Will twenty-first century physics need biology?

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Acknowledgments and sources

- Scott Kelso (coordination dynamics)
- Jesper Hoffmeyer (biosemiotics; semiotic scaffolding)
- Karen Barad (quantum world seen as living entity)
- Stuart Kauffman (‘world beyond physics’)
- Alex Hankey (locus of control, critical fluctuations)
- Ilexa Yardley (circular theory)

Main thesis of this talk

- An equation-oriented approach has led physics along a false trail, ending up with a limited and confused picture of reality. Biologists, on the other hand, have been developing a deeper understanding of life's subtleties.
- Hypothesis: nature is essentially *biological*, being organised in the same way as ordinary life. Accordingly, *physics* can learn from biological insight

Quantum/Biological parallels

LANGUAGE OF QUANTUM PHYSICS		**LANGUAGE OF BIOLOGY**
quantum subsystem, describable by a state vector	↔	signal or form
particle type	↔	type of signal or form
state vector representing a specific possibility	↔	signal representing a specific possibility
collapse of state vector	↔	decision process
measuring instrument determining state of subsystem	↔	structures which determine and regulate signals or forms

from *Beyond Quantum Theory: a Realist Psychobiological Interpretation of Physical Reality* (arXiv:1610.09347)

by Michael Conrad, D. Home, and Brian Josephson (1988)

QM: ‘limited and confused’?

- Paradox of Schrödinger’s cat
- Collapse? Many-worlds? Ithaca interpretation? There is no consensus
- The complexity of life leads to problems dealing with biological systems in QM terms (see arXiv:1110.1768)
- Is mind in some form involved in quantum phenomena?

Historical comments on mind in physics

- Jeans: “the universe begins to look more like a great thought than like a great machine. Mind no longer appears as an accidental intruder into the realm of matter; we are beginning to suspect that we ought rather to hail it as a creator and governor of the realm of matter...
- Dyson: “Matter in quantum mechanics is not an inert substance but an active agent, constantly making choices between alternative possibilities according to probabilistic laws. ...It appears that mind, as manifested by the capacity to make choices, is to some extent inherent in every electron”

Historical comments on mind in physics II

- Wheeler: “if the views that we are exploring here are correct, one principle, ‘observer-participancy’, suffices to build everything”
- Penrose and Hameroff: “orchestrated reduction”
- Stapp: “a mental event occurs that grasps a whole unit of structural information, and injects it into the quantum state of the universe”
- Bohm: matter and meaning are two sides of reality (soma-significance)

Quantum domain as life

- Barad: ‘agencies’ undergo ‘intra-actions’ giving rise to phenomena (agential realism ontology)
- Relationships are crucial; entities are not separate things (cf. QM observer-observed relationship, EPR paradox)
- Similar to coordination dynamics (a mathematical picture)

Ideas vs. Models

- Physics involves more than words and ideas; to advance physics a more systematic approach is needed, involving well-defined models at the very least.

Insights from the life sciences, on which to base a New Physics

- Peirce's theory of signs (semiotics); sign entities have *referents*, consequent upon *interpretation*
- *Biosemiotics* analyses the role of signs in biology
- Other concepts: coordination, semiotic scaffolding, locus of control, constraint closure, symbolic signs

The role of non-mathematical concepts

- Concepts can constrain possibilities (a model either fits a concept or it doesn't), and have their own logic
- Life is highly constrained (most possibilities don't survive), necessitating domain-specific mechanisms for survival, each associated with specific concepts and models
- Such modelling is not necessarily of a mathematical character (cf. Stuart Kauffman's *A world beyond physics*)

A Different Type of Order

- Basic fact: life is associated with a different type of order to that of matter, involving hierarchical organisation, creative
- This order emerges spontaneously (e.g. language)
- Study of this order, via experimental investigation and/or models exhibiting this kind of order, will open up new possibilities and transform physics, because mind will be included (cf. the way group theory transformed physics)

The organisation of life

- In the picture proposed, dynamical systems take the place of the molecules of biology, but corresponding analyses apply
- There are many processes, and coordination between processes leading to higher level processes (functions), as with computer software
- Physical perspective: competition between individuality and coordination
- Processes are active or inactive, as determined by the context
- Processes as they evolve acquire means to sustain themselves (cf. catalyst), systems work together

Design

- Generic mechanisms may emerge, derivative of efficient performance
- Example: generic language mechanism (strategy to build language)
- Leading to increasingly complex highly effective systems, emerging under constraint of utility
- Scaffolding : hypothesised construct underlying an effective strategy

Community aspect

Communities can solve problems in ways that individuals can not

Individuals benefit from the discoveries of others

Individual or group *system* $\longleftrightarrow$ *activity* of individual or group

a third element emerges: a relationship

Community and individual systems advance one step at a time as problems are solved, building up a high level of complexity over time

Conclusions

- This complicated logic is supported by both observation and theoretical models
- Mind aspect comes in (mental processes are effective specialisations of various kinds)
- Supports Wheeler's idea of emergence of laws of nature through observer-participancy
- Cymatics (study of how water is affected by sound) shows this kind of process occurring in simple physical systems
- The various concepts fit well together like pieces of a jigsaw
- (speculation) Life, the universe and everything involve, in essence, unusually high-amplitude organised near-critical fractal nonlinear fluctuations
- *This lecture is a kind of blueprint for a new science*