Title: New informatic dogmas in quantum foundations

Speakers: Isaac Friend

Series: Quantum Foundations

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Abstract: In the new wave of quantum foundations activity with its indirect approach to problems of fundamental ontology, individual explicit positions of informational immaterialism are replaced by a shared "soft informatic realism" that governs research practice, encouraging conflation of theories of information processes and theories of physical processes, and disregard for the microphysical dynamics effecting a given information process. This kind of abstraction, indispensable in the formulation of enlightening no-go theorems, can become problematic when imported to certain other projects, including recently popular investigations of quantum causal structure. I shall provide examples, describe ramifications for the efficiency of knowledge production in quantum foundations, and consider when features of quantum information processing can legitimately be called informatic features of quantum physics.

Zoom link: https://pitp.zoom.us/j/93415836509?pwd=MXJLZVVzMnZjcWFQSWM0dmg5czE3dz09

New informatic dogmas in quantum foundations

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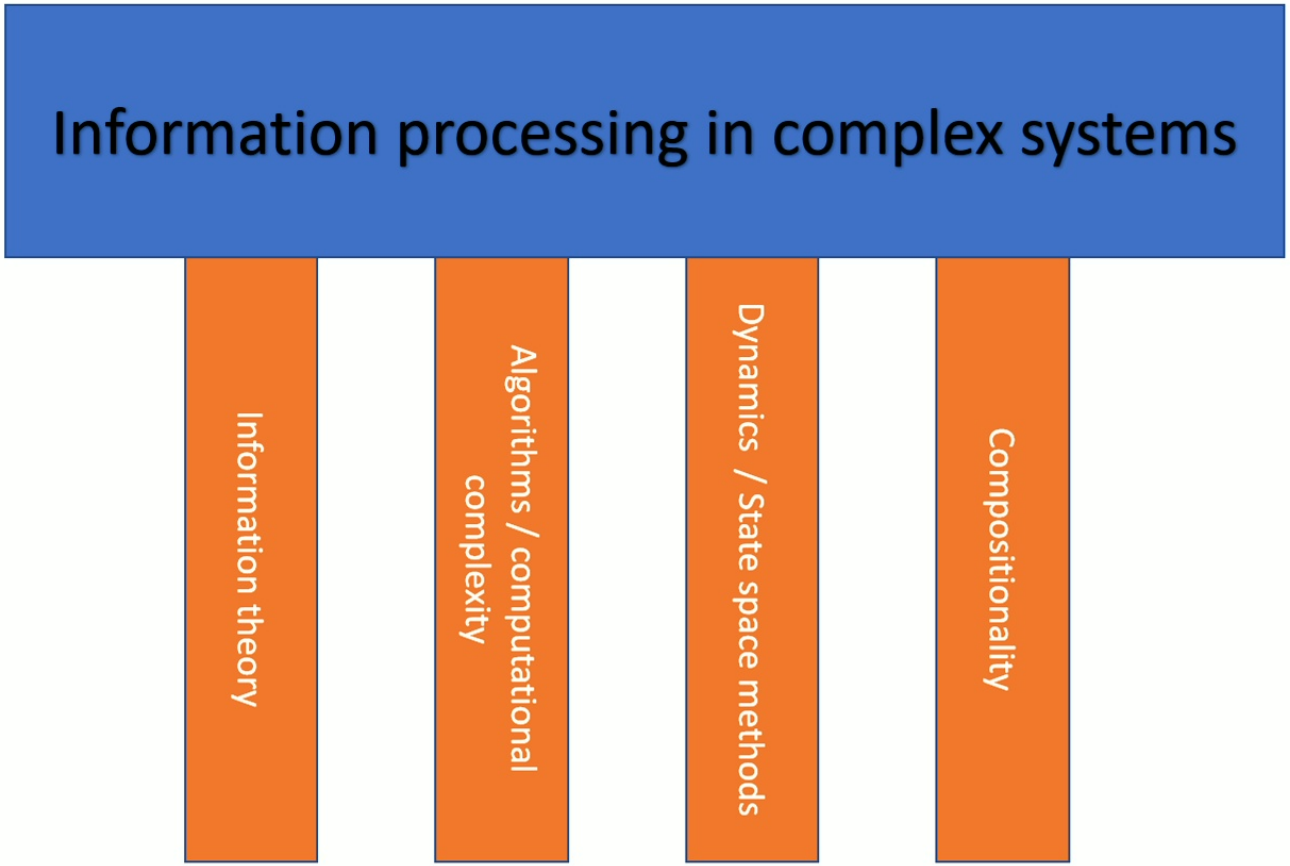
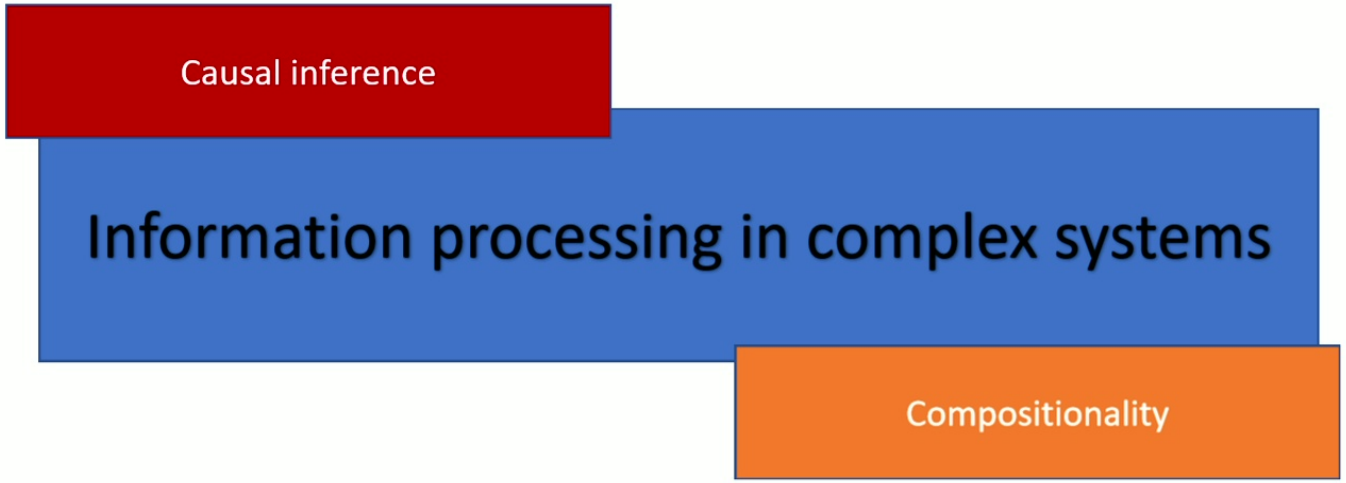
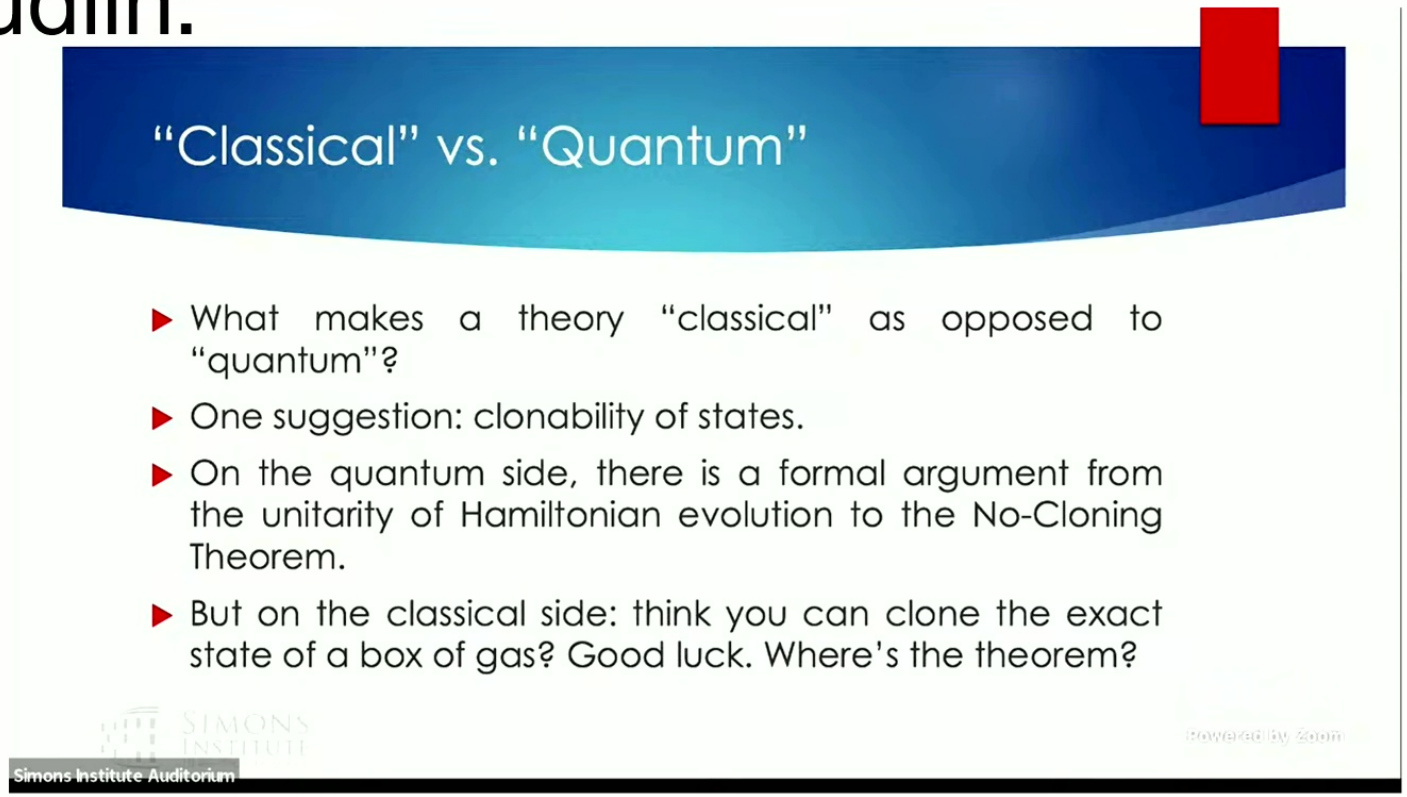

