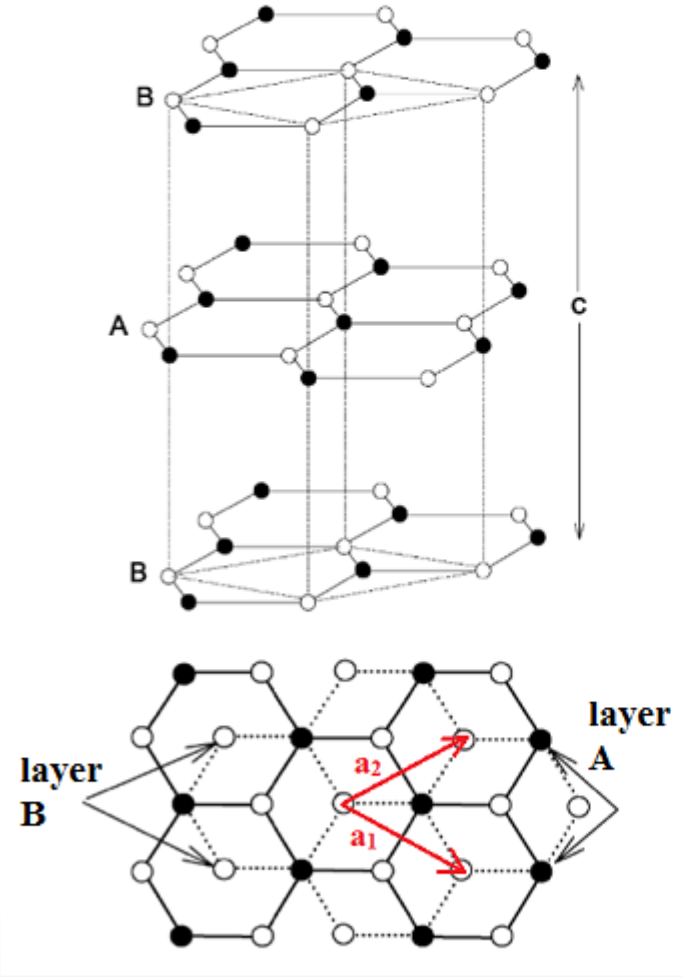
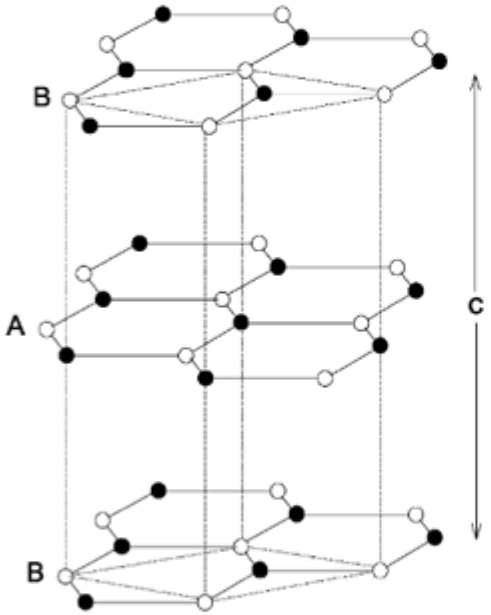
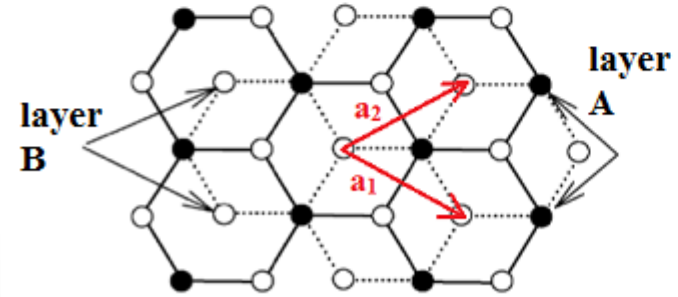
Assignment - Q1



- Graphite has a hexagonal lattice structure that is a stacking of 2D layers according to an ABABAB scheme
- The primitive lattice vectors are
  $\mathbf{a}_1 = a\left(\sqrt{3}/2, -1/2, 0\right)$
  $\mathbf{a}_2 = a\left(\sqrt{3}/2, 1/2, 0\right)$
  $\mathbf{a}_3 = c\left(0, 0, 1\right)$
- $a = 0.246\ \mathrm{nm}$, $c = 0.671\ \mathrm{nm}$ are the lattice constants of graphite

Assignment - Q1





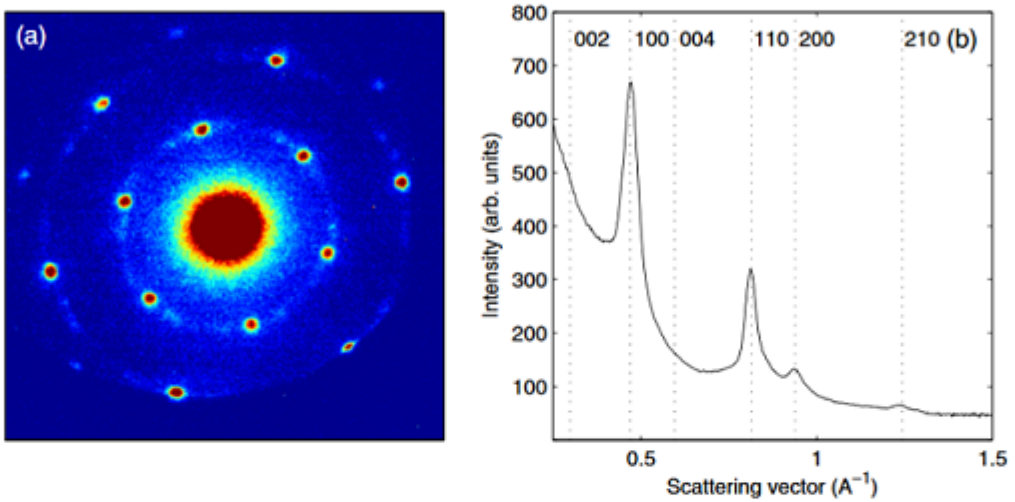
The unit cell has four Carbon atoms located at:

