Quantum Mechanics and Psyche

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Layout

- Synchronicity effects and long distance correlations between individual psyche
- Choice of the past: the photon delayed-choice experiment
- Models of quantum entanglement
  - Long-distance correlations
  - Psychological processes: mourning processes
  - Group unconscious, group insight, group consciousness

Synchronicity effects

Mental state (subjective) ⟷ External world ("objective")

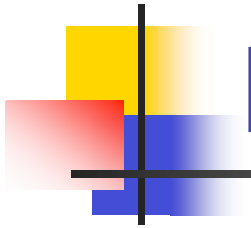
C.G.Jung and W.Pauli

Types of synchronicity effects

- Significant coincidence among psyche
  - Psyche of two individuals (mind-to-mind)
  - Correlations that appear in group therapy or group training
- Significant coincidence between mind and matter
  - Jung remnants of holistic reality: *unus mundus* – "one world" from the alchemist G.Dorn (~ 1600)
  - Could be related to the world of ideas of Plato

Synchronicity effects

- No causal link localised in space and in time
- Global effects (in space and time)
  - Analogy with quantum entanglement
  - Quantum entanglement between mind and matter (H.Primas)
  - Dualistic view of mind and matter (C.G.Jung, W.Pauli, …)

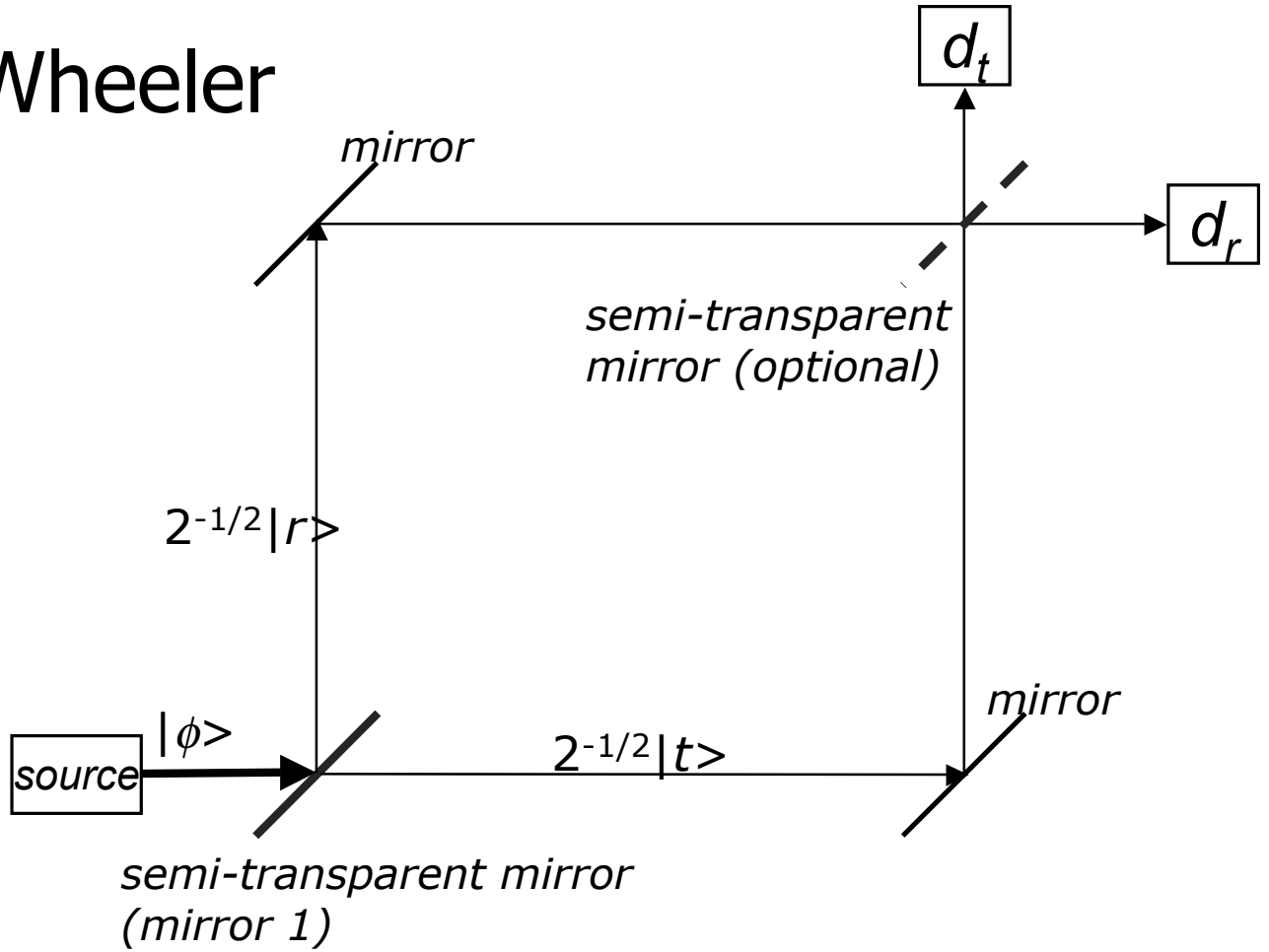


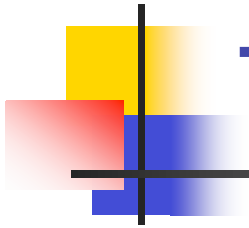
Mental states

- Non localisation of unconscious mental states in space and time
- Mental state not exclusively localised in the human brain
- Mental states treated as quantum states
  - Vectors of Hilbert space

Choice of the past: photon delayed-choice experiment (PDCE)

- J.A.Wheeler



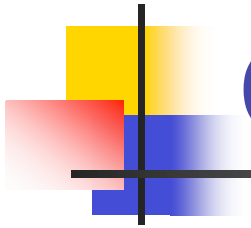


