Supplementary Information (SI) for Physical Chemistry Chemical Physics.

Respiratory Complex II Acting as a Homeostatic Regulatory Sensor

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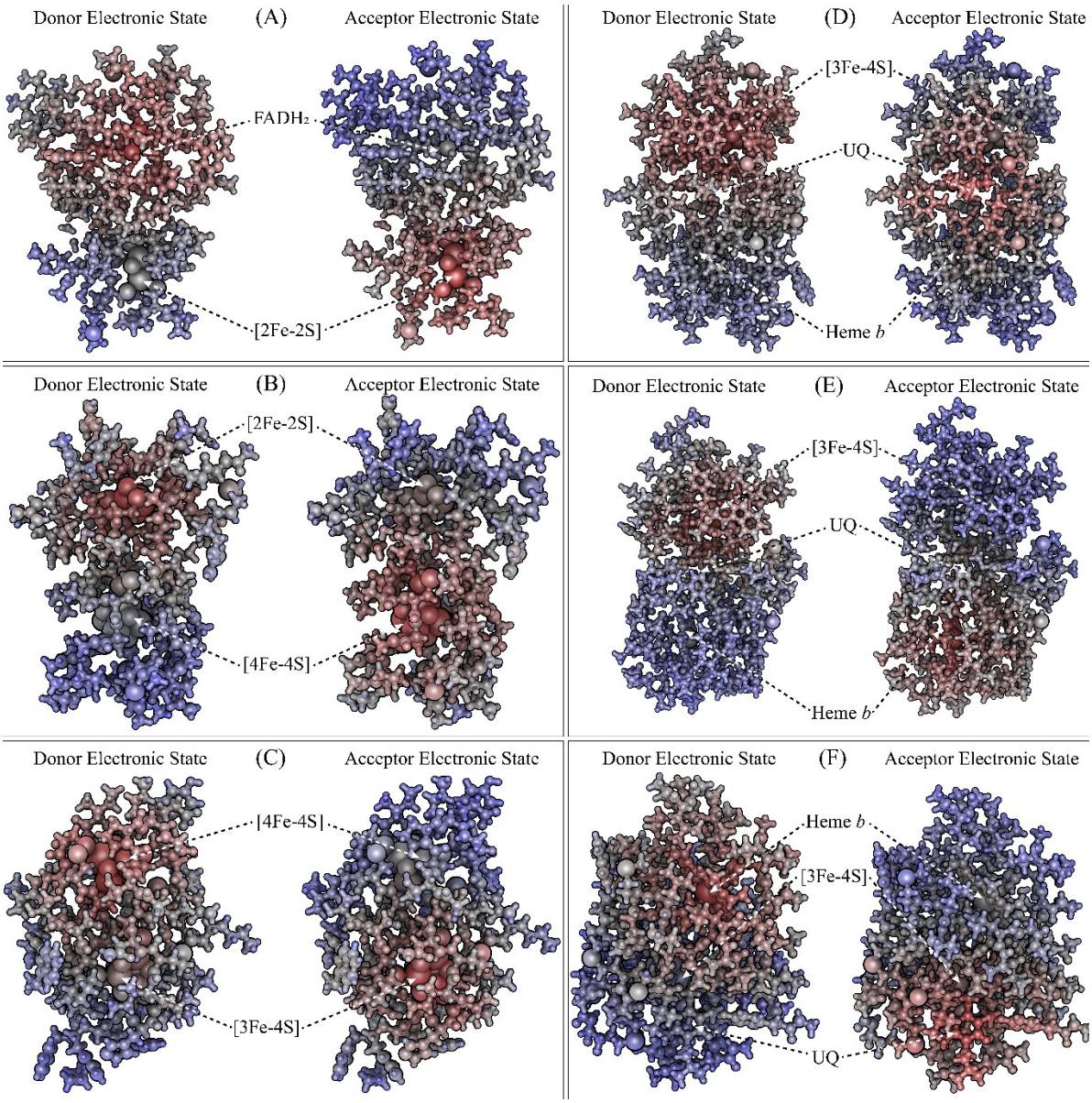

Figure S1. Electronic localized diabatic donor and acceptor states for the different studied redox systems in respiratory complex II.

