Tackling the Hard Problem

A View Behind the Scenes of Matter Provides Valuable Clues for the Development of a Theory of Consciousness

Toward a Science of Consciousness 2012

Tucson, April 10, 2012

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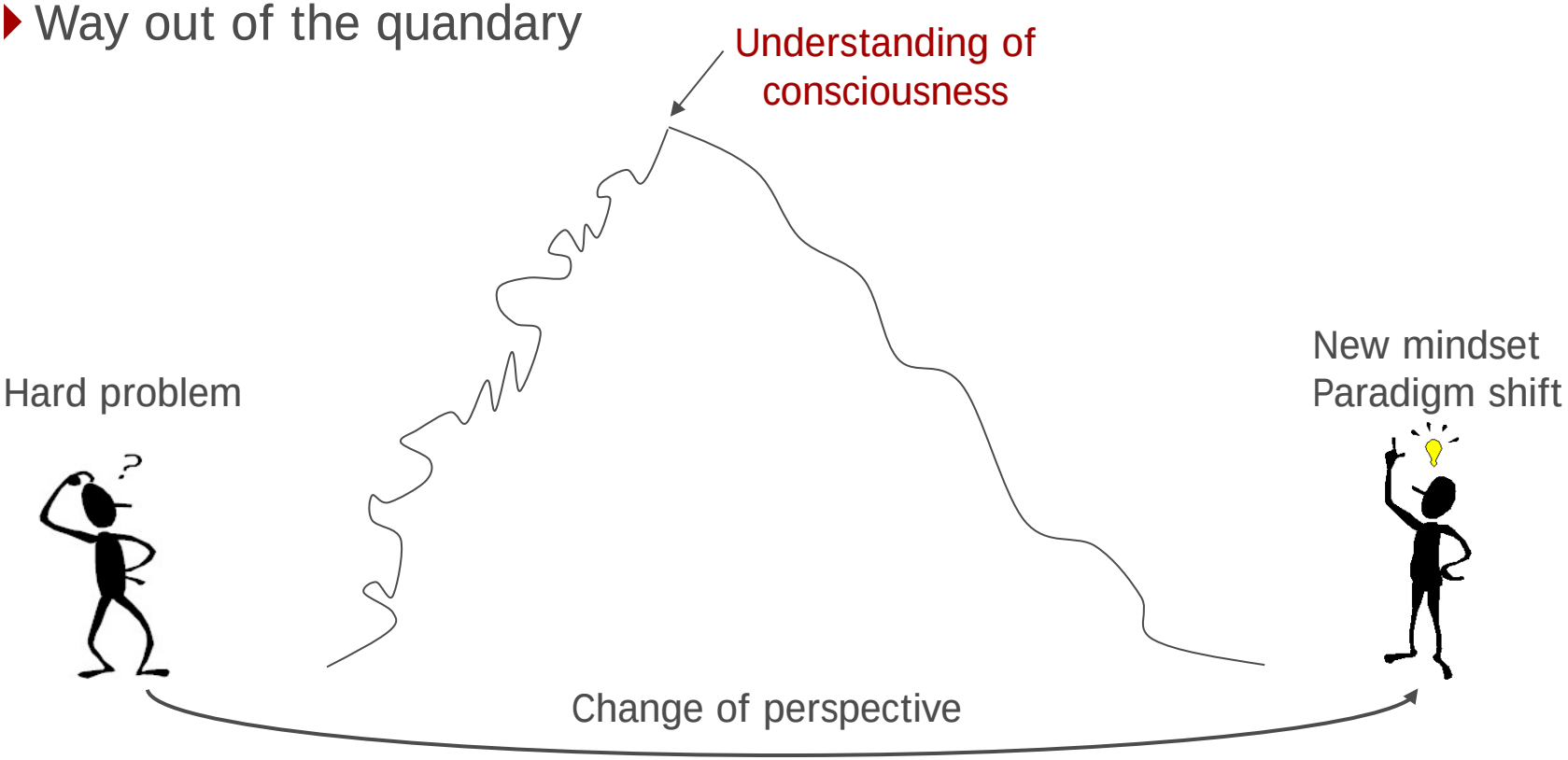
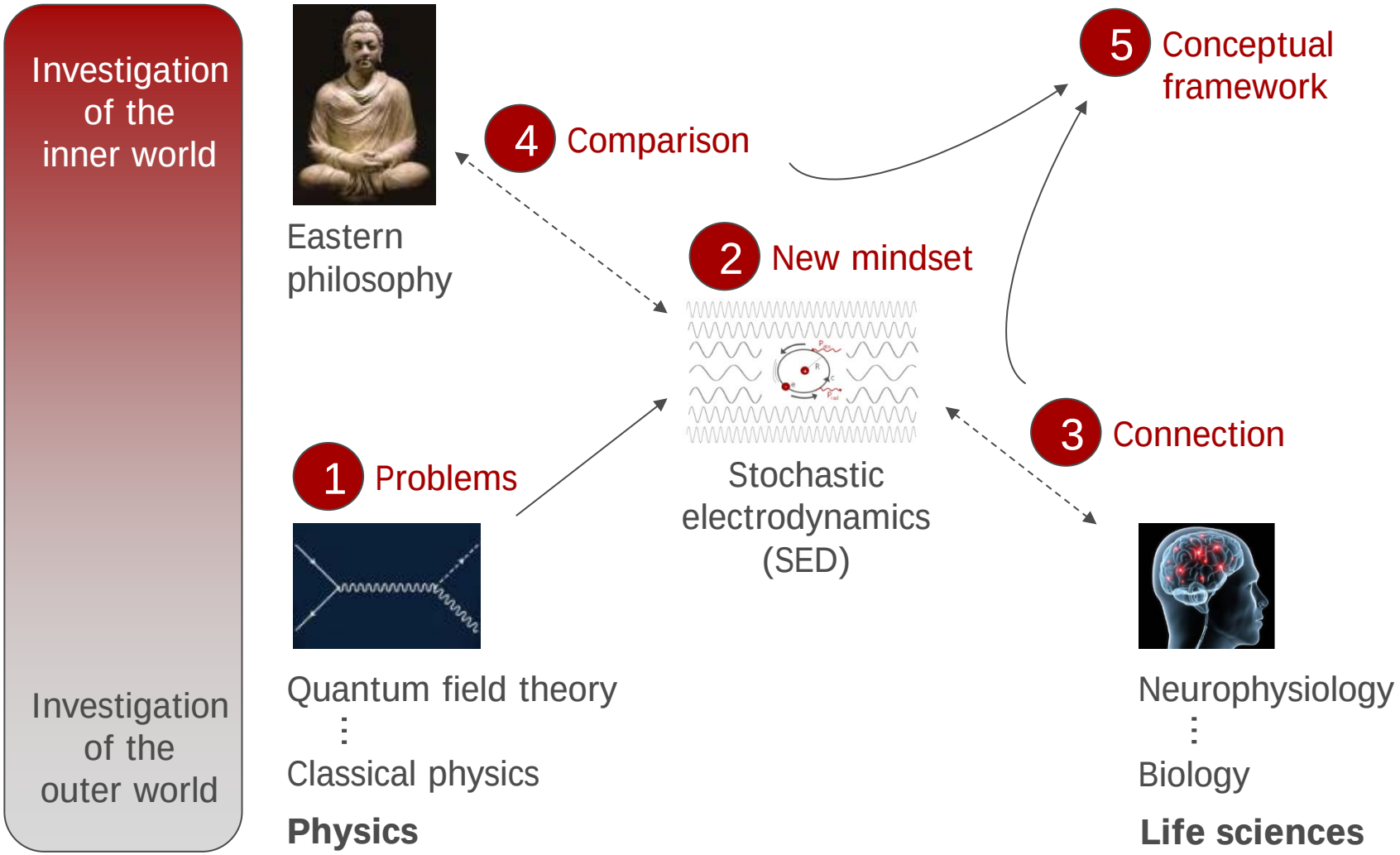
Tackling the Hard Problem

