8b. Preliminary routines

We have two bases of the Lie algebra. We use the complex basis **Zlist** to the general routine **R** of right differentiation, and the basis **XWlist** for the routine **M** of interior differentiation based on the Iwasawa decomposition

In[ ]:=
```
Zlist
XWlist
```

Out[ ]= {Z13, Z23, Z12, CKi, WW0, Z21, Z32, Z31}

Out[ ]= {XX0, XX1, XX2, HHr, HHi, WW0, WW1, WW2}

In[ ]:=
```
Clear[inlist, FreeLie, nofunction]
Lielist = Union[Zlist, XWlist];
inlist[a_, lst_] := Module[{in}, in = False;
  Do[If[lst⟦j⟧ == a, in = True;
    Break[]], {j, 1, Length[lst]}]; in]
FreeLie[a_] := Module[{fr}, fr = True;
  Do[If[! FreeQ[a, Lielist⟦j⟧], fr = False;
    Break[]], {j, 1, Length[Lielist]}]; fr]
fctlist = {Phi, f, g, bt};
nofunction[f_] := Module[{fr}, fr = True;
  Do[If[! FreeQ[f, fctlist⟦j⟧], fr = False;
    Break[]], {j, 1, Length[fctlist]}];
  fr]
```

The routine **inlist[a,lst]** checks whether the symbol **a** occurs in the list **lst**.

The routine **FeeLie[a]** gives **true** if the expression **a** does not contain an element in the bases of the Lie algebra.

In the differentiations only the symbols in **fctlist** are considered as functions with non-zero derivatives. If more functions are used, add them to **fctlist.**

The routine **nofunction[f]** gives **true** if **f** is not recognized as a function.

In[ ]:=

Multiplication relations

The routine **mult** carries out the multiplication of basis functions of **k** by the factors that occur in the transition from right differentiation to interior differentiation.

The routine uses definitions in section 4c of this notebook.

The substitution rule recognizes products only if all brackets in expressions are expanded. To enlarge the probability of catching all products the routine **Expand** is used twice.

In[ ]:=
```
Clear[mult]
multsub =
  {Phi[eta_, 1, eps_, zt_] × Phi[h_, p_, r_, q_] :→ Phiprod[eta, eps, zt, h, p, r, q]};
mult[xx_] := Module[{x}, x = Expand[xx] /. multsub; Expand[x] /. multsub]
(* See 4d *)
```

In[ ]:=