In[75]:= **ClearAll["Global`*"]**

In[76]:= $\mathbf{M_S = \{\{s_x, 0, 0, 0\}, \{0, s_y, 0, 0\}, \{0, 0, s_z, 0\}, \{0, 0, 0, 1\}\}}$

Out[76]= $\{\{s_x, 0, 0, 0\}, \{0, s_y, 0, 0\}, \{0, 0, s_z, 0\}, \{0, 0, 0, 1\}\}$

In[77]:= $\mathbf{M_R = \{\{\cos\gamma, -\sin\gamma, 0, 0\}, \{\sin\gamma, \cos\gamma, 0, 0\}, \{0, 0, 1, 0\}, \{0, 0, 0, 1\}\}}$

Out[77]= $\{\{\cos\gamma, -\sin\gamma, 0, 0\}, \{\sin\gamma, \cos\gamma, 0, 0\}, \{0, 0, 1, 0\}, \{0, 0, 0, 1\}\}$

In[78]:= $\mathbf{M_T = \{\{1, 0, 0, 0\}, \{0, 1, 0, 0\}, \{0, 0, 1, 0\}, \{t_x, t_y, t_z, 1\}\}}$

Out[78]= $\{\{1, 0, 0, 0\}, \{0, 1, 0, 0\}, \{0, 0, 1, 0\}, \{t_x, t_y, t_z, 1\}\}$

In[79]:= $\mathbf{v = \{x, y, z, 1\}}$

Out[79]= $\{x, y, z, 1\}$

In[80]:= $\mathbf{v.M_S.M_R.M_T}$

Out[80]= $\{\cos\gamma\, x\, s_x + \sin\gamma\, y\, s_y + t_x, -\sin\gamma\, x\, s_x + \cos\gamma\, y\, s_y + t_y, z\, s_z + t_z, 1\}$

In[81]:= $\mathbf{M_{MW} = M_S.M_R.M_T}$

Out[81]= $\{\{\cos\gamma\, s_x, -\sin\gamma\, s_x, 0, 0\}, \{\sin\gamma\, s_y, \cos\gamma\, s_y, 0, 0\}, \{0, 0, s_z, 0\}, \{t_x, t_y, t_z, 1\}\}$

In[82]:= $\mathbf{v.M_{MW}}$

Out[82]= $\{\cos\gamma\, x\, s_x + \sin\gamma\, y\, s_y + t_x, -\sin\gamma\, x\, s_x + \cos\gamma\, y\, s_y + t_y, z\, s_z + t_z, 1\}$

In[83]:= $\mathbf{M_{MW}}$ **// MatrixForm**

Out[83]//MatrixForm=

$$\begin{pmatrix} \cos\gamma\, s_x & -\sin\gamma\, s_x & 0 & 0 \\ \sin\gamma\, s_y & \cos\gamma\, s_y & 0 & 0 \\ 0 & 0 & s_z & 0 \\ t_x & t_y & t_z & 1 \end{pmatrix}$$

In[84]:= $\mathbf{M_i}$ **= {{i01, i02, i03, i04}, {i05, i06, i07, i08},**
{i09, i10, i11, i12}, {i13, i14, i15, i16}}

Out[84]= {{i01, i02, i03, i04}, {i05, i06, i07, i08}, {i09, i10, i11, i12}, {i13, i14, i15, i16}}

In[85]:= $\mathbf{M_j}$ **= {{j01, j02, j03, j04}, {j05, j06, j07, j08},**
{j09, j10, j11, j12}, {j13, j14, j15, j16}}

Out[85]= {{j01, j02, j03, j04}, {j05, j06, j07, j08}, {j09, j10, j11, j12}, {j13, j14, j15, j16}}

