The Faster-Than-Light Step Is an Interpretation

Physical interaction, causal records, and conditional states
at the double slit

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Sabine Hossenfelder is largely right about the double-slit phenomenology.[1] A single slit produces a diffraction envelope, not a narrow classical stripe. Two coherent alternatives produce interference. A path detector creates distinguishable records, and the interference disappears when those records are ignored.

The disagreement begins with the word *update*.

The video describes switching on a detector near one slit and then says that the wavefunction suddenly updates at both slits. If that update is an objective physical event occurring throughout space, the conflict with relativity is immediate. But the experiment itself does not observe such an event at the unmonitored slit. It observes a detector record and, later, a changed distribution at the screen.

Three different things have been combined:

1. a physical interaction between the path and the detector;
2. the state of the ensemble when the detector result is ignored;
3. a conditional state assigned after a particular detector record is known.

Only the first is measurement dynamics. The third is conditionalization. Treating the third as another physical process is an interpretive choice, not a result of the double-slit experiment.

The physical interaction

Let $|L\rangle$ and $|R\rangle$ denote the two path alternatives, and let $|D_0\rangle$ be the detector's ready state. A path-sensitive unitary interaction has the form

$$\big(\alpha|L\rangle + \beta|R\rangle\big)|D_0\rangle \longrightarrow \alpha|L\rangle|D_L\rangle + \beta|R\rangle|D_R\rangle. \tag{1}$$

[1] Sabine Hossenfelder, *You probably misunderstand the double slit experiment*, 20 July 2026.

Nothing collapses in Eq. (1). The detector becomes correlated with the path.

At a later screen position x, the detector-unread probability is

$$\begin{aligned} P(x) = |\alpha|^2|\psi_L(x)|^2 + |\beta|^2|\psi_R(x)|^2 \\ + 2\,\mathrm{Re}[\alpha\beta^*\psi_L(x)\psi_R^*(x)\langle D_R|D_L\rangle]\,. \end{aligned} \tag{2}$$

The overlap $\langle D_R|D_L\rangle$ measures how distinguishable the records are. If the detector states are identical, interference remains. If they are orthogonal, perfect path information exists and the cross term vanishes. Real detectors lie between these limits, leaving residual interference determined by the record overlap.

This loss of interference is a physical consequence of system–detector correlation. No message has to travel from the monitored slit to the unmonitored slit.

No click and the conditional state

The no-click result can look more mysterious because the detector did not fire. For an ideal detector monitoring the right path, the global interaction may be written

$$\big(\alpha|L\rangle + \beta|R\rangle\big)|D_0\rangle \longrightarrow \alpha|L\rangle|D_0\rangle + \beta|R\rangle|D_1\rangle. \tag{3}$$

The no-click record $|D_0\rangle$ is correlated with the left-path component. Conditional on that record, the relative state is therefore $|L\rangle$. This does not require a second law that physically projects the global state. It follows by selecting the component correlated with the record that was obtained.

In instrument notation, let $\mathcal{I}_0$ and $\mathcal{I}_1$ denote the no-click and click branches of the interaction, and let $p_0 = \mathrm{Tr}\,\mathcal{I}_0(\rho)$ be the no-click probability. The distinction is then compact:

$$\rho_{\text{unread}} = \mathcal{I}_0(\rho) + \mathcal{I}_1(\rho), \qquad \rho_{0|\text{record}} = \frac{\mathcal{I}_0(\rho)}{p_0}. \tag{4}$$

The unread state and the no-click-conditioned state answer different questions. Substituting the second for the first and then describing the substitution as a physical influence is exactly the step that needs justification.

For imperfect records the same distinction remains stable provided the selected outcome is not too rare; conditioning can amplify small errors when its probability is very low.

The displayed unitary describes a nondestructive path marker. If a click absorbs the particle instead, the click branch does not reach the screen and the screen-arrival ensemble is the no-click sector. That changes the downstream statistics, but not the distinction between physical interaction and conditionalization.

What relativity constrains

The screen lies in the causal future of the slit interaction. Switching the detector after emission does not by itself make the detector-to-screen relation spacelike. The video provides no distances or switching times from which a spacelike separation between the detector event and any remote region could be established. The altered screen distribution therefore has an ordinary causal explanation: the detector changes the correlations that subsequently propagate to the screen.

The stronger question concerns a region spacelike separated from the detector. Relativistic local-measurement theory distinguishes the same two cases. For a compactly coupled local probe, the nonselective operation leaves causal-complement statistics unchanged. A selected outcome may change the conditional state assigned to correlated observables, but the selection record is unavailable outside the causal future of its physical registration.

