

A Novel Approach to the Scientific Understanding and Exploration of Consciousness

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Roots and Future of Consciousness

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Introduction: Problem of Consciousness

- ▶ Consciousness is the essence of our existence.
- ▶ Conscious awareness manifests itself in a huge variety of phenomenal qualities:
 - ▶▶ Sweet juicy taste of a fresh strawberry,
 - ▶▶ Fragrance of a rose,
 - ▶▶ Moment of happiness while viewing a colorful sunset.
- ▶ Subjective, experiential character of conscious states → qualia.
- ▶ Scientific explanation of qualia cannot be simply reduced to the physical properties of the associated brain states.
- ▶ Explanatory gap: the hard problem of consciousness.
- ▶ Challenge: development of a theory of consciousness that bridges the gap and improves our understanding of phenomenal awareness.

(Chalmers, 1995, 1996)

Requirements for a Theory of Consciousness

- ▶ Theory of consciousness is ultimately expected to ...
 - ▶▶ be seamlessly integrated into the physical worldview,
 - ▶▶ correctly predict the states of consciousness that are associated with the physical states of any given system,
 - ▶▶ assign a state of consciousness to any physical state.

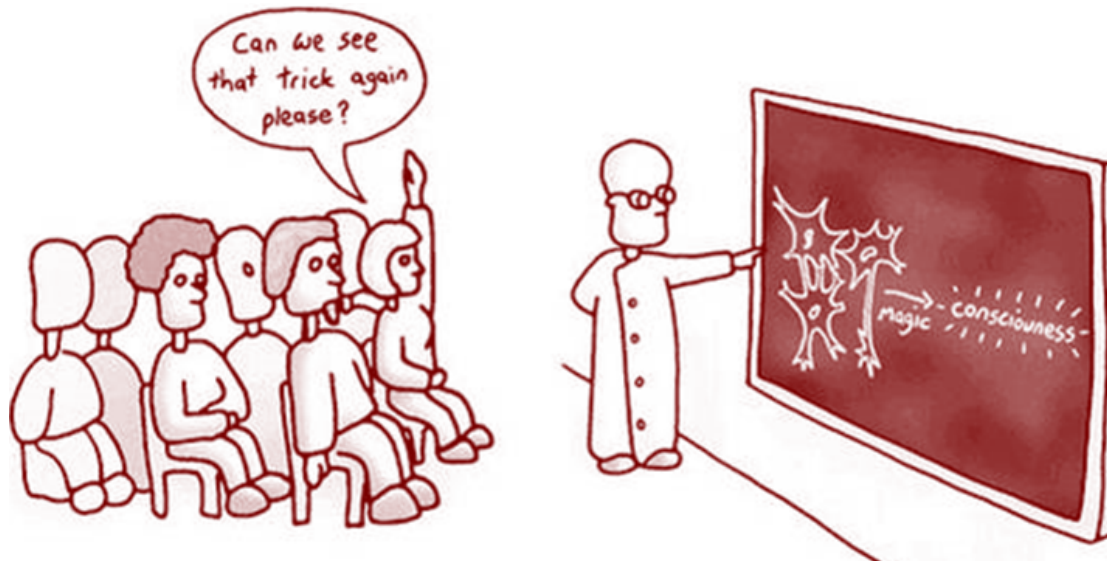
- ▶ Ambitious goal that can be accomplished only after a longer process of theory building.

- ▶ Guiding research questions:
 - ▶▶ What is the relationship between brain and consciousness? 1
 - ▶▶ What is the substrate of consciousness? 2
 - ▶▶ What is the mechanism behind conscious systems? 3
 - ▶▶ What distinguishes conscious from non-conscious systems? 4
 - ▶▶ How is the mechanism realized in the brain? 5
 - ▶▶ How can we measure the quantity of consciousness of a given system? 5

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Option 1: Brain is the Generator of Consciousness

