Title: Many-worlds and one-world interpretations of quantum theory (Part 1B)

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Abstract:

A key question for Everettians

If universal quantum theory (+ quantum gravity + cosmology) is correct, why do we find ourselves to be people from a species that seems to have evolved without relying on deviations from Copenhagen q.m., and to have accumulated experimental data which led us to Copenhagen q.m.?

On a one-world view, the answer could be that no other types of people (or intelligent life) exist. But on an Everettian view, they definitely do exist, in proliferation.

Clearly, Everettians are going to have to say something about $|\psi|^2$ and give some (presumably non-standard) account of probability, to have any hope of answering this.

! Let's be alert to the possibility that Everettians might offer an account of probability that (possibly) addresses some other interesting questions but fails to answer this one.

(Confession: if any Everettian account of probability has succeeded in answering this, then I have so far failed to understand how.)

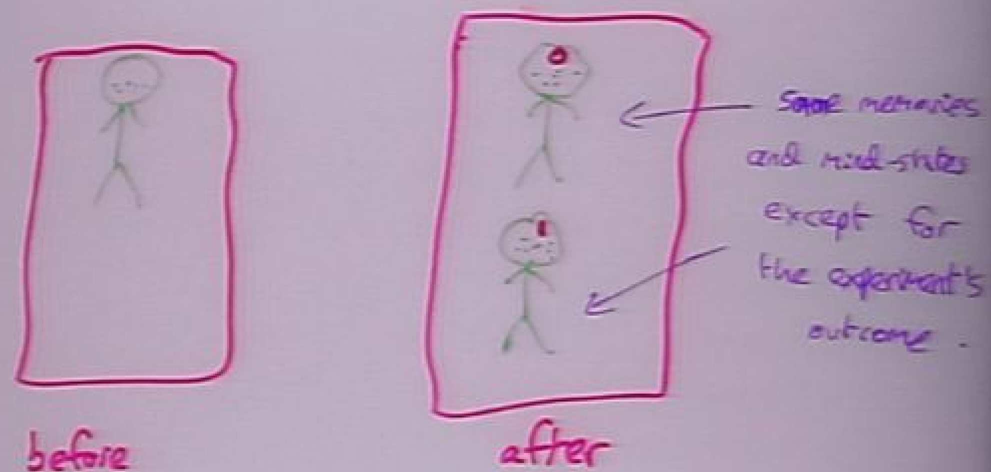
What if Everettians can't answer the key question?

- Everett's theory isn't logically refuted: it describes a universe or multiverse teeming with creatures, including some whose world is described by Copenhagen q.m.
- But it isn't a very good theory if we can only say "pretty much anything, including Copenhagen q.m., could be right".
- Everett's claim, quoted earlier, "to supply a --formulation, from which the conventional interpretation can be <u>deduced</u>", is wrong if we can't explain our experience of Copenhagen q.m. from an Everettian perspective.

Everett and identity

Physical theories can have unsettling consequences for our worldview, but we shouldn't reject them on that account alone.

Everett says: after you do a quantum experiment, or experience a quantum event, you have no unique successor:



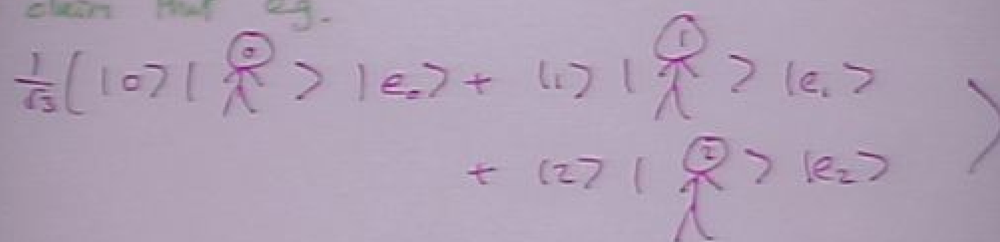
So why care about them? Well, you'd care if there were only one of them: why wouldn't you care about two or more? What sensible reasons can be advanced for not caring that don't also apply in a single-successor universe?

How to treat your Everettian successors?

Given that you have non-unique successors, and given that you care about their welfare, it would be good if we could establish a rational calculus for decisions affecting their welfare.

Deutsch and Wallace have tried to establish and justify such a calculus.

Very roughly, one starts by appealing to symmetry to claim that e.g.



$$\frac{1}{\sqrt{3}}\left(|0\rangle\, |\ \rangle\, |e_0\rangle + |1\rangle\, |\ \rangle\, |e_1\rangle + |2\rangle\, |\ \rangle\, |e_2\rangle \right)$$

contains three successors about whom you should care equally.

Then non-equally-weighted successors are dealt with by considering the possibility of further splittings that produce equally weighted outcomes (cf Wojciech Zurek's arguments for deriving the Born rule).

Conclusion: it's argued that $|\psi_i|^2$ emerges as a unique rational "caring weight" for successors.

Connection between caring weight and classical probability

On this view, to say your caring weight for a particular successor X is p, means:

① your weights for all the others sum to $(1-p)$

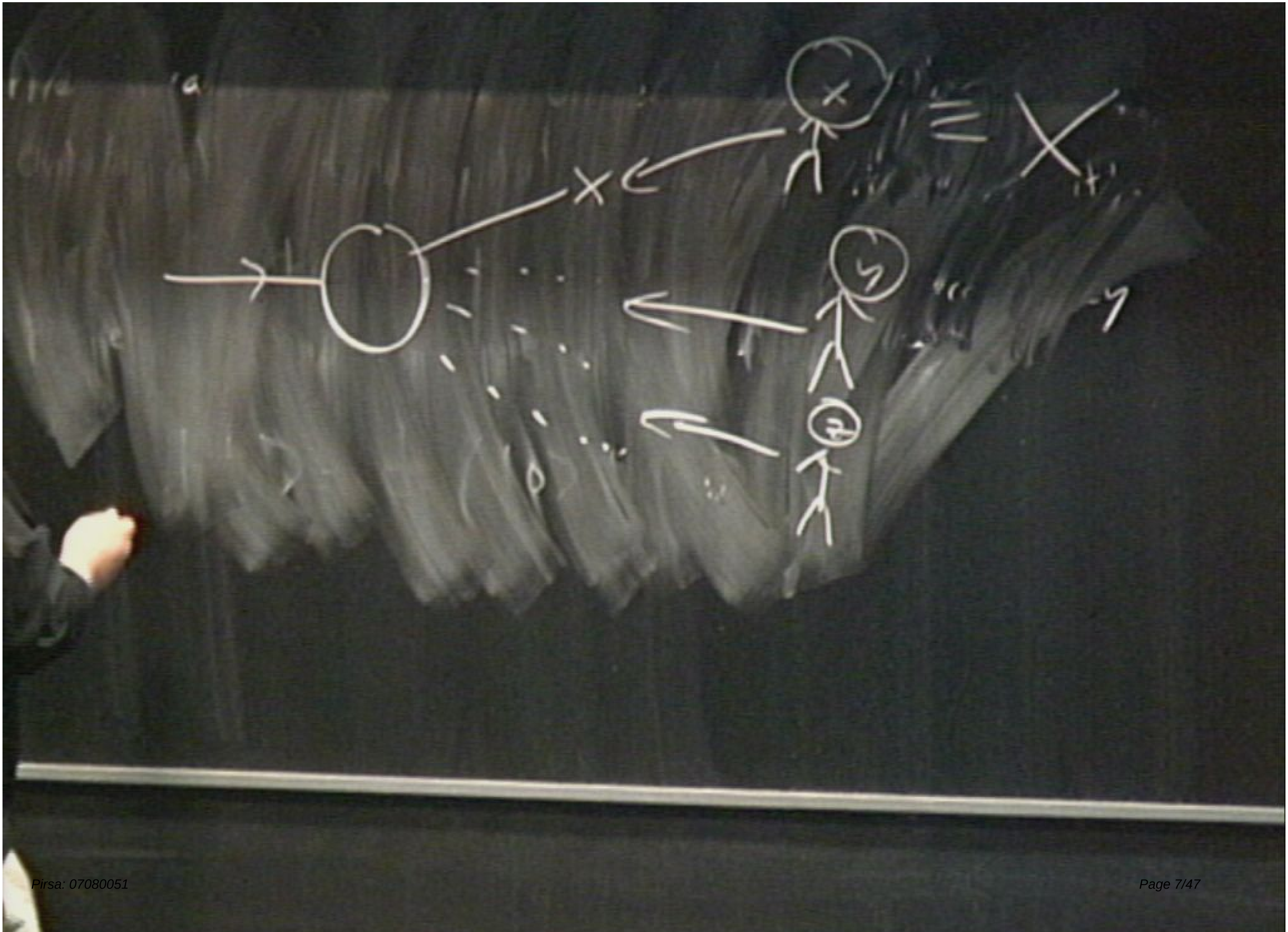
② you're happy to give \$CAN a to X and subtract \$CAN b from all the others

