```
In[50]:= ClearAll[E01, E02, E03, F1, F2, F3, F4, F5, F6, F7, F8, F9, Fi1, Fi2, Fi3, Fi4,
          Fi5, Fi6, Fi7, Fi8, Fi9, d, r01, r02, r03, r04, r05, r06, r07, r08, r09]

         (*DEFINICIONES*)

         (*Definicion de matrices de primeros vecinos*)
         Fi1 = Array[F1, {3, 3}];
         Fi2 = Array[F2, {3, 3}];
         Fi3 = Array[F3, {3, 3}];

         (*Definicion de matrices de segundos vecinos*)
         Fi4 = Array[F4, {3, 3}];
         Fi5 = Array[F5, {3, 3}];
         Fi6 = Array[F6, {3, 3}];
         Fi7 = Array[F7, {3, 3}];
         Fi8 = Array[F8, {3, 3}];
         Fi9 = Array[F9, {3, 3}];

         (*Definicion de matrices de rotación de 120º y-120º=240º*)
         Q60 = RotationMatrix[60 Degree, {0, 0, 1}];
         Q90 = RotationMatrix[90 Degree, {0, 0, 1}];
         Q120 = RotationMatrix[120 Degree, {0, 0, 1}];
         Q240 = RotationMatrix[240 Degree, {0, 0, 1}];




         (*Definición de matriz de reflexión en el plano XY:z→-z*)
         Rz = {{1, 0, 0}, {0, 1, 0}, {0, 0, -1}};
         (*Definición de matriz de reflexión en el plano XZ:y→-y*)
         Ry = {{1, 0, 0}, {0, -1, 0}, {0, 0, 1}};



         (*RESOLUCIÓN DE LAS ECUACIONES*)

         (*PRIMEROS VECINOS*)



         (*reflexiones z→-z, y→-y, primer vecino: F1,
         reflejado en YZ ha de coincidir consigo mismo, ídem reflejado en XY*)

         Fi1 = Fi1 /. Flatten[Solve[Fi1 == Rz.Fi1.(Transpose[Rz])]];
         Fi1 = Fi1 /. Flatten[Solve[Fi1 == Ry.Fi1.(Transpose[Ry])]];

         (* giros, primeros vecinos*)
         Fi2 = Fi2 /. Flatten[Solve[Fi2 == Q240.Fi1.(Transpose[Q240]), {F2[1, 1], F2[1, 2],
               F2[1, 3], F2[2, 1], F2[2, 2], F2[2, 3], F2[3, 1], F2[3, 2], F2[3, 3]}]];

         Fi3 = Fi3 /. Flatten[Solve[Fi3 == Q120.Fi1.(Transpose[Q120]), {F3[1, 1], F3[1, 2],
               F3[1, 3], F3[2, 1], F3[2, 2], F3[2, 3], F3[3, 1], F3[3, 2], F3[3, 3]}]];

         TextCell["Fi1="]
         Fi1 // MatrixForm
         TextCell["Fi2="]
         Fi2 // MatrixForm
         TextCell["Fi3="]
```

```
Fi3 // MatrixForm


(*SEGUNDOS VECINOS*)
(*En primer lugar, hallamos la expresión general de Fi4*)


Fi4 = Fi4 /. Flatten[Solve[Fi4 == Rz.Fi4.(Transpose[Rz])]];

Fi6 = Fi6 /. Flatten[Solve[Fi6 == Q120.Fi4.(Transpose[Q120]), {F6[1, 1], F6[1, 2],
      F6[1, 3], F6[2, 1], F6[2, 2], F6[2, 3], F6[3, 1], F6[3, 2], F6[3, 3]}]];

Fi5 = Fi5 /. Flatten[Solve[Fi5 == Ry.Fi6.(Transpose[Ry]), {F5[1, 1], F5[1, 2],
      F5[1, 3], F5[2, 1], F5[2, 2], F5[2, 3], F5[3, 1], F5[3, 2], F5[3, 3]}]];

Fi7 = Fi7 /. Flatten[Solve[Fi7 == Q120.Fi5.(Transpose[Q120]), {F7[1, 1], F7[1, 2],
      F7[1, 3], F7[2, 1], F7[2, 2], F7[2, 3], F7[3, 1], F7[3, 2], F7[3, 3]}]];
(*Esta última operación proporciona que F7[1,2]==-F4[1,2] y F7[2,1]==F4[2,1]
   Y como F7[1,2]==F4[2,1] y F7[2,1]==F4[1,2] tenemos que F4[2,1]=-F4[1,2]*)

Fi4 = Fi4 /. Flatten[F4[2, 1] → -F4[1, 2]];

TextCell[" La forma general de Fi4, aplicadas todas las simetrías y condiciones es"]
TextCell["Fi4="]
Fi4 // MatrixForm

(* con lo que ya tenemos Fi7:*)
Fi7 = Fi7 /. Flatten[F4[2, 1] → -F4[1, 2]];

TextCell["Fi7="]
Fi7 // MatrixForm


(*Fi6 y Fi8 se hallan aplicando a Fi4 un giro de 120º y -
 120º (alrededor del eje Z) respectivamente:*)
Fi6 = Fi6 /. Flatten[Solve[Fi6 == Q120.Fi4.(Transpose[Q120]), {F6[1, 1], F6[1, 2],
      F6[1, 3], F6[2, 1], F6[2, 2], F6[2, 3], F6[3, 1], F6[3, 2], F6[3, 3]}]];
TextCell["Fi6="]
Fi6 // MatrixForm

Fi8 = Fi8 /. Flatten[Solve[Fi8 == Q240.Fi4.(Transpose[Q240]), {F8[1, 1], F8[1, 2],
     F8[1, 3], F8[2, 1], F8[2, 2], F8[2, 3], F8[3, 1], F8[3, 2], F8[3, 3]}]]
TextCell["Fi8="]
Fi8 // MatrixForm

(*Fi5 y Fi9 sen halla haciendo un giro de 120º y -
 120º respectivamente al ya hallado Fi7*)
Fi5 = Fi5 /. Flatten[Solve[Fi5 == Q240.Fi7.(Transpose[Q240]), {F5[1, 1], F5[1, 2],
      F5[1, 3], F5[2, 1], F5[2, 2], F5[2, 3], F5[3, 1], F5[3, 2], F5[3, 3]}]];
TextCell["Fi5="]
Fi5 // MatrixForm

Fi9 = Fi9 /. Flatten[Solve[Fi9 == Q120.Fi7.(Transpose[Q120]), {F9[1, 1], F9[1, 2],
      F9[1, 3], F9[2, 1], F9[2, 2], F9[2, 3], F9[3, 1], F9[3, 2], F9[3, 3]}]];
TextCell["Fi9="]
Fi9 // MatrixForm
```

