

# WHAT IS ELECTRON?

*Particle versus wave*

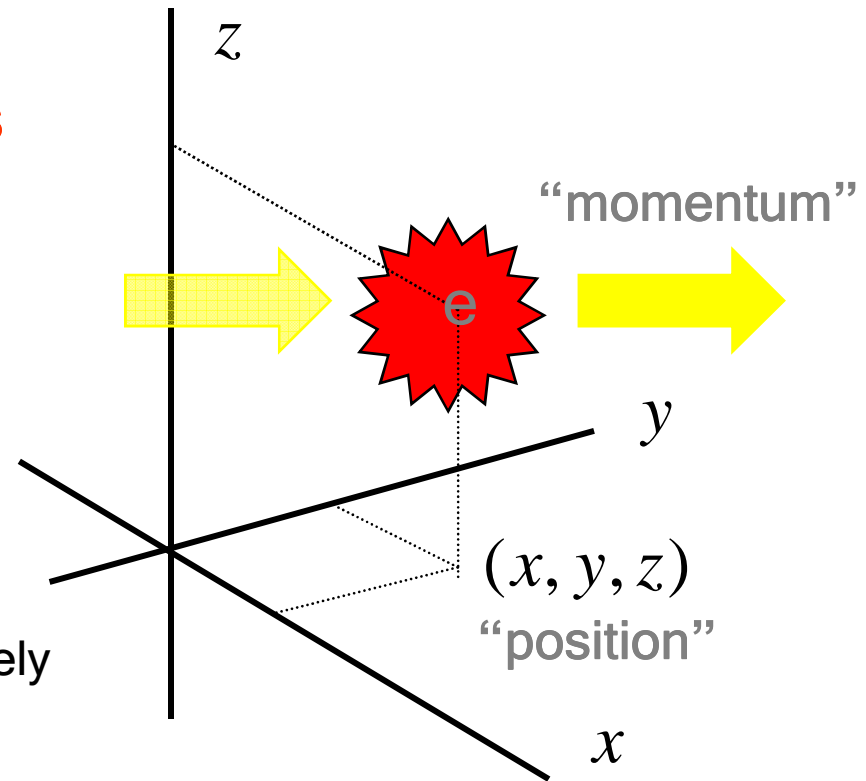
*100 years old simple-yet unsolved problem*

Part 1



- Assume that an electron is a particle.
- What is a particle?

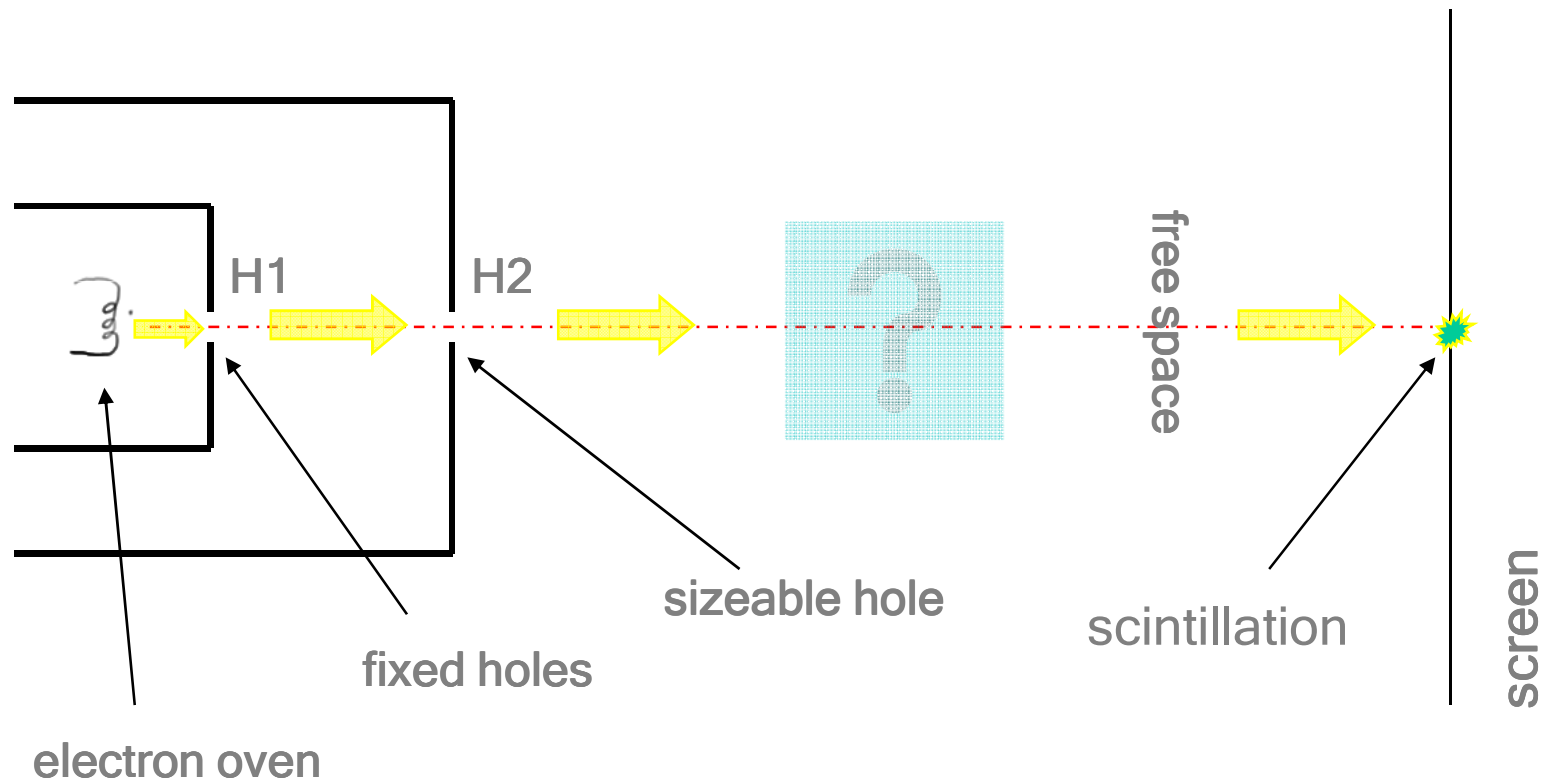
Ignoring ....  
the internal degree of freedom  
(spin, etc.), a particle is a spatially  
localized thing determined completely  
by its “position” and “momentum”



