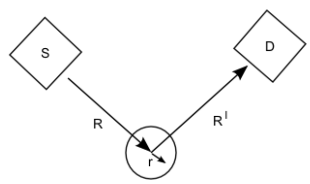
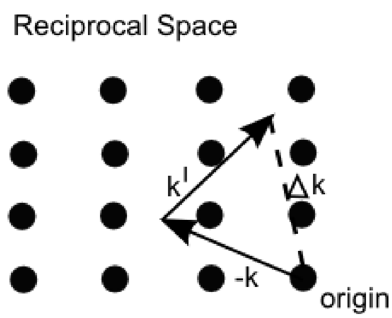
Topic 4-1: Ewald Sphere
Kittel: Figure 2.8

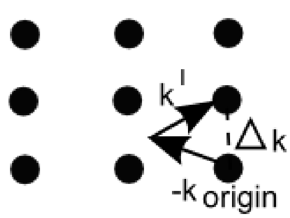
Summary: We begin this video by discussing the Ewald sphere as a way to visualize when constructive interference happens. However, a stationary sphere does not tend to show many constructive interference conditions. To fix this one can move the source, change the source wavelength or tilt the sample to create changes in the Ewald sphere or reciprocal space and discover more constructive interference points.

- The Ewald sphere construction helps us look at the geometry of diffraction measurements in single crystal materials
- Start with the same diffractometer as in topic 3

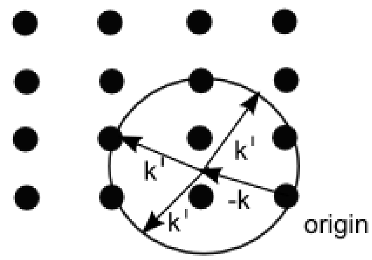




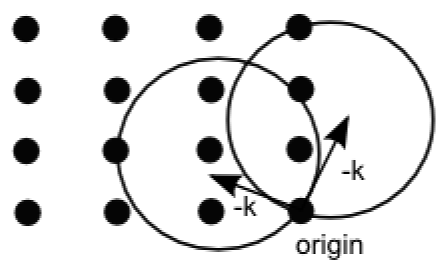
- Where $\Delta\vec{k} = \vec{k}' - \vec{k}$ (technically drawn as –k+k')
- Now we move the detector
  - This will result in new $\vec{k}'$ vectors and a new $\Delta\vec{k}$
  - We may eventually reach a configuration where $\Delta\vec{k} = \vec{G}_{h,k,l}$ which gives constructive interference



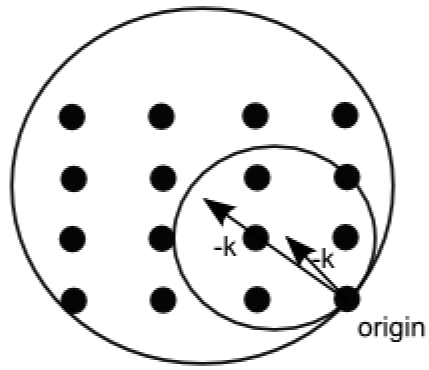
- As we move the detector we effectively carve out a circle which is a spherical surface that represents all possible $\Delta\vec{k}$ conditions



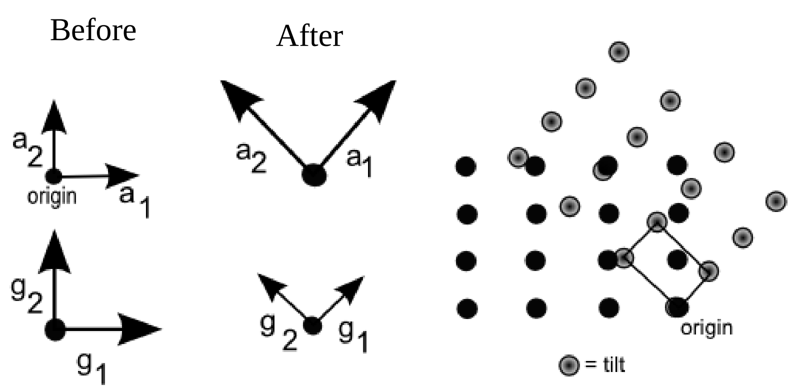
- This is the **Ewald sphere**
  - It allows us to see how and when constructive interference happens, which is when the circle and a *G* lattice point intersect
- Using the previous example we only hit 2 points of constructive interference
- There are 3 other ways to create constructive interference conditions, beyond moving the detector to sweep out the Ewald sphere.
  - Move the source which will shift the center of the Ewald sphere



  - Change wavelength
    - Since $|\Delta\vec{k}| = \frac{2\pi}{\lambda}$ this changes the sphere diameter
    - A smaller wavelength will result in a bigger Ewald sphere which is more likely to intersect a lattice point



- Tilt the sample, which drags the reciprocal lattice around the origin without affecting the Ewald sphere



Questions to Ponder

1. Since changing wavelength changes the size of the sphere, what is the biggest wavelength you can use and still get scattering?

2. What wavelength would you expect for a real space lattice spacing of about 5 Angstroms?

3. How would an Ewald sphere created by electrons compare to one created by x-rays?