Out[70]= Fi1=

Out[71]//MatrixForm=

$$\begin{pmatrix} F1[1,1] & 0 & 0 \\ 0 & F1[2,2] & 0 \\ 0 & 0 & F1[3,3] \end{pmatrix}$$

Out[72]= Fi2=

Out[73]//MatrixForm=

$$\begin{pmatrix} \frac{1}{4}(F1[1,1]+3\,F1[2,2]) & \frac{1}{4}\left(\sqrt{3}\,F1[1,1]-\sqrt{3}\,F1[2,2]\right) & 0 \\ \frac{1}{4}\left(\sqrt{3}\,F1[1,1]-\sqrt{3}\,F1[2,2]\right) & \frac{1}{4}(3\,F1[1,1]+F1[2,2]) & 0 \\ 0 & 0 & F1[3,3] \end{pmatrix}$$

Out[74]= Fi3=

Out[75]//MatrixForm=

$$\begin{pmatrix} \frac{1}{4}(F1[1,1]+3\,F1[2,2]) & \frac{1}{4}\left(-\sqrt{3}\,F1[1,1]+\sqrt{3}\,F1[2,2]\right) & 0 \\ \frac{1}{4}\left(-\sqrt{3}\,F1[1,1]+\sqrt{3}\,F1[2,2]\right) & \frac{1}{4}(3\,F1[1,1]+F1[2,2]) & 0 \\ 0 & 0 & F1[3,3] \end{pmatrix}$$

Out[81]= La forma general de Fi4, aplicadas todas las simetrías y condiciones es

Out[82]= Fi4=

Out[83]//MatrixForm=

$$\begin{pmatrix} F4[1,1] & F4[1,2] & 0 \\ -F4[1,2] & F4[2,2] & 0 \\ 0 & 0 & F4[3,3] \end{pmatrix}$$

Out[85]= Fi7=

Out[86]//MatrixForm=

$$\begin{pmatrix} F4[1,1] & -F4[1,2] & 0 \\ F4[1,2] & F4[2,2] & 0 \\ 0 & 0 & F4[3,3] \end{pmatrix}$$

Out[88]= Fi6=

Out[89]//MatrixForm=

$$\begin{pmatrix} \frac{1}{4}\left(F4[1,1]+\sqrt{3}\,F4[1,2]+\sqrt{3}\,F4[2,1]+3\,F4[2,2]\right) & \frac{1}{4}\left(-\sqrt{3}\,F4[1,1]+F4[1,2]-3\,F4[2,1]+\right. \\ \frac{1}{4}\left(-\sqrt{3}\,F4[1,1]-3\,F4[1,2]+F4[2,1]+\sqrt{3}\,F4[2,2]\right) & \frac{1}{4}\left(3\,F4[1,1]-\sqrt{3}\,F4[1,2]-\sqrt{3}\,F4[2,1\right. \\ 0 & 0 \end{pmatrix}$$

Out[90]= $\left\{\left\{\frac{1}{4}(F4[1,1]+3\,F4[2,2]),\ \frac{1}{4}\left(\sqrt{3}\,F4[1,1]+4\,F4[1,2]-\sqrt{3}\,F4[2,2]\right),\ 0\right\},\right.$
$\left.\left\{\frac{1}{4}\left(\sqrt{3}\,F4[1,1]-4\,F4[1,2]-\sqrt{3}\,F4[2,2]\right),\ \frac{1}{4}(3\,F4[1,1]+F4[2,2]),\ 0\right\},\ \{0,0,F4[3,3]\}\right\}$

Out[91]= Fi8=

Out[92]//MatrixForm=

$$\begin{pmatrix} \frac{1}{4}(F4[1,1]+3\,F4[2,2]) & \frac{1}{4}\left(\sqrt{3}\,F4[1,1]+4\,F4[1,2]-\sqrt{3}\,F4[2,2]\right) & 0 \\ \frac{1}{4}\left(\sqrt{3}\,F4[1,1]-4\,F4[1,2]-\sqrt{3}\,F4[2,2]\right) & \frac{1}{4}(3\,F4[1,1]+F4[2,2]) & 0 \\ 0 & 0 & F4[3,3 \end{pmatrix}$$

