

Cargar el paquete

In[1]:=

Needs ["qm`Dirac`"]

The qm add-on qm`Dirac` version BETA

7/May/2017 has been loaded today Sun 7 May 2017 11:54:43

Mathematica 11.0.0 for Microsoft Windows (64-bit) (July 28, 2016)

Symbols that have been modified by loading the qm add-ons:

s	†	AngleBracket	MakeBoxes
OverHat	SubscriptBox	SuperDagger	SuperscriptBox
SuperStar			

New keyboard aliases for this Mathematica session

<code>[ESC]qmket[ESC]</code>	<code> ■⟩</code> ket template
<code>[ESC]qmbra[ESC]</code>	<code>⟨■ </code> bra template
<code>[ESC]qmbraket[ESC]</code>	<code>⟨■ □⟩</code> braket template
<code>[ESC]qmsum[ESC]</code>	<code>∑_{□=□} ■</code> sum template
<code>[ESC]qmint[ESC]</code>	<code>∫_□ ■ d□</code> definite integral template
<code>[ESC]qmprd[ESC]</code>	<code>∏_{□=□} ■</code> product template
<code>[ESC]qmpowe[ESC]</code>	<code>■[□]</code> power template
<code>[ESC]qmconj[ESC]</code>	<code>■*</code> complex conjugate template
<code>[ESC]qmsubs[ESC]</code>	<code>■_□</code> subscript template
<code>[ESC]qmoper[ESC]</code>	<code>■[^]</code> operator template
<code>[ESC]qmopes[ESC]</code>	<code>■_□[^]</code> subscripted operator template
<code>[ESC]qmo pep[ESC]</code>	<code>■^{^□}</code> power of operator template
<code>[ESC]qmo pep h[ESC]</code>	<code>■^{^†}</code> hermitian of operator template
<code>[ESC]qmo pps[ESC]</code>	<code>■_□^{^□}</code> power of subscripted operator
<code>[ESC]qmo psp[ESC]</code>	<code>■^{^□}</code> power of subscripted operator
<code>[ESC]qmo phs[ESC]</code>	<code>■_□^{^†}</code> hermitian of subscripted operator
<code>[ESC]qmo psh[ESC]</code>	<code>■^{^†}</code> hermitian of subscripted operator
<code>[ESC]qmcomm[ESC]</code>	<code>[[■, □]]₋</code> commutator template
<code>[ESC]qmant[ESC]</code>	<code>[[■, □]]₊</code> anticommutator template
<code>[ESC]mqmut[ESC]</code>	<code>[[■, □]]_□</code> q-mutator template
<code>[ESC]qmexpe[ESC]</code>	<code>⟨■⟩</code> expectation template

These aliases begin and end with the [ESC] key

Out[1]=

Caminante

Definitions

(Timing 0 at 20170329. Subió a 0.016 después de cambios de Block a Module)

In[2]:=

```
qm[
  Timing[
    
$$\hat{h}_1 = \frac{|\mathbf{0}_1\rangle \langle \mathbf{0}_1| + |\mathbf{1}_1\rangle \langle \mathbf{0}_1| + |\mathbf{0}_1\rangle \langle \mathbf{1}_1| - |\mathbf{1}_1\rangle \langle \mathbf{1}_1|}{\sqrt{2}};$$


$$\hat{s}_{1,2} = |\mathbf{0}_1\rangle \langle \mathbf{0}_1| \sum_{j=-\infty}^{\infty} |(\mathbf{j}-\mathbf{1})_2\rangle \langle \mathbf{j}_2| + |\mathbf{1}_1\rangle \langle \mathbf{1}_1| \sum_{j=-\infty}^{\infty} |(\mathbf{j}+\mathbf{1})_2\rangle \langle \mathbf{j}_2|;$$

     $\langle \mathbf{m}_{-1} | \mathbf{n}_{-1} \rangle := \text{KroneckerDelta}[m, n];$ 
     $\langle \mathbf{m}_{-2} | \mathbf{n}_{-2} \rangle := \text{KroneckerDelta}[m, n];$ 
  ]
]
```

Out[2]=

```
qm[{0.015625, Null}]
```

Evolución

(Timing 15.3 at 20170329. Subió a 18.56 al cambiar algunos Block en Modules en 20170331.

