Physics : Part 2 : Video 7a : 2 Types of Knowledge Questions

Phil Chan
Department of Physics

Contents:

- What is a Scientific Theory (Model) ?
- Is your question Ontological or Epistemological ?
- What is the Difference ?
- Asking Silly Questions and Schrodinger cat ?
- Is there Logic ?

Reminder : A Scientific Theory

Scientific theories begin from basic assumptions or postulates (conjectures, hypotheses, principles).

All Physical (Physics) theories seek to develop a mathematical structure that is also logically consistent. Then the theory is ready for use.

Example : 2 postulates of Special Relativity.

What is a good scientific theory ?

Must not only explain quantitatively all known physical phenomena of the kind it is supposed to deal with.

Makes successful predictions about new phenomena not known before. The predictions are verified later by experiment.

Example : General Relativity predicts the bending of light by gravity and is subsequently verified by the Solar Eclipse experiment … we can see stars change their positions.

What is a Theory (Model) ?

It is a ***model*** (or framework) for *Reality*. The word reality seems deceptively simple but lurking behind it lies many subtle complications.

Reiterate: theories of physics (science) essentially attempt a mathematical description of physical reality. Which theory eventually survives depends on which one provides the best description of reality.

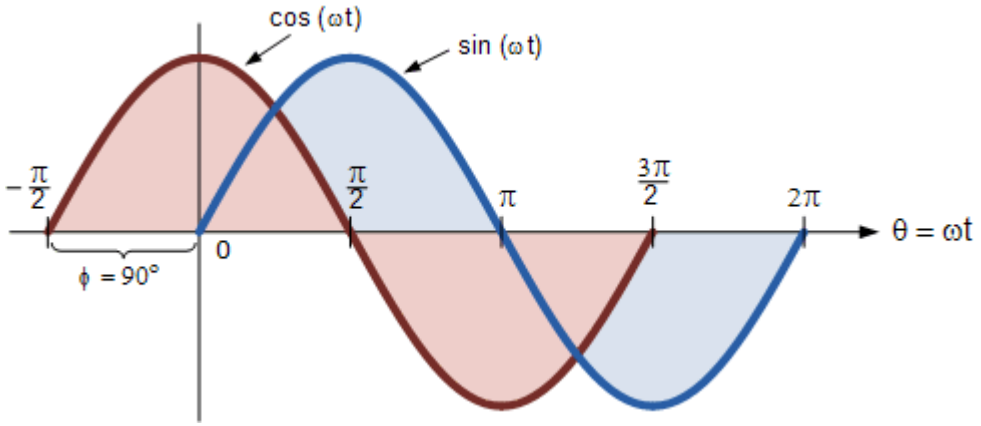
Contents:

- What is a Scientific Theory (Model) ?
- Is your question Ontological or Epistemological ?
- What is the Difference ?
- Asking Silly Questions and Schrodinger cat ?
- Is there Logic ?

What is Ontological Knowledge ?

Ontology : A branch of Philosophy that deals with the nature of being … it simply means the nature of the system as it actually exists.

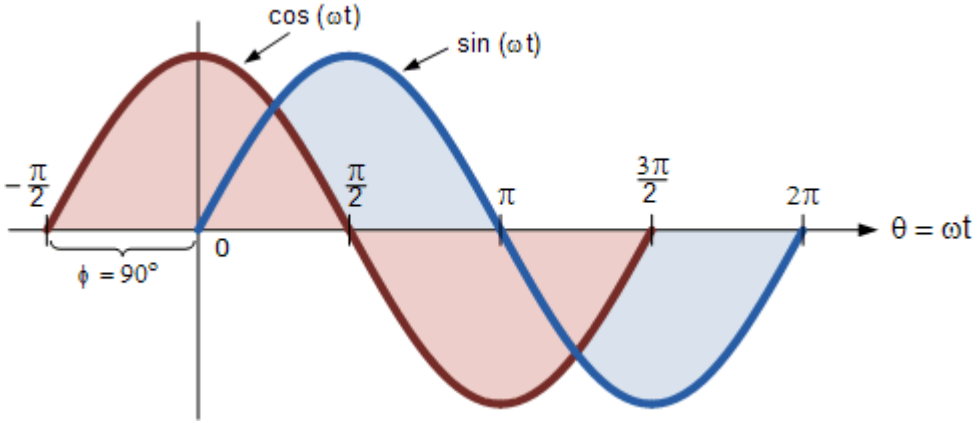
Example : We can use a sine (cosine) wave to model waves at the beach.