1. $(0, 0, 0)$
2. $(0, 0, c/2)$
3. $(a/(2\sqrt{3}), a/2, 0)$
4. $(-a/(2\sqrt{3}), -a/2, c/2)$

Assignment - Q1

1. Find the reciprocal lattice vectors of graphite
2. Calculate the structure factor in terms of planar indices h,k,l (assume that the atomic form factor is f_C)
3. Based on the previous question, determine which reflections are allowed and which are forbidden
4. The interplanar distance $d(hkl)$ for the hexagonal lattice is given by
   $\frac{1}{d^2} = \frac{4}{3}\left(\frac{h^2+hk+k^2}{a^2}\right) + \frac{l^2}{c^2}$
   Find the interplanar distance for the (101) reflection
5. For x-rays with wavelength $= 0.1\ \mathrm{nm}$, find the Bragg angle θ for reflections off the (101) crystal planes

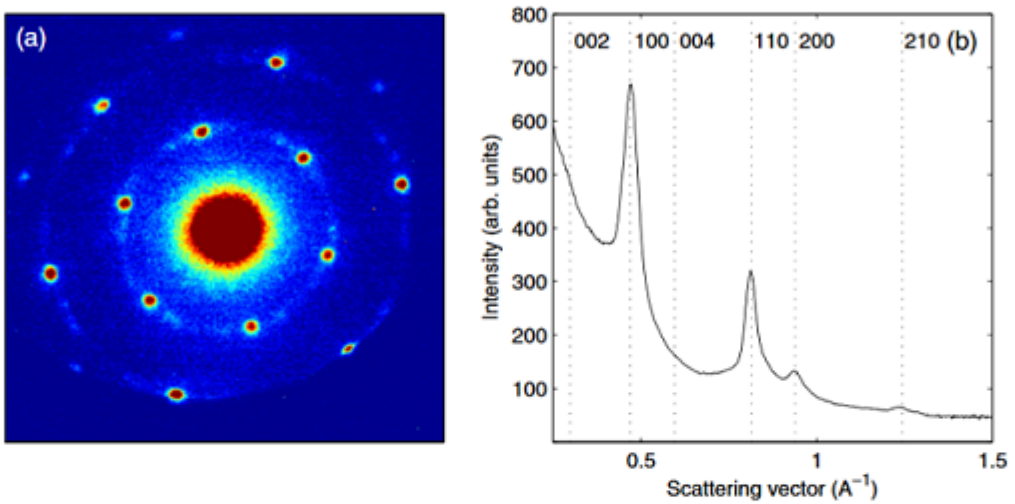
Assignment - Q2



The above is an electron diffraction image from a thin film of graphite. The following are some details about the experimental setup:

- Electron energy was $= 60$ KeV
- The electron beam was approximately normal to the film surface
- The graphite crystal was oriented such that the surface of the film corresponds to the hexagonal 2D layers

Assignment - Q2

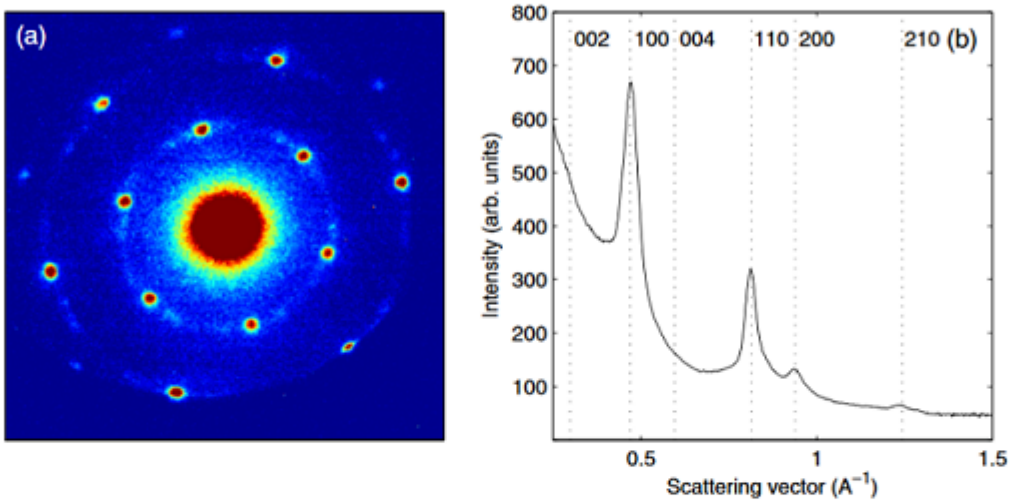


Explain the following:

1. Why are there multiple reflections at once, even though care was not taken to tune the angle of incidence to the Bragg condition for any of these reflections?

2. Some reflections are present while others are conspicuously absent from the pattern (e.g. the (002) and (004) reflections). Why is that?

Assignment - Q2



Explain the following:

3. The six spots closest to the center of the image correspond to the (100) crystal planes. Why are there six of these? Identify each using the hkl indexing system
4. The line profile shows that the reflections are not infinitely sharp (there's some broadness to each peak). What different effects contribute to the broadness of the peaks?