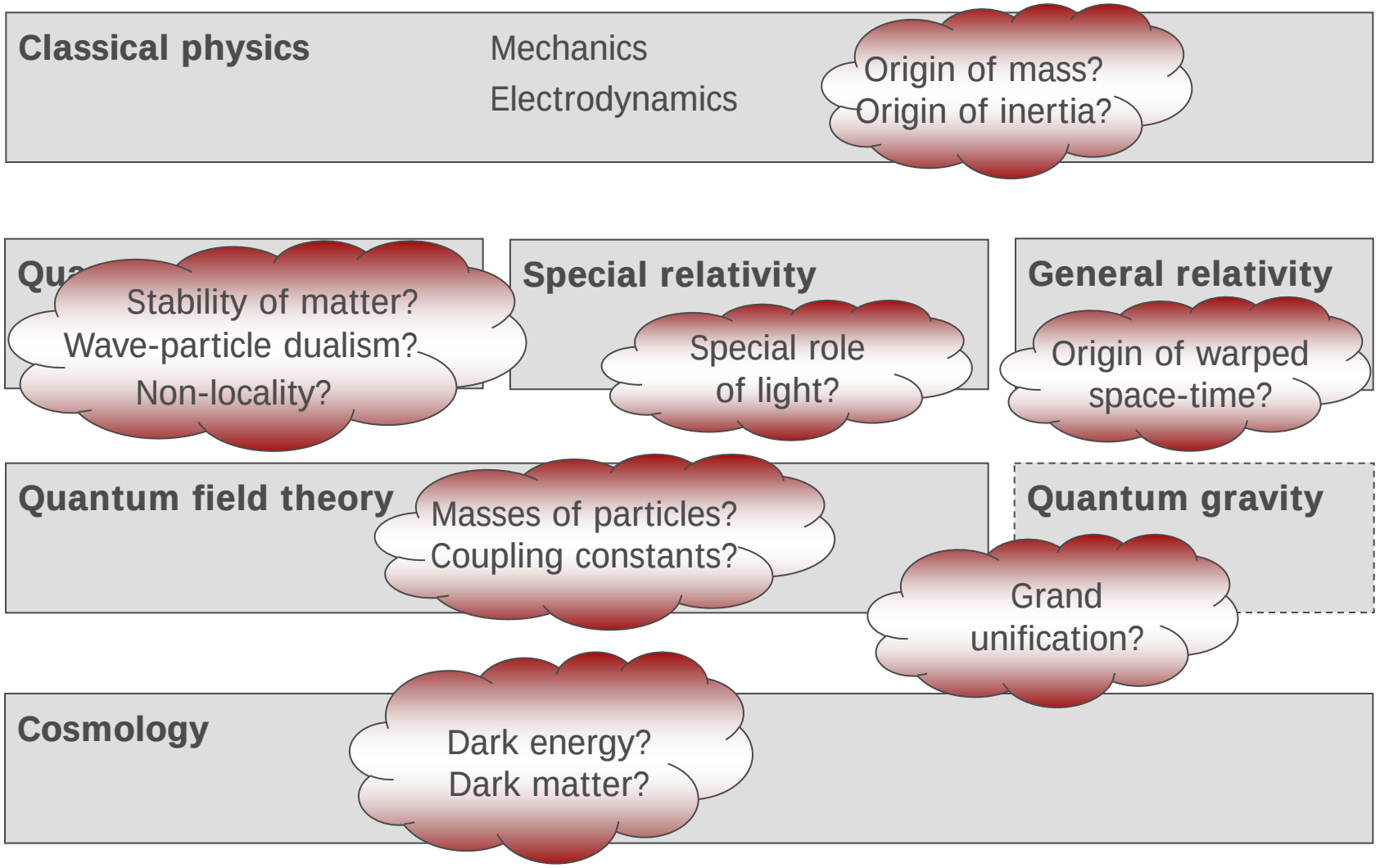
- Hard Problem (Chalmers, 1996)
  - How can physical matter give rise to conscious experience?
  - How can physics be reconciled with consciousness?
- Way out of the quandary