Out[94]= Fi5=

Out[95]//MatrixForm=

$$\begin{pmatrix} \frac{1}{4}\left(F4[1,1]+\sqrt{3}\,F4[1,2]+\sqrt{3}\,F4[2,1]+3\,F4[2,2]\right) & \frac{1}{4}\left(\sqrt{3}\,F4[1,1]-F4[1,2]+3\,F4[2,1]-\sqrt{\cdot}\right. \\ \frac{1}{4}\left(\sqrt{3}\,F4[1,1]+3\,F4[1,2]-F4[2,1]-\sqrt{3}\,F4[2,2]\right) & \frac{1}{4}\left(3\,F4[1,1]-\sqrt{3}\,F4[1,2]-\sqrt{3}\,F4[2,1]\right. \\ 0 & 0 \end{pmatrix}$$

Out[97]= Fi9=

Out[98]//MatrixForm=

$$\begin{pmatrix} \frac{1}{4}(F4[1,1]+3\,F4[2,2]) & \frac{1}{4}\left(-\sqrt{3}\,F4[1,1]-4\,F4[1,2]+\sqrt{3}\,F4[2,2]\right) & 0 \\ \frac{1}{4}\left(-\sqrt{3}\,F4[1,1]+4\,F4[1,2]+\sqrt{3}\,F4[2,2]\right) & \frac{1}{4}(3\,F4[1,1]+F4[2,2]) & 0 \\ 0 & 0 & F4[3, \end{pmatrix}$$