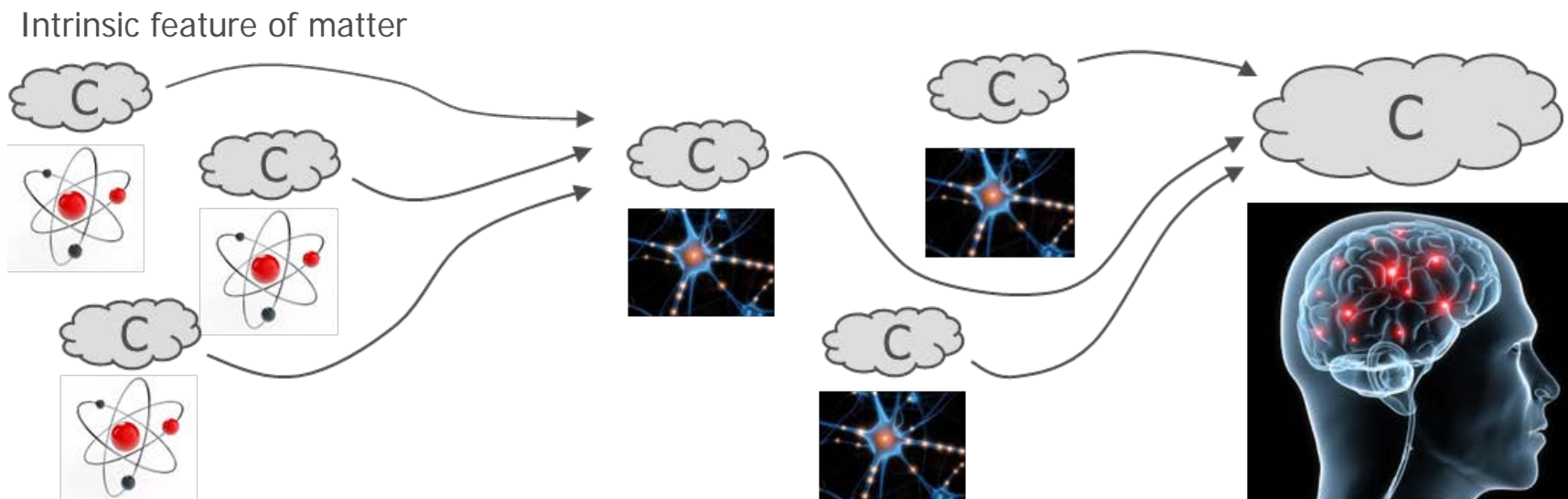
- ▶ **Hypothesis:** consciousness arises as an emergent property of a large collection of interacting neurons and their activity patterns.
- ▶ **Challenge:** if qualia truly emerge from physical processes, this act of creation must be explicable by means of a reasonable mechanism and intelligible laws of nature.
- ▶ **Problem:** while all emergent phenomena known in physics can be explained on the basis of weak emergence, the emergence of consciousness from originally non-conscious system components requires strong or brute emergence → magic.



(Strawson, 2006)

1 Option 2: Brain is an Assembler of Consciousness

- ▶ **Hypothesis:** brain assembles higher states of consciousness from a great number of elementary building blocks of consciousness (intrinsic feature of matter).
- ▶ **Challenge:** if there are conscious and non-conscious systems in the universe, a scientific approach has to explain the difference between the two types of systems.
- ▶ **Problem:** identification of a plausible aggregation mechanism that is able to explain how our rich spectrum of unified macro experiences emerges from a limited spectrum of micro experiences → combination problem of panpsychism.

