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A Glitch in Simulation or Reality: The Limits of Digital Ontology as Cosmological Theory

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Abstract

This article examines the simulation hypothesis through a formal epistemic and axiomatic lens, assessing whether it can constitute a coherent and testable account of cosmological reality. After outlining the conceptual claim that our universe might be a high-level computational construct, the paper develops a minimal axiomatic framework for a "simulation matrix" and evaluates its logical status. It is shown that the hypothesis is internally consistent yet inherently incomplete, in the Gödelian sense that no observer embedded within the simulated domain can obtain evidential access to the ontological ground of its implementation. Even when strengthened with empirical commitments intended to render it testable, the hypothesis remains ontologically underdetermined: detectable implementation is not equivalent to demonstrable provenance. Accordingly, the simulation hypothesis, far from being a cosmological thesis, functions as a limit-case of self-referential epistemology — a modern restatement of the logical horizon beyond which no system can verify the reality of its own foundations.

Keywords: virtual reality; ontology; cosmological theory; Gödel incompleteness

1. Introduction

The simulation argument occupies a curious position at the intersection of metaphysics and epistemology, insofar as it purports to describe the ontological status of reality while simultaneously denying embedded observers access to any standpoint outside their own experiential domain. Unlike empirical hypotheses within the natural sciences, which are adjudicated by further observation or experimentation, the simulation hypothesis concerns the status of the framework within which all possible observations occur. Its credibility thus depends not on evidential accumulation, but on whether it can satisfy the logical conditions of a coherent theory of reality. Philosophical scrutiny therefore requires asking not whether the world looks simulated, but whether the notion of simulation is intelligible, non-circular, and epistemically tractable from within the domain it seeks to characterise.

This raises a methodological question central to metaphysics: whether a theory that cannot, even in principle, supply evidential access to its own truth-makers can qualify as an ontologically substantive thesis at all. In what follows, I set out the simulation argument in its strongest possible form, formalise it within an axiomatic framework, and assess its epistemic standing by analogy with Gödelian incompleteness. I then show why the hypothesis remains undecidable even under conditions that would render it apparently testable, before concluding that its force lies not in cosmology but in demonstrating the epistemic limits of embedded self-interpretation.

2. The Premises of the Simulation Argument

The proposed argument is based on the assumption that our reality is a sort of a computer simulation (Simulation Hypothesis) in a very refined manner that makes the species that live within it unable to distinguish that this reality is in effect virtual. The simulation hypothesis entails that the future bears three exclusive probabilities: (1) human civilisation becomes extinct; (2) it attains the capacity but refrains from simulation for ethical reasons; or (3) it runs ancestor simulations, and we

are currently within one. Proponents claim that if sufficiently many simulations are run, then we are statistically more likely to be simulated minds than original biological agents (Bostrom 2003).

3. Virtual Minds Between Proponents and Sceptics

Proponents such as Tegmark, Gates, and Musk suggest that the mathematical regularities of the universe, the role of information in physics, and the trajectories of computation point toward a simulated substrate. Critics like Lisa Randall, however, reject the probabilistic premises and argue that such claims smuggle in selective anthropic reasoning without epistemic warrant (Moskowitz 2016). The hypothesis is thus suspended between speculative technological projection and metaphysical assertion, without supplying an epistemic route for verification. Clearly, as a scientific proposal in its minimal form, it is not testable; and as a metaphysical thesis, it risks circularity unless it specifies conditions under which its claims could be distinguished from ordinary realism.

Let's examine then what the axioms for a simulated reality are and see whether they are complete in the context of Gödel's undecidability theorems.

Gödel's Incompleteness in the Simulation Context

Firstly, if the simulation hypothesis is based on formal logic, then Gödel's theorems apply, and hence there will be true statements about the universe that cannot be proven within it. This implies that the consistency of the simulation's rules cannot be proven from inside, and the existence of the simulation itself may be undecidable. On the other hand, if the simulation does not rely on formal logic as its foundational structure, Gödel's arguments would not then necessarily constrain the system, which may be complete in the sense that every observable phenomenon has an explanation within it even if that explanation is not formally provable (Harris 2024). Thus, it becomes a matter of empirical adequacy or system coherence rather than logical provability to foster this simulation. So even without formal logic implied (inapplicability of Gödel's), there may still be epistemic limits (what simulated beings can know), there may be computational limits (due to finite resources) within this system and there may also be chaotic or emergent behaviours that defy prediction (Agatonović 2023).

4. An Axiomatic Schema for the Simulation Matrix

Let the simulated world be represented by the structure

$$M = \langle W, O, LW, Obs, B, P, \sigma_0, I \rangle,$$

where W is the simulated world (domain we inhabit); O the observers (us); LW the effective laws (physics we know); Obs the set of observation-reports (empirical data collected by observers); B the base reality (real world outside the simulation); P a program (or process) in B that generates W ; σ_0 an initial state of simulation; and I an implementation map- how transitions in B cause transitions in W .

