Dyadic approximation of the scaling and wavelet functions

In[695]:=
```
fa = Filling → Axis; pa = PlotRange → All; ta → TableAlignments → ".";
```

Solving the eigenvalue problem

In[786]:=
```
eigen[h_] := Module[{A, vec, sum, hlen, len},
   hlen = Length[h];
   len = hlen - 2;
   A = Table[
     If[1 ≤ 2 i + 1 - j ≤ hlen, h[[2 i + 1 - j]], 0], {i, 1, len} ,
     {j, 1, len}];
   Print["The matrix for the eigenvalue problem"];
   Print[MatrixForm[A]];
   vec = Eigenvectors[A, 1][[1]];
   sum = Total[vec];
   Print["The eigenvector for the eigenvalue 1"];
   Print[MatrixForm[vec / sum, ta]];
   vec / sum
  ]
```

In[697]:=
```
eigen::usage = "Solves the eigenvalue problem belonging to the
    scaling equation given by the filter h.
    Needed for starting the dyadic interpolation
    for the true values of the scaling function
    belonging to h";
```

Interpolation by iterating the scaling equation

In[789]:=
```
dphi[h_, j_] := Module[{hlen, hvec, vec, tmp, vlen},
  hlen = Length[h];
  hvec = eigen[h];
  vec[0] = Join[{0}, hvec, {0}];
  Do[
   vlen = Length[vec[s - 1]];
   tmp = Table[
     Sum[h[[n]] (vec[s - 1])[[
         Min[
          Max[2 k - 2 ^ (s - 1) (n - 1), 1], vlen]]],
      {n, 1, hlen}],
     {k, 1, vlen - 1}];
   vec[s] = Riffle[vec[s - 1], tmp], {s, 1, j}];
  Table[vec[i], {i, 1, j}]
 ]
```

In[735]:=
```
dyadicphi[h_, j_] := Module[{hlen, data},
  hlen = Length[h];
  data = Last[dphi[h, j]];
  Table[{k / 2^j, data[[k + 1]]}, {k, 0, 2^(j) (hlen - 1)}]
 ]
dyadicphi::usage =
  "level-j dyadic approximation of the scaling function belonging to the filter h";
dyadicphiall[h_, n_] := Module[{hlen, data},
  hlen = Length[h];
  data = dphi[h, n];
  Table[Table[{k / 2^j, data[[j, k + 1]]}, {k, 0, 2^(j) (hlen - 1)}], {j, 1, n}]
  ]
```

In[762]:=
```
phianimate[h_, n_] := Module[{data},
  data = dyadicphiall[h, n];
  ListAnimate[Table[ListPlot[
     data[[t]],
     Filling → Axis,
     PlotRange → All], {t, 1, n}],
   AnimationRunning → False]
 ]
```

In[769]:=
```
dyadicpsi[h_, j_] := Module[{hlen, vec, vlen},
  If[j == 0, Return[{0}]];
  hlen = Length[h];
  vec = Last[dphi[h, j - 1]];
  vlen = Length[vec];
  Table[{k / 2 ^ j,
    Sum[(-1) ^ n h[[hlen - n]] vec[[
        Min[
         Max[ k + 1 - 2 ^ (j - 1) n, 1], vlen]]],
      {n, 0, hlen - 1}]},
   {k, 0, 2 ^ (j) (hlen - 1)}]
 ]
```

In[776]:=
```
dyadicpsiall[h_, n_] := Module[{hlen, vec, vlen},
  If[n == 0, Return[{0}]];
  hlen = Length[h];
  vec = dphi[h, n - 1];
  Table[
  vlen = Length[vec];
  Table[{k / 2 ^ j,
    Sum[(-1) ^ m h[[hlen - m]] ×
       vec[[j,
       Min[
        Max[ k + 1 - 2 ^ (j - 1) m, 1], Length[vec[[j]]]]]]],
     {m, 0, hlen - 1}]},
   {k, 0, 2 ^ (j) (hlen - 1)}], {j, 1, n - 1}]
  ]
```

In[773]:=
```
psianimate[h_, n_] := Module[{data},
  data = dyadicpsiall[h, n];
  ListAnimate[Table[ListPlot[
     data[[t]],
     Filling -> Axis,
     PlotRange -> All], {t, 1, n - 1}],
   AnimationRunning -> False]
  ]
```

In[777]:=
```
dyadicpsiall[db4, 2]
```

The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.18301 & 0.683013 \\ -0.183013 & 0.316987 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.36603 \\ -0.366025 \end{pmatrix}$$

Out[777]= $\left\{\left\{\{0, 0.\}, \left\{\frac{1}{2}, -0.170753\right\}, \{1, -0.545753\}, \left\{\frac{3}{2}, 0.670753\right\}, \{2, 1.04575\}, \left\{\frac{5}{2}, -0.829247\right\}, \{3, -0.454247\}\right\}\right\}$

In[702]:=
```
dyadicpsi::usage =
  "level-j dyadisc approximation of the wavelet function belonging to the filter h";
```

Example Daubechies-4

In[703]:=
```
db4 = 2 Map[#[[2]] &, WaveletFilterCoefficients[DaubechiesWavelet[2]]];
TableForm[db4, ta]
```

Out[704]//TableForm=
```
 0.683013
 1.18301
 0.316987
-0.183013
```

In[705]:=
```
eigen[db4]
```

The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.18301 & 0.683013 \\ -0.183013 & 0.316987 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.36603 \\ -0.366025 \end{pmatrix}$$

In[749]:=
```
dyadicphi[db4, 2]
```

The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.18301 & 0.683013 \\ -0.183013 & 0.316987 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.36603 \\ -0.366025 \end{pmatrix}$$

Out[749]=

$$\left\{\{0, 0\}, \left\{\frac{1}{4}, 0.63726\right\}, \left\{\frac{1}{2}, 0.933013\right\}, \left\{\frac{3}{4}, 1.10377\right\}, \{1, 1.36603\}, \left\{\frac{5}{4}, 0.341506\right\}, \left\{\frac{3}{2}, 1.66533\times 10^{-16}\right\}, \left\{\frac{7}{4}, -0.0915064\right\}, \{2, -0.366025\}, \left\{\frac{9}{4}, 0.0212341\right\}, \left\{\frac{5}{2}, 0.0669873\right\}, \left\{\frac{11}{4}, -0.0122595\right\}, \{3, 0\}\right\}$$