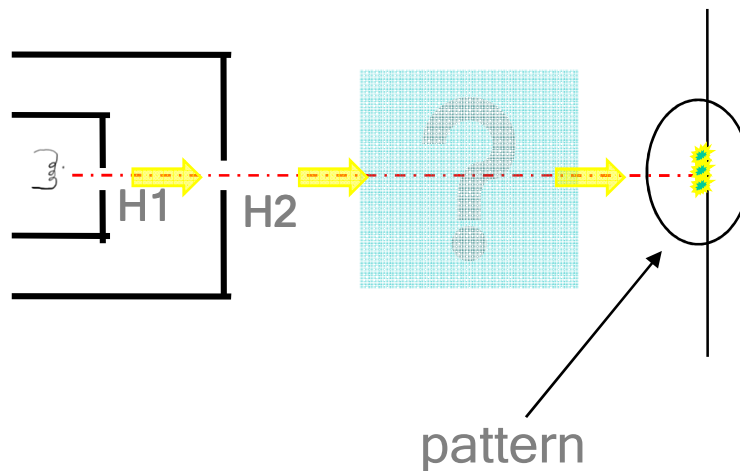
$$\text{“momentum”} = \text{“mass”} \times \text{“velocity”}$$



electron beam in television set



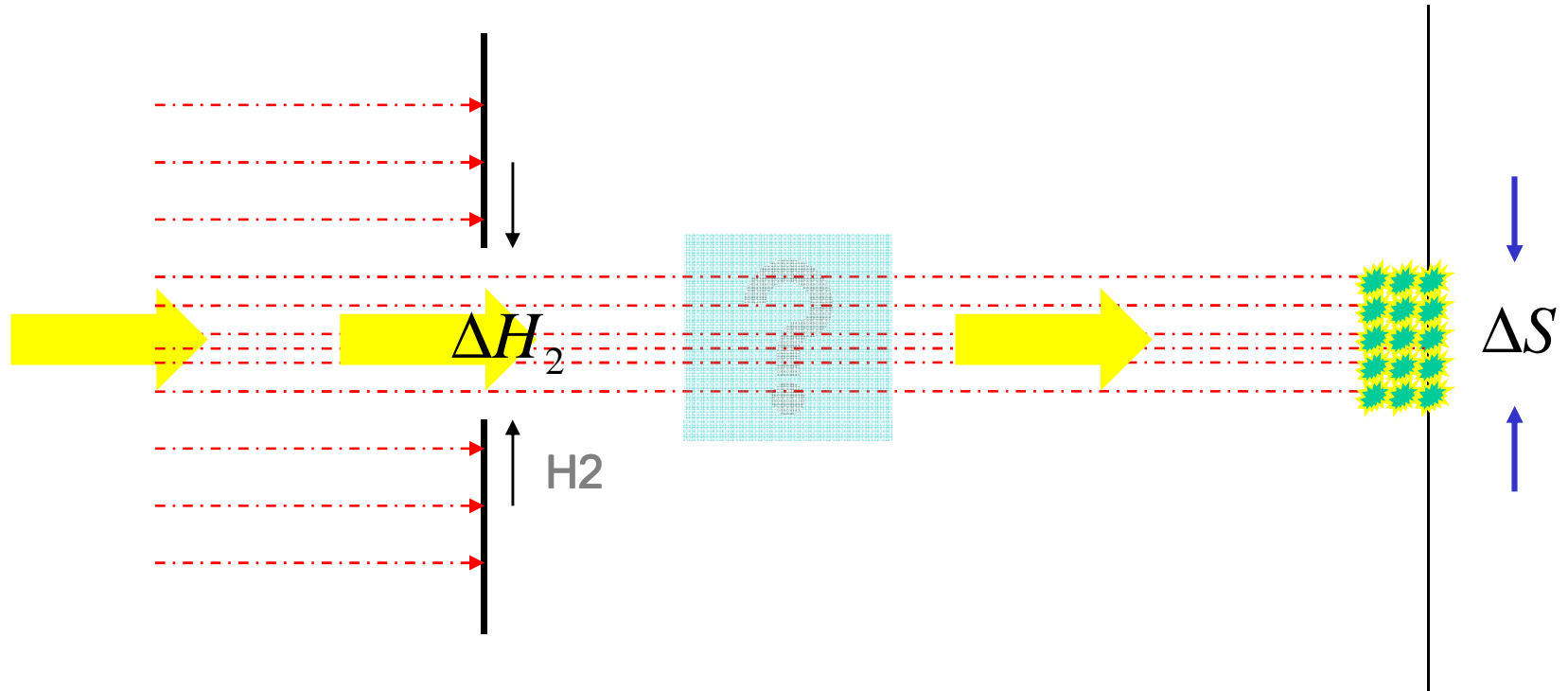
electron beam in television set



- One electron passes a hole in a time
- The location of all the points of the scintillations on the screen is recorded.
- The accumulation of all the points of scintillation makes an **pattern**

