Punto cuántico

In[∘]:=
```
rho = Table[Subscript[ρ, i - 1, j - 1], {i, 1, 2}, {j, 1, 2}];
      └tabla    └subíndice
H = {{0, 0}, {0, ϵ}};
L1 = {{0, 0}, {1, 0}} * Sqrt[Γ1];
                        └raíz cuadrada
L2 = {{0, 1}, {0, 0}} * Sqrt[Γ2];
                        └raíz cuadrada
Ls = {L1, L2};
```

In[∘]:=
```
coh = -I * (H.rho - rho.H);
       └número i
incoh = Sum[
        └suma
   ConjugateTranspose[Ls[[i]]].rho.Ls[[i]] - 1 / 2 * (Ls[[i]].ConjugateTranspose[Ls[[i]]].rho +
   └transpuesto conjugado                              └transpuesto conjugado
       rho.Ls[[i]].ConjugateTranspose[Ls[[i]]]), {i, 1, 2}] ;
                   └transpuesto conjugado
incoh = FullSimplify[incoh, Assumptions → {Γ1 > 0, Γ2 > 0}];
        └simplifica completamente └asunciones
```

In[∘]:=
```
coh // MatrixForm
       └forma de matriz
incoh // MatrixForm
         └forma de matri
```

Out[∘]//MatrixForm=

$$\begin{pmatrix} 0 & i\,\epsilon\,\rho_{0,1} \\ -i\,\epsilon\,\rho_{1,0} & 0 \end{pmatrix}$$

Out[∘]//MatrixForm=

$$\begin{pmatrix} -\Gamma2\,\rho_{0,0} + \Gamma1\,\rho_{1,1} & -\frac{1}{2}\,(\Gamma1 + \Gamma2)\,\rho_{0,1} \\ -\frac{1}{2}\,(\Gamma1 + \Gamma2)\,\rho_{1,0} & \Gamma2\,\rho_{0,0} - \Gamma1\,\rho_{1,1} \end{pmatrix}$$

In[∘]:=
```
Solve[{-coh == incoh, Tr[rho] == 1}, Flatten[rho]]
└resuelve              └traza         └aplana
```

Out[∘]=

$$\left\{\left\{\rho_{0,0} \to \frac{\Gamma1}{\Gamma1 + \Gamma2},\ \rho_{0,1} \to 0,\ \rho_{1,0} \to 0,\ \rho_{1,1} \to \frac{\Gamma2}{\Gamma1 + \Gamma2}\right\}\right\}$$

Doble punto cuántico

In[∘]:=
```
rho = Table[Subscript[ρ, i - 1, j - 1], {i, 1, 3}, {j, 1, 3}];
      tabla   subíndice
H = {{0, 0, 0}, {0, ϵ / 2, τ / 2}, {0, τ / 2, -ϵ / 2}};
L1 = {{0, 0, 0}, {1, 0, 0}, {0, 0, 0}} * Sqrt[Γ1];
                                         raíz cuadrada
L2 = {{0, 0, 1}, {0, 0, 0}, {0, 0, 0}} * Sqrt[Γ2];
                                         raíz cuadrada
Ls = {L1, L2};
Ls[[1]] // MatrixForm
           forma de matriz
Ls[[2]] // MatrixForm
           forma de matriz
```

Out[∘]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ \sqrt{\Gamma 1} & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Out[∘]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & \sqrt{\Gamma 2} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

In[∘]:=
```
coh = -I * (H.rho - rho.H);
       número i
incoh = Sum[
        suma
   Ls[[i]].rho.ConjugateTranspose[Ls[[i]]] - 1 / 2 * (ConjugateTranspose[Ls[[i]]].Ls[[i]].rho +
               transpuesto conjugado                 transpuesto conjugado
       rho.ConjugateTranspose[Ls[[i]]].Ls[[i]]), {i, 1, 2}];
           transpuesto conjugado
incoh = FullSimplify[incoh, Assumptions → {Γ1 > 0, Γ2 > 0}];
        simplifica completamente  asunciones
```

In[∘]:=
```
coh // MatrixForm
       forma de matriz
incoh // MatrixForm
         forma de matri
```