In[744]:=

```
ListPlot[dyadicphi[db4, 5], Filling → Axis, PlotRange → All]
```

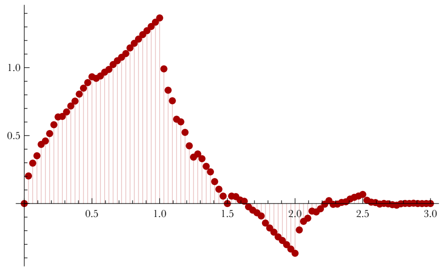
The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.18301 & 0.683013 \\ -0.183013 & 0.316987 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.36603 \\ -0.366025 \end{pmatrix}$$

Out[744]=



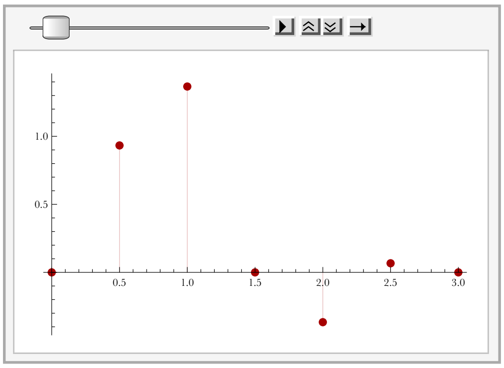
In[763]:=
```
phianimate[db4, 5]
```

The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.18301 & 0.683013 \\ -0.183013 & 0.316987 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.36603 \\ -0.366025 \end{pmatrix}$$

Out[763]=


In[770]:= ListPlot[dyadicpsi[db4, 5], Filling → Axis, PlotRange → All]

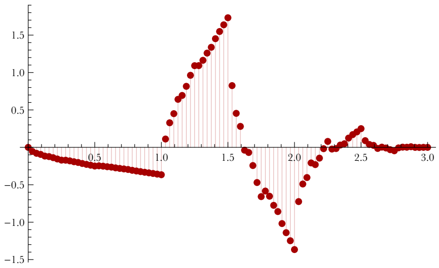
The matrix for the eigenvalue problem

1.18301	0.683013
−0.183013	0.316987

The eigenvector for the eigenvalue 1

1.36603
−0.366025

Out[770]=



In[778]:=
```
psianimate[db4, 5]
```

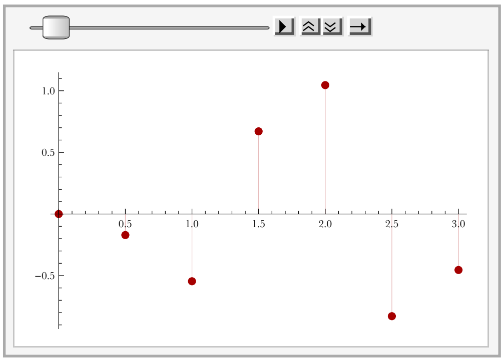
```
The matrix for the eigenvalue problem
```

$$\begin{pmatrix} 1.18301 & 0.683013 \\ -0.183013 & 0.316987 \end{pmatrix}$$

```
The eigenvector for the eigenvalue 1
```

$$\begin{pmatrix} 1.36603 \\ -0.366025 \end{pmatrix}$$

Out[778]=



Example Daubechies-6

In[710]:=
```
db6 = 2 Map[#[[2]] &, WaveletFilterCoefficients[DaubechiesWavelet[3]]];
TableForm[db6, ta]
```

Out[711]//TableForm=
```
 0.470467
 1.14112
 0.650365
-0.190934
-0.120832
 0.0498175
```

In[712]:=
```
eigen[db6]
```

The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.14112 & 0.470467 & 0 & 0 \\ -0.190934 & 0.650365 & 1.14112 & 0.470467 \\ 0.0498175 & -0.120832 & -0.190934 & 0.650365 \\ 0 & 0 & 0.0498175 & -0.120832 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.28634 \\ -0.385837 \\ 0.0952675 \\ 0.00423435 \end{pmatrix}$$

Out[712]=
```
{1.28634, -0.385837, 0.0952675, 0.00423435}
```

In[723]:=
```
ListPlot[dyadicphi[db6, 5], Filling → Axis, PlotRange → All]
```

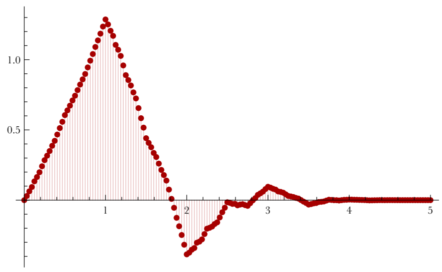
The matrix for the eigenvalue problem

$$\begin{pmatrix} 1.14112 & 0.470467 & 0 & 0 \\ -0.190934 & 0.650365 & 1.14112 & 0.470467 \\ 0.0498175 & -0.120832 & -0.190934 & 0.650365 \\ 0 & 0 & 0.0498175 & -0.120832 \end{pmatrix}$$

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.28634 \\ -0.385837 \\ 0.0952675 \\ 0.00423435 \end{pmatrix}$$

Out[723]=



In[779]:=

```
phianimate[db6, 5]
```

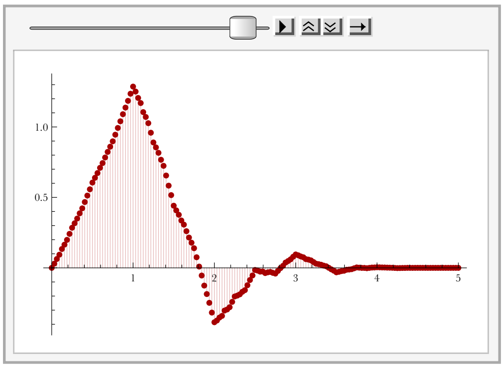
The matrix for the eigenvalue problem

1.14112	0.470467	0	0
−0.190934	0.650365	1.14112	0.470467
0.0498175	−0.120832	−0.190934	0.650365
0	0	0.0498175	−0.120832

