# Physics with neutrons 2

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Exercise sheet 4
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### EXERCISE 4.1

A 2-dimensional hexagonal lattice with lattice constant $a$ is given in the normal space. Draw the corresponding lattice in reciprocal space. How are the reciprocal lattice vectors determined? What does the first Brillouin zone look like?

### EXERCISE 4.2

Diffraction of neutrons from argon monolayers absorbed on graphite basal planes indicated that an ordered, two dimensional triangular argon lattice is formed at low temperatures [Taub et. al. (1977)], see Fig. 1. There are two possible configurations for the argon monolayers, either commensurate with the graphite lattice or incommensurate corresponding to the closest packing.
(a) Explain the asymmetric sawtooth profile of the Bragg peaks in Fig. 1.
(b) Determine from the observed reflections displayed in Fig. 1 whether the Ar monolayers are commensurate or incommensurate with the graphite lattice. The C atoms have a nearest neighbor distance $a_C = 2.46$ Å in the hexagonal plane of graphite.

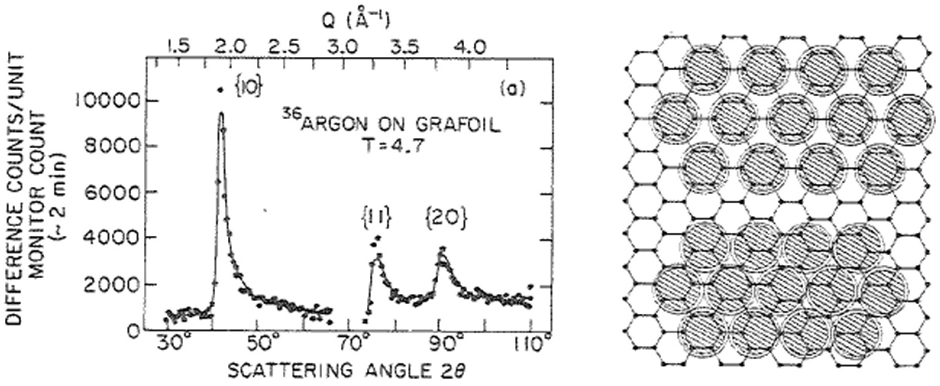


Figure 1: (left) Diffraction pattern from a two-dimensional Ar monolayer absorbed on graphite showing the Bragg reflections (1,0), (1,1) and (2,0). (right) Schematic representation of a commensurate (top) and incommensurate (bottom) Ar monolayer phase.

**EXERCISE 4.3**

Prove the lattice sum equation:

$$\sum_{\mathbf{v}_{mnp}} \exp(i\mathbf{Q}\cdot\mathbf{v}_{mnp}) = \frac{(2\pi)^3}{V_{UC}} \sum_{\mathbf{G}_{hkl}} \delta(\mathbf{Q}-\mathbf{G}_{hkl})$$