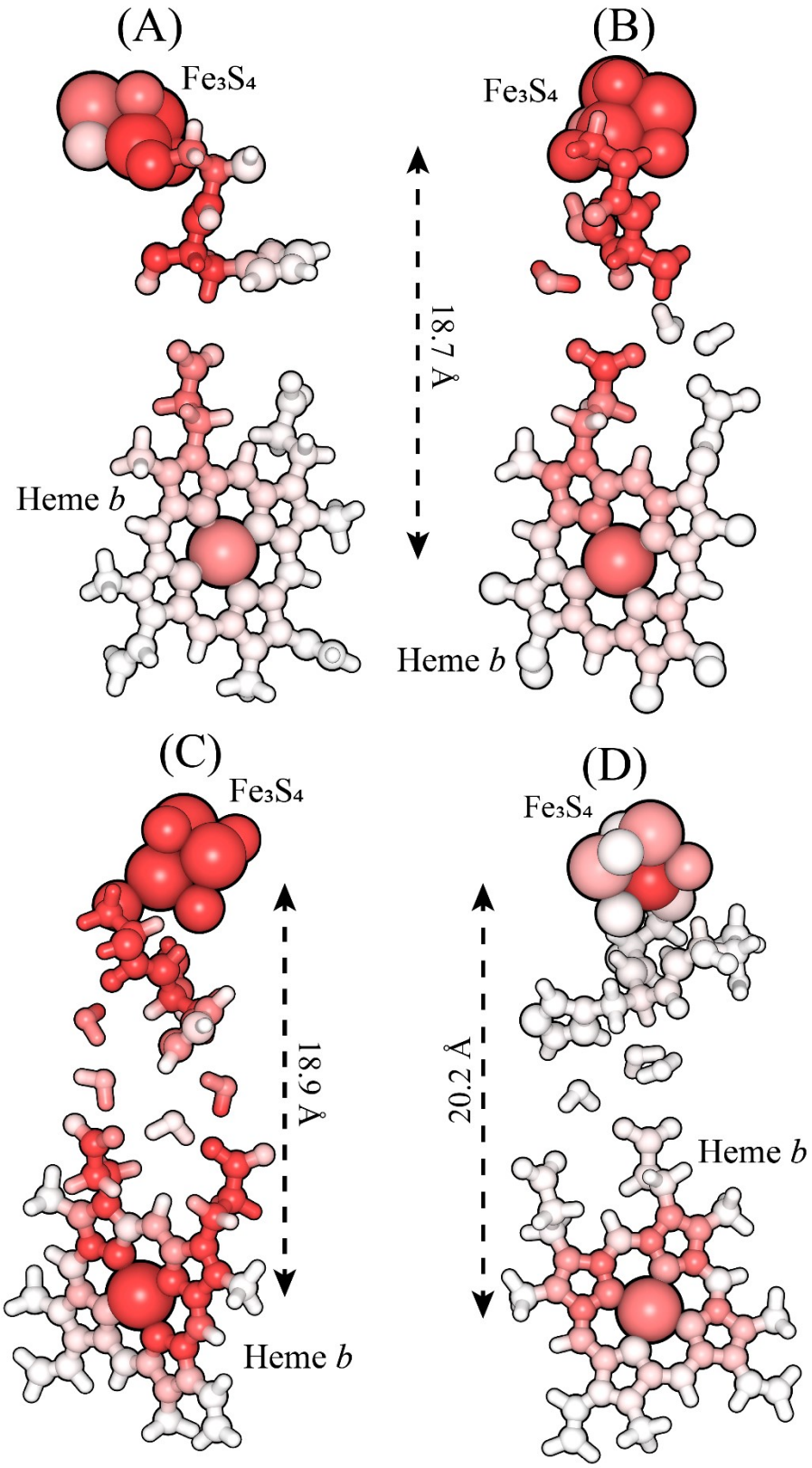

Figure S2. ET pathways for (A) WAT_A, (B) WAT_B, (C) MD_A, and (D) MD_B states.