**“HOW FAR CAN ONE FOCUS THE ELECTRON BEAM ONTO THE SCREEN BY REDUCING THE WIDTH OF H2?”**

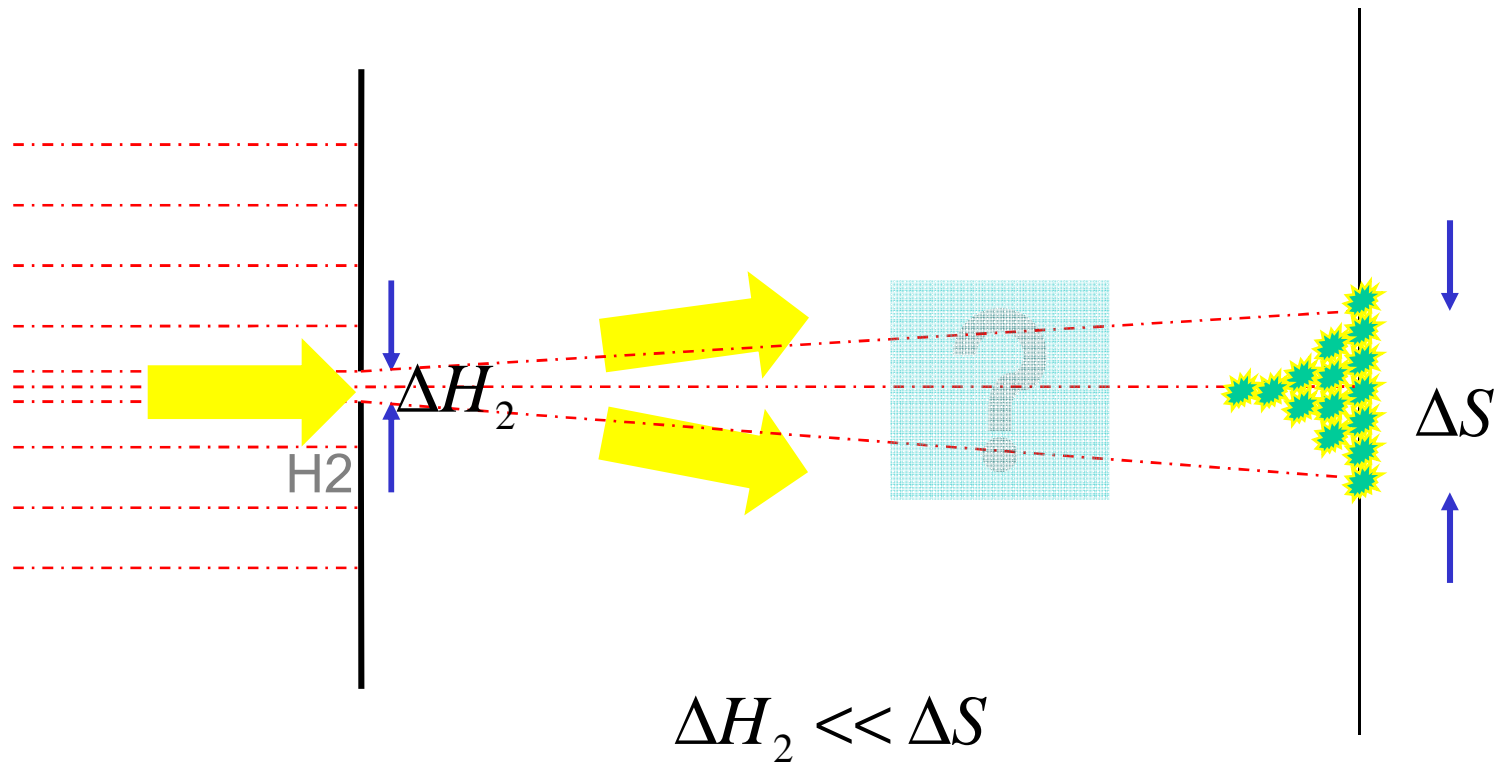


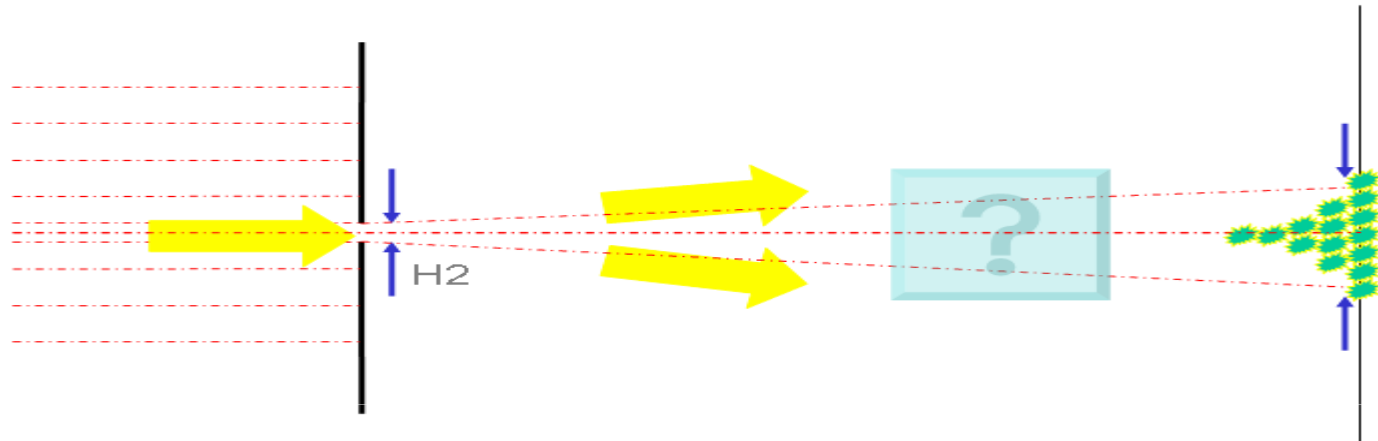


“The narrower the hole  $H_2$ , the more focusing the beam”

