Title: What would a consistent instrumentalism about quantum mechanics be? Or, why Wigner's friendly after all.

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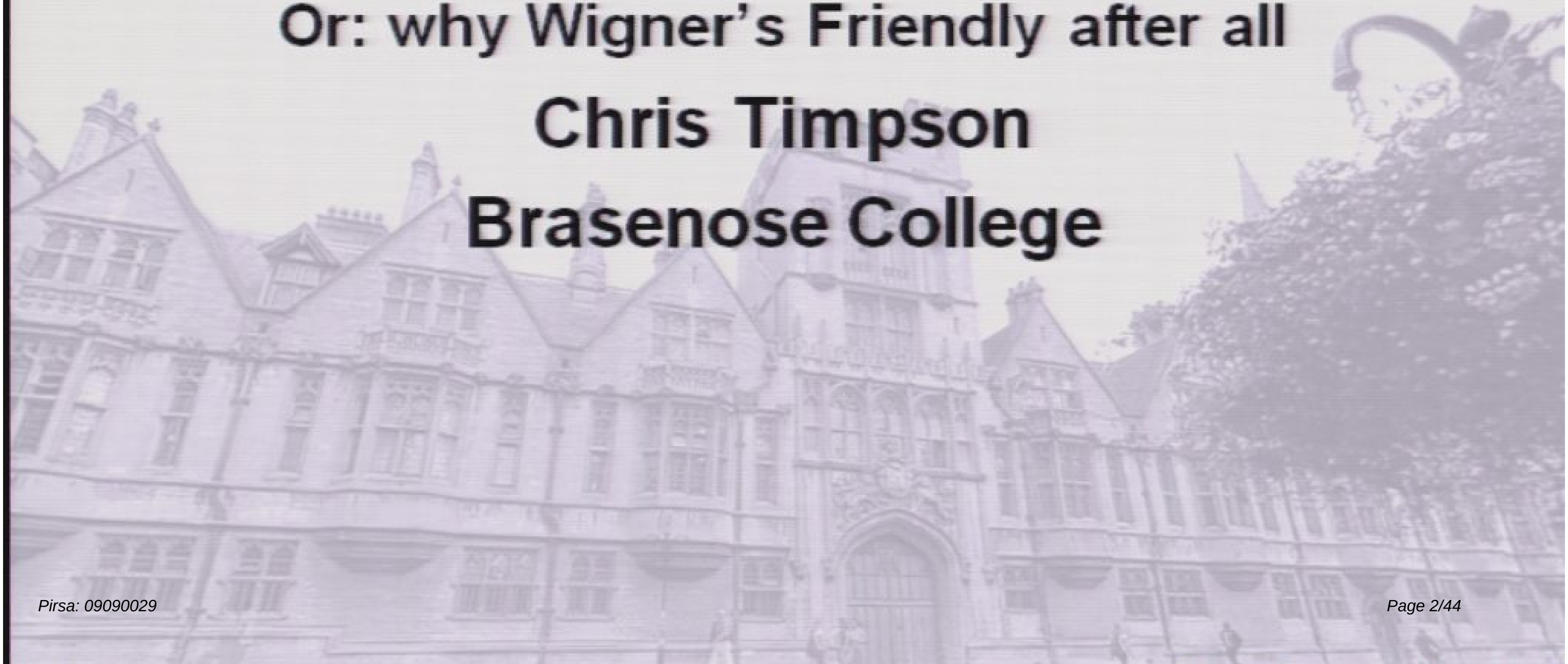
Abstract: Instrumentalism about the quantum state is the view that this mathematical object does not serve to represent a component of (non-directly observable) reality, but is rather a device solely for making predictions about the results of experiments. One honest way to be such an instrumentalist is a) to take an ensemble view (= frequentism about quantum probabilities), whereby the state represents predictions for measurement results on ensembles of systems, but not individual systems and b) to assign some specific level for the quantum/classical cut. But what happens if one drops (b), or (a), or both, as some have been inclined to? Can one achieve a consistent view then? A major worry is illustrated by the Wigner's friend scenario: it looks as if it should make a measurable difference where one puts the cut, so how can it be consistent to slide it around (as, e.g., Bohr was wont to)? I'll discuss two main cases: that of Asher Peres' book, which adopts (a) but drops (b); and that of the quantum Bayesians Caves, Fuchs and Shack, which drops both. A view of Peres' sort can I, think, be made consistent, though may look a little strained; the quantum Bayesians' can too, though there are some subtleties (which I shall discuss) about how one should handle Wigner's friend.

What Would a Consistent Instrumentalism about Quantum Mechanics Be?

Or: why Wigner's Friendly after all

Chris Timpson

Brasenose College



Peres' view:

"The essence of quantum theory is to provide a mathematical representation of states (that is, of *preparation procedures*) together with rules for computing the probabilities of the various outcomes of any tests.

A test is more than the occurrence of an unpredictable event...to be interesting to physicists, these macroscopic events must be accompanied by a theoretical interpretation...[this] must be partly classical [cf. Bohr]" p.26

"...you may ask: why can't we describe the measuring instrument by quantum theory too? We can...However, this only shifts the imaginary boundary between the quantum world – which is an abstract concept – and the mundane, tangible world of everyday. If we quantize the original classical instrument, we need another classical instrument to measure the first one, and to record the permanent data that will remain available for us to study." *ibid.*

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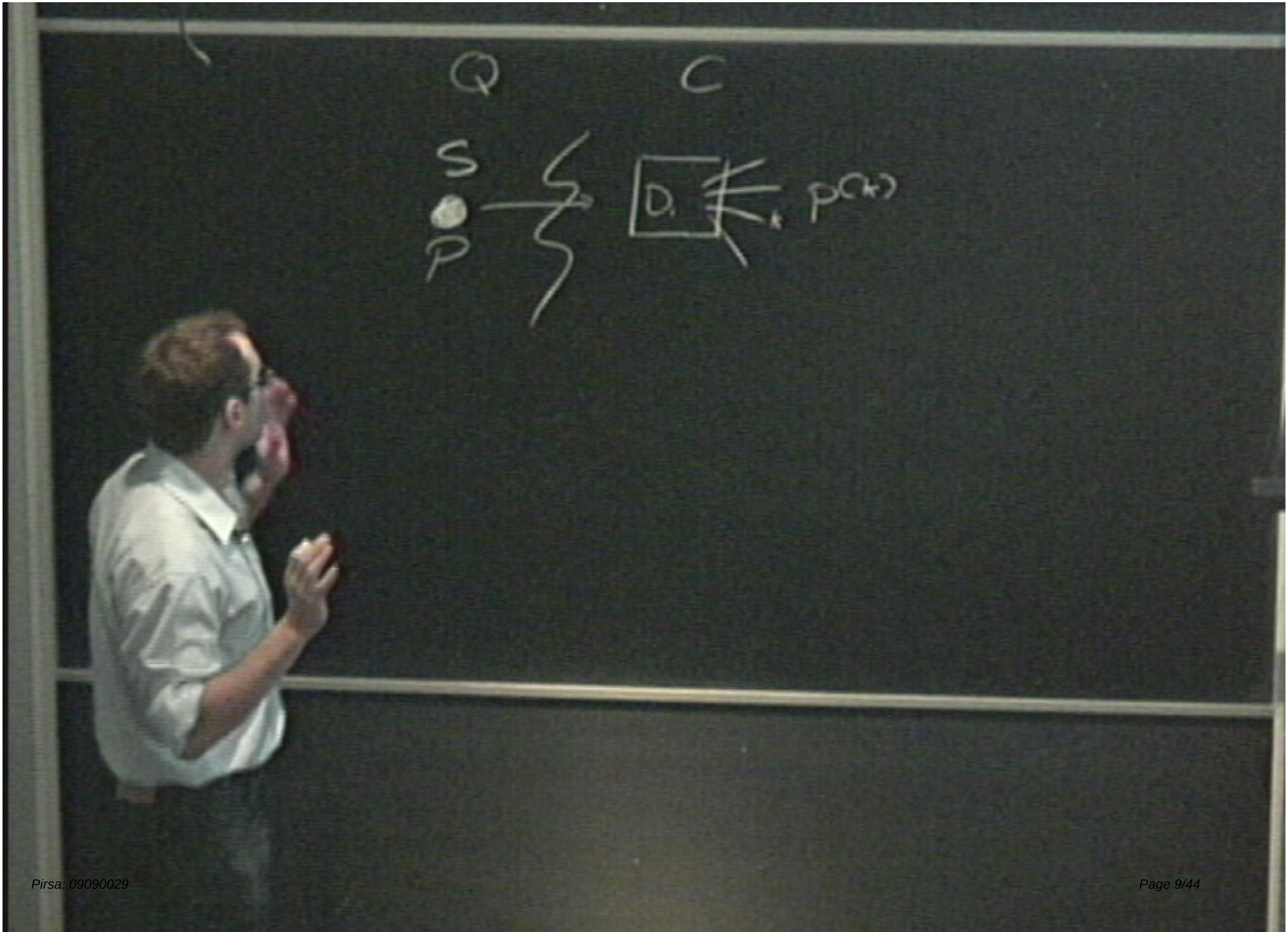
Summary:

