

THEME OF MY TALK

Quantum mechanics, *unlike classical mechanics*, allows consciousness to play an important dynamical role in the determination of the flow of bodily events

THE TWO AIMS OF MY TALK

1. To provide a rationally coherent QM framework for understanding of how our conscious intentions can influence our physical actions.
2. To extend this initially anthropocentric understanding to a general ontology.

An Incidental Aim

- To expose the profound ill-informedness of the quip:
“The idea of quantum physicists that consciousness is linked to QM originates from the idea that because *consciousness is a mystery and QM is a mystery, maybe the two are related.*”

Brief Historical Overview 1

Classical (Newtonian-type) Mechanics

→ "Causal Closure of the Physical"

The *physical* past determines the *physical* future

"*Physical*" = The mathematical spatio-temporal description given by physical theory

Conscious enters **classical** mechanics as a causally inert spectator---
i.e., as a passive witness.

Brief Historical Overview 2

- In QM the human being enters

ALSO as a causal agent!

BOHR: “The freedom of experimentation, presupposed in classical physics, is of course retained, and corresponds to the free choice of experimental arrangement for which the quantum mechanical formalism offers the appropriate latitude.”

Brief Historical Overview 3

- This “free choice” was formalized by Von Neumann as **Process 1**:

$$\mathbf{S} \rightarrow \mathbf{S}' = \mathbf{PSP} + \mathbf{P}'\mathbf{S}\mathbf{P}' \quad [\mathbf{P}' = (1 - \mathbf{P})]$$

[S is the density matrix.

P is a projection operator: $\mathbf{P}\mathbf{P} = \mathbf{P}$]

Process 2 is the Schroedinger Evolution.

BUT THERE IS A CAUSAL GAP ! :

Process 1 is not determined by Process 2,

or by any other described process!

This “Causal Gap” is Bohr’s “Appropriate Latitude”.

An Example

An experimenter places a particle detector in a weak beam of particles.

His *action* poses a question, which nature will answer “Yes” or “No”, according to whether the detector fires or not.

The QM equations of motion do not determine exactly when and where the detector will be placed!

In actual practice that choice is determined by the experimenter,
on the basis of his *motives and reasons.*

Process 1

Poses A Yes-or-No Question

In orthodox QM a *particular question* must be put to nature before Nature can return a reply.

Process 1 poses the question.

Process 2 evolves the system.

Process 3 is Nature's statistically controlled reply.

Statistics Enters QM ONLY IN PROCESS 3 !

- Process 1 is restricted neither deterministically nor statistically in orthodox QM.

Brief Historical Overview 4

The Copenhagen (pragmatic)
Interpretation

separates the world into two parts.

1. The system being studied/examined.
2. The observing system, which includes the human observer and his measuring devices.

Brief Historical Overview 5

- The system being studied/examined is described in terms of *the quantum mathematics*.
- The acting and observing system is described in *ordinary every-day language, refined by the concepts of classical physics*.

Brief Historical Overview 6

**Science, to be useful,
must link the
*mathematical
structure/formalism
to human experiences.***

The Psycho-Physical Link--- as Classically Conceived

In **classical** physics the external events produce excitations in the brain, and these excitations are converted, *by a process not integral to classical physics*, to mental images, which, however, can, according to **classical** physics, *have no effects in the physical world.*

The Psycho-Physical Link---as Conceived in QM

In QM, the needed linkage is via
Psycho-Physical Events.

Each such event has
two components:

1. A representation in the realm of experience, and
2. A representation in the realm of mathematical physics.

(Psycho-Physical Parallelism)

Psycho-Physical Events

Each psycho-physical event is a *co-occurring pair* consisting of:

1. An increment in knowledge,
and
2. An associated change in the
quantum state S .

The Von Neumann Shift.

Von Neumann Shifts the Cut so that:

The entire “physical” world (of particles and fields) is described in terms of the quantum mathematics.

(No awkward division of the unified physical universe into two differently described parts.)

Von Neumann's shift makes the
QM psycho-physical connection
into a mind-brain connection!

More reasonable,
ontologically.

