

Linking Consciousness to the Foundations of Physics

Toward a Self-Consistent Theory of Consciousness

ConnectIONS Live Webinar
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Joachim Keppler, PhD



Agenda

- ▶ 1 Setting the Scene for a Theory of Consciousness
- ▶ 2 Toward a Theory of Consciousness: Discussing Potential Options
- ▶ 3 Toward a Self-Consistent Theory of Consciousness
- ▶ 4 Looking at Future Research Avenues

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Integration of Consciousness Into the Scientific Worldview

- ▶ As a theoretical physicist, one has the ambition to search for fundamental principles and universal mechanisms.
- ▶ These universal principles and mechanism are reflected in the standard model of physics (cosmic blueprint).
- ▶ In search of an all-encompassing theory, it seems reasonable to strive to establish a relationship between consciousness and the foundational entities that show up in the cosmic blueprint.

Cosmic blueprint (particles, fields, and their dynamic interactions):

$$\begin{aligned}
 \mathcal{L} = & -\frac{1}{2}\text{Tr} G_{\mu\nu}G^{\mu\nu} - \frac{1}{2}\text{Tr} W_{\mu\nu}W^{\mu\nu} - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} \\
 & + (D_\mu\phi)^\dagger D^\mu\phi + \mu^2\phi^\dagger\phi - \frac{1}{2}\lambda(\phi^\dagger\phi)^2 \\
 & + \sum_{f=1}^3 \left(\bar{\ell}_L^f i \not{D} \ell_L^f + \bar{\ell}_R^f i \not{D} \ell_R^f + \bar{q}_L^f i \not{D} q_L^f + \bar{d}_R^f i \not{D} d_R^f + \bar{u}_R^f i \not{D} u_R^f \right) \\
 & - \sum_{f=1}^3 y_\ell^f \left(\bar{\ell}_L^f \phi \ell_R^f + \bar{\ell}_R^f \phi^\dagger \ell_L^f \right) \\
 & - \sum_{f,g=1}^3 \left(y_d^{fg} \bar{q}_L^f \phi d_R^g + (y_d^{fg})^* \bar{d}_R^g \phi^\dagger q_L^f + y_u^{fg} \bar{q}_L^f \tilde{\phi} u_R^g + (y_u^{fg})^* \bar{u}_R^g \tilde{\phi}^\dagger q_L^f \right)
 \end{aligned}$$



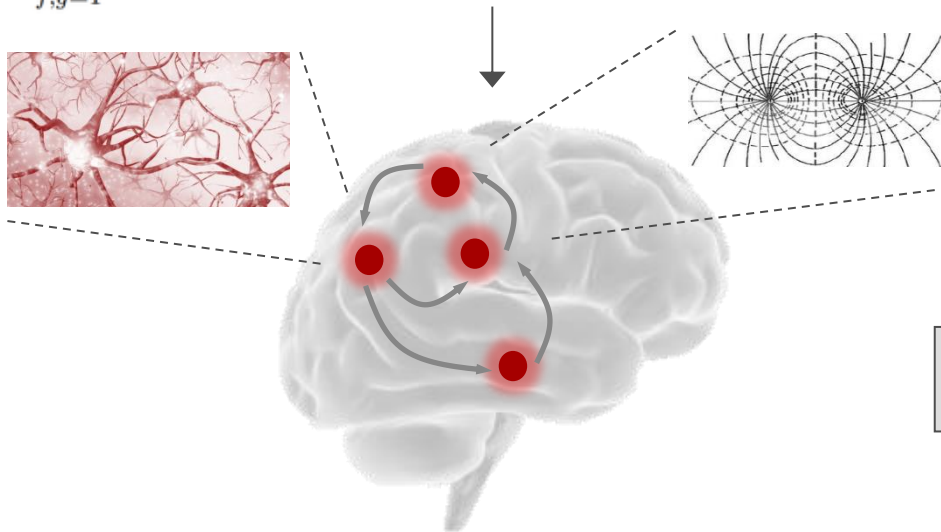
- ▶ Subjective experience (inner presence)
- ▶ Phenomenal qualities (qualia)

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Standard Physicalism: Consciousness as a Product of Cosmic Evolution

