

Answer on question #86636, Physics / Atomic and Nuclear Physics:

Given:

$$A = a\hat{x} + ib\hat{p}$$

Where, a and b are constants and \hat{x} and \hat{p} position and momentum operator.

To find:

$$[A, \hat{x}] \text{ and } [A, A]$$

Solution:

$$\begin{aligned} (1) \quad [A, \hat{x}] &= [a\hat{x} + ib\hat{p}, \hat{x}] \\ &= a[\hat{x}, \hat{x}] + ib[\hat{p}, \hat{x}] \\ \text{But } [\hat{x}, \hat{x}] &= 0 \text{ and } [\hat{p}, \hat{x}] = -i\hbar \\ &= ib(-i\hbar) \\ &= b\hbar \end{aligned}$$

$$\begin{aligned} (2) \quad [A, A] &= [a\hat{x} + ib\hat{p}, a\hat{x} + ib\hat{p}] \\ &= a^2[\hat{x}, \hat{x}] + iab[\hat{x}, \hat{p}] + iab[\hat{p}, \hat{x}] - b^2[\hat{p}, \hat{p}] \\ \text{But } [\hat{x}, \hat{x}] &= 0, [\hat{x}, \hat{p}] = i\hbar, [\hat{p}, \hat{x}] = -i\hbar \text{ and } [\hat{p}, \hat{p}] = 0 \\ &= -ab + ab \\ &= 0 \end{aligned}$$

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