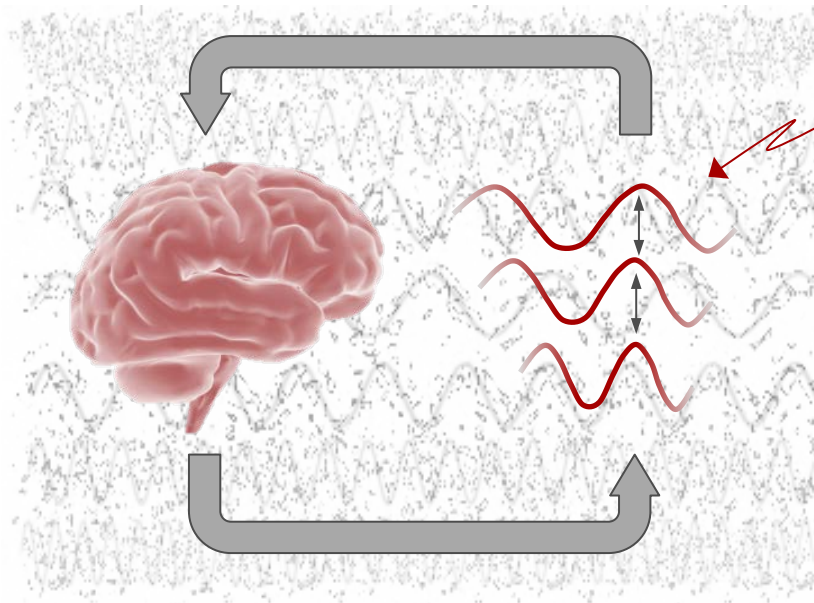


(Seager, 1995; Goff, 2009; Chalmers, 2013)

① Option 3: Brain is a Filter of Consciousness

- ▶ **Hypothesis:** (a) full spectrum of phenomenal qualities is built into the frequency spectrum of a ubiquitous background field; (b) conscious systems employ a universal mechanism by means of which they extract phenomenal nuances from this field.
- ▶ **Challenges:**
 - (a) promising candidate for the background field,
 - (b) appropriate mechanism,
 - (c) evidence that conscious processes in the brain are based on this mechanism.

②
③
④



Principle of flexible coupling of selected frequencies is ideally suited to extract a huge variety of phenomenal nuances from the available phenomenal color palette and to conflate shades of phenomenal awareness into unified moments of consciousness

(Keppler, 2012, 2013, 2015)

Zero-point Field as the Substrate of Consciousness

- ▶ Modern perspective of physics acknowledges the structure of the vacuum as the primary reality from which the properties of matter emerge as the secondary reality.
- ▶ Stochastic electrodynamics: Conception that the vacuum is imbued with permanent activity → all-pervasive stochastic radiation field → zero-point field (ZPF).
- ▶ ZPF is inherently complete (full spectrum of frequency components) and of stochastic nature (frequency components are entirely uncorrelated among each other).
- ▶ ZPF is qualified for playing the dual role as both the carrier of energy and consciousness.

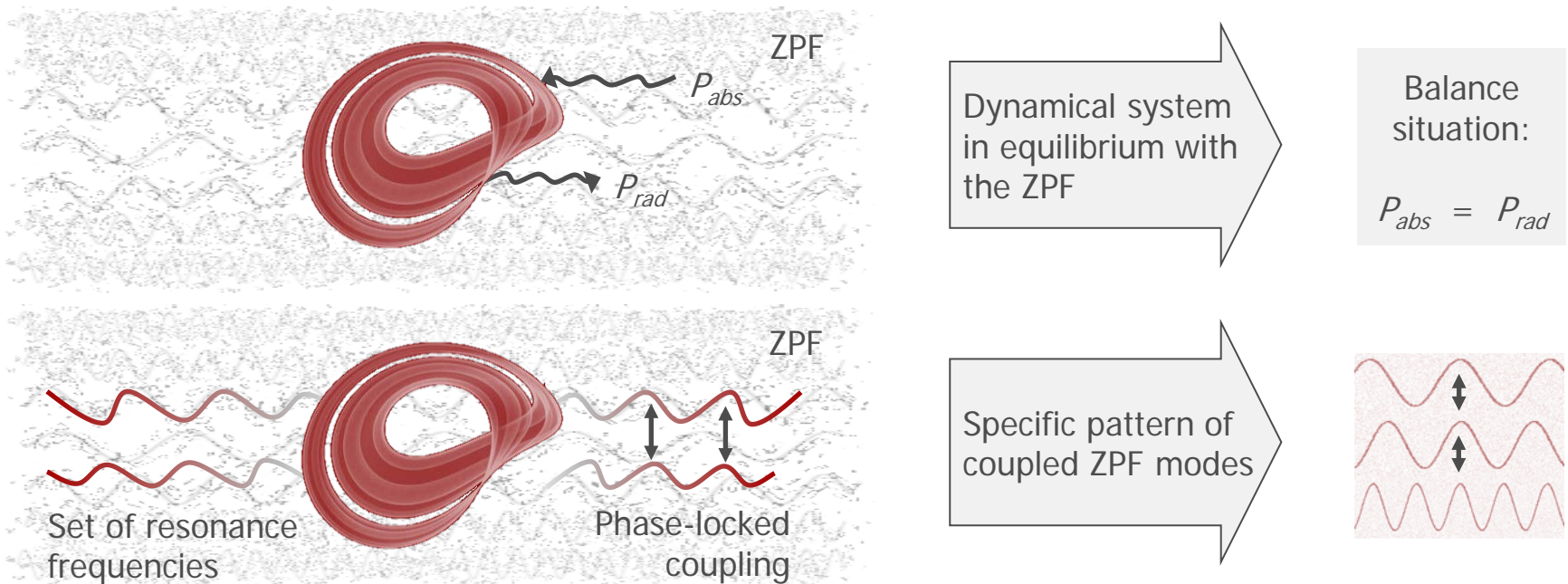
Hypothesis: ZPF is the substrate of consciousness

