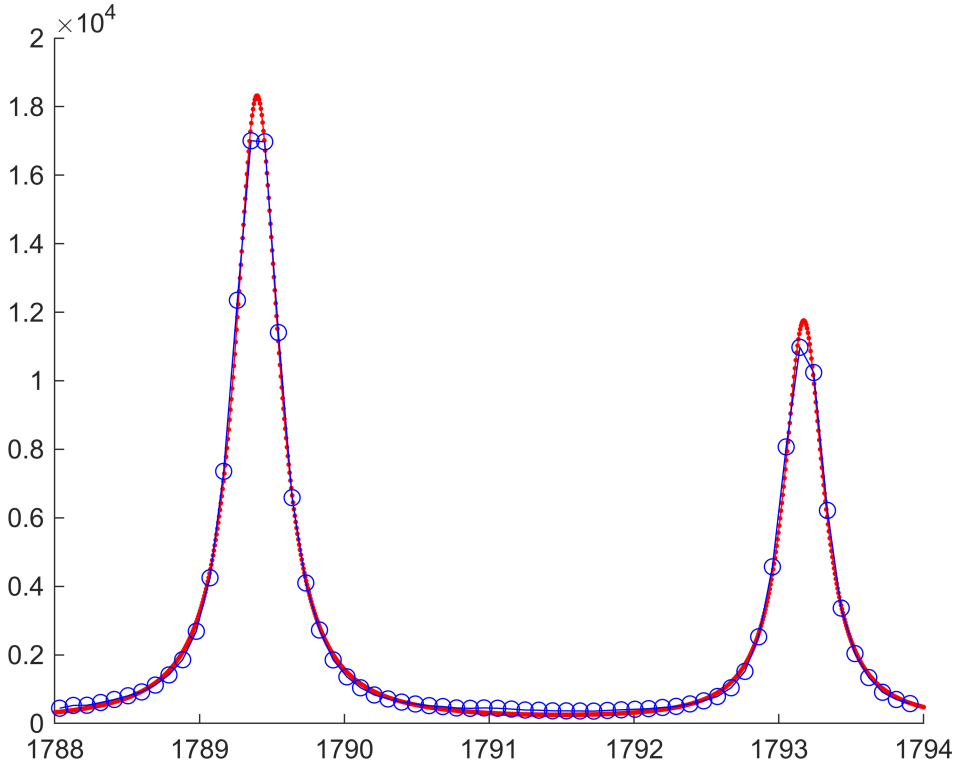

```
Loss = 18.58
I0 = 3249
d_{20}/d_{10} = 0.8956
Linewidths = [0.3327, 0.3044]
Delta = 3.774
E1 = 1789
```



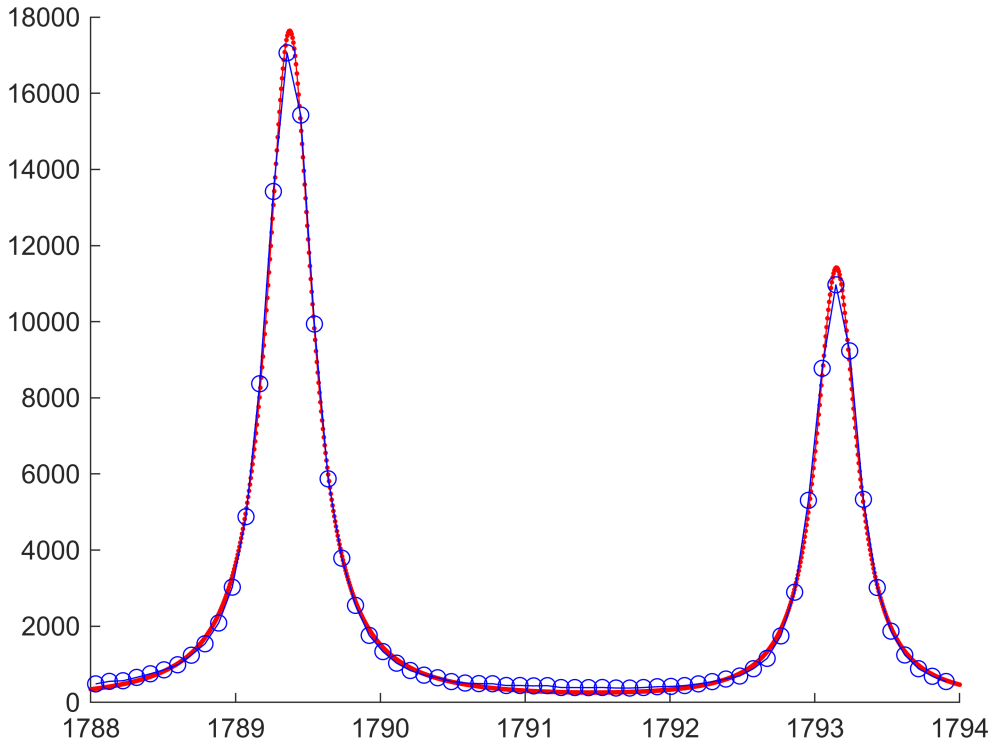

```
Loss = 17.23
I0 = 3196
d_{20}/d_{10} = 0.8851
Linewidths = [0.345, 0.3128]
Delta = 3.774
E1 = 1789
```