Summary

Process 1: Choice of Question

$$S \rightarrow S' = PSP + P'SP'$$

Process 2: Schroedinger Evolution.

$$S(t) = (\text{Exp } -iHt)S(0)(\text{Exp } iHt).$$

Process 3: Nature's Reply

$$S' \rightarrow PSP \text{ or } P'SP' \quad (\text{"Yes" or "No"})$$

QM *Two-Way* Mind-Brain Linkage

- Brain Affects Mind (Process 3)
- Mind Affects Brain (Process 1)

Brain Affects Mind via Process 3

Each **Process-3-type event** in a person's brain ***co-occurs*** with the associated experience in that person's stream of consciousness.

- Thus in QM the brain effectively “excretes” consciousness! (As Searle says!)
- “Emergence” **is an integral aspect of von Neumann QM.** (cf. Philosophical idea of Non-reductive Physicalism)

Define “Template for action A”=

“A Pattern of *Brain* activity that if sustained for a sufficient length of time, will tend to cause action A to occur!”

Process-1

Intentional Thought

→ A Bodily Action

Psycho-Physical Event:

Psy side: Conscious Intention to do action A
(To Intend to receive the conscious feed-back:
“Action A is happening”)

Phy side:

In the Process 1 Event

$$S' = PSP + P'SP'$$

P eliminate the part of the physical brain activity that conflicts with the “template for action A”.

Then the answer “Yes” eliminates the competition!

QZE

- Sufficiently rapid repetitions of the same process 1 action can, by virtue of the *Quantum Zeno Effect*, cause the template for action to be held in place, in the face of physical fatigue effects, for longer than would otherwise be the case. That extended holding-in-place of the template will tend to make the action A occur.

Thus QM Provides
A Physics-Based Way
for an
Intentional Thought
to ***Inject The Physical Correlate***
Of A Mental Concept into the
physically described universe!

Thus QM naturally accommodates *both aspects* of the two-way mind-brain linkage, whereas classical physics can comprehend neither.

Invoking QM To Explain Consciousness Is Not Just Saying “Consciousness Is A Mystery And QM Is A Mystery, So Maybe These Two Mysteries are Related.”

- Both “mysteries” stem from the same mistake of accepting the precepts of classical physics as fundamentally correct.
- **QM explains naturally the two-way mind-brain connection that baffles thinkers who accept classical physics.**

QM leads to a radically different
view of human beings

Classical Physics → “Man is a Machine”

Quantum Physics →

“Man is an Injector of Mentally
Described Concepts into the Physically
Described World.”

Filling The Causal Gap!

Answering The Basic Question
That QM Does Not Answer.

How is it decided *when* a Process
1 action will occur, and *what* the
associated projection operator P
will be?

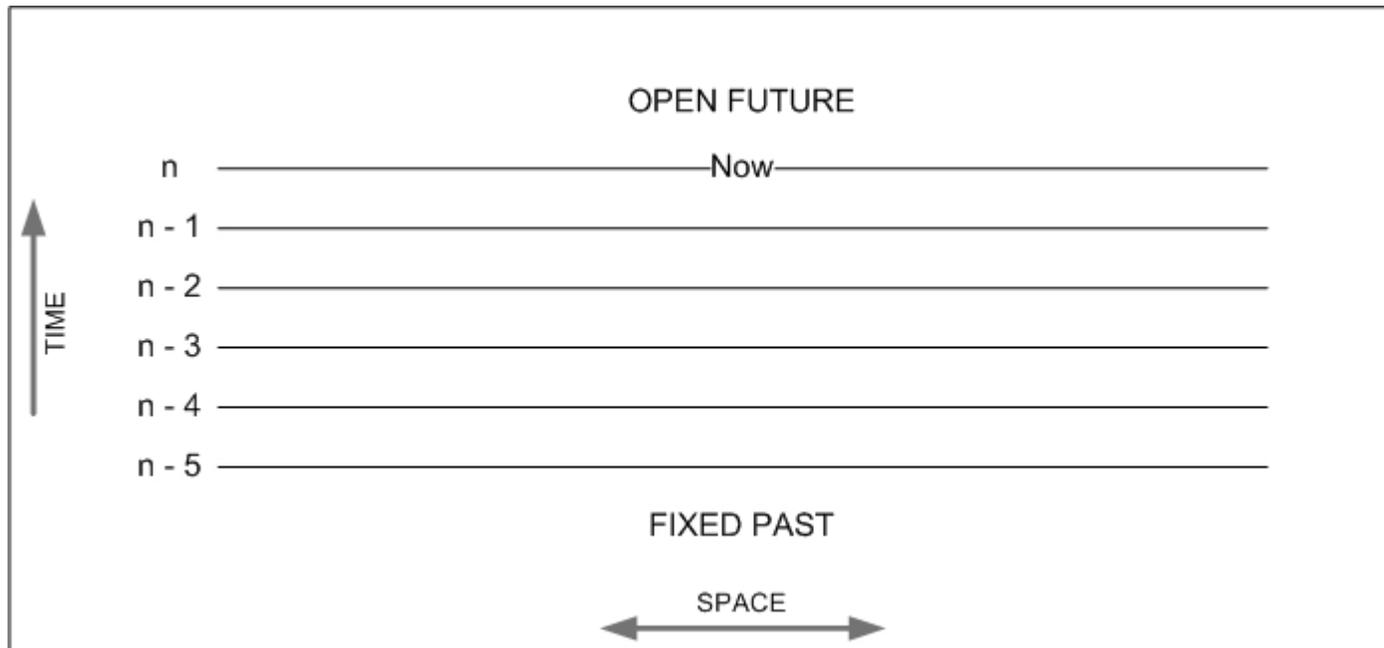
Ontology demands another Process!