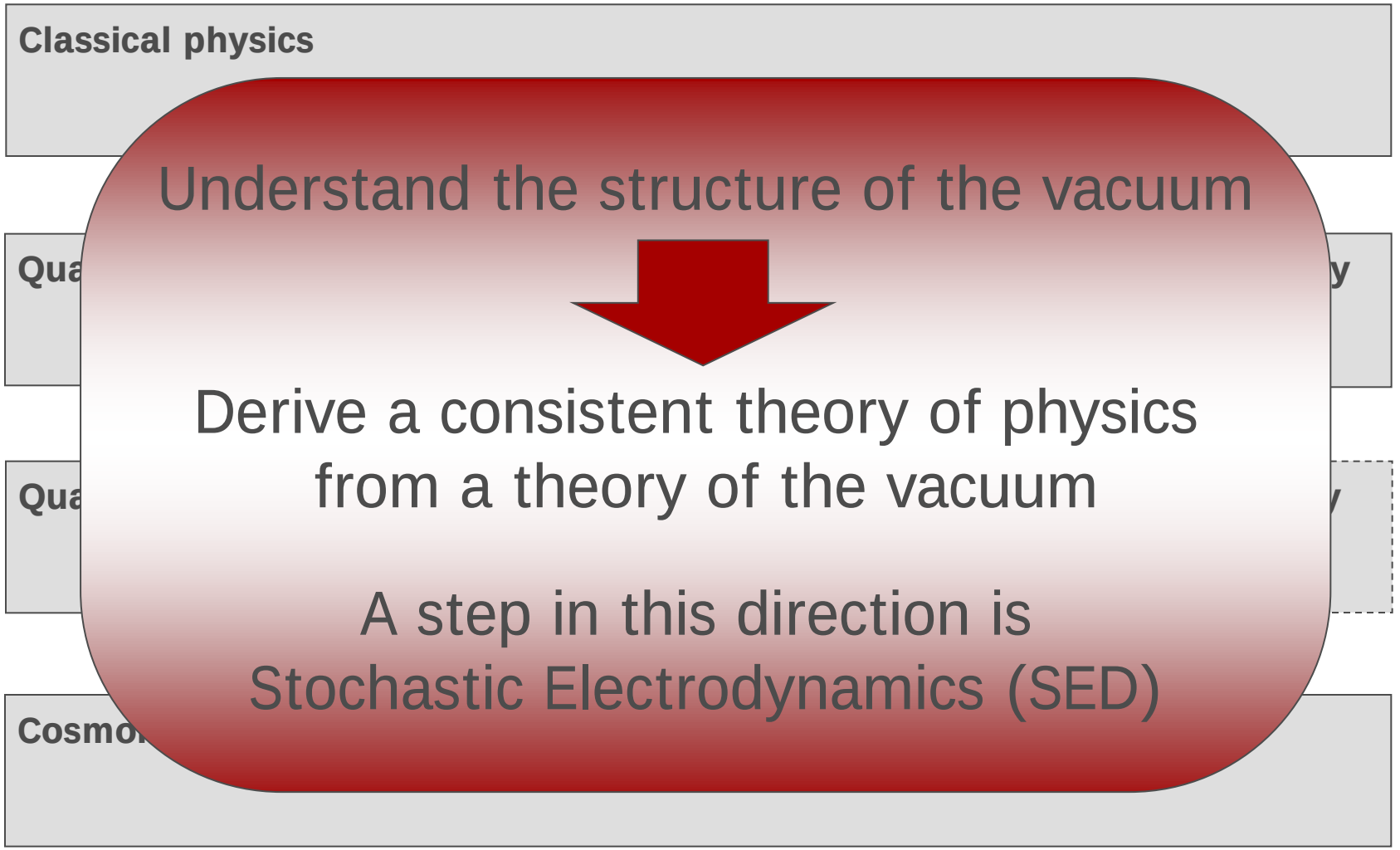
Path through the Presentation



Problems and Open Questions of Physics



The Key to Solving the Problems and Open Questions



The Vacuum of SED is Filled with a Stochastic Radiation Field

Zero-point field (ZPF)

