Supporting information

Table of Contents

Figures

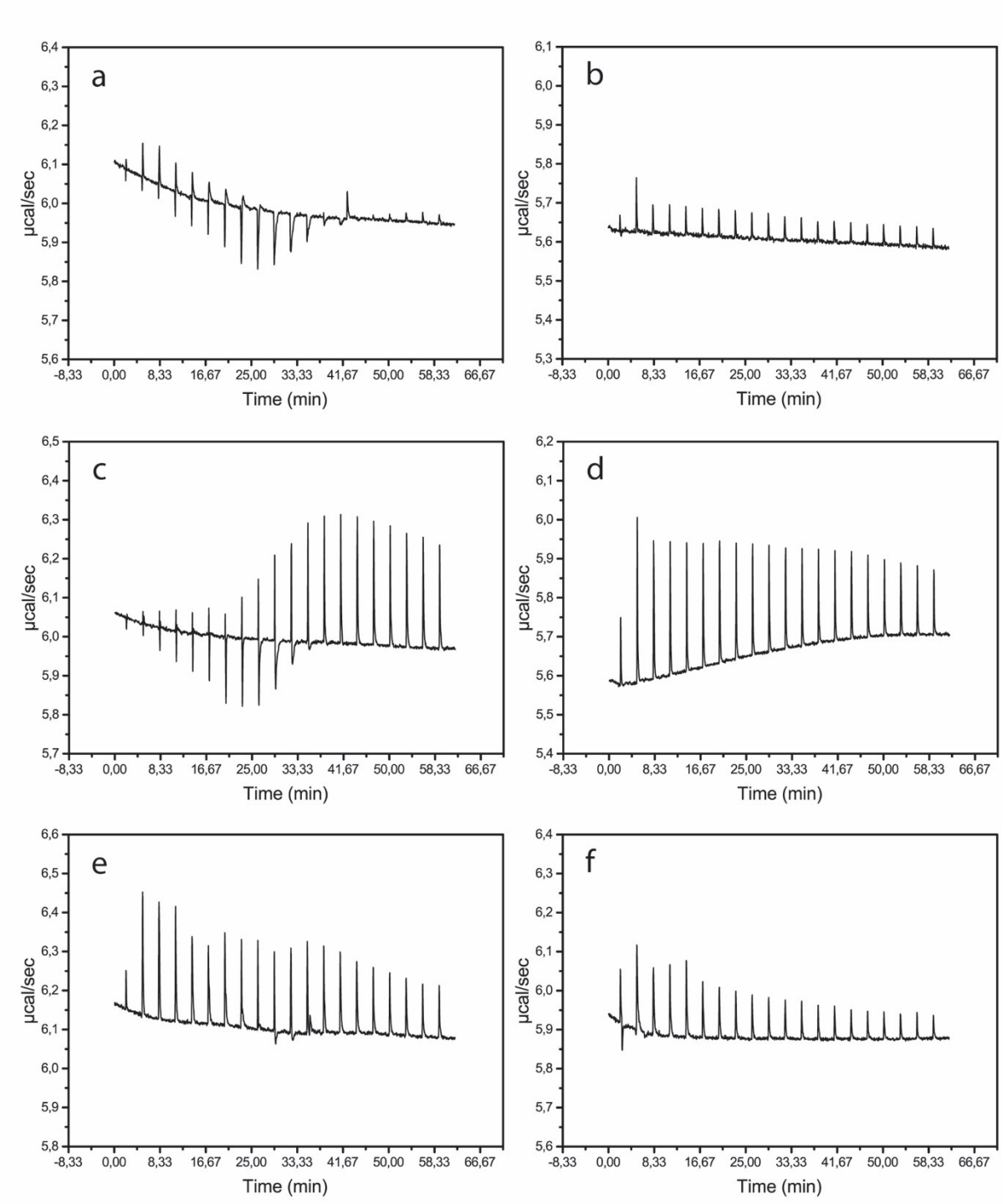

Figure S1 ITC raw data for the titration of the Δ-enantiomer of (a) **1** to AT-DNA; (b) **1** to buffer; (c) **2** to AT-DNA; (d) **2** to buffer; (e) **3** to AT-DNA; (f) **3** to buffer. All titrations were performed in 150 mM NaCl aqueous solution at 25°C. Complex (~590 µM) was injected in 2 µl aliquots to the 206 µl cell containing the DNA (~320 µM nucleotides).

