# SU(3) commutators

Physics 262: Group Theory for Physicists
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Flip Tanedo
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## Define a commutator

In[4]:=
```
Com[A_, B_] := MatrixForm[A.B - B.A]
```

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## Pick a basis

I think these are roughly the basis used in Cahn.

In[95]:=
```
Tp = {{0, 1, 0}, {0, 0, 0}, {0, 0, 0}};

Tm = {{0, 0, 0}, {1, 0, 0}, {0, 0, 0}};

Vp = {{0, 0, 1}, {0, 0, 0}, {0, 0, 0}};

Vm = {{0, 0, 0}, {0, 0, 0}, {1, 0, 0}};

UUp = {{0, 0, 0}, {0, 0, 1}, {0, 0, 0}};

UUm = {{0, 0, 0}, {0, 0, 0}, {0, 1, 0}};

T3 = 1/2 {{1, 0, 0}, {0, -1, 0}, {0, 0, 0}};

T8 = 1/(2 Sqrt[3]) {{1, 0, 0}, {0, 1, 0}, {0, 0, -2}};
```

# Print out relevant commutators

## $T^{\pm}$

In[119]:=
```
Com[Tp, Tm]
Print["T3"]
Com[T3, Tp]
Com[T3, Tm]
Print["T8"]
Com[T8, Tp]
Com[T8, Tm]
```

Out[119]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

T3

Out[121]//MatrixForm=

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

Out[122]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

T8

Out[124]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Out[125]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

## $V^{\pm}$

In[126]:=
```
Com[Vp, Vm]
Print["T3"]
Com[T3, Vp]
Com[T3, Vm]
Print["T8"]
Com[T8, Vp]
Com[T8, Vm]
```

Out[126]//MatrixForm=

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

T3

Out[128]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & \frac{1}{2} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Out[129]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -\frac{1}{2} & 0 & 0 \end{pmatrix}$$

T8

Out[131]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & \frac{\sqrt{3}}{2} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Out[132]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ -\frac{\sqrt{3}}{2} & 0 & 0 \end{pmatrix}$$

In[133]:=
```
Com[1/2 T3 + Sqrt[3]/2 T8, Vp]
```

Out[133]//MatrixForm=

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

## $U^{\pm}$

In[141]:=
```
Com[UUp, UUm]
Print["T3"]
Com[T3, UUp]
Com[T3, UUm]
Print["T8"]
Com[T8, UUp]
Com[T8, UUm]
```

Out[141]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

T3

Out[143]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{2} \\ 0 & 0 & 0 \end{pmatrix}$$

Out[144]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & \frac{1}{2} & 0 \end{pmatrix}$$

T8

Out[146]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & \frac{\sqrt{3}}{2} \\ 0 & 0 & 0 \end{pmatrix}$$

Out[147]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -\frac{\sqrt{3}}{2} & 0 \end{pmatrix}$$

## Check Cross Commutators

In[151]:=
```
Com[Tp, Vm]
Com[Tp, UUp]
Com[Vp, UUm]
```

Out[151]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & -1 & 0 \end{pmatrix}$$

Out[152]//MatrixForm=

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

Out[153]//MatrixForm=

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

In[154]:=
```
Com[Tm, Vm]
Com[Tm, UUp]
Com[Vm, UUm]
```

Out[154]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Out[155]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

Out[156]//MatrixForm=

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$