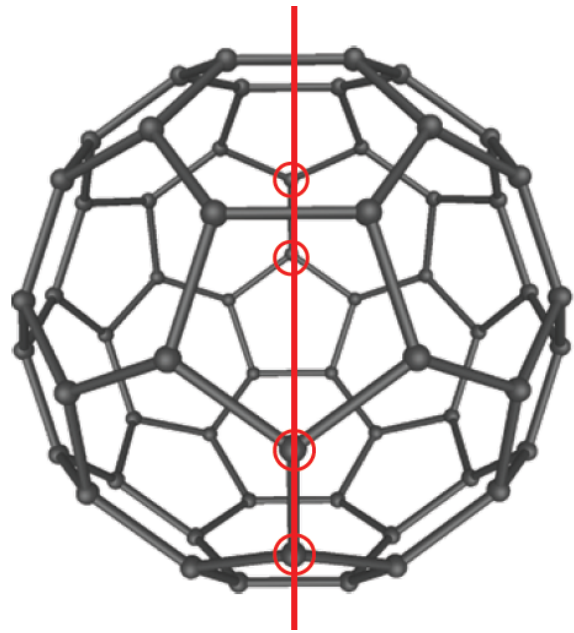


1. The 174 internal vibrations of the  $C_{60}$  molecule contain only one normal mode whose eigenvector is completely fixed by symmetry, namely the  $A_{1u}$  mode. **Explain what the eigenvector is.** To do this, all you need is the character table and some thought. What you should most importantly think about is how this mode behaves



under the 15 mirror operations  $\sigma$ . Each such operation leaves 4 atoms in their original places (see the picture above), and each atom is on exactly one such mirror plane.

2. This is problem 5.4.2 from Lax, p. 166. The square molecule  $AB_4$  has  $C_{4v}$  symmetry. Consider the internal vibrations in the  $x,y$  plane. Find the representation of the permutations of the B atoms. Find the irreducible representations. Find the eigenvectors and eigenfrequencies. You can leave them in the form of unsolved matrix eigenproblems provided their dimension is as small as possible.