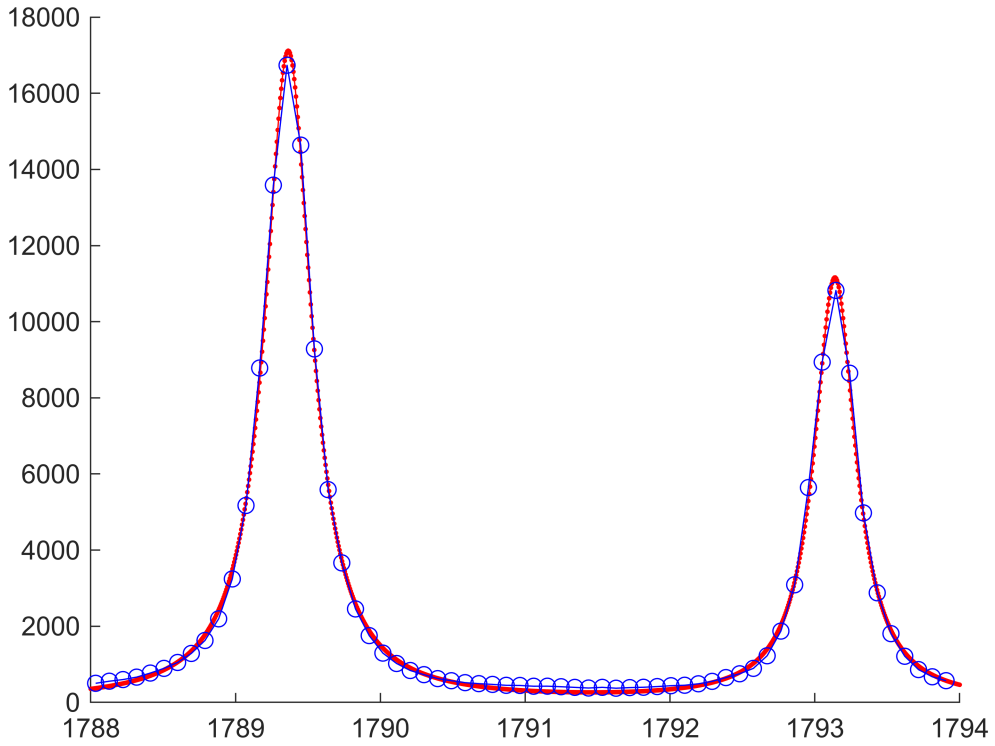

```
Loss = 17.23
I0 = 3196
d_{20}/d_{10} = 0.8759
Linewidths = [0.345, 0.3128]
Delta = 3.774
E1 = 1789
```



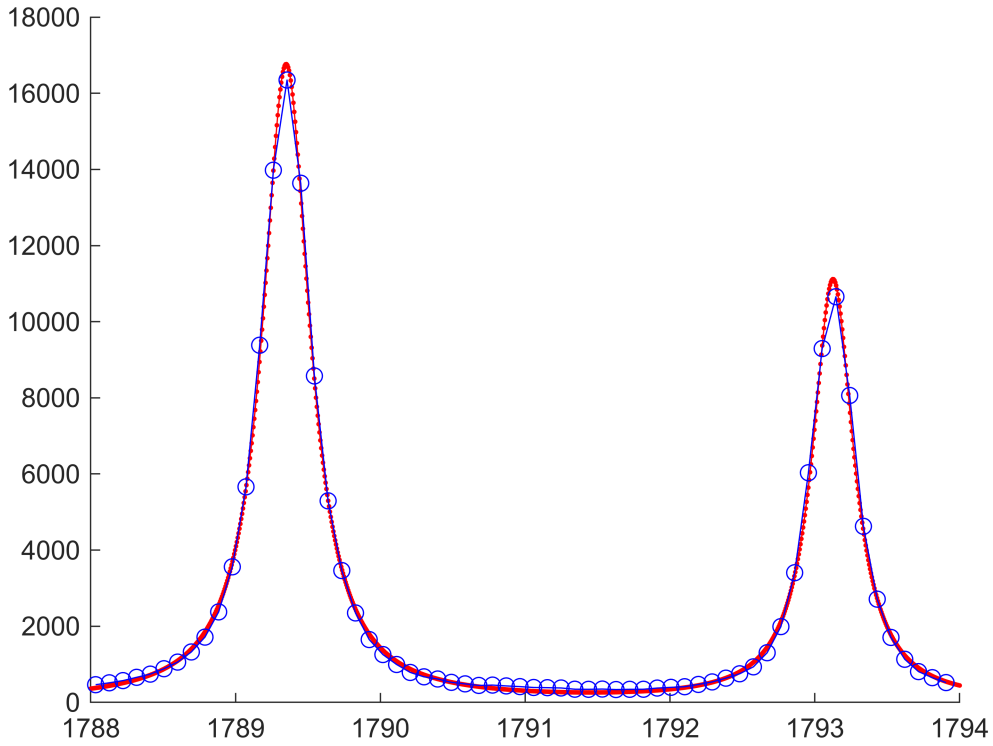

```
Loss = 15.01
I0 = 3351
d_{20}/d_{10} = 0.8712
Linewidths = [0.3662, 0.3301]
Delta = 3.775
E1 = 1789
```



