Strong Determinism

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Definitions:

- A possible world w: a four-dimensional spacetime and its (material) contents.
- The actual world α: the actual spacetime and its contents.
- Ω^T: the set of possible worlds that satisfy the fundamental laws specified in theory T.
- Ω_α: the set of possible worlds that satisfy the actual fundamental laws obtaining in α, i.e. the set of all physically / nomologically possible worlds.

Determinism$_T$ Theory T is *deterministic* just in case, for any two $w, w' \in \Omega^T$, if w and w' agree at any time, they agree at all times.

Determinism$_\alpha$ The actual world α is *deterministic* just in case, for any two $w, w' \in \Omega_\alpha$, if w and w' agree at any time, they agree at all times.

Strong Determinism$_T$ Theory T is strongly deterministic if $|\Omega^T| = 1$, i.e. its fundamental laws are compatible with exactly one possible world.

Strong Determinism$_\alpha$ The actual world α is strongly deterministic if $\Omega_\alpha = \{\alpha\}$.

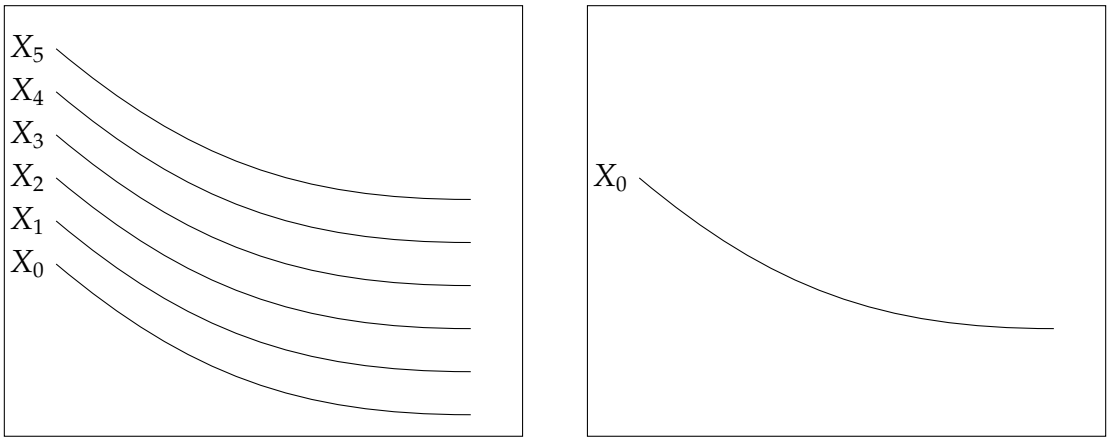

Figure 1: A deterministic theory vs. a strongly deterministic theory.

Implications of strong determinism:

1. Strong explanation;
2. PSR;
3. Causation and counterfactuals;
4. Strong prediction;
5. Other philosophical implications (naturalness, laws, free will, modal realism).

Toy Example #1: An Aristotelian spacetime, with an absolute spatial center x_0 and a lone particle whose only property is position. It is a fundamental law that the particle is located at x_0 at any time.

Toy Example #2: The Mandelbrot world, where it is a fundamental law that the matter distribution is given by the simple rule that generates the Mandelbrot set.

The Everettian Wentaculus is a more realistic example. It has two fundamental laws:

1. The von Neumann equation, $i\hbar\frac{d\hat{W}(t)}{dt} = [\hat{H}, \hat{W}]$, dictates how a fundamental density matrix changes in time.
2. The Initial Projection Hypothesis (IPH), $\hat{W}_{IPH}(t_0) = \frac{\mathbb{I}_{PH}}{dim\mathscr{H}_{PH}}$, where $\mathscr{H}_{PH}$ denotes the Past-Hypothesis subspace in the Hilbert space, pins down a unique initial density matrix of the universe.

The Everettian Wentaculus is strongly deterministic; it allows exactly one nomologically possible history of the multiverse — the actual one.

Theoretical virtues (in virtue of being a Wentaculus theory):

1. No fundamental probability. (Chen, in *Statistical Mechanics and Scientific Explanation*, 2020)
2. Nature of the quantum state. (Chen, *BJPS* 2021)
3. Fundamentality of physical spacetime. (Chen, *JPhil* 2017)
4. Compatibility with Humean supervenience. (Chen, *Noûs* 2022)
5. Narratability and Lorentz invariance. (Chen, *Noûs* 2022)
6. Elimination of nomic vagueness. (Chen, *Phil Review* 2022)
7. Unification. (Chen, in *The Probability Map of the Universe*, 2023; in *Physics and the Nature of Reality*, forthcoming)

Conclusion: Strong determinism is surprisingly easy to achieve. Empirical evidence underdetermines whether strong determinism is true. Theoretical virtues may even favor certain strongly deterministic theories.

To be further explored: (1) Strong determinism is more natural in a quantum universe. (2) Strong determinism is not only permissible but perhaps required for the final theory of the universe.