$$\Delta H_2 \approx \Delta S$$



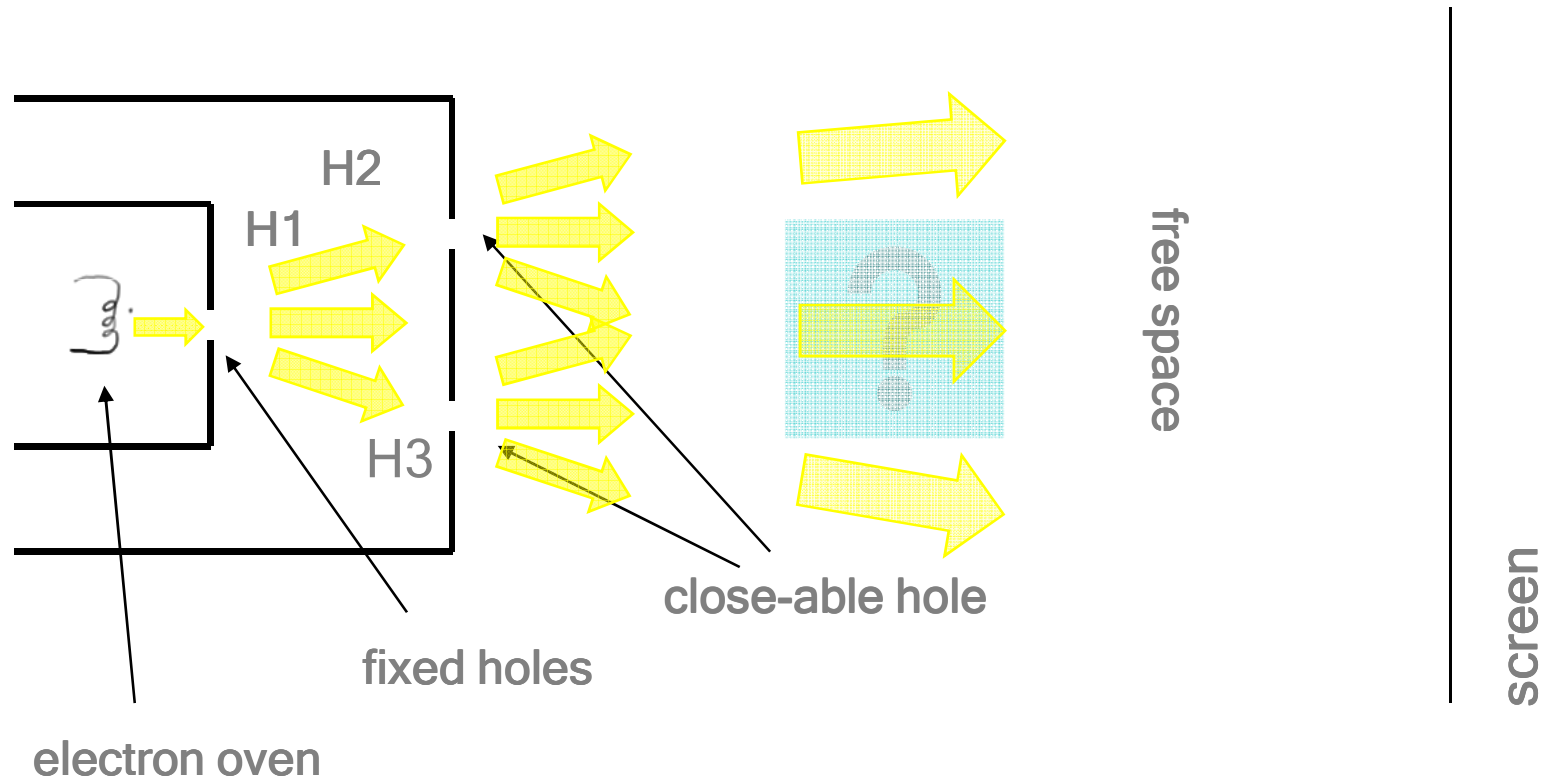




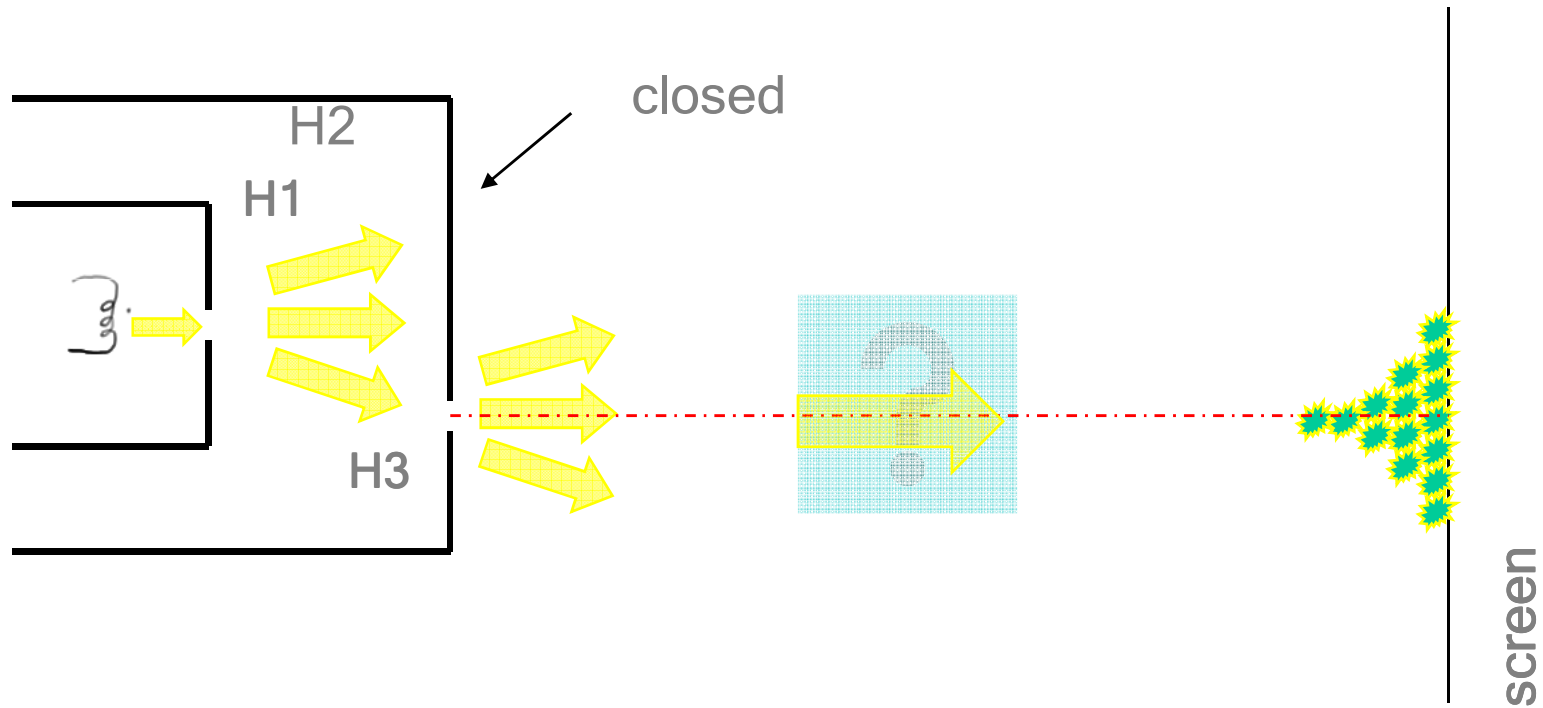
- “At some point”, the narrower  $H_2$ , the more difficult we focus the electron beam
- At some point, the more precise we know the position of the electron, the more imprecise is the direction of the beam
- *There is a limit to our knowledge (position and momentum) about the particle electron*