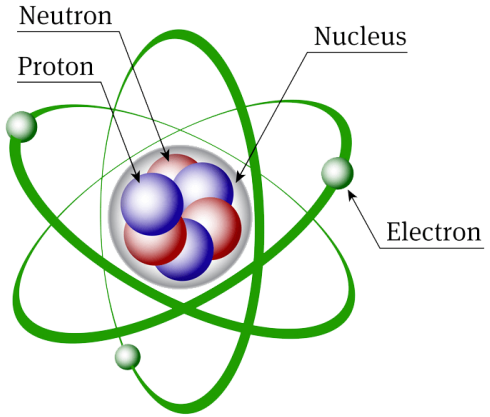


What is Epistemological Knowledge ?

Epistemology: A branch of Philosophy that deals with the theory of knowledge … simply means our knowledge or conception about a physical system.

Example : Physicists and Chemists use a sine (or cosine) wave to model a micro (quantum) particle (“ball” like) in the atom.





Are you upset ?

… tarassei tous anthropous ou ta pragmata alla ta peri ton pragmaton dogmata …

…what upsets people is not things themselves, but their Theories about things …

Epictetus
Greek & Stoic Philosopher
55-135 AD

Contents:

- What is a Scientific Theory (Model) ?
- Is your question Ontological or Epistemological ?
- What is the Difference ?
- Asking Silly Questions and Schrodinger cat ?
- Is there Logic ?

What is the Difference ?

Epistemology deals with knowledge built up from observation whereas Ontology refers to attributes the system has, independent of whether one observes them or not.

Caveat Emptor : Our knowledge about a physical system might in fact be quite different from what the system actually is.

Epistemic Example : Spin

All micro particles in the Universe have “spins”.

Bosons (force) : Integer Spin i.e. 1, 2 ,3, … etc.
Fermions (matter) : Half Integer Spin i.e. ½, 3/2, …etc.

Caveat : But it is not physically spinning like a physical top. Why ?

Is there an Analogy ?

What toys were Pauli and Bohr playing ? Reportedly

Winston Churchill also enjoyed this top !

Caveat : Micro (Quantum) Spins have no Physical (Classical) analogy.

http://www.youtube.com/watch?v=AhmUElH6cTY
http://www.youtube.com/watch?v=AyAgeUneFds
The Mechanical Theory http://www.fysikbasen.dk/English.php?page=Vis&id=79

What is the Difference ?

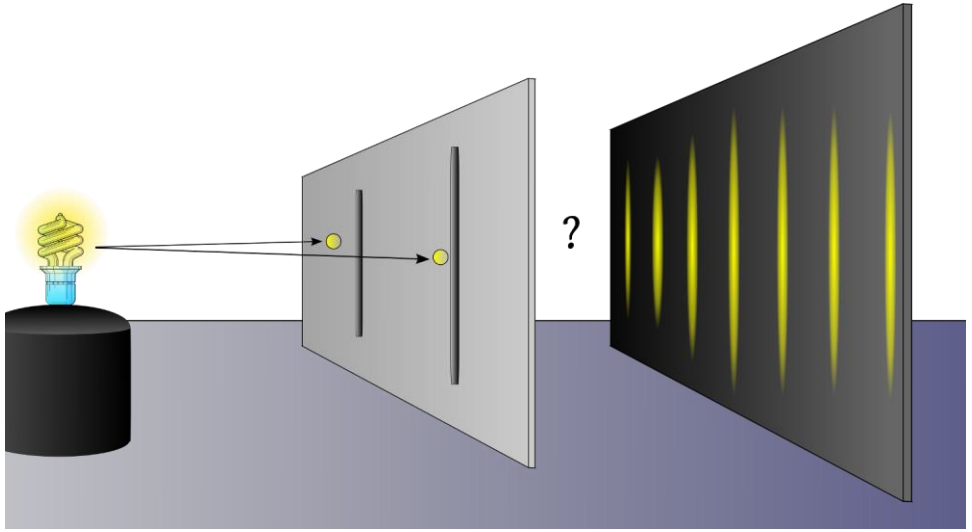
Epistemology deals with knowledge built up from observation whereas Ontology refers to attributes the system has, *independent of whether one observes them or not.*