In[86]:= $\mathbf{M_i.M_j}$ **// MatrixForm**

Out[86]//MatrixForm=

$$\begin{pmatrix} i01\, j01 + i02\, j05 + i03\, j09 + i04\, j13 & i01\, j02 + i02\, j06 + i03\, j10 + i04\, j14 & i01\, j03 + i02\, j07 + i \\ i05\, j01 + i06\, j05 + i07\, j09 + i08\, j13 & i05\, j02 + i06\, j06 + i07\, j10 + i08\, j14 & i05\, j03 + i06\, j07 + i \\ i09\, j01 + i10\, j05 + i11\, j09 + i12\, j13 & i09\, j02 + i10\, j06 + i11\, j10 + i12\, j14 & i09\, j03 + i10\, j07 + i \\ i13\, j01 + i14\, j05 + i15\, j09 + i16\, j13 & i13\, j02 + i14\, j06 + i15\, j10 + i16\, j14 & i13\, j03 + i14\, j07 + i \end{pmatrix}$$

In[87]:= $\mathbf{M_i}$ **= {{i0, i1, i2, 0}, {i4, i5, i6, 0}, {i8, i9, i10, 0}, {i12, i13, i14, 1}}**

Out[87]= {{i0, i1, i2, 0}, {i4, i5, i6, 0}, {i8, i9, i10, 0}, {i12, i13, i14, 1}}

```
In[88]:= Mj = {{j0, j1, j2, 0}, {j4, j5, j6, 0}, {j8, j9, j10, 0}, {j12, j13, j14, 1}}
Out[88]= {{j0, j1, j2, 0}, {j4, j5, j6, 0}, {j8, j9, j10, 0}, {j12, j13, j14, 1}}

In[89]:= Mi.Mj // MatrixForm
Out[89]//MatrixForm=
```

$$\begin{pmatrix} i0\,j0 + i1\,j4 + i2\,j8 & i0\,j1 + i1\,j5 + i2\,j9 & i2\,j10 + i0\,j2 + i1\,j6 & 0 \\ i4\,j0 + i5\,j4 + i6\,j8 & i4\,j1 + i5\,j5 + i6\,j9 & i6\,j10 + i4\,j2 + i5\,j6 & 0 \\ i8\,j0 + i9\,j4 + i10\,j8 & i8\,j1 + i9\,j5 + i10\,j9 & i10\,j10 + i8\,j2 + i9\,j6 & 0 \\ i12\,j0 + j12 + i13\,j4 + i14\,j8 & i12\,j1 + j13 + i13\,j5 + i14\,j9 & i14\,j10 + j14 + i12\,j2 + i13\,j6 & 1 \end{pmatrix}$$

```
In[90]:=

(*bounding volumes, spheres*)

In[92]:= p1 = {x1, y1, z1}
Out[92]= {x1, y1, z1}

In[93]:= p2 = {x2, y2, z2}
Out[93]= {x2, y2, z2}

In[94]:= EuclideanDistance[p1, p2]
```

Out[94]= $\sqrt{\text{Abs}[x1 - x2]^2 + \text{Abs}[y1 - y2]^2 + \text{Abs}[z1 - z2]^2}$

```
(*spheres in collission if*)
EuclideanDistance[p1, p2] < r1 + r2
```

Out[95]= $\sqrt{\text{Abs}[x1 - x2]^2 + \text{Abs}[y1 - y2]^2 + \text{Abs}[z1 - z2]^2} < r1 + r2$

In[96]:= $(x1 - x2)^2 + (y1 - y2)^2 + (z1 - z2)^2 == (r1 + r2)^2$

Out[96]= $(x1 - x2)^2 + (y1 - y2)^2 + (z1 - z2)^2 == (r1 + r2)^2$

```
In[97]:= dp = p1 - p2
Out[97]= {x1 - x2, y1 - y2, z1 - z2}
```

In[98]:= dp^2

Out[98]= $\{(x1 - x2)^2, (y1 - y2)^2, (z1 - z2)^2\}$

In[100]:= dp.dp

Out[100]= $(x1 - x2)^2 + (y1 - y2)^2 + (z1 - z2)^2$

In[103]:= $dp.dp == (\text{EuclideanDistance}[p1, p2])^2$

Out[103]= $(x1 - x2)^2 + (y1 - y2)^2 + (z1 - z2)^2 == \text{Abs}[x1 - x2]^2 + \text{Abs}[y1 - y2]^2 + \text{Abs}[z1 - z2]^2$