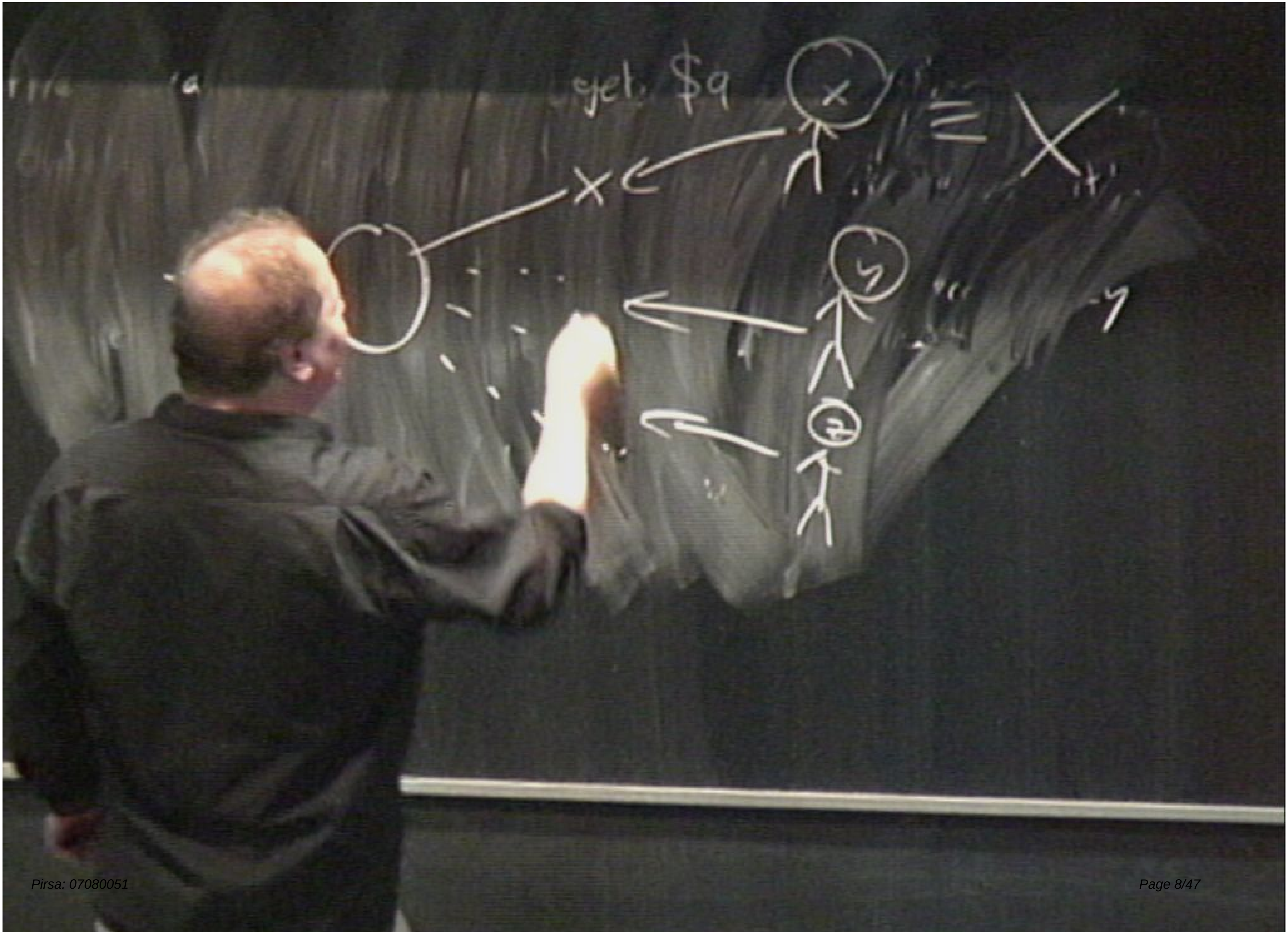
$$\Leftrightarrow \quad ap - b(1-p) \geq 0$$

③ thus you'll accept a bet on the outcome of an experiment being x (seen only by X) at odds of $(1-p):p$ or better.

④ ... which is how you would proceed if you believed the probability of outcome x was p in a single-outcome experiment.

