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Symbols of a cosmic order

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HIGHLIGHTS

- A cosmic order couples unpredictability beyond quantum uncertainty to predictable physical behavior.
- Predictable behavior depends on unpredictable symbol-handling agents, living and non-living.
- To agree about symbols, agents self-adjust in response to unpredictable phases of signals.
- Agents employ explanations of evidence, always subject to revision, precluding any final truth.
- The cosmic order brings a source of time irreversibility and a "striping" of spacetime.

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ABSTRACT

The world runs on networks over which signals communicate sequences of symbols, e.g. numerals. Examining both engineered and natural communications networks reveals an unsuspected order that depends on contact with an unpredictable entity. This order has three roots. The first is a proof within quantum theory that no evidence can ever determine its explanation, so that an agent choosing an explanation must do so unpredictably. The second root is the showing that clocks that step computers do not "tell time" but serve as self-adjusting symbol-handling agents that regulate "logically synchronized" motion in response to unpredictable disturbances. Such a clock-agent has a certain independence as well as the capacity to communicate via unpredictable symbols with other clock-agents and to adjust its own tick rate in response to that communication. The third root is the noticing of unpredictable symbol exchange in natural systems, including the transmission of symbols found in molecular biology. We introduce a *symbol-handling agent* as a role played in some cases by a person, for example a physicist who chooses an explanation of given experimental outcomes, and in other cases by some other biological entity, and in

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still other cases by an inanimate device, such as a computer-based detector used in physical measurements. While we forbear to try to explain the propensity of agents at all levels from cells to civilizations to form and operate networks of logically synchronized symbol-handling agents, we point to this propensity as an overlooked cosmic order, an order structured by the unpredictability ensuing from the proof. Appreciating the cosmic order leads to a conception of agency that replaces volition by unpredictability and reconceives the notion of objectivity in a way that makes a place for agency in the world as described by physics. Some specific implications for physics are outlined.

1. Introduction

Physicists find numerically expressed regularities in a world that every day surprises us all with its irregularities. Recently, commenting on Canales' book about Bergson and Einstein [1], Crease pointed to an "experiential amnesia" in physics [2], an amnesia that blocks attention to pre-conditions for physical time: "Bergson was trying to bring to light a sense of time presupposed in the construction of physical time itself—indeed, in Einstein's own effort to give to such time a definitive, mathematical formula". The thesis of the present report is that "time" as it works in physics is built out of networks of agent-clocks that do not dumbly tick, but that self-adjust in response to unpredictable communications from other clocks of the network. Examining both engineered and natural networks of clocks reveals an unsuspected order that depends on contact with an unpredictable entity. Attention to this unsuspected order has several implications, including an impact on the notion of scientific objectivity.

Our exposition of this "cosmic order" has three roots. The first root is the sharpening of a distinction obscured in today's theoretical physics, namely the distinction between obtaining numerically expressed evidence from experiments on the laboratory bench and explaining that evidence in mathematical symbols on the blackboard. As reviewed in Section 2, the sharpening of the distinction between physical numerical evidence and numbers calculated from a theory rests on a proof within the mathematics of quantum theory that no amount of evidence, represented in quantum theory in terms of probabilities, can uniquely determine its explanation in terms of wave functions and linear operators. Beyond mere opinion, the proof enables a clarity of thought otherwise unattainable in the distinction between measured and calculated numbers. The proof underpins all the work presented here. Building on the proof we show a heretofore overlooked unpredictability of explanations, an unpredictability beyond quantum uncertainty. The choice of an explanation requires an unpredictable reach beyond logic, a fact that challenges the traditionally notion of objectivity and that precludes any "final answers".

The second root stems from our experience with the design of clocking for fault-tolerant computer networks. A computer operates one step after another, regulated by the ticks of its clock. Fault tolerance is achieved by using a cluster of several computers, all designed to do the same task; each computer makes its computational moves in step with the others, and the computers compare notes at each step. Their clocks are organized in a network in which each clock regulates its tick rate to stay close enough to the other functioning clocks for comparisons to make sense, but loosely enough so that if one clock fails, the other clocks continue. This requires self-adjusting clocks used not primarily to "tell time" but as agents that regulate motion. Such a clock-agent has a certain independence as well as the capacity to communicate with other clock-agents and to adjust its own tick rate in response to that communication.

Clocks-as-agents are required also by the national and international organizations that generate time broadcasts. As spelled out in [3], no two clocks, even those that "define" the international