In[962]:=

```
ClearAll[d, r01, r02, r03, r04, r05, r06, r07, r08, r09,
 r12, r23, r31, r98, r76, r54, ϵ1, ϵ2, ϵ3, α1, α2, γ1, γ2, δ, θ1, θ2]
(*Definicion de matrices de rotación de 120º y-120º=240º*)
Q60 = RotationMatrix[60 Degree, {0, 0, 1}];
Q90 = RotationMatrix[90 Degree, {0, 0, 1}];
Q120 = RotationMatrix[120 Degree, {0, 0, 1}]; T120 = Transpose[Q120];
Q240 = RotationMatrix[240 Degree, {0, 0, 1}];
(*Definición de vectores posición de átomos*)
(*primeros vecinos*)
r01 = {d, 0, 0};
r02 = Q240.r01;
r03 = Q120.r01;
(*segundos vecinos*)
r04 = {0, d √3, 0};
r05 = Q60.r04;
r06 = Q60.r05;
r07 = Q60.r06;
r08 = Q60.r07;
r09 = Q60.r08;

r12 = r02 - r01;
r23 = r03 - r02;
r31 = r01 - r03;
r98 = r08 - r09;
r76 = r06 - r07;
r54 = r04 - r05;
r19 = -r02;
r18 = -r03;
r27 = -r03;
r26 = -r01;
r35 = -r01;
r34 = -r02;

(*primeros vecinos,  p.ej.:Eprimeros[r01]*)


Eprimeros = (α1 / (d^2)) Outer[Times, #, #] &;

(*segundos vecinos, p.ej.:Esegundos[r12]*)
Esegundos = (α2 / (3 d^2)) (Outer[Times, #, #]) &;
TEsegundos = (α2 / (3 d^2)) Transpose[(Outer[Times, #, #])] &;

(*angulos en el plano xy, p.ej.: Eangulos[r01,r02]*)
Eangulos = (γ1 / (d^4)) Q90.(Outer[Times, #1, #2]).Transpose[Q90] &;
```

```
TEangulos = (γ1 / (d^4)) Transpose[Q90.(Outer[Times, #1, #2]).Transpose[Q90]] &;

(*flexión fuera del plano*)
Eflexion = (γ2 / (d^2)) {{0, 0, 0}, {0, 0, 0}, {0, 0, 1}};

(*torsión*)
Etorsion = (δ / (3 * d^2)) {{0, 0, 0}, {0, 0, 0}, {0, 0, 1}};

(*sumamos cada contribución a su matriz psi correspondiente*)


psi[0, 1, 1] =
  Eprimeros[r01] + Esegundos[r12] + Esegundos[r31] + Esegundos[r54] + Esegundos[r76] +
   2 * Eangulos[r01, r01] + Eangulos[r35, r35] + Eangulos[r26, r26] + Eflexion + 4 * Etorsion;
psi[0, 2, 2] = Eprimeros[r02] + Esegundos[r12] + Esegundos[r23] +
   Esegundos[r98] + Esegundos[r54] + 2 * Eangulos[r02, r02] +
   Eangulos[r19, r19] + Eangulos[r34, r34] + Eflexion + 4 * Etorsion;
psi[0, 3, 3] = Eprimeros[r03] + Esegundos[r31] + Esegundos[r23] +
   Esegundos[r98] + Esegundos[r76] + 2 * Eangulos[r03, r03] +
   Eangulos[r18, r18] + Eangulos[r27, r27] + Eflexion + 4 * Etorsion;

psi[0, 1, 2] = -Esegundos[r12] - Eangulos[r01, r02] + Eflexion - Etorsion;
psi[0, 2, 1] = -Esegundos[r12] - TEangulos[r01, r02] + Eflexion - Etorsion;
psi[0, 1, 3] = -Esegundos[r31] - TEangulos[r03, r01] + Eflexion - Etorsion;
psi[0, 3, 1] = -Esegundos[r31] - Eangulos[r03, r01] + Eflexion - Etorsion;
psi[0, 2, 3] = -Esegundos[r23] - Eangulos[r02, r03] + Eflexion - Etorsion;
psi[0, 3, 2] = -Esegundos[r23] - TEangulos[r02, r03] + Eflexion - Etorsion;

psi[-ϵ3, 2, 3] = -Esegundos[r98] - Eangulos[r19, r18] - Etorsion;
psi[ϵ3, 3, 2] = -Esegundos[r98] - TEangulos[r19, r18] - Etorsion;
psi[ϵ2, 1, 2] = -Esegundos[r54] - Eangulos[r35, r34] - Etorsion;
psi[-ϵ2, 2, 1] = -Esegundos[r54] - TEangulos[r35, r34] - Etorsion;
psi[ϵ1, 1, 3] = -Esegundos[r76] - TEangulos[r27, r26] - Etorsion;
psi[-ϵ1, 3, 1] = -Esegundos[r76] - Eangulos[r27, r26] - Etorsion;

psi[-ϵ2, 2, 3] = Etorsion;
psi[ϵ2, 3, 2] = Etorsion;
psi[ϵ2, 1, 3] = Etorsion;
psi[-ϵ2, 3, 1] = Etorsion;
psi[-ϵ1, 3, 2] = Etorsion;
psi[ϵ1, 2, 3] = Etorsion;
psi[ϵ1, 1, 2] = Etorsion;
psi[-ϵ1, 2, 1] = Etorsion;
psi[ϵ3, 1, 2] = Etorsion;
psi[-ϵ3, 2, 1] = Etorsion;
psi[-ϵ3, 1, 3] = Etorsion;
psi[ϵ3, 3, 1] = Etorsion;

psi[ϵ2, 2, 2] = -Etorsion;
psi[-ϵ2, 2, 2] = -Etorsion;
psi[ϵ1, 3, 3] = -Etorsion;
psi[-ϵ1, 3, 3] = -Etorsion;
psi[ϵ1, 1, 1] = -Etorsion;
psi[-ϵ1, 1, 1] = -Etorsion;
psi[ϵ3, 2, 2] = -Etorsion;
psi[-ϵ3, 2, 2] = -Etorsion;
psi[ϵ3, 3, 3] = -Etorsion;
psi[-ϵ3, 3, 3] = -Etorsion;
```

```
psi[∊2, 1, 1] = -Etorsion;
psi[-∊2, 1, 1] = -Etorsion;

θ = {θ1, θ2};
cero = {0, 0};
e1 = {1, 0};
e2 = {0, 1};
e3 = {-1, 1};
fl = Exp[-I * θ.#] &;

(*montamos las transformadas de las psi*)

Fpsi11 = psi[0, 1, 1] fl[cero] + psi[∊1, 1, 1] fl[e1] +
   psi[-∊1, 1, 1] fl[-e1] + psi[∊2, 1, 1] fl[e2] + psi[-∊2, 1, 1] fl[-e2];

Fpsi22 = psi[0, 2, 2] fl[cero] + psi[∊2, 2, 2] fl[e2] +
   psi[-∊2, 2, 2] fl[-e2] + psi[∊3, 2, 2] fl[e3] + psi[-∊3, 2, 2] fl[-e3];

Fpsi33 = psi[0, 3, 3] fl[cero] + psi[∊3, 3, 3] fl[e3] +
   psi[-∊3, 3, 3] fl[-e3] + psi[∊1, 3, 3] fl[e1] + psi[-∊1, 3, 3] fl[-e1];


Fpsi12 =
  psi[0, 1, 2] fl[cero] + psi[∊2, 1, 2] fl[e2] + psi[∊1, 1, 2] fl[e1] + psi[∊3, 1, 2] fl[e3];

Fpsi21 = psi[0, 2, 1] fl[cero] +
   psi[-∊2, 2, 1] fl[-e2] + psi[-∊1, 2, 1] fl[-e1] + psi[-∊3, 2, 1] fl[-e3];

Fpsi13 =
  psi[0, 1, 3] fl[cero] + psi[∊1, 1, 3] fl[e1] + psi[∊2, 1, 3] fl[e2] + psi[-∊3, 1, 3] fl[-e3];

Fpsi31 = psi[0, 3, 1] fl[cero] +
   psi[-∊1, 3, 1] fl[-e1] + psi[-∊2, 3, 1] fl[-e2] + psi[∊3, 3, 1] fl[e3];

Fpsi23 = psi[0, 2, 3] fl[cero] +
   psi[-∊3, 2, 3] fl[-e3] + psi[-∊2, 2, 3] fl[-e2] + psi[∊1, 2, 3] fl[e1];

Fpsi32 =
  psi[0, 3, 2] fl[cero] + psi[∊3, 3, 2] fl[e3] + psi[∊2, 3, 2] fl[e2] + psi[-∊1, 3, 2] fl[-e1];

(*montamos la matriz con las tranformadas de las psi, Fpsi*)
Fpsi = {{Fpsi11, Fpsi12, Fpsi13}, {Fpsi21, Fpsi22, Fpsi23}, {Fpsi31, Fpsi32, Fpsi33}};




Q = {{1, 1, 1}, {-e^(i θ2), -1, -e^(i (θ2-θ1))}};
(*Definimos CQ como la conjugada de Q*)
CQ = {{1, 1, 1}, {-e^(-i θ2), -1, -e^(-i (θ2-θ1))}};
TCQ = Transpose[CQ];

Ffi11 = Sum[Q[[1, i]] * Fpsi[[i, j]] * TCQ[[j, 1]], {i, 1, 3}, {j, 1, 3}];
Ffi12 = Sum[Q[[1, i]] * Fpsi[[i, j]] * TCQ[[j, 2]], {i, 1, 3}, {j, 1, 3}];
Ffi21 = Sum[Q[[2, i]] * Fpsi[[i, j]] * TCQ[[j, 1]], {i, 1, 3}, {j, 1, 3}];
Ffi22 = Sum[Q[[2, i]] * Fpsi[[i, j]] * TCQ[[j, 2]], {i, 1, 3}, {j, 1, 3}];

(*Deshacemos la transformación para hallar las Fi*)
```

```
f2 = Exp[I * {θ1, θ2}.#] &;
(*primeros vecinos*)
Fi01 = (1 / (2 * Pi) ^2) * Integrate[Ffi12 * f2[e2], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi02 = (1 / (2 * Pi) ^2) * Integrate[Ffi12 * f2[e3], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi03 = (1 / (2 * Pi) ^2) * Integrate[Ffi12 * f2[{0, 0}], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
(*segundos vecinos*)
Fi04 = (1 / (2 * Pi) ^2) * Integrate[Ffi11 * f2[e3], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi05 = (1 / (2 * Pi) ^2) * Integrate[Ffi11 * f2[-e1], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi06 = (1 / (2 * Pi) ^2) * Integrate[Ffi11 * f2[-e2], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi07 = (1 / (2 * Pi) ^2) * Integrate[Ffi11 * f2[-e3], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi08 = (1 / (2 * Pi) ^2) * Integrate[Ffi11 * f2[e1], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];
Fi09 = (1 / (2 * Pi) ^2) * Integrate[Ffi11 * f2[e2], {θ1, -Pi, Pi}, {θ2, -Pi, Pi}];

Simplify[Fi01] // MatrixForm
Simplify[Fi02] // MatrixForm
Simplify[Fi03] // MatrixForm

Fi04 // MatrixForm
Fi05 // MatrixForm
Fi06 // MatrixForm
Fi07 // MatrixForm
Fi08 // MatrixForm
Fi09 // MatrixForm
```