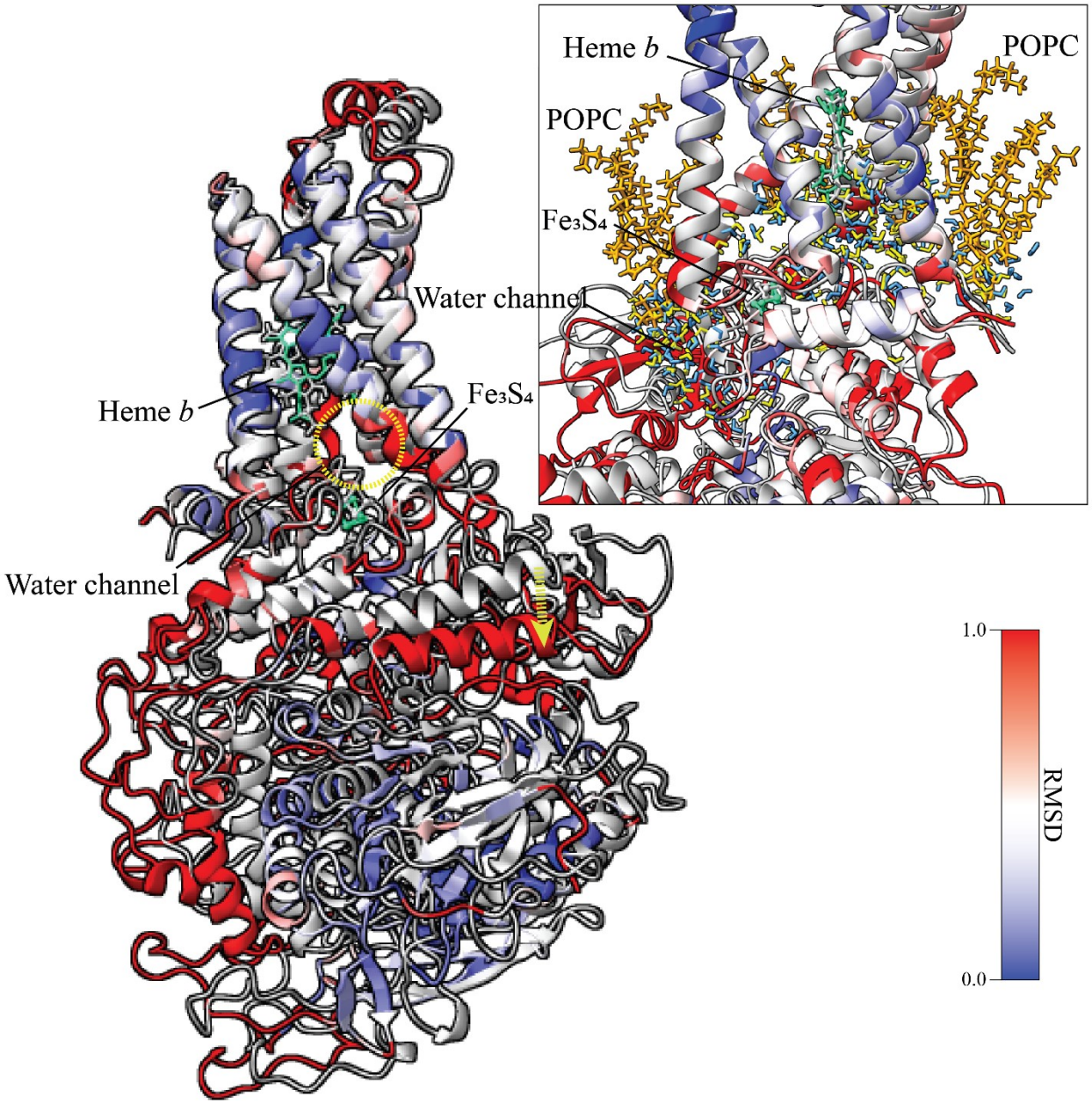

Figure S3. Superposition of MD_B (red-to-blue colored based on RMSD value) snapshot on MD_A (white-colored) snapshot of the SQR complex. The yellow hashed arrow shows the displacement direction. The yellow hashed circle shows the entrance to the water channel. The upper inset shows the location of heme *b*, Fe_3S_4, and the intervening waters. Also, representative molecules of the inner mitochondrial membrane (POPC) are shown.