The eigenvector for the eigenvalue 1

1.28634
−0.385837
0.0952675
0.00423435

Out[779]=



In[725]:=
```
ListPlot[dyadicpsi[db6, 5], Filling → Axis, PlotRange → All]
```

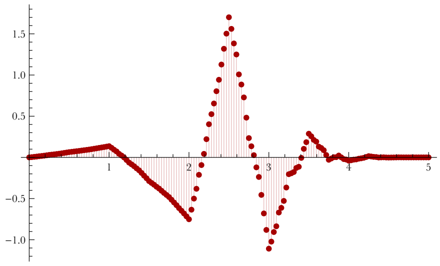
```
The matrix for the eigenvalue problem
```

1.14112	0.470467	0	0
−0.190934	0.650365	1.14112	0.470467
0.0498175	−0.120832	−0.190934	0.650365
0	0	0.0498175	−0.120832

```
The eigenvector for the eigenvalue 1
```

1.28634
−0.385837
0.0952675
0.00423435

Out[725]=



In[780]:=
```
psianimate[db6, 5]
```

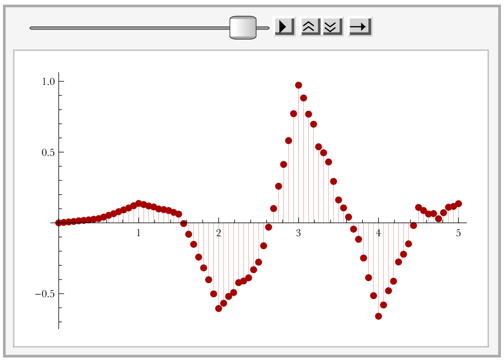
The matrix for the eigenvalue problem

1.14112	0.470467	0	0
−0.190934	0.650365	1.14112	0.470467
0.0498175	−0.120832	−0.190934	0.650365
0	0	0.0498175	−0.120832

The eigenvector for the eigenvalue 1

1.28634
−0.385837
0.0952675
0.00423435

Out[780]=



Example Daubechies-8

In[791]:=
```
db8 = 2 Map[#[[2]] &, WaveletFilterCoefficients[DaubechiesWavelet[4]]];
TableForm[db8, ta]
```

Out[792]//TableForm=
```
 0.325803
 1.01095
 0.8922
-0.039575
-0.264507
 0.0436163
 0.0465036
-0.014987
```

In[793]:=
```
eigen[db8]
```

The matrix for the eigenvalue problem

1.01095	0.325803	0	0	0	0
-0.039575	0.8922	1.01095	0.325803	0	0
0.0436163	-0.264507	-0.039575	0.8922	1.01095	0.325803
-0.014987	0.0465036	0.0436163	-0.264507	-0.039575	0.8922
0	0	-0.014987	0.0465036	0.0436163	-0.264507
0	0	0	0	-0.014987	0.0465036

The eigenvector for the eigenvalue 1

1.00717
-0.033837
0.0396105
-0.0117644
-0.00119796
0.0000188294

Out[793]=
```
{1.00717, -0.033837, 0.0396105, -0.0117644, -0.00119796, 0.0000188294}
```

In[794]:=
```
ListPlot[dyadicphi[db8, 4], Filling → Axis, PlotRange → All]
```

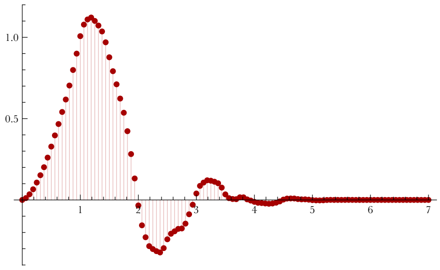
The matrix for the eigenvalue problem

1.01095	0.325803	0	0	0	0
-0.039575	0.8922	1.01095	0.325803	0	0
0.0436163	-0.264507	-0.039575	0.8922	1.01095	0.325803
-0.014987	0.0465036	0.0436163	-0.264507	-0.039575	0.8922
0	0	-0.014987	0.0465036	0.0436163	-0.264507
0	0	0	0	-0.014987	0.0465036

The eigenvector for the eigenvalue 1

1.00717
-0.033837
0.0396105
-0.0117644
-0.00119796
0.0000188294

Out[794]=



In[795]:= phianimate[db6, 5]

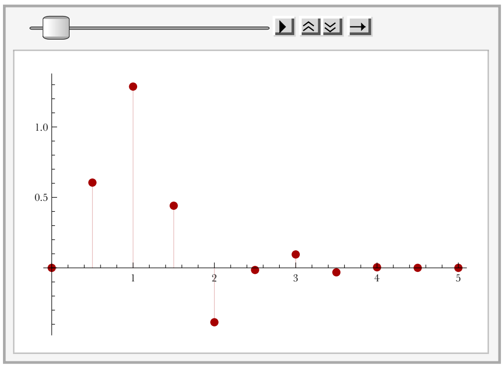
The matrix for the eigenvalue problem

1.14112	0.470467	0	0
−0.190934	0.650365	1.14112	0.470467
0.0498175	−0.120832	−0.190934	0.650365
0	0	0.0498175	−0.120832

The eigenvector for the eigenvalue 1

1.28634
−0.385837
0.0952675
0.00423435

Out[795]=



In[796]:=

```
ListPlot[dyadicpsi[db8, 5], Filling → Axis, PlotRange → All]
```

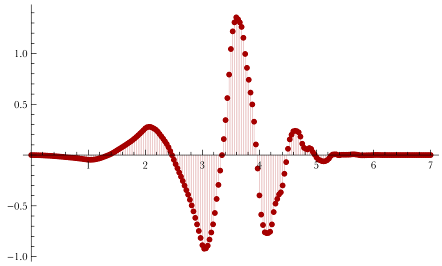
The matrix for the eigenvalue problem

1.01095	0.325803	0	0	0	0
−0.039575	0.8922	1.01095	0.325803	0	0
0.0436163	−0.264507	−0.039575	0.8922	1.01095	0.325803
−0.014987	0.0465036	0.0436163	−0.264507	−0.039575	0.8922
0	0	−0.014987	0.0465036	0.0436163	−0.264507
0	0	0	0	−0.014987	0.0465036