Infinite sea of light, all-pervasive radiation field, pure energy and potential

Perfect symmetry: homogeneity, isotropy, Lorentz invariance, scale invariance

$$\mathbf{E}_{ZP}(\mathbf{r},t) = \sum_{\lambda=1}^{2} \int d^3\mathbf{k} \left(\frac{\hbar\,\omega}{2\,\pi^2}\right)^{1/2} \boldsymbol{\varepsilon}(\mathbf{k},\lambda)\cos\left(\mathbf{k}^*\mathbf{r} - \omega\,t + \theta(\mathbf{k},\lambda)\right)$$

random phase

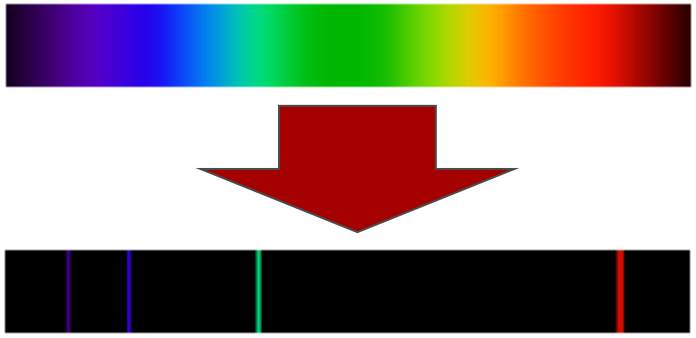
$$\mathbf{B}_{ZP}(\mathbf{r},t) = \sum_{\lambda=1}^{2} \int d^3\mathbf{k} \left(\frac{\hbar\,\omega}{2\,\pi^2}\right)^{1/2} \left(\mathbf{k} \times \boldsymbol{\varepsilon}(\mathbf{k},\lambda)\right)\cos\left(\mathbf{k}^*\mathbf{r} - \omega\,t + \theta(\mathbf{k},\lambda)\right)$$

$$\rho_{ZP}(\omega) = \frac{\hbar\,\omega^3}{2\,\pi^2\,c^3}$$

(Marshall, 1963; Boyer, 1975; de la Peña and Cetto, 1996)

Paradigm Shift: Vacuum and Creation Principle of SED

- Vacuum is filled with permanent activity
  - Real, persistent background field (ZPF) instead of virtual fluctuations
  - Starting point of the theory instead of unavoidable by-product
  - Core ingredient instead of problematic appendage
- Creation principle
  - Physical phenomena are filtered out of an infinite potential
  - Creation amounts to selective restriction of the ZPF



Creation through selective filtering

- It is exactly this mindset inherent in SED that constitutes the required paradigm shift.

(de la Peña and Cetto, 1996; Haisch, 2006)

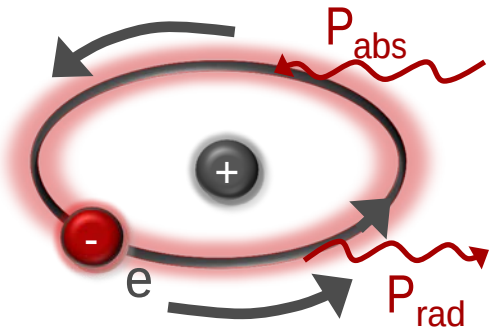
Interaction between ZPF and Matter: Impacts on Matter (I)

Example: hydrogen atom

Stability through selective filtering of the ZPF

Balance condition: $P_{rad} = P_{abs}$

Dynamic creation of stability



Quantization of energy levels:
$m\,v\,R = n\,\hbar$

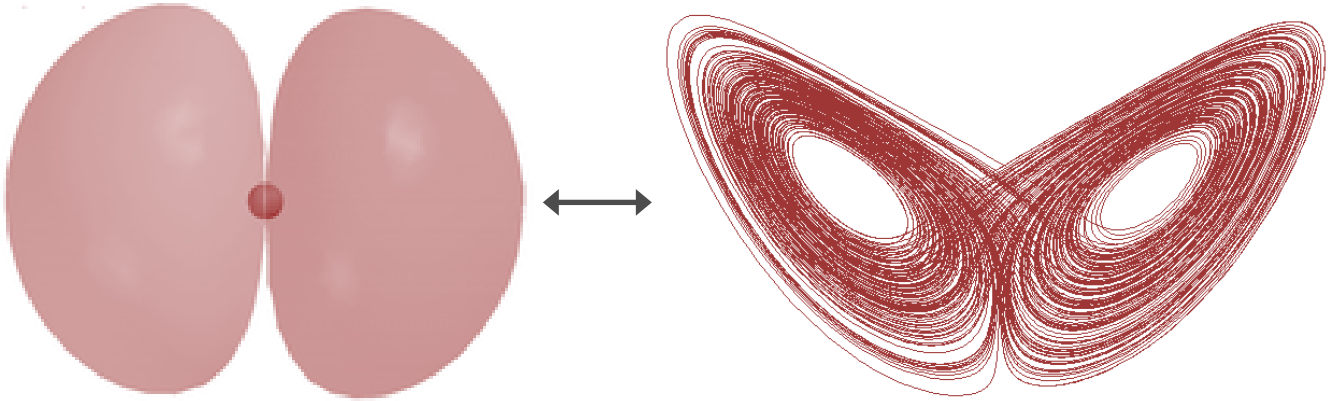
$$m\,\ddot{\mathbf{r}} = -\frac{e^2\,\mathbf{r}}{|\mathbf{r}|^3} + \frac{2\,e^2}{3\,c^3}\,\dddot{\mathbf{r}} - e\left(\mathbf{E}_{ZP}(\mathbf{r},t) + \frac{\mathbf{v}}{c} \times \mathbf{B}_{ZP}(\mathbf{r},t)\right)$$

(Cole and Zou, 2003; Cavalleri et al., 2010)

Interaction between ZPF and Matter: Impacts on Matter (II)

Example: hydrogen atom

Structure and conformation are governed by the ZPF



Orbitals are stable attractors of a stochastic interaction process

External stimuli can cause transitions between different attractors

(Rodriguez, 2012)

