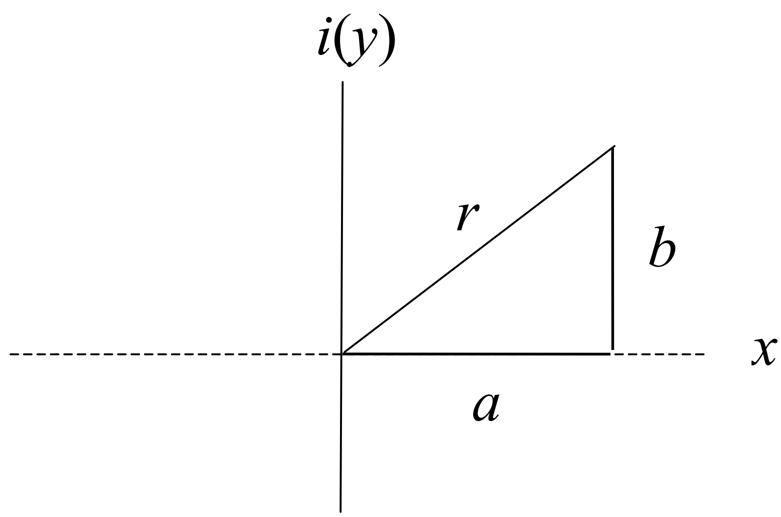
Notes on Anomalous Scattering

For ideal situations Friedel's Law states that $F_h = F_{\bar{h}}$. This is true for coherently scattered X-rays, however when the X-ray wavelength is just less than the absorption edge of a scattering atom, then Friedel's law breaks down and the structural factors become complex and gives rise to the phenomenon of anomalous scattering.

The complex plane (Argand plane) can be employed to explain the complex nature of the structural factor. A complex number can be written in the form $a + ib$, where $i = \sqrt{-1}$. The complex plane is represented by "real" numbers, both positive and negative, that extended along a straight line in the x and $-x$ direction. The imaginary component i, is directed along the y axis of the plane.

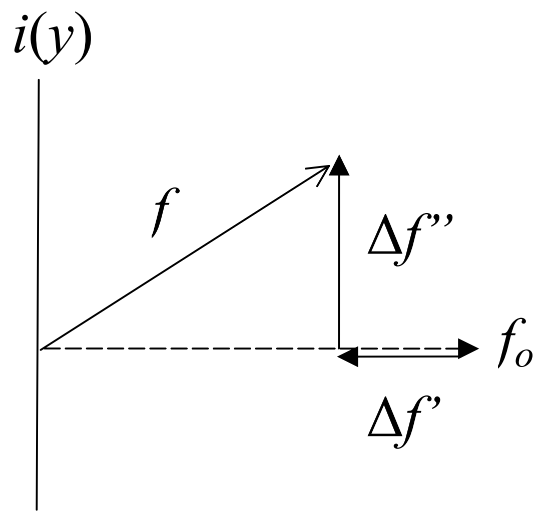


Representation of a complex quantity $r = a + ib$

The scattering factor can be represented by the complex quantity

$$f = f_o + \Delta f' + i\Delta f''$$

The complex plane can then be drawn



To demonstrate the effect of anomalous scattering let us assume a structure where a single atom has an anomalous component while the remaining have no anomalous scattering. Let f_a(h) represent the anomalous scattering atomic factor and *R*(h) represent the scattering factor for the remaining atoms and the combined factor as *F*(h). For the positive *h* case then

$$F(h) = R(h) + f_0 + \Delta f' + i\Delta f''$$

$$F(-h) = R(-h) + f_0 + \Delta f' - i\Delta f''$$

$$F(h) \neq F(-h)$$