Generalised Quantum Theory and Entanglement

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VQT References

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H. Atmanspacher, Th. Filk, H. R.: "Weak Quantum Theory: Formal Framework and Selected Applications" in Quantum Theory: Reconsideration of Foundations-3, AIP Conference Proceedings, A. Khrennikov ed. vol 810 Melville NY 2006

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Generalised Quantum Theory

- Niels Bohr was convinced that the quantum theoretical structure of complementarity was realised beyond physics. Also W. Pauli, C.G. Jung, W. James,…
- GQT: Minimal formal framework, in which complementarity and entanglement can be well defined
- Sucessive enrichment up to the full quantum theoretical formalism open option
- No physical reductionism but partial structural isomorphy
- Many applications worked out

Generalised Quantum theory

- *System* (identification, isolation, subsystems)
- *State* (not necessarily associated Hilbert space, pure and mixed states)
- *Observable* (Features open for investigation), global and local observables
- *Measurement* (Performing investigation belonging to observable A with result a, which has factual validity)

Observables

- Identification of Observables is a highly creative act
- Associated to every observable A there is a set Spec A, the spectrum of A, the set of all possible outcomes of a measurement of A

Measurement and Eigenstate

- The result of a measurement of an observable A depends on the state of the system but is in general not determined by it.
- After measurement of A with result a the system resides in an *eigenstate* z_a, in which a measurement of A yields the result a with certainty. (“facticity”) An immediate repetition of the measurement will give the same result a and will not change the eigenstate z_a. Idealisation: Measurement not process in time. (“inconsistent history”)

Complementarity

- For *complementary* observables A and B measurements are not interchangeable.
- The final state of the system depends on the order in which the measured values were obtained. After measurements the system is in an eigenstate of the last measured observable
- For given measured value a of A there is general no common eigenstate z_{ab} of A und B.
- Thus, in general no common measurement values can be attributed to complementary observables
- This is the essence of quantum theoretical complementarity
- Non complementary observables are called compatible
- Complementarity experimentally testable. Consistent history formulation of QT can be taken over to GQT

Quantum Analogue Behaviour

- “Measurement” changes state, transition from potential to factual: Psyche from first person perspective, discourse systems, “wine tasting”, believe structures, creative acts, decision acts, complex psychophysical systems
- Possible complementarities: Rationality vs. creativity, mental vs. neuronal, process vs. substance, goodness vs. justice; quantitative applications to bistable perception and questionnaires (H. Atmanspacher, Th. Filk, H.R.,…)

Classical World as Special Case

- Classical theory as a special case of GQT: All observables are compatible, order of measurements does not matter, Simultaneous attribution of values possible for all observables
- This is a strong additional assumption, remember examples. From the standpoint of GQT quantum like theories are more natural, “ontological parsimony”

Differences between QT and GQT

- No quantity like Planck‘s constant controlling the degree of non commutativity. Complementarity and entanglement may be macroscopic.
- No probability distributions for results of measurements. Only modal qualifications „impossible“, „possible“, certain“. No Hilbert space for states, no tensor products, no addition of observables, no C*-algebra, no GNS-construction. Only propositions act on states.
- No basis for derivation of Bell‘s inequalities. Indeterminacies need not be of ontic nature. They may be epistemic. (GQT as phenomenological theory); P. Beim Graben, H. Atmanspacher, Th. Filk
- Even in the absence of quantitative features a general quantum theoretically inspired conceptual framework may be instructive, inspiring and fruitful

Towards Full QT-Formalism

The gap between GQT and QT is not too large

- Definition of conjunction for non compatible propositions
- Modularity: P OR (Q AND R) = (P OR Q) AND R for P ≤ R
- Distributivity for every subsystem generated by compatible $P_1 \leq P_2$ and their negations gives full formalism
- Applications of full formalism to bistable perception, questionnaires, psychophysical correlations,… (Atmanspacher, Filk, H.R., Aerts, Primas, Busemeier, Pothos, Uzan,…)