Out[∘]//MatrixForm=

$$\begin{pmatrix} 0 & -i\left(-\frac{1}{2}\,\epsilon\,\rho_{0,1}-\frac{1}{2}\,\tau\,\rho_{0,2}\right) & -i\left(-\frac{1}{2}\,\tau\,\rho_{0,1}+\frac{1}{2}\,\epsilon\,\rho_{0,2}\right) \\ -i\left(\frac{1}{2}\,\epsilon\,\rho_{1,0}+\frac{1}{2}\,\tau\,\rho_{2,0}\right) & -i\left(-\frac{1}{2}\,\tau\,\rho_{1,2}+\frac{1}{2}\,\tau\,\rho_{2,1}\right) & -i\left(-\frac{1}{2}\,\tau\,\rho_{1,1}+\epsilon\,\rho_{1,2}+\frac{1}{2}\,\tau\,\rho_{2,2}\right) \\ -i\left(\frac{1}{2}\,\tau\,\rho_{1,0}-\frac{1}{2}\,\epsilon\,\rho_{2,0}\right) & -i\left(\frac{1}{2}\,\tau\,\rho_{1,1}-\epsilon\,\rho_{2,1}-\frac{1}{2}\,\tau\,\rho_{2,2}\right) & -i\left(\frac{1}{2}\,\tau\,\rho_{1,2}-\frac{1}{2}\,\tau\,\rho_{2,1}\right) \end{pmatrix}$$

Out[∘]//MatrixForm=

$$\begin{pmatrix} -\Gamma 1\,\rho_{0,0}+\Gamma 2\,\rho_{2,2} & -\frac{1}{2}\,\Gamma 1\,\rho_{0,1} & -\frac{1}{2}\,(\Gamma 1+\Gamma 2)\,\rho_{0,2} \\ -\frac{1}{2}\,\Gamma 1\,\rho_{1,0} & \Gamma 1\,\rho_{0,0} & -\frac{1}{2}\,\Gamma 2\,\rho_{1,2} \\ -\frac{1}{2}\,(\Gamma 1+\Gamma 2)\,\rho_{2,0} & -\frac{1}{2}\,\Gamma 2\,\rho_{2,1} & -\Gamma 2\,\rho_{2,2} \end{pmatrix}$$

In[∘]:=
```
sol = Solve[{-coh == incoh, Tr[rho] == 1}, Flatten[rho]] // FullSimplify
```
resuelve · traza · aplana · simplifica complet

Out[∘]=

$$\left\{\left\{\rho_{0,0}\to\frac{\Gamma 2\,\tau^2}{\Gamma 1\left(\Gamma 2^2+4\,\epsilon^2\right)+(2\,\Gamma 1+\Gamma 2)\,\tau^2},\ \rho_{0,1}\to 0,\ \rho_{0,2}\to 0,\ \rho_{1,0}\to 0,\right.\right.$$

$$\rho_{1,1}\to 1-\frac{(\Gamma 1+\Gamma 2)\,\tau^2}{\Gamma 1\left(\Gamma 2^2+4\,\epsilon^2\right)+(2\,\Gamma 1+\Gamma 2)\,\tau^2},\ \rho_{1,2}\to\frac{\Gamma 1\,(\mathrm{i}\,\Gamma 2+2\,\epsilon)\,\tau}{\Gamma 1\left(\Gamma 2^2+4\,\epsilon^2\right)+(2\,\Gamma 1+\Gamma 2)\,\tau^2},$$

$$\left.\left.\rho_{2,0}\to 0,\ \rho_{2,1}\to\frac{\Gamma 1\,(-\mathrm{i}\,\Gamma 2+2\,\epsilon)\,\tau}{\Gamma 1\left(\Gamma 2^2+4\,\epsilon^2\right)+(2\,\Gamma 1+\Gamma 2)\,\tau^2},\ \rho_{2,2}\to\frac{\Gamma 1\,\tau^2}{\Gamma 1\left(\Gamma 2^2+4\,\epsilon^2\right)+(2\,\Gamma 1+\Gamma 2)\,\tau^2}\right\}\right\}$$

In[∘]:=
```
(sol /. {ϵ → 0, τ → 0}) // FullSimplify
```
simplifica completamente

Out[∘]=

$$\{\{\rho_{0,0}\to 0,\ \rho_{0,1}\to 0,\ \rho_{0,2}\to 0,\ \rho_{1,0}\to 0,\ \rho_{1,1}\to 1,\ \rho_{1,2}\to 0,\ \rho_{2,0}\to 0,\ \rho_{2,1}\to 0,\ \rho_{2,2}\to 0\}\}$$

