**Character Tables: Procedure for Derivation**

- delineate symmetry elements, classes
- \# of I.R.’s = \# of Classes
- dimensions of I.R.’s:
  \[
  \sum_i [\chi_i(E)]^2 = h
  \]
- orthogonality and normalization of I.R.’s
  \[
  \sum_R |\chi_i(R)|^2 = h ; \sum_R \chi_i(R)\chi_j(R) = 0 \text{ when } i \neq j
  \]
- Mulliken Symbols
- bases for I.R.’s, linear and bilinear forms

**Derivation of Character Tables; Examples**

- ★ $C_{2v}$ - easy!
- ★ $C_{4v}$ - an example with a 2-dim. I.R.
- ★ $D_{3h}$ vs. $D_{3d}$
- ★ $O_h$ - Divide and Conquer
  - ★ $O_h = O \times C_i$

**A Crucial Practical Relationship**

- ★ Any reducible rep. can be put in block-diagonal form by some similarity transformation (i.e., appropriate choice of basis)
- ★ Let $a_j$ be the \# of times the $j^{th}$ irred. rep. occurs. The character of the red. rep. is then:
  \[
  \chi(R) = \sum_j a_j \chi_j(R)
  \]
- ★ A formula for $a_i$ is:
  \[
  a_i = \frac{1}{h} \sum_R \chi(R)\chi_i(R)
  \]

**Examples**

- ★ Find the characters of the reducible representation obtained using the four hydrogen 1s orbitals of methane as a basis — then find the irred. reps. spanned by this rep.
- ★ Follow the same procedure using the twelve CO $\pi^*$ orbitals of Cr(CO)$_6$ as a basis.
- ★ Follow the same procedure using the six CO stretching vibrations of Cr(CO)$_6$ as a basis.