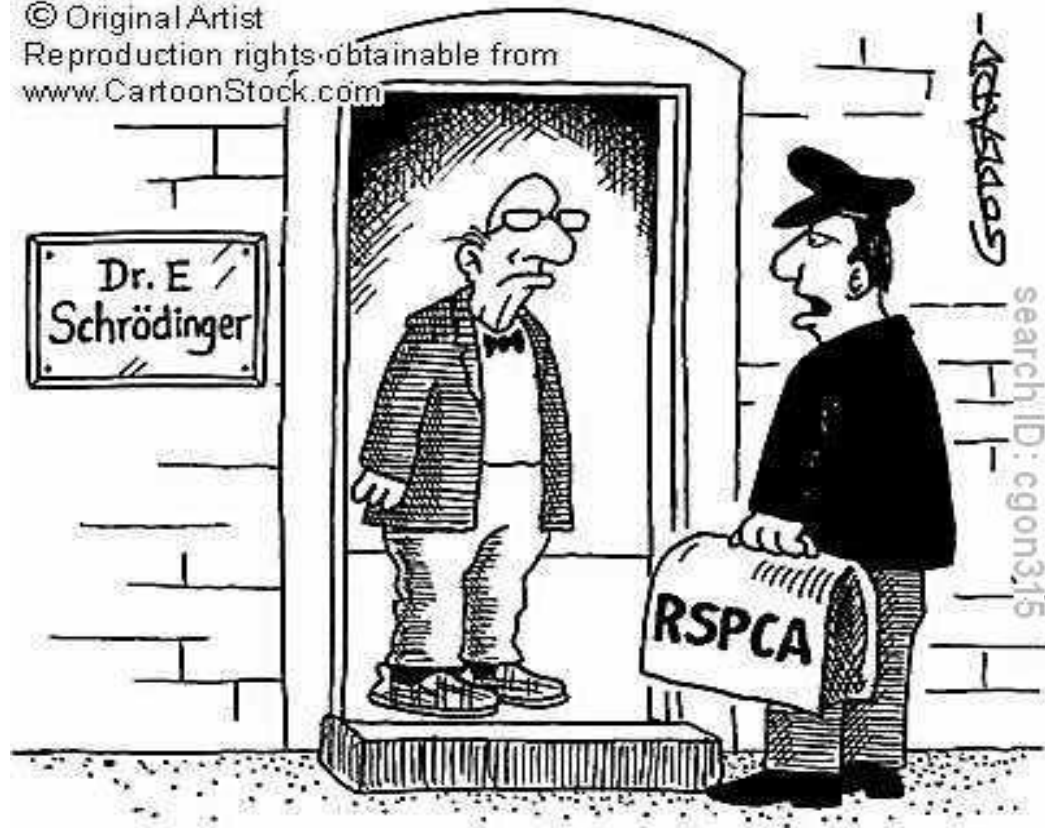


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"And you're quite sure it's just a hypothetical cat?"

# SCHRODINGER'S CAT

*Group 1: Sudheer, Venkatesh, Hrudil, Praveen*

# IN SHORT

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- Schrodinger's Thought Experiment
- The Principle of Superposition
- The Copenhagen Interpretation
- The Young's Double Slit Experiment
- Some obvious questions
- Many Worlds Interpretation
- Implications for Artificial Intelligence



# THE THOUGHT EXPERIMENT

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- A steel chamber



# THE THOUGHT EXPERIMENT (CONTD.)

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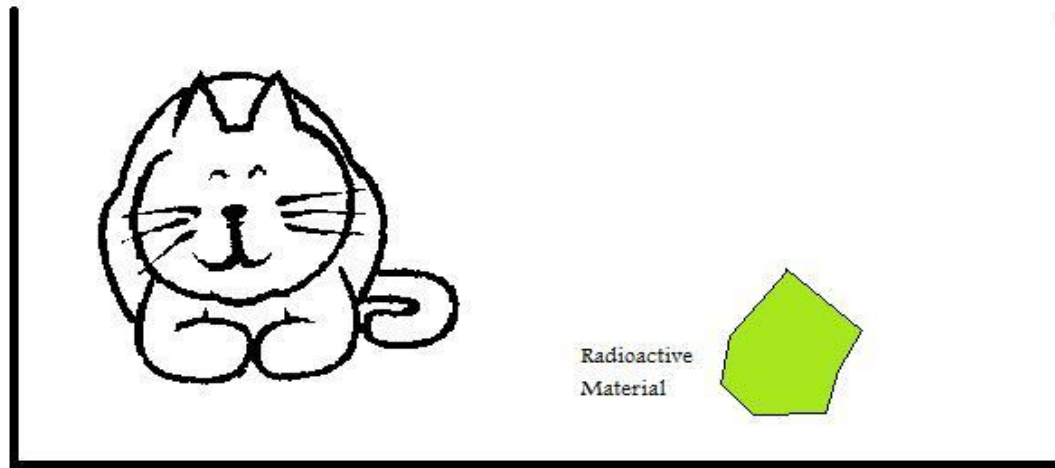
- A cat is placed in it