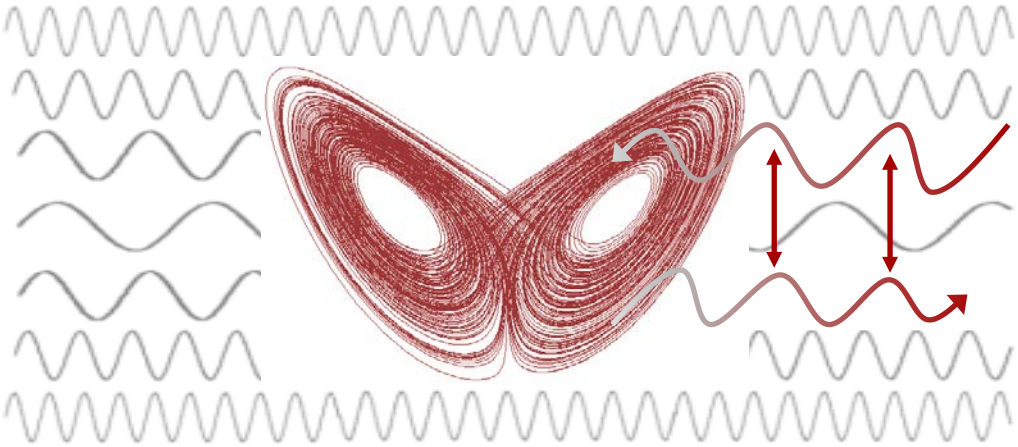
Interaction between ZPF and Matter: Impacts on ZPF

- Study simple nonlinear system driven by the ZPF:

$$\ddot{x} = -\omega_0^2 x - \beta x^2 + \tau \dddot{x} + \frac{e}{m} E_{ZP}(t) \quad \text{with} \quad E_{ZP}(t) = \int d\omega \, \tilde{E}(\omega) \, e^{-i\,\omega t + \theta(\omega)}$$

initially random phase

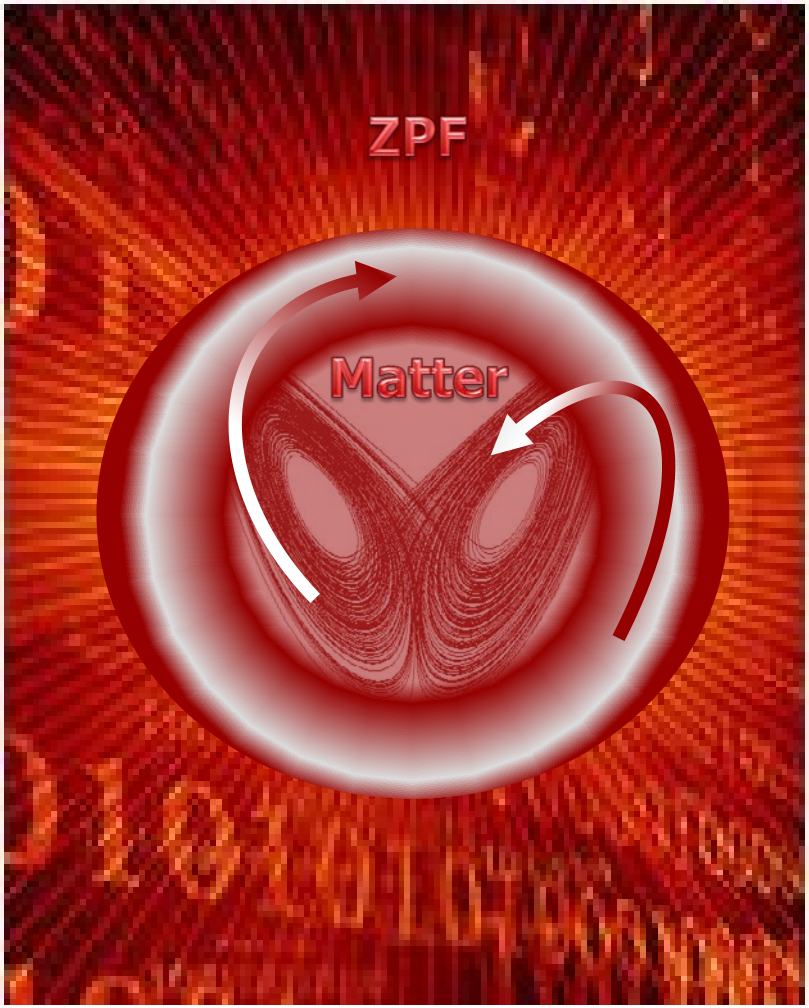
- ZPF is modified as soon as the system reaches a stable attractor:



- The relevant frequency components involved in the maintenance of the equilibrium become highly correlated ("de-randomization").
- Every attractor imprints an information state on the ZPF.

(de la Peña and Cetto, 1994; 2001; 2006)

Interaction between ZPF and Matter: Summary of Findings



- Matter is a resonant stochastic oscillator driven by the ZPF.
- There is a permanent flow of energy between the ZPF and matter.
- As soon as a system reaches a stationary state (attractor), quantum behavior sets in.
- Each attractor is associated with an information state in the ZPF.
- All parts of a stationary system are connected and coupled through the ZPF.
- Stationary systems exhibit collective cooperation, even on macroscopic scales (long-range coherence).
- For an external observer this behavior appears to be nonlocal since the ZPF remains unobserved.