4.1. Core Axioms (Minimal Simulation Matrix)

The following proposed axioms make the simulation metaphysically coherent but not empirically testable- they do not allow us to distinguish a simulation from a non-simulated reality:

A1 (Ontological Two-Levelness): There exist distinct domains base B and simulated W , with $W \neq B$.

A2 (Causal Implementation): A physically realisable process P in B , via I , induces the causal structure of W .

A3 (Observer Supervenience): All observer states have only access to W -level states; no autonomous access to B .

A4 (Internal Empirical Adequacy): All observation-reports in Obs are explained by LW .

A5 (Opacity / No Channel): No evidentially accessible signalling channel from B to W beyond I .

A6 (Level Distinctness): LW need not match base laws; W 's dynamics arise solely via I (W 's laws may differ from B 's laws).

These axioms define the metaphysical framework of a simulation. However, in this minimal form the framework is not empirically discriminable from non-simulation realism.

4.2. Strengthened Axioms (Empirical Commitments)

These axioms add empirical consequences that could, in principle, make the simulation hypothesis testable:

S1 (Finite Resource Bound): Implementation uses finite resources, entailing discretisation, cut-off scales.

S2 (Algorithmic Constraints): Design introduces detectable statistical or complexity biases.

S3 (Implementation Error): Low-probability (rare) anomalies (“glitches”) produce reproducible deviations from LW.

S4 (Open Channel): A discoverable, or detectable signalling interface from B to W.

Only with S1–S4 (if at least one of these holds) does the simulation hypothesis become, even in principle, testable.

5. Lemma and Corollary on Testability and Underdetermination

Lemma (Testability Condition): The simulation hypothesis is empirically decidable within L_{Obs} if and only if there exists at least one strengthened axiom among S1–S4 that yields a falsifiable predictive asymmetry not entailed by LW alone. In the absence of such an asymmetry, the hypothesis remains observationally inert and collapses into metaphysical duplication of ordinary realism.

Corollary (Ontological Underdetermination): Even if S1–S4 are satisfied and the simulation hypothesis becomes empirically testable at the level of implementation, the existence of empirically detectable structure in W does not entail epistemic access to the ontology of B (cannot infer the nature of B). Multiple non-isomorphic base realities could generate indistinguishable simulations; hence verification of implementation never yields verification of provenance. The “base world” remains undecidable across all empirically equivalent models (Raatikainen 2005).

This establishes that the simulation hypothesis does not merely fail empirically, but fails structurally: it presupposes access to a meta-system whose existence, if real, is definitionally outside the inferential closure of the simulated domain. In this respect it is not a cosmological thesis but a self-referential limit theorem concerning the epistemic boundaries of embedded observers. The hypothesis is thus properly categorised not as a scientific conjecture but as an illustration of the fact that no formal system can, from within, verify the ontological ground of its own apparent coherence. Thus

- The simulation hypothesis presupposes a meta-system B that is definitionally inaccessible from within W.
- Therefore, it is not a scientific hypothesis but a limit theorem: it illustrates that no formal system (like W) can verify the ontological ground B of its own coherence.
- This is akin to Gödel’s incompleteness: a system cannot prove its own consistency from within.

6. Conclusions

To conclude, the incompleteness of the simulation hypothesis mirrors Gödel’s insight that no sufficiently expressive system can prove all truths about its own structure from within its own axioms (Gödel 1931). The simulated world, if one postulates it, would constitute a closed formal system whose internal observers have access only to LW, not to its meta-ground B. Thus, any purported demonstration of simulation status from within W faces an intrinsic Gödelian boundary: the decisive meta-fact — namely the existence of B — cannot be established internally without importing information that exceeds the system’s own inferential resources. Accordingly, the hypothesis is not merely empirically untestable in its minimal form, but logically incomplete by construction, since its purported ontological ground lies in a meta-system structurally inaccessible to its inhabitants. Hence what is advertised as a cosmological thesis ultimately reduces to a Gödelian horizon of epistemic limitation, exposing the simulation argument not as an extension of explanatory power but as a restatement of the limits of formal self-knowledge (Peacocke 2024).

In this respect, the simulation hypothesis becomes philosophically valuable precisely where it fails as ontology: it exemplifies the inherent limits of any theory that requires a perspective external to the world it describes in order to verify its own truth conditions. Its interest is therefore methodological rather than cosmological, illustrating that epistemic closure at the level of first-order description does not translate into ontological transparency. What this reveals is that metaphysics when formally expressed, like arithmetic in Gödel's proof, cannot be both internally self-grounding and complete. The simulation argument thus serves not as a window onto a hidden digital substrate, but as a reminder that the boundary of knowability is structural, not merely technological.

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