# THE THOUGHT EXPERIMENT (CONTD.)

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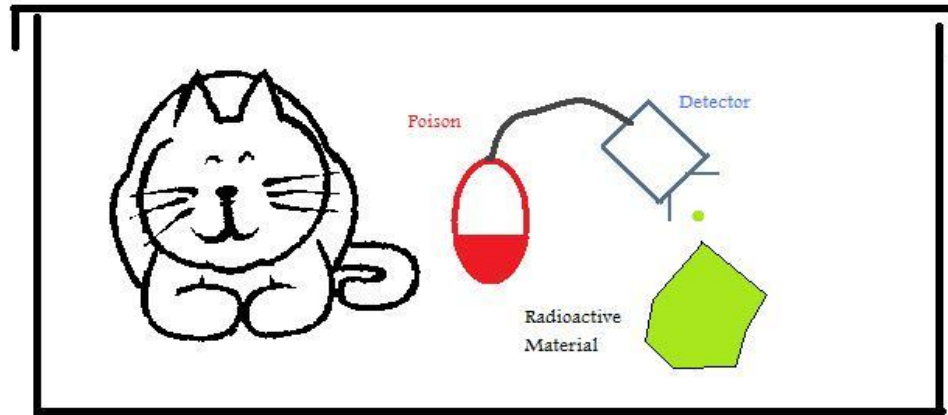
- And with it, a small amount of a radioactive substance



# THE THOUGHT EXPERIMENT (CONTD.)

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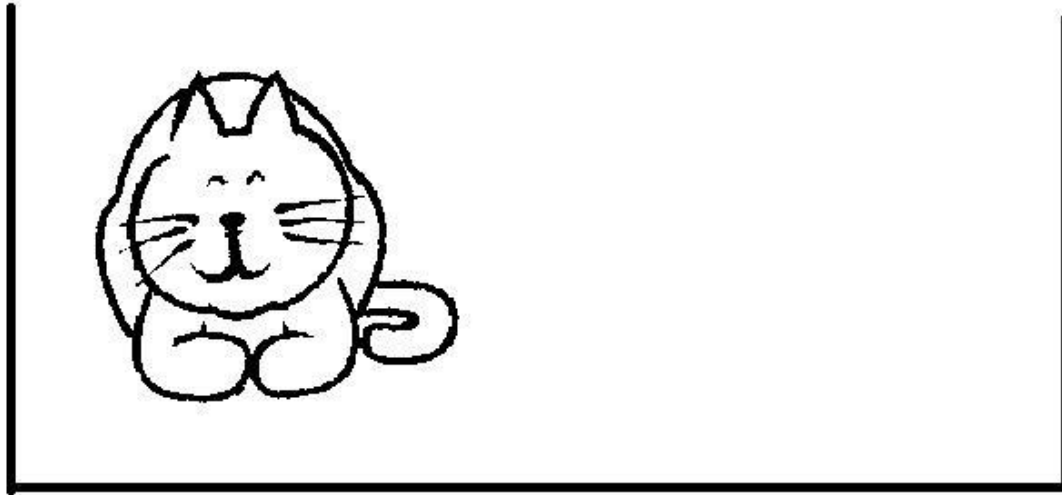
- And a veil of poison
- The box is shielded against *quantum decoherence*



# THE THOUGHT EXPERIMENT (CONTD.)

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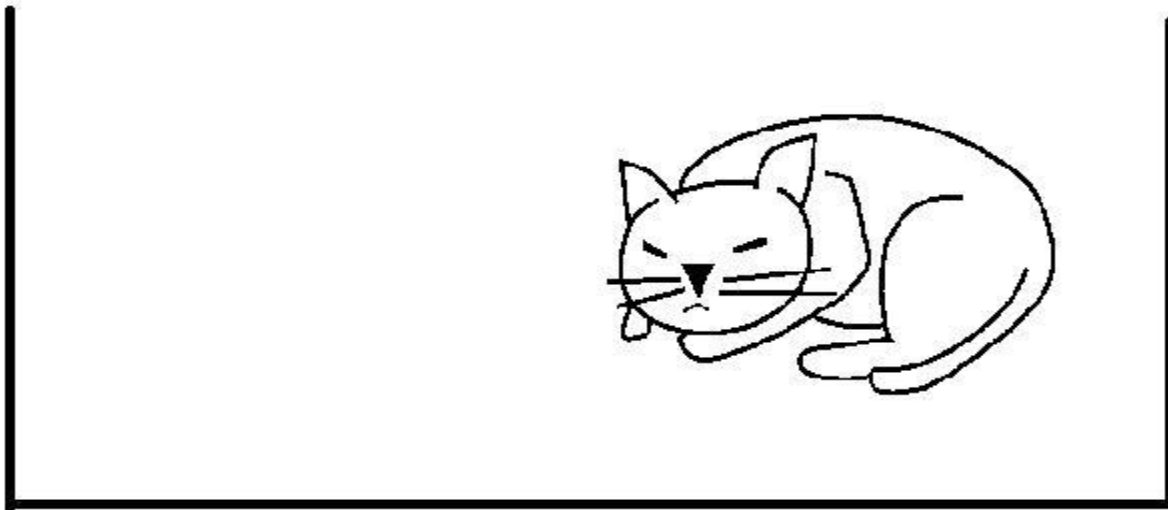
- The cat can be alive 😊