- Honest and Shifty Instrumentalism
- The way of Levels and the Core Problem
- What of decoherence?
- What of reversibility?
- From Peres to Fuchs; and Wigner

Setting up:

- Begin with **quantum systems** (and their *states*); and **measuring devices** (and their *POVMs*).
- The **HONEST APPROACH:**
  - **(A) No dealings with individual systems; statistics for** ***ensembles*** **only** (frequentism).
  - **(B) A fixed quantum/classical divide.**
  - (N.B., advantages w.r.t. measurement problem and EPR.)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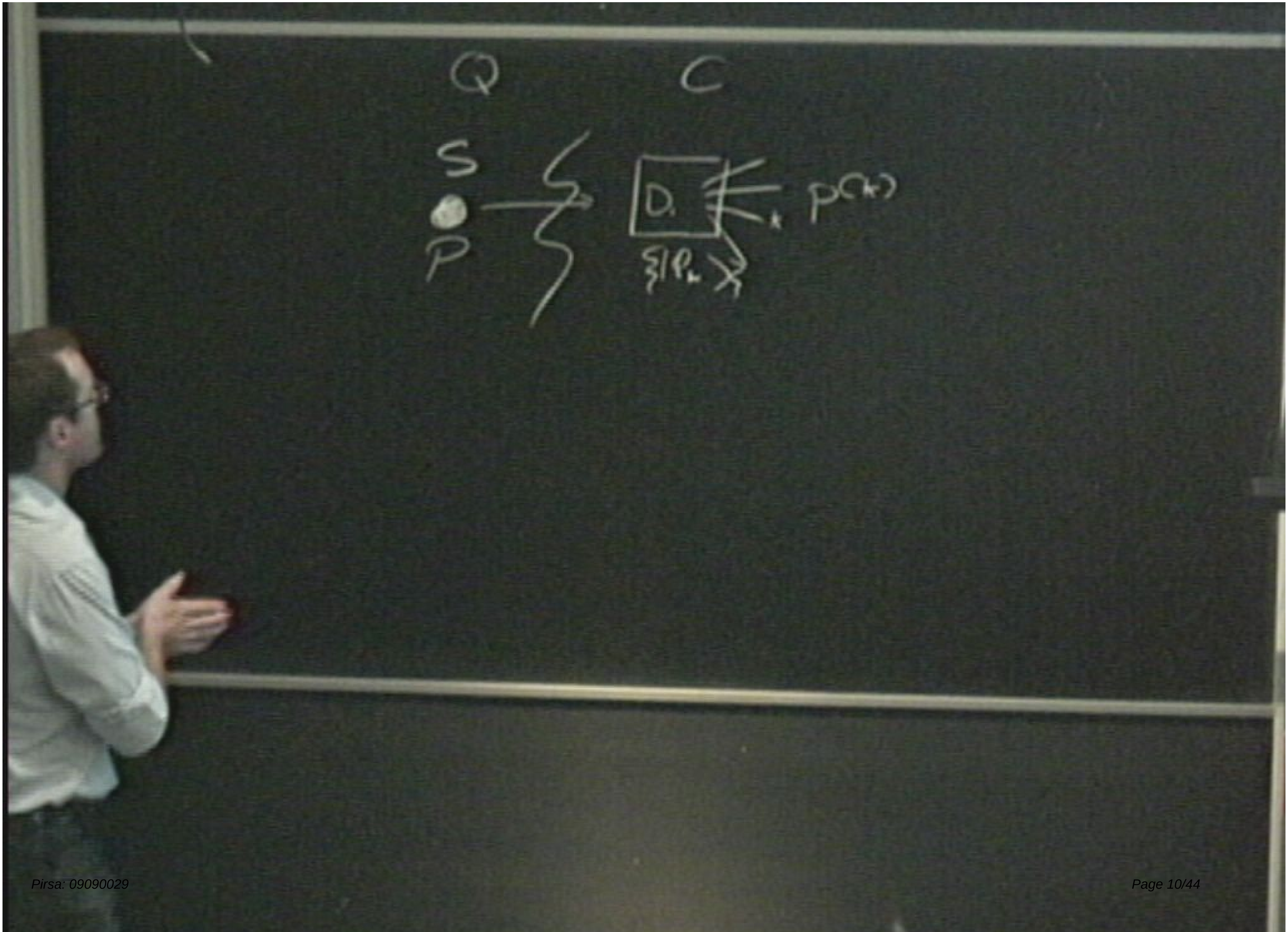
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Shiftiness: Drop (B)

- Distinct **Levels** of description:
  - at L_1, S is quantum and D_1 is classical (macro).
  - at L_2, S and D_1 are quantum (assigned state); D_2 is classical, etc.
  - At Level n instrumental q states only assigned to systems at level n-1; we only talk of determinate properties at level n.

