

Complex forms and Real forms of atomic orbitals

$l = 1$ (p orbitals)

$m_l = 0$ Ang. Wave. function $3^{1/2} \cos \theta$ real form

$m_l = \pm 1$ $\mp \left(\frac{3}{2}\right)^{1/2} \sin \theta e^{\pm i\phi}$ complex form

Real form	Standing wave	electrons concentrated in real space.
Complex form	Traveling wave	electrons circulating around nucleus.

Linear Combinations of complex forms

$$\frac{e^{i\phi} + e^{-i\phi}}{2} = \cos \phi \qquad \frac{e^{i\phi} - e^{-i\phi}}{2i} = \sin \phi$$

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Real form
of P_x

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 P_y