GetPauliStringFromMatrix

```
SetDirectory @ NotebookDirectory[];
Import["../Link/QuESTlink.m"];
```

```
test[in_] := Module[
    {out, check, error},
    out = GetPauliStringFromMatrix[in];
    check = Simplify @ Normal @ CalcPauliExpressionMatrix[out];
    error = check -in // N // Abs // Chop // Max;
    Echo[out, "output: "];
    Echo[error, "error: "];
    If[error =!= 0, Style["ERRONEOUS PAULI STRING!", Red]]]
```

Deprecation

Merged into **GetPauliString** as of v0.18

? GetPauliStringFromMatrix

> Symbol
>
> This function is deprecated. Please instead use GetPauliString.
>
> ⌄

GetPauliStringFromMatrix @ IdentityMatrix[2]

⋯ GetPauliString: The function GetPauliStringFromMatrix[] is deprecated. Use GetPauliString[] or temporarily hide this message using Quiet[].

Id_0

Doc

? GetPauliStringFromMatrix

> Symbol
>
> GetPauliStringFromMatrix[m] returns a complex-weighted sum of
>   Pauli tensors equivalent to the given square, power-of-2 length matrix m.
> If the input matrix is Hermitian, the output can be passed
>   to Chop[] in order to remove the negligible imaginary components.
>
> ⌄

Floating-point

test @ RandomComplex[(i + 1) {-10, 10}, {2, 2}]

» output: $(-0.973073 + 0.741944\,i)\,\mathrm{Id}_0 - (2.97398 + 4.26202\,i)\,X_0 +$
$(3.4839 - 1.23818\,i)\,Y_0 + (7.76152 - 5.63547\,i)\,Z_0$

» error: 0

test @ RandomComplex[(i + 1) {-10, 10}, {8, 8}]

