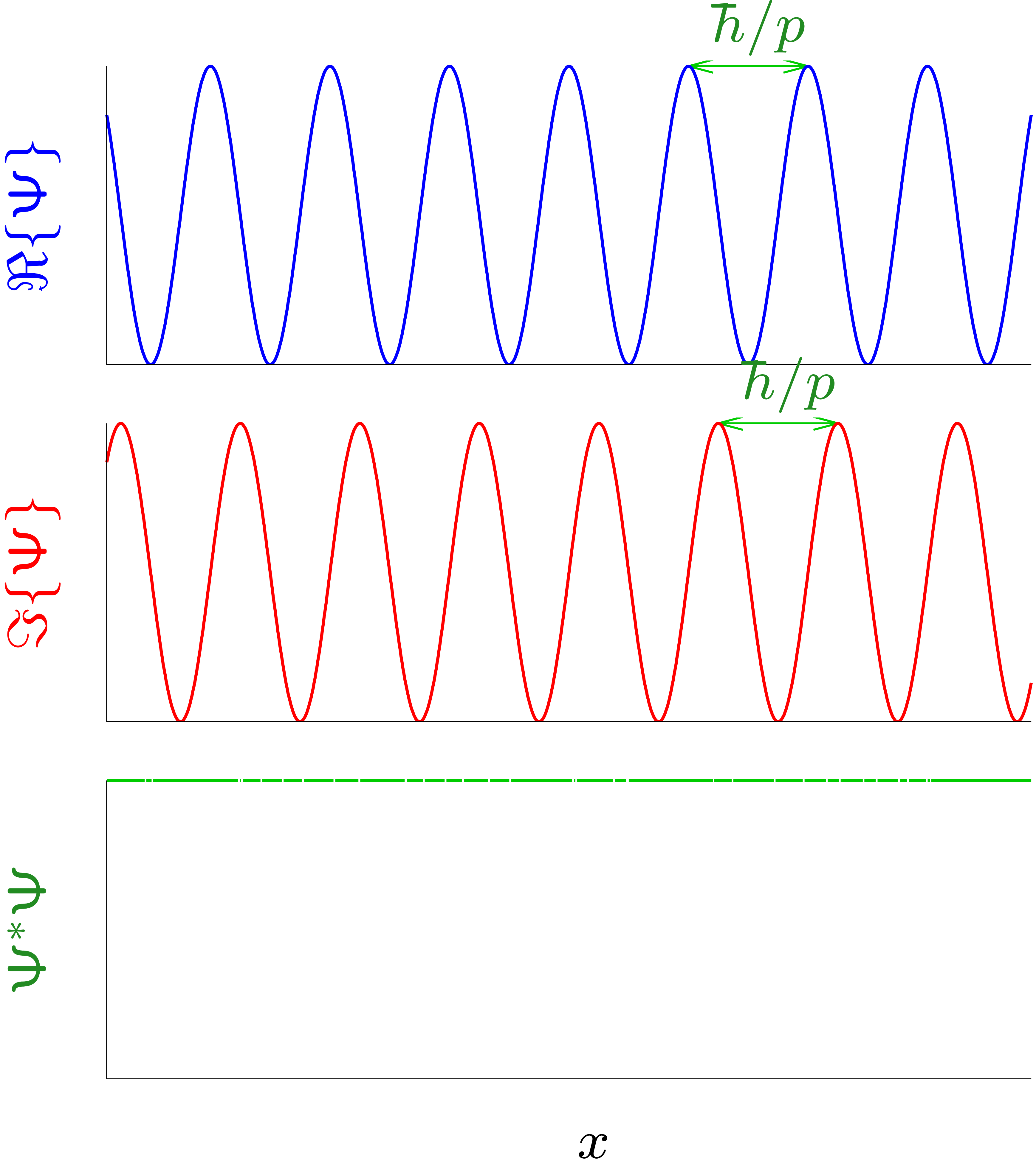
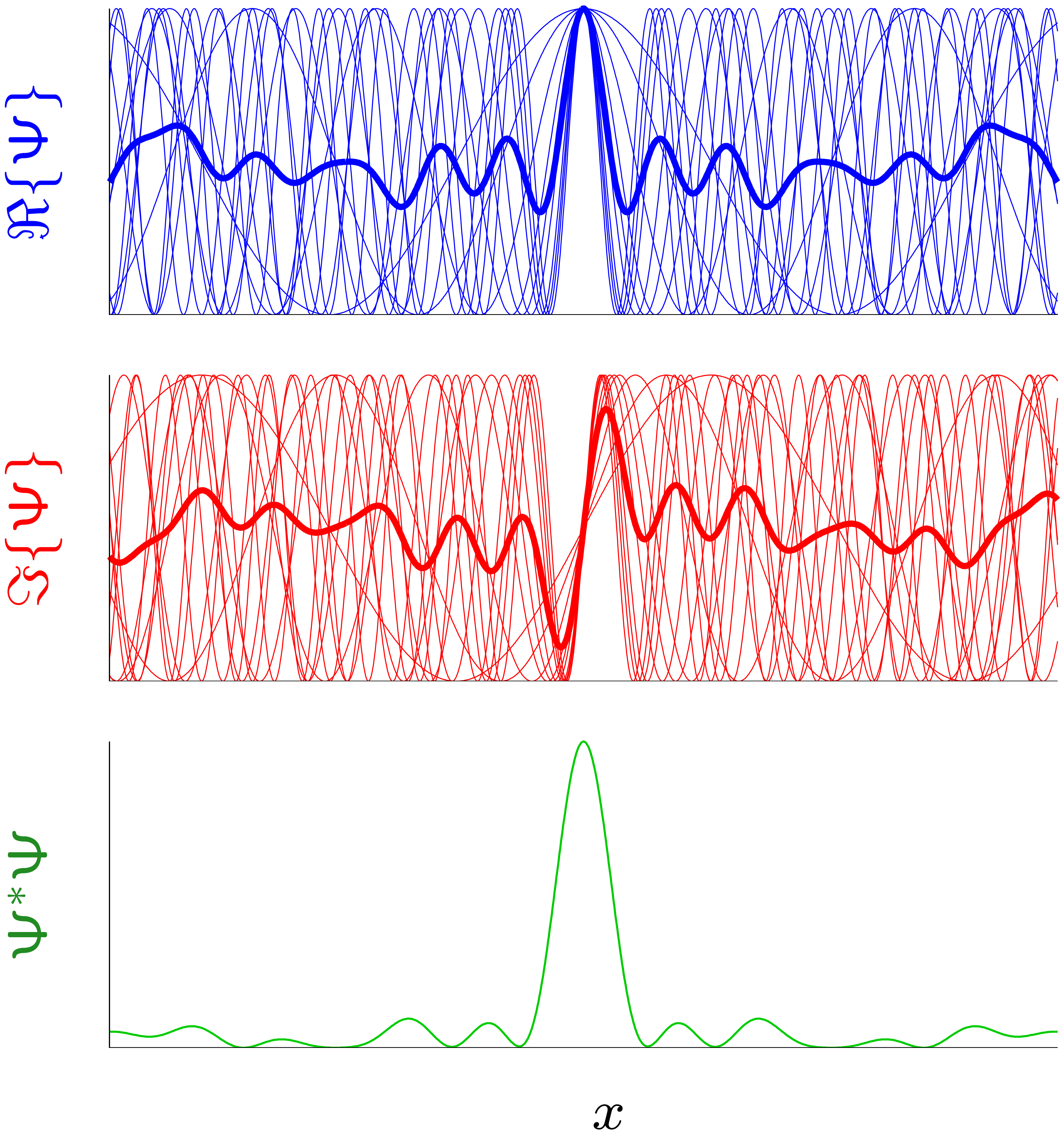
Lecture 3: Review of quantum mechanics