All shades of phenomenal consciousness are inherent in the full frequency spectrum of the ZPF

(Kepler, 2015)

3 Mechanism Underlying Conscious Systems

- ▶ Electrically charged constituents of every physical system interact permanently with the ZPF, thus behaving as stochastic oscillators.
- ▶ Under appropriate conditions a balance situation can be reached → the system falls into an attractor and enters the quantum regime.
- ▶ Formation of an attractor is accompanied by a pattern of phase-locked ZPF modes.



(De la Peña and Cetto, 1994, 1995, 1996, 2001, 2006; Cetto et al., 2012; De la Peña et al., 2009, 2015)

Interpretation of the Phase Locking Mechanism

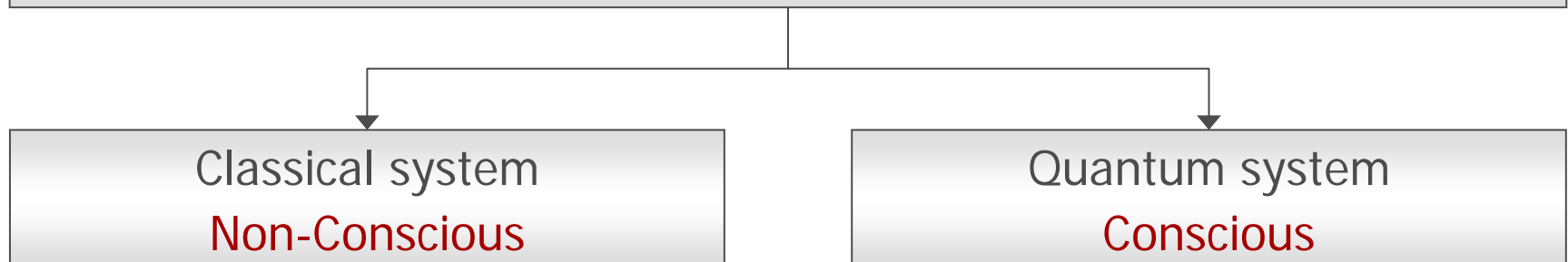
- ▶ **Filtering:** quantum systems filter their sets of resonance frequencies selectively out of the full ZPF spectrum → the formation of an attractor corresponds to a chord played on the keyboard of the zero-point field.
- ▶ **Information:** quantum systems leave characteristic fingerprints in the ZPF → the formation of an attractor imprints an information state on the ZPF.

Following the hypothesis that the ZPF is the substrate of consciousness, I posit that ...

- ▶ every ZPF information state is associated with a conscious state,
- ▶ every quantum system is a conscious system.

Strong argument:

- ▶ Universal mechanism that provides such systems with the ability to acquire not only their physical properties, but also their phenomenal qualities.