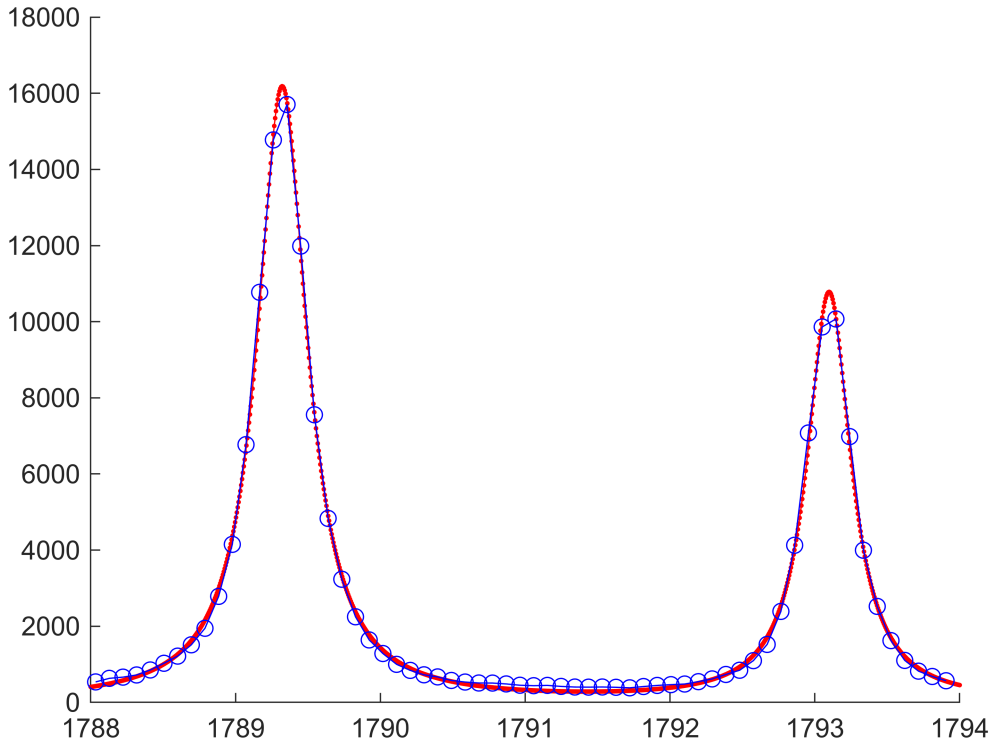

```
Loss = 14.43
I0 = 3348
d_{20}/d_{10} = 0.8648
Linewidths = [0.3801, 0.3402]
Delta = 3.775
E1 = 1789
```



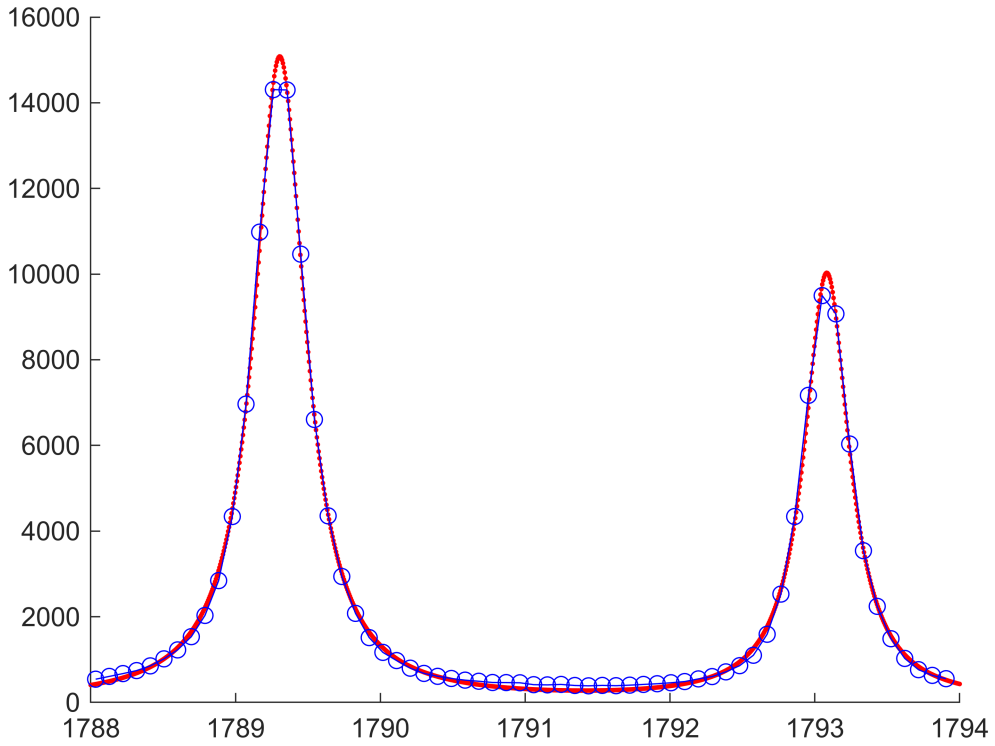

```
Loss = 13.32
I0 = 3329
d_{20}/d_{10} = 0.8595
Linewidths = [0.3895, 0.3469]
Delta = 3.775
E1 = 1789
```