This is the direction made precise in the Fewster–Verch system–probe framework. I am not claiming to have constructed the video's exact detector as a full quantum-field-theoretic model. The limited point needed here is that local physical dynamics and global conditional state assignment are not the same operation.

No experiment in the remote region can learn, from its local unread statistics, whether the detector was activated. The conditioned description becomes usable only when the detector record is communicated. Consequently, it cannot serve as a faster-than-light signal.

This establishes operational causal consistency, not a completely local ontology. Entanglement, Bell correlations, and global nonseparability remain.

When does an observer update?

Calling the update *epistemic* does not mean that it is arbitrary or merely psychological. It is licensed by a physical record.

An observer cannot condition on a microscopic detector distinction merely because it exists somewhere in the global state. A stable representation of that distinction must reach the observer through an ordinary causal channel. Before it arrives, the observer uses the detector-unread state. After it arrives, the observer may use the state conditional on the record actually received.

A finite observer may not resolve every microscopic detector outcome. In that case the correct conditional state is associated with the coarse record the observer possesses, not with an inaccessible finer distinction. Different observers can therefore make different intermediate assignments because they possess different records. They become directly comparable after ordinary record exchange in their common causal future.

No global *now* at which every observer must replace the state is required. The physical events are localized detector and memory updates. The state assignments are indexed to those records.

Everett and the Ignorant Observer are an implementation, not a proof

Everett provides one explicit host for this distinction. The global state evolves unitarily and retains every decohered record sector. Relative to a particular branch record, an observer uses the corresponding conditional state.

That option has a real interpretive cost. Everett retains definite records within each decohered branch but denies that measurement produces one uniquely real global outcome. The double-slit experiment does not prove that this is the correct ontology.

Nor is record conditioning itself an IOF invention. The narrower contribution of the Ignorant Observer framework is the finite-access criterion: it asks which stable physical record distinctions are actually available to this observer and forbids conditioning on concealed distinctions.

The underlying finite-observer framework is developed in *The Ignorant Observer* [5]. Its explicit realization inside an Everettian host is developed in *The Ignorant Observer inside Everett: A Finite-Record Quotient Theory* [6].

Everett+IOF is therefore not evidence extracted from the experiment. It is a concrete consistency demonstration. It shows that unitary local interaction, causal record propagation, and observer-relative state assignment can coexist without an objective superluminal collapse and without measurement dependence between the source and the later detector setting.

What remains of the dilemma

If one assumes from the start that:

- exactly one outcome is globally real;
- the wavefunction is an observer-independent physical object; and
- measurement physically replaces that object everywhere at once,

then the relativistic collapse problem is genuine. The video is right to press it.

But those are interpretive premises. They are not consequences of the diffraction pattern, the loss of interference, or the no-click result. Superdeterministic measurement dependence is therefore not the only logical alternative to a physical faster-than-light collapse. A unitary relative-state account supplies another possibility, at its own stated cost.

> *The double-slit experiment shows local detector interaction, path–record correlation, loss of interference, and record-conditioned predictions. It does not show a physical update propagating from one slit to the other. Faster-than-light collapse enters only when a conditional state assignment is promoted to an objective spacetime event.*

That conclusion does not select an interpretation. It identifies exactly where interpretation enters.

Further reading

[1] Hugh Everett III, Relative-State Formulation of Quantum Mechanics, *Reviews of Modern Physics* **29**, 454–462 (1957). doi:10.1103/RevModPhys.29.454.

[2] Wojciech H. Zurek, Decoherence, einselection, and the quantum origins of the classical, *Reviews of Modern Physics* **75**, 715–775 (2003). doi:10.1103/RevModPhys.75.715.

[3] Berthold-Georg Englert, Fringe Visibility and Which-Way Information: An Inequality, *Physical Review Letters* **77**, 2154–2157 (1996). doi:10.1103/PhysRevLett.77.2154.

[4] Christopher J. Fewster and Rainer Verch, Quantum fields and local measurements, *Communications in Mathematical Physics* **378**, 851–889 (2020). doi:10.1007/s00220-020-03800-6.

[5] Aernoud Dekker, *The Ignorant Observer*, OSF Preprints (2026). doi:10.17605/OSF.IO/FCDSN.

[6] Aernoud Dekker, *The Ignorant Observer inside Everett: A Finite-Record Quotient Theory*, OSF Preprints (2026). doi:10.17605/OSF.IO/GHJBQ.