Information processing in complex systems
Information theory
Algorithms / computational complexity
Dynamics / State space methods
Compositionality


Causal inference
Information processing in complex systems
Compositionality

"It is important to notice that there is a conceptual gap between the processes of classical information theory and those of some classical physical theory...the information processes of the latter are constrained by additional structure and parameters."

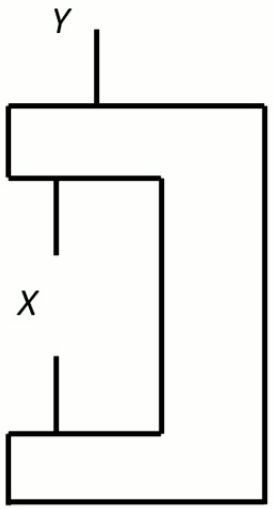
Nicholas J. Teh, On classical cloning and no-cloning, Studies in History and Philosophy of Science Part B: Studies in History and Philosophy of Modern Physics, Volume 43, Issue 1, 2012, Pages 47-63, ISSN 1355-2198, https://doi.org/10.1016/j.shpsb.2011.11.005.

Maudlin:

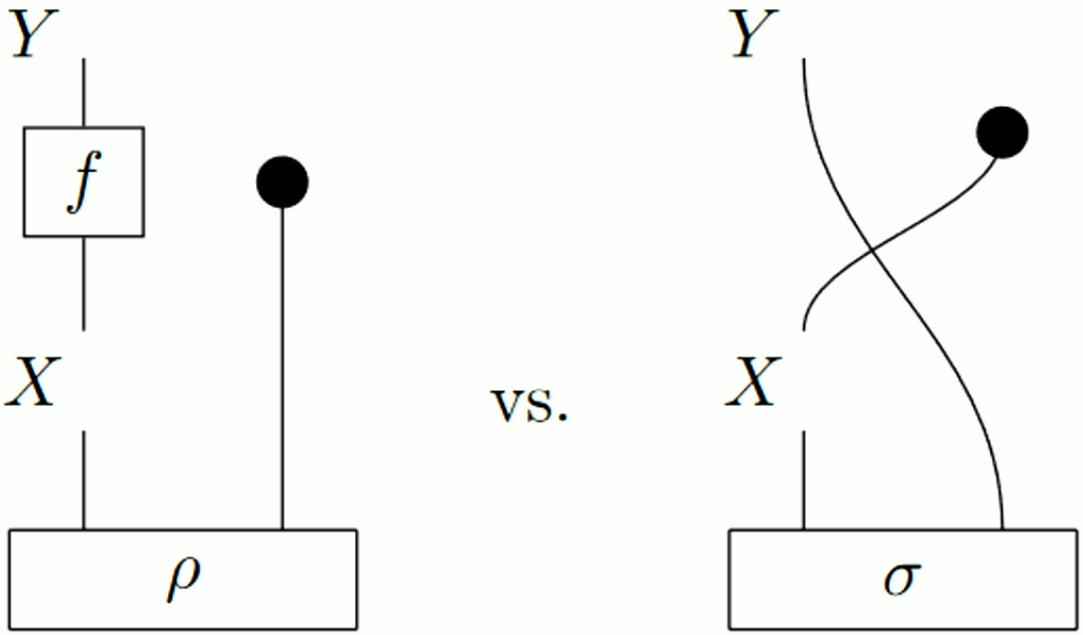


Tim Maudlin (2022), "Fine-Tuned", "Unfaithful", "Unnatural": Abuse of Terminology in Causal Modeling. Simons Institute for the Theory of Computing. https://simons.berkeley.edu/talks/fine-tuned-unfaithful-unnatural-abuse-terminology-causal-modeling

Quantum advantage for causal inference



Ried, K., Agnew, M., Vermeyden, L. *et al.* A quantum advantage for inferring causal structure. *Nature Phys* **11**, 414–420 (2015). https://doi.org/10.1038/nphys3266