So (if we buy the argument) we've recovered at least this particular aspect of probabilities in an Everettian universe.

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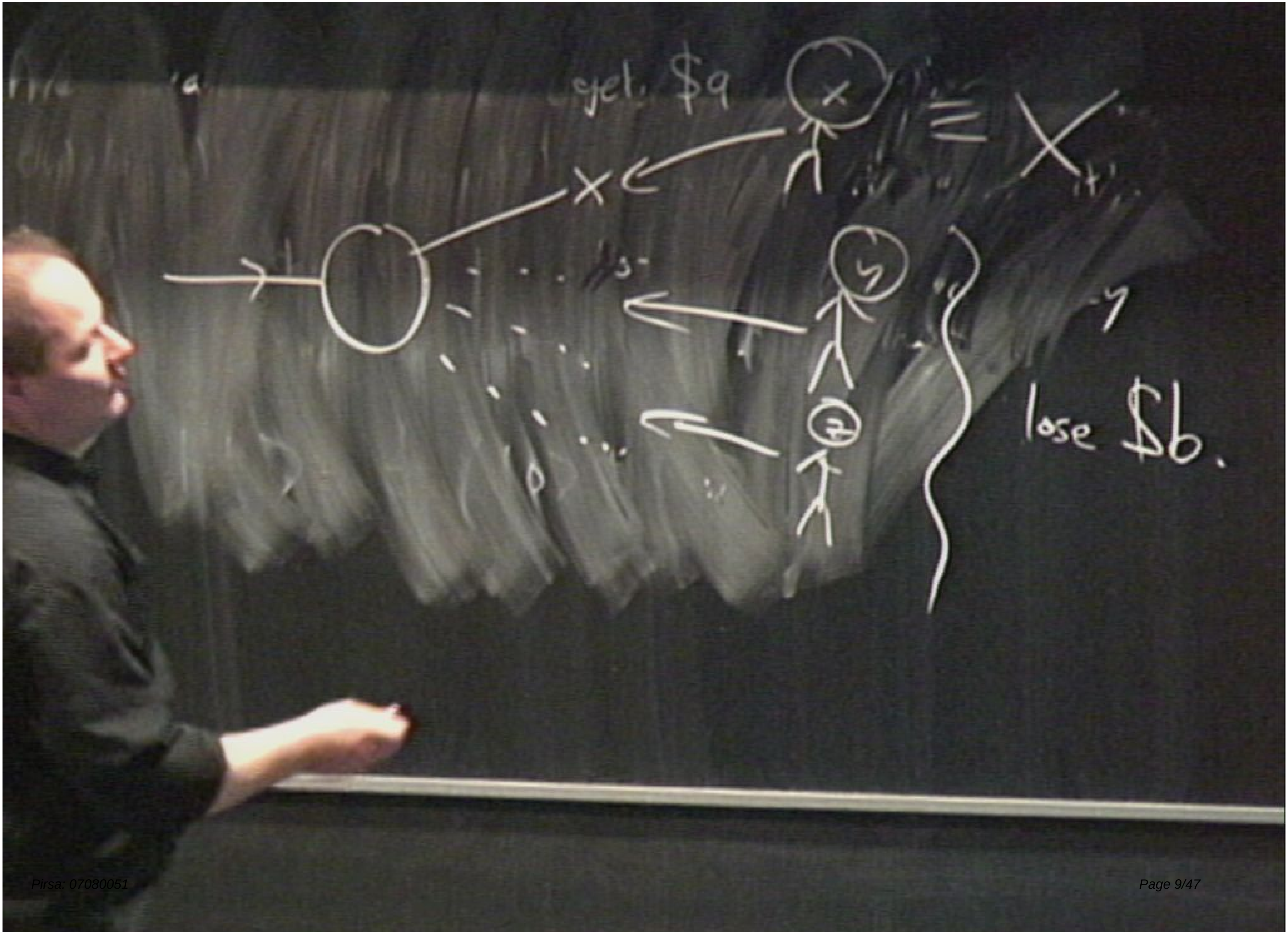
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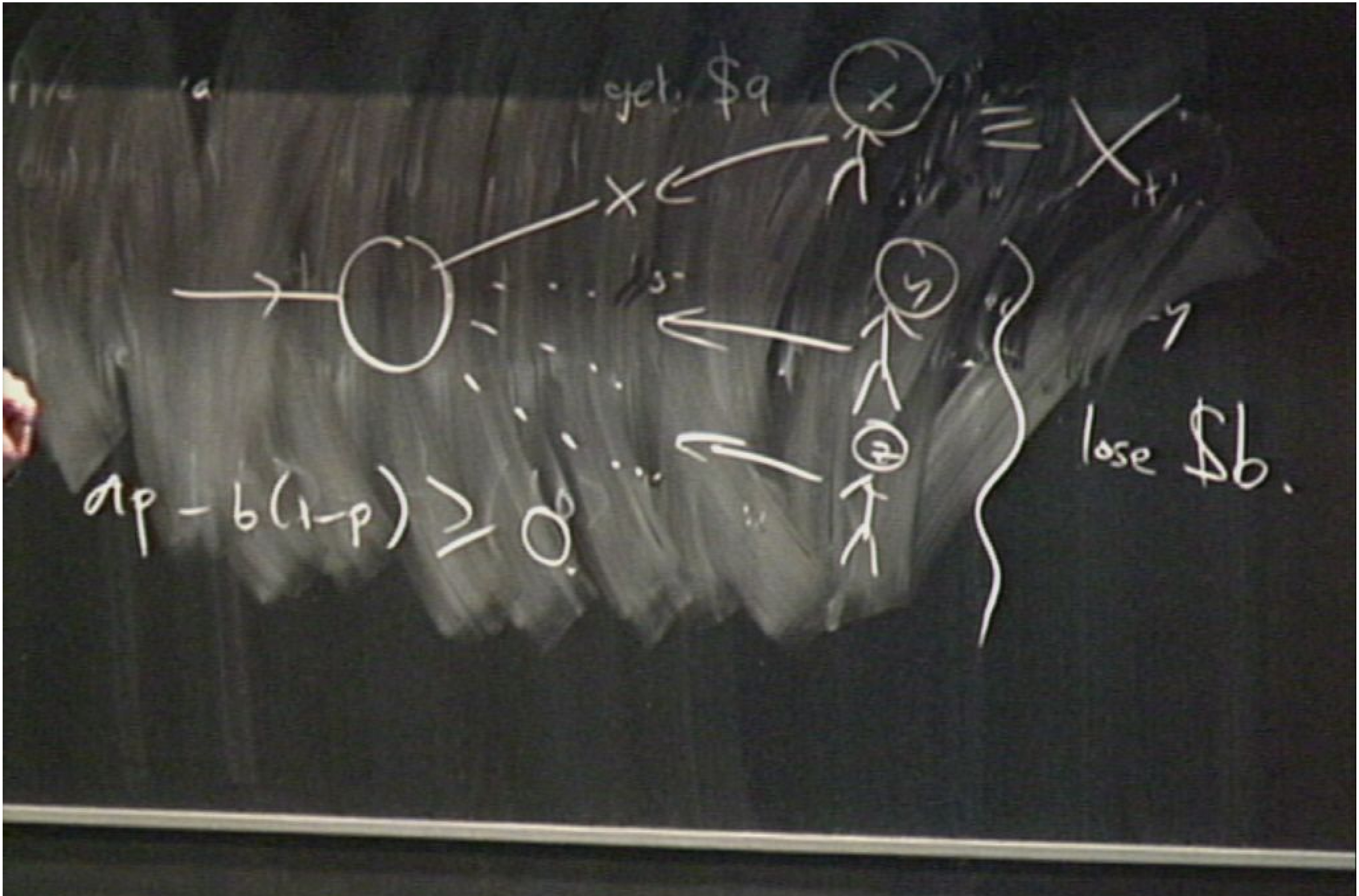
lose $b.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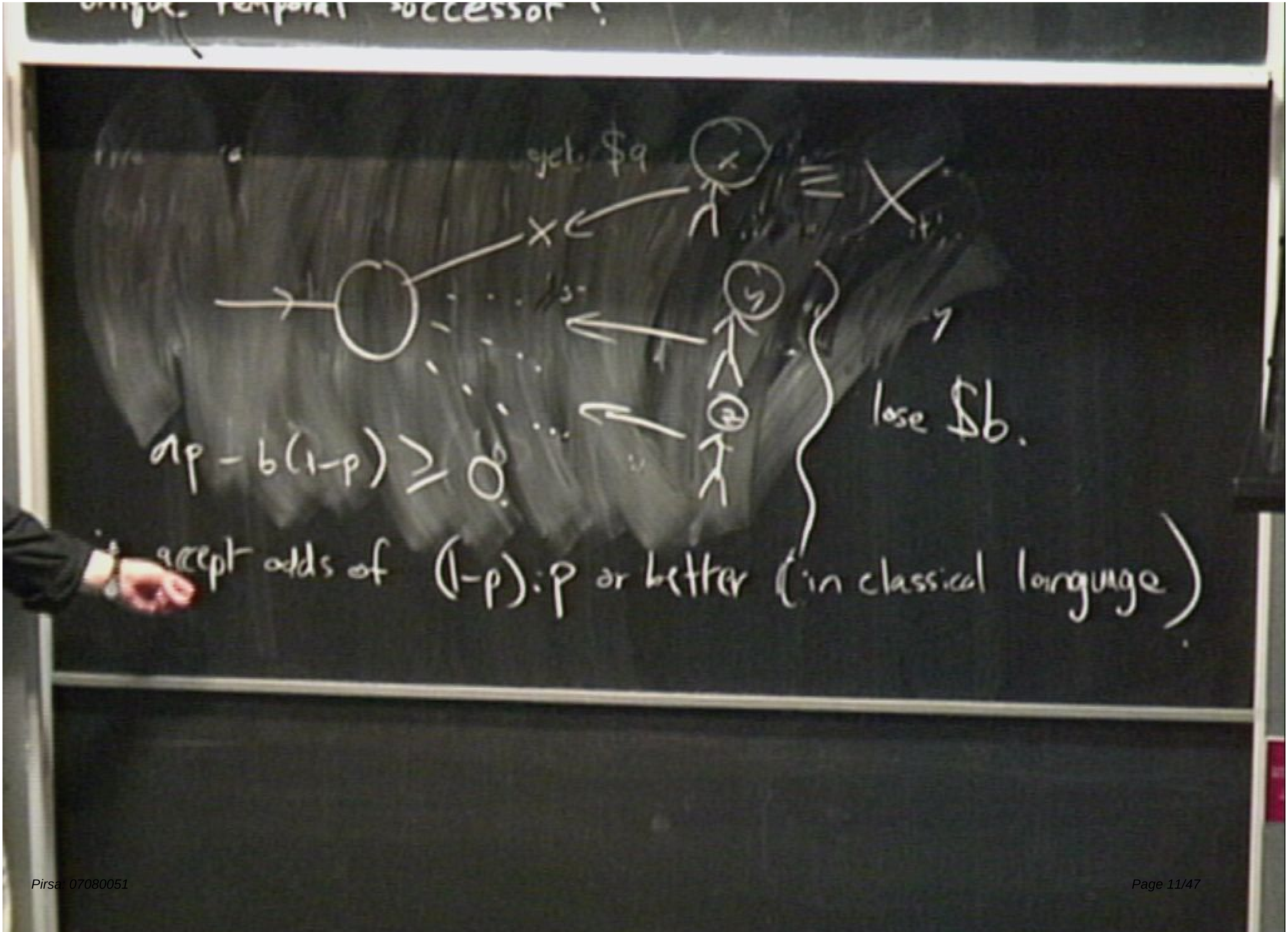
ap - b(1-p) ≥ 0