Cosmic blueprint:

$$\begin{aligned} \mathcal{L} = & -\frac{1}{2}\text{Tr} G_{\mu\nu}G^{\mu\nu} - \frac{1}{2}\text{Tr} W_{\mu\nu}W^{\mu\nu} - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} \\ & + (D_\mu\phi)^\dagger D^\mu\phi + \mu^2\phi^\dagger\phi - \frac{1}{2}\lambda(\phi^\dagger\phi)^2 \\ & + \sum_{f=1}^3 (\bar{\ell}_L^f i \not{D} \ell_L^f + \bar{\ell}_R^f i \not{D} \ell_R^f + \bar{q}_L^f i \not{D} q_L^f + \bar{d}_R^f i \not{D} d_R^f + \bar{u}_R^f i \not{D} u_R^f) \\ & - \sum_{f=1}^3 y_\ell^f (\bar{\ell}_L^f \phi \ell_R^f + \bar{\ell}_R^f \phi^\dagger \ell_L^f) \\ & - \sum_{f,g=1}^3 (y_d^{fg} \bar{q}_L^f \phi d_R^g + (y_d^{fg})^* \bar{d}_R^g \phi^\dagger q_L^f + y_u^{fg} \bar{q}_L^f \tilde{\phi} u_R^g + (y_u^{fg})^* \bar{u}_R^g \tilde{\phi}^\dagger q_L^f) \end{aligned}$$



Generation (cosmic latecomer)



- ▶ **Ontological discontinuity:** consciousness arises spontaneously in a previously insentient universe.
- ▶ **Demarcation problem:** what distinguishes activity patterns that are accompanied by conscious experiences from those patterns that are devoid of phenomenal qualities? ↑
- ▶ “Conscious states are assumed to emerge from or to be identical with certain activity patterns of sufficiently complex systems.”
- ▶ “Consciousness awakens as soon as the structural conditions, the organizational principles, or the processes characterizing a physical system exceed a critical level of complexity.”

Micro-Level Panpsychism: Consciousness as an Intrinsic Property of Matter

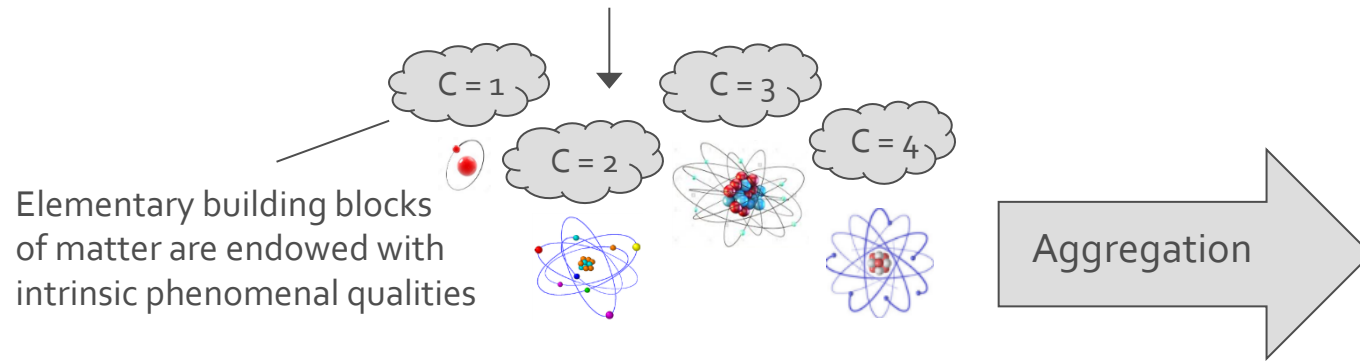
Cosmic blueprint:

$$\mathcal{L} = -\frac{1}{2}\text{Tr} G_{\mu\nu}G^{\mu\nu} - \frac{1}{2}\text{Tr} W_{\mu\nu}W^{\mu\nu} - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + (D_\mu\phi)^\dagger D^\mu\phi + \mu^2\phi^\dagger\phi - \frac{1}{2}\lambda(\phi^\dagger\phi)^2$$

$$+ \sum_{f=1}^3 (\bar{\ell}_L^f i \not{D} \ell_L^f + \bar{\ell}_R^f i \not{D} \ell_R^f + \bar{q}_L^f i \not{D} q_L^f + \bar{d}_R^f i \not{D} d_R^f + \bar{u}_R^f i \not{D} u_R^f)$$

$$- \sum_{f=1}^3 y_\ell^f (\bar{\ell}_L^f \phi \ell_R^f + \bar{\ell}_R^f \phi^\dagger \ell_L^f)$$

$$- \sum_{f,g=1}^3 (y_d^{fg} \bar{q}_L^f \phi d_R^g + (y_d^{fg})^* \bar{d}_R^g \phi^\dagger q_L^f + y_u^{fg} \bar{q}_L^f \tilde{\phi} u_R^g + (y_u^{fg})^* \bar{u}_R^g \tilde{\phi}^\dagger q_L^f)$$



- ▶ Rudimentary form of consciousness
- ▶ Simple structure, phenomenal barrenness

- ▶ **Combination problem:** how does our rich spectrum of unified macro experiences emerge from a limited spectrum of micro experiences?
- ▶ **Challenge:** presentation of a plausible aggregation mechanism that explains the rich spectrum of unified macro experiences.

Macro-level consciousness:

- ▶ Complex multimodal structure
- ▶ Phenomenal richness

emotional
visual
auditory
olfactory
...