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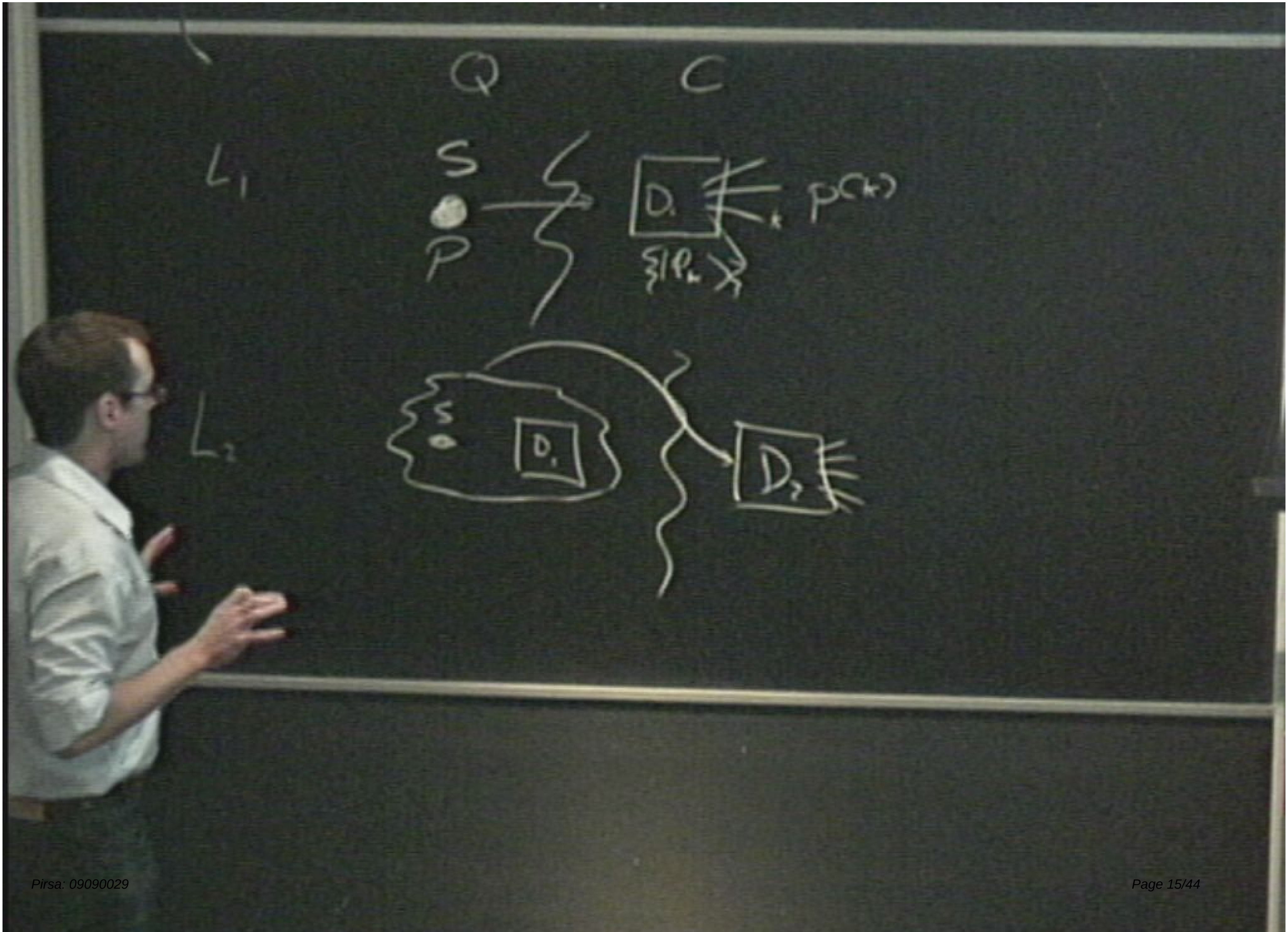
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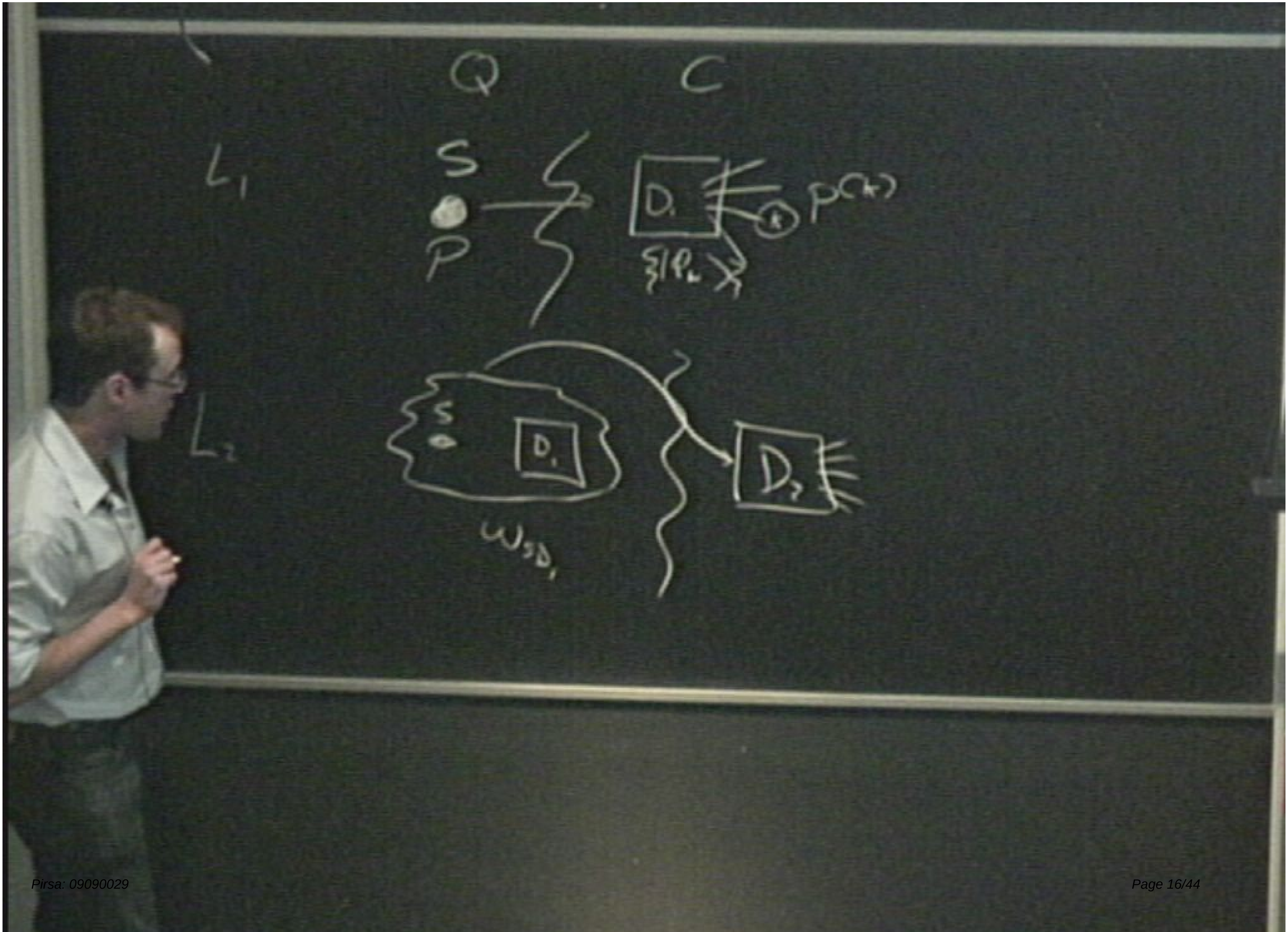
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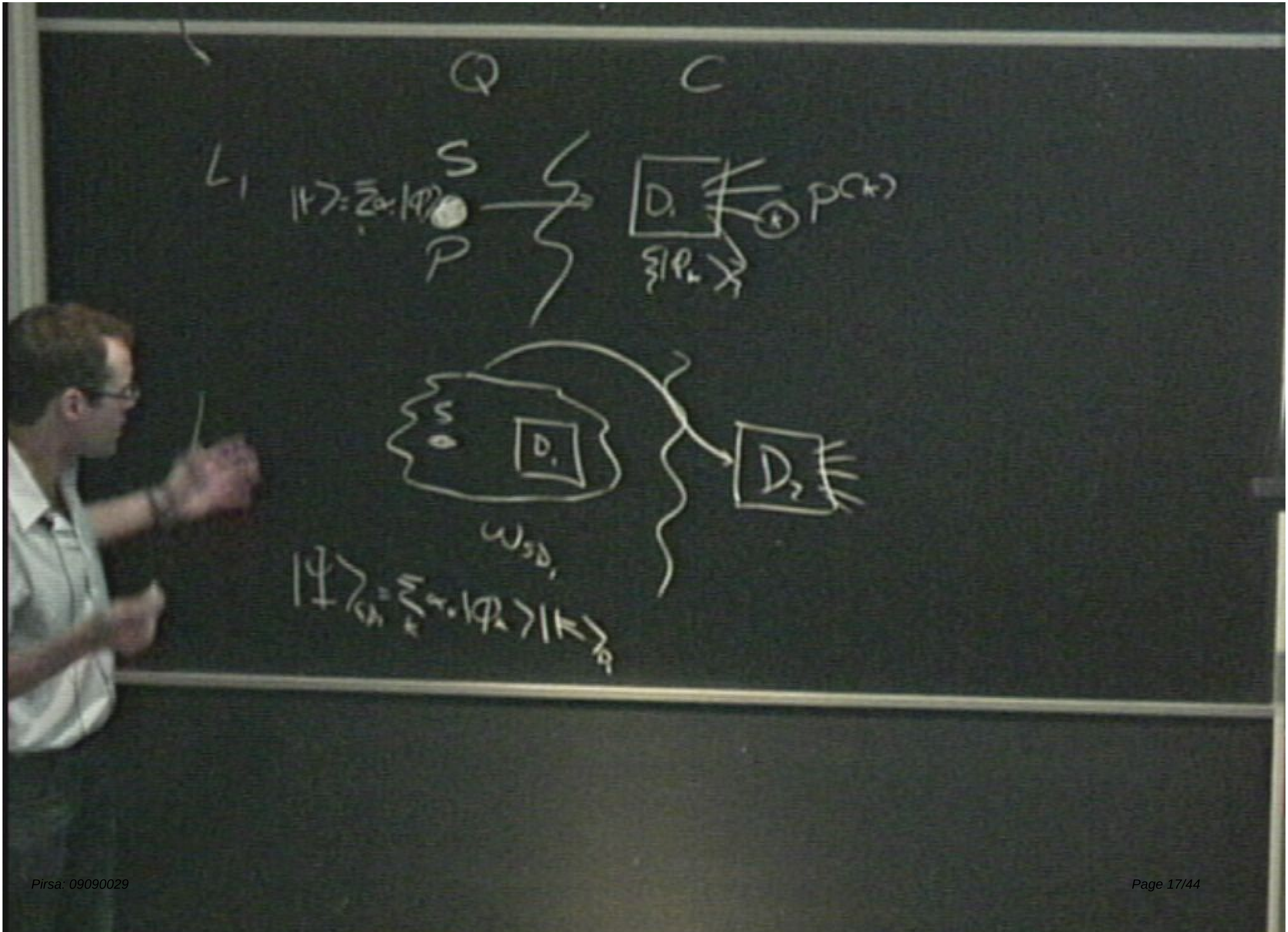
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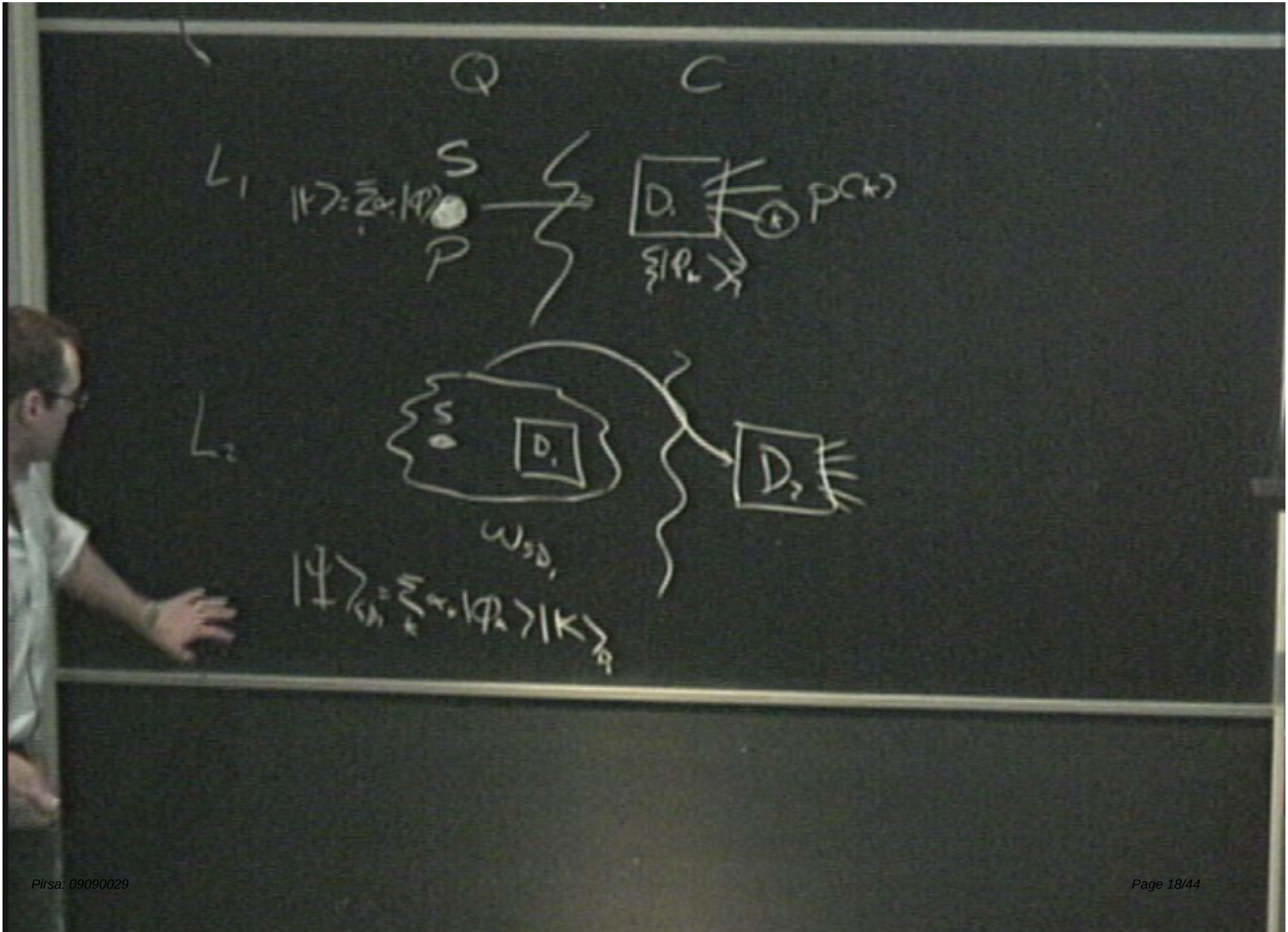
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Two points:

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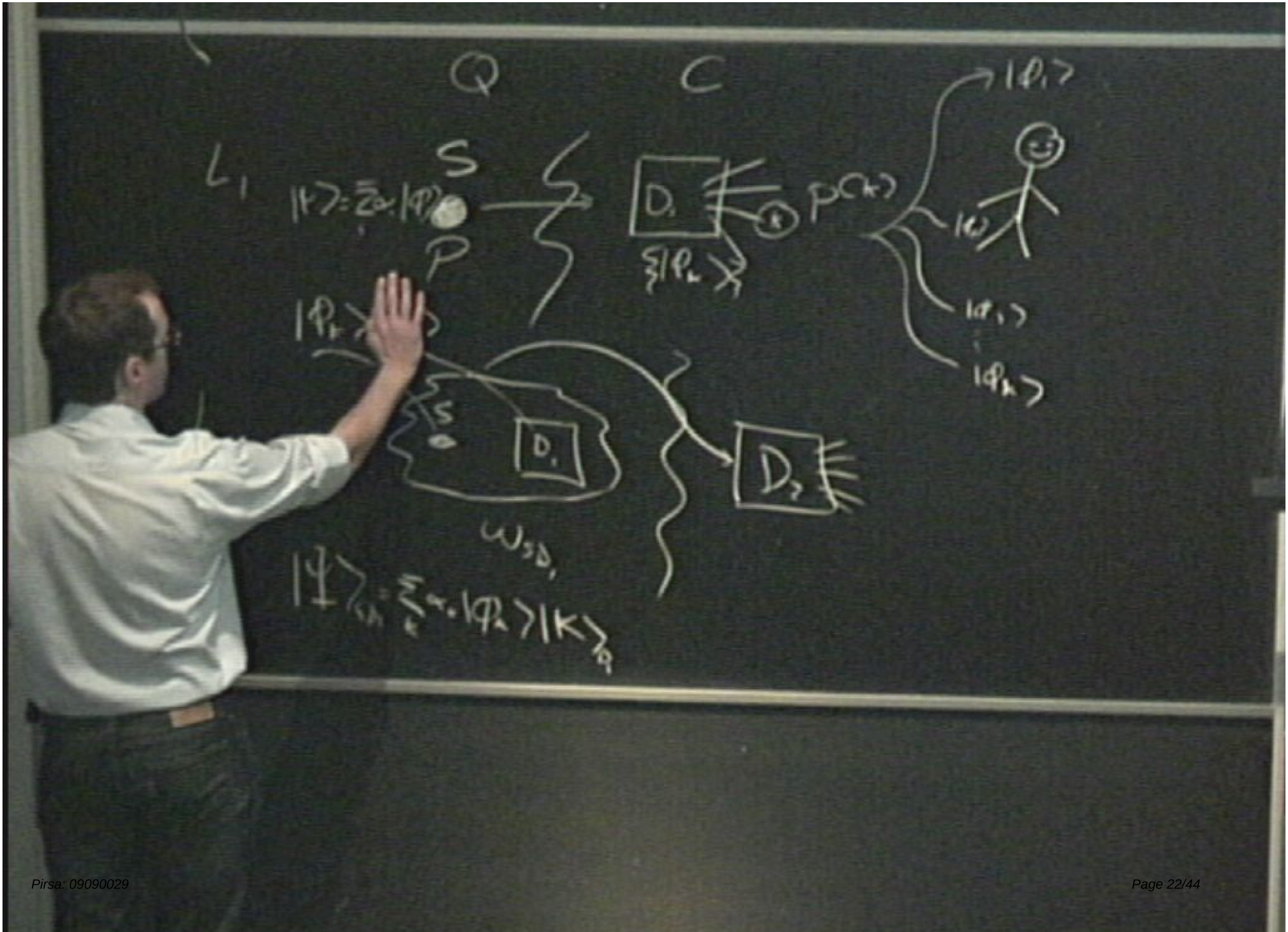