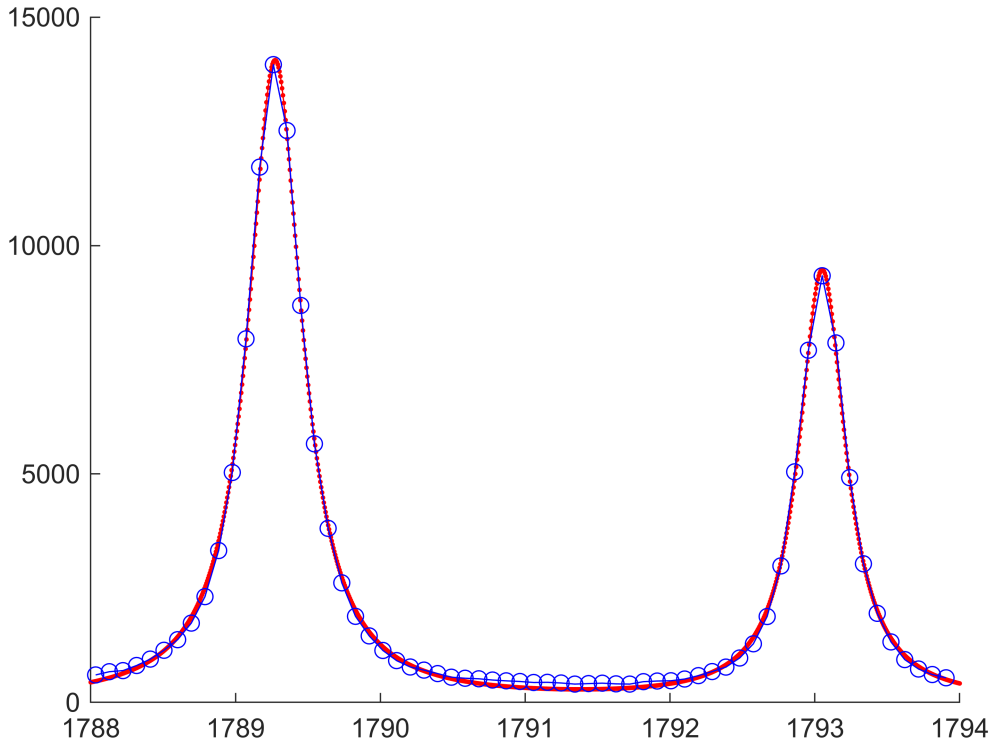

```
Loss = 8.378
I0 = 3294
d_{20}/d_{10} = 0.8547
Linewidths = [0.3934, 0.345]
Delta = 3.776
E1 = 1789
```



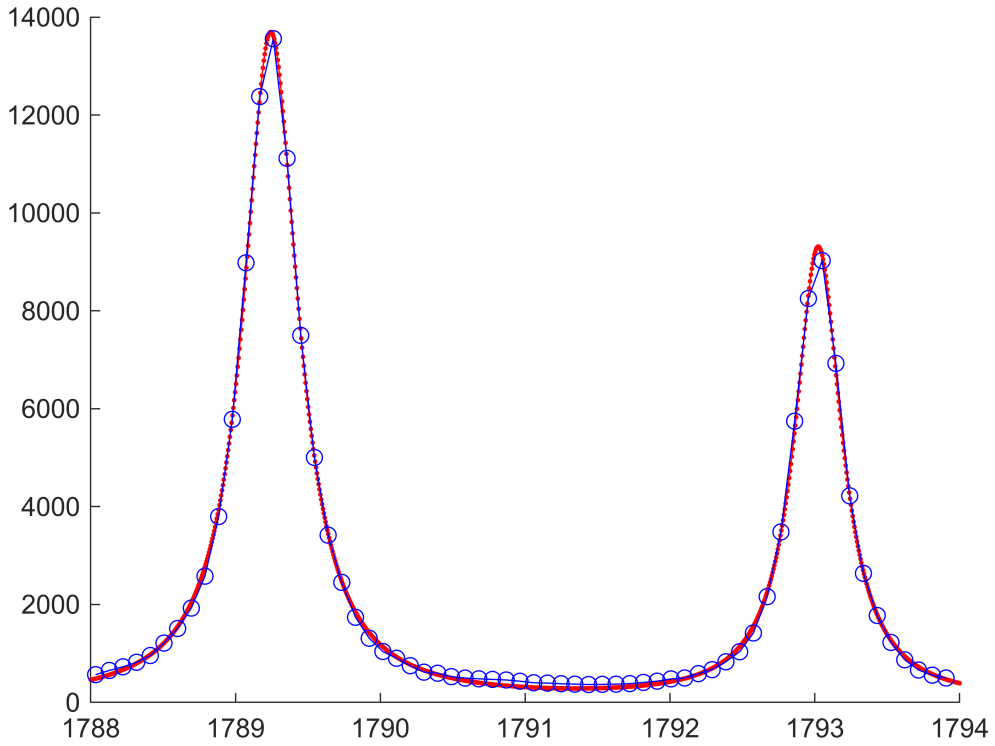

```
Loss = 11.51
I0 = 3370
d_{20}/d_{10} = 0.8512
Linewidths = [0.4171, 0.3654]
Delta = 3.776
E1 = 1789
```



