Exercise 9.2. Prove Eq. 9.10 by expanding each side and comparing the results.

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We are given

$$[\mathbf{P}^2, \mathbf{X}] = \mathbf{P}[\mathbf{P}, \mathbf{X}] + [\mathbf{P}, \mathbf{X}]\mathbf{P} \tag{9.10}$$

Expanding the commutators in (9.10) we have

$$[\mathbf{P}^2, \mathbf{X}] = \mathbf{PPX} - \mathbf{XPP}$$

$$\mathbf{P}[\mathbf{P}, \mathbf{X}] = \mathbf{PPX} - \mathbf{PXP}$$

$$[\mathbf{P}, \mathbf{X}]\mathbf{P} = \mathbf{PXP} - \mathbf{XPP}$$

Substitute the expansions back into (9.10) to obtain

$$\mathbf{PPX} - \mathbf{XPP} = \mathbf{PPX} - \mathbf{PXP} + \mathbf{PXP} - \mathbf{XPP}$$

The $\mathbf{PXP}$ cancel and (9.10) is proved.