Entanglement between separated subsystems in full QT

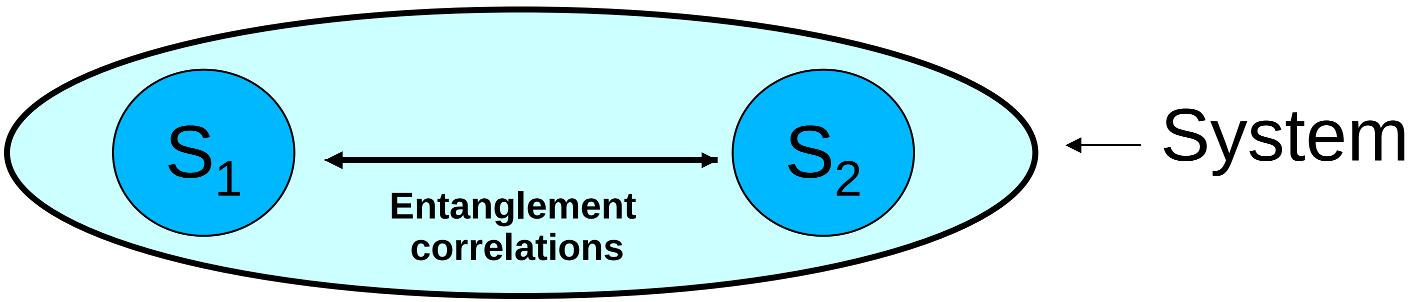
- Total Hilbert space as tensor product of separated components
- Pure entangled state: Not a tensor product of subsystem states
- Mixed entangled state: Not a convex combination of tensor product states
- In any case: Existence of a global observable, which is complementary to local observables pertaining to the subsystems. E.g. projector on entangled state or density matrix interpreted as observable. (Standard example $(\mathbf{s}_1 + \mathbf{s}_2)^2$ vs. $\mathbf{s}_1$ and $\mathbf{s}_2$)

Generalised Entanglement

1. Partition into separated subsystems: Local observables for different subsystems compatible
2. Existence of global observable complementary to local observables
3. Entangled global state, in which values of local observables are undetermined (E.g. eigenstate of global observable). Entanglement correlations as in full QT
4. Product states $(z^{(1)},z^{(2)})$ definable also in GQT, but no superposition principle
5. Axiom NT: Entanglement correlations not usable for signals or controllable causal influences (H.R.: Mind anMatter 2 (2004), 105-125; W. von Lucadou, H.R., H. Walach: Journal of Consciouness Studies 14 (2007) 50-74)

Conditions 2. and 3. are experimentally testable, at least in principle. 5. is an exclusion criterion against entanglement.

Entanglement



- Complementarity of global and local observables
- For entangled states measurement values for subsystems undetermined, but
- *Entanglement correlations* between subsystems: non-local in space and time, Einstein's „spooky interactions",not controllably causal, *not usable for signal transmission* (Axiom NT for GQT, necessary to avoid paradoxes)

Entanglement vs. Mixture

- "Black and white balls" as examples for mixed non product states. Axiom NT holds also in this situation but no global-local complementarity
- In quantum physics, inequalities of Bell's type allow for a distinction between an entangled state and a mixture of product states and for a decision in favor of the ontic character of indeteminacies, complementarity and entanglement.
- In GQT in its most general form the question for the ontic or epistemic origin of indeterminacies sometimes remains open (GQT as phenomenological theory). Compare H. Atmanspacher, Th. Filk: Epistemic Entanglement

Résumé

- Entanglement correlations: Non-causal order structures as fully legitimate elements of reality
- Entangled state does not fully determine the states of subsystems but leaves freedom to them. Holism resides in correlations
- Phenomenological character of GQT. Axiom NT, but non controllable causal mechanisms not excluded, epistemic entanglement possible, causal and non causal ordering may collaborate
- Even in the absence of quantifiable predictions merits of an alternative conceptual framework should be appreciated.

Predictions of GQT for Synchronistic Phenomena 1

No Signal: Everything which at first sight looks like an effect of a controllable signal or causal action is bound to disappear under closer inspection

This is a consequence of the NT-axiom, which is at first a statement of an impossibility, but, similar to the impossibility of a perpetuum mobile of second kind, leads to positive consequences.

Predictions of GQT for Synchronistic Phenomena 2

- Decline- Effect:

  Under repitition and attempts to statistical validation effects dwindle away up to eventual disappearence

  - Converse: „Timm‘s rule“
  - Strategy for repression of undesirable Psi-Effects
  - $E \sim 1/n^{1/2}$

- Reciprocity of effect strength and ease of validation

Predictions of GQT for Synchronistic Phenomena 3

- Displacement/Evasion:

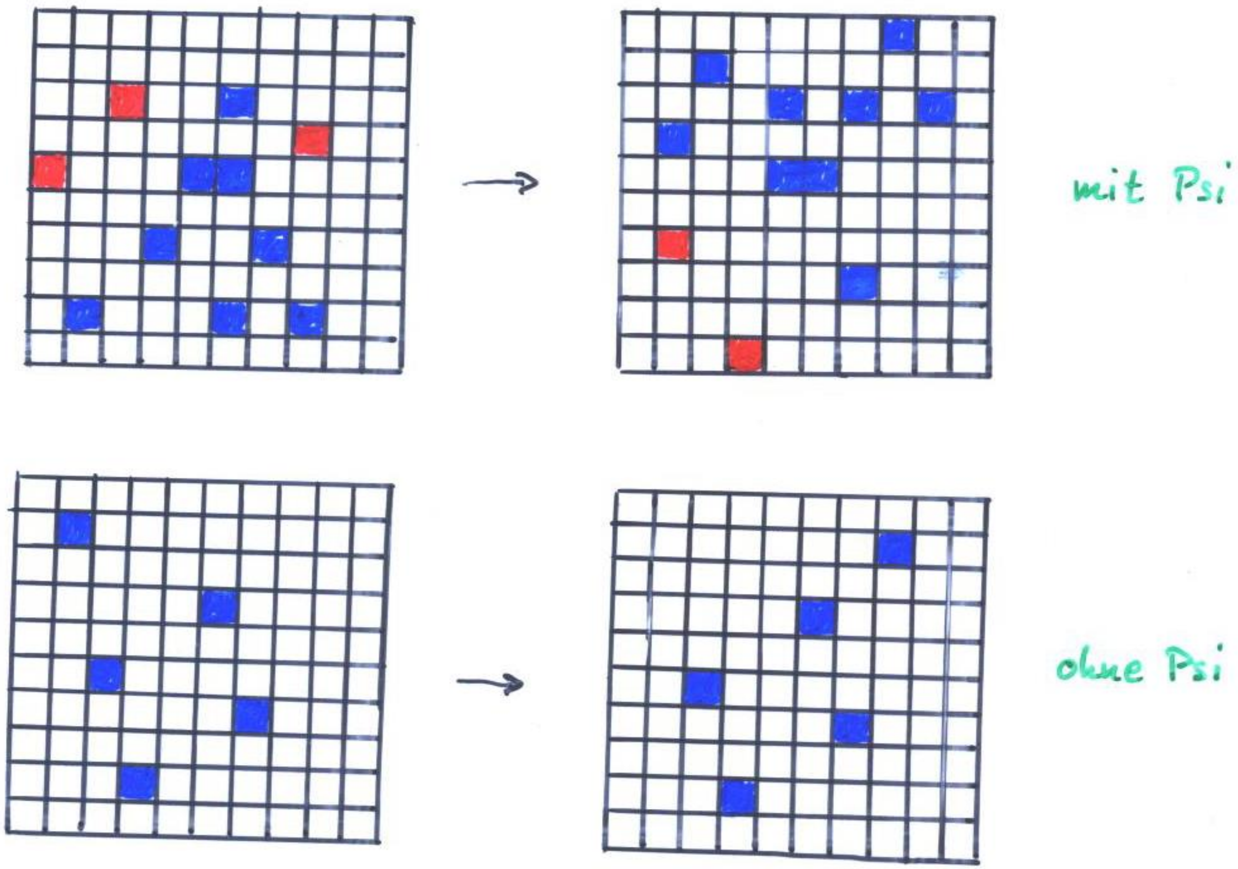
  When one tries to catch or nail down synchronistic phenomena they tend to show up not where one is looking for them but at unexpected different places.

  - „Rosebug instead of scarabeus“
  - Movability and lack of marcability for sematically marked objects (Quantumtheory)
  - Elusive, „goblin-like“ character of synchronistic Phenomena

Planning of Psi-Experiments 1

- Large effects not to be expected under laboratory conditions.
- Organisational closure (entangled state) must be kept stable and not be destoyed by observation.
- One should concentrate on correlations rather than causal influences. Their exclusion is somtimes clear (precognition, presentiment) sometimes problematic.
- Displacement should be used for reducing the decline effect: Many open channels may be helpful; metaanalyses; replications not very promising; correlations expected to jump and change

Planning of Psi-Experiments 2



W. Von Lucadou, H. Römer, H. Walach:
Journal of Consciousness Studies 14 (2007) 50-74

Order Structures

	Material	Mental
Time directed, influencing, signalising	Physical causality	Information Intensions Psycic causality
Undirected, Patterns, understanding	Physical entanglement and patterns, Laws of nature	Gestalt, entanglements of sense and meaning