successor ?
get $a
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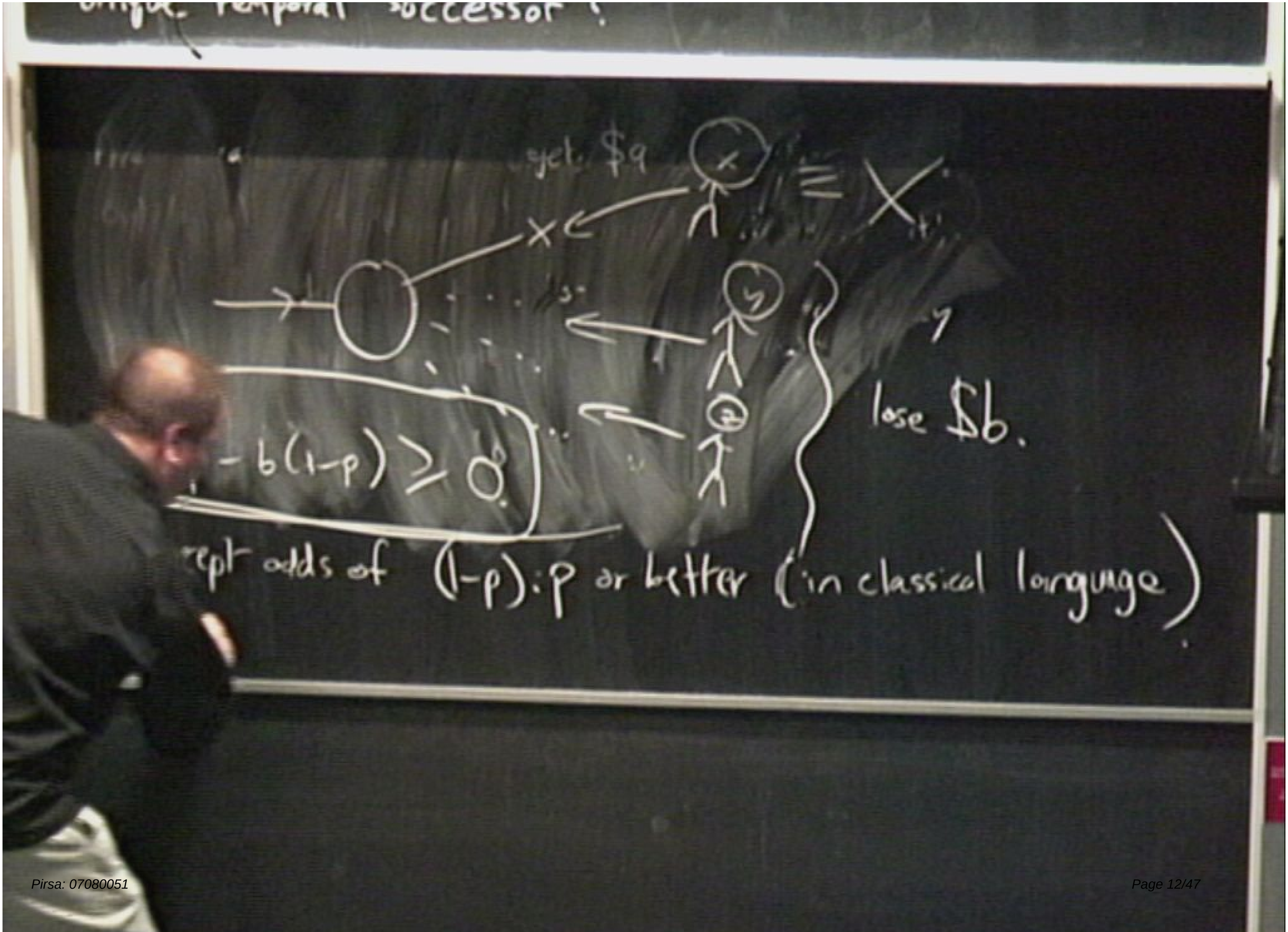
ap − b(1−p) ≥ 0
accept odds of (1−p):p or better (in classical language)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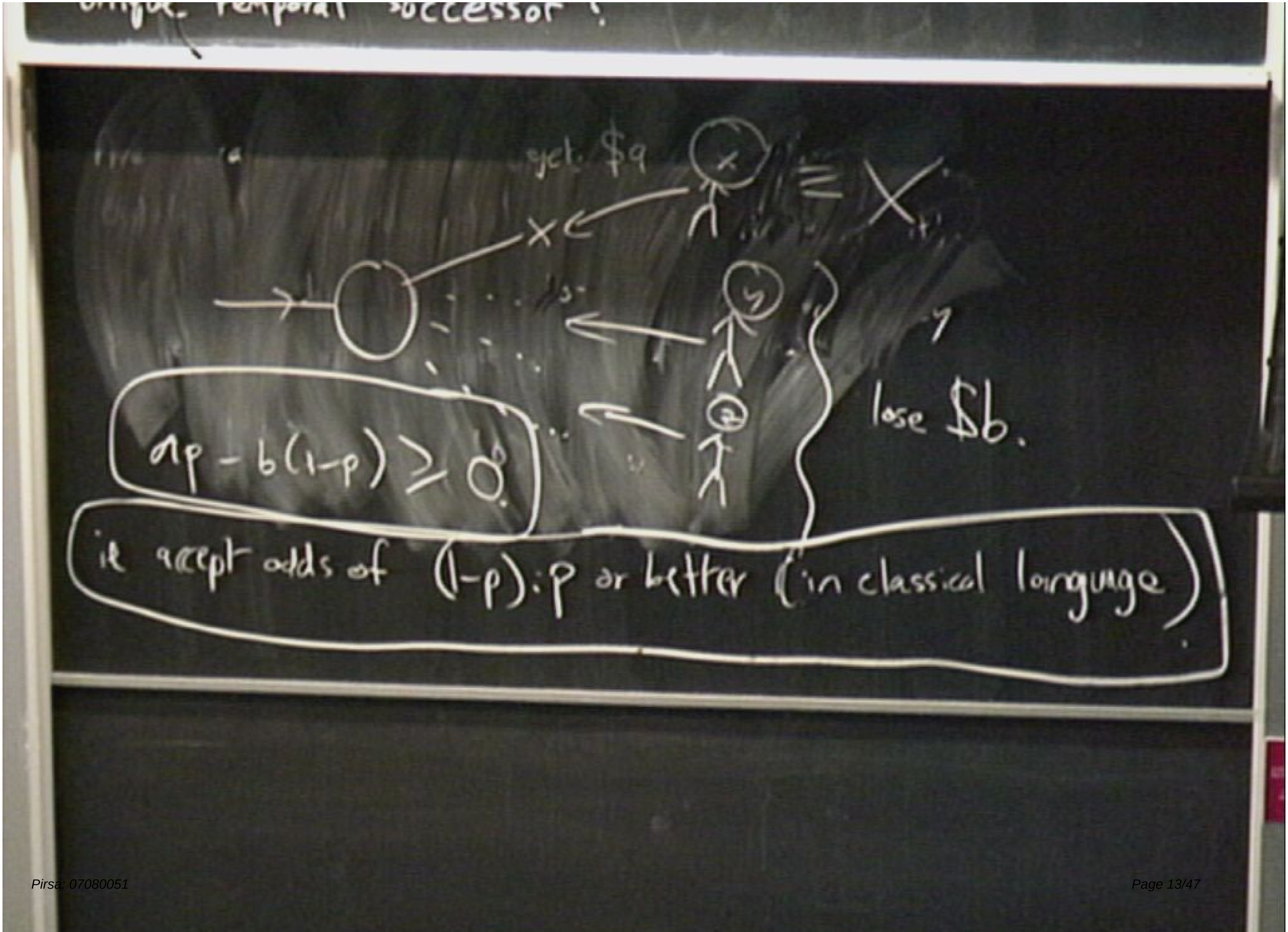
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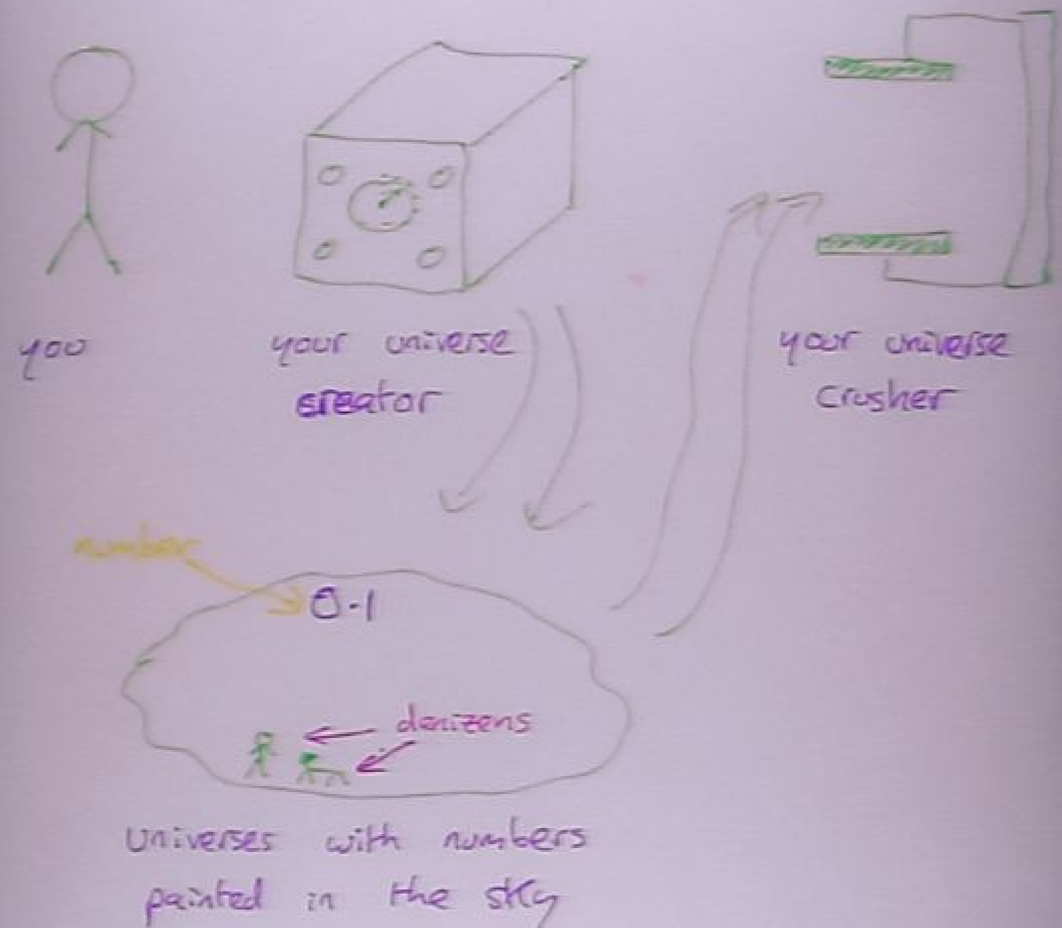
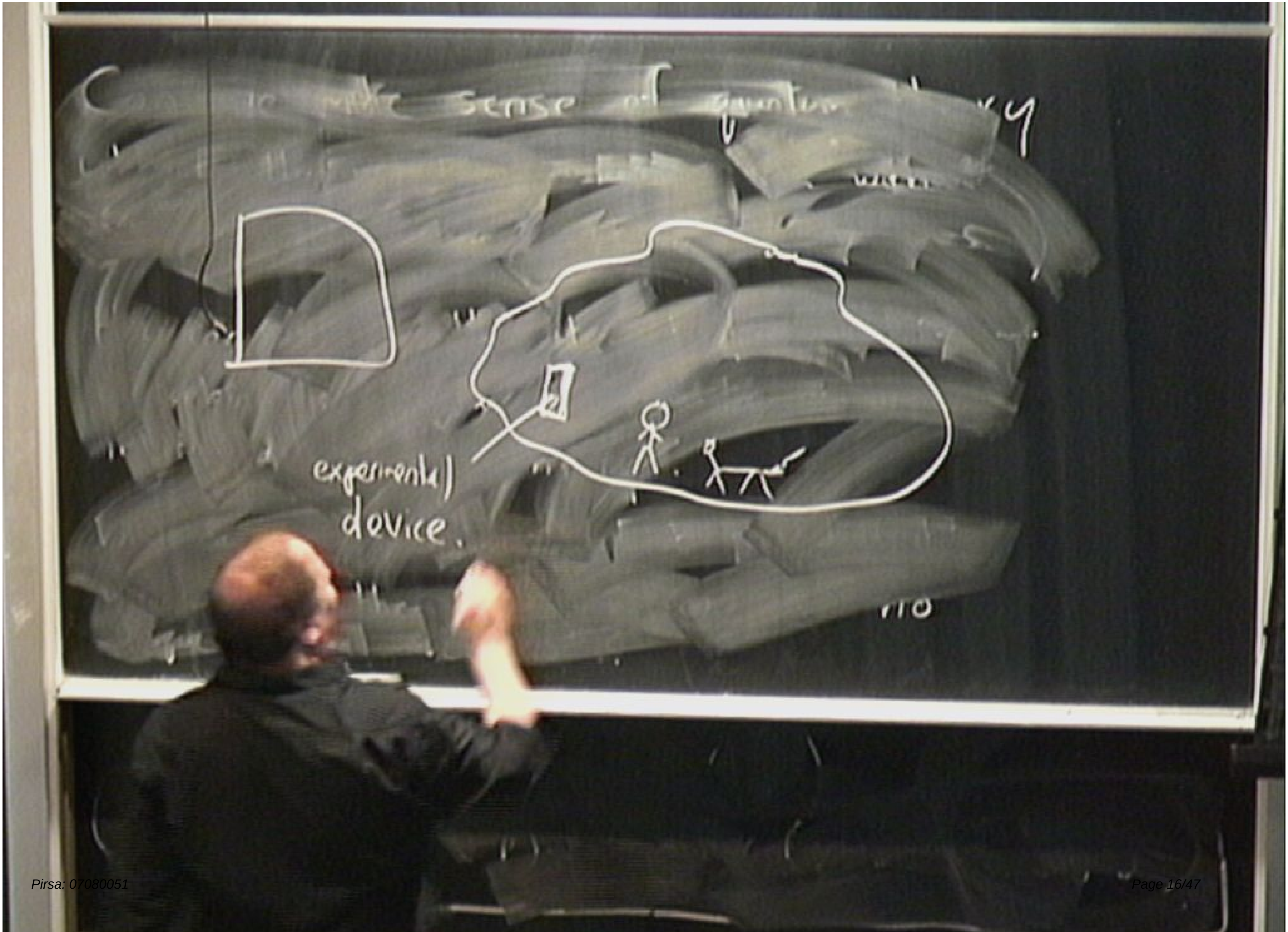
Problems with caring weight arguments (incomplete list)

