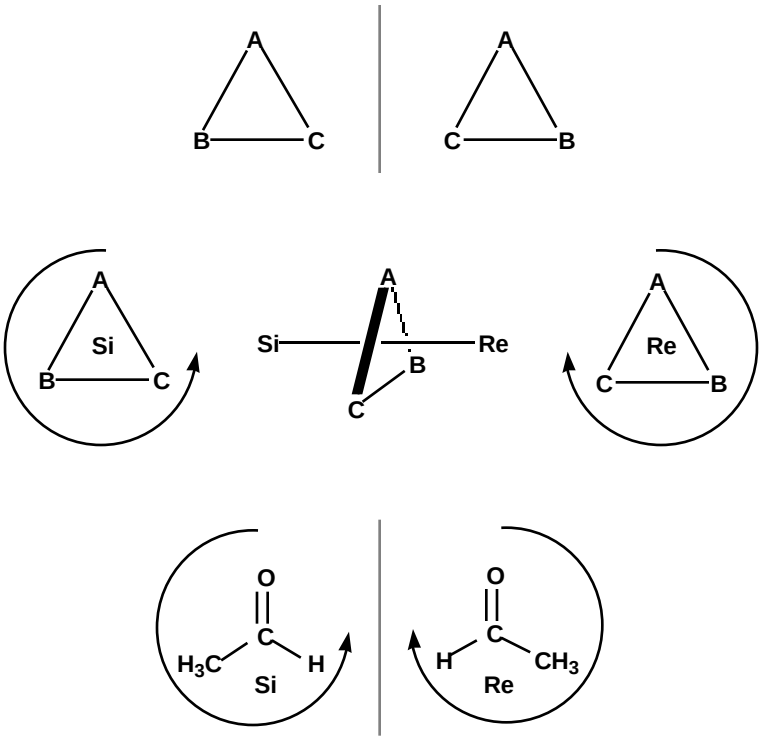
Text Related to Segment 6.06 ©2002 Claude E. Wintner

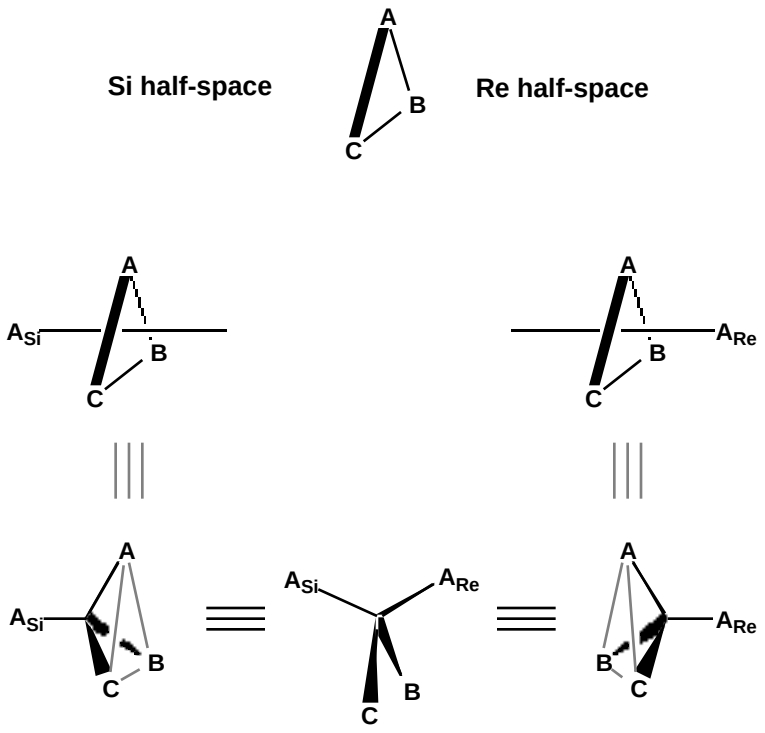
The phenomenon of stereotopism in three dimensions ultimately rests on the existence of two-dimensional chirality in two-dimensional space (that is, in "Flatland"). A triangle with three differing identified vertices is two-dimensionally chiral, that is, it is not congruent, either by translation or by rotation in its plane, with its mirror image. In other words, in two-dimensional space such a triangle is enantiomorphous with its mirror image. However, the two-dimensionally enantiomorphous triangles can be made congruent by rotation and translation in three-dimensional space, where the two-dimensional enantiomorphs become a single object with two different faces that can be given specifying descriptors. The descriptor Re is used for the face, and also can be used for the two-dimensional chirality, if the order of the vertices is clockwise. The descriptor Si is used if the order is counterclockwise:



two-dimensional chirality; Re and Si faces of acetaldehyde

This is a model for a molecule such as acetaldehyde, for which we soon shall discuss the bonding. Suffice it to say for the present that in acetaldehyde three different ligands are held in planar position by a trigonal carbon atom (which plays the same role here as does the central stereogenic tetrahedral carbon atom in an appropriately substituted case in three-dimensional space). Thus, using the C-I-P system, the two faces of acetaldehyde can be labeled Re and Si.

Two-dimensionally chiral objects, for example, two-dimensionally chiral triangles, divide three-dimensional space into two enantiomorphous half-spaces, which also can be specified by Re and Si:



enantiotopic ligands A_{Si} and A_{Re} lie in enantiomorphous half-spaces

Where the fourth ligand A of a tetrahedron which contains a two-dimensionally chiral triangle is the same as one of the ligands comprising the triangle, and all of the ligands are achiral, the two ligands A lie in two enantiomorphous half-spaces and are

enantiotopic; they may be designated A_{Si} and A_{Re}. (If one of the ligands B or C on the triangle is — three-dimensionally — chiral, then the two half-spaces are diastereomorphous, and the two ligands A are diastereotopic.) The central tetrahedral atom in such cases sometimes is termed *prochiral.* (A problem with the word "prochiral" is its relative non-specificity, for it may be used to cover a variety of cases that — when considered in detail — differ in their stereochemical properties. Nevertheless, the term appears in general usage.) In our present discussion we already have uncovered several examples of prochiral atoms. Thus, C-2 in n-butane, C-2 in 3-methylpentane, and C-4 in *achiral* 3,5-dimethylheptane (but *not* C-4 in *chiral* 3,5-dimethylheptane!) are prochiral carbon atoms.