Triple punto cuántico

In[10]:=
```
rho = Table[Subscript[ρ, i - 1, j - 1], {i, 1, 4}, {j, 1, 4}];
```
tabla · subíndice
```
H = {{0, 0, 0, 0}, {0, ϵ, -τ, 0}, {0, -τ, 0, -τ}, {0, 0, -τ, ϵ}};
L1 = {{0, 0, 0, 0}, {1, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}} * Sqrt[Γ1];
```
raíz cuadrada
```
L2 = {{0, 0, 0, 1}, {0, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}} * Sqrt[Γ2];
```
raíz cuadrada
```
Ls = {L1, L2};
Ls[[1]] // MatrixForm
```
forma de matriz
```
Ls[[2]] // MatrixForm
```
forma de matriz

Out[15]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & 0 \\ \sqrt{\Gamma 1} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Out[16]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 & \sqrt{\Gamma 2} \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

In[17]:=

$$\begin{pmatrix} 0 & 0 & 0 & 0 \\ \sqrt{\Gamma 1} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

Out[17]=

$$\left\{\{0, 0, 0, 0\}, \left\{\sqrt{\Gamma 1}, 0, 0, 0\right\}, \{0, 0, 0, 0\}, \{0, 0, 0, 0\}\right\}$$

In[18]:=
```
{{0, 0, 0, 0}, {√Γ1, 0, 0, 0}, {0, 0, 0, 0}, {0, 0, 0, 0}}
```

Out[18]=

$$\{\{0, 0, 0, 0\}, \{\sqrt{\Gamma 1}, 0, 0, 0\}, \{0, 0, 0, 0\}, \{0, 0, 0, 0\}\}$$

In[19]:=
```
coh = -I * (H.rho - rho.H);
      número i
incoh = Sum[
        suma
   Ls[[i]].rho.ConjugateTranspose[Ls[[i]]] - 1 / 2 * (ConjugateTranspose[Ls[[i]]].Ls[[i]].rho +
               transpuesto conjugado                  transpuesto conjugado
       rho.ConjugateTranspose[Ls[[i]]].Ls[[i]]), {i, 1, 2}] ;
           transpuesto conjugado
incoh = FullSimplify[incoh, Assumptions → {Γ1 > 0, Γ2 > 0}];
        simplifica completamente  asunciones
```

In[23]:=
```
sol = Solve[{-coh == incoh, Tr[rho] == 1}, Flatten[rho]] // FullSimplify
      resuelve                  traza      aplana           simplifica complet
```

Out[23]=

$$\Big\{\Big\{\rho_{0,0} \to \frac{4\,\Gamma 2\,\tau^4}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},\ \rho_{0,1} \to 0,$$

$$\rho_{0,2} \to 0,\ \rho_{0,3} \to 0,\ \rho_{1,0} \to 0,\ \rho_{1,1} \to \frac{\Gamma 1\,(4\,\tau^4 + \Gamma 2^2\,(\epsilon^2 + \tau^2))}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},$$

$$\rho_{1,2} \to -\frac{\Gamma 1\,\Gamma 2\,\tau\,(\Gamma 2\,\epsilon + 2\,i\,\tau^2)}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},\ \rho_{1,3} \to \frac{2\,i\,\Gamma 1\,\Gamma 2\,\epsilon\,\tau^2}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},$$

$$\rho_{2,0} \to 0,\ \rho_{2,1} \to \frac{\Gamma 1\,\Gamma 2\,\tau\,(-\Gamma 2\,\epsilon + 2\,i\,\tau^2)}{\Gamma 1\,\Gamma 2^2\,\epsilon^2 + 2\,\Gamma 1\,\Gamma 2^2\,\tau^2 + 4\,(3\,\Gamma 1 + \Gamma 2)\,\tau^4},$$

$$\rho_{2,2} \to \frac{\Gamma 1\,\tau^2\,(\Gamma 2^2 + 4\,\tau^2)}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},\ \rho_{2,3} \to -\frac{2\,i\,\Gamma 1\,\Gamma 2\,\tau^3}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},$$

$$\rho_{3,0} \to 0,\ \rho_{3,1} \to -\frac{2\,i\,\Gamma 1\,\Gamma 2\,\epsilon\,\tau^2}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},$$

$$\rho_{3,2} \to \frac{2\,i\,\Gamma 1\,\Gamma 2\,\tau^3}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)},\ \rho_{3,3} \to \frac{4\,\Gamma 1\,\tau^4}{12\,\Gamma 1\,\tau^4 + 4\,\Gamma 2\,\tau^4 + \Gamma 1\,\Gamma 2^2\,(\epsilon^2 + 2\,\tau^2)}\Big\}\Big\}$$