① The Parable of the Numbers in the Sky

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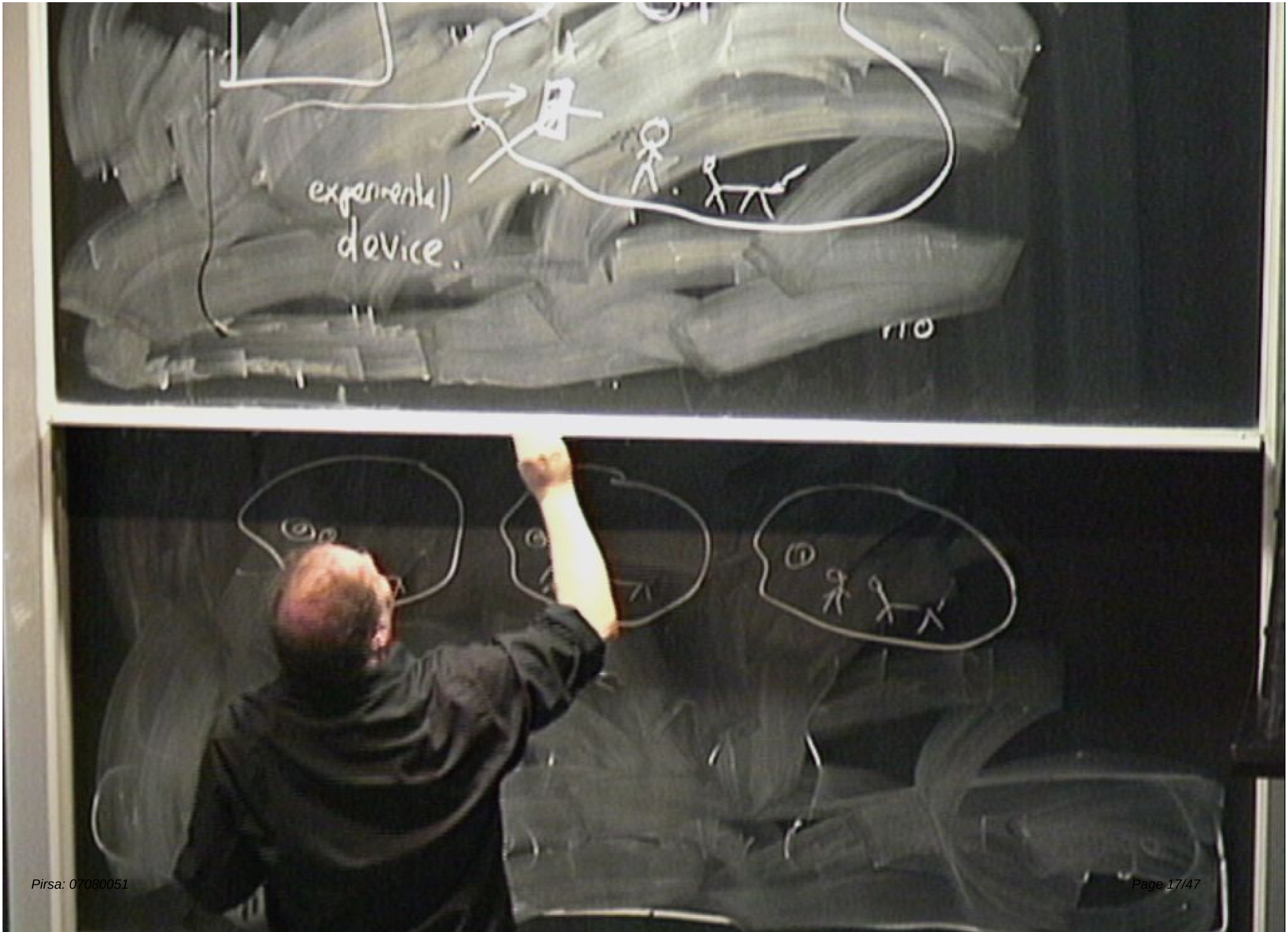
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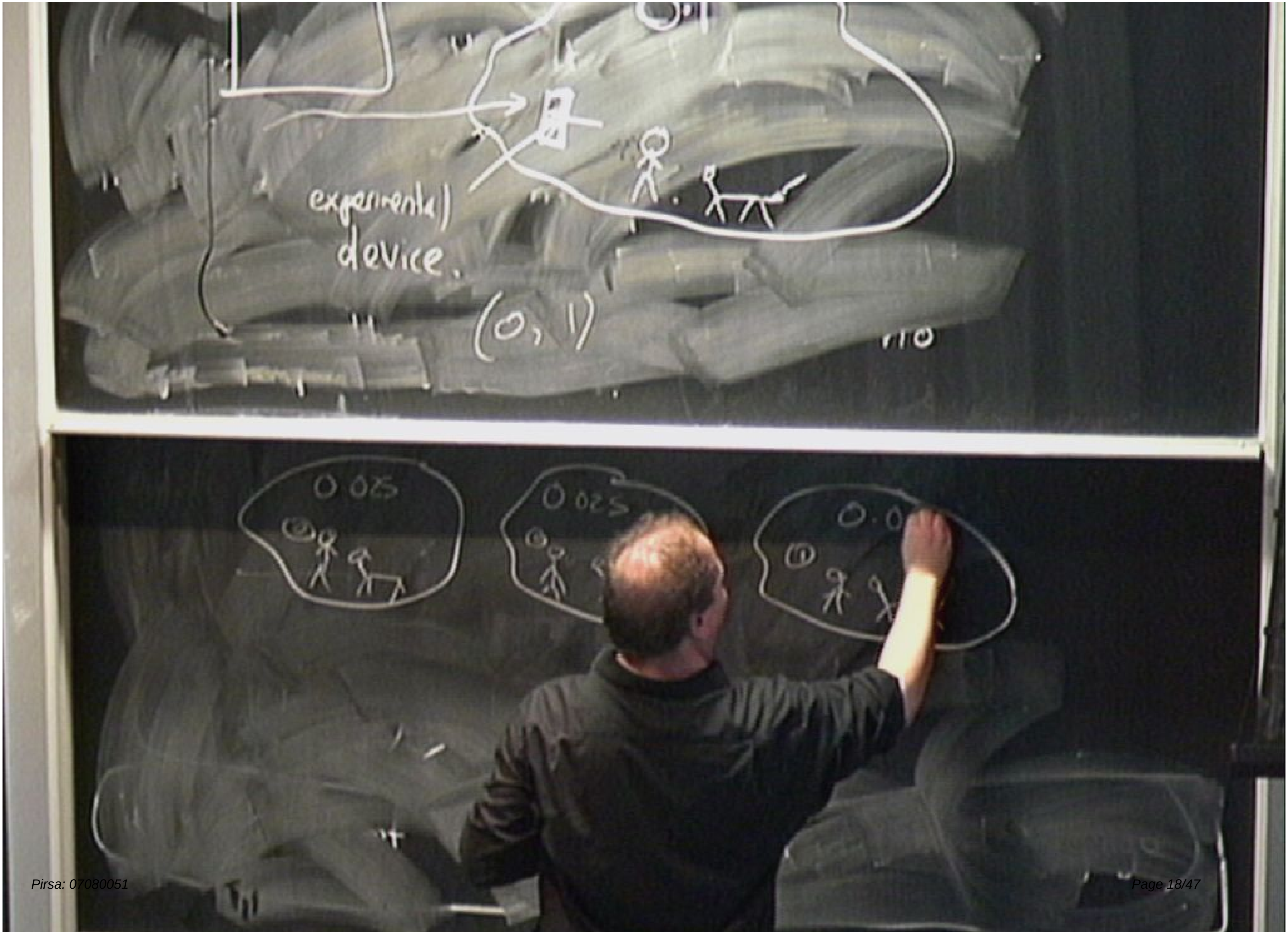