Cosmopsychism: Consciousness as an Intrinsic Property of the Ubiquitous Background (Force) Fields

Cosmic blueprint:

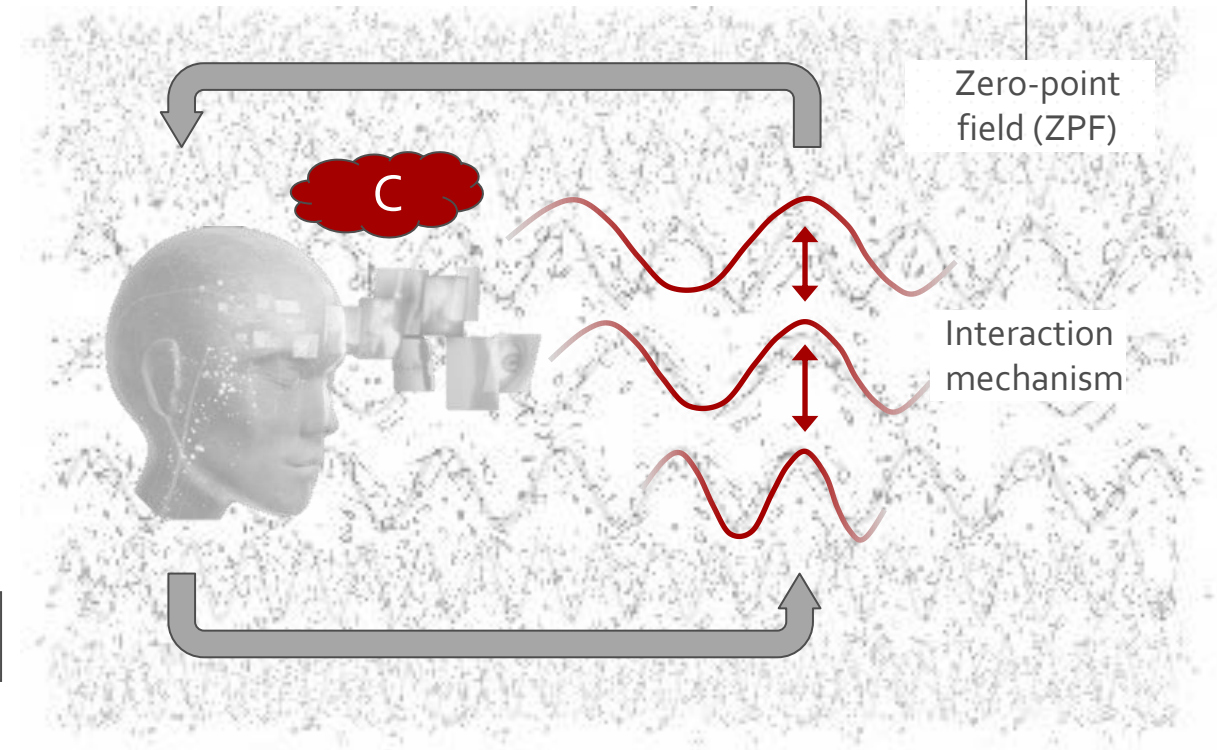
$$\mathcal{L} = -\frac{1}{2}\text{Tr} G_{\mu\nu}G^{\mu\nu} - \frac{1}{2}\text{Tr} W_{\mu\nu}W^{\mu\nu} - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + (D_\mu\phi)^\dagger D^\mu\phi + \mu^2\phi^\dagger\phi - \frac{1}{2}\lambda(\phi^\dagger\phi)^2 + \sum_{f=1}^3 (\bar{\ell}_L^f i \not{D} \ell_L^f + \bar{\ell}_R^f i \not{D} \ell_R^f + \bar{q}_L^f i \not{D} q_L^f + \bar{d}_R^f i \not{D} d_R^f + \bar{u}_R^f i \not{D} u_R^f) - \sum_{f=1}^3 y_\ell^f (\bar{\ell}_L^f \phi \ell_R^f + \bar{\ell}_R^f \phi^\dagger \ell_L^f) - \sum_{f,g=1}^3 (y_d^{fg} \bar{q}_L^f \phi d_R^g + (y_d^{fg})^* \bar{d}_R^g \phi^\dagger q_L^f + y_u^{fg} \bar{q}_L^f \tilde{\phi} u_R^g + (y_u^{fg})^* \bar{u}_R^g \tilde{\phi}^\dagger q_L^f)$$

- ▶ **Filtering:** conscious systems employ a universal mechanism through which they tap into the phenomenal spectrum predetermined by the ZPF → extraction of a subset of phenomenal shades from the full phenomenal spectrum.



- ▶ The proposed interaction mechanism is intelligible, avoids ontological discontinuities, and is fully compatible with empirical evidence.
- ▶ The approach provides elegant solutions to the demarcation problem and the combination problem.

