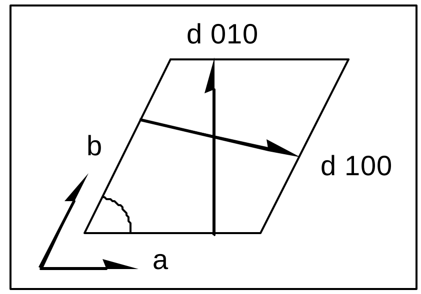
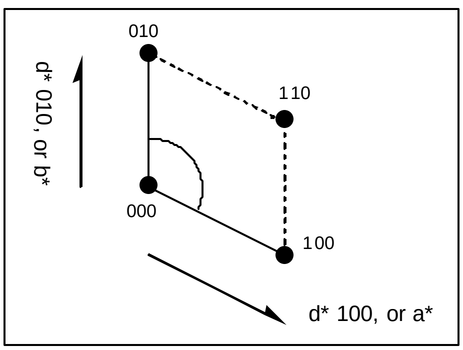
The exercise yields a repeating pattern of reciprocal lattice points that is generated by

(a) constructing normals to families of planes that pass through one unit cell,
(b) calculating the reciprocal of the length of each normal - and from a common origin,
(c) marking the end of the reciprocal length after
(d) positioning it in the same orientation as the original normal.



In real space, suppose the angle between two cell axes (say a and b) is not 90 degrees, then, the normal between parallel cell edges is given by $a \sin g$ and $b \sin g$ respectively. These particular normals are labeled as d_{100} and d_{010} respectively. In a real space, cell limits are marked by an imaginary boundary selected so it contains the unique chemical/crystallographic information of its contents.



In reciprocal space, a unit cell may also be recognized. It has edge lengths that are the reciprocals of the normals of the real space cell, and they are labeled as $d*_{100}$ and $d*_{010}$, or $a*$ and $b*$ respectively.

In reciprocal space, cell limits are marked by lattice points which represent families of planes. Each lattice point can be uniquely labeled with a set of indices.

Accordingly, the relationship between so-called real and reciprocal space for this 2-D examples is as follows:

real cell edge lengths	real cell normals	reciprocal cell edge lengths
a , b	$d_{100} = a \sin$	$a* = d*_{100} = \frac{1}{d_{100}}$, $b* = d*_{010} = \frac{1}{d_{010}}$
	$d_{010} = b \sin g$	
cell area	$A = ab \sin g$	$A* = a*b* \sin g*$ $\quad g* = 180 - g$

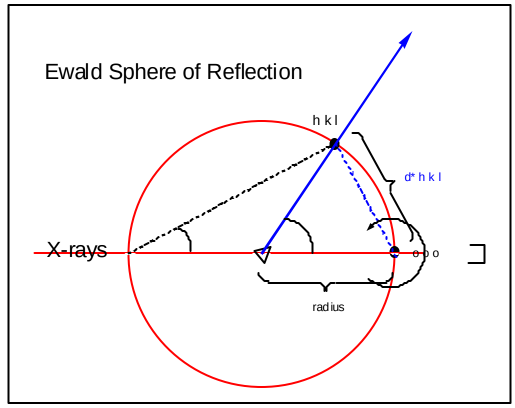
for a monoclinic unit cell in three dimensional space:

$$a \neq b \neq c,\ a = g = 90 \neq b \qquad a* = 1/a \sin g\ ,\ b* = 1/b\ ,\ c* = 1/c \sin g$$

cell volume $V = abc \sin g$ $\qquad \frac{1}{V} = V* = a*b*c* \sin g*$

Suffice it to say the reciprocal lattice is observed as a diffraction pattern. A two-dimensional example of a reciprocal lattice was prepared for today's class. Of course a three-dimensional crystal with corresponding 3-D unit cell will produce a 3-D diffraction pattern associated with a 3-d reciprocal lattice. It is convenient to examine the 3-D lattice in terms of separate "levels" or "slices" in which one index is held constant. So, for example, reflections of the type $hk0$ for which the ℓ index is zero could be grouped and considered. This yields a 2-D pattern similar to the one prepared for today's class. The complete set of reflections would be obtained by collecting additional levels having $\ell = 1,2,3...$

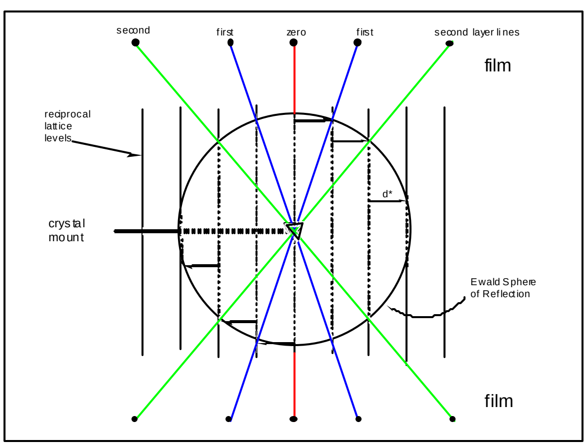
Diffraction: in order to "reflect" x_rays of wavelength l a familiy of planes (hkl) separated by a normal (d_{hkl}) must be oriented at an angle q w/r to the x-ray beam, so that Bragg's Law is satisfied: $2d_{hkl}\sin q = l$.

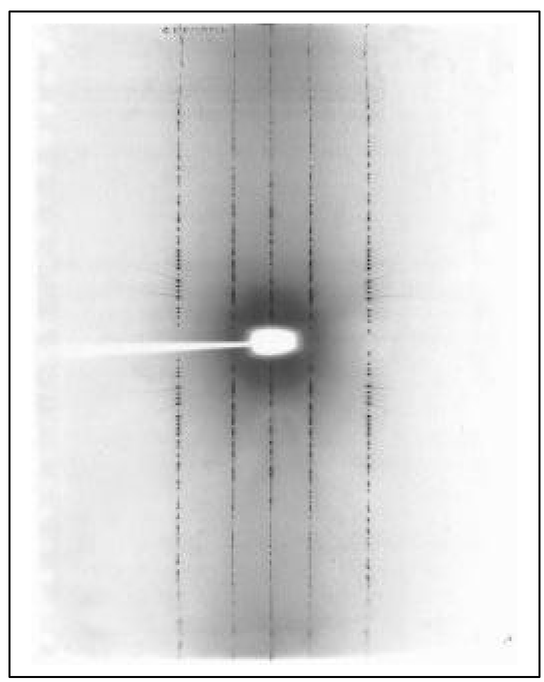


This is accomplished in reciprocal space by invoking a model known as Ewald's sphere of reflection. The origin of the reciprocal lattice (000) is fixed at the point where x-rays exit the sphere. The radius of the sphere is $1/l$. (A triangle whose hypotenuse is a diameter is a right triangle.)

As the crystal is moved in the x-ray beam its associated reciprocal lattice also moves correspondingly. Consider the situation when a reciprocal lattice point is in contact with the sphere… It was demonstrated that Bragg's law is obeyed in such situations.

Rotation Method: is one of the first methods used to detect the reciprocal lattice. DEMO.





A real axis is perpendicular to parallel reciprocal lattice layers.