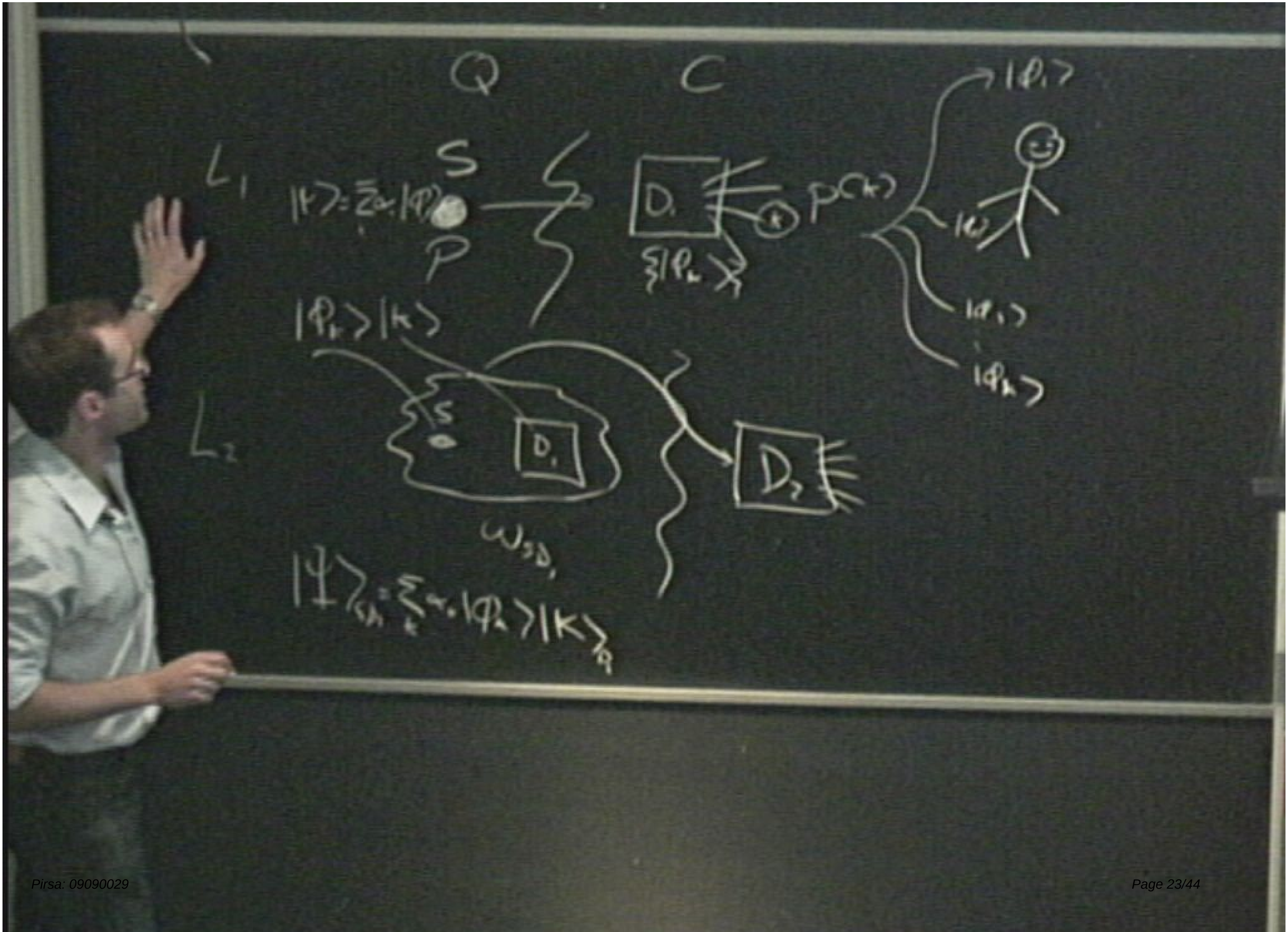
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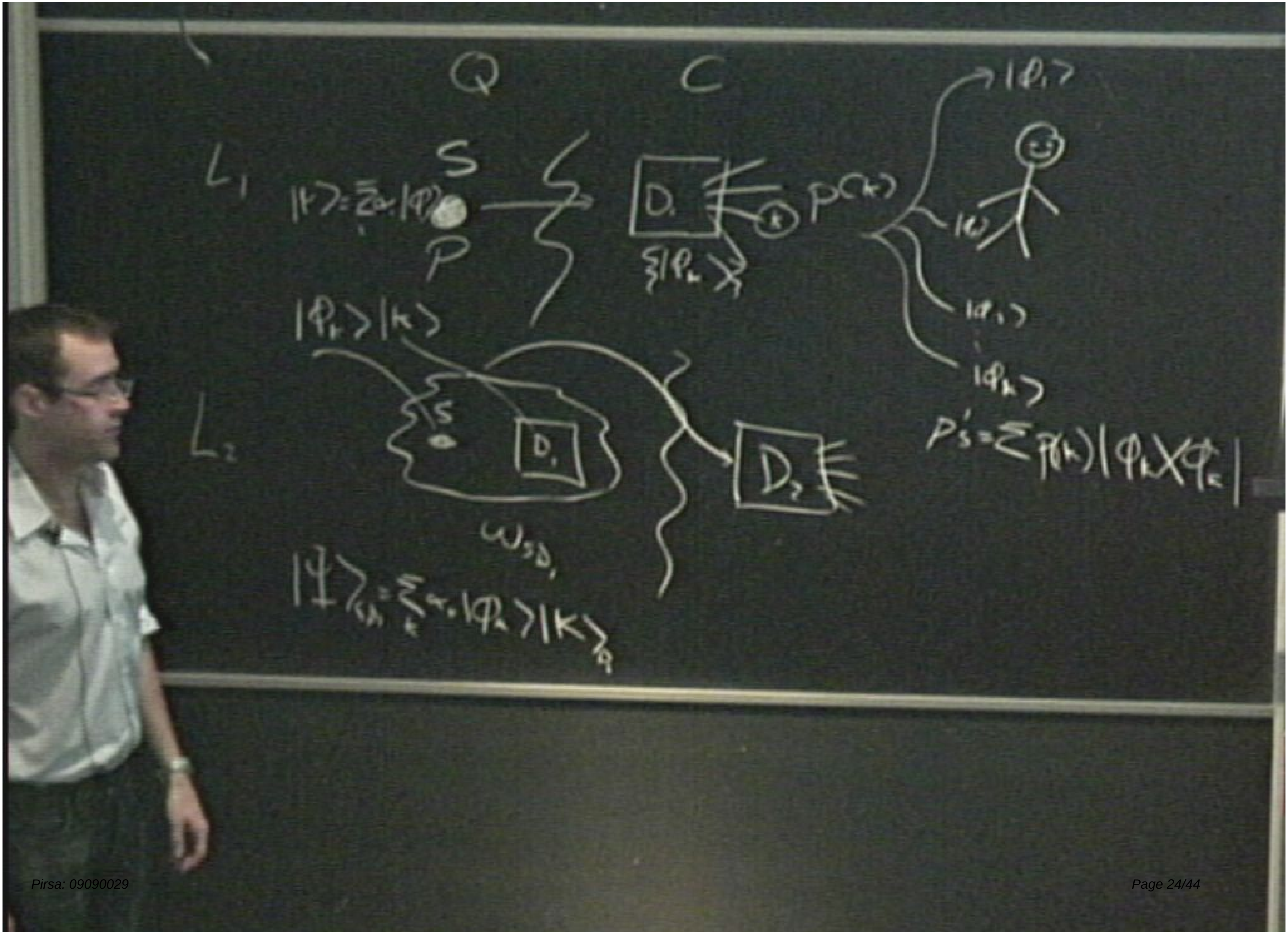
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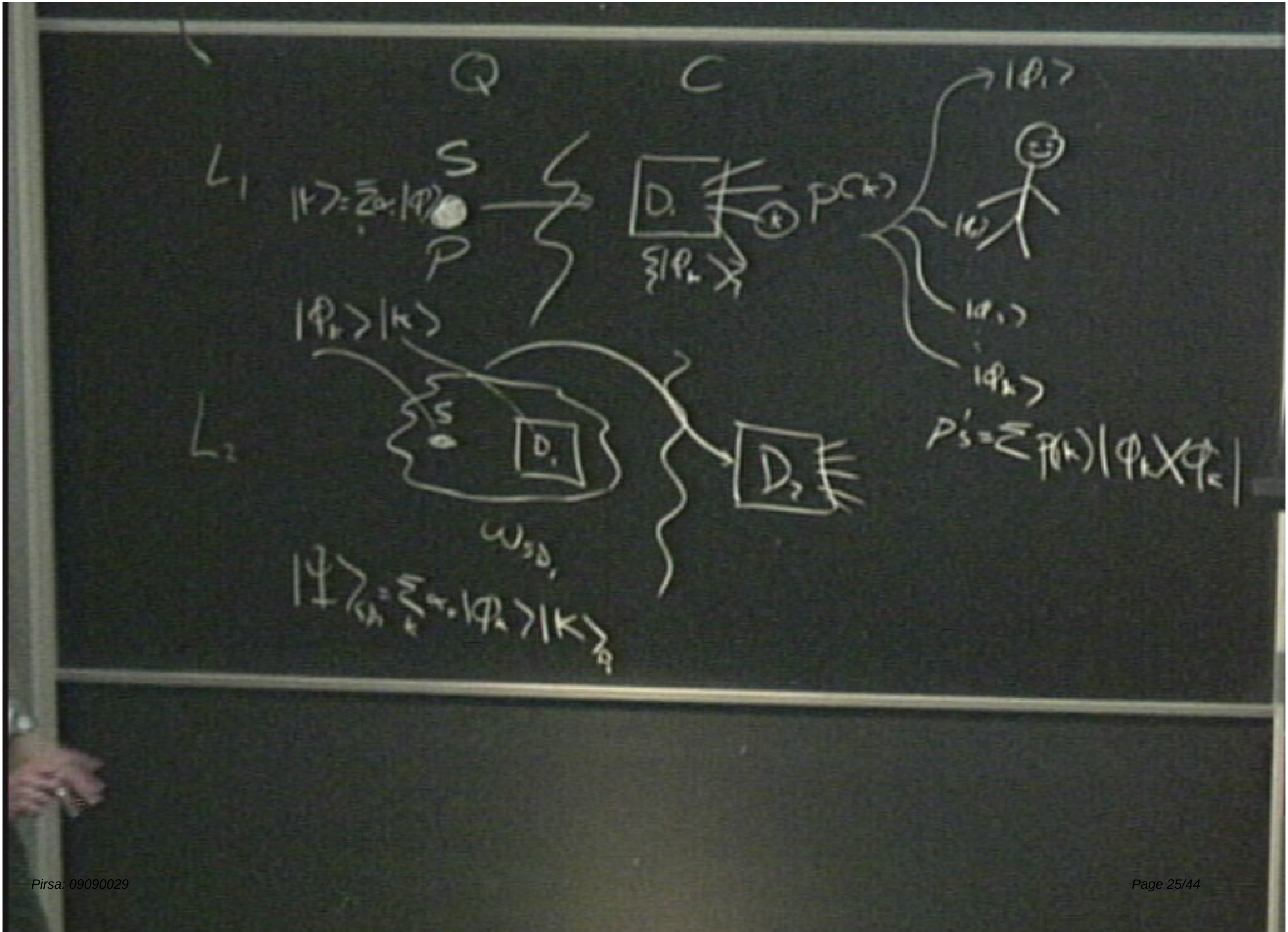
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