# THE THOUGHT EXPERIMENT (CONTD.)

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- The cat can be dead 😞

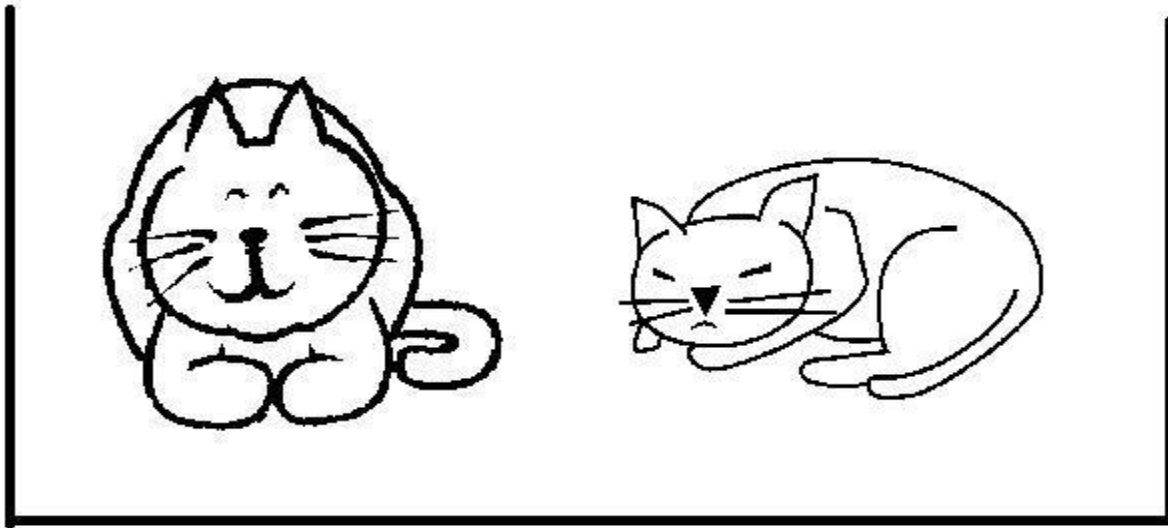




# THE THOUGHT EXPERIMENT (CONTD.)

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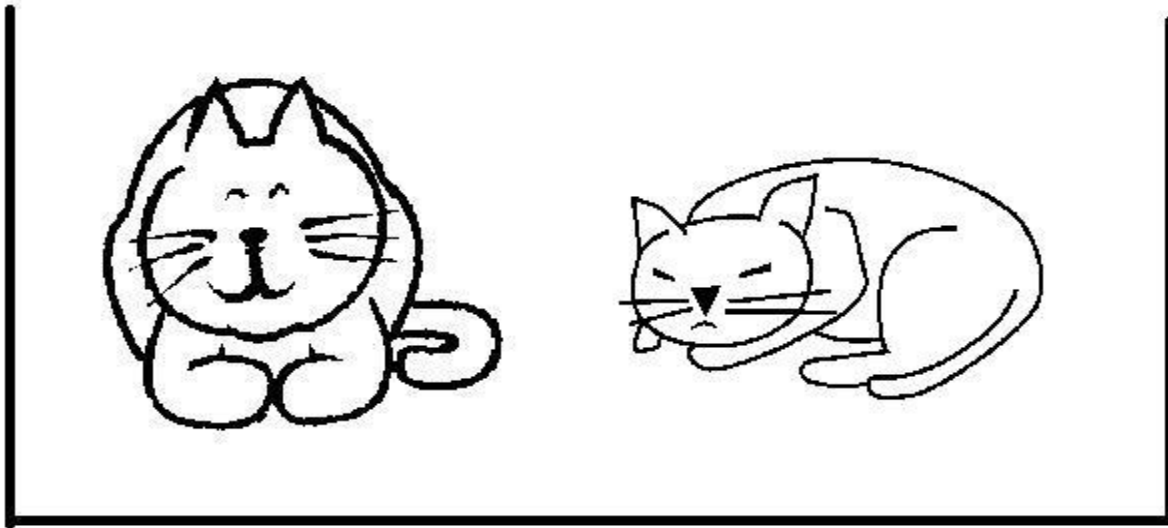
○ Or *both*?



# THE THOUGHT EXPERIMENT (CONTD.)

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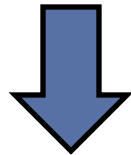
○ Or *both*? **Yes** ☹️



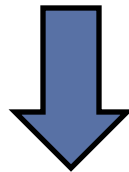
## HOW ??

---

*Any atom in the radioactive substance decays*



*The veil breaks open and releases poison*



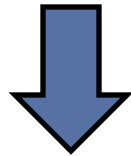
*The cat dies*



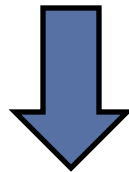
## How ??