» output: $(0.139814 - 1.54188\,i)\,\mathrm{Id}_2 + (1.73462 + 1.48615\,i)\,X_0 +$
$(3.02282 + 2.05665\,i)\,X_1 + (0.454681 - 1.87161\,i)\,X_0\,X_1 + (1.34732 + 2.02739\,i)\,X_2 -$
$(1.86537 + 2.35614\,i)\,X_0\,X_2 + (2.65145 - 0.871312\,i)\,X_1\,X_2 + (0.326747 - 2.3702\,i)\,X_0\,X_1\,X_2 -$
$(0.763019 - 0.169465\,i)\,Y_0 + (3.48826 + 5.08657\,i)\,X_1\,Y_0 + (0.648935 - 0.403203\,i)\,X_2\,Y_0 +$
$(0.891398 + 1.90618\,i)\,X_1\,X_2\,Y_0 - (0.164189 - 3.28807\,i)\,Y_1 + (0.0127069 - 1.08187\,i)\,X_0\,Y_1 +$
$(1.72165 - 0.282772\,i)\,X_2\,Y_1 - (2.30141 - 0.24752\,i)\,X_0\,X_2\,Y_1 + (1.3647 - 1.18187\,i)\,Y_0\,Y_1 +$
$(2.00364 - 0.882466\,i)\,X_2\,Y_0\,Y_1 - (0.94013 - 1.09517\,i)\,Y_2 + (1.78227 + 0.824745\,i)\,X_0\,Y_2 +$
$(0.101885 - 0.738079\,i)\,X_1\,Y_2 + (0.98813 + 5.06933\,i)\,X_0\,X_1\,Y_2 + (1.54881 + 3.34238\,i)\,Y_0\,Y_2 -$
$(1.08937 - 3.08663\,i)\,X_1\,Y_0\,Y_2 + (2.26801 + 1.45578\,i)\,Y_1\,Y_2 - (0.316869 + 3.18929\,i)\,X_0\,Y_1\,Y_2 -$
$(3.74421 + 2.25177\,i)\,Y_0\,Y_1\,Y_2 + (2.30453 - 1.37679\,i)\,Z_0 + (0.0914269 - 0.760655\,i)\,X_1\,Z_0 +$
$(4.5844 - 0.492016\,i)\,X_2\,Z_0 - (1.29936 + 0.863364\,i)\,X_1\,X_2\,Z_0 - (2.86909 + 0.758535\,i)\,Y_1\,Z_0 +$
$(0.843282 + 0.70642\,i)\,X_2\,Y_1\,Z_0 - (0.24794 - 0.23487\,i)\,Y_2\,Z_0 - (3.04599 + 0.993896\,i)\,X_1\,Y_2\,Z_0 -$
$(2.45986 - 2.84889\,i)\,Y_1\,Y_2\,Z_0 - (3.58186 + 0.570081\,i)\,Z_1 + (3.6915 + 2.96072\,i)\,X_0\,Z_1 +$
$(1.11257 + 3.25462\,i)\,X_2\,Z_1 + (3.26331 - 2.18514\,i)\,X_0\,X_2\,Z_1 + (0.120717 - 0.0854912\,i)\,Y_0\,Z_1 -$
$(1.31298 + 0.759866\,i)\,X_2\,Y_0\,Z_1 - (2.12883 - 1.45747\,i)\,Y_2\,Z_1 + (2.92552 + 0.810047\,i)\,X_0\,Y_2\,Z_1 +$
$(2.29638 - 2.36478\,i)\,Y_0\,Y_2\,Z_1 - (1.00239 - 0.251881\,i)\,Z_0\,Z_1 - (0.78218 - 1.65059\,i)\,X_2\,Z_0\,Z_1 +$
$(1.40744 + 0.792362\,i)\,Y_2\,Z_0\,Z_1 + (1.62985 + 2.38714\,i)\,Z_2 + (3.27005 - 3.53969\,i)\,X_0\,Z_2 +$
$(1.86487 + 0.715973\,i)\,X_1\,Z_2 - (0.62627 - 0.902676\,i)\,X_0\,X_1\,Z_2 + (1.89233 + 0.580809\,i)\,Y_0\,Z_2 +$
$(1.35633 + 1.71375\,i)\,X_1\,Y_0\,Z_2 + (0.550727 - 2.01131\,i)\,Y_1\,Z_2 + (1.45508 - 0.858943\,i)\,X_0\,Y_1\,Z_2 -$
$(0.144475 - 1.38886\,i)\,Y_0\,Y_1\,Z_2 - (4.30294 + 2.655\,i)\,Z_0\,Z_2 + (2.09851 + 1.77015\,i)\,X_1\,Z_0\,Z_2 +$
$(2.70976 + 0.358614\,i)\,Y_1\,Z_0\,Z_2 - (2.19259 - 2.53062\,i)\,Z_1\,Z_2 - (2.44097 + 0.383743\,i)\,X_0\,Z_1\,Z_2 -$
$(1.52336 + 0.754148\,i)\,Y_0\,Z_1\,Z_2 + (0.382741 + 3.61576\,i)\,Z_0\,Z_1\,Z_2$

» error: 0

test @ RandomReal[{-10, 10}, {4, 4}]

» output: $-1.40379\,\mathrm{Id}_1 + 0.796864\,X_0 + 0.492345\,X_1 + 2.99213\,X_0\,X_1 - (0. + 1.9158\,i)\,Y_0 +$
$(0. + 0.0733287\,i)\,X_1\,Y_0 - (0. + 2.16448\,i)\,Y_1 + (0. + 2.06191\,i)\,X_0\,Y_1 +$
$0.101484\,Y_0\,Y_1 - 1.34646\,Z_0 + 2.54854\,X_1\,Z_0 - (0. + 2.70442\,i)\,Y_1\,Z_0 +$
$0.518598\,Z_1 + 2.25656\,X_0\,Z_1 + (0. + 4.69625\,i)\,Y_0\,Z_1 + 4.33439\,Z_0\,Z_1$

» error: 0

hermitian = -i MatrixLog @ RandomVariate @ CircularUnitaryMatrixDistribution @ 4;
test @ hermitian