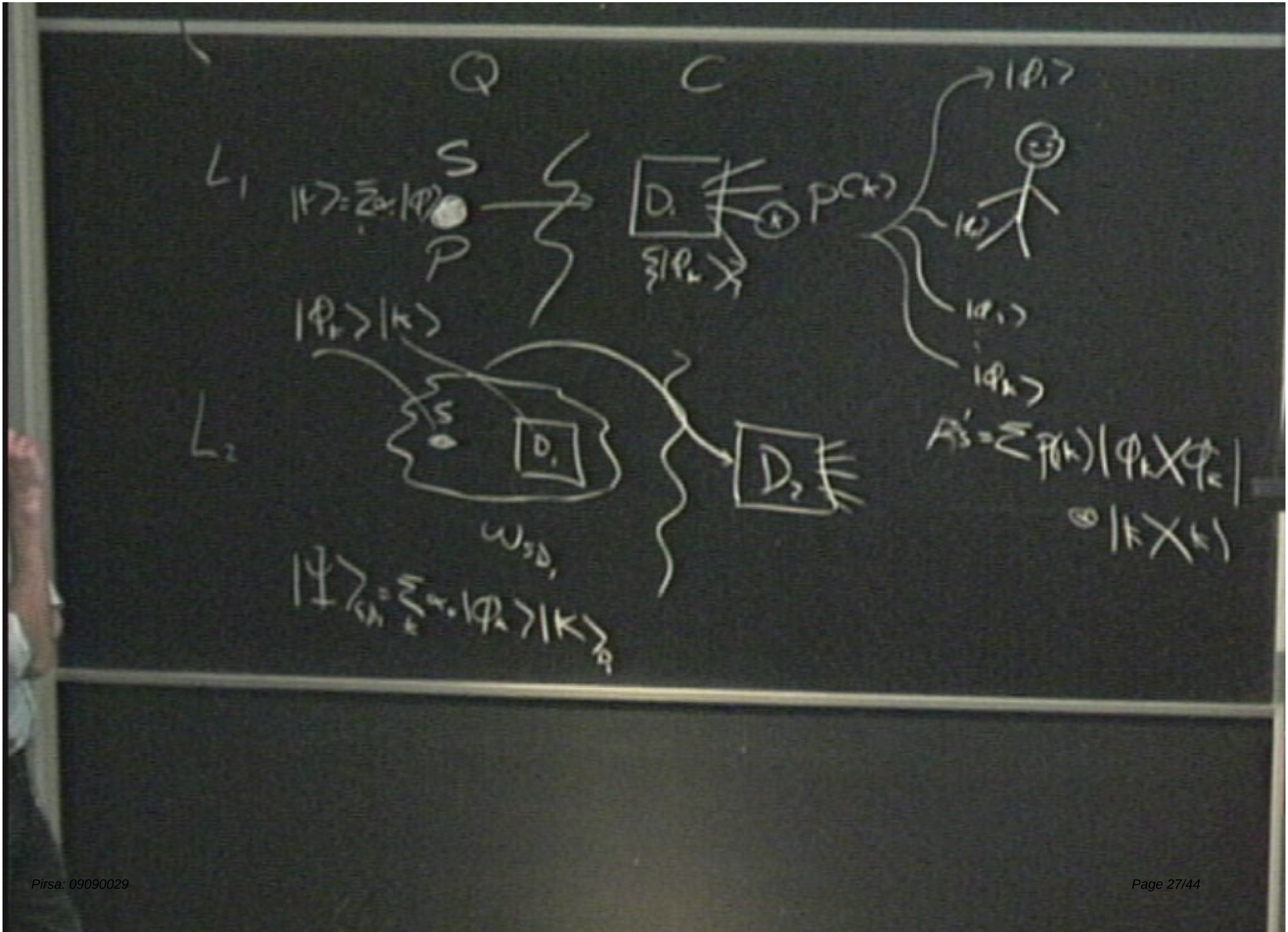
2) means: the existence of clicks *does not entail* that the L_2 state of *S* and D_1 should really be the pure product or convex combination of pure products.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The picture:

- There is a level of classical (macro) facts which is not treated by the theory (except for probs for measurement outcomes);
- The theory correlates macro-preparations and observations by means of states assigned to the micro systems;
- Intrinsically approximate in application: facets of interaction which are not predictively complete;
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What of decoherence?

Peres again:

"The internal consistency of the theory will simply mean that if an instrument is quantized and observed by another instrument, whose description will remain classical, the result obtained by the second instrument must agree with the result that was registered by the first...More precisely, the probability for obtaining conflicting results must be arbitrarily low. This requirement imposes conditions on what can legitimately be called a measuring apparatus. It will be shown that an apparatus must have enough degrees of freedom to behave irreversibly in a thermodynamic sense. This will establish the consistency of out approach." (pp.26-7)

"The result is *definite* and cannot be affected by reconsidering the measuring apparatus as a quantum object...measurements are *conclusive* only if there are no super-observers; that is, if the interaction processes are *de facto* irreversible." (p.376)

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- Whether or not a process will be reversible is a logically separate question from that of the existence of detector clicks.

From Peres to Fuchs:

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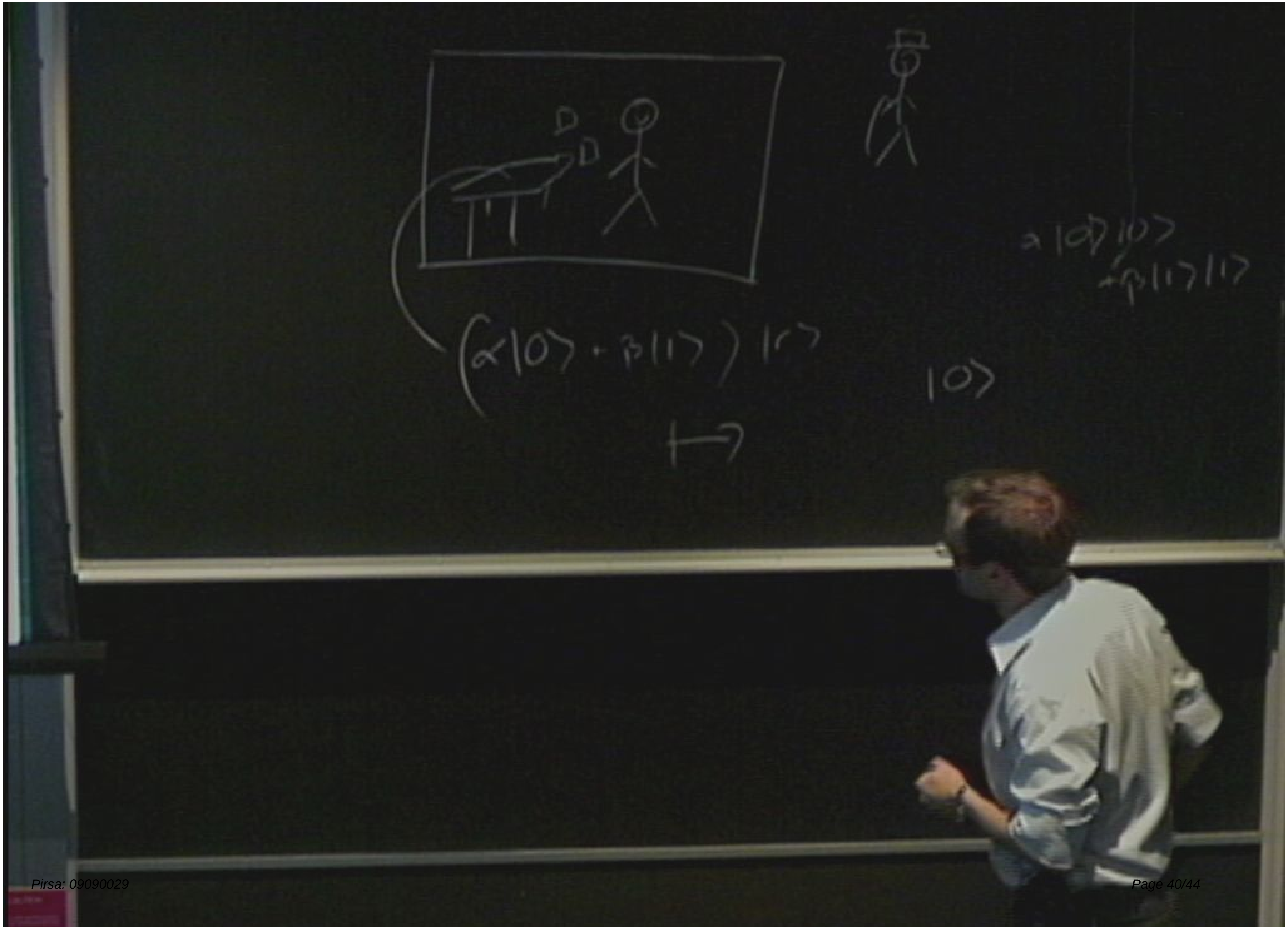
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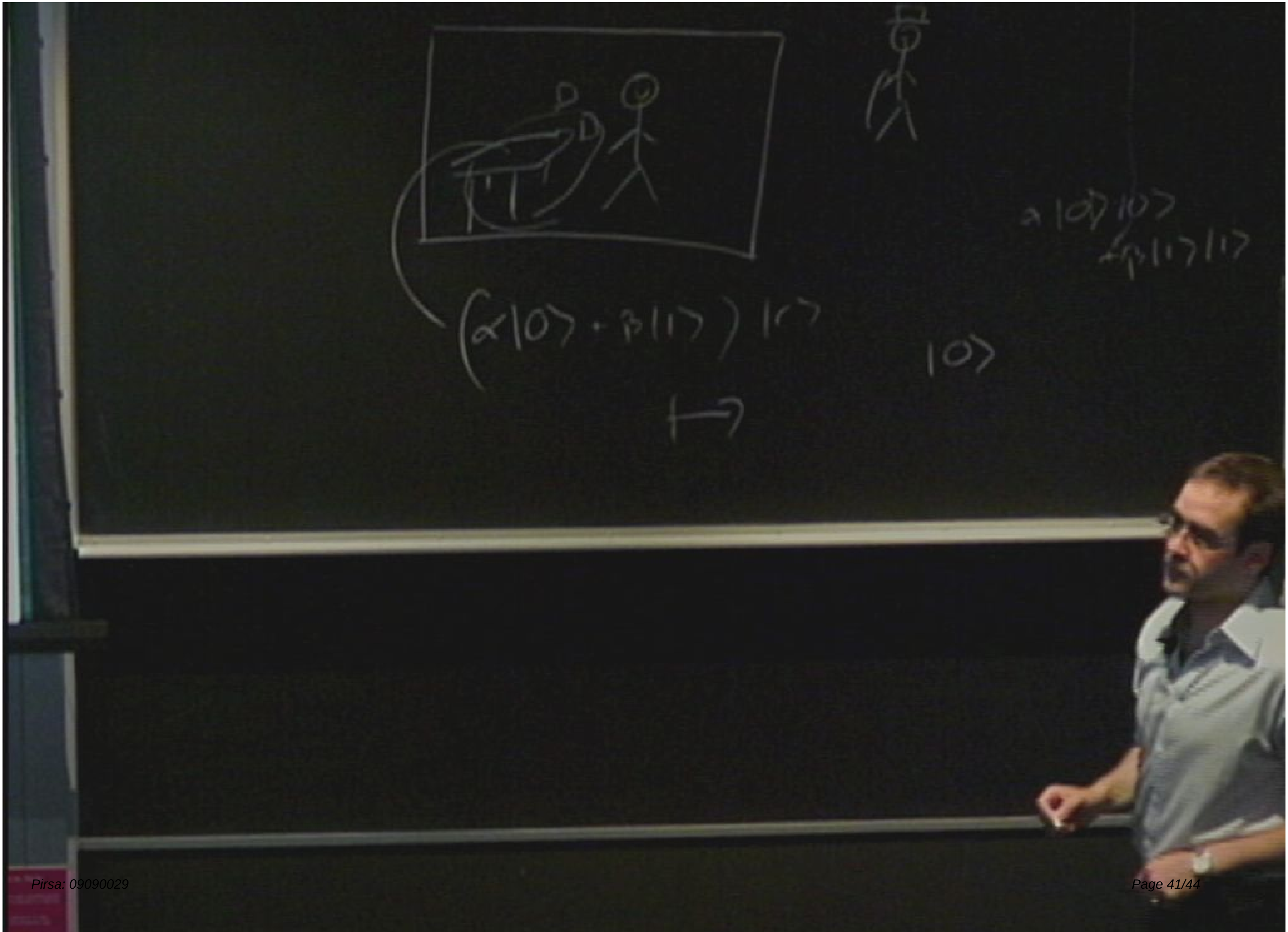