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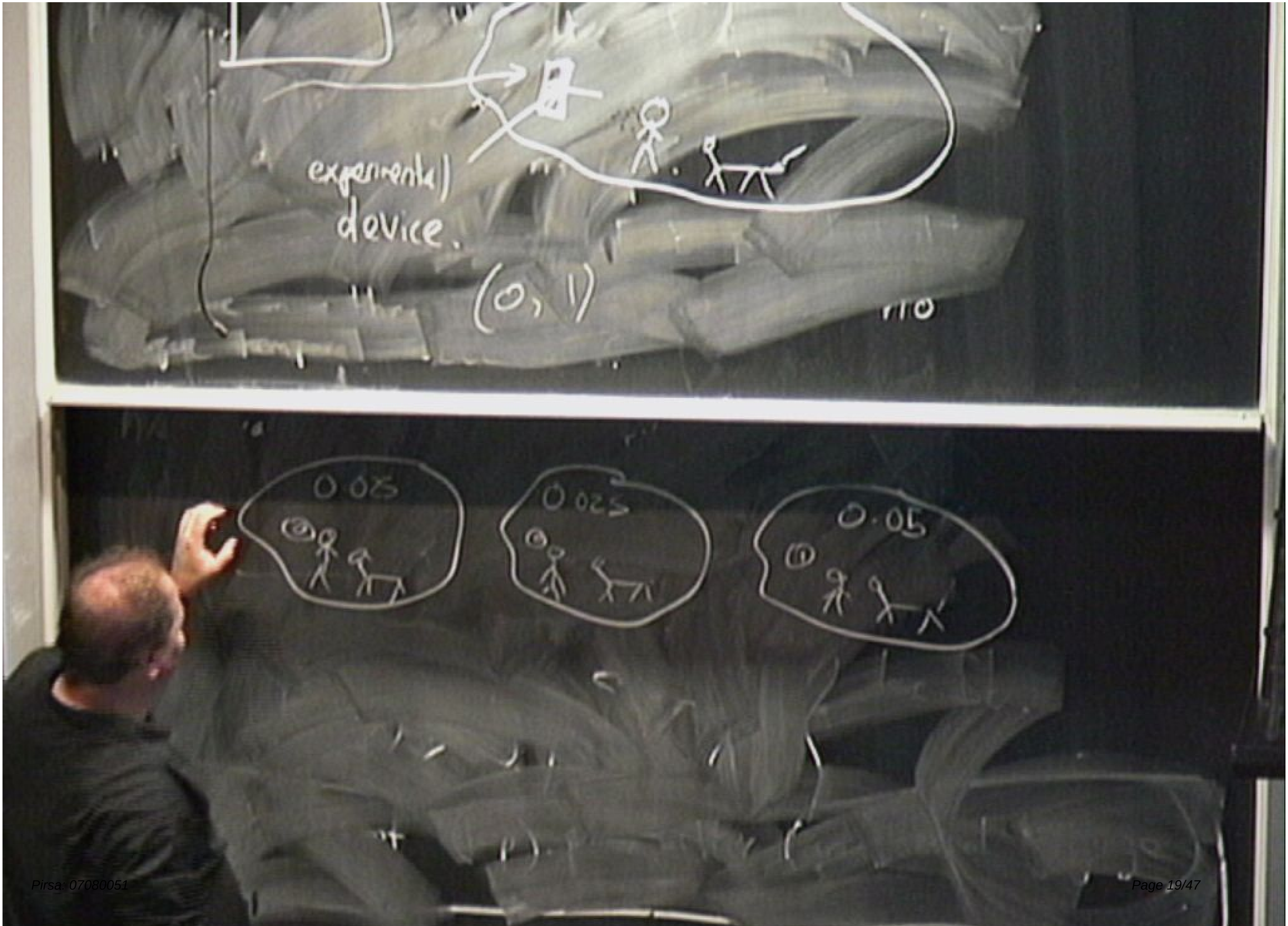
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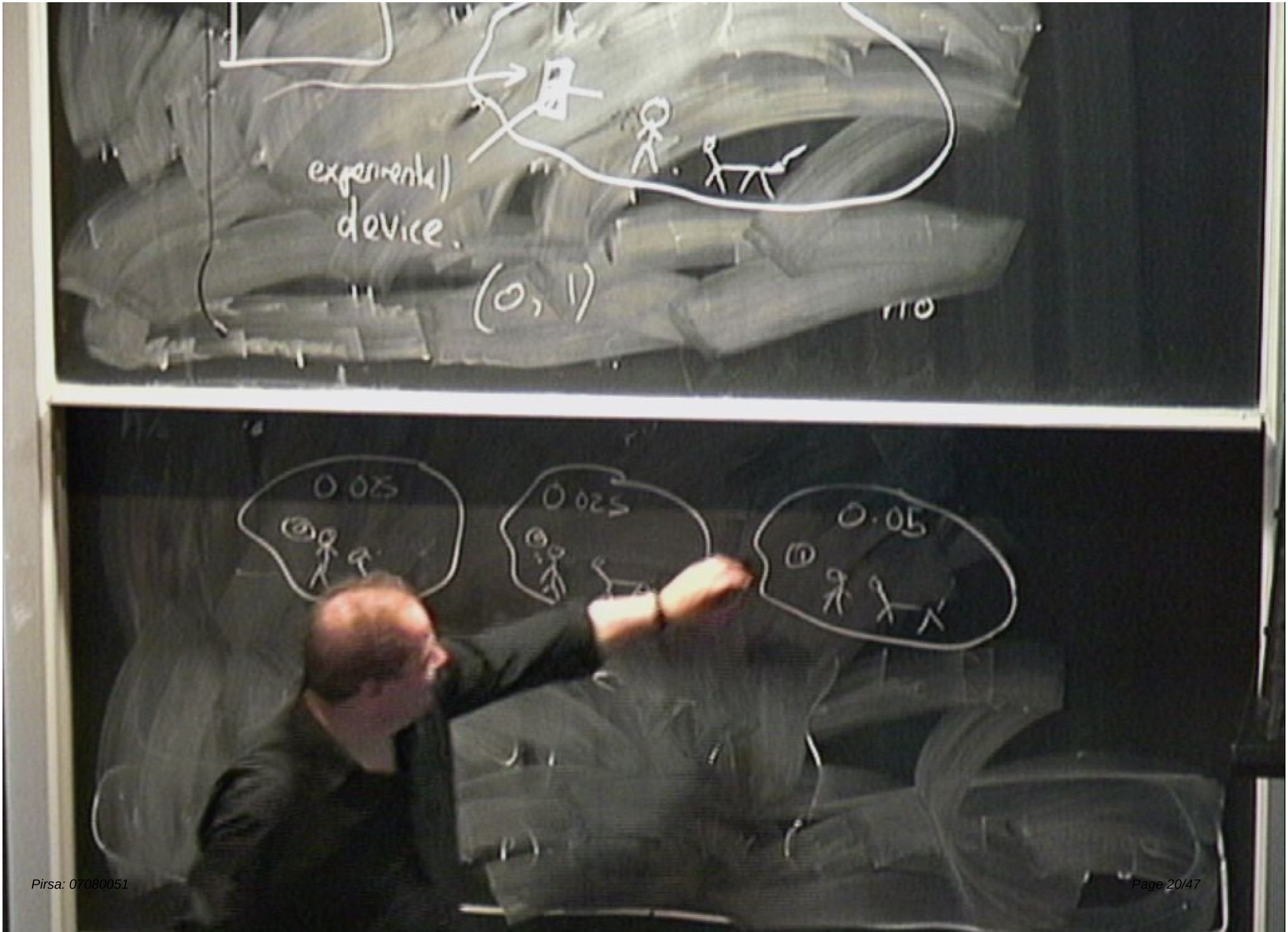
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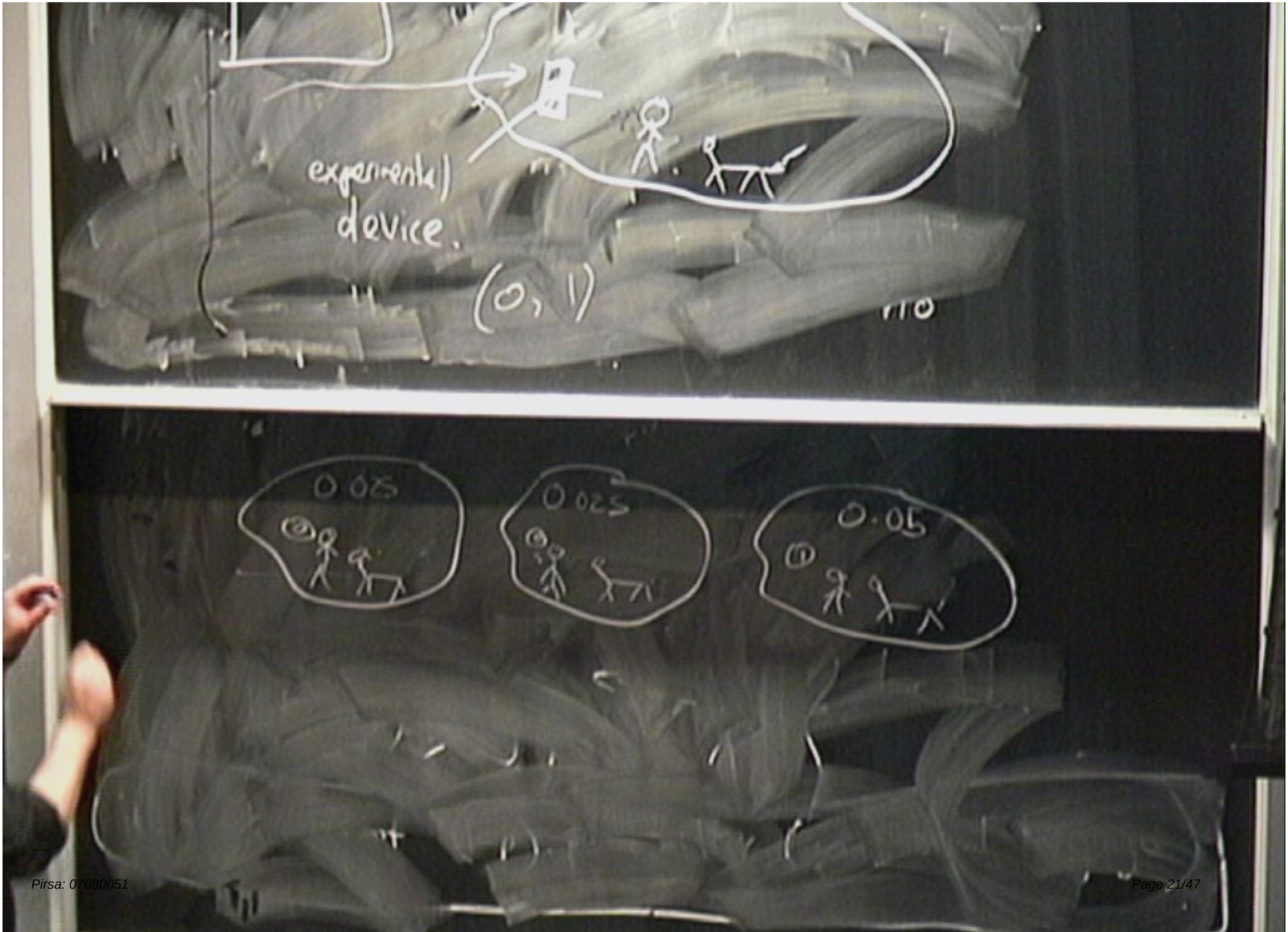