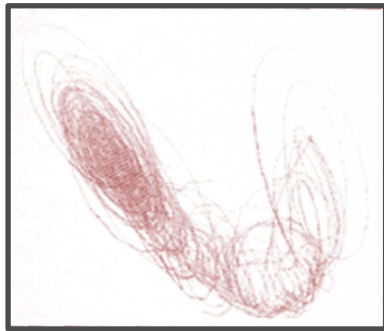


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Realization of the Mechanism in the Brain

- ▶ Neurophysiological body of evidence supports the view that the brain has all the characteristics of a macroscopic quantum system.
- ▶ Dynamical properties of the neural correlates of consciousness can only be understood on the basis of quantum physics.

Disordered phase /
unconscious phase



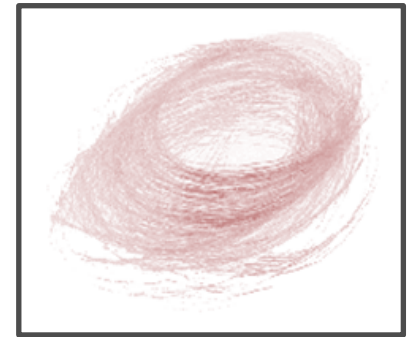
Irregular dynamics
Spontaneous activity
1/f scaling behavior

Brain operates near a
critical point of a phase transition



Appropriate stimulus induces
an abrupt phase transition

Ordered phase /
conscious phase



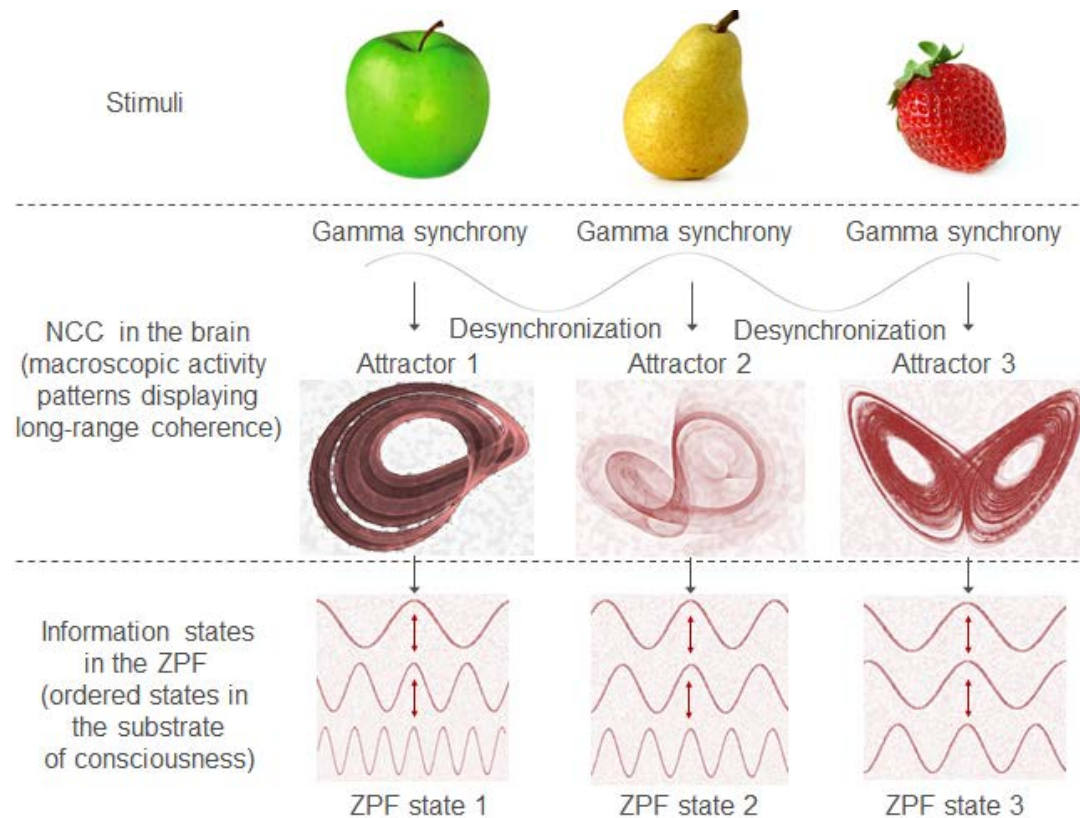
Long-range correlations
(gamma synchrony)
Stable attractors