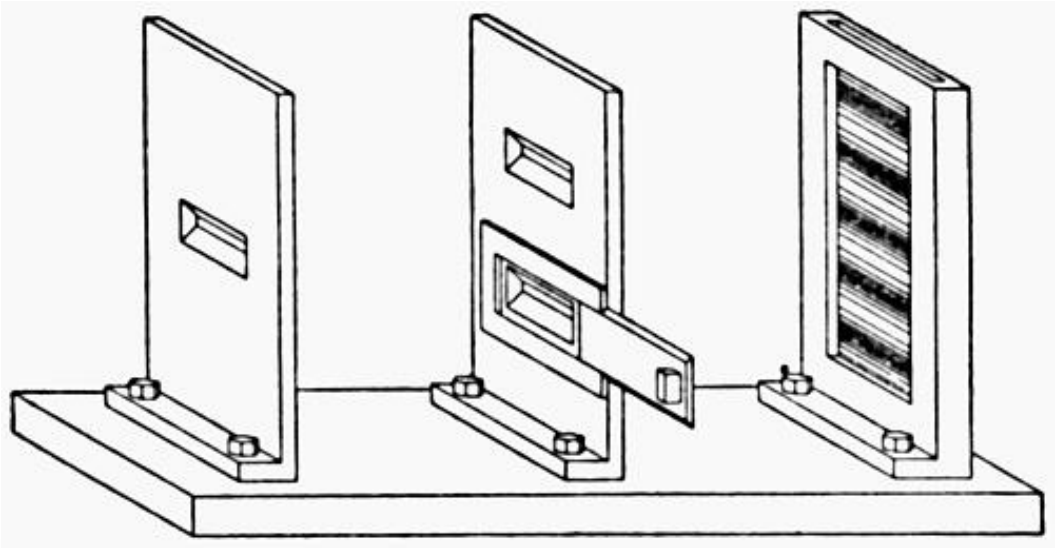
Caveat Emptor : Our knowledge about a physical system might in fact be quite different from what the system actually is.

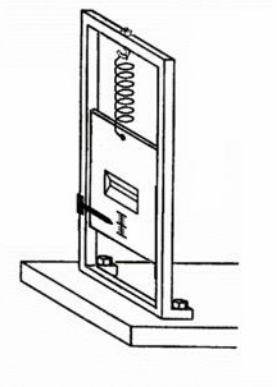
Gedanken (s) debates ?

At the 5th Solvay Conference in 1927 (see picture below), Einstein raised doubts regarding Bohr's Quantum Interpretation of the 2 slits experiment.

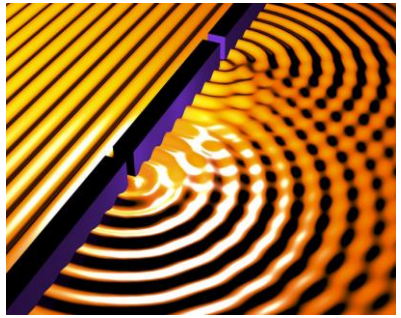
Is it possible to construct Gedanken (s)?