---

*No atom in the radioactive  
substance decays*



*The poison is not released*



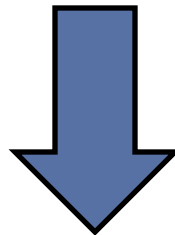
*The cat is alive*



## How ??

---

*Atom in the radioactive substance is in a state of both 'decayed' and 'undecayed'*



*The cat is both dead and alive*



# THE PRINCIPLE OF SUPERPOSITION

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- The principle of superposition says that if an object can be in *any configuration*, and if the object could also be in *another configuration*, then the object can also be in a state which is a *superposition of the two*.
- The thought experiment uses this and transforms an indeterminacy in the atomic domain to macroscopic indeterminacy.



# THE PROBLEM

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- Thus an atom of the radioactive substance can be in both decayed and non-decayed states *at the same time*.
- This leads to the conclusion that the cat can be both dead and alive at the same time.
- But we can never *observe* the cat to be both dead and alive at the same time!!!



## AN INTERESTING EXPLANATION - THE COPENHAGEN INTERPRETATION

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- A system stops being in a superposition of states and becomes either one or the other when an *observation* takes place.
- The Young's Double Slit Experiment – what happens when we interfere with this phenomenon?

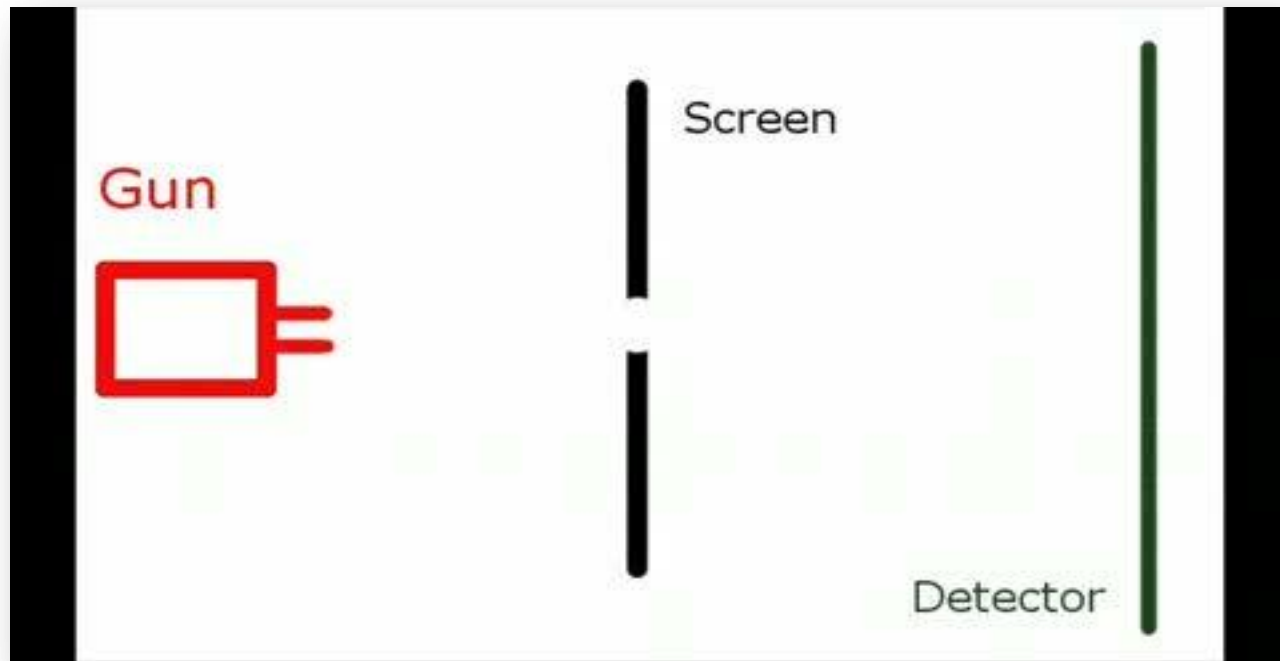




# THE YOUNG'S DOUBLE SLIT EXPT.

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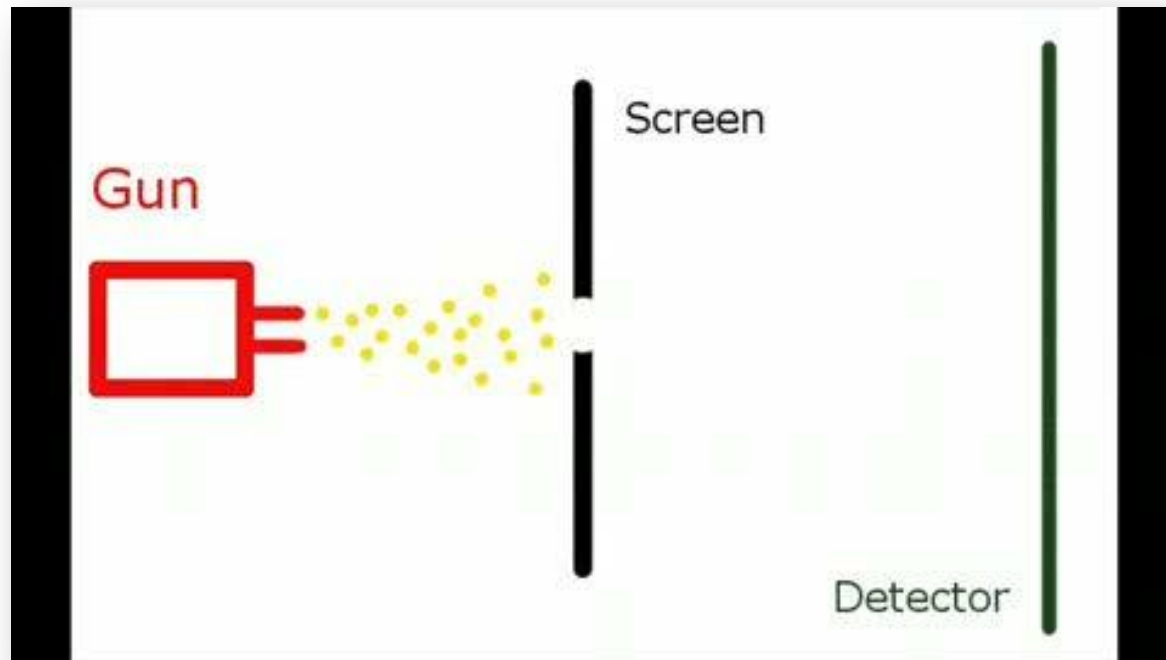
Consider the equipment given below.