Call it “**Process 0**”

Space and Time

The “When” question pertains to how the Processes 1 & 3 are represented in space and time.

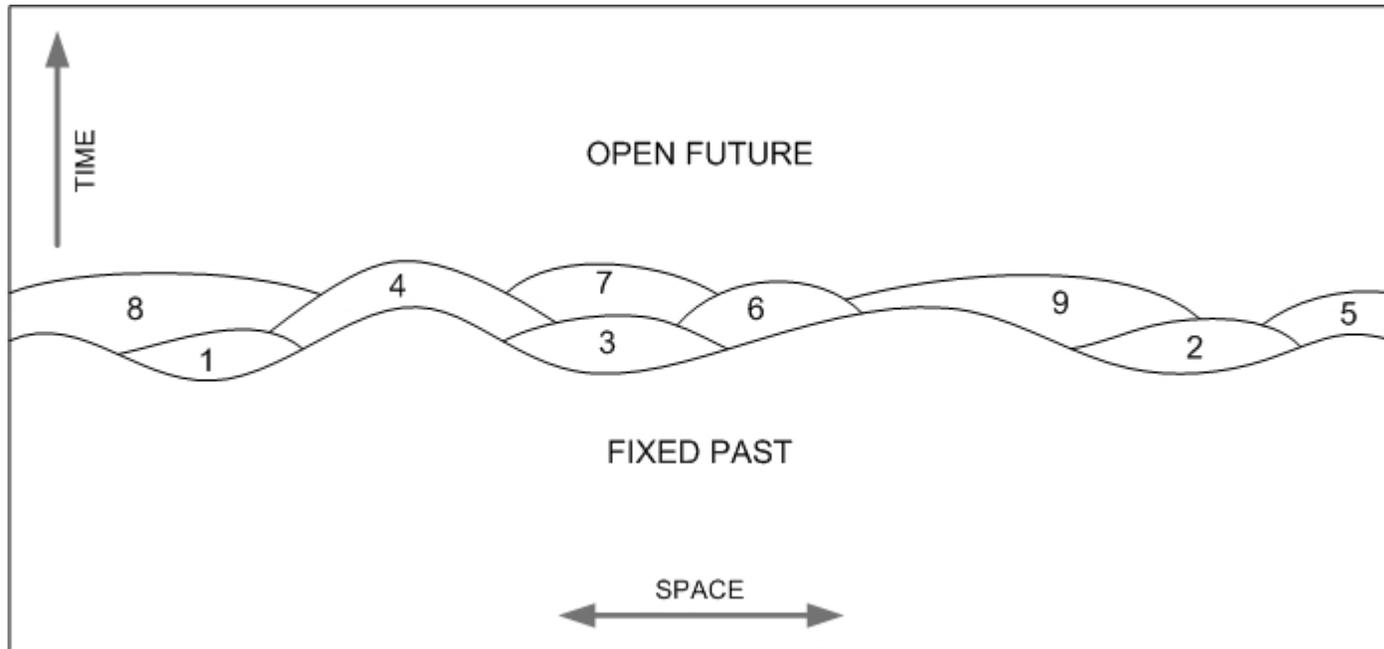
Von Neumann's Non-relativistic QM



Collapse Postulate (NonRel)