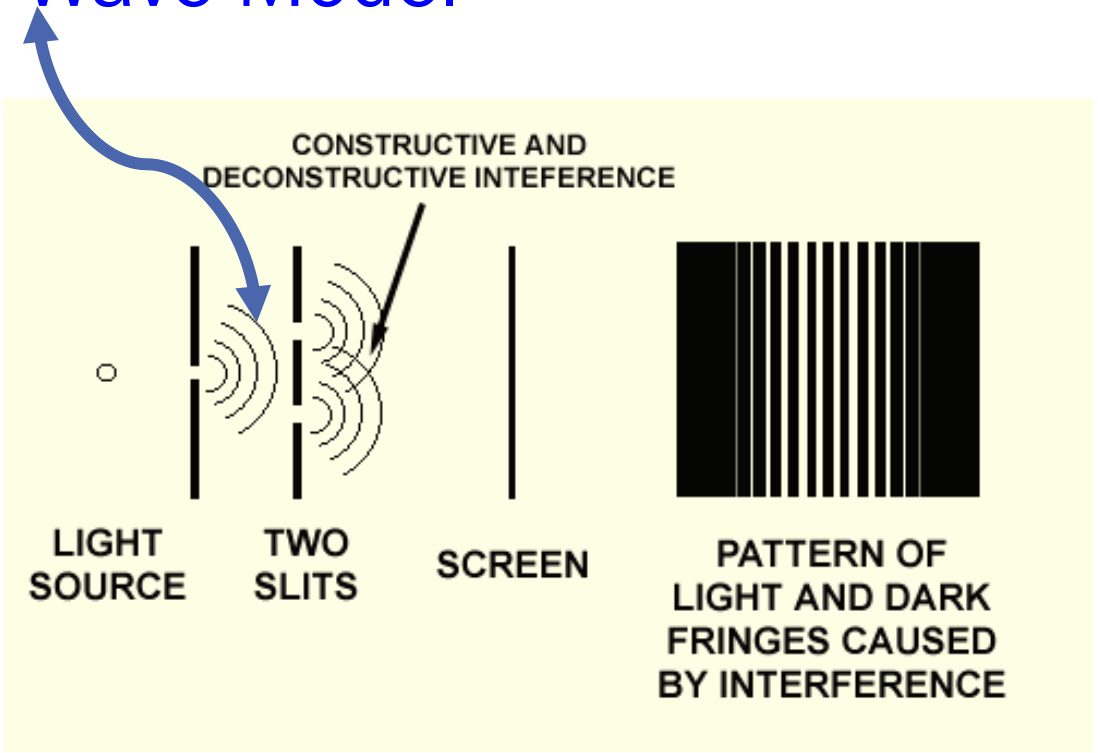


https://en.wikipedia.org/wiki/Niels_Bohr

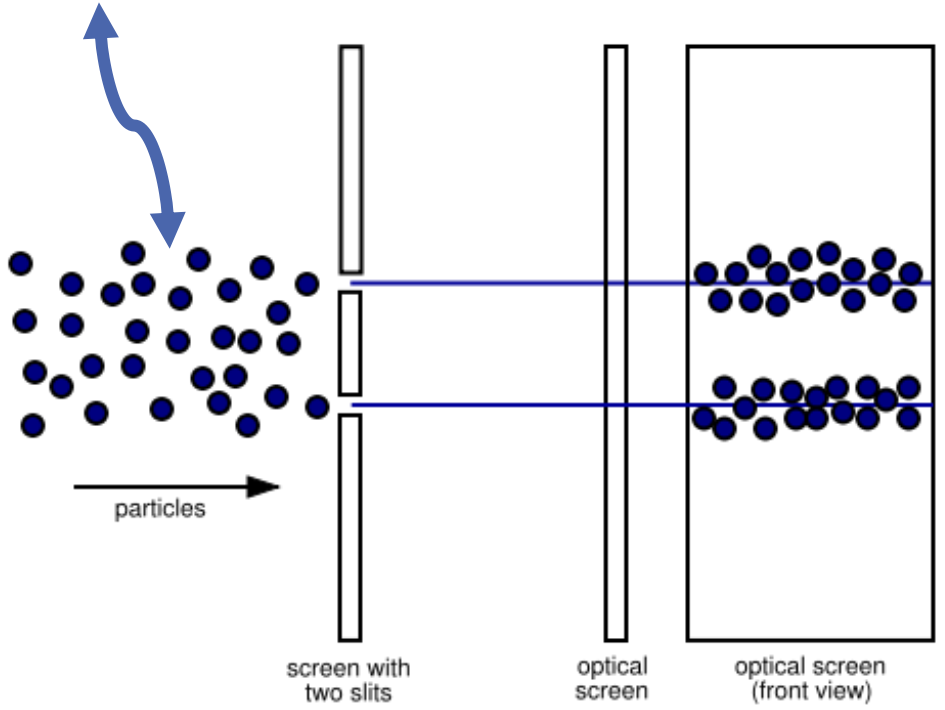


Example : 2 slits Experiment

Wave Model



Particle Model



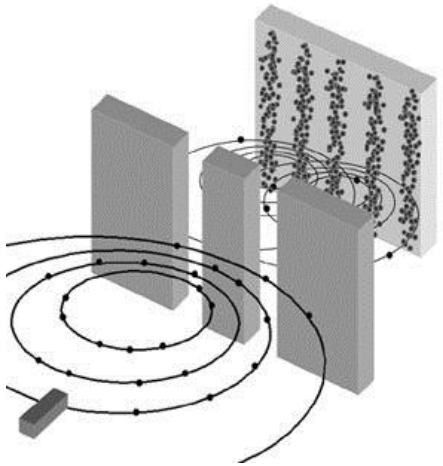
Example : 2 slits Experiment

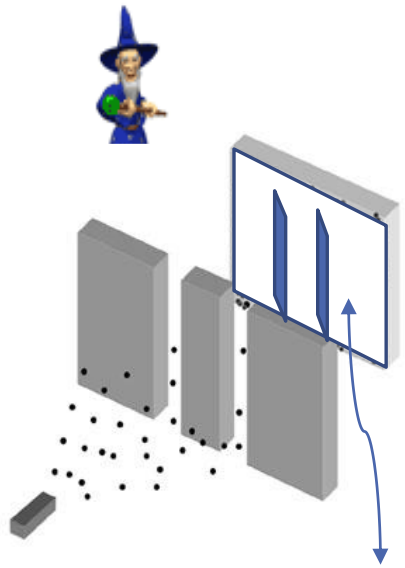
Use Electron ("ball" like localized objects) or Photon gun (on the left) to get the interference pattern on the right.

If one models Electrons or Photons as waves, then the electrons or photons have to be found at 2 places (slits) at the same time … What is going on ?

Example : 2 slits Experiment

Let us put a spy to check exactly which slit the electron or photon goes through.





If we put a “spy” then the wave interference pattern disappears. It seems that the electron or photon has a “mind or consciousness” of their own and they know that they are being spied on and behave differently.

So measurements (observations) in Quantum Mechanics is really Weird !