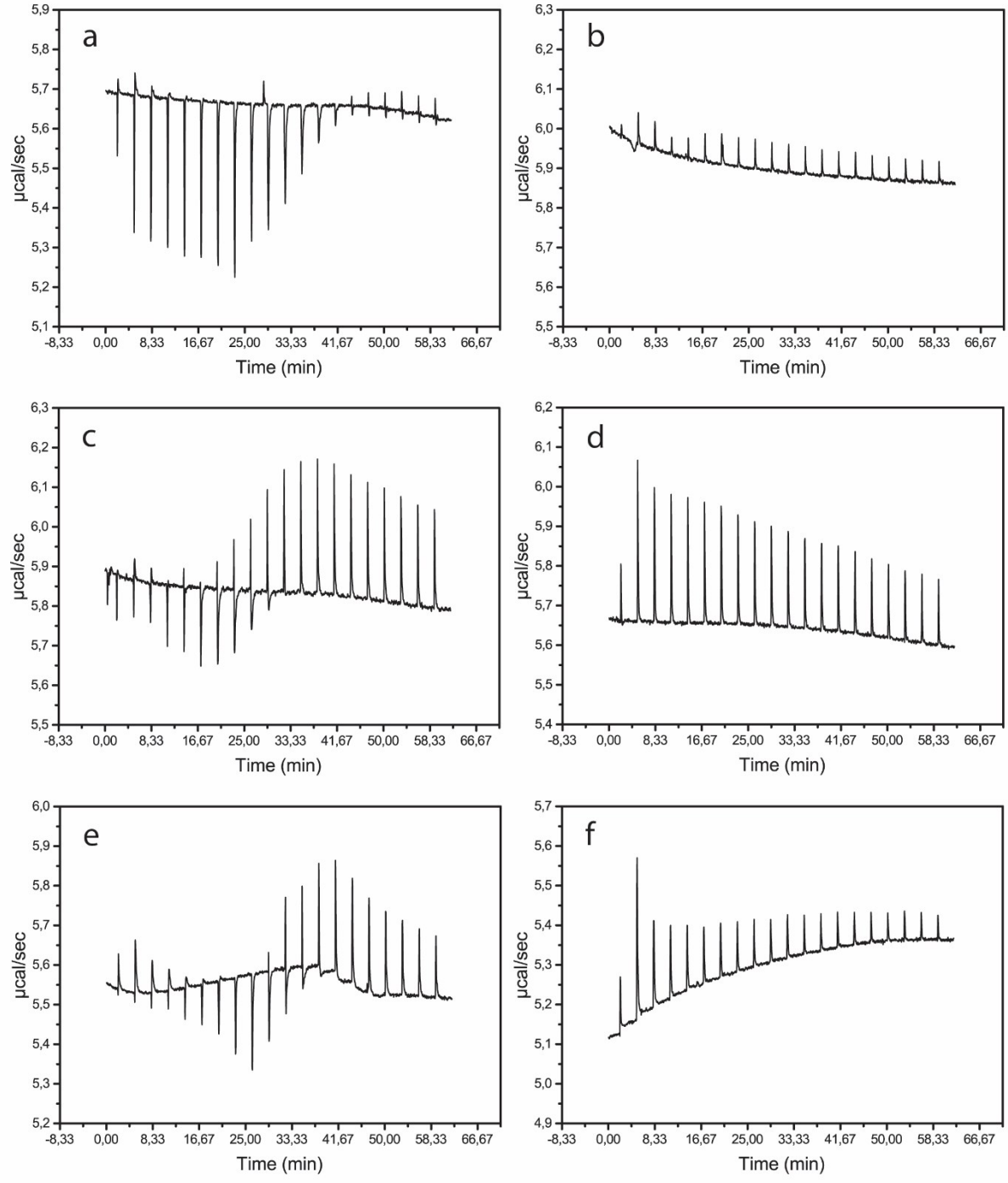

Figure S2 ITC raw data for the titration of the Λ-enantiomer of (a) **1** to AT-DNA; (b) **1** to buffer; (c) **2** to AT-DNA; (d) **2** to buffer; (e) **3** to AT-DNA; (f) **3** to buffer. All titrations were performed in 150 mM NaCl aqueous solution at 25°C. Complex (~590 µM) was injected in 2 µl aliquots to the 206 µl cell containing the DNA (~320 µM nucleotides).