» output: $\left(0.309257 - 6.57569 \times 10^{-17} \, i\right) \text{Id}_1 + \left(0.274875 + 1.38778 \times 10^{-17} \, i\right) X_0 +$
$\left(1.59668 - 2.56739 \times 10^{-16} \, i\right) X_1 - \left(0.0811653 - 2.77556 \times 10^{-16} \, i\right) X_0 \, X_1 -$
$\left(0.141415 + 2.22045 \times 10^{-16} \, i\right) Y_0 + \left(0.588161 + 2.77556 \times 10^{-17} \, i\right) X_1 \, Y_0 +$
$\left(0.0430516 - 5.55112 \times 10^{-17} \, i\right) Y_1 + \left(0.479953 - 2.498 \times 10^{-16} \, i\right) X_0 \, Y_1 -$
$\left(0.709693 - 2.77556 \times 10^{-16} \, i\right) Y_0 \, Y_1 + \left(0.0241915 + 1.96295 \times 10^{-16} \, i\right) Z_0 -$
$\left(0.292846 + 1.38778 \times 10^{-16} \, i\right) X_1 \, Z_0 + \left(0.275077 + 4.44089 \times 10^{-16} \, i\right) Y_1 \, Z_0 -$
$\left(0.166739 - 4.09774 \times 10^{-16} \, i\right) Z_1 - \left(0.747069 - 4.02456 \times 10^{-16} \, i\right) X_0 \, Z_1 -$
$\left(0.218264 - 1.11022 \times 10^{-16} \, i\right) Y_0 \, Z_1 - \left(0.171741 + 1.51734 \times 10^{-16} \, i\right) Z_0 \, Z_1$

» error: 0

```
test @ Table[0., 2, 2]
```

» output: $0. + 0. \, i$

» error: 0

Integer

```
test @ RandomInteger[{-10, 10}, {2, 2}]
```

» output: $-7 \, \text{Id}_0 - 6 \, X_0 + 2 \, i \, Y_0 - Z_0$

» error: 0

```
test @ RandomInteger[{-10, 10}, {4, 4}]
```

» output: $\dfrac{5 \, \text{Id}_1}{4} - \dfrac{X_0}{4} + \dfrac{5 \, X_1}{4} + X_0 \, X_1 - \dfrac{21 \, i \, Y_0}{4} - \dfrac{5}{2} \, i \, X_1 \, Y_0 + \dfrac{i \, Y_1}{4} -$
$3 \, i \, X_0 \, Y_1 + \dfrac{5 \, Y_0 \, Y_1}{2} + \dfrac{3 \, Z_0}{4} - \dfrac{25 \, X_1 \, Z_0}{4} - \dfrac{9}{4} \, i \, Y_1 \, Z_0 + \dfrac{Z_1}{4} + \dfrac{X_0 \, Z_1}{4} - \dfrac{3}{4} \, i \, Y_0 \, Z_1 + \dfrac{11 \, Z_0 \, Z_1}{4}$

» error: 0

```
test @ Table[1, {i, 8}, {i, 8}]
```

» output: $\text{Id}_2 + X_0 + X_1 + X_0 \, X_1 + X_2 + X_0 \, X_2 + X_1 \, X_2 + X_0 \, X_1 \, X_2$

» error: 0

```
test @ Table[0, {i, 8}, {i, 8}]
```

» output: 0

» error: 0

```
test[ IdentityMatrix[8] ]
```

» output: Id_2

» error: 0

Symbolic

```
test @ {{a, b}, {c, d}}
```

» output: $\dfrac{1}{2} \, (a + d) \, \text{Id}_0 + \dfrac{1}{2} \, (b + c) \, X_0 + \dfrac{1}{2} \, (i \, b - i \, c) \, Y_0 + \dfrac{1}{2} \, (a - d) \, Z_0$

» error: 0

test[a IdentityMatrix[4]]

» output: $a\,Id_1$

» error: 0

test @ Table[a, {i, 8}, {i, 8}]

» output: $a\,Id_2 + a\,X_0 + a\,X_1 + a\,X_0\,X_1 + a\,X_2 + a\,X_0\,X_2 + a\,X_1\,X_2 + a\,X_0\,X_1\,X_2$

» error: 0

test @ RandomChoice[{a, b, c, d}, {4, 4}]

» output: $\frac{1}{4}\left(2\,a + c + d\right)Id_1 + \frac{1}{4}\left(b + c + 2\,d\right)X_0 + \frac{1}{4}\left(a + 2\,b + c\right)X_1 + \frac{1}{4}\left(a + 2\,b + c\right)X_0\,X_1 +$