(de la Peña and Cetto, 2001)

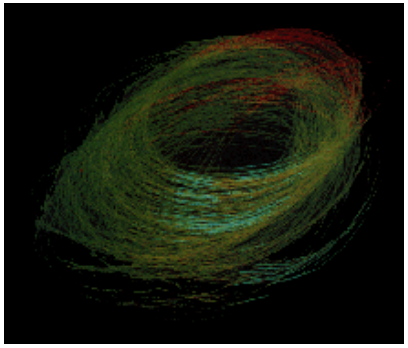
Analysis of Activity Patterns in the Brain: Body of Evidence

- Long-range coherence (correlations) in the brain
- Gamma synchrony strongly associated with perceptual awareness / consciousness
- Shows up during attention to an external stimulus, meditation, and REM sleep

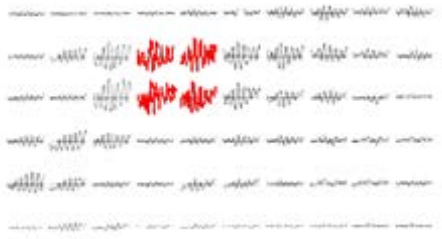
- Deterministic models generate autocoherent gamma oscillations as emergent property
- Data analysis rules out such models → brain behaves like a resonant stochastic oscillator → stochastic driving force

- Dynamics is scale-free
- Activity patterns of the system are governed by a universal mechanism

- Conditioned stimulus is associated with a specific activity pattern = attractor
- Adapt. attractor landscape



Activity pattern / attractor



- Vast number of neurons shift abruptly between different attractors
- Requires instantaneous communication

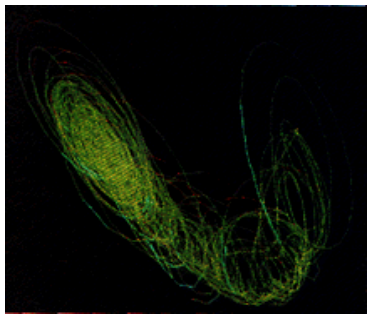
(Crick and Koch, 1990; Engel and Singer, 2001; Lutz et al., 2004; Llinás and Ribary, 1993; Burns et al., 2010; Freeman, 1991; 2004; 2005)

Brain has All Characteristics of a Macroscopic Quantum System

- Patterns detected in the brain resemble those of quantum many-body systems
- Many-body quantum field theory is the appropriate tool to study brain dynamics
- Only way to understand pattern formation and phase transitions in complex systems

Brain is a stochastic oscillator that operates near the critical point of a phase transition

Disordered phase



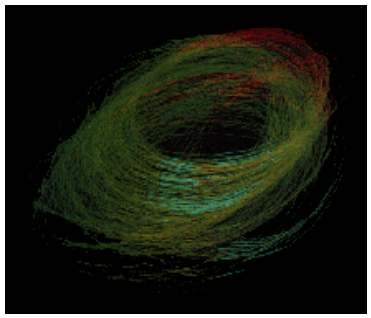
Irregular dynamics

Spontaneous activity

1/f scaling behavior

External stimulus varies system parameters and induces spontaneous phase transition

Ordered phase



Long-range correlations (gamma synchrony)

Spatiotemporal attractors (stationary states)

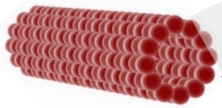
(Freeman, 1991; Freeman and Vitiello, 2006)

Causal Chain Underlying the Phase Transition

Phase transition includes all levels of microscopic and macroscopic organization

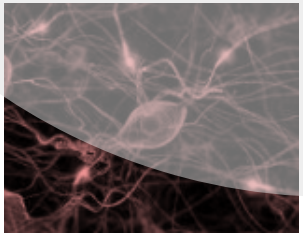
ZPF

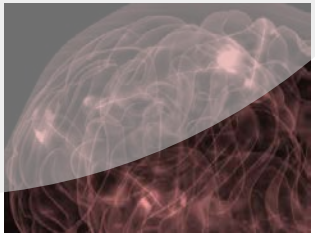
Microtubules are arrays of coupled dipole oscillators + ordered water molecules



Stable attractor

Microtubules organize cell activities by operating in two different phases, depending on the parameter values





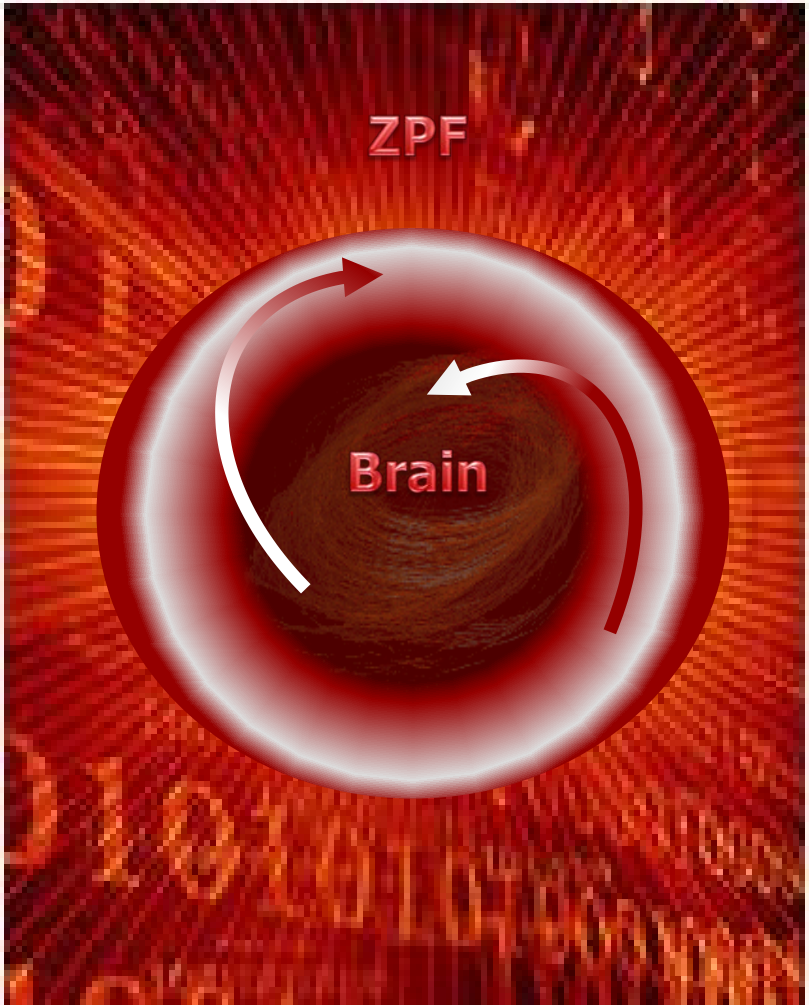
Ordered phase is mediated by coherent modes in the system of microtubules

