1 & 2) It was mentioned in Lab 1 that the diffraction pattern observed on a film or screen is the Fourier transform of the structure. Explain how a diffraction pattern with one peak (one d-spacing) is related to the real space structure of a crystal using the pairwise correlation function (rod throwing probability) and a Fourier transform of this function.

3) Show how the phase difference, \( \phi = \frac{2\pi}{\lambda} (S - S_0) \cdot AB \) can be obtained from a sketch of the diffraction from atoms A and B.

4) Construct the Sphere of Reflection by sketching a reciprocal lattice with an origin, (000) and the center of the diffraction measurement indicating \( 2\theta \) and \( (S - S_0)/\lambda \). Why are only a few peaks seen when a perfect crystal diffracts with a single wavelength x-ray radiation?

5) Construct the limiting sphere and explain why Debye-Scherrer rings are seen from a powder pattern in a 2D photographic measurement such as was done in lab 2.
Consider only one d-spacing.

1) Probability of a rod in phase with atoms is one at r = 0 than 0 if t > 2d
   sin 60° t < d and high at t = d etc.

This correlation function can be represented by a single sin wave of wave 1/k d
   so the resulting FT is single valued

\[ g = \frac{2\pi}{d} \]
4) Sphere of Reflection (or Ewald Sphere)

It is unlikely that a given point will intersect the sphere of fixed radius $\frac{1}{\lambda}$ in a fixed orientation relative to the lattice.

5) By rotation of the crystal to all possible orientations, the sphere of reflection traces out a larger sphere of radius $\frac{2}{\lambda}$ called the limity sphere.

For the intersection of the Ewald sphere with a reciprocal lattice point rotating the lattice will trace out a circle on the surface of the Ewald sphere creating a Debye–Scherrer ring on the film which is part of the surface.