- At each one of a sequence of times t_n the state $S(t)$ is abruptly reduced to a new state
---by a Process 1 or 3 event.

RQFT Generalization



Collapse Postulate (Relativistic)

- At each one of an “advancing” discrete sequence of spacelike surfaces σ_n the state $\Psi(\sigma_n)$ is abruptly reduced to a new form.
- The “Moment M_n ” of reduction n is the **front surface** of Region R_n of the diagram.

THE SECOND MAIN POINT!

- The Evolution Described by orthodox QM is evolution via Process 2.
- “PROCESS 2” DESCRIBES THE UNFOLDING OF THE QUANTUM STATE.
- THIS EVOLUTION REPRESENTS THE UNFOLDING (*MERELY*) OF:
- **THE POTENTIALITIES FOR THE NEXT PSYCHO-PHYSICAL EVENT!**

The Process of Choosing
Which Event Will Actually Occur
is Logically&Ontologically
Different From The Process 2
Of Evolving (merely) the
Potentialities For This Event!

Physics Time Versus Process Time

- The Time Occurring in RQFT Is The “Physics Time” in Which ***Potentialities*** Unfold via Process 2.
- If we are to retain intact the beautiful mathematical structure of RQFT then We need ***a different time*** to support the unfolding of Process 0 !!!

Psycho-Physical Dualism Both Ontologically and Dynamically!

QM calls for:

Two different processes linked at/by

THE PSYCHO-PHYSICAL EVENTS!

**Classical physics reduces these two Logically
& Ontologically different processes to one
single process.**

That is why classical thinking fails!

Empirical questions

- **Is there empirical evidence for mental processing that proceeds more rapidly than brain processes would appear to be able to accommodate?**

Idiot Savants?

Does the idea of *two different processes* tied together at psycho-physical events *by the fixed rules of QM* work better *in actual scientific practice* than the classical-physics-based idea of one single classically describable physical process with a causally inert psychological excretion?

Promissory Materialism versus Existing Theory.

Adding Whitehead

So far I have merely filled in what seems to me to be essentially implicit in orthodox vN QM.

Now I will add some nontrivial ideas of Alfred North Whitehead.
(This is more speculative)

Whiteheadian Quantum Ontology

- *Inspired by Whitehead's "Process and Reality" (1928)*
- But built directly upon Relativistic Quantum Field Theory (RQFT) as formulated by Tomonaga and by Schwinger around 1950.

Creation Of Relational Space-Time

Whitehead sees a need to create the *relational space-time* in which the physical relationships hold.

Newtonian Space-Time = Receptacle.

Leibniz Space-Time = Relational Space-Time.

(Empty Space is Nonsense)

A Whiteheadian Process Creates a Relational Space-Time, which is Physical Space-Time.

What is the nature of the Process 0 that selects the P of Process 1 ?

- Whitehead pursues the idea that the process that determines what event will occur next in a specified spatial region is a **psychological-type process** based on the **psychological (conceptual) realities** associated with that spatial region.
- Key Ideas: Appetite & Satisfaction

Localized Psychological Process

- Suppose the next event is localized---as regards its physical aspects---in the brain of some person.
- What are the associated psychological realities?

The Input To The Psychological Process

The *Inputs From the Past* To The Process 0 That Determines

The Process 1 Brain Event Associated With Moment M_n

Are The Psy Sides Of The Events That Have Created The Aspects of the Quantum State Localized At M_n .

An Important Difference

The input to Process 2 is the current physical state itself,
Independent of its Past, but

But the inputs from the past to Process 0 are the psy sides of the psy-phy events that have created that physical state.

