

```

speciesPattenAll = Flatten[Table[{i, j, k, l, p},
                                |压平 |表格
                                {i, -1, 1}, {j, -1, 1}, {k, -1, 1}, {l, -1, 1}, {p, -1, 1}], 4];
deletePatten1 = Flatten[Table[{i, j, k, l, p}, {i, 0, 1},
                              |压平 |表格
                              {j, 0, 1}, {k, 0, 1}, {l, 0, 1}, {p, 0, 1}], 4];
deletePatten2 = Flatten[Table[{i, j, k, l, p}, {i, -1, 0},
                              |压平 |表格
                              {j, -1, 0}, {k, -1, 0}, {l, -1, 0}, {p, -1, 0}], 4];
speciesPatten = Complement[speciesPattenAll, deletePatten1, deletePatten2];
|补集

(*This function return all possible reactant
  matrices corresponding to a stoichiometric matrix*)
coresAlpha[capitalN_] := Block[{n = capitalN},
|块
  alpha = Table[0, {i, 4}, {j, 5}];
|表格
  oneposi = Position[n, 1];
|位置
  zeroposi = Position[n, 0];
|位置
  minusoneposi = Position[n, -1];
|位置
  Do[alpha[[oneposi[[i, 1]], oneposi[[i, 2]]] = 0, {i, 1, Length@oneposi}];
|Do循环 |长度
  Do[alpha[[minusoneposi[[i, 1]], minusoneposi[[i, 2]]] = 1,
|Do循环
    {i, 1, Length@minusoneposi}];
|长度
  coefs = Tuples[{0, 1}, Length@zeroposi];
|元组 |长度
  Table[temp = alpha;
|表格
    Do[temp[[zeroposi[[i, 1]], zeroposi[[i, 2]]] = coefs[[j, i]],
|Do循环
      {i, 1, Length@zeroposi}];
|长度
    temp, {j, 1, Length@coefs}]
|长度
  ]

```

```

(*For two matrices A and B with the same size,
  [For循环]
if rowcolTally[{A,1}]==rowcolTally[{B,1}],
then A can be obtained by swapping the rows and
  columns from B (i.e., A and B are naturally equivalent)*)
rowcolTally[{A_, index_}] := Block[{a = A, ind = index},
  [块]
  aa = speciesPatten[a];
  rowA = Tally[Sort[Tally /@ Sort /@ aa]];
  [重… [排序 [重复次数 [排序]
  colA = Tally[Sort[Tally /@ Sort /@ Transpose@aa]];
  [重… [排序 [重复次数 [排序 [转置]
  {{rowA, colA}, ind}
]

In[54]:= ParallelSow[expr_] := Sow[expr];
  [散布]

SetSharedFunction[ParallelSow]
[设置共享函数]

In[46]:= s = 4;
m = 5;
allh = Table[Symbol["h" <> ToString[i]], {i, 1, s}];
  [表格 [符号 [转换为字符串]

(*We start by finding out all stoichiometric matrices
  (namely capitalN) that admit a positive steady state*)
capitalNWithSteadyState = Reap[ParallelDo[
  [收获 [并行Do循环]
  capitalN = {speciesPatten[[i],
    speciesPatten[[j], speciesPatten[[k], speciesPatten[[l]]];
  If[MatrixRank[capitalN] != 4, Continue[]];
  [… [矩阵的秩 [继续]
  ker = NullSpace@capitalN;
  [零空间]
  If[Length@ker != 1, Continue[]];
  [… [长度 [继续]
  If[Cases[ker[[1]], Except[{a_ /; a > 0}]] != {}, Continue[]];
  [… [模式匹配 [除了 [继续]
  ParallelSow[{i, j, k, l}];
  , {i, 1, 180}, {j, i + 1, 180}, {k, j + 1, 180}, {l, k + 1, 180}]]]; //
AbsoluteTiming
[绝对时间]

Out[54]= {5047.25, Null}

```

In[7]:= **capitalNWithSteadyState**[[2]][1]