The eigenvector for the eigenvalue 1

1.00717
−0.033837
0.0396105
−0.0117644
−0.00119796
0.0000188294

Out[796]=



In[797]:=
```
psianimate[db8, 5]
```

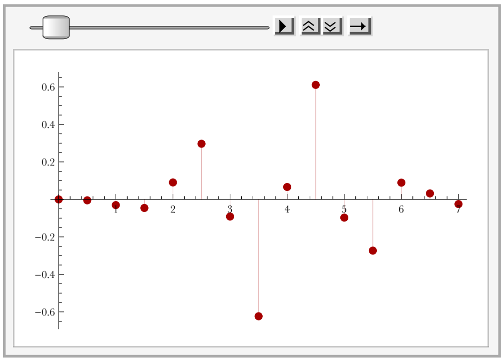
The matrix for the eigenvalue problem

1.01095	0.325803	0	0	0	0
−0.039575	0.8922	1.01095	0.325803	0	0
0.0436163	−0.264507	−0.039575	0.8922	1.01095	0.325803
−0.014987	0.0465036	0.0436163	−0.264507	−0.039575	0.8922
0	0	−0.014987	0.0465036	0.0436163	−0.264507
0	0	0	0	−0.014987	0.0465036

The eigenvector for the eigenvalue 1

1.00717
−0.033837
0.0396105
−0.0117644
−0.00119796
0.0000188294

Out[797]=



Example Daubechies-12

```
db12 = 2 Map[#[[2]] &, WaveletFilterCoefficients[ DaubechiesWavelet[6]]];
TableForm[db12, ta]
```

Out[799]//TableForm=

```
 0.157742
 0.699504
 1.06226
 0.445831
-0.319987
-0.183518
 0.137888
 0.0389232
-0.0446637
 0.000783251
 0.00675606
-0.00152353
```

In[800]:=

```
eigen[db12]
```

The matrix for the eigenvalue problem

0.699504	0.157742	0	0	0	0	0	0
0.445831	1.06226	0.699504	0.157742	0	0	0	0
-0.183518	-0.319987	0.445831	1.06226	0.699504	0.157742	0	0
0.0389232	0.137888	-0.183518	-0.319987	0.445831	1.06226	0.699504	0.157742
0.000783251	-0.0446637	0.0389232	0.137888	-0.183518	-0.319987	0.445831	1.06226
-0.00152353	0.00675606	0.000783251	-0.0446637	0.0389232	0.137888	-0.183518	-0.319987
0	0	-0.00152353	0.00675606	0.000783251	-0.0446637	0.0389232	0.137888
0	0	0	0	-0.00152353	0.00675606	0.000783251	-0.0446637
0	0	0	0	0	0	-0.00152353	0.00675606
0	0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 0.436912 \\ 0.832309 \\ -0.384754 \\ 0.142798 \\ -0.0255074 \\ -0.00353052 \\ 0.00175977 \\ 0.0000155912 \\ -2.57792\times10^{-6} \\ 3.95427\times10^{-9} \end{pmatrix}$$

Out[800]= $\{0.436912, 0.832309, -0.384754, 0.142798, -0.0255074, -0.00353052, 0.00175977, 0.0000155912, -2.57792\times10^{-6}, 3.95427\times10^{-9}\}$

In[801]:=
```
ListPlot[dyadicphi[db12, 5], Filling → Axis, PlotRange → All]
```

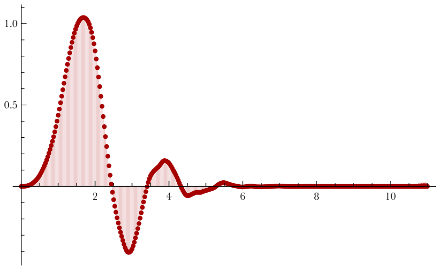
The matrix for the eigenvalue problem

0.699504	0.157742	0	0	0	0	0	0
0.445831	1.06226	0.699504	0.157742	0	0	0	0
-0.183518	-0.319987	0.445831	1.06226	0.699504	0.157742	0	0
0.0389232	0.137888	-0.183518	-0.319987	0.445831	1.06226	0.699504	0.157742
0.000783251	-0.0446637	0.0389232	0.137888	-0.183518	-0.319987	0.445831	1.06226
-0.00152353	0.00675606	0.000783251	-0.0446637	0.0389232	0.137888	-0.183518	-0.319987
0	0	-0.00152353	0.00675606	0.000783251	-0.0446637	0.0389232	0.137888
0	0	0	0	-0.00152353	0.00675606	0.000783251	-0.0446637
0	0	0	0	0	0	-0.00152353	0.00675606
0	0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

0.436912
0.832309
-0.384754
0.142798
-0.0255074
-0.00353052
0.00175977
0.0000155912
-2.57792×10^{-6}
3.95427×10^{-9}

Out[801]=



In[802]:=

```
ListPlot[dyadicpsi[db12, 5], Filling → Axis, PlotRange → All]
```

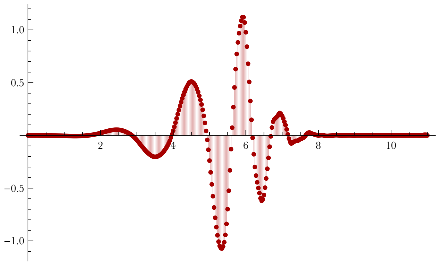
The matrix for the eigenvalue problem

0.699504	0.157742	0	0	0	0	0	0
0.445831	1.06226	0.699504	0.157742	0	0	0	0
-0.183518	-0.319987	0.445831	1.06226	0.699504	0.157742	0	0
0.0389232	0.137888	-0.183518	-0.319987	0.445831	1.06226	0.699504	0.157742
0.000783251	-0.0446637	0.0389232	0.137888	-0.183518	-0.319987	0.445831	1.06226
-0.00152353	0.00675606	0.000783251	-0.0446637	0.0389232	0.137888	-0.183518	-0.319987
0	0	-0.00152353	0.00675606	0.000783251	-0.0446637	0.0389232	0.137888
0	0	0	0	-0.00152353	0.00675606	0.000783251	-0.0446637
0	0	0	0	0	0	-0.00152353	0.00675606
0	0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