Ubiquitous background (force) fields are endowed with intrinsic phenomenal qualities

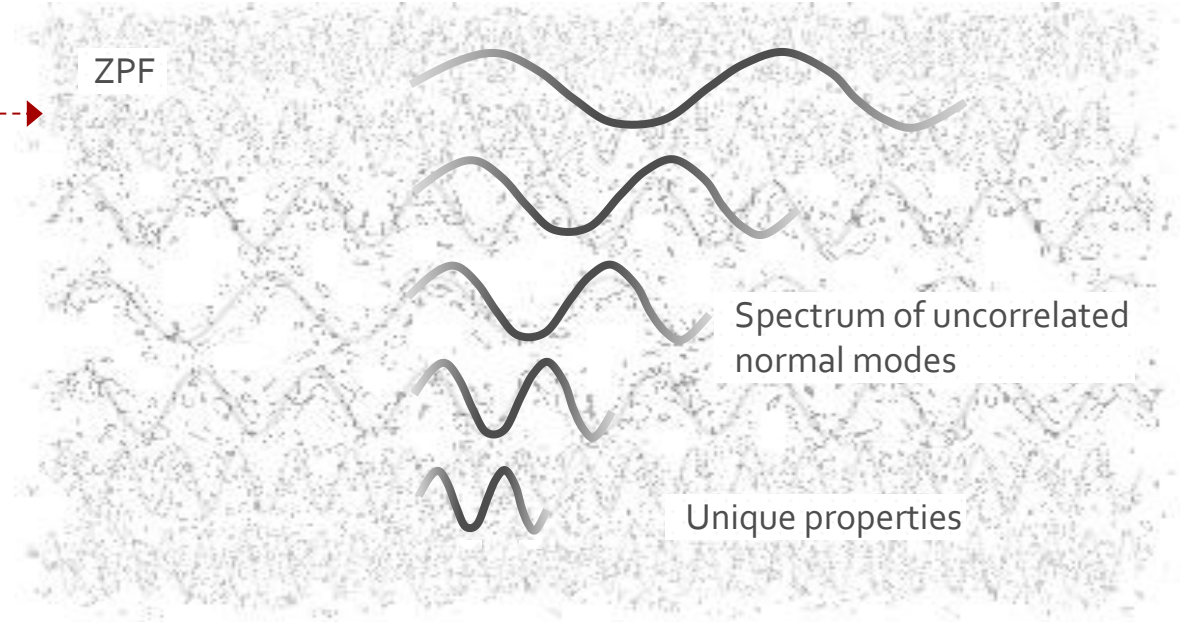


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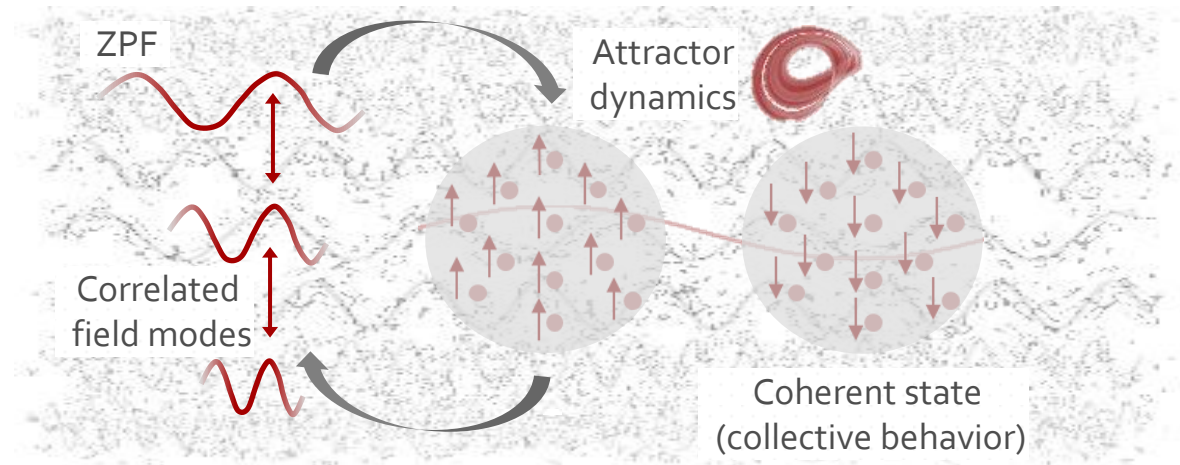
Fundamental Mechanism Underlying Quantum Systems

Cosmic blueprint:

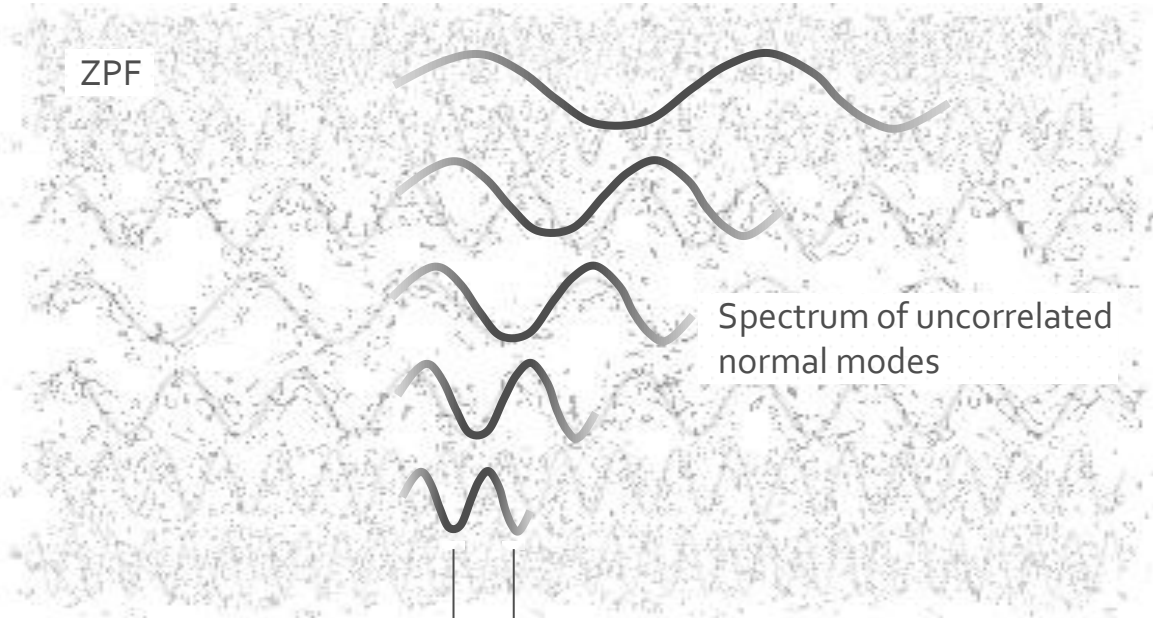
$$\mathcal{L} = -\frac{1}{2}\text{Tr} G_{\mu\nu}G^{\mu\nu} - \frac{1}{2}\text{Tr} W_{\mu\nu}W^{\mu\nu} - \frac{1}{4}F_{\mu\nu}F^{\mu\nu} + (D_\mu\phi)^\dagger D^\mu\phi + \mu^2\phi^\dagger\phi - \frac{1}{2}\lambda(\phi^\dagger\phi)^2 + \sum_{f=1}^3 (\bar{\ell}_L^f i \not{D} \ell_L^f + \bar{\ell}_R^f i \not{D} \ell_R^f + \bar{q}_L^f i \not{D} q_L^f + \bar{d}_R^f i \not{D} d_R^f + \bar{u}_R^f i \not{D} u_R^f) - \sum_{f=1}^3 y_\ell^f (\bar{\ell}_L^f \phi \ell_R^f + \bar{\ell}_R^f \phi^\dagger \ell_L^f) - \sum_{f,g=1}^3 (y_d^{fg} \bar{q}_L^f \phi d_R^g + (y_d^{fg})^* \bar{d}_R^g \phi^\dagger q_L^f + y_u^{fg} \bar{q}_L^f \tilde{\phi} u_R^g + (y_u^{fg})^* \bar{u}_R^g \tilde{\phi}^\dagger q_L^f)$$



- ▶ The ZPF is the fundamental substrate of the electromagnetic force, i.e., all electromagnetic phenomena are mediated by the ZPF.
- ▶ Macroscopic quantum phenomena originate from the resonant coupling of the system components to a set of ZPF modes.
- ▶ The formation of a coherent activity pattern (attractor) has repercussions on the internal structure of the field and results in a modulation of the ZPF (relevant modes become highly correlated).