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Conclusions:

- Consistent instrumentalist views of the state can be had which drop **(B)**, or **(A)**, or both;
- Crucially:
  - *Objective* states for individual systems must be lacking;
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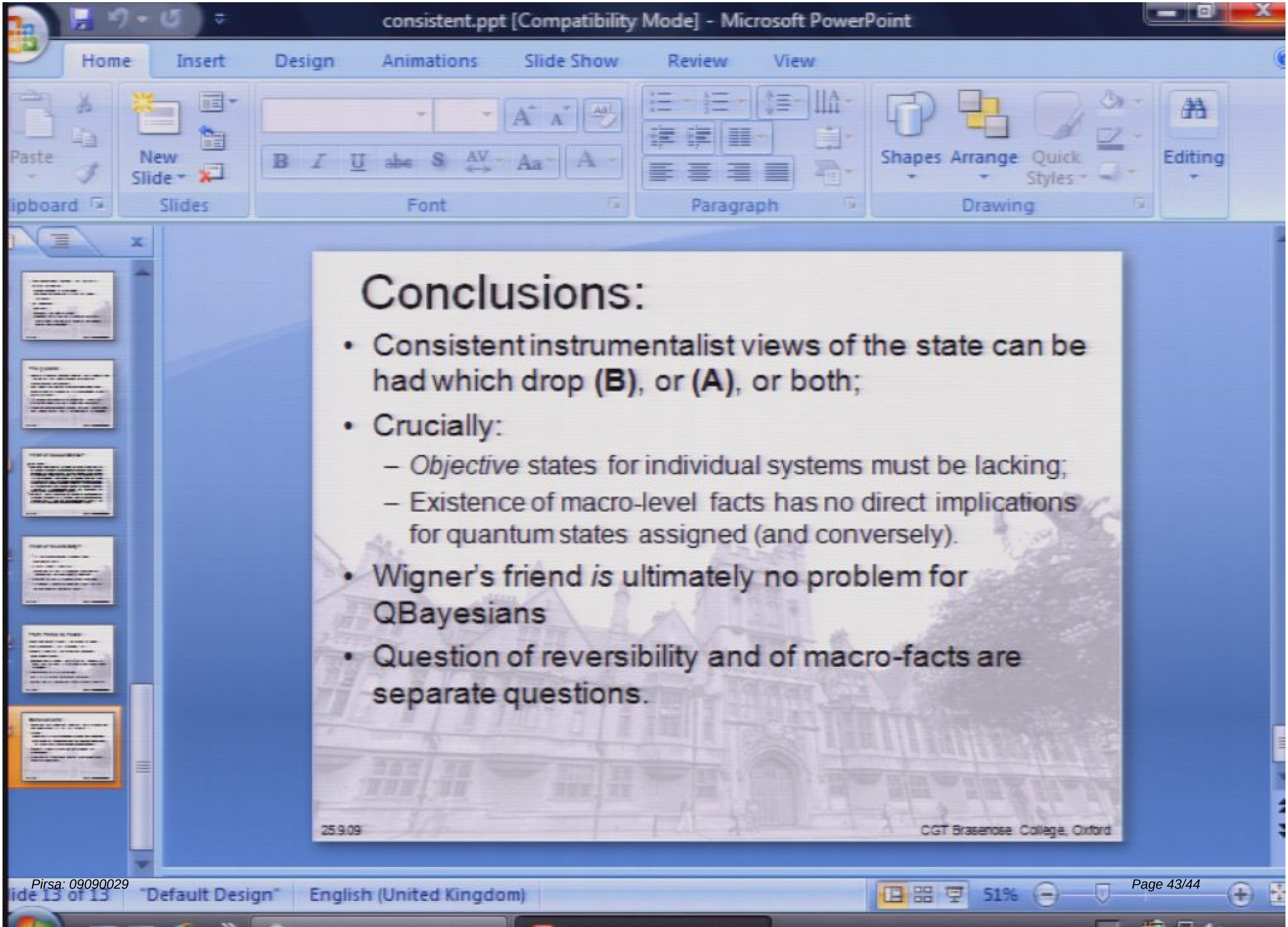
- Wigner's friend *is* ultimately no problem for QBayesians
- Question of reversibility and of macro-facts are separate questions.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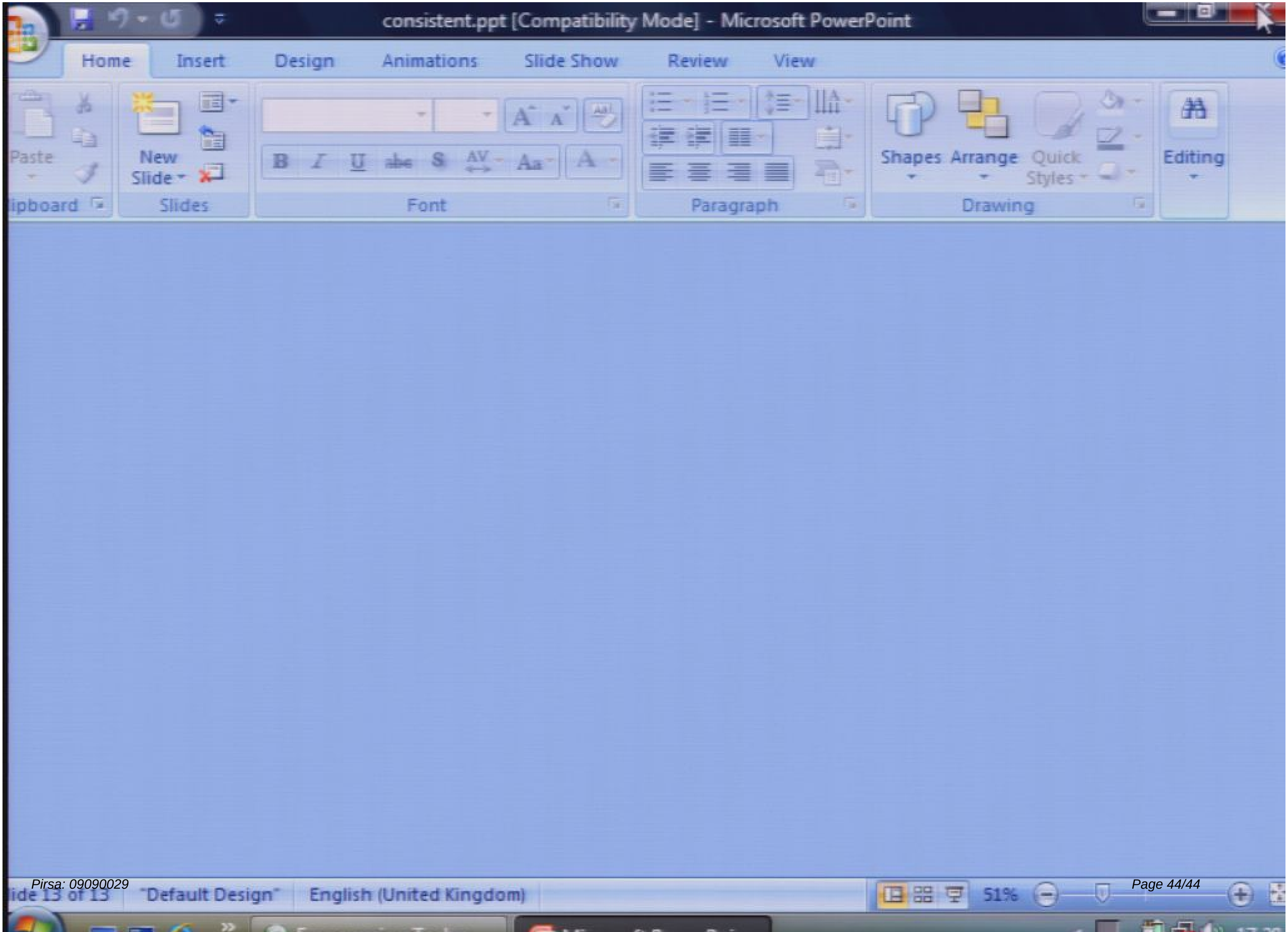
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