1.19: Centered lattices

When the unit cell does not reflect the symmetry of the lattice, it is usual in crystallography to refer to a 'conventional', non-primitive, crystallographic basis, $\mathbf{a_c}$, $\mathbf{b_c}$, $\mathbf{c_c}$ instead of a primitive basis, **a**, **b**, **c**. This is done by adding lattice nodes at the center of the unit cell or at one or three faces. The vectors joining the origin of the unit cell to these additional nodes are called 'centering vectors'. In such a lattice $\mathbf{a_c}$, $\mathbf{b_c}$ and $\mathbf{c_c}$ with all their integral linear combinations are lattice vectors again, but there exist other lattice vectors $\mathbf{t} \in \mathbf{L}$, $\mathbf{t} = t_1\,\mathbf{a_c} + t_2\,\mathbf{b_c} + t_3\,\mathbf{c_c}$; with at least two of the coefficients t_1, t_2, t_3 being fractional. The table below gives the various types of centering vectors and the corresponding types of centering. Each one is described by a letter, called the Bravais letter, which is to be found in the Hermann-Mauguin symbol of a space group.

The 'multiplicity', m, of the centered cell is the number of lattice nodes per unit cell (see table).

The volume of the unit cell, $V_c = (\mathbf{a_c}, \mathbf{b_c}, \mathbf{c_c})$ is given in terms of the volume of the primitive cell, $V = (\mathbf{a}, \mathbf{b}, \mathbf{c})$, by:

$V_c = m\,V$