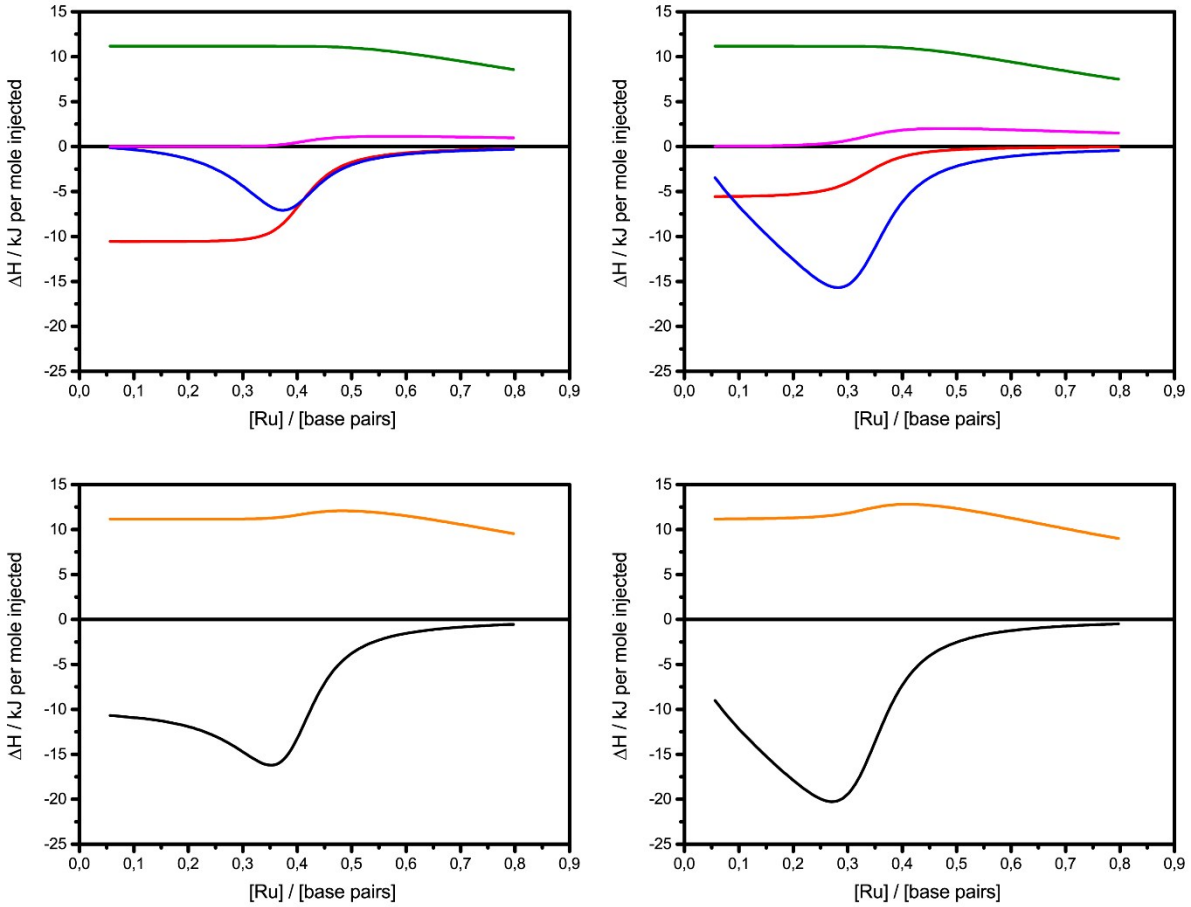

Figure S3 ITC profiles with fitted traces for the titrations of Δ-**2** (left) and Λ-**2** (right) to poly(dAdT)$_2$. Each trace show the different contributions of enthalpy change for the ligand-DNA binding interaction; Green: dilution of free ligand; Red: intercalation; Blue: neighbor interactions; Magenta: external binding; Orange: background (dilution + external); Black: ITC signal with background enthalpy removed.