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

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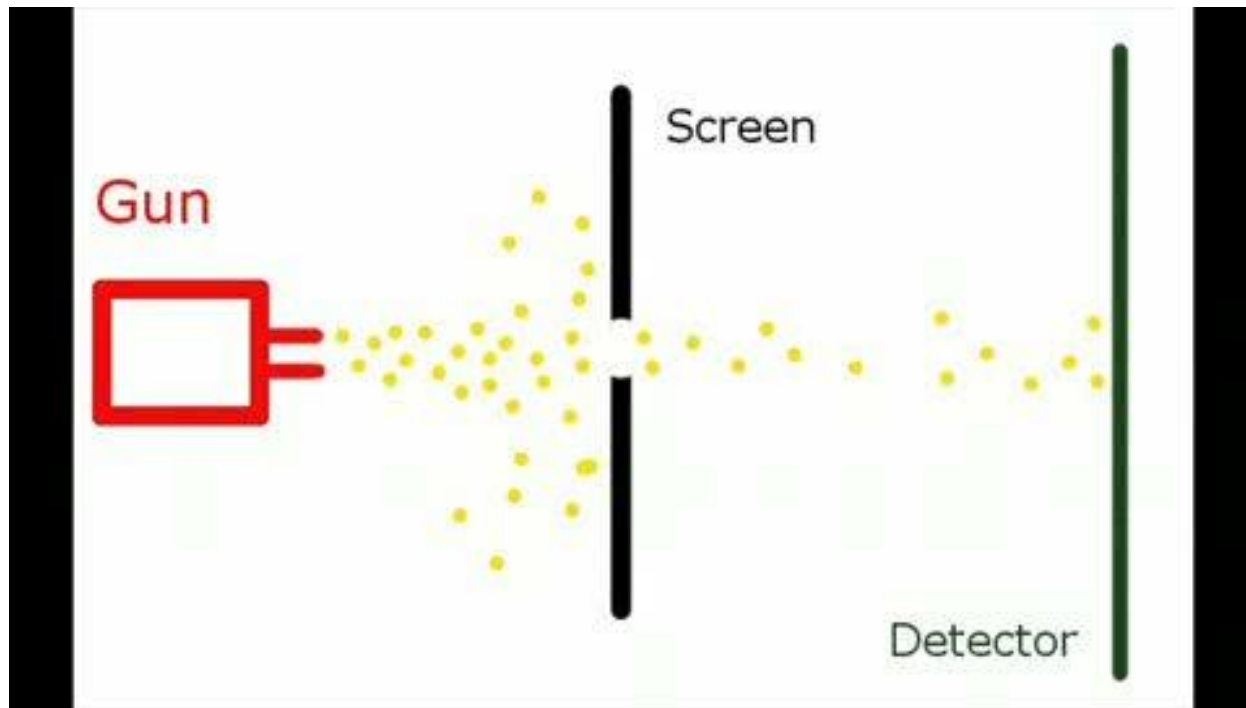
The photon gun emits photons that reach the detector through the slit in the screen.