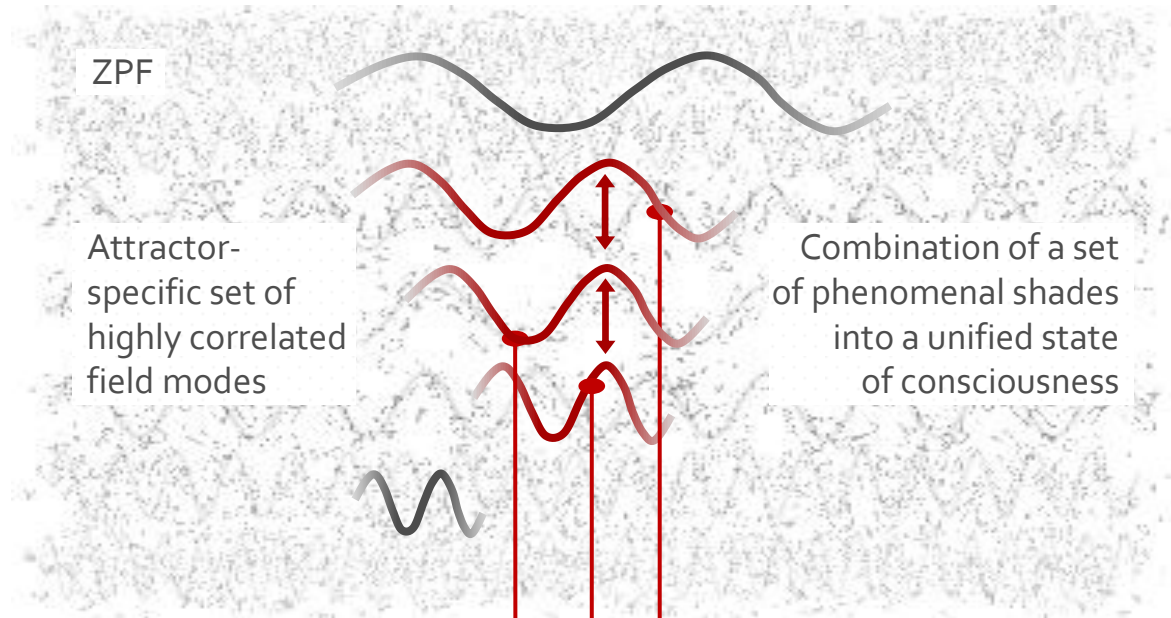


Fundamental Mechanism Underlying Conscious Systems



- ▶ Extrinsic physical manifestation
- ▶ Each normal mode is associated with a specific energy
- ▶ Elementary frequency components
- ▶ Formless ocean of energy

- ▶ Intrinsic phenomenal essence
- ▶ Each normal mode is associated with a specific phenomenal quality
- ▶ Elementary shades of consciousness
- ▶ Formless ocean of consciousness