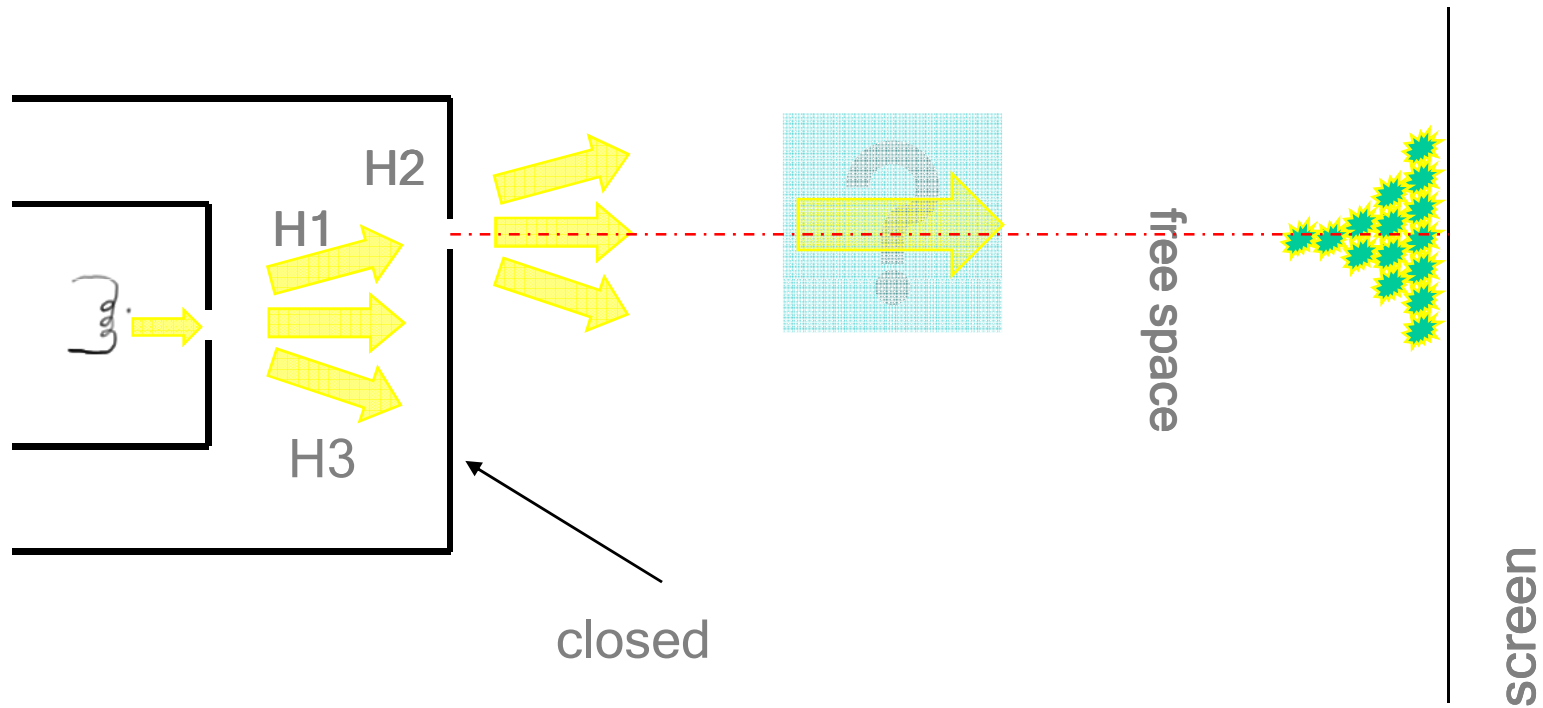
double slits experiments



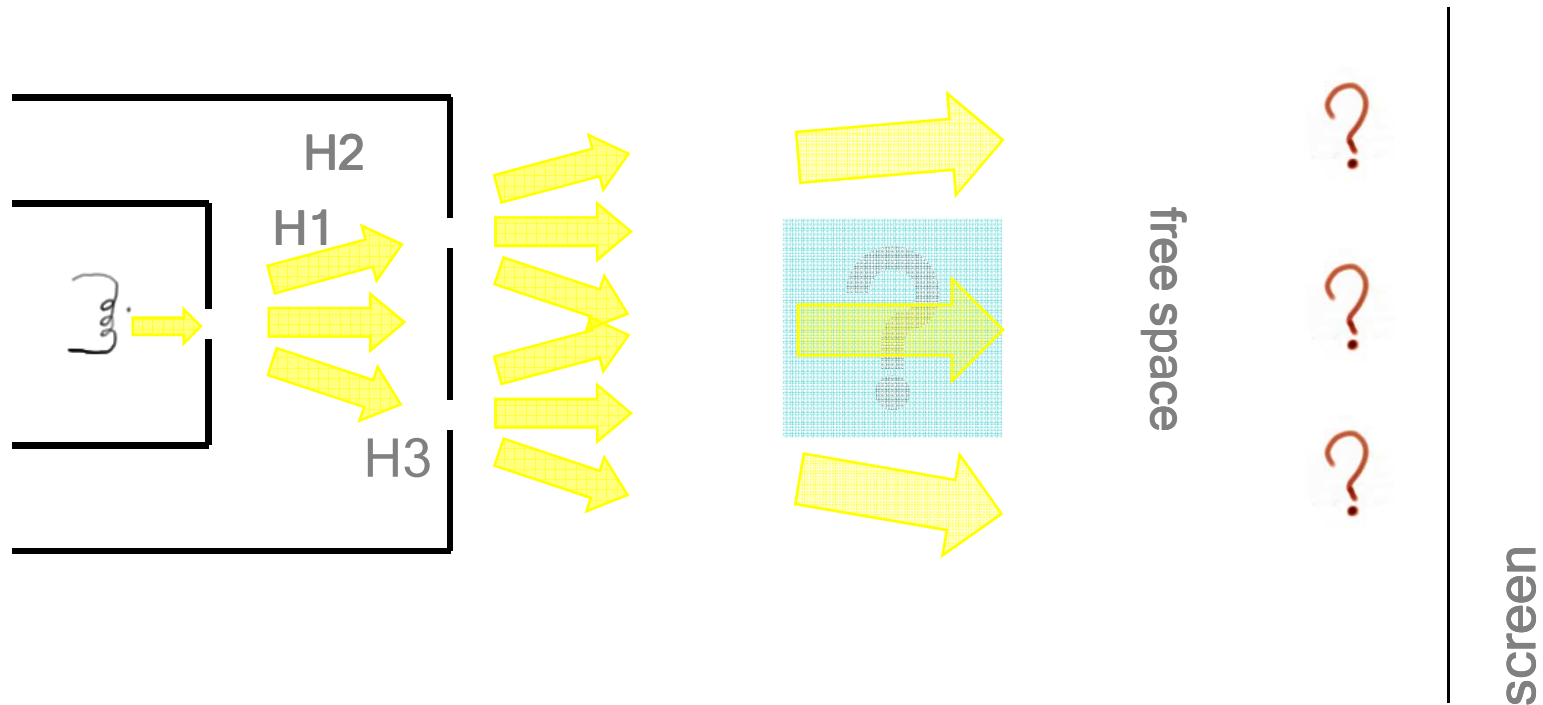