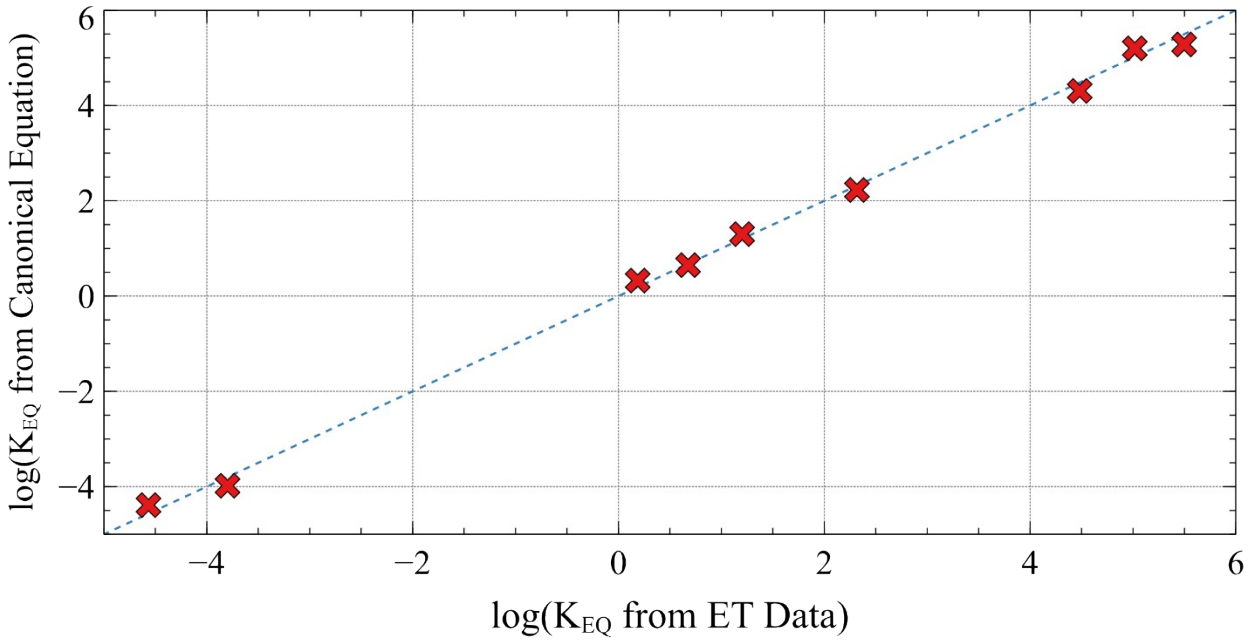

Figure S4. Correlation plot between the calculated equilibrium constant based on the calculated ET rate constants (X-axis) and the equilibrium constant based on the canonical thermodynamic equation (Y-axis).

%Chk=FADFE2S2DONOR
%NProcShared=24
%Mem=216MW
#P SP UB3LYP/Gen Pseudo=read Guess=(Fragment=6,Only) Pop=Full NoSymmetry

FAD=>Fe2S2 pruned protein.

0,1 0,1 3,6 3,-6 -2,1 -2,1 -2,1
S(Fragment=1) 94.454 57.639 124.048
.
.
FE(Fragment=2) 95.100 52.760 108.862
FE(Fragment=3) 94.610 53.692 111.341
S(Fragment=4) 96.408 53.528 110.603
S(Fragment=5) 93.443 53.320 109.781
C(Fragment=6) 96.538 71.441 129.385
.
.
H(Fragment=6) 96.065 59.124 106.311

