In[1]:=
```
Needs["SpinDynamica`"]
```

```
SpinDynamica version 3.0.1 loaded
```

ModifyBuiltIn: The following built-in routines have been modified in SpinDynamica:
{Chop, Dot, Duration, Exp, Expand, ExpandAll, NumericQ, Plus, Power, Simplify, Times, WignerD}.
Evaluate ??*symbol* to generate the additional definitions for *symbol*.

In[2]:=
```
SetSpinSystem[3]
```

SetSpinSystem: the spin system has been set to $\{\{1, \frac{1}{2}\}, \{2, \frac{1}{2}\}, \{3, \frac{1}{2}\}\}$

SetBasis: the state basis has been set to ZeemanBasis$[\{\{1, \frac{1}{2}\}, \{2, \frac{1}{2}\}, \{3, \frac{1}{2}\}\}$, BasisLabels → Automatic$]$.

In[3]:=
```
ExpressOperator[opI[1, "x"].opI[2, "+"].opI[3, "z"],
 CartesianProductOperatorBasis[]
]
```

Out[3]= $I_{1x}\bullet I_{2x}\bullet I_{3z} + i\,(I_{1x}\bullet I_{2y}\bullet I_{3z})$

In[4]:=
```
ExpressOperator[opI[1, "x"].opI[2, "+"].opI[3, "z"],
 ShiftAndPolarizationOperatorBasis[]
]
```

Out[4]= $\frac{1}{4}\left(I_1^-\bullet I_2^+\bullet I_3^\alpha\right) - \frac{1}{4}\left(I_1^-\bullet I_2^+\bullet I_3^\beta\right) + \frac{1}{4}\left(I_1^+\bullet I_2^+\bullet I_3^\alpha\right) - \frac{1}{4}\left(I_1^+\bullet I_2^+\bullet I_3^\beta\right)$

In[5]:=
```
ExpressOperator[opI[1, "x"].opI[2, "+"].opI[3, "z"],
 ShiftAndZOperatorBasis[]
]
```

Out[5]= $\frac{1}{2}\left(I_1^-\bullet I_2^+\bullet I_{3z}\right) + \frac{1}{2}\left(I_1^+\bullet I_2^+\bullet I_{3z}\right)$

In[6]:=
```
ExpressOperator[
 ProjectionOperator[Ket["αβα"]],
 CartesianProductOperatorBasis[]
]
```

Out[6]= $-\frac{1}{2}(I_{1z}\bullet I_{2z}) + \frac{1}{2}(I_{1z}\bullet I_{3z}) - \frac{1}{2}(I_{2z}\bullet I_{3z}) - I_{1z}\bullet I_{2z}\bullet I_{3z} + \frac{I_{1z}}{4} - \frac{I_{2z}}{4} + \frac{I_{3z}}{4} + \frac{\mathbb{1}}{8}$

In[7]:=
```
ExpressOperator[
 ShiftOperator[Ket["αβα"], Bra["ααβ"]],
 CartesianProductOperatorBasis[]
]
```

Out[7]= $\frac{1}{2}(I_{2x}\bullet I_{3x}) + \frac{1}{2}i\,(I_{2x}\bullet I_{3y}) - \frac{1}{2}i\,(I_{2y}\bullet I_{3x}) + \frac{1}{2}(I_{2y}\bullet I_{3y}) +$
$I_{1z}\bullet I_{2x}\bullet I_{3x} + i\,(I_{1z}\bullet I_{2x}\bullet I_{3y}) - i\,(I_{1z}\bullet I_{2y}\bullet I_{3x}) + I_{1z}\bullet I_{2y}\bullet I_{3y}$

In[8]:=
```
ExpressOperator[
 ShiftOperator[Ket["αβα"], Bra["ααβ"]],
 SphericalTensorOperatorBasis[]
]
```

Out[8]=

$$\frac{1}{4}\left(I_2^-\bullet I_3^+ - I_2^+\bullet I_3^-\right) + \frac{1}{12}\left(I_2^-\bullet I_3^+ + I_2^+\bullet I_3^- - 4\left(I_{2z}\bullet I_{3z}\right)\right) +$$
$$\frac{1}{6}\left(I_2^-\bullet I_3^+ + I_2^+\bullet I_3^- + 2\left(I_{2z}\bullet I_{3z}\right)\right) + \frac{1}{4}\left(I_1^-\bullet I_{2z}\bullet I_3^+ - I_1^+\bullet I_{2z}\bullet I_3^- + I_{1z}\bullet I_2^-\bullet I_3^+ - I_{1z}\bullet I_2^+\bullet I_3^-\right) +$$
$$\frac{1}{6}\left(I_1^-\bullet I_2^+\bullet I_{3z} - I_1^-\bullet I_{2z}\bullet I_3^+ - I_1^+\bullet I_2^-\bullet I_{3z} + I_1^+\bullet I_{2z}\bullet I_3^- + I_{1z}\bullet I_2^-\bullet I_3^+ - I_{1z}\bullet I_2^+\bullet I_3^-\right) +$$
$$\frac{1}{12}\left(-2\left(I_1^-\bullet I_2^+\bullet I_{3z}\right) - I_1^-\bullet I_{2z}\bullet I_3^+ + 2\left(I_1^+\bullet I_2^-\bullet I_{3z}\right) + I_1^+\bullet I_{2z}\bullet I_3^- + I_{1z}\bullet I_2^-\bullet I_3^+ - I_{1z}\bullet I_2^+\bullet I_3^-\right) +$$
$$\frac{1}{4}\left(-\left(I_1^-\bullet I_{2z}\bullet I_3^+\right) - I_1^+\bullet I_{2z}\bullet I_3^- + I_{1z}\bullet I_2^-\bullet I_3^+ + I_{1z}\bullet I_2^+\bullet I_3^-\right) +$$
$$\frac{1}{10}\left(I_1^-\bullet I_2^+\bullet I_{3z} + I_1^-\bullet I_{2z}\bullet I_3^+ + I_1^+\bullet I_2^-\bullet I_{3z} + I_1^+\bullet I_{2z}\bullet I_3^- + I_{1z}\bullet I_2^-\bullet I_3^+ + I_{1z}\bullet I_2^+\bullet I_3^- - 4\left(I_{1z}\bullet I_{2z}\bullet I_{3z}\right)\right) +$$
$$\frac{1}{20}\left(-2\left(I_1^-\bullet I_2^+\bullet I_{3z}\right) + 3\left(I_1^-\bullet I_{2z}\bullet I_3^+\right) - 2\left(I_1^+\bullet I_2^-\bullet I_{3z}\right) + 3\left(I_1^+\bullet I_{2z}\bullet I_3^-\right) + 3\left(I_{1z}\bullet I_2^-\bullet I_3^+\right) + 3\left(I_{1z}\bullet I_2^+\bullet I_3^-\right) + 8\left(I_{1z}\bullet I_{2z}\bullet I_{3z}\right)\right)$$