Out[1067]//MatrixForm=

$$\begin{pmatrix} -\alpha1 & 0 & 0 \\ 0 & -\frac{6\,\gamma1}{d^2} & 0 \\ 0 & 0 & -\frac{3\,\gamma2}{d^2} \end{pmatrix}$$

Out[1068]//MatrixForm=

$$\begin{pmatrix} -\frac{\alpha1}{4}-\frac{9\,\gamma1}{2\,d^2} & \frac{\sqrt{3}\,(d^2\,\alpha1-6\,\gamma1)}{4\,d^2} & 0 \\ \frac{\sqrt{3}\,(d^2\,\alpha1-6\,\gamma1)}{4\,d^2} & \frac{3}{4}\left(-\alpha1-\frac{2\,\gamma1}{d^2}\right) & 0 \\ 0 & 0 & -\frac{3\,\gamma2}{d^2} \end{pmatrix}$$

Out[1069]//MatrixForm=

$$\begin{pmatrix} -\frac{\alpha1}{4}-\frac{9\,\gamma1}{2\,d^2} & -\frac{\sqrt{3}\,(d^2\,\alpha1-6\,\gamma1)}{4\,d^2} & 0 \\ -\frac{\sqrt{3}\,(d^2\,\alpha1-6\,\gamma1)}{4\,d^2} & -\frac{3\,\alpha1}{4}-\frac{3\,\gamma1}{2\,d^2} & 0 \\ 0 & 0 & -\frac{3\,\gamma2}{d^2} \end{pmatrix}$$

Out[1070]//MatrixForm=

$$\begin{pmatrix} \frac{3\,\gamma1}{4\,d^2} & -\frac{\sqrt{3}\,\gamma1}{4\,d^2} & 0 \\ \frac{\sqrt{3}\,\gamma1}{4\,d^2} & -\frac{4\,d^2\,\alpha2+\gamma1}{4\,d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1071]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha2}{4} & \frac{\sqrt{3}\,(d^2\,\alpha2+2\,\gamma1)}{4\,d^2} & 0 \\ \frac{\sqrt{3}\,\alpha2}{4} & \frac{1}{4}\left(-\alpha2+\frac{2\,\gamma1}{d^2}\right) & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1072]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha 2}{4} & -\frac{\sqrt{3}\,\left(d^2\,\alpha 2+2\,\gamma 1\right)}{4\,d^2} & 0 \\ -\frac{\sqrt{3}\,\alpha 2}{4} & \frac{1}{4}\left(-\alpha 2+\frac{2\,\gamma 1}{d^2}\right) & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1073]//MatrixForm=

$$\begin{pmatrix} \frac{3\,\gamma 1}{4\,d^2} & \frac{\sqrt{3}\,\gamma 1}{4\,d^2} & 0 \\ -\frac{\sqrt{3}\,\gamma 1}{4\,d^2} & -\frac{4\,d^2\,\alpha 2+\gamma 1}{4\,d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1074]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha 2}{4} & \frac{\sqrt{3}\,\alpha 2}{4} & 0 \\ \frac{\sqrt{3}\,\left(d^2\,\alpha 2+2\,\gamma 1\right)}{4\,d^2} & \frac{1}{4}\left(-\alpha 2+\frac{2\,\gamma 1}{d^2}\right) & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1075]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha 2}{4} & -\frac{\sqrt{3}\,\alpha 2}{4} & 0 \\ -\frac{\sqrt{3}\,\left(d^2\,\alpha 2+2\,\gamma 1\right)}{4\,d^2} & \frac{1}{4}\left(-\alpha 2+\frac{2\,\gamma 1}{d^2}\right) & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