Out[7]=
 { {41, 42, 48, 83}, {41, 42, 48, 84}, {41, 42, 48, 97}, {41, 42, 48, 98},
 {41, 42, 48, 143}, {41, 42, 48, 144}, {41, 42, 48, 145}, {41, 42, 48, 146},
 {41, 42, 48, 147}, {41, 42, 48, 148}, {41, 42, 48, 149}, {41, 42, 48, 152},
 ... 2 514 983 ... , {24, 155, 163, 171}, {24, 155, 164, 165},
 {24, 155, 164, 171}, {24, 156, 163, 168}, {24, 156, 163, 171},
 {24, 156, 163, 174}, {24, 156, 164, 174}, {24, 156, 166, 174},
 {24, 163, 165, 171}, {24, 163, 168, 171}, {24, 164, 165, 171} }

大型输出 显示更少 显示更多 显示全部 设定大小限制...

In[*]:= **Length**@**capitalNWithSteadyState**[[2]][1]
 [长度]

Out[*]= 2 515 006

In[22]:= **allcapitalNwithindex** =
Transpose@{**capitalNWithSteadyState**[[2]][1], **Range**[2 515 006]}
 [转置] [范围]

Out[22]=
 { { {41, 42, 48, 83}, 1}, { {41, 42, 48, 84}, 2}, { {41, 42, 48, 97}, 3},
 { {41, 42, 48, 98}, 4}, { {41, 42, 48, 143}, 5}, { {41, 42, 48, 144}, 6},
 { {41, 42, 48, 145}, 7}, ... 2 514 992 ... , { {24, 156, 163, 171}, 2 515 000},
 { {24, 156, 163, 174}, 2 515 001}, { {24, 156, 164, 174}, 2 515 002},
 { {24, 156, 166, 174}, 2 515 003}, { {24, 163, 165, 171}, 2 515 004},
 { {24, 163, 168, 171}, 2 515 005}, { {24, 164, 165, 171}, 2 515 006} }

大型输出 显示更少 显示更多 显示全部 设定大小限制...

In[25]:= **alltally** = **ParallelMap**[**rowcolTally**, **allcapitalNwithindex**] // **AbsoluteTiming**
 [并行映射] [绝对时间]

Out[25]=
 {211.102, { { { { { {-1, 3}, {1, 2}}, 1}, { {-1, 1}, {0, 2}, {1, 2}}, 1},
 { {-1, 3}, {0, 1}, {1, 1}}, 2}, { { {-1, 1}, {1, 3}}, 1},
 { {-1, 3}, {0, 1}}, 1}, { { {-1, 2}, {0, 1}, {1, 1}}, 3}}, 1},
 ... 2 515 004 ... , { { { { { {-1, 2}, {1, 3}}, 1}, { {-1, 2}, {0, 1}, {1, 2}}, 3},
 { { {-1, 1}, {1, 3}}, 1}, { { {-1, 2}, {1, 2}}, 1}, { { {-1, 3}, {0, 1}}, 1},
 { { {0, 1}, {1, 3}}, 1}, { { {-1, 2}, {0, 1}, {1, 1}}, 1}}, 2 515 006} }

大型输出 显示更少 显示更多 显示全部 设定大小限制...

In[34]:= **allunitally** = **DeleteDuplicates**[**alltally**[[2]], #1[[1]] == #2[[1]] &];
 [删除重复元素]

(*All indexes of nonequivalent capitalN*)
[全部]

allindex = Transpose[allunitally][[2]];
[转置]

In[39]:= Length@allindex
[长度]

Out[39]= 8436

(*All 4s5m reactions with Hopf

[全部]

bifurcations. The first number is the index in allindex,
the second number is the index in the corresponding result of coresAlpha. *)
count = 0;

SetSharedVariable[count]

[设置共享变量]

Monitor[reactionsWithHB = Reap[ParallelDo[

[监控]

[收获] [并行Do循环]

count = Max[count, i];

[最大值]

capitalN = speciesPatten[[capitalNWithSteadyState[[2]][[1]][allindex[[i]]]]];

ker = NullSpace@capitalN;

[零空间]

alphas = coresAlpha[capitalN];

Do[alpha = alphas[[j]];

[Do循环]

J = capitalN.DiagonalMatrix[ker[[1]].