Synchronous gamma waves are generated

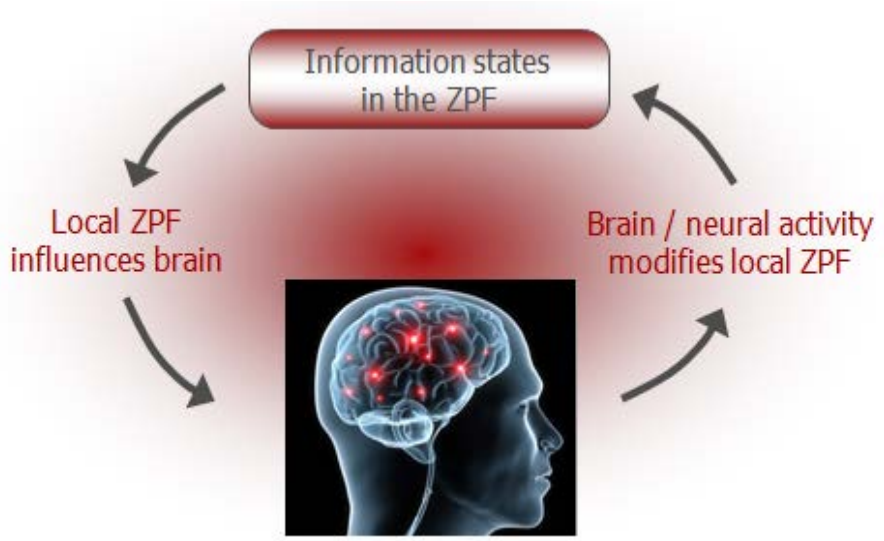
Better understanding of the details and conditions is required

Quantum properties of microtubules: (Jibu et al., 1994; Mavromatos et al., 2002)

Translating the Findings into the Framework of SED



- The brain is a resonant stochastic oscillator driven by the ZPF.
- Quantum behavior emerges whenever the brain falls into stable attractor.
- Each attractor is associated with an information state in the ZPF.



Comparison between Physics (SED) and Eastern Philosophy

Physics (SED)

1. The universe is based on an all-pervasive radiation field (ZPF) exhibiting infinite potential and energy.
2. All phenomena result from selective restriction of the ZPF, i.e., from dynamic interaction between matter and the ZPF.
3. Nothing exists on its own. The properties of matter are not intrinsic but acquired by interaction with the 'rest of the world'.
4. The ZPF shapes matter and matter shapes the ZPF. This interplay gives rise to information states in the ZPF.
5. All forces of the universe are mediated by the ZPF, i.e., local modifications and distortions of the ZPF result in forces.

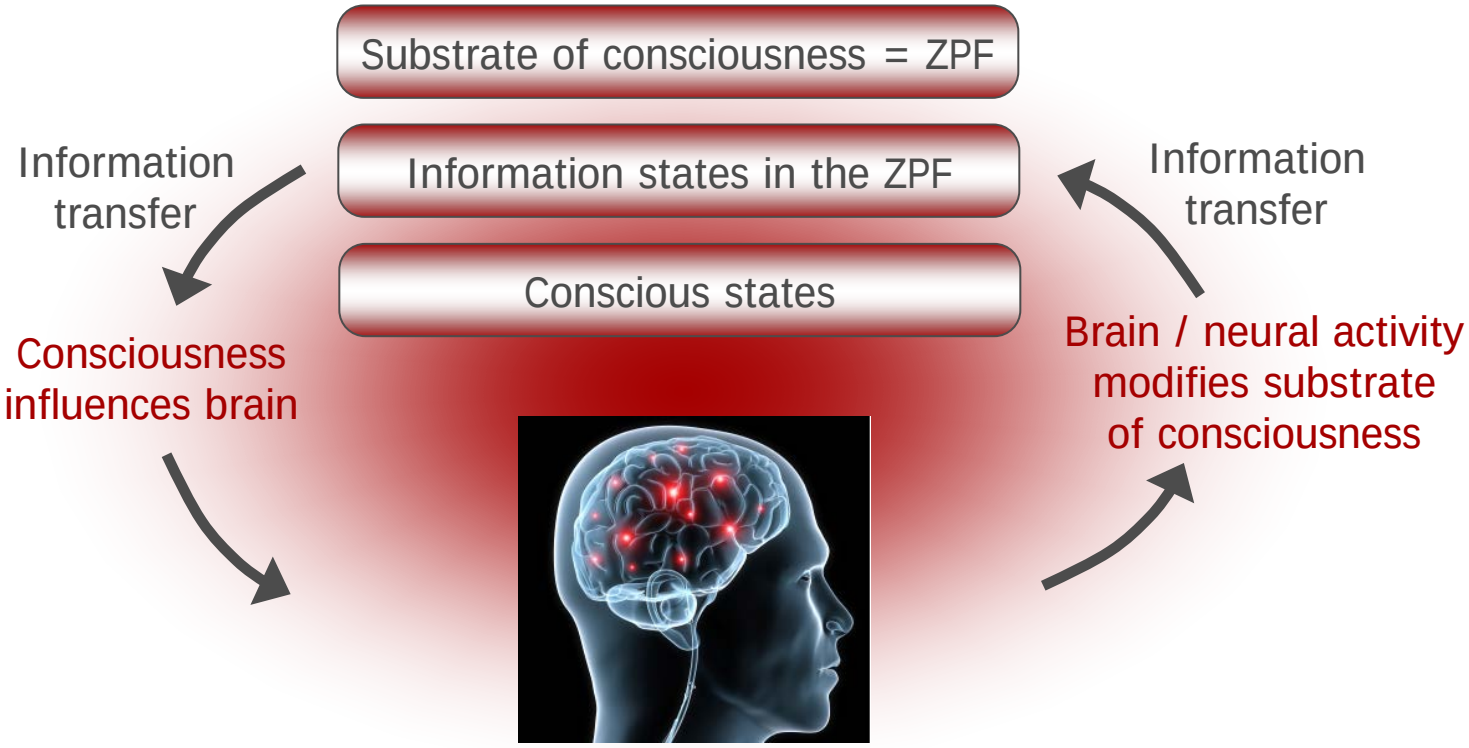
Eastern Philosophy (Buddhism)