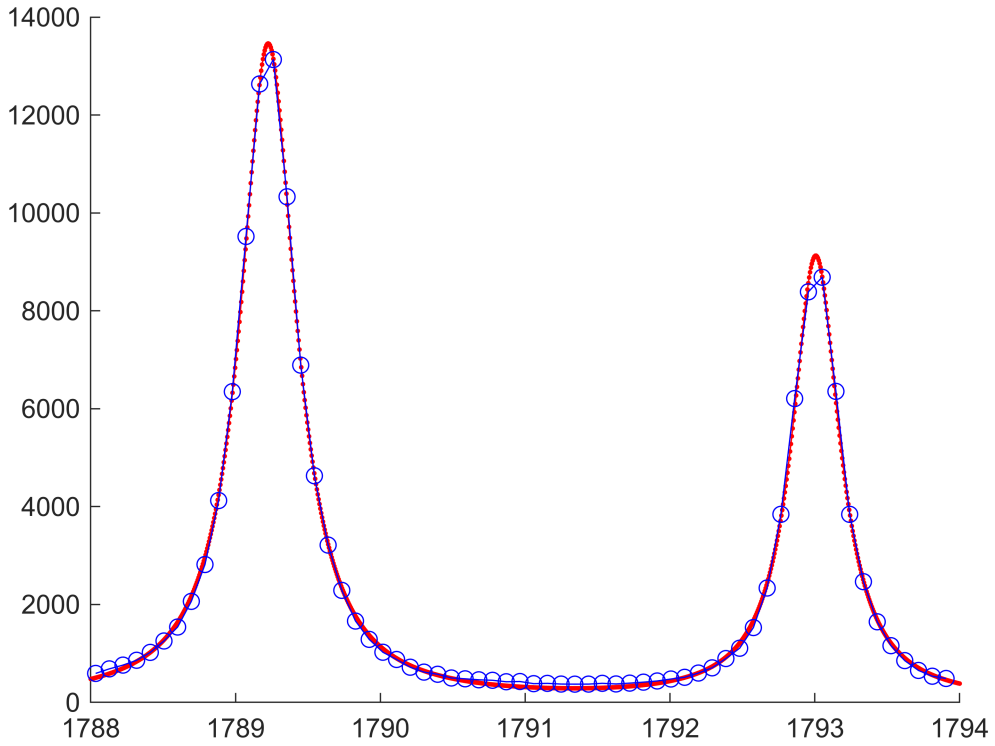

```
Loss = 10.94
I0 = 3211
d_{20}/d_{10} = 0.8468
Linewidths = [0.4265, 0.3745]
Delta = 3.777
E1 = 1789
```



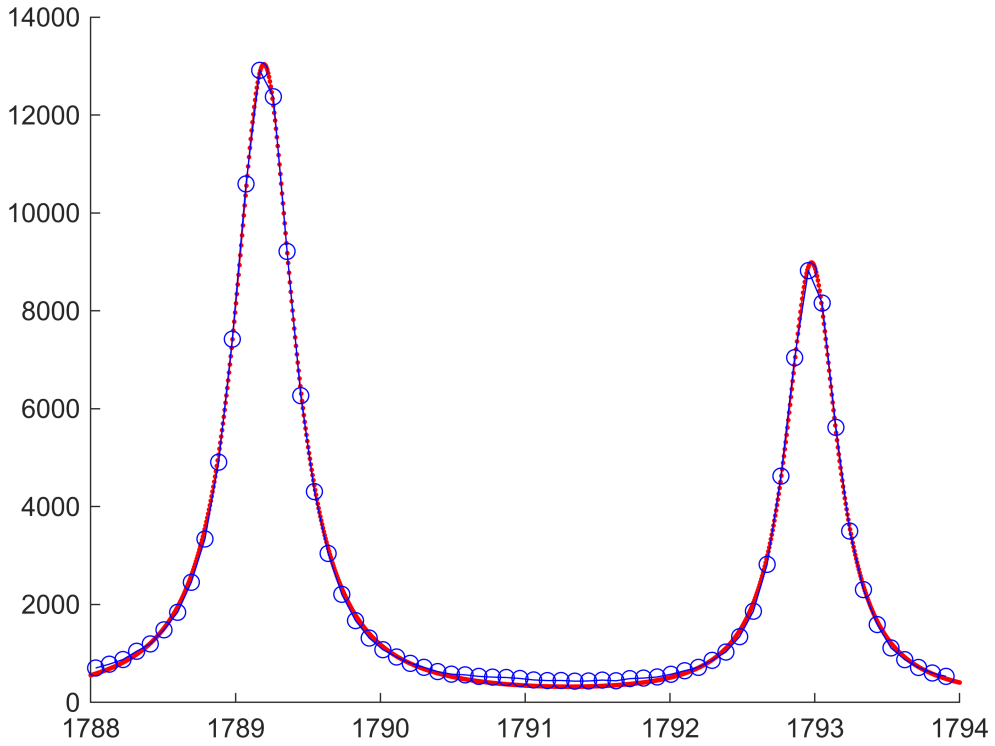

```
Loss = 10.99
I0 = 3162
d_{20}/d_{10} = 0.8433
Linewidths = [0.4507, 0.391]
Delta = 3.778
E1 = 1789
```