Subió a 25.13 al hacer que la suma ordene sus argumentos con el mismo orden que usa qmArrangeProducts en 201704171355.

Bajó a 15.8 al hacer que la regla de ordenar argumentos de la suma se “apague” durante las transformaciones algebraicas como qmExpand, y se restaure al salir del comando

)

In[3]:=

```
qm[
  Timing[
    |ψ>₀ = |θ₁, θ₂>;
    n = 20;
    Do[
      |ψ>ₜ = qmExpandProducts[ŝ₁,₂ ĥ₁ |ψ>ₜ₋₁],
      {t, 1, n}];
    |ψ>ₙ
  ]
]
```

Out[3]=

$$\begin{aligned}
 & \text{qm} \left[\left\{ 16.6094, -\frac{247|1_1\rangle|14_2\rangle}{1024} - \frac{105}{512}|\theta_1\rangle|(-4)_2\rangle - \frac{51}{256}|1_1\rangle|(-8)_2\rangle - \frac{49}{256}|\theta_1\rangle|(-8)_2\rangle - \right. \right. \\
 & \frac{35|0_1\rangle|4_2\rangle}{256} - \frac{33}{256}|\theta_1\rangle|(-10)_2\rangle - \frac{63|0_1\rangle|0_2\rangle}{512} - \frac{63|1_1\rangle|2_2\rangle}{512} - \frac{29|1_1\rangle|12_2\rangle}{256} - \\
 & \frac{103|1_1\rangle|16_2\rangle}{1024} - \frac{49}{512}|1_1\rangle|(-2)_2\rangle - \frac{23|1_1\rangle|8_2\rangle}{256} - \frac{21|\theta_1\rangle|8_2\rangle}{256} - \frac{11|\theta_1\rangle|10_2\rangle}{256} - \frac{7|1_1\rangle|6_2\rangle}{256} - \\
 & \frac{17|1_1\rangle|18_2\rangle}{1024} - \frac{|1_1\rangle|20_2\rangle}{1024} + \frac{|\theta_1\rangle|(-20)_2\rangle}{1024} + \frac{|\theta_1\rangle|18_2\rangle}{1024} + \frac{|1_1\rangle|(-18)_2\rangle}{1024} + \frac{15|\theta_1\rangle|16_2\rangle}{1024} + \\
 & \frac{17|1_1\rangle|(-16)_2\rangle}{1024} + \frac{19|\theta_1\rangle|(-18)_2\rangle}{1024} + \frac{7}{256}|1_1\rangle|(-4)_2\rangle + \frac{75|\theta_1\rangle|14_2\rangle}{1024} + \frac{23}{256}|1_1\rangle|(-6)_2\rangle + \\
 & \frac{49|1_1\rangle|4_2\rangle}{512} + \frac{103|1_1\rangle|(-14)_2\rangle}{1024} + \frac{29}{256}|1_1\rangle|(-10)_2\rangle + \frac{121|\theta_1\rangle|12_2\rangle}{1024} + \frac{63|\theta_1\rangle|2_2\rangle}{512} + \\
 & \frac{63|1_1\rangle|0_2\rangle}{512} + \frac{135|\theta_1\rangle|(-16)_2\rangle}{1024} + \frac{35|\theta_1\rangle|6_2\rangle}{256} + \frac{77}{512}|\theta_1\rangle|(-2)_2\rangle + \frac{51|1_1\rangle|10_2\rangle}{256} + \\
 & \left. \left. \frac{247|1_1\rangle|(-12)_2\rangle}{1024} + \frac{65}{256}|\theta_1\rangle|(-6)_2\rangle + \frac{425|\theta_1\rangle|(-14)_2\rangle}{1024} + \frac{121}{256}|\theta_1\rangle|(-12)_2\rangle \right\} \right]
 \end{aligned}$$

Cálculo de probabilidades (Timing 10.7 at 20170329. Subió a 12.95 al cambiar algunos Block en Modules. Subió a 18.7 al hacer que la suma ordene sus argumentos con el mismo orden que usa qmArrangeProducts en 201704171355.