1. The universe is formed out of an infinite potential (Prana). Everything is produced by this primordial energy.
2. All phenomena spring forth from Prana through a transformation process, a dynamic flow of interactions.
3. Phenomena have no intrinsic existence (emptiness). The properties of matter are caused by interdependence.
4. Consciousness shapes matter and matter shapes consciousness. Mind and matter are composed of the same primordial energy.
5. All forces of the universe are modifications of Prana, also those of the human mind from consciousness to the subconscious.

Eastern philosophy: (Govinda, 1969; Ricard and Thuan, 2004)

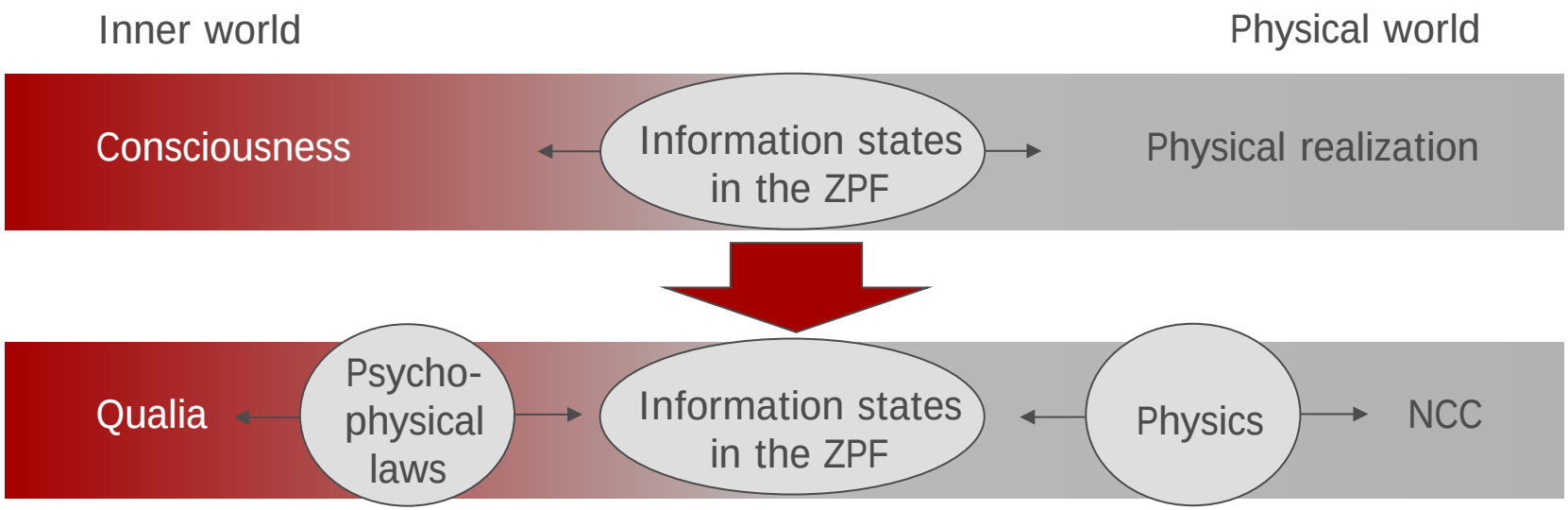
Conceptual Framework for Consciousness (I)

- Consciousness is a fundamental property of the universe.
- The ZPF is the substrate of consciousness.
- Our individual consciousness is the result of an interaction (filtering) process that causes the realization of information states in the ZPF.



Conceptual Framework for Consciousness (II)

- Physical and phenomenal properties turn out to be two different aspects of a single world → double-aspect principle.
- Particular information states in the ZPF, if not all, are associated with a physical realization and a conscious experience.
- The internal aspects of such states are phenomenal, i.e., a conscious moment is a ZPF information state experienced from inside.
- The external aspects of such information states are the NCC.



Double-aspect principle: (Chalmers, 1996)

Experimental Strategy: From Conceptual Framework to Theory

- Identify attractors related to conscious experience
- Understand attractor dynamics
- Determine corresponding ZPF information states

Attractors → **ZPF information states**

- Find appropriate representation
- Classify ZPF information states
  - What are the characteristics of visual, auditory, olfactory ... states?
  - What makes them different?
  - Is there a similarity principle (similar states → similar feels)?
  - Is every information state associated with qualia?
  - What distinguishes information states with qualia from states without qualia?
- Determine reference states: e.g., the unfiltered state (free ZPF) corresponds to the ultimate positive, called bliss consciousness

ZPF information states → **Qualia**

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