Programs

ITCalgorithmDeltaLambda

```
function [err,err0,sim,heat]=ITCalgorithmDeltaLambda(tpar,totdata1,totdata2,A0)
%Calculates the ITC curves for binding of enantiomer ligands La and Lb
%that form single symmetrical subunits when binding
%to an infinite chain of identical binding sites D using
%the combined SGF-McGhee von Hippel approach. The oligomerization of L in solution
%and the further binding of L to the saturated lattice are both taken into account.

%INPUT:
%tpar=[1) Ka  2) yAA 3) na 4) Kb 5) yBB 6) nb 7) Km 8) m-2]
%there Km is the equilibrium constant for oligomerization: m L <-> Lm

%totdata1=[ITC-dilution ITC-data D0 La] Delta enantiomer data
%totdata1=[ITC-dilution ITC-data D0 Lb] Lambda enantiomer data
%(4*19) X 4 matrix with data and total
%concentrations, preferably with total concentrations of L in increasing order

%A0 = concentration in injectant stock solution

%OUTPUT:
%err = least square error of fit to data including penalty for very high
%entalpy and parameter values
%err0 = least square error of fit to data
%sim = [ITC-data  simulated data]

%heat = calculated heat of reaction

if min(tpar)<=0
    err=1e6;
else
Km=tpar(7)/1000;
m=tpar(8)+2;
data=[(totdata1(2:end,1)+totdata2(2:end,1))/2;totdata1(2:end,2);totdata2(2:end,2)];
%The dilution data for La and Lb are averaged.

L=1;
q=1;
while norm(q)>1e-10
    q=L+m*Km*L^m-A0;
    dqdL=1+m^2*Km*L^(m-1);
    dL=q/dqdL;
    while norm(L-dL)<=0
        dL=dL/3;
    end
    L=L-dL;
end
    M0=Km*L^m;


%Dilution
tot=totdata1(:,4);
C=[];
for t=tot'
    L=1;
q=1;
while norm(q)>1e-10
    q=L+m*Km*L^m-t;
    dqdL=1+m^2*Km*L^(m-1);
    dL=q/dqdL;
    while norm(L-dL)<=0
        dL=dL/3;
    end
    L=L-dL;
end
    C=[C;Km*L^m];
end
dc0=C(2:end,1)-(204*C(1:end-1,1)+2*M0)/206;
dc1=dc0/(2*A0/206);

%Delta:
par=tpar(1:3);
K=par(1);
Y=[1 1 ;1 par(2)];
```

```
n=par(3);
C0=totdata1(:,3:4);
r=0.01;
conc=[];
for t=C0';
    D0=t(1);
    L0=t(2);
    q=1;
    while norm(q)>1e-9;
       s=1./(Y*[1;r]);
       P=diag(s)*Y*diag([1;r]);
       v=1-P(2,2)+n*P(1,2);
       f=inv(v)*P(1,2);
       x=s(2)*r/(s(1)^n);
       q=x/K+f*D0+m*Km*(x/K)^m-L0;
       u=inv(v)*(f-P(:,2)'*diag([1-n*f;f])*P(:,2));
       dqdr=(D0*u+(x/K)*(1+m^2*Km*(x/K)^(m-1))*v)/r;
       dr=q/dqdr;
       while min(r-dr)<=0
             dr=dr/3;
       end
       r=r-dr;
    end
    conc=[conc;[(Km*(x/K)^m)-M0 D0*f*[1 P(2,2) 0.001*x/K] ]];
end
dc2=[conc(2:end,:)-conc(1:end-1,:)*204/206]/(2*A0/206);

%Lambda:
par=tpar(4:6);
K=par(1);
Y=[1 1 ;1 par(2)];
n=par(3);
C0=totdata2(:,3:4);
r=0.01;
conc=[];
for t=C0';
    D0=t(1);
    L0=t(2);
    q=1;
    while norm(q)>1e-9;
       s=1./(Y*[1;r]);
       P=diag(s)*Y*diag([1;r]);
       v=1-P(2,2)+n*P(1,2);
       f=inv(v)*P(1,2);
       x=s(2)*r/(s(1)^n);
       q=x/K+f*D0+m*Km*(x/K)^m-L0;
       u=inv(v)*(f-P(:,2)'*diag([1-n*f;f])*P(:,2));
       dqdr=(D0*u+(x/K)*(1+m^2*Km*(x/K)^(m-1))*v)/r;
       dr=q/dqdr;
       while min(r-dr)<=0
             dr=dr/3;
       end
       r=r-dr;
    end
    conc=[conc;[(Km*(x/K)^m)-M0 D0*f*[1 P(2,2) 0.001*x/K] ]];
end
dc3=[conc(2:end,:)-conc(1:end-1,:)*204/206]/(2*A0/206);

ze1=zeros(size(dc1(:,1)));

dc=[ dc1 ze1 ze1 ze1 ze1 ze1 ze1;dc2 ze1 ze1 ze1 ;dc3(:,1) ze1 ze1 ze1 dc3(:,2:4)];

heat=pinv(dc)*data;
    sim=dc*heat;
    err0=norm(data-sim,'fro');
    err=err0;
    err=err+norm(tpar)/220;         %Penalty for guess with very high parameter values
    err=err+norm(heat,'fro')/75;  %Penalty for guess that result in very high enthalpy values
    sim=[data sim];
end
```