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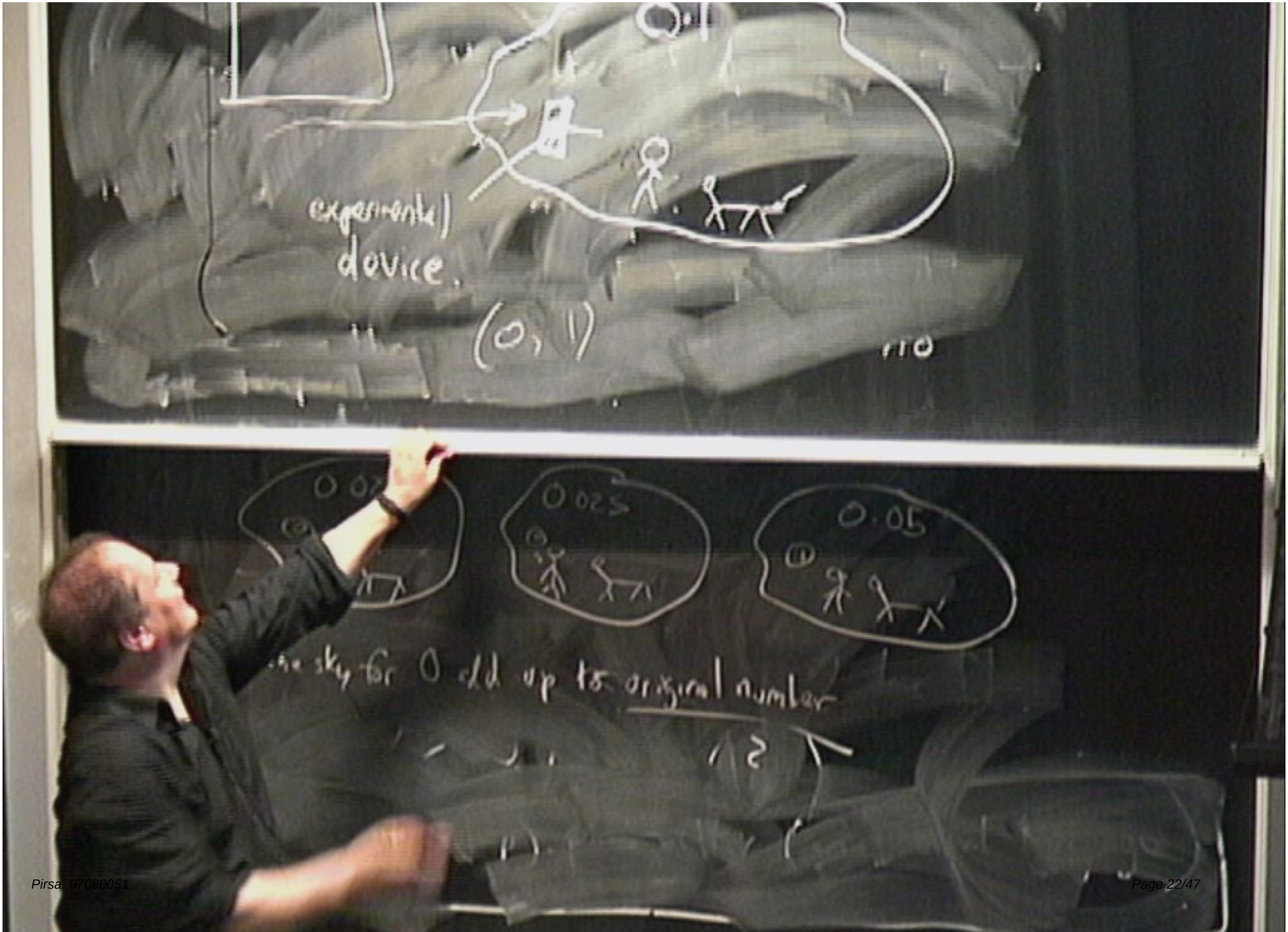
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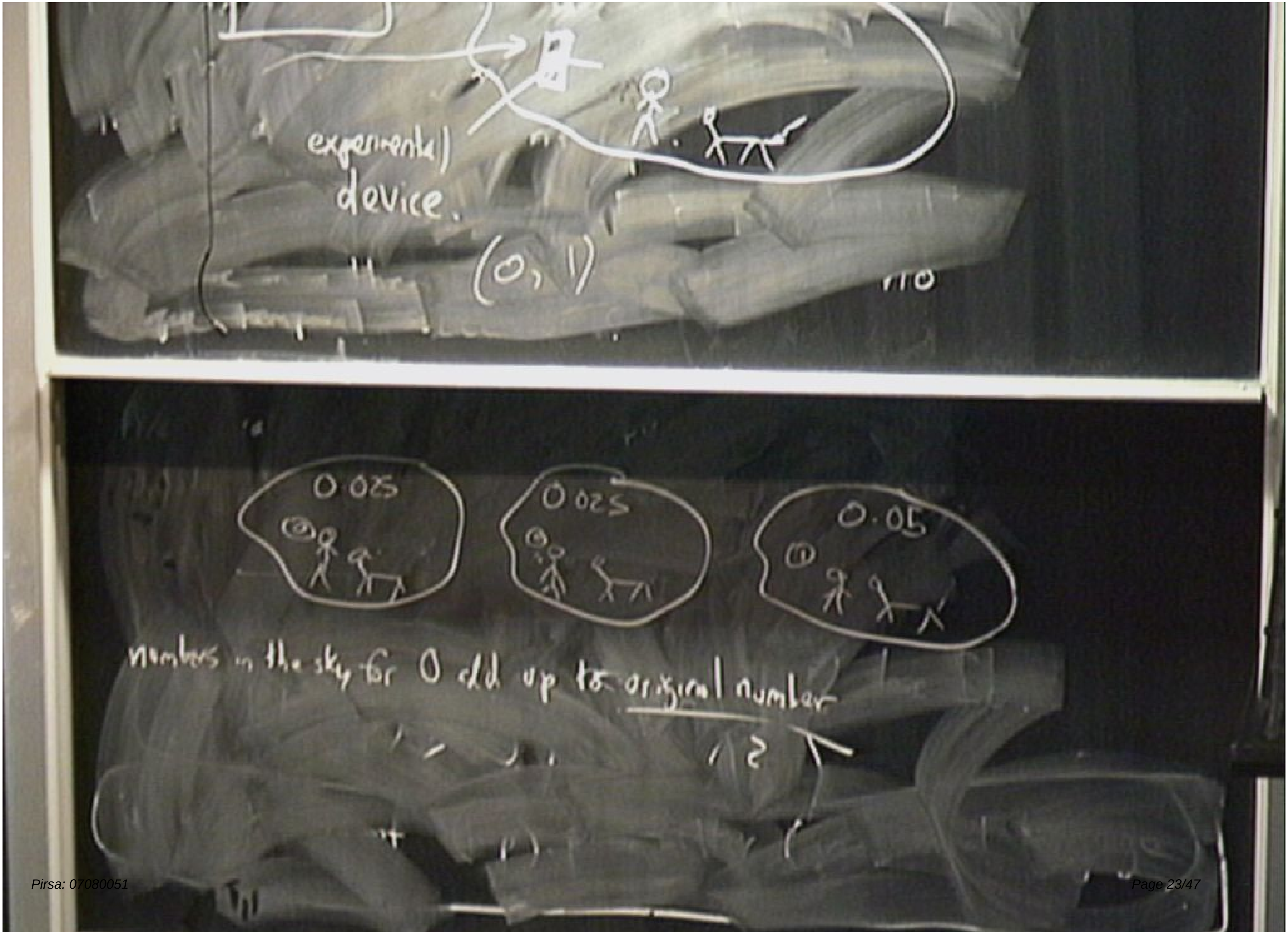
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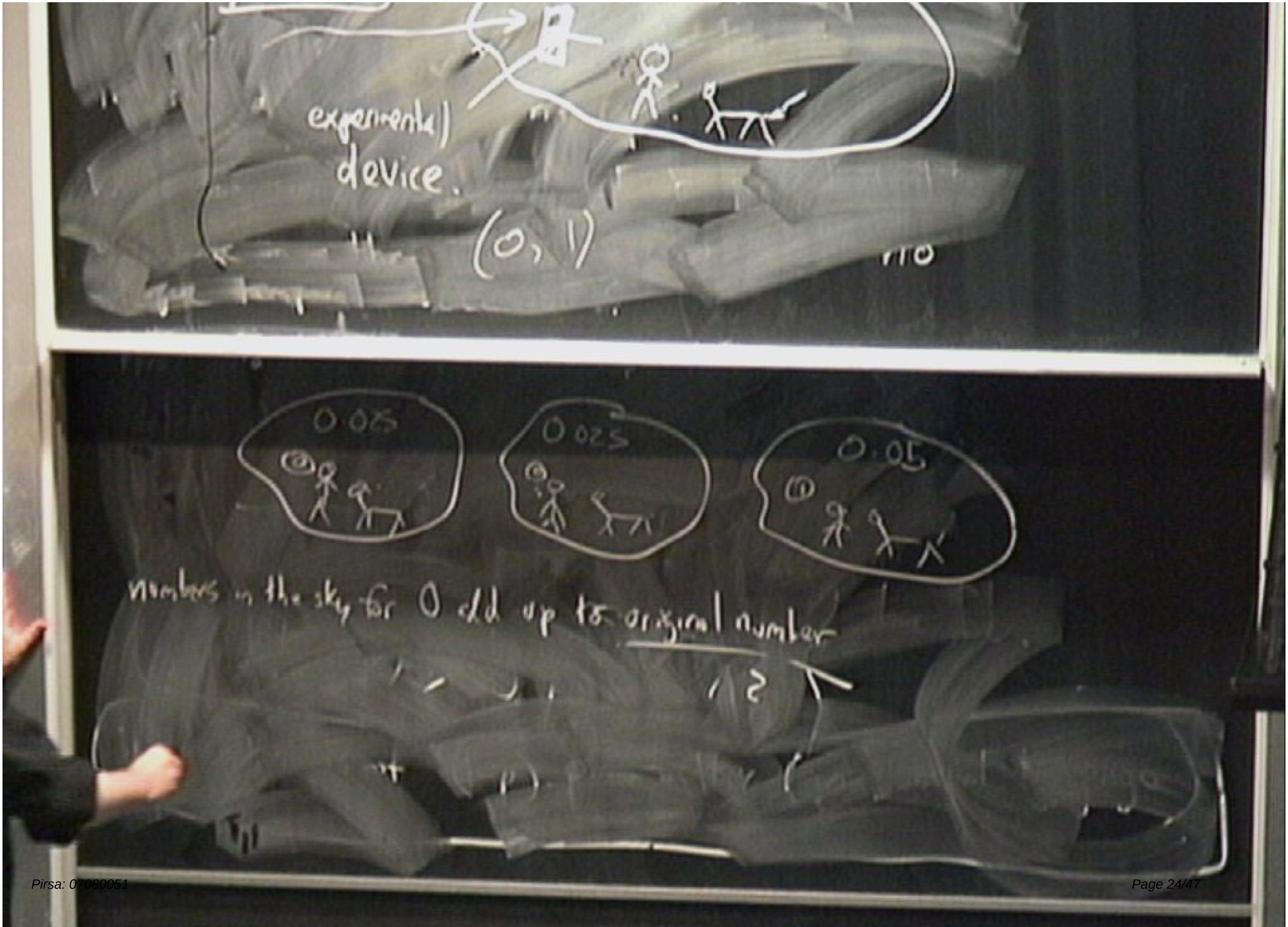
numbers in the sky for 0 add up to original number