(Freeman, 1991, 2004, 2005, 2007, 2009; Freeman and Vitiello, 2006, 2007)

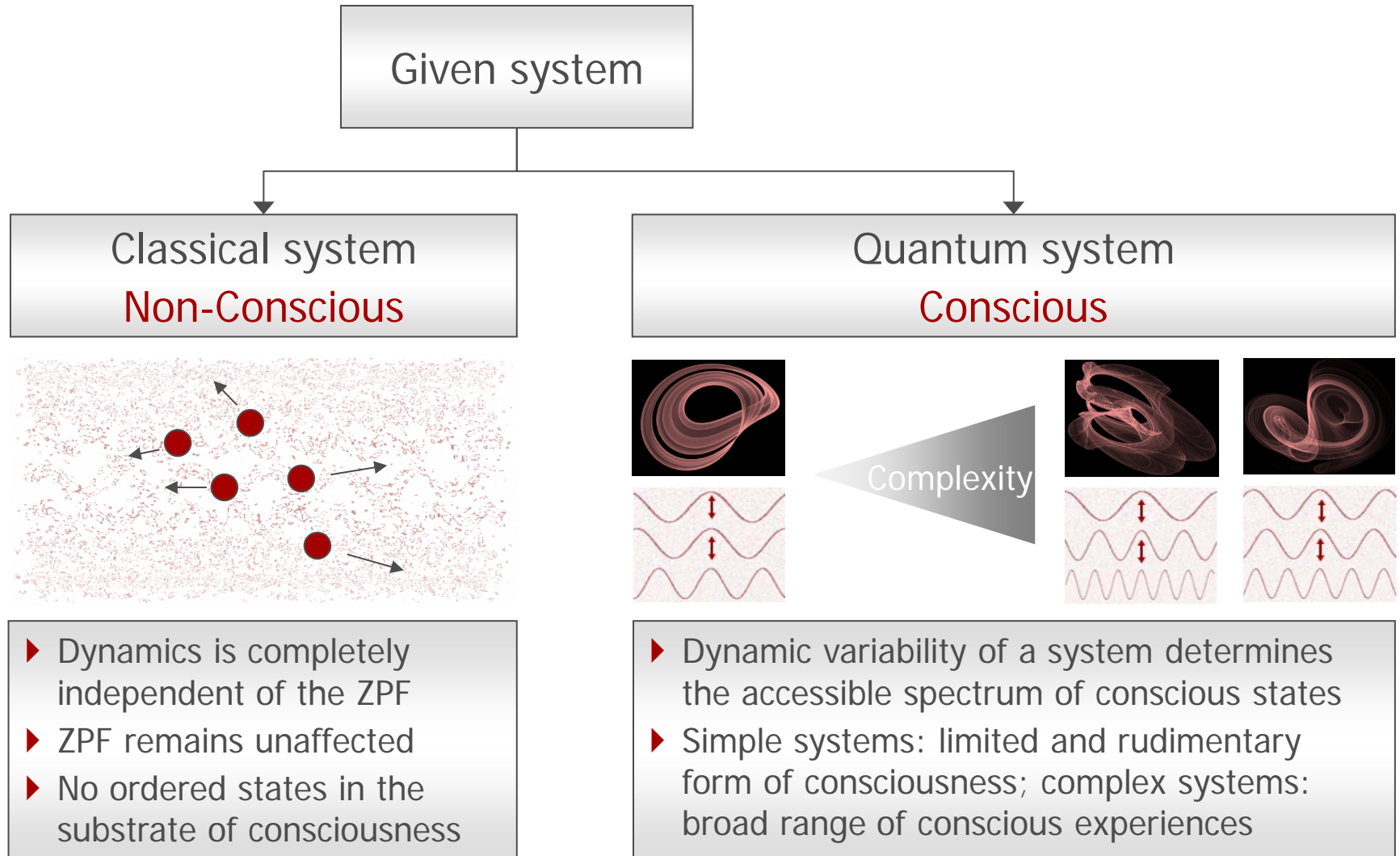
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How the Brain Produces a Stream of Consciousness

- ▶ Fundamental mechanism behind conscious processes is the recurring formation and dissolution of quantum states.
- ▶ Brain produces an individual stream of phenomenal awareness by periodically modifying the presumed substrate of consciousness.