Observations not only disturb what has to be measured but in fact produce it … we ourselves produce the results of the measurement.

P. Jordan

Atoms or elementary particles are not real; they form a world of potentialities or possibilities rather than one of the things or facts.

W. Heisenberg

Summary

In Quantum Mechanics (micro systems), actual state of existence depends on how we observe and what we choose to observe … prior to a measurement we cannot even think that the electron has definite momentum and a definite co-ordinate.

Questions ?

What we observe is not nature itself, but nature exposed to our method of questioning.

W. Heisenberg

Perhaps this is what we mean by "*understanding*" nature at it is most fundamental level !

The Road Not Taken !

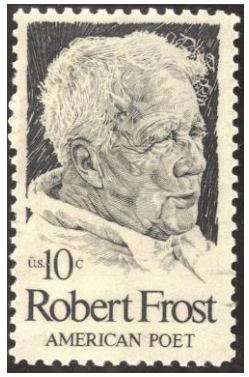
*Two roads diverged in a **yellow** wood*

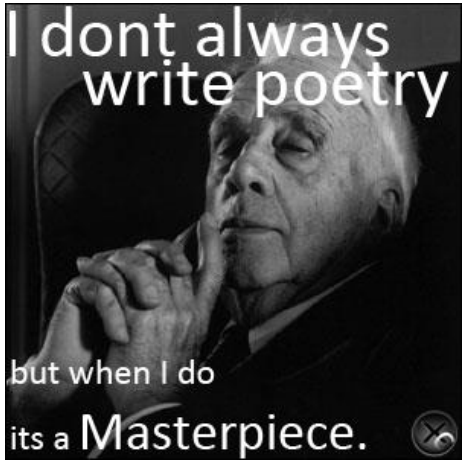
and sorry I could not travel both

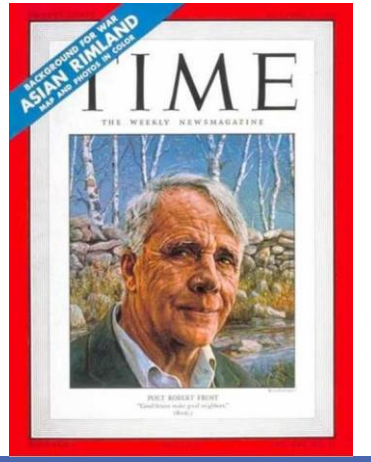
And be one traveller, long I stood

And looked down one as long as I could

To where it bent in the under growth;



