Arvind Borde / PHY 19, Week 12: General Properties of Ψ

§12.1 What Causes What?

Let's ponder some fundamentals:

$$F = ma$$

$$F = G\frac{m_1 m_2}{r^2}$$

(1) "Which F" is it?

1

That was true for, like, forever, or at least between 1666 and 1865, till Maxwell said

$$\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$$
$$\vec{\nabla} \cdot \vec{B} = 0$$
$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$
$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

2

Cause & effect are intertwined in these equations.

(2) What's an example here where cause is effect, and effect cause? ______________________

(3) Still, there are causes in these equations. Which? ____________

3

In all of these "classical" situations, some cause (external or internal) causes behavior that we can predict and *precisely* observe.

The behavior is usually motion, but it can be something static such as an interference pattern.

(4) What's the deal with QM? _____________

4

(5) In the $\mathcal{S}$ eq.

$$-\frac{\hbar^2}{2m}\nabla^2\Psi + U(x,y,z)\Psi = i\hbar\frac{\partial \Psi}{\partial t}$$

what's cause and effect?

5

OK, you've arm-twisted me.

But, previously, an "effect" was motion, an interference pattern, etc.

(6) What's an effect here?

6

ADDITIONAL NOTES

§12.2 Curvature and Quantization

In 1d the time-independent $\mathcal{S}$ eq. is

$$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2} + U(x)\psi(x) = E\psi(x)$$

(7) Do you want to understand ψ geometrically?

7

(8) Is a constant ψ solution possible?

8

(9) If $\psi(x)$ is a solution, is $\psi(x)+c$ ($c =$ constant)?

9

(10) Is a linear $\psi(x) \neq 0$ possible?

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(11) If ψ is a solution E, is it for $E + c$?

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(12) If ψ is a solution of the $\mathcal{S}$ eq. with a given $U(x)$, is *the same* ψ a solution with $\hat{U} = U + c$?

11

(13) Using prime notation ($f' = df/dx$) rewrite the $\mathcal{S}$ eq. with all ψ, and just ψ, terms (including derivatives) on the left.

Let us consider potentials where $U(0) = 0$.

12

ADDITIONAL NOTES

This leads to several behaviors:

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Case 1a: $U(x) < E$, $\psi > 0$:

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ADDITIONAL NOTES

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