Two levels of reality

- Quantum level
  - Deterministic evolution in time given by a unitary operator
  - In PDCE the photon wave function or the QED field
- Classical level
  - Single reality (consciousness or experimental device)

Passage between the two levels

- Reduction of the wave packet or collapse of the wave function
- Irreversible and non-deterministic

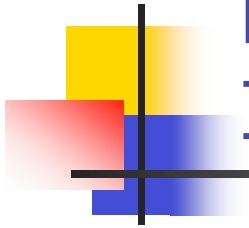


Choice of the past

- Influence on the past of the photon considered as a classical system
- Observer-participancy (Wheeler)
- Repercussion of wave function collapse on the (classical?) past
- Collapse global in space-time

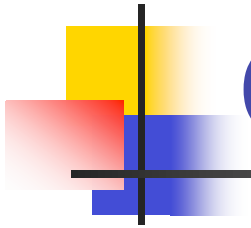
Psychological processes

- Registration of synchronicity effect by consciousness
  - Collapse of the wave function containing the potentiality of the event? (unconscious state)
  - Global (holistic) effect
- Acts and choices trigger off synchronicity effects
- Synchronicity effects appear as non-causal



Models of quantum entanglement - 1
Is there a collapse of the wave function?

- Some models escape the collapse
  - Relative state theory of H.Everett
  - Quantum information theory of Cerf & Adami
    - Measurement process: entropy-conserving unitary interaction
    - No collapse of wave function
    - No quantum jump



Quantum Information Theory

- Quantum object Q
- Measurement device A (*quantum ancilla*)
- EPR state |QA>
- Between Q & A
  - Quantum correlations (super-correlations)
  - No classical correlation
- Another ancilla A’ needed to create classical correlations between part of |QA> and |A’>