0.436912
0.832309
-0.384754
0.142798
-0.0255074
-0.00353052
0.00175977
0.0000155912
-2.57792×10^{-6}
3.95427×10^{-9}

Out[802]=



Example Coiflet-12

```
coif12 = 2 Map[#[[2]] &,
    WaveletFilterCoefficients[CoifletWavelet[2]]];
TableForm[coif12, ta]
```

Out[804]//TableForm=

```
 0.0231752
-0.0586403
-0.0952792
 0.546042
 1.14936
 0.589734
-0.108171
-0.084053
 0.0334888
 0.00793577
-0.00257841
-0.00101901
```

In[805]:=
```
eigen[coif12]
```

The matrix for the eigenvalue problem

-0.0586403	0.0231752	0	0	0	0	0	0
0.546042	-0.0952792	-0.0586403	0.0231752	0	0	0	0
0.589734	1.14936	0.546042	-0.0952792	-0.0586403	0.0231752	0	0
-0.084053	-0.108171	0.589734	1.14936	0.546042	-0.0952792	-0.0586403	0.0231
0.00793577	0.0334888	-0.084053	-0.108171	0.589734	1.14936	0.546042	-0.0952
-0.00101901	-0.00257841	0.00793577	0.0334888	-0.084053	-0.108171	0.589734	1.149
0	0	-0.00101901	-0.00257841	0.00793577	0.0334888	-0.084053	-0.108
0	0	0	0	-0.00101901	-0.00257841	0.00793577	0.0334
0	0	0	0	0	0	-0.00101901	-0.0025
0	0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 0.000750387 + 0.\,i \\ 0.0342776 + 0.\,i \\ -0.147015 + 0.\,i \\ 1.23031 + 0.\,i \\ -0.162912 + 0.\,i \\ 0.0470858 + 0.\,i \\ -0.00252724 + 0.\,i \\ 0.0000251784 + 0.\,i \\ 2.53036\times 10^{-6} + 0.\,i \\ -2.57183\times 10^{-9} + 0.\,i \end{pmatrix}$$

Out[805]= $\{0.000750387 + 0.\,i,\ 0.0342776 + 0.\,i,\ -0.147015 + 0.\,i,\ 1.23031 + 0.\,i,\ -0.162912 + 0.\,i,\ 0.0470858 + 0.\,i,\ -0.00252724 + 0.\,i,\ 0.0000251784 + 0.\,i,\ 2.53036\times 10^{-6} + 0.\,i,\ -2.57183\times 10^{-9} + 0.\,i\}$

In[806]:=
```
ListPlot[dyadicphi[coif12, 5], Filling → Axis, PlotRange → All]
```

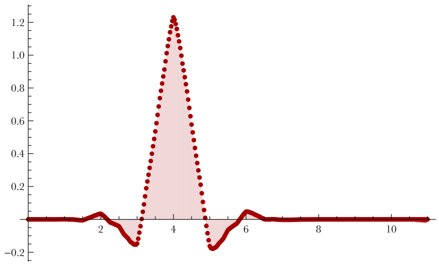
The matrix for the eigenvalue problem

-0.0586403	0.0231752	0	0	0	0	0	0
0.546042	-0.0952792	-0.0586403	0.0231752	0	0	0	0
0.589734	1.14936	0.546042	-0.0952792	-0.0586403	0.0231752	0	0
-0.084053	-0.108171	0.589734	1.14936	0.546042	-0.0952792	-0.0586403	0.0231
0.00793577	0.0334888	-0.084053	-0.108171	0.589734	1.14936	0.546042	-0.0952
-0.00101901	-0.00257841	0.00793577	0.0334888	-0.084053	-0.108171	0.589734	1.149
0	0	-0.00101901	-0.00257841	0.00793577	0.0334888	-0.084053	-0.108
0	0	0	0	-0.00101901	-0.00257841	0.00793577	0.0334
0	0	0	0	0	0	-0.00101901	-0.0025
0	0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 0.000750387 + 0.\,i \\ 0.0342776 + 0.\,i \\ -0.147015 + 0.\,i \\ 1.23031 + 0.\,i \\ -0.162912 + 0.\,i \\ 0.0470858 + 0.\,i \\ -0.00252724 + 0.\,i \\ 0.0000251784 + 0.\,i \\ 2.53036\times10^{-6} + 0.\,i \\ -2.57183\times10^{-9} + 0.\,i \end{pmatrix}$$

Out[806]=



In[808]:= phianimate[coif12, 5]

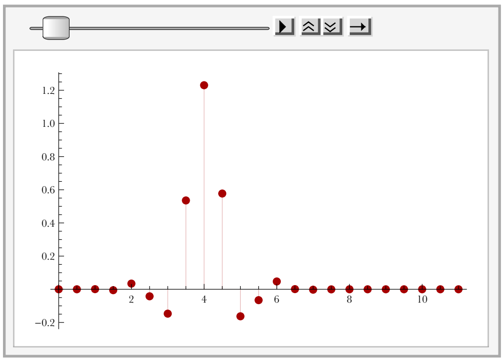
The matrix for the eigenvalue problem

−0.0586403	0.0231752	0	0	0	0	0	0
0.546042	−0.0952792	−0.0586403	0.0231752	0	0	0	0
0.589734	1.14936	0.546042	−0.0952792	−0.0586403	0.0231752	0	0
−0.084053	−0.108171	0.589734	1.14936	0.546042	−0.0952792	−0.0586403	0.0231
0.00793577	0.0334888	−0.084053	−0.108171	0.589734	1.14936	0.546042	−0.0952
−0.00101901	−0.00257841	0.00793577	0.0334888	−0.084053	−0.108171	0.589734	1.149
0	0	−0.00101901	−0.00257841	0.00793577	0.0334888	−0.084053	−0.108
0	0	0	0	−0.00101901	−0.00257841	0.00793577	0.0334
0	0	0	0	0	0	−0.00101901	−0.0025
0	0	0	0	0	0	0	0