How Can One Idea “Know” Another?

- Each Knowing is an ACTION,
- The Knowing of a first Knowing by a second Knowing is a ***re-enacting*** of the first action within the second action.

Memory in a Stream of Consciousness is,
According to Whitehead,
Re-Enactment

“Process 0”

Psycho-Dynamics of the selection of
Process 1.

The “input” to the psy Process 0
draws upon the brain process, but the
process 0 unfolds *not in physical time*
but in a different time:

Process Time.

Selecting Process 1

If this psycho-dynamical process proceeds to a conceptual satisfaction that can be represented in the brain by a projection operator P acting back on the brain then the Process 1 action associated with this P occurs *on the same surface* M_n that was associated with the **input** to the associated Process 0.

The Character of Psycho-Physical Events

- Each psy-phy event is either an “actual occasions”, which creates a conceptual structure and injects it (Process 1) into the quantum state of the universe, or a Process 3 psy-phy event, which specifies nature’s reply to one or more previously posed questions.

Coherent States

- RQFT supports a special kind of strictly quantum mechanical state, called coherent states, that can be labeled by classical states, and that have many properties of classical states. To make the quantum Zeno effect act on an appropriate time scale the projection operators associated with Process 1 should project onto such coherent states.

- The repetitious collapse onto these classically behaving quantum coherent states will tend to keep the state of the brain essentially classically describable, in accordance with our classical-physics-based intuitions, while allowing, however, our conscious intentional efforts to be causally efficacious!

- This dualistic conception of the mind-brain connection ***is not contrary to physics!***
- It is rationally based upon **VALID physical precepts.**
- It is the traditional neuroscience idea of a single essentially classical physical process that “excretes” causally inert consciousness that is contra-physical!

Remark 1

This Model Fills a **NEED:**
The Need to Close the Causal Gap

The orthodox QM is incomplete because the “what” and “when” of the Process 1 actions are not specified by the orthodox dynamical rules of QM.

Remark 2

This Model Accords with Intuitions About Intentions

- The model provides a framework, built on RQFT, that accords with the intuitive idea that our intentions arise from the interplay of psychologically felt motives and evaluations, which themselves arise from states of the brain

Remark 3

This Model Accounts for Pervasive Empirical Data.

- The model gives a framework for understanding, in a physically coherent way, the observed pervasive empirical connection between one's inner experiences of effortful intention and one's frequent subsequent experience of intended bodily actions.

Remark 4

The Model **Exploits** Quantum Uncertainty, Rather Than Ignoring It.

Processes 1 & 3 act **within** the domain of quantum uncertainty, and inject *conceptually organized order* into nature by acting within this domain, where classical physical ideas fail.

Remark 5

The Model Allows Our Mental Capacities to Evolve by Natural Selection.

The model makes our thoughts physically efficacious, thereby giving them both a reason to exist, and the capacity to evolve in ways that enhance an organism's chances of survival.

Non-Anthropocentric

- **The essential prerequisite for this conceptualization is the existence in the physical system of a “template for action”.**

not a mechanism for conscious thought!

Thoughts are related to a physical system,

but the structure of QM suggests that the process of conscious choosing is not represented by the process (Process 2) of physically described unfolding that is represented in contemporary physical theory.

The non-dependence on ordering.

The arguments of Tomonaga and Schwinger show that the ordering of the Process 1 actions is immaterial:

The Process1 actions at places all over the universe can proceed jointly together, and unordered, without affecting any prediction of the theory.

Then Process 3 can act simultaneously on any combination of already-posed (by Process 1 actions) questions.

Faster-Than-Light Action?

- The theory is relativistic: No observer's experience can be affected *faster-than-light* by the *choice* of a faraway Process 1.
- On the other hand, one cannot assume that the outcomes in each of two regions , for each of several incompatible experiments that seemingly *could, alternatively, be performed there, are independent* of the faraway choice of the Process 1 action.

Further details in a New Book

Mindful Universe:

Quantum Mechanics and the
Participating Observer

Springer, July 1, 2007

Website: [http://www-physics.lbl.gov/
~stapp/stappfiles.html](http://www-physics.lbl.gov/~stapp/stappfiles.html)