In[868]:=

```
Fi00 = Simplify[-(Fi01 + Fi02 + Fi03 + Fi04 + Fi05 + Fi06 + Fi07 + Fi08 + Fi09)] // MatrixForm
```

Out[868]//MatrixForm=

$$\begin{pmatrix} \frac{3}{2}\left(\alpha 1+2\,\alpha 2+\frac{5\,\gamma 1}{d^2}\right) & 0 & 0 \\ 0 & \frac{3}{2}\left(\alpha 1+2\,\alpha 2+\frac{5\,\gamma 1}{d^2}\right) & 0 \\ 0 & 0 & \frac{9\,\gamma 2+2\,\delta}{d^2} \end{pmatrix}$$

In[1076]:=

```
TextCell["psi[0,1,1]="]
psi[0, 1, 1] // MatrixForm
TextCell["psi[0,2,2]="]
psi[0, 2, 2] // MatrixForm
TextCell["psi[0,3,3]="]
psi[0, 3, 3] // MatrixForm
TextCell["psi[0,1,2]="]
psi[0, 1, 2] // MatrixForm
TextCell["psi[0,2,1]="]
psi[0, 2, 1] // MatrixForm
TextCell["psi[0,1,3]="]
psi[0, 1, 3] // MatrixForm
TextCell["psi[0,3,1]="]
psi[0, 3, 1] // MatrixForm;
TextCell["psi[0,2,3]="]
psi[0, 2, 3] // MatrixForm
TextCell["psi[0,3,2]="]
psi[0, 3, 2] // MatrixForm
TextCell["psi[0,3,2]="]
psi[-ϵ3, 2, 3] // MatrixForm
TextCell["psi[-ϵ3,2,3]="]
psi[ϵ3, 3, 2] // MatrixForm
TextCell["psi[ϵ2,1,2]="]
```

```
psi[ϵ2, 1, 2] // MatrixForm
TextCell["psi[-ϵ2,2,1]="]
psi[-ϵ2, 2, 1] // MatrixForm
TextCell["psi[ϵ1,1,3]="]
psi[ϵ1, 1, 3] // MatrixForm
TextCell["psi[-ϵ1,3,1]="]
psi[-ϵ1, 3, 1] // MatrixForm
TextCell["psi[-ϵ2,2,3]="]
psi[-ϵ2, 2, 3] // MatrixForm
TextCell["psi[ϵ2,3,2]="]
psi[ϵ2, 3, 2] // MatrixForm
TextCell["psi[ϵ2,1,3]="]
psi[ϵ2, 1, 3] // MatrixForm
TextCell["psi[-ϵ2,3,1]="]
psi[-ϵ2, 3, 1] // MatrixForm
TextCell["psi[-ϵ1,3,2]="]
psi[-ϵ1, 3, 2] // MatrixForm
TextCell["psi[ϵ1,2,3]="]
psi[ϵ1, 2, 3] // MatrixForm
TextCell["psi[ϵ1,1,2]="]
psi[ϵ1, 1, 2] // MatrixForm
TextCell["psi[-ϵ1,2,1]="]
psi[-ϵ1, 2, 1] // MatrixForm
TextCell["psi[ϵ3,1,2]9="]
psi[ϵ3, 1, 2] // MatrixForm
TextCell["[-ϵ3,2,1]="]
psi[-ϵ3, 2, 1] // MatrixForm
TextCell["psi[-ϵ3,1,3]="]
psi[-ϵ3, 1, 3] // MatrixForm;
TextCell["psi[ϵ3,3,1]="]
psi[ϵ3, 3, 1] // MatrixForm
TextCell["psi[ϵ2,2,2]="]
psi[ϵ2, 2, 2] // MatrixForm
TextCell["psi[-ϵ2,2,2]="]
psi[-ϵ2, 2, 2] // MatrixForm
TextCell["psi[ϵ1,3,3]="]
psi[ϵ1, 3, 3] // MatrixForm
TextCell["psi[-ϵ1,3,3]="]
psi[-ϵ1, 3, 3] // MatrixForm
TextCell["psi[ϵ1,1,1]="]
psi[ϵ1, 1, 1] // MatrixForm
TextCell["psi[-ϵ1,1,1]="]
psi[-ϵ1, 1, 1] // MatrixForm
TextCell["psi[ϵ3,2,2]="]
psi[ϵ3, 2, 2] // MatrixForm
TextCell["si[-ϵ3,2,2]="]
psi[-ϵ3, 2, 2] // MatrixForm
TextCell["psi[ϵ3,3,3]="]
psi[ϵ3, 3, 3] // MatrixForm
TextCell["psi[-ϵ3,3,3]="]
psi[-ϵ3, 3, 3] // MatrixForm
TextCell["psi[ϵ2,1,1]="]
psi[ϵ2, 1, 1] // MatrixForm
TextCell["psi[-ϵ2,1,1]="]
psi[-ϵ2, 1, 1] // MatrixForm
```