H2 is closed and H3 is open



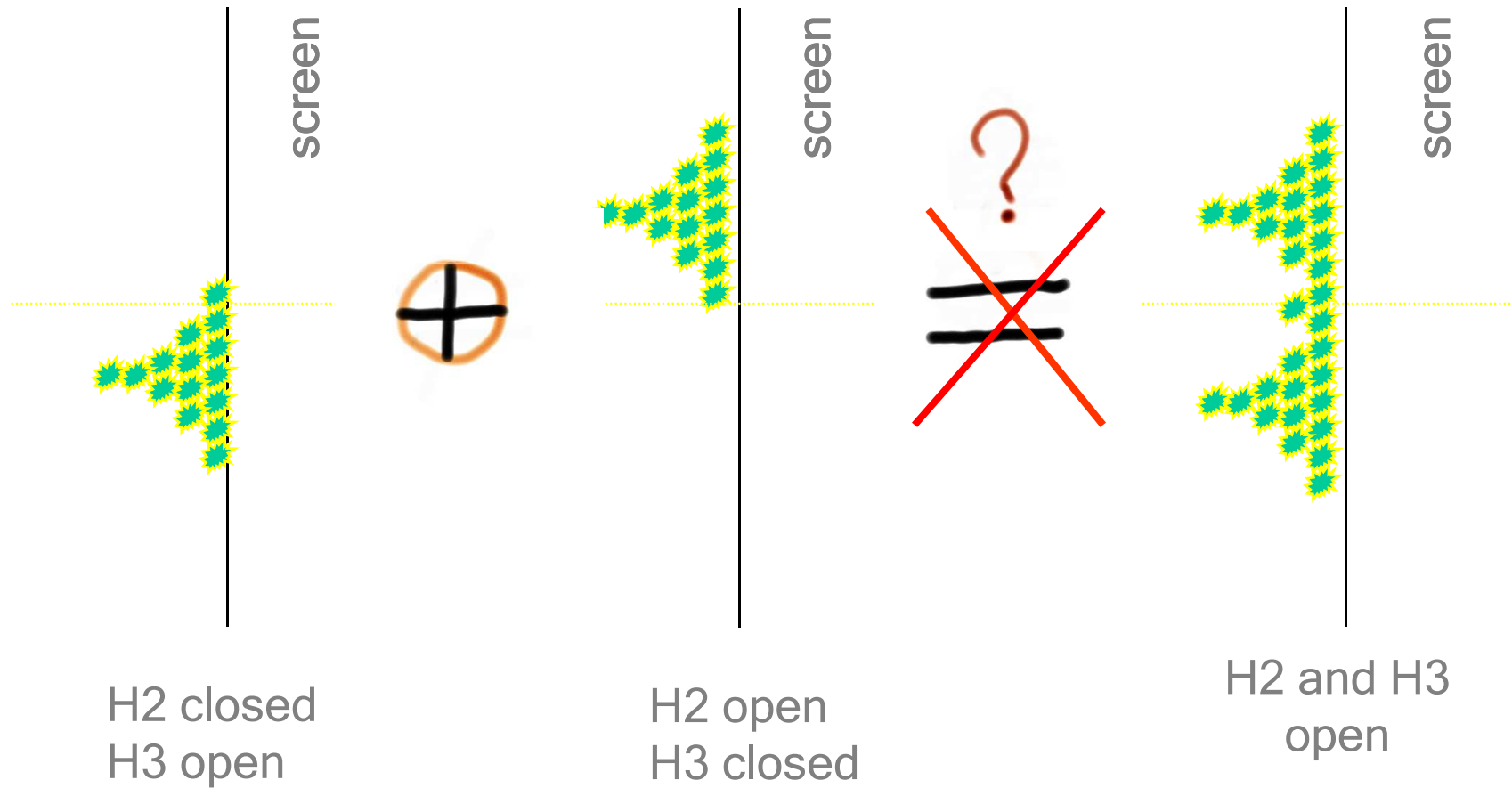