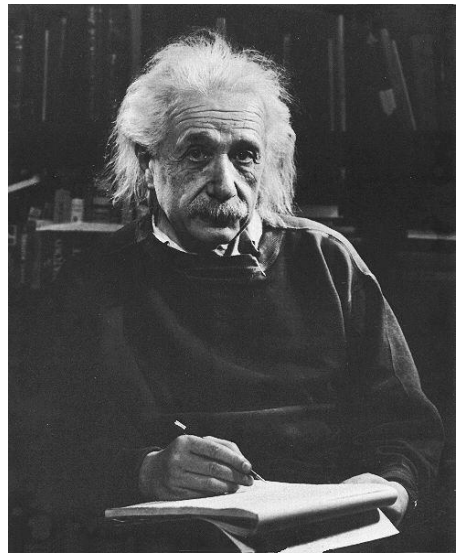




Contents:

- What is a Scientific Theory (Model) ?
- Is your question Ontological or Epistemological ?
- What is the Difference ?
- Asking Silly Questions and Schrodinger cat ?
- Is there Logic ?

So Einstein asked ? A Silly Question ?



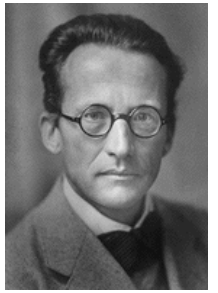
Einstein asked Abraham Pais

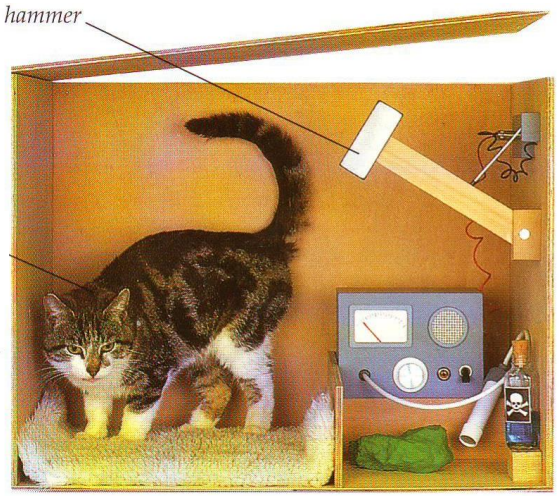
… during one walk Einstein suddenly stopped, turned to me and asked whether I really believe that the moon exists only when I look at it ?

… I would like to think so.