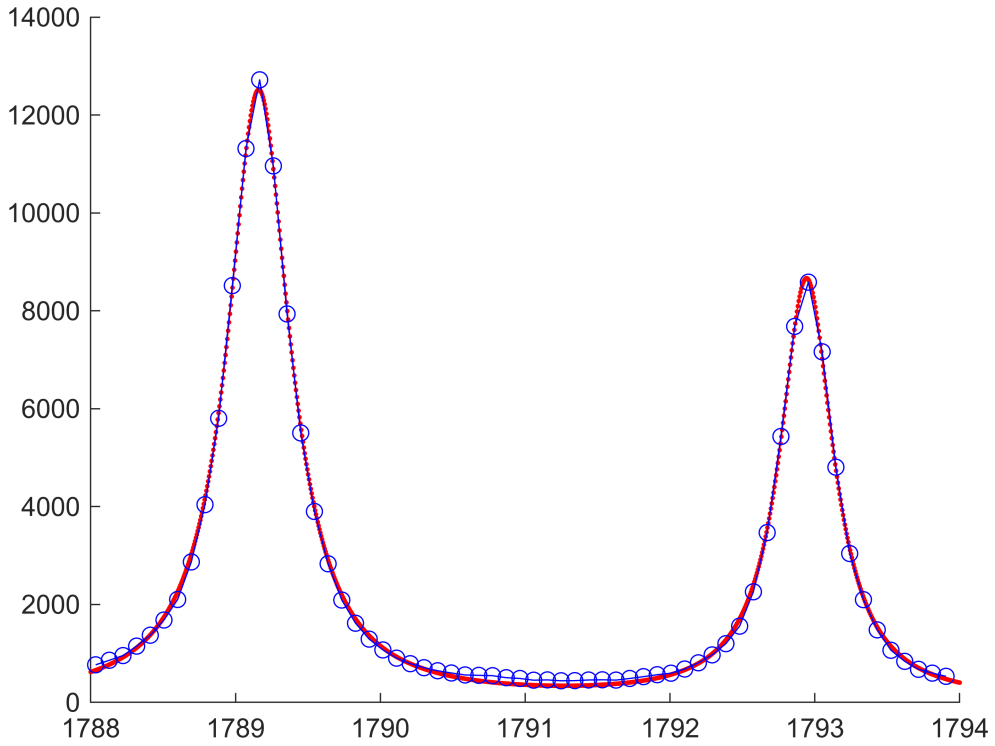

```
Loss = 6.682
I0 = 3123
d_{20}/d_{10} = 0.8397
Linewidths = [0.4569, 0.3929]
Delta = 3.78
E1 = 1789
```



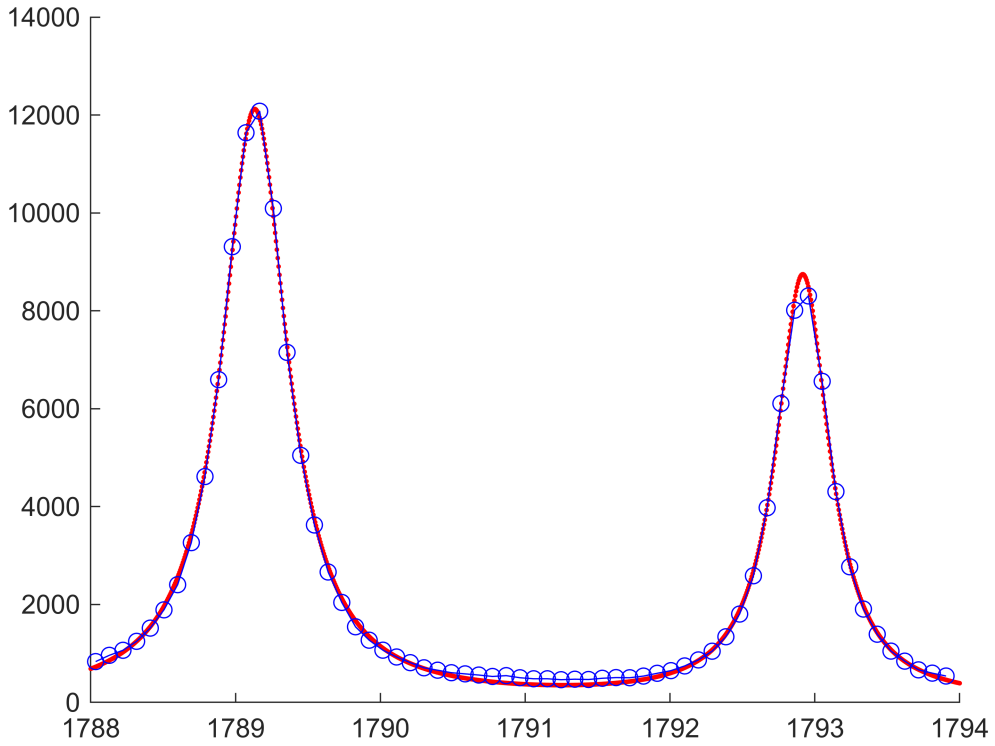

```
Loss = 5.815
I0 = 3111
d_{20}/d_{10} = 0.8367
Linewidths = [0.4631, 0.3997]
Delta = 3.781
E1 = 1789
```