$\frac{1}{4}\left(\mathbb{i}\,b + \mathbb{i}\,c - 2\,\mathbb{i}\,d\right)Y_0 + \frac{1}{4}\left(\mathbb{i}\,a - \mathbb{i}\,c\right)X_1\,Y_0 + \frac{1}{4}\left(\mathbb{i}\,a - \mathbb{i}\,c\right)Y_1 + \frac{1}{4}\left(-\mathbb{i}\,a + \mathbb{i}\,c\right)X_0\,Y_1 +$

$\frac{1}{4}\left(a - 2\,b + c\right)Y_0\,Y_1 + \frac{1}{4}\left(-c + d\right)Z_0 + \frac{1}{4}\left(-a + c\right)X_1\,Z_0 + \frac{1}{4}\left(-\mathbb{i}\,a + 2\,\mathbb{i}\,b - \mathbb{i}\,c\right)Y_1\,Z_0 +$

$\frac{1}{4}\left(-c + d\right)Z_1 + \frac{1}{4}\left(b - c\right)X_0\,Z_1 + \frac{1}{4}\left(\mathbb{i}\,b - \mathbb{i}\,c\right)Y_0\,Z_1 + \frac{1}{4}\left(-2\,a + c + d\right)Z_0\,Z_1$

» error: 0

test @ RandomChoice[{a, b, c, d}, {8, 8}]

» output: $\frac{1}{8}$ (a + 5 b + 2 c) Id$_2$ + $\frac{1}{8}$ (a + 4 b + 2 c + d) X$_0$ + $\frac{1}{8}$ (a + b + c + 5 d) X$_1$ +

$\frac{1}{8}$ (3 b + c + 4 d) X$_0$ X$_1$ + $\frac{1}{8}$ (5 a + 2 c + d) X$_2$ + $\frac{1}{8}$ (2 b + c + 5 d) X$_0$ X$_2$ + $\frac{1}{8}$ (3 a + 3 b + 2 d) X$_1$ X$_2$ +

$\frac{1}{8}$ (a + 2 b + 3 c + 2 d) X$_0$ X$_1$ X$_2$ + $\frac{1}{8}$ (- i a + 2 i c - i d) Y$_0$ + $\frac{1}{8}$ (i b - i c) X$_1$ Y$_0$ +

$\frac{1}{8}$ (- 2 i b - i c + 3 i d) X$_2$ Y$_0$ + $\frac{1}{8}$ (- i a + i c) X$_1$ X$_2$ Y$_0$ + $\frac{1}{8}$ (i a - i b - i c + i d) Y$_1$ +

$\frac{1}{8}$ (- i b - i c + 2 i d) X$_0$ Y$_1$ + $\frac{1}{8}$ (i a - i b) X$_2$ Y$_1$ + $\frac{1}{8}$ (i a - i c) X$_0$ X$_2$ Y$_1$ + $\frac{1}{8}$ (- b - c + 2 d) Y$_0$ Y$_1$ +

$\frac{1}{8}$ (a - 2 b + 3 c - 2 d) X$_2$ Y$_0$ Y$_1$ + $\frac{1}{8}$ (- i a + i d) Y$_2$ + $\frac{1}{8}$ (i c - i d) X$_0$ Y$_2$ + $\frac{1}{8}$ (i a - i b) X$_1$ Y$_2$ +

$\frac{1}{8}$ (- i a - 2 i b + i c + 2 i d) X$_0$ X$_1$ Y$_2$ + $\frac{1}{8}$ (c - d) Y$_0$ Y$_2$ + $\frac{1}{8}$ (- a + c) X$_1$ Y$_0$ Y$_2$ + $\frac{1}{8}$ (- 3 a + b + 2 d) Y$_1$ Y$_2$ +

$\frac{1}{8}$ (a - c) X$_0$ Y$_1$ Y$_2$ + $\frac{1}{8}$ (- i a + 2 i b + i c - 2 i d) Y$_0$ Y$_1$ Y$_2$ + $\frac{1}{8}$ (a + b - 2 c) Z$_0$ + $\frac{1}{8}$ (a - b + c - d) X$_1$ Z$_0$ +

