Incompatible observables

$$[\hat{A}, \hat{B}] = \hat{A}\hat{B} - \hat{B}\hat{A} \neq 0$$

→ in any state $|\psi\rangle$

either ΔA or ΔB
$\neq 0$ or $\Delta B \neq 0$

or both

Example: $\hat{X}$, $\hat{P}$

$$\hat{X}\hat{P}\,\psi(x) = x \cdot \left(-i\hbar \frac{d\psi}{dx}\right)$$

$$\hat{P}\hat{X}\,\psi(x) = -i\hbar \frac{d}{dx}(x \cdot \psi(x))$$

$$= x \cdot \left(-i\hbar \frac{d\psi}{dx}\right) - i\hbar \frac{dx}{dx}\,\psi(x)$$

$$(\hat{P}\hat{X} - \hat{X}\hat{P})\,\psi(x) = -i\hbar\,\psi(x)$$

$$[\hat{P}, \hat{X}]\,|\psi\rangle = -i\hbar\,|\psi\rangle$$