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

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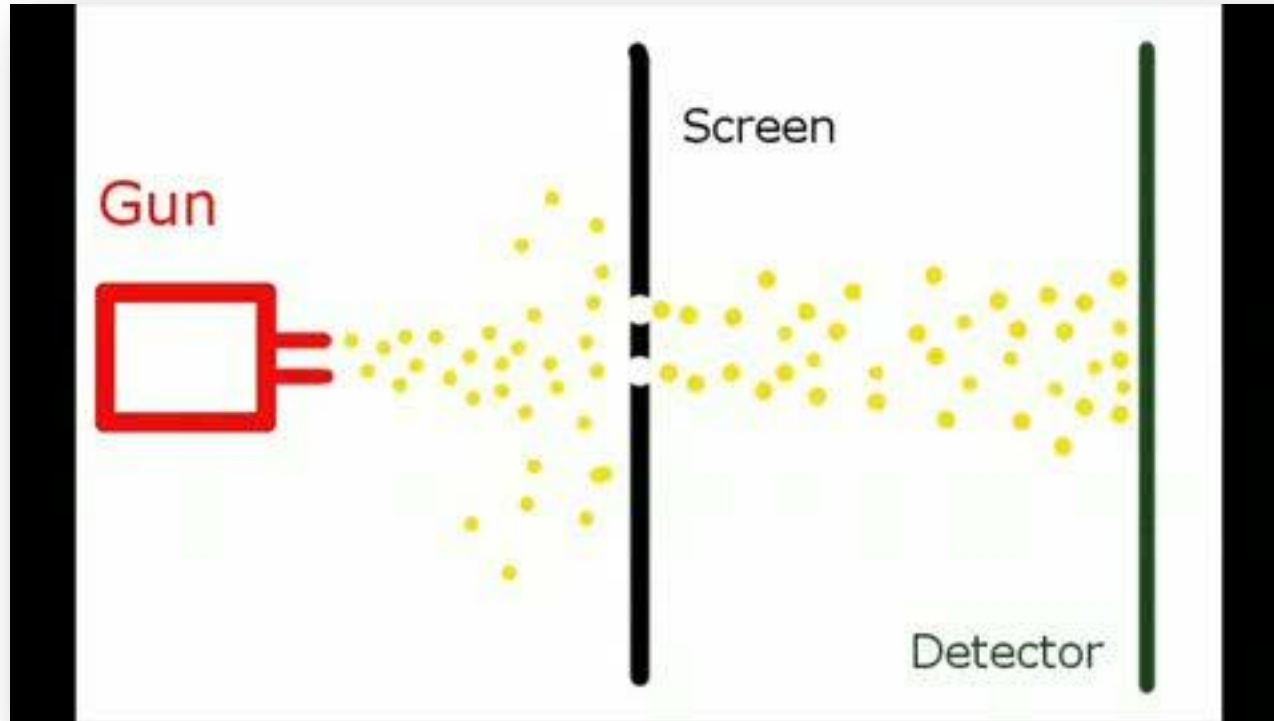
With a single slit : Particle behaviour



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

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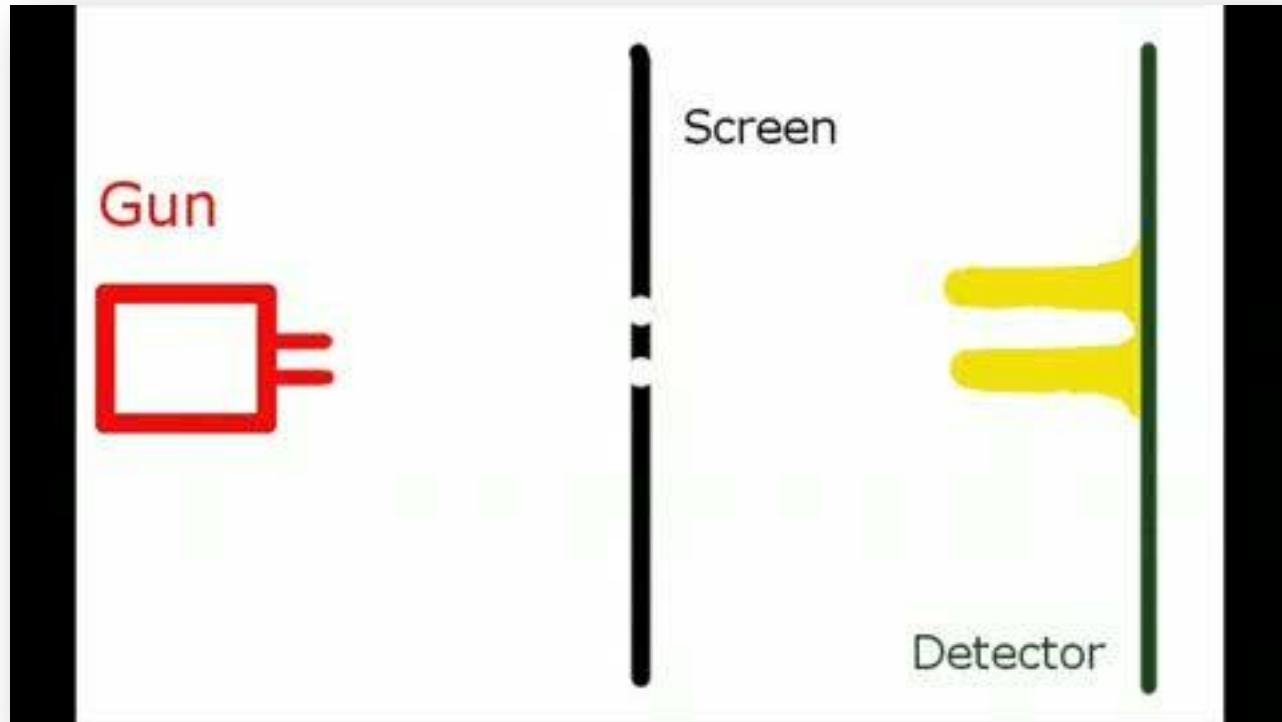
With 2 slits : Expected behaviour