H 0
S 6 1.00
  0.3326836535D+02 0.9163596281D-02

```
      0.6099718369D+01  0.4936149294D-01
      0.1706481387D+01  0.1685383049D+00
      0.5862224134D+00  0.3705627997D+00
      0.2276473177D+00  0.4164915298D+00
      0.9375773694D-01  0.1303340841D+00
****
C 0
S    6 1.00
      0.7310560386D+02 -0.4151277819D-02
      0.1340682447D+02 -0.2067024148D-01
      0.3767606913D+01 -0.5150303337D-01
      0.5387761534D+00  0.3346271174D+00
      0.2445297546D+00  0.5621061301D+00
      0.1166148582D+00  0.1712994697D+00
P       6  1.00
      0.1549594249D+02  0.7924233646D-02
      0.4041026682D+01  0.5144104825D-01
      0.1445917850D+01  0.1898400060D+00
      0.6044212998D+00  0.4049863191D+00
      0.2763825918D+00  0.4012362861D+00
      0.1306639377D+00  0.1051855189D+00
****
N 0
S    6 1.00
      0.1052720696D+03 -0.4151277819D-02
      0.1930582723D+02 -0.2067024148D-01
      0.5425353955D+01 -0.5150303337D-01
      0.7758376610D+00  0.3346271174D+00
      0.3521228466D+00  0.5621061301D+00
      0.1679253958D+00  0.1712994697D+00
P       6  1.00
      0.2231415718D+02  0.7924233646D-02
      0.5819078422D+01  0.5144104825D-01
      0.2082121704D+01  0.1898400060D+00
      0.8703666717D+00  0.4049863191D+00
      0.3979909322D+00  0.4012362861D+00
      0.1881560703D+00  0.1051855189D+00
****
Fe 0
SP  6 1.00
      0.2562617907D+01  0.3775056180D-02  -0.7052075733D-02
      0.8245621480D+00 -0.5585965266D-01  -0.5259505547D-01
      0.3523070806D+00 -0.3192946152D+00  -0.3773450392D-01
      0.1756829076D+00 -0.2764780132D-01   0.3874773403D+00
      0.9482592425D-01  0.9049199432D+00   0.5791672602D+00
      0.5272876523D-01  0.3406258162D+00   0.1221817127D+00
```

```
D    12 1.00
      0.9162910103D+02  0.2941169002D-02
      0.2939104856D+02  0.2175159417D-01
      0.1705928866D+02  0.5243247962D-02
      0.1219363969D+02  0.8367181843D-01
      0.5741286553D+01  0.1722695568D+00
      0.5471955697D+01  0.3877675907D-01
      0.2900898783D+01  0.1551822341D+00
      0.2270182910D+01  0.1491624899D+00
      0.1494497181D+01  0.3594911907D-01
      0.1068899111D+01  0.3071064607D+00
      0.5400824538D+00  0.2766447396D+00
      0.2782419399D+00  0.6408681213D-01
****
O 0
S       6 1.00
      0.1432869836D+03 -0.4151277819D-02
      0.2627737596D+02 -0.2067024148D-01
      0.7384509550D+01 -0.5150303337D-01
      0.1056001261D+01  0.3346271174D+00
      0.4792783190D+00  0.5621061301D+00
      0.2285651220D+00  0.1712994697D+00
P   6 1.00
      0.3037204728D+02  0.7924233646D-02
      0.7920412296D+01  0.5144104825D-01
      0.2833998986D+01  0.1898400060D+00
      0.1184665748D+01  0.4049863191D+00
      0.5417098800D+00  0.4012362861D+00
      0.2561013179D+00  0.1051855189D+00
****
S 0
S       6 1.00
                0.1080191457D+02 -0.6775596947D-02
                0.3036457305D+01 -0.5639325779D-01
                0.1185905238D+01 -0.1587856086D+00
                0.2850346615D+00  0.5534527651D+00
                0.1583266618D+00  0.5015351020D+00
                0.8992402648D-01  0.7223633674D-01
P    6 1.00
                0.1675872345D+02 -0.3329929840D-02
                0.4424969343D+01 -0.1419488340D-01
                0.7420459567D+00  0.1639395770D+00
                0.3735062471D+00  0.4485358256D+00
                0.2005383724D+00  0.3908813050D+00
                0.1094182103D+00  0.7411456232D-01
****
```

C N O S 0
LP-31G
Fe 0
LANL1TZ

List S1. Gaussian input file to calculate the donor initial guess molecular orbitals for the FAD/Fe_2S_2 redox pair.

%Chk=FADFE2S2DONOR
%NProcShared=24
%Mem=1028MW
#p uzindo(root=1,nstates=1) nosymmetry Guess=read scf=(maxcycle=10000,ssd,damp) geom=allcheck pop=full

List S2. Gaussian input file to calculate the donor electronic state for the FAD/Fe_2S_2 redox pair.

%Chk=FADFE2S2DONOR
%Mem=516MW
%NProcShared=24
#p uzindo(root=1,nstates=1) nosymmetry Guess=read scf=(maxcycle=10000,ssd,damp) geom=allcheck pop=full iop(3/33=5) iop(5/33=5)

List S3. Gaussian input file to obtain the required data of the converged donor electronic state for the FAD/Fe_2S_2 redox pair.