Bajó a 12. al hacer que la regla de ordenar argumentos se “apague” durante las transformaciones algebraicas como qmExpand, y se restaure al salir del comando

)

In[4]:=

```
qm[
  Timing[
     $\hat{\rho}_{1,2} = |\theta_1, k_2\rangle \langle \theta_1, k_2| + |\mathbf{1}_1, k_2\rangle \langle \mathbf{1}_1, k_2|;$ 
    probabilities =
      Table[{k, qmExpandProducts[ $\langle \psi |_n \hat{\rho}_{1,2} | \psi \rangle_n$ ]},
        {k, -n, n}]
  ]
]
```

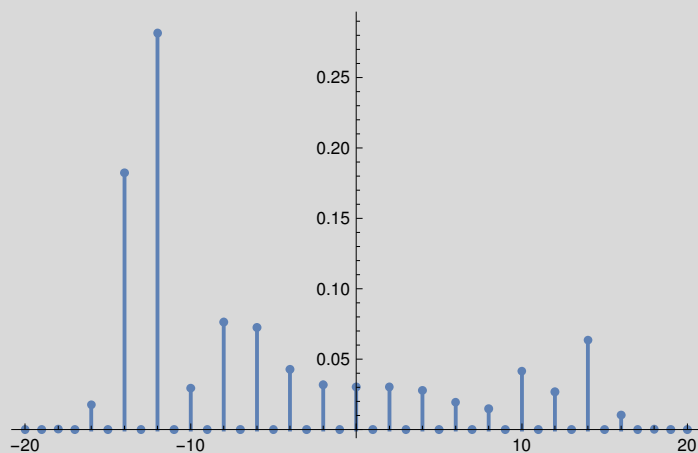
Out[4]=

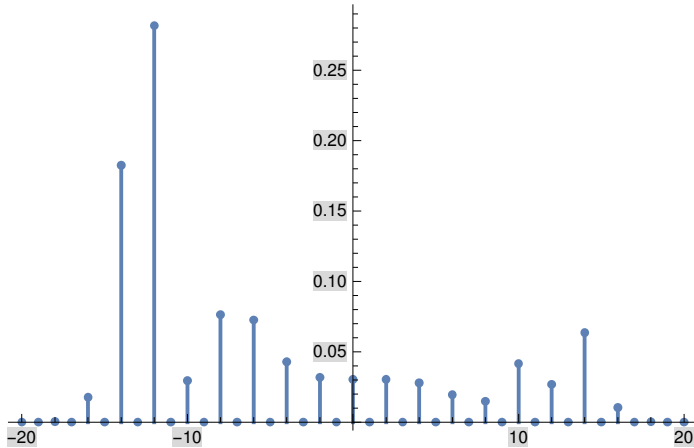
```
qm[{{12.8125, {{-20,  $\frac{1}{1048576}$ }, {-19, 0}, {-18,  $\frac{181}{524288}$ }, {-17, 0},
  {-16,  $\frac{9257}{524288}$ }, {-15, 0}, {-14,  $\frac{95617}{524288}$ }, {-13, 0}, {-12,  $\frac{295265}{1048576}$ },
  {-11, 0}, {-10,  $\frac{965}{32768}$ }, {-9, 0}, {-8,  $\frac{2501}{32768}$ }, {-7, 0}, {-6,  $\frac{2377}{32768}$ },
  {-5, 0}, {-4,  $\frac{11221}{262144}$ }, {-3, 0}, {-2,  $\frac{4165}{131072}$ }, {-1, 0}, {0,  $\frac{3969}{131072}$ }, {1, 0},
  {2,  $\frac{3969}{131072}$ }, {3, 0}, {4,  $\frac{7301}{262144}$ }, {5, 0}, {6,  $\frac{637}{32768}$ }, {7, 0}, {8,  $\frac{485}{32768}$ },
  {9, 0}, {10,  $\frac{1361}{32768}$ }, {11, 0}, {12,  $\frac{28097}{1048576}$ }, {13, 0}, {14,  $\frac{33317}{524288}$ },
  {15, 0}, {16,  $\frac{5417}{524288}$ }, {17, 0}, {18,  $\frac{145}{524288}$ }, {19, 0}, {20,  $\frac{1}{1048576}$ }}}]
```