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

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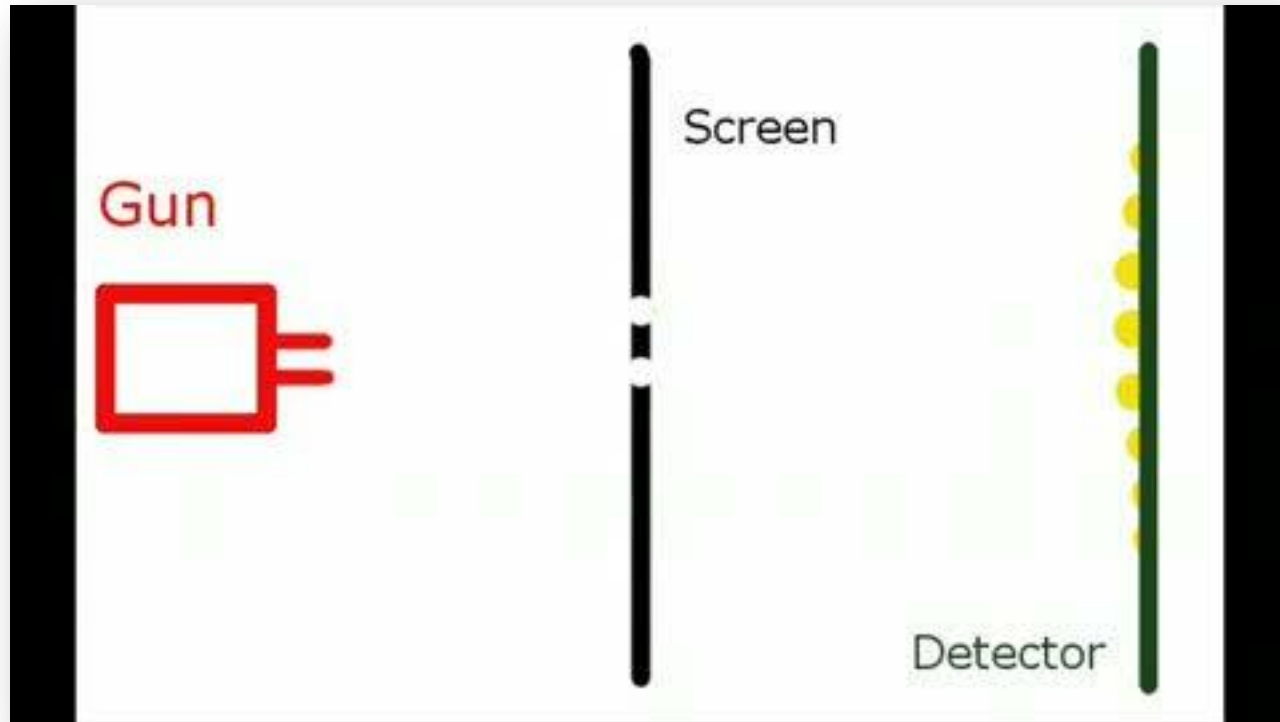
With 2 slits : Expected behaviour



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

---

With 2 slits : Observed behaviour



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

---

- Inference: The photons are exhibiting both particle and wave nature resulting in *interference*
- Hence the pattern – the *interference pattern*.

So far so good ...



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

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The gun is slowed down to emit a *single photon*. Do you expect interference to happen now?