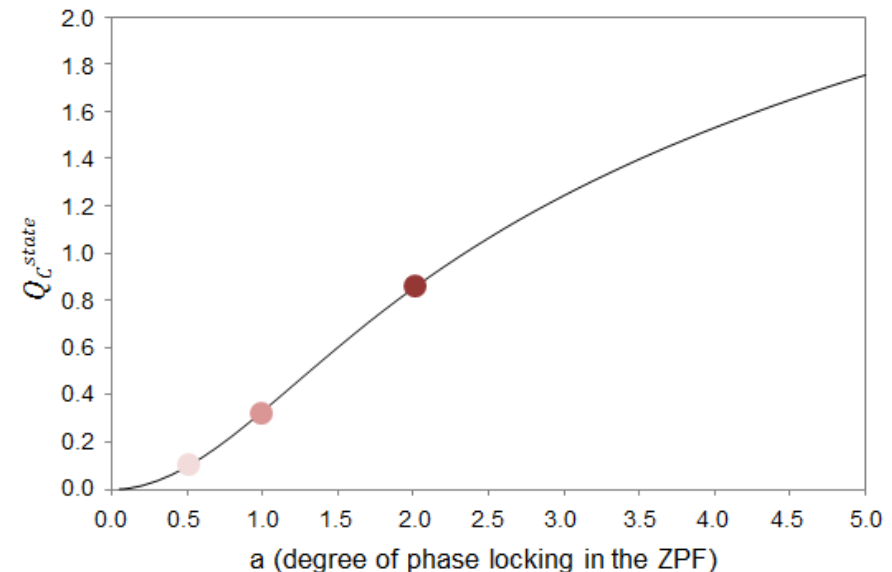
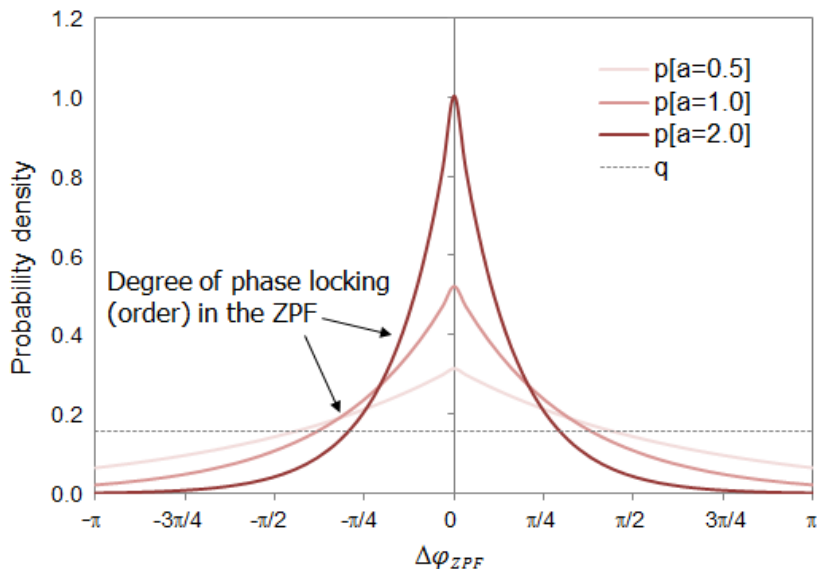
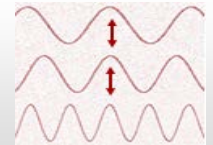
(Kepler, 2013)



Indicator for the Quantity of Consciousness of a State

- ▶ Natural measure for the quantity of consciousness of a state is the degree of order in the local ZPF.
- ▶ Information gain of the corresponding ZPF information state compared to the disordered initial state:

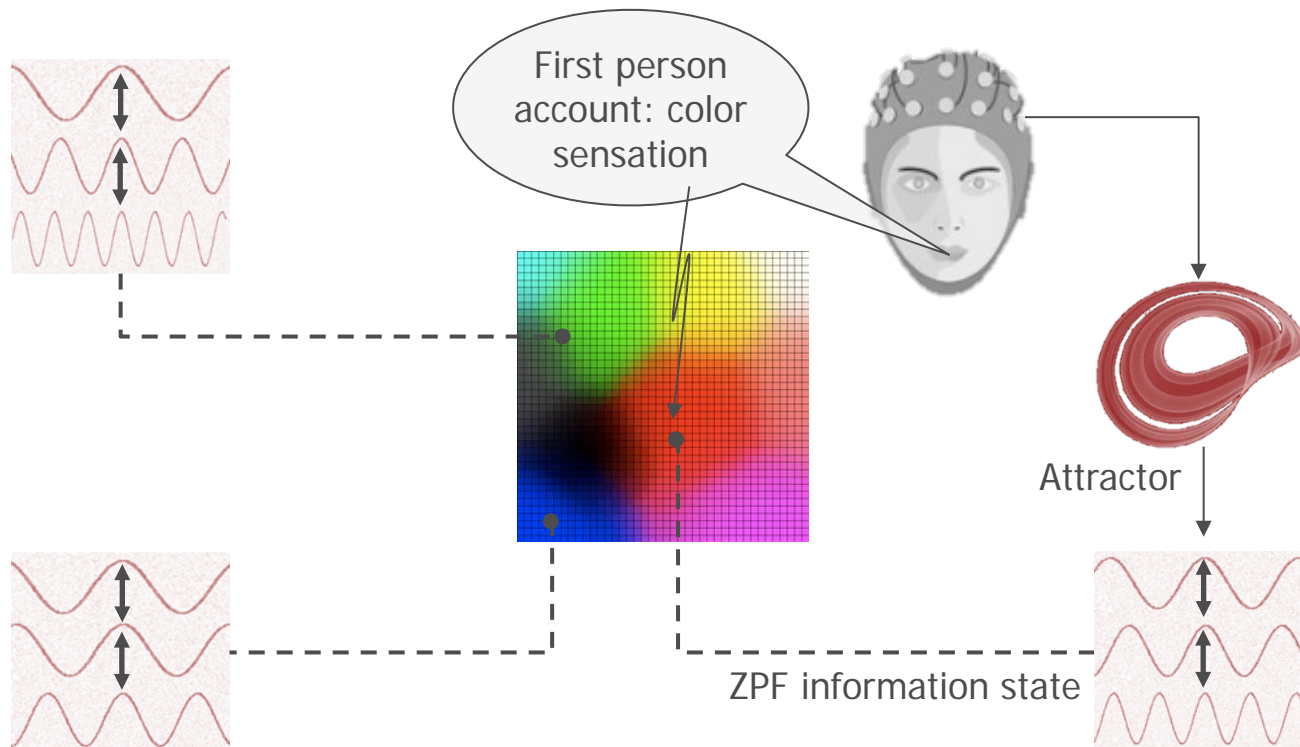
$$Q_C^{state} = \int_{-\pi}^{\pi} p(\Delta\varphi_{ZPF}) \log \frac{p(\Delta\varphi_{ZPF})}{q(\Delta\varphi_{ZPF})} d(\Delta\varphi_{ZPF})$$



(Kepler, 2015)

Outlook: Toward a Science of Consciousness

- ▶ **Hypothesis:** qualia space can be systematically explored by classifying ZPF information space.
- ▶ **Strategy:** classification and calibration of ZPF information states on the basis of first-person accounts.



(Kepler, 2015)

Conclusions

- ▶ Powerful approach to tackle the problem of consciousness.
- ▶ Proposed solution is comprehensive and conceptually coherent.
- ▶ Manages very well to integrate our current knowledge about mind and matter into a consistent picture.
- ▶ Preserves the principle of causal closure and answers the question of how phenomenal awareness can be reconciled with the laws of nature.
- ▶ Specified mechanism behind conscious systems offers an explanation for the unity of phenomenal consciousness.
- ▶ Provides demarcation criteria for the domain of consciousness and sheds light on the conditions under which a given system can have conscious experiences.
- ▶ Criteria are hardware- and species-independent, making them a suitable basis for the classification of all kinds of organisms.

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