Out[1076]= psi[0,1,1]=

Out[1077]//MatrixForm=

$$\begin{pmatrix} \alpha 1 + 3\,\alpha 2 & 0 & 0 \\ 0 & \alpha 2 + \frac{4\,\gamma 1}{d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} + \frac{4\,\delta}{3\,d^2} \end{pmatrix}$$

Out[1078]= psi[0,2,2] =

Out[1079]//MatrixForm=

$$\begin{pmatrix} \frac{\alpha 1}{4} + \frac{3\,\alpha 2}{2} + \frac{3\,\gamma 1}{d^2} & \frac{\sqrt{3}\,\alpha 1}{4} + \frac{\sqrt{3}\,\alpha 2}{2} - \frac{\sqrt{3}\,\gamma 1}{d^2} & 0 \\ \frac{\sqrt{3}\,\alpha 1}{4} + \frac{\sqrt{3}\,\alpha 2}{2} - \frac{\sqrt{3}\,\gamma 1}{d^2} & \frac{3\,\alpha 1}{4} + \frac{5\,\alpha 2}{2} + \frac{\gamma 1}{d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} + \frac{4\,\delta}{3\,d^2} \end{pmatrix}$$

Out[1080]= psi[0,3,3] =

Out[1081]//MatrixForm=

$$\begin{pmatrix} \frac{\alpha 1}{4} + \frac{3\,\alpha 2}{2} + \frac{3\,\gamma 1}{d^2} & -\frac{\sqrt{3}\,\alpha 1}{4} - \frac{\sqrt{3}\,\alpha 2}{2} + \frac{\sqrt{3}\,\gamma 1}{d^2} & 0 \\ -\frac{\sqrt{3}\,\alpha 1}{4} - \frac{\sqrt{3}\,\alpha 2}{2} + \frac{\sqrt{3}\,\gamma 1}{d^2} & \frac{3\,\alpha 1}{4} + \frac{5\,\alpha 2}{2} + \frac{\gamma 1}{d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} + \frac{4\,\delta}{3\,d^2} \end{pmatrix}$$

Out[1082]= psi[0,1,2] =

Out[1083]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha 2}{4} & -\frac{\sqrt{3}\,\alpha 2}{4} & 0 \\ -\frac{\sqrt{3}\,\alpha 2}{4} - \frac{\sqrt{3}\,\gamma 1}{2\,d^2} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2\,d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} - \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1084]= psi[0,2,1] =

Out[1085]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha 2}{4} & -\frac{\sqrt{3}\,\alpha 2}{4} - \frac{\sqrt{3}\,\gamma 1}{2\,d^2} & 0 \\ -\frac{\sqrt{3}\,\alpha 2}{4} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2\,d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} - \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1086]= psi[0,1,3] =

Out[1087]//MatrixForm=

$$\begin{pmatrix} -\frac{3\,\alpha 2}{4} & \frac{\sqrt{3}\,\alpha 2}{4} & 0 \\ \frac{\sqrt{3}\,\alpha 2}{4} + \frac{\sqrt{3}\,\gamma 1}{2\,d^2} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2\,d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} - \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1088]= psi[0,3,1] =

Out[1090]= psi[0,2,3] =

Out[1091]//MatrixForm=

$$\begin{pmatrix} \frac{3\,\gamma 1}{4\,d^2} & \frac{\sqrt{3}\,\gamma 1}{4\,d^2} & 0 \\ -\frac{\sqrt{3}\,\gamma 1}{4\,d^2} & -\alpha 2 - \frac{\gamma 1}{4\,d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} - \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1092]= psi[0,3,2] =

Out[1093]//MatrixForm=

$$\begin{pmatrix} \frac{3\gamma 1}{4 d^2} & -\frac{\sqrt{3}\ \gamma 1}{4 d^2} & 0 \\ \frac{\sqrt{3}\ \gamma 1}{4 d^2} & -\alpha 2 - \frac{\gamma 1}{4 d^2} & 0 \\ 0 & 0 & \frac{\gamma 2}{d^2} - \frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1094]= psi[0,3,2] =

Out[1095]//MatrixForm=

$$\begin{pmatrix} \frac{3\gamma 1}{4 d^2} & \frac{\sqrt{3}\ \gamma 1}{4 d^2} & 0 \\ -\frac{\sqrt{3}\ \gamma 1}{4 d^2} & -\alpha 2 - \frac{\gamma 1}{4 d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1096]= psi[-∈3,2,3] =

Out[1097]//MatrixForm=

$$\begin{pmatrix} \frac{3\gamma 1}{4 d^2} & -\frac{\sqrt{3}\ \gamma 1}{4 d^2} & 0 \\ \frac{\sqrt{3}\ \gamma 1}{4 d^2} & -\alpha 2 - \frac{\gamma 1}{4 d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1098]= psi[∈2,1,2] =

Out[1099]//MatrixForm=

$$\begin{pmatrix} -\frac{3\alpha 2}{4} & -\frac{\sqrt{3}\ \alpha 2}{4} & 0 \\ -\frac{\sqrt{3}\ \alpha 2}{4} - \frac{\sqrt{3}\ \gamma 1}{2 d^2} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2 d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1100]= psi[-∈2,2,1] =

Out[1101]//MatrixForm=

$$\begin{pmatrix} -\frac{3\alpha 2}{4} & -\frac{\sqrt{3}\ \alpha 2}{4} - \frac{\sqrt{3}\ \gamma 1}{2 d^2} & 0 \\ -\frac{\sqrt{3}\ \alpha 2}{4} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2 d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1102]= psi[∈1,1,3] =