[对角矩阵]

Transpose[alpha].DiagonalMatrix[allh];

[转置]

[对角矩阵]

a4 = Det[-J];

[行列式]

If[a4 == 0, Continue[]];

[如果]

[继续]

If[Cases[Expand[(a4 - h1 h2 h3 h4 h5) * 2],

[...]

[模...]

[展开]

Except[(a_ * b___ /; a < 0)] == {}, Continue[]];

[除了]

[继续]

a1 = Tr[-J];

[迹]

a2 =

Det[J[[{1, 2}, {1, 2}]]] + Det[J[[{1, 3}, {1, 3}]]] + Det[J[[{1, 4}, {1, 4}]]] +

[行列式]

[行列式]

[行列式]

Det[J[[{2, 3}, {2, 3}]]] + Det[J[[{2, 4}, {2, 4}]]] + Det[J[[{3, 4}, {3, 4}]]];

[行列式]

[行列式]

[行列式]

a3 = -Det[J[[{1, 2, 3}, {1, 2, 3}]]] - Det[J[[{1, 2, 4}, {1, 2, 4}]]] -

[行列式]

[行列式]

Det[J[[{1, 3, 4}, {1, 3, 4}]]] - Det[J[[{2, 3, 4}, {2, 3, 4}]]];

[行列式]

[行列式]

dH3 = a1 * a2 * a3 - a3 * a3 - a1 * a1 * a4;

If[Cases[Expand[(dH3) * 2], Except[(a_ * b___ /; a > 0)] == {},

[...]

[模...]

[展开]

[除了]

Continue[], ParallelSow[{i, j}]]];

[继续]

, {j, 1, Length@alphas}];

[长度]

, {i, 1, 8436}]]]; // AbsoluteTiming, count]

[绝对时间]

Out[145]= {164.229, Null}

In[244]:= **reactionsWithHB[[2]][[1]]**

Out[244]=

```
{ {673, 5}, {673, 23}, {673, 25}, {673, 55}, {673, 133}, {673, 172}, {291, 11},
  {674, 28}, {291, 27}, {674, 87}, {100, 12}, {291, 69}, {291, 85}, {484, 105},
  {195, 69}, {484, 106}, {195, 101}, {484, 149}, {484, 233}, {484, 234},
  {102, 283}, {102, 295}, {389, 98}, {389, 146}, {102, 364}, {389, 169},
  {295, 22}, {389, 182}, {102, 411}, ... 35 111 ..., {7864, 332}, {7864, 334},
  {7864, 348}, {7864, 362}, {7864, 364}, {7864, 518}, {7864, 520}, {7864, 551},
  {7864, 552}, {7864, 559}, {7864, 575}, {7864, 615}, {7864, 623},
  {7864, 774}, {7864, 815}, {7864, 831}, {7864, 844}, {7864, 860},
  {7865, 97}, {7866, 28}, {7866, 32}, {7866, 50}, {7866, 92}, {7866, 158},
  {7866, 196}, {7866, 200}, {7866, 204}, {7866, 215}, {7866, 387} }
```

大型输出

显示更少

显示更多

显示全部

设定大小限制...

In[146]:= **Length[reactionsWithHB[[2]][[1]]]**

[长度](#)

Out[146]= 35 169

In[267]:= **all4s5mReactionsWithHB = ParallelTable[temp2 = reactionsWithHB[[2]][[1]][[i]];**

[并行产生表格](#)

capitalN =

speciesPatten[capitalNWithSteadyState[[2]][[1]][[allindex[temp2[[1]][[i]]]]];

alpha = coresAlpha[capitalN][temp2[[2]]];

beta = alpha + capitalN;

Transpose[{alpha, beta}], {i, 1, 35 169}];

[转置](#)

In[270]:= **Export["/Users/aspirin/Desktop/all4s5mReactionsWithHB.txt",**

[导出](#)

all4s5mReactionsWithHB, "Table"]

[表格](#)

Out[270]= /Users/aspirin/Desktop/all4s5mReactionsWithHB.txt