Quantum Information Theory

- Creation of an EPR triplet |QAA'> via unitary process
- Density matrix

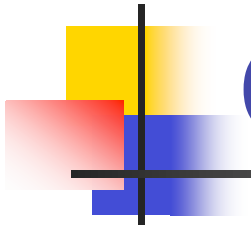
$$\rho_{QAA'}=|QAA'><QAA'|$$

- Classical correlations between A & A' are observable when we do not know the state of Q
  - Correlations between A & Q are unobservable
  - Trace over Q states → mixed state A A'
  - Reduced density matrix

$$\rho_{AA'}^{red} = Tr_Q\left(\rho_{QAA'}\right)$$

Quantum Information Theory

- The *positive* von Neumann entropy of AA' is compensated by a *negative* conditional entropy of Q (when the system AA' is known)
- EPR-triplet |QAA'> remains a pure state after measurement
  - No collapse of the wave function and no quantum jump
- Discriminating experiment needed…

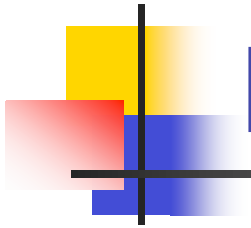


Quantum Information Theory

- A quantum state appears as a classical one as soon as it is quantum-entangled with another system that remains unknown
  - Cerf & Adami → Q unknown
  - Quantum decoherence → environment unknown
- This introduces two ways to look at the Photon Delayed Choice Experiment

Quantum Information Theory
from physics to psyche…

- No collapse of the wave function, no quantum jump (just unitary evolution) is very interesting when treating unconscious state
- No destruction of the quantum-entangled state of the unconscious and of several unconscious



Pointer-states

- Pointer-states of consciousness are defined by interaction of psyche with the environment
- These are compatible with the classical reality that surrounds us
- Minimum of entropy of interaction with the environment

Models of quantum entanglement - 2
Quantum model of mourning

- Binary situation
  - Bob has to face the death of his father
  - Pointer-states

    |BD1> mourning not realised at all

    |BD0> mourning achieved
  - Unconscious states that correspond to conscious pointer-states |BC1>, |BC0>

Quantum model of mourning

- State of Bob's unconscious related to the mourning: superposition of |BD1> and |BD0>

$$\left|BD\right\rangle = \sin\frac{\vartheta}{2}\left|BD0\right\rangle + \cos\frac{\vartheta}{2}e^{i\varphi}\left|BD1\right\rangle$$

Bloch's sphere representation

- Between the unconscious state |BD> and the conscious state |BC> we need an ancilla: the insight |BI>

Quantum model of mourning

- First stage: EPR-doublet between unconscious and insight

$$\left|BD,BI\right\rangle = \sin\frac{\vartheta}{2}\left|BD0\right\rangle\left|BI0\right\rangle + \cos\frac{\vartheta}{2}e^{i\varphi}\left|BD1\right\rangle\left|BI1\right\rangle$$

- Second stage: EPR-triplet with state of consciousness

$$\left|BD,BI,BC\right\rangle = \sin\frac{\vartheta}{2}\left|BD0\right\rangle\left|BI0\right\rangle\left|BC0\right\rangle + \cos\frac{\vartheta}{2}e^{i\varphi}\left|BD1\right\rangle\left|BI1\right\rangle\left|BC1\right\rangle$$

Quantum model of mourning

- Quantum entanglement between unconscious, insight and consciousness
- Density matrix of this pure state

$$\rho_{BD,BI,BC} = \left| BD, BI, BC \right\rangle \left\langle BD, BI, BC \right|$$

- Sum over unconscious states |BD> to which Bob has no access

Quantum model of mourning

- Resulting reduced density matrix

$$\rho_{BI,BC}^{red} = Tr_{BD}\left(\rho_{BD,BI,BC}\right)$$

$$= \sin^2\frac{\vartheta}{2}\left|BI0\right\rangle\left\langle BI0\right\|BC0\rangle\left\langle BC0\right|$$

$$+ \cos^2\frac{\vartheta}{2}\left|BI1\right\rangle\left\langle BI1\right\|BC1\rangle\left\langle BC1\right|$$