$\frac{1}{8}$ (- a + d) X$_2$ Z$_0$ + $\frac{1}{8}$ (a - b) X$_1$ X$_2$ Z$_0$ + $\frac{1}{8}$ (i a + i b - i c - i d) Y$_1$ Z$_0$ + $\frac{1}{8}$ (- i a - i b + 2 i d) X$_2$ Y$_1$ Z$_0$ +

$\frac{1}{8}$ (i a - 2 i c + i d) Y$_2$ Z$_0$ + $\frac{1}{8}$ (- i a + 3 i b - 2 i d) X$_1$ Y$_2$ Z$_0$ + $\frac{1}{8}$ (- a + b) Y$_1$ Y$_2$ Z$_0$ +

$\frac{1}{8}$ (a - b) Z$_1$ + $\frac{1}{8}$ (- a - 2 b + 2 c + d) X$_0$ Z$_1$ + $\frac{1}{8}$ (- a + d) X$_2$ Z$_1$ + $\frac{1}{8}$ (2 b - c - d) X$_0$ X$_2$ Z$_1$ +

$\frac{1}{8}$ (i a - 2 i b + 2 i c - i d) Y$_0$ Z$_1$ + $\frac{1}{8}$ (- 2 i b + i c + i d) X$_2$ Y$_0$ Z$_1$ + $\frac{1}{8}$ (i a - 2 i c + i d) Y$_2$ Z$_1$ +

$\frac{1}{8}$ (- i c + i d) X$_0$ Y$_2$ Z$_1$ + $\frac{1}{8}$ (- c + d) Y$_0$ Y$_2$ Z$_1$ + $\frac{1}{8}$ (a - b) Z$_0$ Z$_1$ + $\frac{1}{8}$ (- 3 a + 2 c + d) X$_2$ Z$_0$ Z$_1$ +

$\frac{1}{8}$ (- i a + i d) Y$_2$ Z$_0$ Z$_1$ + $\frac{1}{8}$ (a - 3 b + 2 c) Z$_2$ + $\frac{1}{8}$ (- a + 2 b - d) X$_0$ Z$_2$ + $\frac{1}{8}$ (a + b + c - 3 d) X$_1$ Z$_2$ +

$\frac{1}{8}$ (- b - c + 2 d) X$_0$ X$_1$ Z$_2$ + $\frac{1}{8}$ (i a - 2 i b + i d) Y$_0$ Z$_2$ + $\frac{1}{8}$ (- 3 i b + i c + 2 i d) X$_1$ Y$_0$ Z$_2$ +

$\frac{1}{8}$ (i a - i b - i c + i d) Y$_1$ Z$_2$ + $\frac{1}{8}$ (- i b + i c) X$_0$ Y$_1$ Z$_2$ + $\frac{1}{8}$ (- b + c) Y$_0$ Y$_1$ Z$_2$ +

$\frac{1}{8}$ (a + b - 2 c) Z$_0$ Z$_2$ + $\frac{1}{8}$ (a - b + c - d) X$_1$ Z$_0$ Z$_2$ + $\frac{1}{8}$ (i a + i b - i c - i d) Y$_1$ Z$_0$ Z$_2$ +

$\frac{1}{8}$ (a - b) Z$_1$ Z$_2$ + $\frac{1}{8}$ (a - d) X$_0$ Z$_1$ Z$_2$ + $\frac{1}{8}$ (- i a + i d) Y$_0$ Z$_1$ Z$_2$ + $\frac{1}{8}$ (a - b) Z$_0$ Z$_1$ Z$_2$

» error: 0

Errors

GetPauliStringFromMatrix @ {1, 2, 3}

GetPauliStringFromMatrix: The input must be a square matrix with power−of−2 dimensions.

$Failed

GetPauliStringFromMatrix @ Table[1, {i, 7}, {j, 7}]

GetPauliStringFromMatrix: The input must be a square matrix with power−of−2 dimensions.

$Failed

`GetPauliStringFromMatrix @ Table[1, {i, 2}, {j, 4}]`

GetPauliStringFromMatrix : The input must be a square matrix with power−of−2 dimensions.

`$Failed`

`GetPauliStringFromMatrix[a, b, c]`

GetPauliStringFromMatrix : Invalid arguments. See ?GetPauliStringFromMatrix

`$Failed`