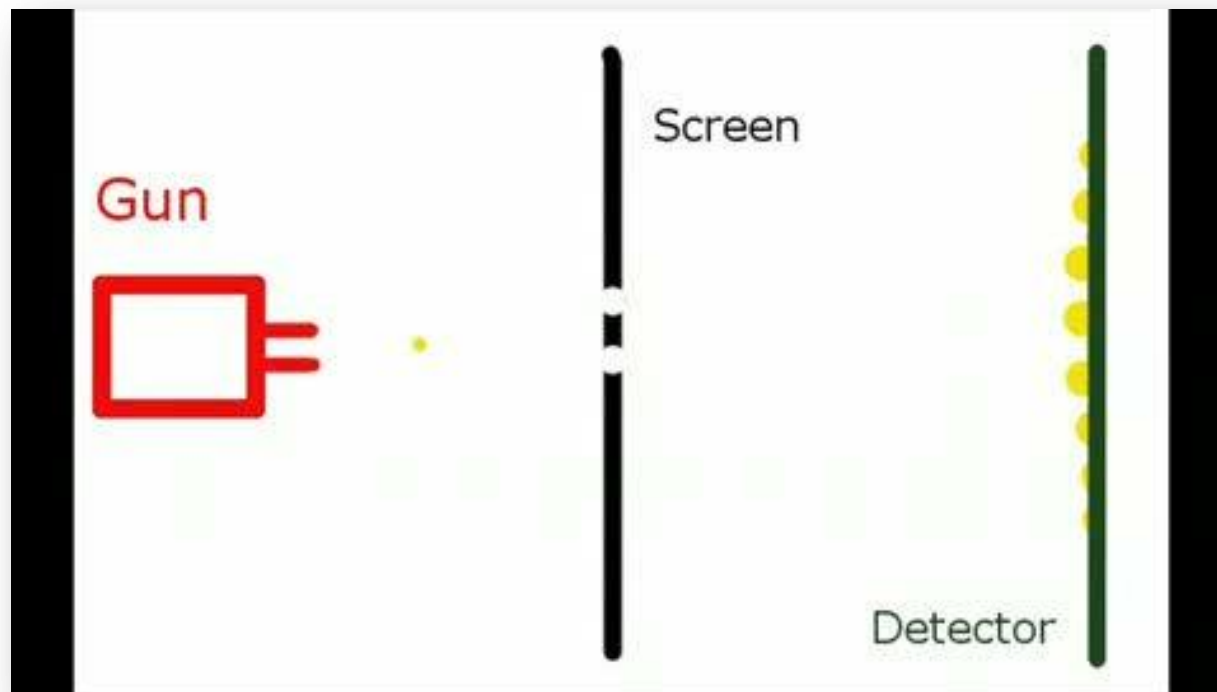




# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

---

Interference occurs even with a  
*single* photon



## THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

# TRYING TO GET CLEVER

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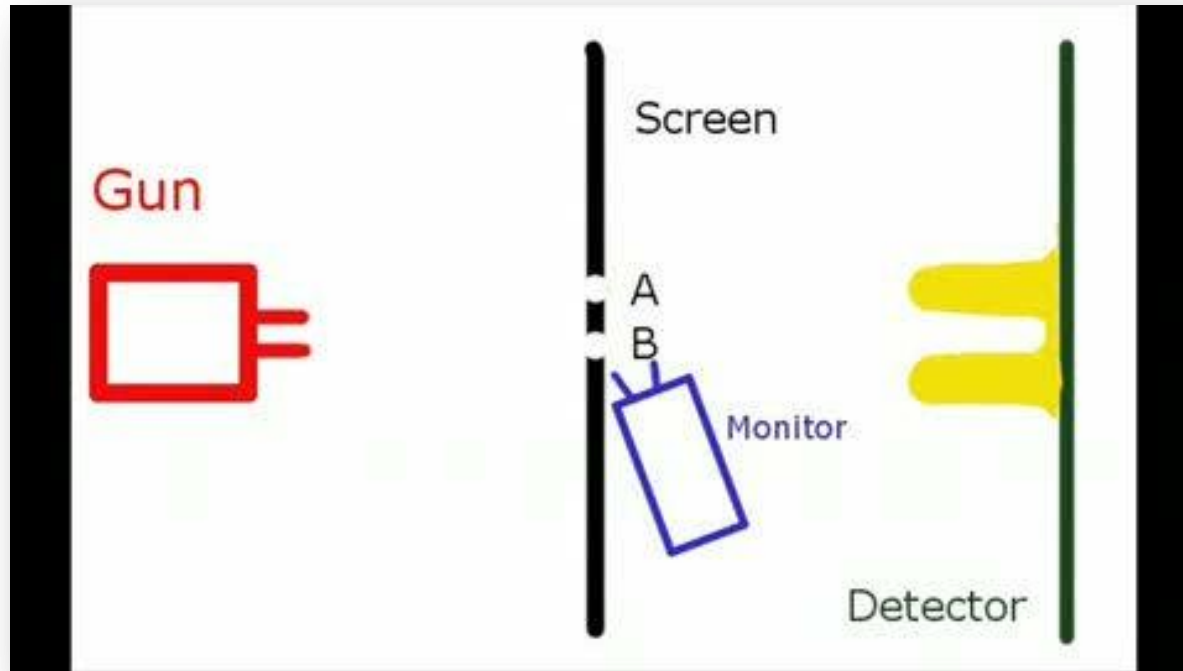
- How can a photon interfere with itself ?
- With an aim to test from which slit the photon is actually passing to reach the other side, we place a monitor near one of the slits and redo the experiment with single photon.
- What do you expect now? Any guesses?



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

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- The photon now behaves as a particle! The wave function of the photon has *collapsed!!!*



# THE YOUNG'S DOUBLE SLIT EXPT. (CONTD.)

---

- Inference: The act of *observation* triggered the collapse of the photon's wave function.
- Thus, the Copenhagen Interpretation appears to provide a justifiable explanation.

But then ...



# SOME OBVIOUS QUESTIONS

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- What does *observation* mean?
- Does observation need human interference?
- If yes, WHY?
- If no, then why does the wave function not collapse when the detector is inside the steel chamber?
- ...



# ANOTHER INTERESTING EXPLANATION

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## Many Worlds Interpretation

- There is a very large number of universes
- Observer's state is *entangled* with the cat's state
- The alive and dead cats are both equally real
- But they cannot interact with each other
- Each has its own existence and remembers its own history.

and many others ...



# WHAT THIS MEANS TO AI

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- Going by the results of the Young's Double Slit Experiment, we come across serious limitations to what AI is capable of.
- According to quantum theory, a system evolves causally until it is observed. The act of observation causes a break in the causal chain.
- Thus, if *intelligent* machines are to continually evolve through learning, they should not be observed.



# WHAT THIS MEANS TO AI

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- But learning should come from interaction with the environment.
- This would mean that such intelligent machines would never be possible!





# THANK YOU

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- For good explanations on the various quantum terms used,

[http://en.wikipedia.org/wiki/Quantum\\_mechanics](http://en.wikipedia.org/wiki/Quantum_mechanics)