GlobalITC

```
function [err,err0,sim,heat,terr,terr0,tvar]=GlobalITC(var,d1,d2,d3,d4,d5,d6,A0)
%Global fit of 3 ITC titrations of Delta and Lambda enantiomers of 3
%different compounds, sharing the same KD, KL, yDD and yLL binding parameters. n-values
%are allowed to vary between the 3 pairs of enantiomers, while heat of dilution is
%the same for Delta and Lambda.
%No:   1  2  3   4  5   6  7  8  9 10  11  12   13   14   15   16
%var=[KD KL yDD yLL n1 n2 n3 n4 n5 n6 Km12 Km34 Km56 m12  m34  m56  ]
%A0=stock solution conc för 1-6
if min(var)<=0
    err=1e6;
else
[err1,err01,sim1,heat1]=ITCalgorithmDeltaLambda(var([1 3 5 2 4 6 11 14]),d1,d2,A0);

[err2,err02,sim2,heat2]=ITCalgorithmDeltaLambda(var([1 3 7 2 4 8 12 15]),d3,d4,A0);

[err3,err03,sim3,heat3]=ITCalgorithmDeltaLambda(var([1 3 9 2 4 10 13 16]),d5,d6,A0);
terr=[err1 err2 err3];
terr0=[err01 err02 err03];
err=norm(terr);
err0=norm(terr0);
sim=[sim1;sim2;sim3];
heat=[heat1 heat2 heat3];
tvar=[var([1 3 5 2 4 6 11 14]);var([1 3 7 2 4 8 12 15]);var([1 3 9 2 4 10 13 16])];
end
```

MATLAB workspace

The initial guess for this global fit is based on fits of individual datasets using ITCalgorithmDeltaLambda. The search is restarted until no further reduction of the error is noted.