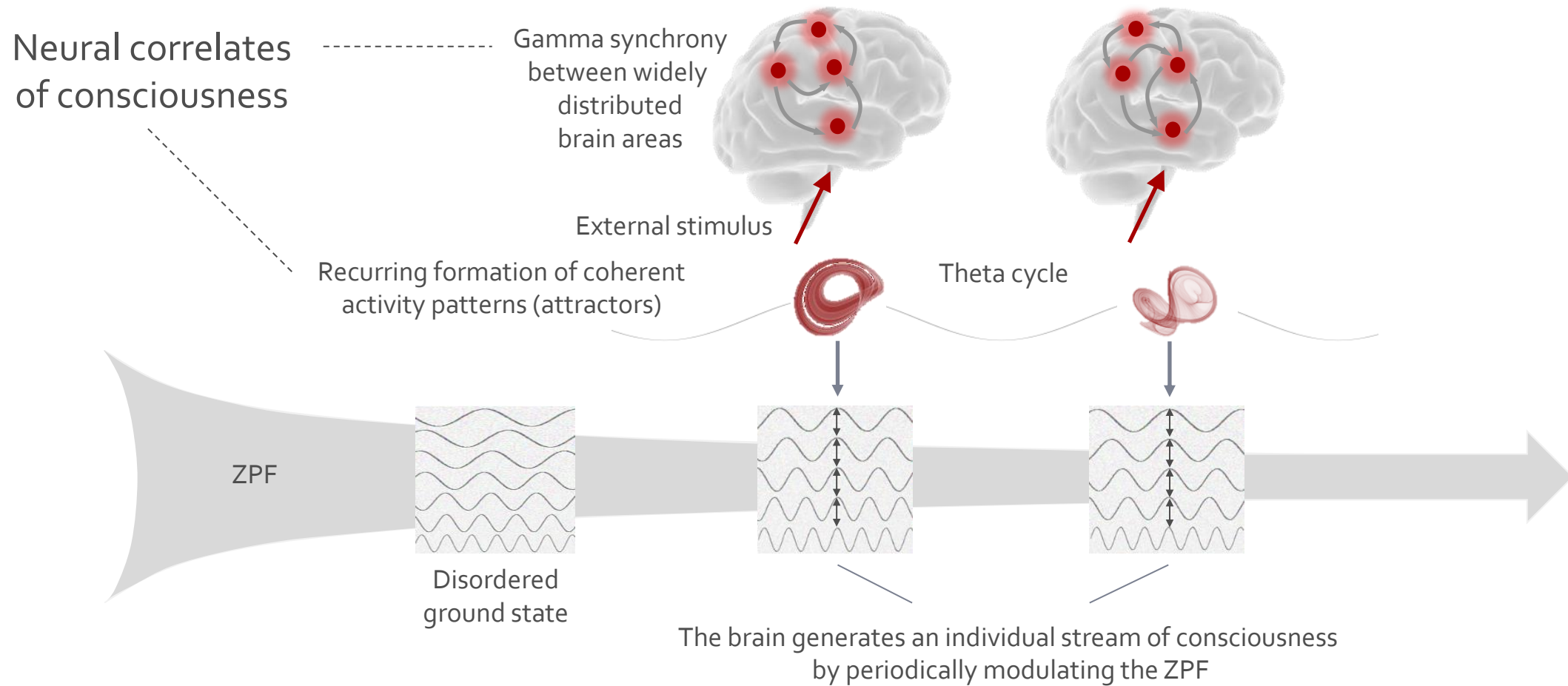
↑
Resonant brain-ZPF
interaction

↓
Long-range coherence

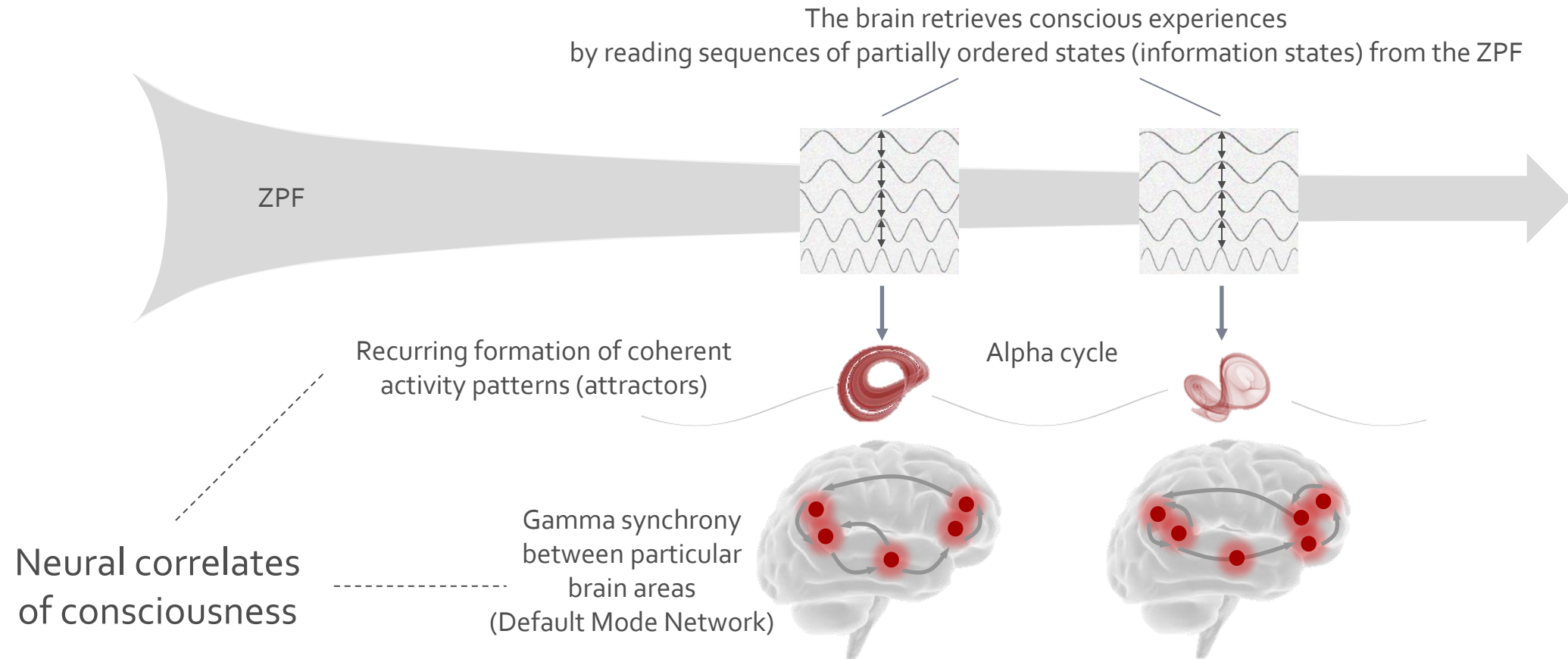
Attractor
formation

Collective system
behavior

Stimulus-Induced Conscious Processes

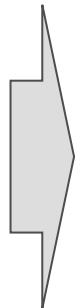


Stimulus-Independent (Self-Referential) Conscious Processes



Implications

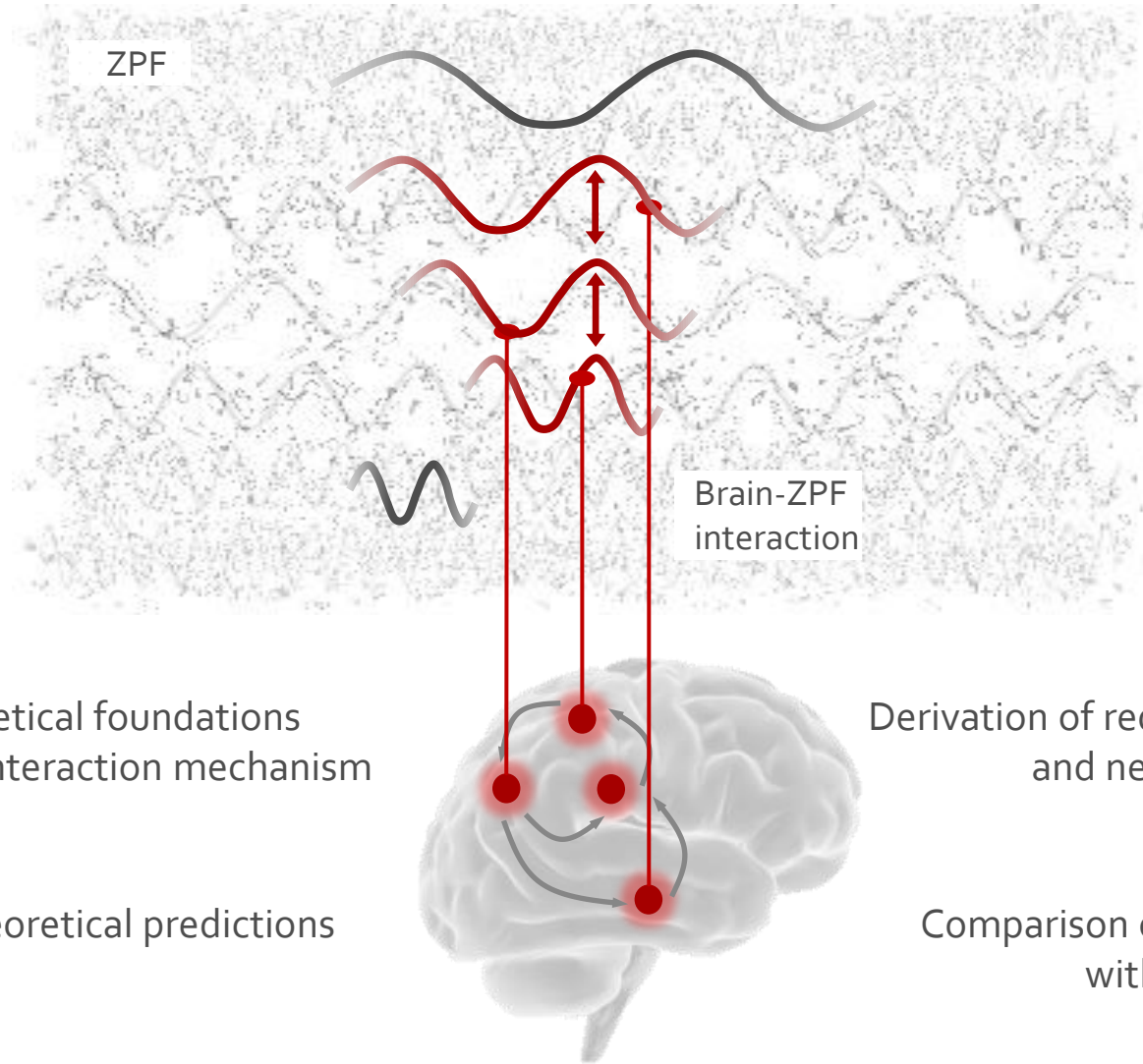
- ▶ A distinctive feature of conscious systems in comparison to non-conscious systems is the capacity to modulate the omnipresent field of consciousness (ZPF).
- ▶ Conscious experiences are restricted to those systems that manage to play the keyboard of the ubiquitous field of consciousness.
- ▶ Even though all types of systems are permeated by the ubiquitous ZPF and are surrounded by an ocean of potential consciousness, the formation of concrete conscious states is confined to those systems that can dynamically interact with the ZPF, which requires the resonant coupling of the system to a set of ZPF modes.
- ▶ Attractors manage the transition from potentiality to actuality, implying that a potential conscious state is actualized once an attractor is fully unfolded and an attractor-specific modification of the ZPF arises.



- ▶ The presented approach provides a well-defined demarcation criterion for conscious systems.
- ▶ The proposed variant of panpsychism (cosmopsychism) describes a universe in which the potential of consciousness is omnipresent, without every system necessarily being conscious.

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Next Steps: Gaining a Deeper Understanding of the Brain-ZPF Interface



1

Formalization of the theoretical foundations for the description of the interaction mechanism

2

Generation of concrete theoretical predictions based on the formalism

Derivation of requirements for data analysis and new experimental approaches

3

Comparison of the experimental findings with the theoretical predictions

4



DiWISS

Joachim Keppler, PhD

E-Mail joachim.keppler@diwiss.de

Web <https://www.diwiss.de/>