Out[1103]//MatrixForm=

$$\begin{pmatrix} -\frac{3\alpha 2}{4} & \frac{\sqrt{3}\ \alpha 2}{4} & 0 \\ \frac{\sqrt{3}\ \alpha 2}{4} + \frac{\sqrt{3}\ \gamma 1}{2 d^2} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2 d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1104]= psi[-∈1,3,1] =

Out[1105]//MatrixForm=

$$\begin{pmatrix} -\frac{3\alpha 2}{4} & \frac{\sqrt{3}\ \alpha 2}{4} + \frac{\sqrt{3}\ \gamma 1}{2 d^2} & 0 \\ \frac{\sqrt{3}\ \alpha 2}{4} & -\frac{\alpha 2}{4} + \frac{\gamma 1}{2 d^2} & 0 \\ 0 & 0 & -\frac{\delta}{3 d^2} \end{pmatrix}$$

Out[1106]= psi[-∈2,2,3] =

Out[1107]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1108]= psi[∈2,3,2] =

Out[1109]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1110]= psi[∈2,1,3] =

Out[1111]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1112]= psi[-∈2,3,1] =

Out[1113]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1114]= psi[-∈1,3,2] =

Out[1115]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1116]= psi[∈1,2,3] =

Out[1117]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1118]= psi[∈1,1,2] =

Out[1119]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1120]= psi[-∈1,2,1] =

Out[1121]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1122]= psi[∈3,1,2]9=

Out[1123]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1124]= [-∈3,2,1] =

Out[1125]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1126]= psi[-∈3,1,3] =

Out[1128]= psi[∈3,3,1] =

Out[1129]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1130]= psi[∈2,2,2] =

Out[1131]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1132]= psi[-∈2,2,2] =

Out[1133]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1134]= psi[∈1,3,3] =

Out[1135]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1136]= psi[-∈1,3,3] =

Out[1137]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1138]= psi[∈1,1,1] =

Out[1139]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1140]= psi[-∈1,1,1] =

Out[1141]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1142]= psi[∈3,2,2] =

Out[1143]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1144]= si[-∈3,2,2] =

Out[1145]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1146]= psi[∈3,3,3] =

Out[1147]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1148]= psi[-∈3,3,3] =

Out[1149]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1150]= psi[∈2,1,1] =

Out[1151]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

Out[1152]= psi[-∈2,1,1] =

Out[1153]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\frac{\delta}{3\,d^2} \end{pmatrix}$$

In[869]:=

```
(*distancia interatómica en grafeno*)
d = 1.42 * 10^(-10);
(*constantes de Aizawa en el sistema métrico*)
α1 = 7.28 * 10^6;
α2 = 1.24 * 10^6;
γ1 = 8.31 * 10^(-19);
γ2 = 3.38 * 10^(-19);
δ = 3.17 * 10^(-19);

Simplify[Fi01] // MatrixForm
Simplify[Fi02] // MatrixForm
Simplify[Fi03] // MatrixForm

Fi04 // MatrixForm
Fi05 // MatrixForm
Fi06 // MatrixForm
Fi07 // MatrixForm
Fi08 // MatrixForm
Fi09 // MatrixForm
```

Out[875]//MatrixForm=

$$\begin{pmatrix} -7.28\times10^{6} & 0 & 0 \\ 0 & -247.272 & 0 \\ 0 & 0 & -50.2876 \end{pmatrix}$$

Out[876]//MatrixForm=

$$\begin{pmatrix} -1.82019\times10^{6} & 3.15223\times10^{6} & 0 \\ 3.15223\times10^{6} & -5.46006\times10^{6} & 0 \\ 0 & 0 & -50.2876 \end{pmatrix}$$

Out[877]//MatrixForm=

$$\begin{pmatrix} -1.82019\times10^{6} & -3.15223\times10^{6} & 0 \\ -3.15223\times10^{6} & -5.46006\times10^{6} & 0 \\ 0 & 0 & -50.2876 \end{pmatrix}$$

Out[878]//MatrixForm=

$$\begin{pmatrix} 30.909 & -17.8453 & 0 \\ 17.8453 & -1.24001\times10^{6} & 0 \\ 0 & 0 & -5.24036 \end{pmatrix}$$

Out[879]//MatrixForm=

$$\begin{pmatrix} -930\,000. & 536\,971. & 0 \\ 536\,936. & -309\,979. & 0 \\ 0 & 0 & -5.24036 \end{pmatrix}$$

Out[880]//MatrixForm=

$$\begin{pmatrix} -930\,000. & -536\,971. & 0 \\ -536\,936. & -309\,979. & 0 \\ 0 & 0 & -5.24036 \end{pmatrix}$$

Out[881]//MatrixForm=

$$\begin{pmatrix} 30.909 & 17.8453 & 0 \\ -17.8453 & -1.24001\times10^{6} & 0 \\ 0 & 0 & -5.24036 \end{pmatrix}$$

Out[882]//MatrixForm=

$$\begin{pmatrix} -930\,000. & 536\,936. & 0 \\ 536\,971. & -309\,979. & 0 \\ 0 & 0 & -5.24036 \end{pmatrix}$$

Out[883]//MatrixForm=

$$\begin{pmatrix} -930\,000. & -536\,936. & 0 \\ -536\,971. & -309\,979. & 0 \\ 0 & 0 & -5.24036 \end{pmatrix}$$