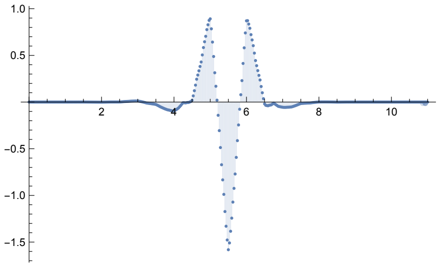
The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 0.000750387 + 0.\, i \\ 0.0342776 + 0.\, i \\ -0.147015 + 0.\, i \\ 1.23031 + 0.\, i \\ -0.162912 + 0.\, i \\ 0.0470858 + 0.\, i \\ -0.00252724 + 0.\, i \\ 0.0000251784 + 0.\, i \\ 2.53036\times 10^{-6} + 0.\, i \\ -2.57183\times 10^{-9} + 0.\, i \end{pmatrix}$$

Out[808]=



```
ListPlot[dyadicpsi[coif12, 5], Filling → Axis, PlotRange → All]
```



In[809]:=
```
psianimate[coif12, 5]
```

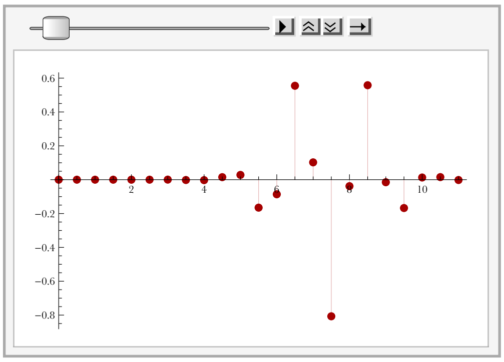
The matrix for the eigenvalue problem

-0.0586403	0.0231752	0	0	0	0	0	0
0.546042	-0.0952792	-0.0586403	0.0231752	0	0	0	0
0.589734	1.14936	0.546042	-0.0952792	-0.0586403	0.0231752	0	0
-0.084053	-0.108171	0.589734	1.14936	0.546042	-0.0952792	-0.0586403	0.0231
0.00793577	0.0334888	-0.084053	-0.108171	0.589734	1.14936	0.546042	-0.0952
-0.00101901	-0.00257841	0.00793577	0.0334888	-0.084053	-0.108171	0.589734	1.149
0	0	-0.00101901	-0.00257841	0.00793577	0.0334888	-0.084053	-0.108
0	0	0	0	-0.00101901	-0.00257841	0.00793577	0.0334
0	0	0	0	0	0	-0.00101901	-0.0025
0	0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

0.000750387 + 0. i
0.0342776 + 0. i
-0.147015 + 0. i
1.23031 + 0. i
-0.162912 + 0. i
0.0470858 + 0. i
-0.00252724 + 0. i
0.0000251784 + 0. i
2.53036×10^{-6} + 0. i
-2.57183×10^{-9} + 0. i

Out[809]=



Example Coiflet-24

In[810]:=
```
coif24 = 2 Map[#[[2]] &, WaveletFilterCoefficients[CoifletWavelet[4]]];
TableForm[coif24, ta]
```

Out[811]//TableForm=

0.00126192
-0.00230445
-0.0103891
0.0227249
0.0377345
-0.114928
-0.0793053
0.587335
1.10625
0.614315
-0.0942255
-0.136076
0.0556273
0.0354717
-0.0215126
-0.00800202
0.00530533
0.00179119
-0.000833
-0.000367659
0.0000881605
0.0000441657
-4.60984×10^{-6}
-2.52436×10^{-6}

In[812]:= **eigen[coif24]**

The matrix for the eigenvalue problem

-0.00230445	0.00126192	0	0	0	0	0
0.0227249	-0.0103891	-0.00230445	0.00126192	0	0	0
-0.114928	0.0377345	0.0227249	-0.0103891	-0.00230445	0.00126192	0
0.587335	-0.0793053	-0.114928	0.0377345	0.0227249	-0.0103891	-0.0023
0.614315	1.10625	0.587335	-0.0793053	-0.114928	0.0377345	0.0227
-0.136076	-0.0942255	0.614315	1.10625	0.587335	-0.0793053	-0.114
0.0354717	0.0556273	-0.136076	-0.0942255	0.614315	1.10625	0.5873
-0.00800202	-0.0215126	0.0354717	0.0556273	-0.136076	-0.0942255	0.6143
0.00179119	0.00530533	-0.00800202	-0.0215126	0.0354717	0.0556273	-0.136
-0.000367659	-0.000833	0.00179119	0.00530533	-0.00800202	-0.0215126	0.0354
0.0000441657	0.0000881605	-0.000367659	-0.000833	0.00179119	0.00530533	-0.0080
-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	-0.000367659	-0.000833	0.00179
0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	-0.00036
0	0	0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.000044
0	0	0	0	0	0	-2.52436
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

1.33974×10^{-9} + 0. i
1.06411×10^{-6} + 0. i
0.000067639 + 0. i
0.000975503 + 0. i
-0.0105753 + 0. i
0.0410692 + 0. i
-0.0880722 + 0. i
1.11781 + 0. i
-0.102635 + 0. i
0.0585417 + 0. i
-0.0214361 + 0. i
0.00490709 + 0. i
-0.000724169 + 0. i
0.0000752093 + 0. i
-1.38855×10^{-6} + 0. i
-3.25612×10^{-7} + 0. i
6.94007×10^{-9} + 0. i
1.38763×10^{-9} + 0. i
5.43309×10^{-12} + 0. i
-2.36781×10^{-14} + 0. i
-1.36065×10^{-17} + 0. i
3.43476×10^{-23} + 0. i

