Date
TDC/2020
Sem II, Paper-II
MJC-physics, Unit-01

Concepts of Wave packets →:

A Pure infinite plane wave (representing a single momentum but no specific location) a wave packet is localized a space (Δx is small). It is a superposition of numberous sinusoidal waves. A wave packet is a localized "packet" of waves created by superposing multiple wave with different frequencies/wave-lengths, used to represents a quantum particle's position and momentum simmul-taneously. It reconcilies wave-particle duality by discribing a particle as a wave group traveling at a group velocity ($v_g$) while its localized amplitude represents the probability density of finding the particle. ~~Some another~~ Wave-particle duality – The wave packet represents the wave nature (spreading, interference) while its localized peak represents the particles nature.

Spread with time → As a wave packet propagates, it typically spreads out over time or the particle becomes less.

Probability Interpretation → The intensity of the wave packet, given by the square of the amplitude of the wave function ($|\psi|^2$). Defines the probability of locating the particle at a specific point.

Heisenberg uncertainty principle – A highly localized wave packet (well-defined position) requires a ~~to~~ broad spectrum of wavelengths, leading to high uncertainty in momentum ($\Delta x \Delta p \geq \frac{\hbar}{2}$)

Group velocity vs phase velocity — Wave packet moves at the group velocity ($v_g = \frac{d\omega}{dk}$). Which corresponds to the classical particle's velocity. The individual component waves inside move at different phase velocities ($v_p = \frac{\omega}{k}$).

$v_p = \frac{\omega}{k}$ —