A. Einstein

The Schrodinger Cat

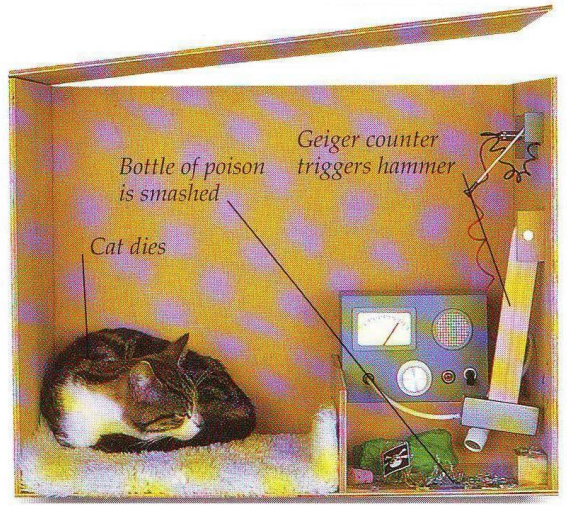




$$\Psi = \psi_{Alive} + \psi_{Dead}$$

$$\Psi =$$  $+$ 

Animation Factory
MEMBERS ONLY
Animation Factory
MEMBERS ONLY

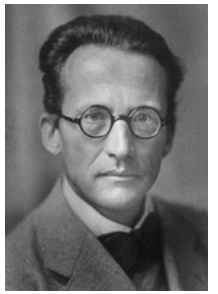


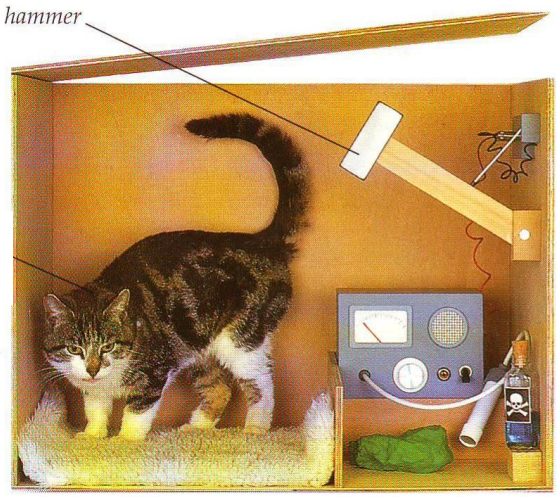
Without opening the lid i.e. we would like to know whether the cat is alive or dead ?

Psi alive: The radioactive atom (half life) has not randomly emitted any particle; the hammer has not fallen; the bottle is not broken; and the cat is alive.

Psi dead: The radioactive atom (half life) has randomly emitted a particle; the detector has registered a particle; the hammer has fallen; the bottle is broken; and the cat is dead.

The Schrodinger Cat





New idea

$$\Psi = \psi_{Alive} + \psi_{Dead}$$

Schrodinger argued that this whole thing is ridiculous; "the psi function of the entire system would express this by having in it the living and the dead cat ("pardon the expression") mixed or smeared out in equal parts". This is absurd, so the standard Quantum Physics must be wrong according to Schrodinger. He wrote a well known book; "*What is life* ?"

A Strange idea, indeed !

This is a very strange result since it seems to indicate that the observation plays a decisive role in the event and that reality varies, depending upon whether we observed it or not.

W. Heisenberg

We cannot make the mystery go away by explaining how it works. Historically, the electron was thought to behave like a particle and then it was found that in many respect it behaved like a wave. So it really behaves like neither. Now we have given up. We say: it is like neither.

R. Feynman

Contents:

- What is a Scientific Theory (Model) ?
- Is your question Ontological or Epistemological ?
- What is the Difference ?
- Asking Silly Questions and Schrodinger cat ?
- Is there Logic ?

Is there any ***Logic*** in Quantum (micro system) Phenomena ?

Boolean Logic (Set Theory)

p : I love this Q GEM

q : I love to DANCE

$\wedge$ means **and ("intersection")**

$\vee$ means **or ("union")**

Mathematicians and Engineers use Truth Tables

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

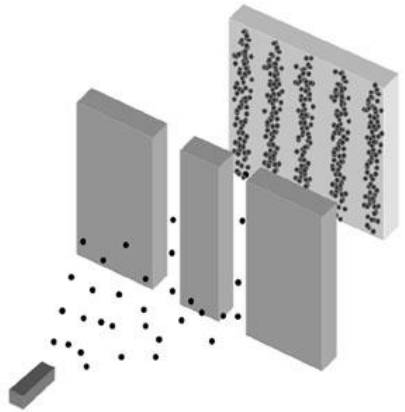
Consider this

$$A \wedge (B \vee C) = (A \wedge B) \vee (A \wedge C)$$

We've learned before in sec. sch. $A \times (B + C) = (A \times B) + (A \times C)$

What is Quantum (micro system) Logic ?

Consider Double Slit Experiment again



A: The electron hits the screen

B: The electron goes through slit 1

C: The electron goes through slit 2

Consider this well known equation again

$$A \wedge (B \vee C) = (A \wedge B) \vee (A \wedge C)$$

The electron hits the screen and the electron has gone through at least one of the 2 slits. i.e. slit 1 or slit 2

=

The electron hits the screen and the electron has gone through slit 1

or

The electron hits the screen and the electron has gone through slit 2

But In Quantum Mechanics, the 2 sides are not equal. Can you see why ?

Questions ?

What we observe is not nature itself, but nature exposed to our method of questioning.

W. Heisenberg

Perhaps this is what we mean by "*understanding*" nature at it is most fundamental level !

Summary

In our quest to understand (or describe) mother nature it is important for us to ask ourselves whether the theoretical (including phenomenological) comprehension (i.e. the scientific framework) is Ontological or Epistemological.

If not we may be asking silly questions like Einstein and Schrodinger.