UNCERTAINTY PRINCIPLE

LALY A.S.
ASST. PROFESSOR
DEPT. OF PHYSICS
LITTLE FLOWER COLLEGE
GURUVAYOOR

When we consider a wave group of a moving particle ,then there is certain limitations to measure accurately the position and linear momentum of the particle at same instant of time

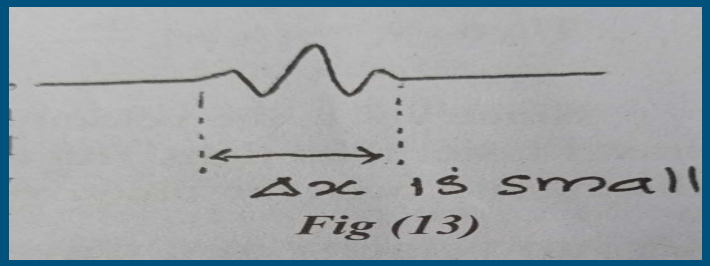

Fig (13)

- In the case of narrow wavegroup,the probability for finding the particle is maximum in a narrow region.
- Thus narrower the wavegroup,more precisely the position of the particle can be specified.
- But there are not enough waves in the group,hence the wavelength can not be well defined.
- Therefore momentum ($p=h/\lambda$)cannot be precisely determined

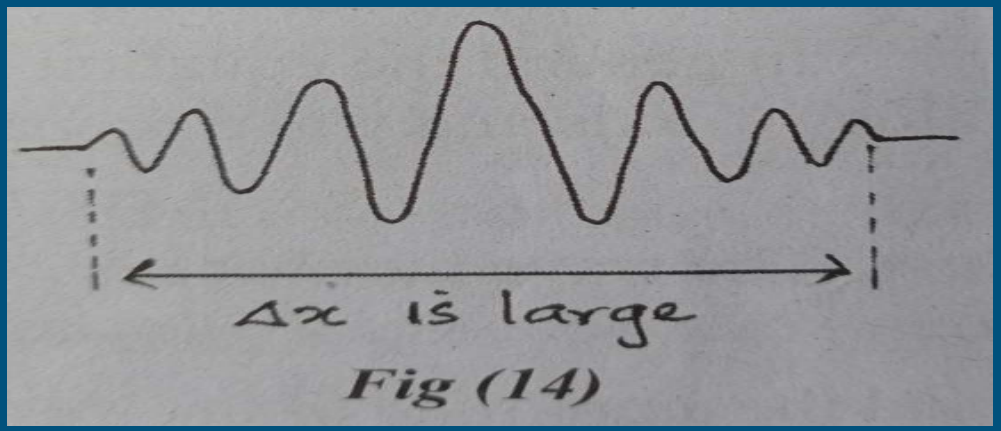

Fig (14)

- In the case of a broader wavegroup,the wavelength is clearly defined,since a large no. of waves are available in the group.
- Hence momentum can be precisely determined.
- There arises uncertainty in determining the position ,since the probability for finding the particle lies in a broad region.

- That means there arises an uncertainty in measuring the position and momentum exactly at the same time.
- Uncertainty Principle states that "*It is impossible to determine both the exact position and exact momentum of an object at the same time*"
- The principle was stated by Heisenberg in 1927

- If Δx and Δp_x are the uncertainties in the measurement of position and on the x axis and the corresponding component of momentum respectively at same instant ,
  then acc. to uncertainty principle

$$\Delta x \, \Delta p_x \geq h/4\pi$$

($p=h/\lambda$, $p_x=h/x$, $\Delta p_x = h/\Delta x$, $\Delta x \, \Delta p_x = h$)

- For a narrow group Δx is very small,then Δp_x is very large.
- For a broader group, Δp_x is very small,then Δx is very large.
- If Δx =0 then Δp_x =∞,similarly if Δp_x =0 then Δx = ∞.

- Another form of uncertainty occurs in energy and time .

  $\Delta E = h\,\Delta v = h/\Delta t$

  $\Delta E\,\Delta t = h$

- More precise calculations leads to

  $\Delta E\,\Delta t \geq h/4\pi$

THANK YOU