For information on what the numerical values etc. represent, see comments in the programs above or MATLAB documentation.

```
>> options=optimset('Display','Iter','MaxIter',24000,'MaxFunEvals',48000,'TolX',1e-6,'TolFun',1e-6);
>> Initguess=[10 1 1 3 2 2 2 2.5 2 2 .5 .01 .4 .01 1 .5];
>> tic;Bestfit=fminsearch('GlobalITC',Initguess,options,D1,L1,D2,L2,D3,L3,595);toc
…
13692      17930       8.26786       shrink
Optimization terminated:
 the current x satisfies the termination criteria using OPTIONS.TolX of 1.000000e-06
 and F(X) satisfies the convergence criteria using OPTIONS.TolFun of 1.000000e-06
Elapsed time is 332.361541 seconds.
>> tic;Bestfit=fminsearch('GlobalITC', Bestfit,options,D1,L1,D2,L2,D3,L3,595);toc
…
8463      11179       8.21745       shrink
Optimization terminated:
 the current x satisfies the termination criteria using OPTIONS.TolX of 1.000000e-06
 and F(X) satisfies the convergence criteria using OPTIONS.TolFun of 1.000000e-06
Elapsed time is 204.539907 seconds.
>> tic;Bestfit=fminsearch('GlobalITC',Bestfit,options,D1,L1,D2,L2,D3,L3,595);toc
…
8167      10802       8.19854       shrink
Optimization terminated:
 the current x satisfies the termination criteria using OPTIONS.TolX of 1.000000e-06
 and F(X) satisfies the convergence criteria using OPTIONS.TolFun of 1.000000e-06
Elapsed time is 196.558224 seconds.
>> tic;Bestfit=fminsearch('GlobalITC',Bestfit,options,D1,L1,D2,L2,D3,L3,595);toc
…
2745       3756       8.19836       shrink
Optimization terminated:
 the current x satisfies the termination criteria using OPTIONS.TolX of 1.000000e-06
 and F(X) satisfies the convergence criteria using OPTIONS.TolFun of 1.000000e-06
Elapsed time is 72.861021 seconds.
>> tic;Bestfit=fminsearch('GlobalITC',Bestfit,options,D1,L1,D2,L2,D3,L3,595);toc
```

…

482 856 8.19836 reflect

Optimization terminated:

the current x satisfies the termination criteria using OPTIONS.TolX of 1.000000e-06

and F(X) satisfies the convergence criteria using OPTIONS.TolFun of 1.000000e-06

Elapsed time is 16.680446 seconds.

>> [err,err0,sim,heat,terr,terr0,tvar]=GlobalITC(Bestfit,D1,L1,D2,L2,D3,L3,595);

>> err0

err0 =

6.1998

>> Bestfit

Bestfit =

Columns 1 through 8

41.389 0.27884 0.38022 3.4107 2.166 2.2949 2.2537 2.9887

Columns 9 through 16

2.235 2.2463 0.40589 0.0098819 0.36508 1.7433e-22 1.0198 0.67749

>> heat

heat =

-19.497 -53.73 -37.039

1.1894 -10.448 0.41634

-7.7106 -4.2695 -4.3563

-9.9474 20.846 23.757

-4.5145 -6.1307 -0.22318

-13.682 -14.811 -16.324

-4.7473 50.509 92.476

Indata matrices:

Column order: Titration into buffer Titration into AT [Base pair]/µM [Complex]/µM

Δ-$Ru(phen)_2dppz^{2+}$

D1 =

3.7566 1.7417 153.74 8.67

2.2114 2.3686 152.26 14.39

2.1588 1.9945 150.79 20.04

2.1218 1.9235 149.33 25.64

2.0451 1.5358 147.89 31.18

2.0713 0.25638 146.46 36.67

2.0021 -2.139 145.04 42.1

1.9833	-5.6969	143.64	47.47
1.9416	-9.7722	142.25	52.79
1.9244	-8.8324	140.87	58.05
1.7454	-5.2572	139.5	63.25
1.61	-1.7669	138.15	68.4
1.6451	-1.3845	136.81	73.49
1.6068	-0.35549	135.48	78.52
1.5799	0.3018	134.17	83.5
1.5607	0.64449	132.86	88.42
1.5472	1.0198	131.57	93.28
1.5006	1.0894	130.29	98.09
1.4047	1.0863	129.02	102.84

Λ-Ru(phen)$_2$dppz^{2+}

L1 =

3.6679	-4.4849	153.74	8.67
2.4308	-6.9631	152.26	14.39
1.2044	-8.4961	150.79	20.04
1.2727	-10.139	149.33	25.64
1.9543	-11.975	147.89	31.18
2.9779	-14.014	146.46	36.67
2.0697	-16.678	145.04	42.1
2.0657	-15.619	143.64	47.47
1.8531	-15.893	142.25	52.79
1.9834	-14.655	140.87	58.05
2.2098	-10.472	139.5	63.25
1.791	-6.2251	138.15	68.4
1.8303	-2.6333	136.81	73.49
1.8249	-0.37025	135.48	78.52
1.7614	0.11584	134.17	83.5
1.7011	0.22984	132.86	88.42
1.7606	0.6107	131.57	93.28
1.5178	0.55798	130.29	98.09
1.7619	0.62827	129.02	102.84

