

In[139]:=

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ClearAll[L1Matrix]
ClearAll[L2Matrix]
ClearAll[L3Matrix]
ClearAll[LMatrix]

(* Define symbolic variables *)
 $\gamma = \gamma$ ;
 $\omega = \omega$ ;
nMax = 16;

L1[m_, n_] :=
If[1 ≤ m ≤ nMax && 1 ≤ n ≤ nMax,
Which[
n > 8, KroneckerDelta[m, n - 8] + KroneckerDelta[m, n - 4] -
KroneckerDelta[m, n - 2] - KroneckerDelta[m, n - 1],
4 < n ≤ 8, KroneckerDelta[m, n + 8] + KroneckerDelta[m, n - 4] -
KroneckerDelta[m, n - 2] - KroneckerDelta[m, n - 1],
2 < n ≤ 4, KroneckerDelta[m, n + 8] + KroneckerDelta[m, n + 4] -
KroneckerDelta[m, n - 2] - KroneckerDelta[m, n - 1],
1 < n ≤ 2, KroneckerDelta[m, n + 8] + KroneckerDelta[m, n + 4] -
KroneckerDelta[m, n + 2] - KroneckerDelta[m, n - 1],
n == 1, KroneckerDelta[m, n + 8] + KroneckerDelta[m, n + 4] -
KroneckerDelta[m, n + 2] - KroneckerDelta[m, n + 1],
True, 0
],
0
]

L2[m_, n_] :=
If[1 ≤ m ≤ nMax && 1 ≤ n ≤ nMax,
Module[{s1, s2, s1Prime, s2Prime},
{s1, s2, s1Prime, s2Prime} = IntegerDigits[n - 1, 2, 4];
(KroneckerDelta[s1, 1] * KroneckerDelta[s1Prime, 1] * KroneckerDelta[m, n - 10]) +
(KroneckerDelta[s1, 1] * KroneckerDelta[s2Prime, 1] * KroneckerDelta[m, n - 9]) +
(KroneckerDelta[s2, 1] * KroneckerDelta[s1Prime, 1] * KroneckerDelta[m, n - 6]) +
(KroneckerDelta[s2, 1] * KroneckerDelta[s2Prime, 1] * KroneckerDelta[m, n - 5])
],
0
]
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L3[m_, n_] :=
If[1 ≤ m ≤ nMax && 1 ≤ n ≤ nMax,
Module[{s1, s2, s1Prime, s2Prime},
{s1, s2, s1Prime, s2Prime} = IntegerDigits[n - 1, 2, 4];
(KroneckerDelta[s1, 1] + KroneckerDelta[s2, 1] +
KroneckerDelta[s1Prime, 1] + KroneckerDelta[s2Prime, 1]) KroneckerDelta[m, n] +
KroneckerDelta[s1, 0] × KroneckerDelta[s2, 1] × KroneckerDelta[m, n + 4] +
KroneckerDelta[s1, 1] × KroneckerDelta[s2, 0] × KroneckerDelta[m, n - 4] +
KroneckerDelta[s1Prime, 0] × KroneckerDelta[s2Prime, 1] × KroneckerDelta[m, n + 1] +
KroneckerDelta[s1Prime, 1] × KroneckerDelta[s2Prime, 0] × KroneckerDelta[m, n - 1]
],
0
]
L1Matrix = Table[L1[m, n], {m, 1, nMax}, {n, 1, nMax}];
L2Matrix = Table[L2[m, n], {m, 1, nMax}, {n, 1, nMax}];
L3Matrix = Table[L3[m, n], {m, 1, nMax}, {n, 1, nMax}];
LMatrix = -I * ω * L1Matrix + γ * L2Matrix - γ / 2 * L3Matrix;

MatrixForm[LMatrix]
eigenvalues = Eigenvalues[LMatrix];
eigenvectors = Eigenvectors[LMatrix];
eigenvalues
eigenvectors // Simplify