- Classical correlation between insight and states of consciousness

Quantum model of mourning

- von Neumann entropy of EPR-triplet (BD,BI,BC) is null

$$S(BD, BI, BC) = 0$$

- Positive von Neumann entropy of (BI, BC)

$$S(BI, BC) = -\left[\sin^2\frac{\vartheta}{2}\log\sin^2\frac{\vartheta}{2} + \cos^2\frac{\vartheta}{2}\log\cos^2\frac{\vartheta}{2}\right]$$

- This positive entropy is compensated by the negative conditional quantum entropy of Bob's unconscious knowing the system (BI,BC)

Models of quantum entanglement - 3
Correlation between Bob & Alice

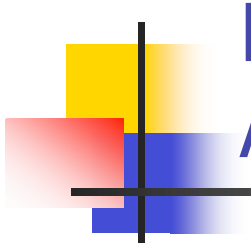
- At the unconscious and insight levels we can suppose a sort of Bose-Einstein condensation
- Part of Alice's unconscious condensates with part of Bob's, to form a single quantum state
- Same holds for insights
- Coalescence, superfluidity, superconductivity… at the unconscious and insight levels

Models of quantum entanglement - 4 Mourning and the correlation between Bob & Alice

- To complete his mourning, Bob sees Alice who is a psychotherapist
- We come back to the state of Bob's unconscious concerning the mourning
- Alice's unconscious will form an EPR-state with this state of Bob's unconscious

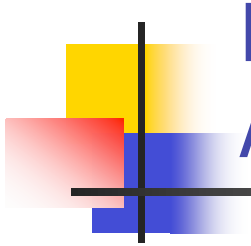
$$\left|BD, AD\right\rangle = \sin\frac{\vartheta}{2}\left|BD0\right\rangle\left|AD0\right\rangle + \cos\frac{\vartheta}{2}e^{i\varphi}\left|BD1\right\rangle\left|AD1\right\rangle$$

Models of quantum entanglement - 4 Mourning and the correlation between Bob & Alice



- Including Alice's insight and consciousness we will have formation of an EPR-quadruplet |BD, AD, AI, AC>
- Sum over unknown |BD,AD>
  - Classical correlation between Alice's insight and consciousness giving her information on Bob's unconscious concerning mourning

Models of quantum entanglement - 4 Mourning and the correlation between Bob & Alice



- The therapist helps Bob to achieve his mourning, i.e. to move the angle θ from 0 to π, via a unitary evolution of the state |BD,AD>
- This is done via quantum entanglement

Models of quantum entanglement - 5
Group states

- For Bob and Alice, if we define group unconscious state as

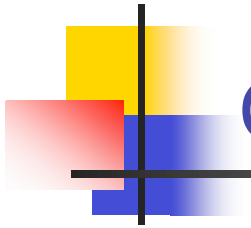
$$\left|D0\right\rangle = \left|BD0\right\rangle\left|AD0\right\rangle$$
$$\left|D1\right\rangle = \left|BD1\right\rangle\left|AD1\right\rangle$$

and similarly, group insight and conscious states |I0> and |I1> and |C0> and |C1> we can write a group EPR-triplet

$$\left|D,I,C\right\rangle = \sin\frac{\vartheta}{2}\left|D0\right\rangle\left|I0\right\rangle\left|C0\right\rangle + \cos\frac{\vartheta}{2}e^{i\varphi}\left|D1\right\rangle\left|I1\right\rangle\left|C1\right\rangle$$

Models of quantum entanglement - 5
Group states

- This can be generalised for more than two persons for example in group therapy or group training
- We propose experiments to test the correlation between members of the group during training sessions
  - “absurd” questionnaires



Conclusions

- Synchronicity effects related to a choice or an act can be associated with a collapse of a wave-function. This collapse has effects in the past, even remote
- On the other hand in situations in which the interaction of the psyche with the environment is minimised, there is no collapse, but a unitary evolution of the wave function (individual or group unconscious)
- We have modelled via quantum entanglement of individual unconscious the correlations that appear between individual psyche