Groups generated by an $S_n$ axis: $S_n$

- $n$ odd $\equiv C_{nh}$
- $n$ even: $S_n$

$S_2 \equiv C_i$
\[
\{E, S_4, S_4^2 = C_2, S_4^3\}
\]

\(S_4\)

1,3,5,7-tetrafluorocyclooctatetraene

---

Figure 3-10. Examples with mirror-rotation axes. (a) \(S_4\) symmetry. (b) \(S_5\) symmetry.
Dihedral groups:

Groups with a $C_n$ axis plus $n$ perpendicular $C_2$ axes: $D_n$

$C_2H_6$ partly rotated (not staggered, not eclipsed).

$$D_3 = \{E, C_3, C_3^2, C_2, C_2', C_2''\}$$
Other example:

\[ Co(\text{NH}_2\text{C}_2\text{H}_4\text{NH}_2)_3 \]

\[ Pt(\text{NH}_2\text{C}_2\text{H}_4\text{NH}_2)_2 \]
Groups with a $C_n$ axis, $n \perp C_2$ axes and a $\sigma_h$ plane: $D_{nh}$

Example: Eclipsed Conformation of Hydrazine, $N_2H_4$

$$D_{2h} = \{E, C_2(z), C_2(y), C_2(x), i, \sigma_{xy}, \sigma_{yz}, \sigma_{zx}\}$$
$D_{3h}: BF_3$

$D_{3h} = \{E, C_3, C_3^2, C_2, C_2', C_2'', S_3, S_3^5, \sigma_h, \sigma_v, \sigma_v', \sigma_v''\}$

$D_{4h}: PtCl_4$
A n-gonal prism

\[ D_{\infty h}; \ H_2, \ BeF_2 \]
\[ \{E, \ C_\infty, ..., \sigma_v, ..., C_2, ..., \sigma_h, i, S_\infty, ...\} \]
Groups with a $C_n$ axis, $n \perp C_2$ axes, and $n \sigma_d$ planes: $D_{nd}$

Symmetry Elements for $D_{3d}$ Point Group ($A_2X_6$)

$C_2H_6$ staggered.

$$D_{3d} = \{E, C_3, C_3^2, C_2, C_2', C_2'', i, S_6, S_6^5, \sigma_d, \sigma_d', \sigma_d'' \}$$

$\sigma_d$: dihedral reflection planes (bisects $\sigma$ or $C_2$)
Allene

\[ D_{2d} = \{ E, C_2, S_4^1, S_4^3, C_2', C_2'', \sigma_d, \sigma_d' \} \]

staggered regular polygons (n-gonal antiprism)

\[ \text{B}_2\text{Cl}_4 \]
Groups with very high symmetry: multiple high-fold rotation axes

The platonic solids: polyhedra constructed from regular polygons with all vertices and edges equivalent: 5 possibilities only.

(a) icosahedron