In[5]:=

```
ListPlot[probabilities, Filling -> Axis, PlotRange -> All, FillingStyle -> Thick]
```

Out[5]=





In[6]:=

```
qm[
  |ψ⟩20
] // TraditionalForm
```

Out[6]/TraditionalForm=

$$\begin{aligned}
& -\frac{247|1_1\rangle|14_2\rangle}{1024} - \frac{105|0_1\rangle|(-4)_2\rangle}{512} - \frac{51|1_1\rangle|(-8)_2\rangle}{256} - \frac{49|0_1\rangle|(-8)_2\rangle}{256} - \frac{35|0_1\rangle|4_2\rangle}{256} - \\
& \frac{33|0_1\rangle|(-10)_2\rangle}{256} - \frac{63|0_1\rangle|0_2\rangle}{512} - \frac{63|1_1\rangle|2_2\rangle}{512} - \frac{29|1_1\rangle|12_2\rangle}{256} - \frac{103|1_1\rangle|16_2\rangle}{1024} - \frac{49}{512}|1_1\rangle|(-2)_2\rangle - \\
& \frac{23|1_1\rangle|8_2\rangle}{256} - \frac{21|0_1\rangle|8_2\rangle}{256} - \frac{11|0_1\rangle|10_2\rangle}{256} - \frac{7|1_1\rangle|6_2\rangle}{256} - \frac{17|1_1\rangle|18_2\rangle}{1024} - \frac{|1_1\rangle|20_2\rangle}{1024} + \frac{|0_1\rangle|(-20)_2\rangle}{1024} + \\
& \frac{|0_1\rangle|18_2\rangle}{1024} + \frac{|1_1\rangle|(-18)_2\rangle}{1024} + \frac{15|0_1\rangle|16_2\rangle}{1024} + \frac{17|1_1\rangle|(-16)_2\rangle}{1024} + \frac{19|0_1\rangle|(-18)_2\rangle}{1024} + \frac{7}{256}|1_1\rangle|(-4)_2\rangle + \\
& \frac{75|0_1\rangle|14_2\rangle}{1024} + \frac{23}{256}|1_1\rangle|(-6)_2\rangle + \frac{49|1_1\rangle|4_2\rangle}{512} + \frac{103|1_1\rangle|(-14)_2\rangle}{1024} + \frac{29}{256}|1_1\rangle|(-10)_2\rangle + \\
& \frac{121|0_1\rangle|12_2\rangle}{1024} + \frac{63|0_1\rangle|2_2\rangle}{512} + \frac{63|1_1\rangle|0_2\rangle}{512} + \frac{135|0_1\rangle|(-16)_2\rangle}{1024} + \frac{35|0_1\rangle|6_2\rangle}{256} + \frac{77}{512}|0_1\rangle|(-2)_2\rangle + \\
& \frac{51|1_1\rangle|10_2\rangle}{256} + \frac{247|1_1\rangle|(-12)_2\rangle}{1024} + \frac{65}{256}|0_1\rangle|(-6)_2\rangle + \frac{425|0_1\rangle|(-14)_2\rangle}{1024} + \frac{121}{256}|0_1\rangle|(-12)_2\rangle
\end{aligned}$$