H2 is open and H3 is closed



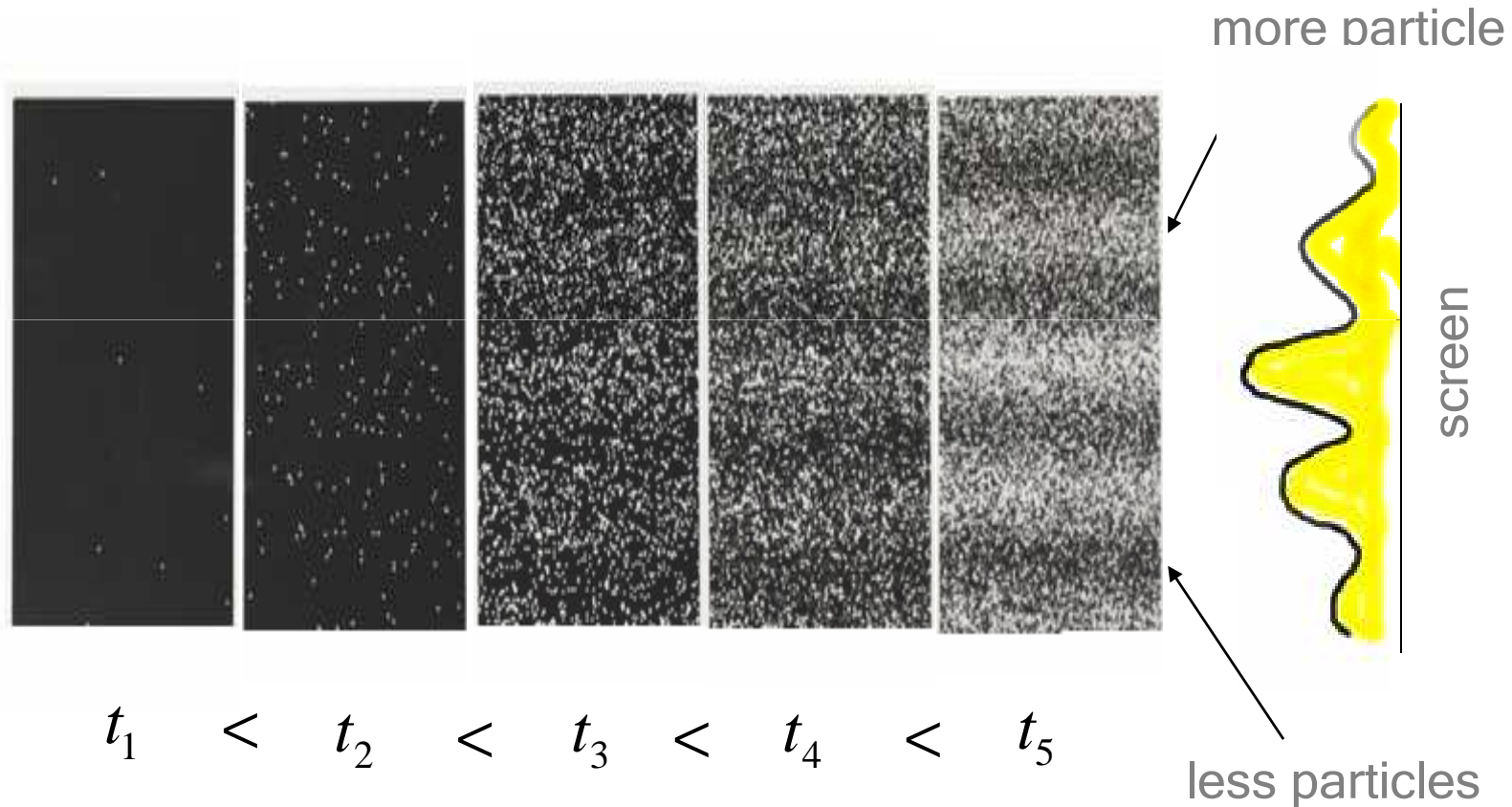
What if both H1 and H2 are open?