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Out[153]//MatrixForm=

$$\begin{pmatrix} 0 & i\omega & i\omega & 0 & -i\omega & \gamma & \gamma & 0 & -i\omega & \gamma & \gamma & 0 & 0 & 0 & 0 & 0 \\ i\omega & -\frac{\gamma}{2} & -\frac{\gamma}{2} + i\omega & i\omega & 0 & -i\omega & 0 & \gamma & 0 & -i\omega & 0 & \gamma & 0 & 0 & 0 & 0 \\ i\omega & -\frac{\gamma}{2} & -\frac{\gamma}{2} & i\omega & i\omega & 0 & -i\omega & \gamma & 0 & 0 & -i\omega & \gamma & 0 & 0 & 0 & 0 \\ 0 & i\omega & 0 & -\gamma & i\omega & i\omega & 0 & -i\omega & 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & 0 \\ -i\omega & 0 & 0 & 0 & -\frac{\gamma}{2} & i\omega & i\omega & 0 & -\frac{\gamma}{2} - i\omega & 0 & 0 & 0 & -i\omega & \gamma & \gamma & 0 \\ 0 & -i\omega & 0 & 0 & 0 & -\gamma & -\frac{\gamma}{2} + i\omega & i\omega & 0 & -\frac{\gamma}{2} - i\omega & 0 & 0 & 0 & -i\omega & 0 & \gamma \\ 0 & 0 & -i\omega & 0 & 0 & -\frac{\gamma}{2} & -\gamma & i\omega & i\omega & 0 & -\frac{\gamma}{2} - i\omega & 0 & 0 & 0 & -i\omega & \gamma \\ 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & -\frac{3\gamma}{2} & i\omega & i\omega & 0 & -\frac{\gamma}{2} - i\omega & 0 & 0 & 0 & -i\omega \\ -i\omega & 0 & 0 & 0 & -\frac{\gamma}{2} & 0 & 0 & 0 & -\frac{\gamma}{2} & i\omega & i\omega & 0 & -i\omega & \gamma & \gamma & 0 \\ 0 & -i\omega & 0 & 0 & 0 & -\frac{\gamma}{2} & 0 & 0 & 0 & -\gamma & -\frac{\gamma}{2} + i\omega & i\omega & 0 & -i\omega & 0 & \gamma \\ 0 & 0 & -i\omega & 0 & 0 & 0 & -\frac{\gamma}{2} & 0 & 0 & -\frac{\gamma}{2} & -\gamma & i\omega & i\omega & 0 & -i\omega & \gamma \\ 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & -\frac{\gamma}{2} & 0 & 0 & 0 & -\frac{3\gamma}{2} & i\omega & i\omega & 0 & -i\omega \\ 0 & 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\gamma & i\omega & i\omega & 0 \\ 0 & 0 & 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\frac{3\gamma}{2} & -\frac{\gamma}{2} + i\omega & i\omega \\ 0 & 0 & 0 & 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & 0 & 0 & 0 & -\frac{\gamma}{2} & -\frac{3\gamma}{2} & i\omega \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & -i\omega & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -2\gamma \end{pmatrix}$$

Out[156]=

$$\left\{ \frac{1}{2} \text{Root}\left[-393216 i \gamma^9 \omega^7 - 2588672 \gamma^8 \omega^8 + 966656 i \gamma^7 \omega^9 + 745472 \gamma^6 \omega^{10} + 655360 i \gamma^5 \omega^{11} + 1916928 \gamma^4 \omega^{12} - 4538368 i \gamma^3 \omega^{13} + \dots 11 \dots\right] + (281344 \gamma^6 + 580160 \gamma^4 \omega^2 - 211744 i \gamma^3 \omega^3 + 166544 \gamma^2 \omega^4 - 121024 i \gamma \omega^5 - 9984 \omega^6) \#1^{10} + (95488 \gamma^5 + 127312 \gamma^3 \omega^2 - 29104 i \gamma^2 \omega^3 + 19040 \gamma \omega^4 - 6016 i \omega^5) \#1^{11} + (23392 \gamma^4 + 18368 \gamma^2 \omega^2 - 2312 i \gamma \omega^3 + 960 \omega^4) \#1^{12} + (4032 \gamma^3 + 1568 \gamma \omega^2 - 80 i \omega^3) \#1^{13} + (464 \gamma^2 + 60 \omega^2) \#1^{14} + 32 \gamma \#1^{15} + \#1^{16} \&, 1\right\}, \frac{1}{2} \text{Root}\left[\dots 1 \dots\right], \dots 12 \dots, \frac{1}{2} \text{Root}\left[\dots 1 \dots\right], \frac{1}{2} \text{Root}\left[\dots 1 \dots \&, 16\right]\right\}$$

Full expression not available (original memory size: 0.5 MB)