Δ-Ru(phen)$_2$(10-methyl-dppz)$^{2+}$

D2 =

12.416	0.31566	153.74	8.67

10.517	0.24837	152.26	14.39
10.162	0.30629	150.79	20.04
9.8768	-0.40978	149.33	25.64
9.7437	-0.75786	147.89	31.18
9.4239	-2.6523	146.46	36.67
8.9994	-2.9636	145.04	42.1
8.4868	-4.3023	143.64	47.47
8.1519	-4.6395	142.25	52.79
7.9208	0.15112	140.87	58.05
7.3004	5.2111	139.5	63.25
7.2236	8.1081	138.15	68.4
6.7909	9.2696	136.81	73.49
6.3102	9.7464	135.48	78.52
6.1268	10.187	134.17	83.5
5.8662	9.8917	132.86	88.42
5.6248	9.6414	131.57	93.28
5.268	9.5963	130.29	98.09
5.0021	8.7626	129.02	102.84

Λ-Ru(phen)$_2$(10-methyl-dppz)$^{2+}$

L2 =

12.855	0.60192	153.74	8.67
10.758	-0.96573	152.26	14.39
10.553	-3.284	150.79	20.04
10.035	-3.8993	149.33	25.64
9.8803	-7.235	147.89	31.18
9.5248	-9.0557	146.46	36.67
9.2223	-8.2744	145.04	42.1
8.6871	-3.9809	143.64	47.47
8.5194	1.559	142.25	52.79
8.0096	6.6224	140.87	58.05
7.5553	9.3006	139.5	63.25
7.0243	10.702	138.15	68.4
6.5891	10.453	136.81	73.49
6.1541	10.094	135.48	78.52
5.6981	9.5558	134.17	83.5
5.3517	9.3407	132.86	88.42
4.9173	8.9005	131.57	93.28

4.8942	8.5054	130.29	98.09
4.6641	8.0139	129.02	102.84

Δ-Ru(phen)$_2$(11,12-dimethyl-dppz)$^{2+}$

D3 =

10.58	10.371	153.74	8.67
7.1918	10.341	152.26	14.39
7.8112	10.743	150.79	20.04
7.6949	10.25	149.33	25.64
5.5588	8.6108	147.89	31.18
4.9684	9.3071	146.46	36.67
4.5578	8.0644	145.04	42.1
4.1777	5.9082	143.64	47.47
3.8389	3.4691	142.25	52.79
3.4636	4.1023	140.87	58.05
3.3941	9.7325	139.5	63.25
3.0645	8.8561	138.15	68.4
2.9066	8.3933	136.81	73.49
2.8998	7.409	135.48	78.52
2.6279	6.9091	134.17	83.5
2.4923	6.1043	132.86	88.42
2.3662	5.5711	131.57	93.28
2.3631	5.1123	130.29	98.09
2.239	4.6724	129.02	102.84

Λ-Ru(phen)$_2$(11,12-dimethyl-dppz)$^{2+}$

L3 =

17.21	6.8366	153.74	8.67
10.192	4.4014	152.26	14.39
7.5429	3.0983	150.79	20.04
6.9045	0.57154	149.33	25.64
5.8226	-1.795	147.89	31.18
5.4285	-2.8647	146.46	36.67
4.7281	-5.7139	145.04	42.1
4.3836	-7.6943	143.64	47.47
4.1021	-6.5846	142.25	52.79
3.9974	-3.3864	140.87	58.05
3.4657	-1.755	139.5	63.25

3.4623	3.4692	138.15	68.4
3.2753	7.7886	136.81	73.49
2.9811	8.8617	135.48	78.52
2.8622	8.5585	134.17	83.5
2.6108	8.1266	132.86	88.42
2.2241	7.2354	131.57	93.28
2.2353	6.3073	130.29	98.09
1.9823	5.5744	129.02	102.84