If electron is particle.....

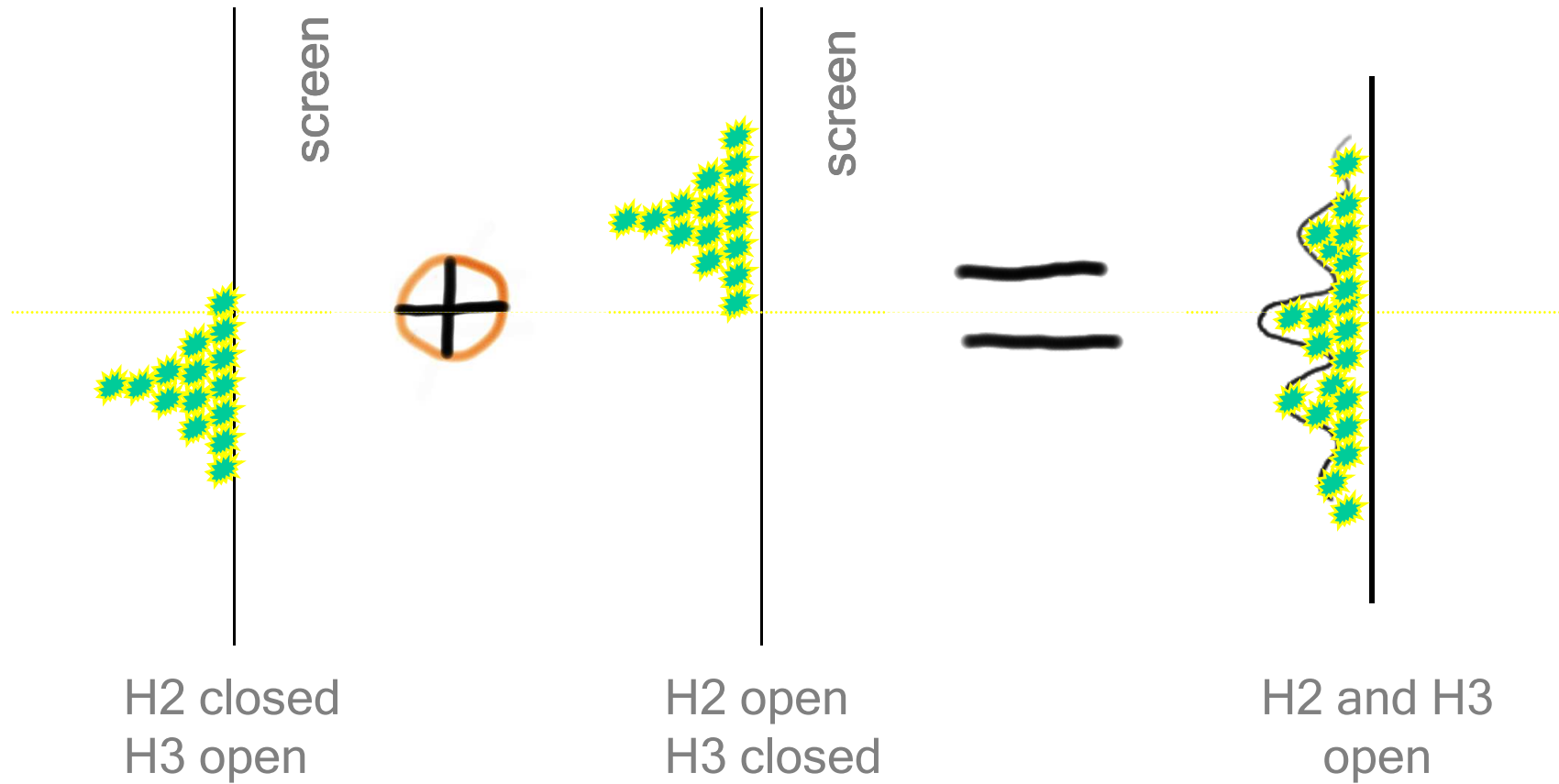


experimental results (Tanomura et. al., 1980)



Pattern develops over time





## CONCLUSION

- Assuming electron as a particle will lead to contradictions
- Electron is not “merely” a particle : there is something more.
- If not particle, then what?  
What do you think?

To be continued...