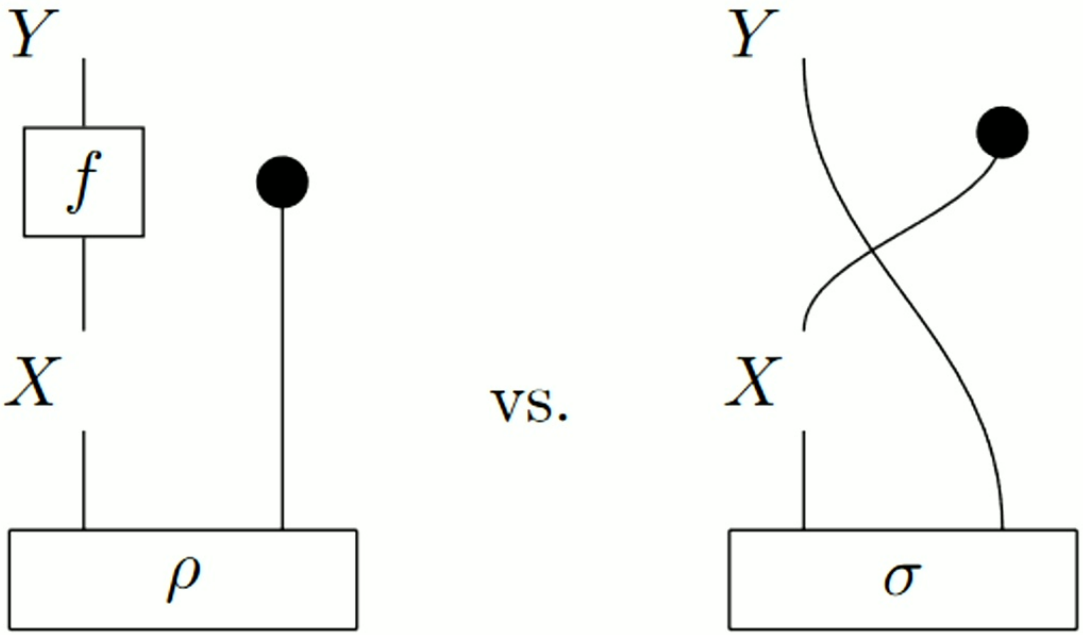

Y
f
X
ρ
vs.
Y
X
σ

"In classical statistics…knowing that two variables are correlated is not enough to conclude that one influences the other. A plane to Milan may take-off regularly a few hours after the landing of a plane from Beijing, not because the arrival of the latter causes the departure of the former, but simply because of the airport schedule….The situation is different in quantum mechanics."

Chiribella, G. Good causes. *Nature Phys* **11**, 379–380 (2015). https://doi.org/10.1038/nphys3295

"Like classical mechanics, quantum mechanics is a causal theory — meaning that present experiments are not affected by the settings of future experiments....But the similarities between quantum and classical causality seem to end here: when it comes to the 'correlation versus causation' business, quantum mechanics has a genuinely new story to tell."

Chiribella, G. Good causes. *Nature Phys* **11**, 379–380 (2015). https://doi.org/10.1038/nphys3295


Y
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X
σ

Aaronson:

"**Q: Why should the universe have been quantum-mechanical?**

If you want, you can divide Q into two subquestions:

Q1: Why didn't God just make the universe classical and be done with it? What would've been wrong with *that* choice?

Q2: Assuming classical physics wasn't good enough for whatever reason, why this specific alternative? Why the complex-valued amplitudes? Why unitary transformations? Why the Born rule? Why the tensor product?"

…

Scott Aaronson, "Why Quantum Mechanics?" *Shtetl-Optimized* (blog), 25 January, 2022, https://scottaaronson.blog/?p=6244.

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…

"I do, on the other hand, agree that "no action without back-action" is an elegant feature of QM, and that it's beautifully illustrated by the Hadamard conjugate of CNOT(a→b) being CNOT(b→a)."

Scott Aaronson, "Why Quantum Mechanics?" *Shtetl-Optimized* (blog), 25 January, 2022, https://scottaaronson.blog/?p=6244.

"[V]arious properties of quantum states labelled in the literature as 'non-classical' are 'non-classical' in not exactly the same sense. Quantum states may be compared with states of different classical theories and the conclusions vary depending on the particular choice."

Luc, J. Quantumness of States and Unitary Operations. *Found Phys* **50,** 1645–1685 (2020). https://doi.org/10.1007/s10701-020-00391-z

Action-reaction is not a quantum feature

"Our last option is that quantum states of finite-dimensional Hilbert spaces can be compared with classical discrete probability distributions and it seems that indeed this is the approach chosen more or less explicitly by many authors in the field."

Luc, J. Quantumness of States and Unitary Operations. *Found Phys* **50,** 1645–1685 (2020). https://doi.org/10.1007/s10701-020-00391-z