Out[812]= {1.33974×10^{-9} + 0. i, 1.06411×10^{-6} + 0. i, 0.000067639 + 0. i, 0.000975503 + 0. i, -0.0105753 + 0. i, 0.0410692 + 0. i, -0.0880722 + 0. i, 1.11781 + 0. i, -0.102635 + 0. i, 0.0585417 + 0. i, -0.0214361 + 0. i, 0.00490709 + 0. i, -0.000724169 + 0. i, 0.0000752093 + 0. i, -1.38855×10^{-6} + 0. i, -3.25612×10^{-7} + 0. i, 6.94007×10^{-9} + 0. i, 1.38763×10^{-9} + 0. i, 5.43309×10^{-12} + 0. i, -2.36781×10^{-14} + 0. i, -1.36065×10^{-17} + 0. i, 3.43476×10^{-23} + 0. i}

In[813]:=

```
ListPlot[dyadicphi[coif24, 2], Filling → Axis, PlotRange → All]
```

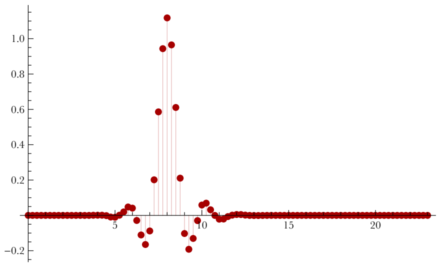
The matrix for the eigenvalue problem

-0.00230445	0.00126192	0	0	0	0	0
0.0227249	-0.0103891	-0.00230445	0.00126192	0	0	0
-0.114928	0.0377345	0.0227249	-0.0103891	-0.00230445	0.00126192	0
0.587335	-0.0793053	-0.114928	0.0377345	0.0227249	-0.0103891	-0.0023
0.614315	1.10625	0.587335	-0.0793053	-0.114928	0.0377345	0.0227
-0.136076	-0.0942255	0.614315	1.10625	0.587335	-0.0793053	-0.114
0.0354717	0.0556273	-0.136076	-0.0942255	0.614315	1.10625	0.5873
-0.00800202	-0.0215126	0.0354717	0.0556273	-0.136076	-0.0942255	0.6143
0.00179119	0.00530533	-0.00800202	-0.0215126	0.0354717	0.0556273	-0.136
-0.000367659	-0.000833	0.00179119	0.00530533	-0.00800202	-0.0215126	0.0354
0.0000441657	0.0000881605	-0.000367659	-0.000833	0.00179119	0.00530533	-0.0080
-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	-0.000367659	-0.000833	0.00179
0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	-0.00036
0	0	0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.000044
0	0	0	0	0	0	-2.52436
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$1.33974\times10^{-9}+0.\,i$
$1.06411\times10^{-6}+0.\,i$
$0.000067639+0.\,i$
$0.000975503+0.\,i$
$-0.0105753+0.\,i$
$0.0410692+0.\,i$
$-0.0880722+0.\,i$
$1.11781+0.\,i$
$-0.102635+0.\,i$
$0.0585417+0.\,i$
$-0.0214361+0.\,i$
$0.00490709+0.\,i$
$-0.000724169+0.\,i$
$0.0000752093+0.\,i$
$-1.38855\times10^{-6}+0.\,i$
$-3.25612\times10^{-7}+0.\,i$
$6.94007\times10^{-9}+0.\,i$
$1.38763\times10^{-9}+0.\,i$
$5.43309\times10^{-12}+0.\,i$
$-2.36781\times10^{-14}+0.\,i$
$-1.36065\times10^{-17}+0.\,i$
$3.43476\times10^{-23}+0.\,i$

Out[813]=



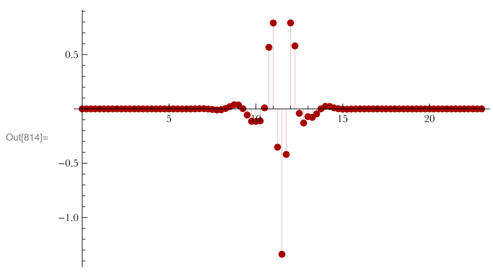
In[814]:=
```
ListPlot[dyadicpsi[coif24, 2], Filling → Axis, PlotRange → All]
```

The matrix for the eigenvalue problem

−0.00230445	0.00126192	0	0	0	0	0
0.0227249	−0.0103891	−0.00230445	0.00126192	0	0	0
−0.114928	0.0377345	0.0227249	−0.0103891	−0.00230445	0.00126192	0
0.587335	−0.0793053	−0.114928	0.0377345	0.0227249	−0.0103891	−0.0023
0.614315	1.10625	0.587335	−0.0793053	−0.114928	0.0377345	0.0227
−0.136076	−0.0942255	0.614315	1.10625	0.587335	−0.0793053	−0.114
0.0354717	0.0556273	−0.136076	−0.0942255	0.614315	1.10625	0.5873
−0.00800202	−0.0215126	0.0354717	0.0556273	−0.136076	−0.0942255	0.6143
0.00179119	0.00530533	−0.00800202	−0.0215126	0.0354717	0.0556273	−0.136
−0.000367659	−0.000833	0.00179119	0.00530533	−0.00800202	−0.0215126	0.0354
0.0000441657	0.0000881605	−0.000367659	−0.000833	0.00179119	0.00530533	−0.0080
-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	−0.000367659	−0.000833	0.00179
0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	−0.00036
0	0	0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.000044
0	0	0	0	0	0	−2.52436
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$$\begin{pmatrix} 1.33974\times10^{-9}+0.\,i \\ 1.06411\times10^{-6}+0.\,i \\ 0.000067639+0.\,i \\ 0.000975503+0.\,i \\ -0.0105753+0.\,i \\ 0.0410692+0.\,i \\ -0.0880722+0.\,i \\ 1.11781+0.\,i \\ -0.102635+0.\,i \\ 0.0585417+0.\,i \\ -0.0214361+0.\,i \\ 0.00490709+0.\,i \\ -0.000724169+0.\,i \\ 0.0000752093+0.\,i \\ -1.38855\times10^{-6}+0.\,i \\ -3.25612\times10^{-7}+0.\,i \\ 6.94007\times10^{-9}+0.\,i \\ 1.38763\times10^{-9}+0.\,i \\ 5.43309\times10^{-12}+0.\,i \\ -2.36781\times10^{-14}+0.\,i \\ -1.36065\times10^{-17}+0.\,i \\ 3.43476\times10^{-23}+0.\,i \end{pmatrix}$$