h/p
ℜ{Ψ}
h/p
ℑ{Ψ}
Ψ*Ψ
x



$\Re\{\Psi\}$
$\Im\{\Psi\}$
$\Psi^*\Psi$
x

We postulate that

• the state of the system is completely described by a *wave function*.

• if possible states of our system are described by $\psi_1, \psi_2, \ldots$, their linear combination also describes a possible state of the system.

• any measurable property is represented by an operator (acting on the wave function) and that result of a measurement must be one of eigenvalues of the operator.

• the expected result of measuring a quantity A represented by an operator $\widehat{A}$ in a state of the system described by a wave function Ψ is $\langle A\rangle = \langle\Psi|\widehat{A}|\Psi\rangle$.

• that if A_m is measured in the state described by $|\Psi\rangle$, then the state immediately after the measurement is described by $\widehat{P}_m|\Psi\rangle/\sqrt{\langle\Psi|\widehat{P}_m|\Psi\rangle}$, where $\widehat{P}_m$ is the projection operator associated with A_m.

• that operators of position and momentum obey the relations $[\widehat{r}_j, \widehat{p}_k] = \mathrm{i}\hbar\delta_{jk}$; $[\widehat{r}_j, \widehat{r}_k] = [\widehat{p}_j, \widehat{p}_k] = 0$.

• that evolution of a system in time is given by the Hamiltonian: $\mathrm{i}\hbar\frac{\partial\Psi}{\partial t} = \widehat{H}\Psi$.

$$\mathsf{i}\hbar\frac{\partial\Psi}{\partial t} = \underbrace{\left(-\frac{\hbar^2}{2m}\left(\left(\frac{\partial}{\partial x}+QA_x\right)^2+\left(\frac{\partial}{\partial y}+QA_y\right)^2+\left(\frac{\partial}{\partial z}+QA_z\right)^2\right)+QV(x,y,z)\right)}_{\widehat{H}}\Psi$$

$$[\widehat{L}_x, \widehat{L}_y] = \mathrm{i}\hbar \widehat{L}_z$$

$$[\widehat{L}_y, \widehat{L}_z] = \mathrm{i}\hbar \widehat{L}_x$$

$$[\widehat{L}_z, \widehat{L}_x] = \mathrm{i}\hbar \widehat{L}_y$$

$$[\widehat{L}^2, \widehat{L}_x] = 0$$

$$[\widehat{L}^2, \widehat{L}_y] = 0$$

$$[\widehat{L}^2, \widehat{L}_z] = 0$$