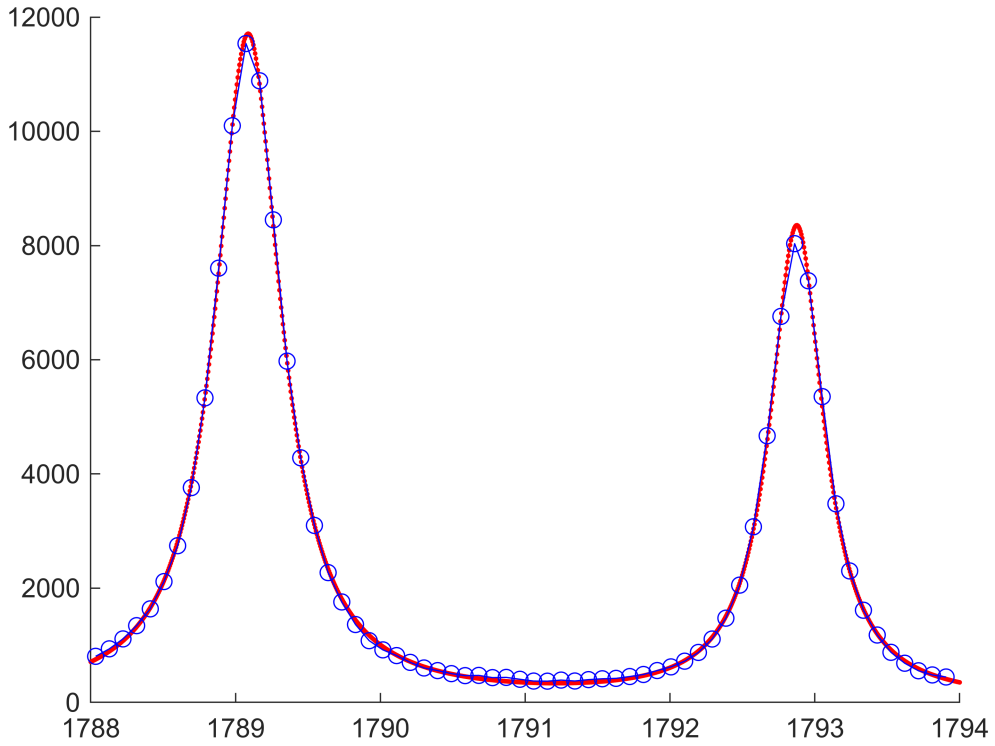

```
Loss = 9.268
I0 = 3235
d_{20}/d_{10} = 0.8373
Linewidths = [0.4974, 0.4261]
Delta = 3.781
E1 = 1789
```



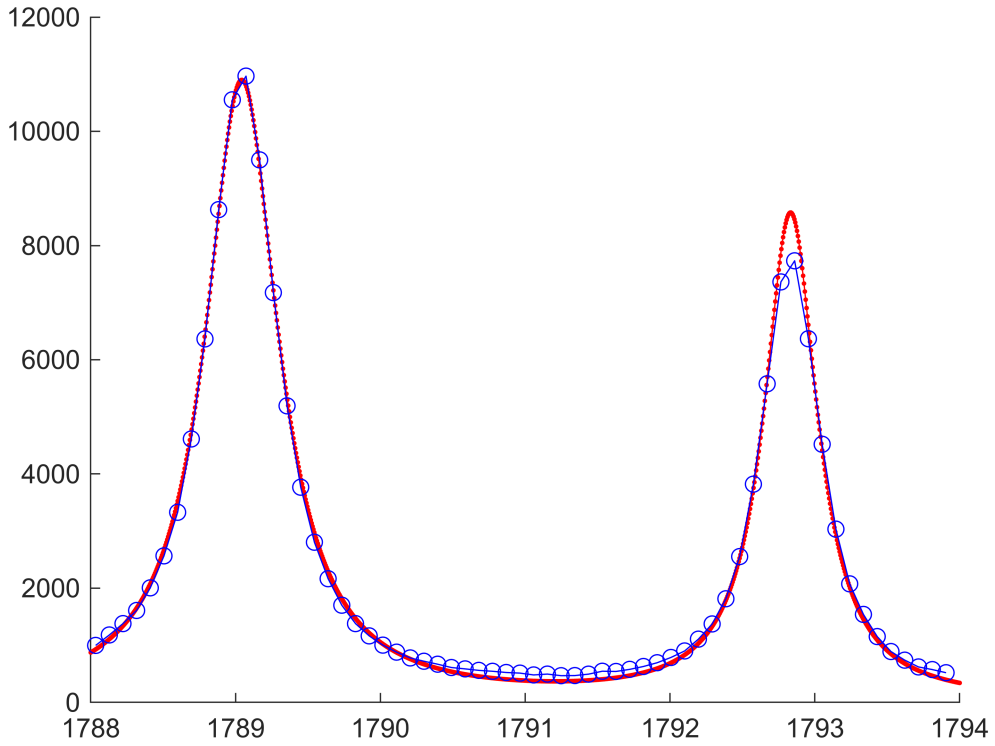

```
Loss = 7.417
I0 = 3268
d_{20}/d_{10} = 0.8346
Linewidths = [0.5233, 0.4467]
Delta = 3.782
E1 = 1789
```




```
Loss = 7.883
I0 = 3315
d_{20}/d_{10} = 0.8298
Linewidths = [0.5482, 0.4467]
Delta = 3.784
E1 = 1789
```




```
Loss = 2.01
I0 = 3189
d_{20}/d_{10} = 0.8244
Linewidths = [0.5461, 0.4467]
Delta = 3.788
E1 = 1789
```




```
Loss = 10.54
I0 = 3315
d_{20}/d_{10} = 0.8168
Linewidths = [0.6098, 0.4467]
Delta = 3.79
E1 = 1789
```