Out[814]=


In[815]:=
```
phianimate[coif24, 5]
```

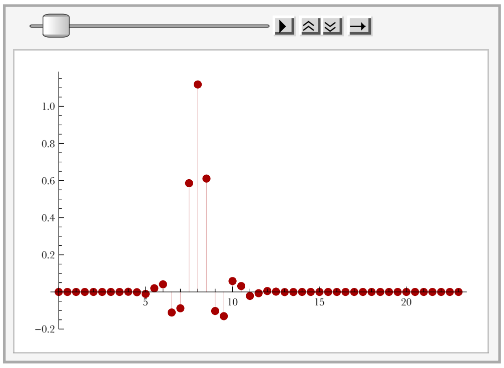
The matrix for the eigenvalue problem

−0.00230445	0.00126192	0	0	0	0	0
0.0227249	−0.0103891	−0.00230445	0.00126192	0	0	0
−0.114928	0.0377345	0.0227249	−0.0103891	−0.00230445	0.00126192	0
0.587335	−0.0793053	−0.114928	0.0377345	0.0227249	−0.0103891	−0.0023
0.614315	1.10625	0.587335	−0.0793053	−0.114928	0.0377345	0.0227
−0.136076	−0.0942255	0.614315	1.10625	0.587335	−0.0793053	−0.114
0.0354717	0.0556273	−0.136076	−0.0942255	0.614315	1.10625	0.5873
−0.00800202	−0.0215126	0.0354717	0.0556273	−0.136076	−0.0942255	0.6143
0.00179119	0.00530533	−0.00800202	−0.0215126	0.0354717	0.0556273	−0.136
−0.000367659	−0.000833	0.00179119	0.00530533	−0.00800202	−0.0215126	0.0354
0.0000441657	0.0000881605	−0.000367659	−0.000833	0.00179119	0.00530533	−0.0080
-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	−0.000367659	−0.000833	0.00179
0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	−0.00036
0	0	0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.000044
0	0	0	0	0	0	−2.52436
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$1.33974\times10^{-9} + 0.\,i$
$1.06411\times10^{-6} + 0.\,i$
$0.000067639 + 0.\,i$
$0.000975503 + 0.\,i$
$-0.0105753 + 0.\,i$
$0.0410692 + 0.\,i$
$-0.0880722 + 0.\,i$
$1.11781 + 0.\,i$
$-0.102635 + 0.\,i$
$0.0585417 + 0.\,i$
$-0.0214361 + 0.\,i$
$0.00490709 + 0.\,i$
$-0.000724169 + 0.\,i$
$0.0000752093 + 0.\,i$
$-1.38855\times10^{-6} + 0.\,i$
$-3.25612\times10^{-7} + 0.\,i$
$6.94007\times10^{-9} + 0.\,i$
$1.38763\times10^{-9} + 0.\,i$
$5.43309\times10^{-12} + 0.\,i$
$-2.36781\times10^{-14} + 0.\,i$
$-1.36065\times10^{-17} + 0.\,i$
$3.43476\times10^{-23} + 0.\,i$

Out[815]=



In[816]:=
```
psianimate[coif24, 5]
```

The matrix for the eigenvalue problem

-0.00230445	0.00126192	0	0	0	0	0
0.0227249	-0.0103891	-0.00230445	0.00126192	0	0	0
-0.114928	0.0377345	0.0227249	-0.0103891	-0.00230445	0.00126192	0
0.587335	-0.0793053	-0.114928	0.0377345	0.0227249	-0.0103891	-0.0023
0.614315	1.10625	0.587335	-0.0793053	-0.114928	0.0377345	0.0227
-0.136076	-0.0942255	0.614315	1.10625	0.587335	-0.0793053	-0.114
0.0354717	0.0556273	-0.136076	-0.0942255	0.614315	1.10625	0.5873
-0.00800202	-0.0215126	0.0354717	0.0556273	-0.136076	-0.0942255	0.6143
0.00179119	0.00530533	-0.00800202	-0.0215126	0.0354717	0.0556273	-0.136
-0.000367659	-0.000833	0.00179119	0.00530533	-0.00800202	-0.0215126	0.0354
0.0000441657	0.0000881605	-0.000367659	-0.000833	0.00179119	0.00530533	-0.0080
-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	-0.000367659	-0.000833	0.00179
0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.0000441657	0.0000881605	-0.00036
0	0	0	0	-2.52436×10^{-6}	-4.60984×10^{-6}	0.000044
0	0	0	0	0	0	-2.52436
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0
0	0	0	0	0	0	0

The eigenvector for the eigenvalue 1

$1.33974\times10^{-9} + 0.\,i$
$1.06411\times10^{-6} + 0.\,i$
$0.000067639 + 0.\,i$
$0.000975503 + 0.\,i$
$-0.0105753 + 0.\,i$
$0.0410692 + 0.\,i$
$-0.0880722 + 0.\,i$
$1.11781 + 0.\,i$
$-0.102635 + 0.\,i$
$0.0585417 + 0.\,i$
$-0.0214361 + 0.\,i$
$0.00490709 + 0.\,i$
$-0.000724169 + 0.\,i$
$0.0000752093 + 0.\,i$
$-1.38855\times10^{-6} + 0.\,i$
$-3.25612\times10^{-7} + 0.\,i$
$6.94007\times10^{-9} + 0.\,i$
$1.38763\times10^{-9} + 0.\,i$
$5.43309\times10^{-12} + 0.\,i$
$-2.36781\times10^{-14} + 0.\,i$
$-1.36065\times10^{-17} + 0.\,i$
$3.43476\times10^{-23} + 0.\,i$

Out[816]=