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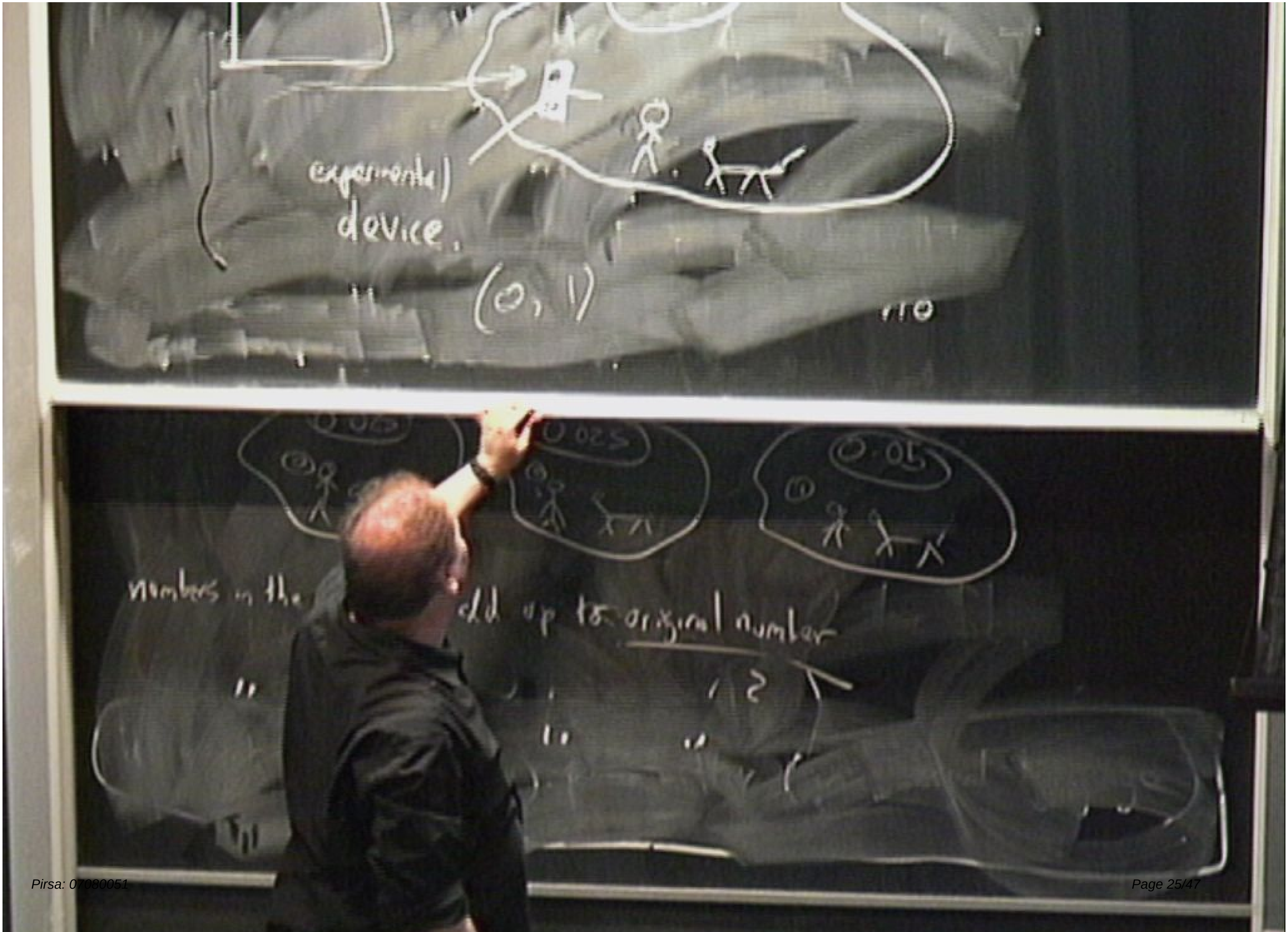
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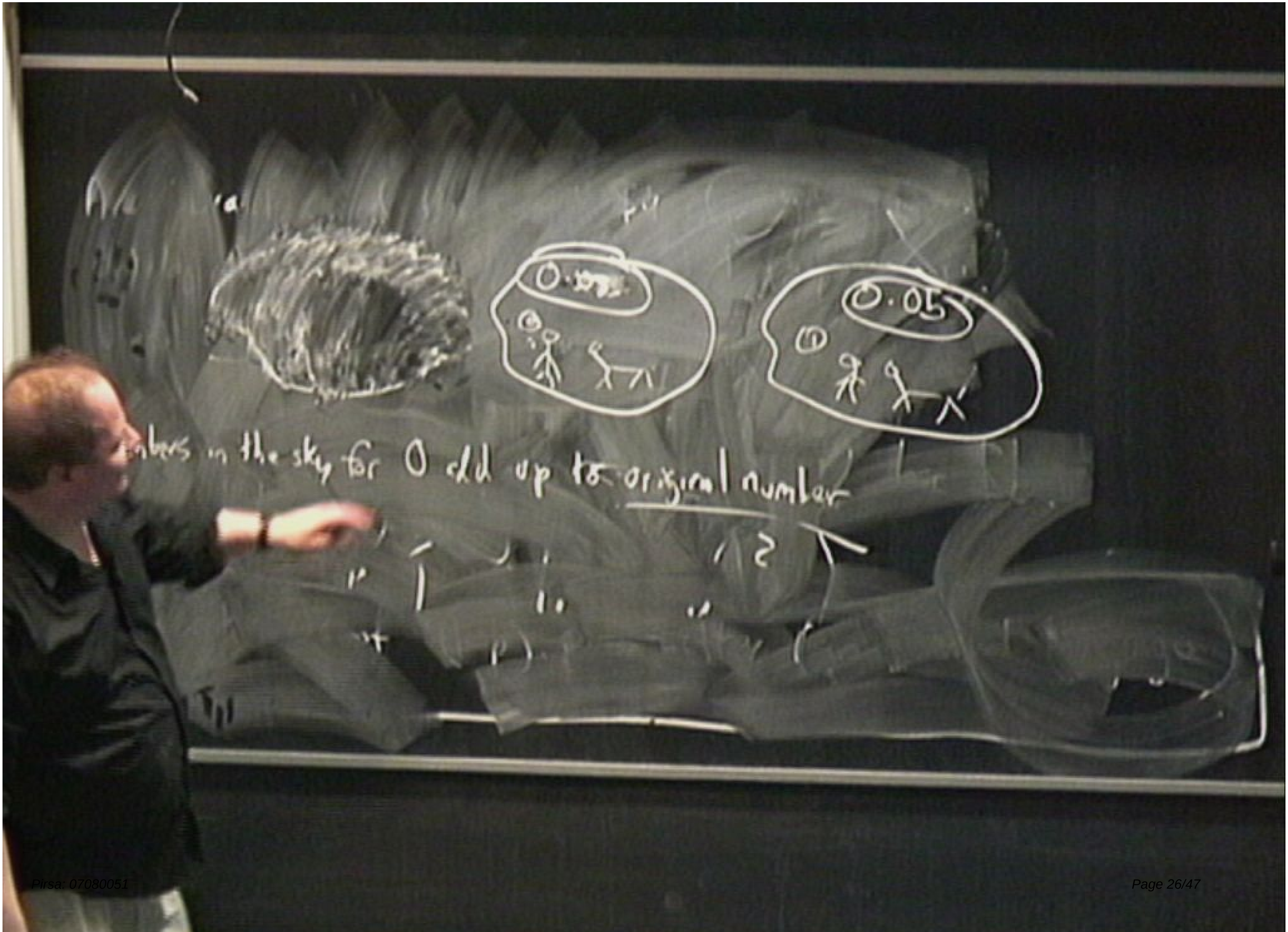
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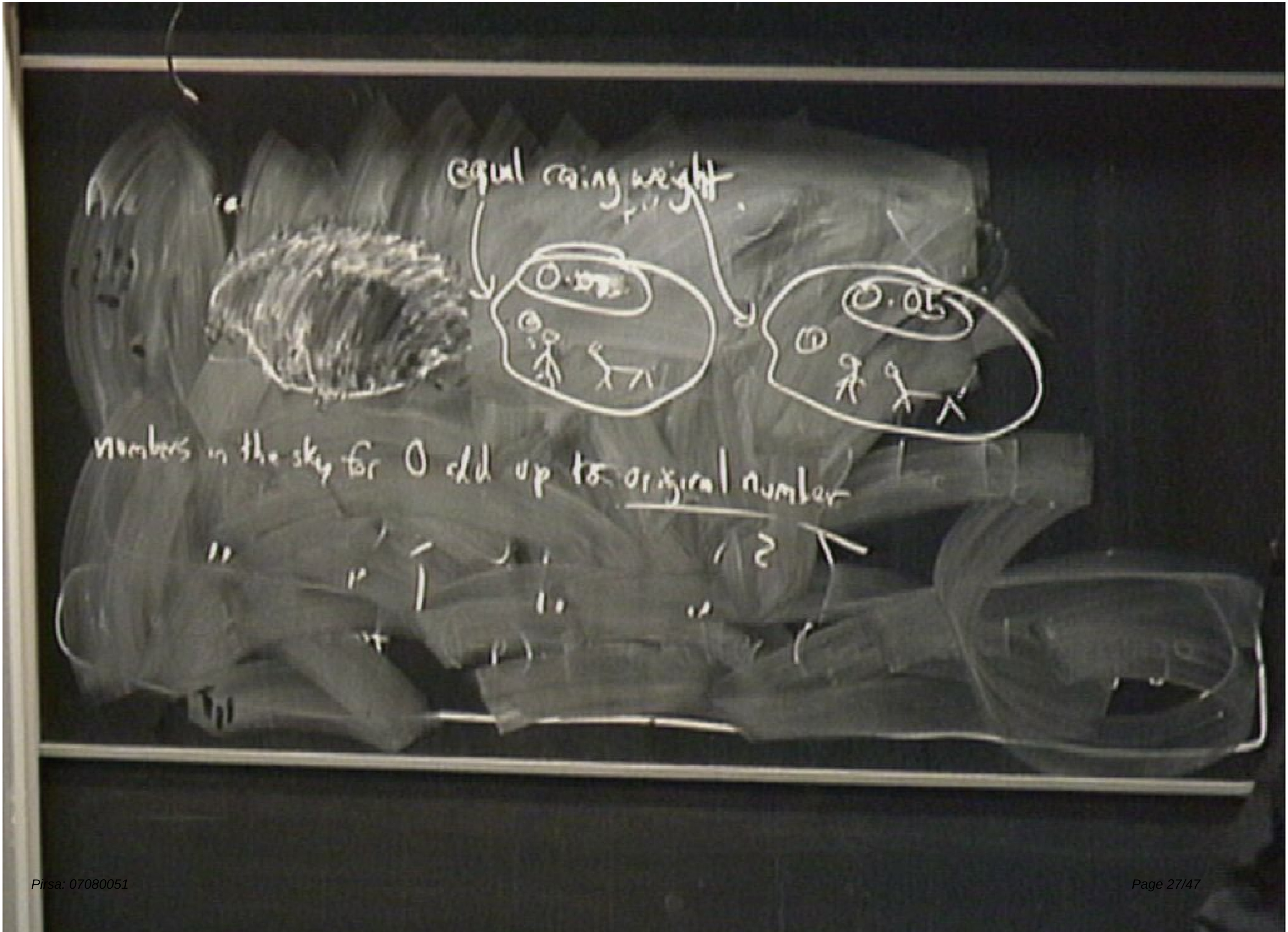
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numbers in the sky for 0 add up to original number

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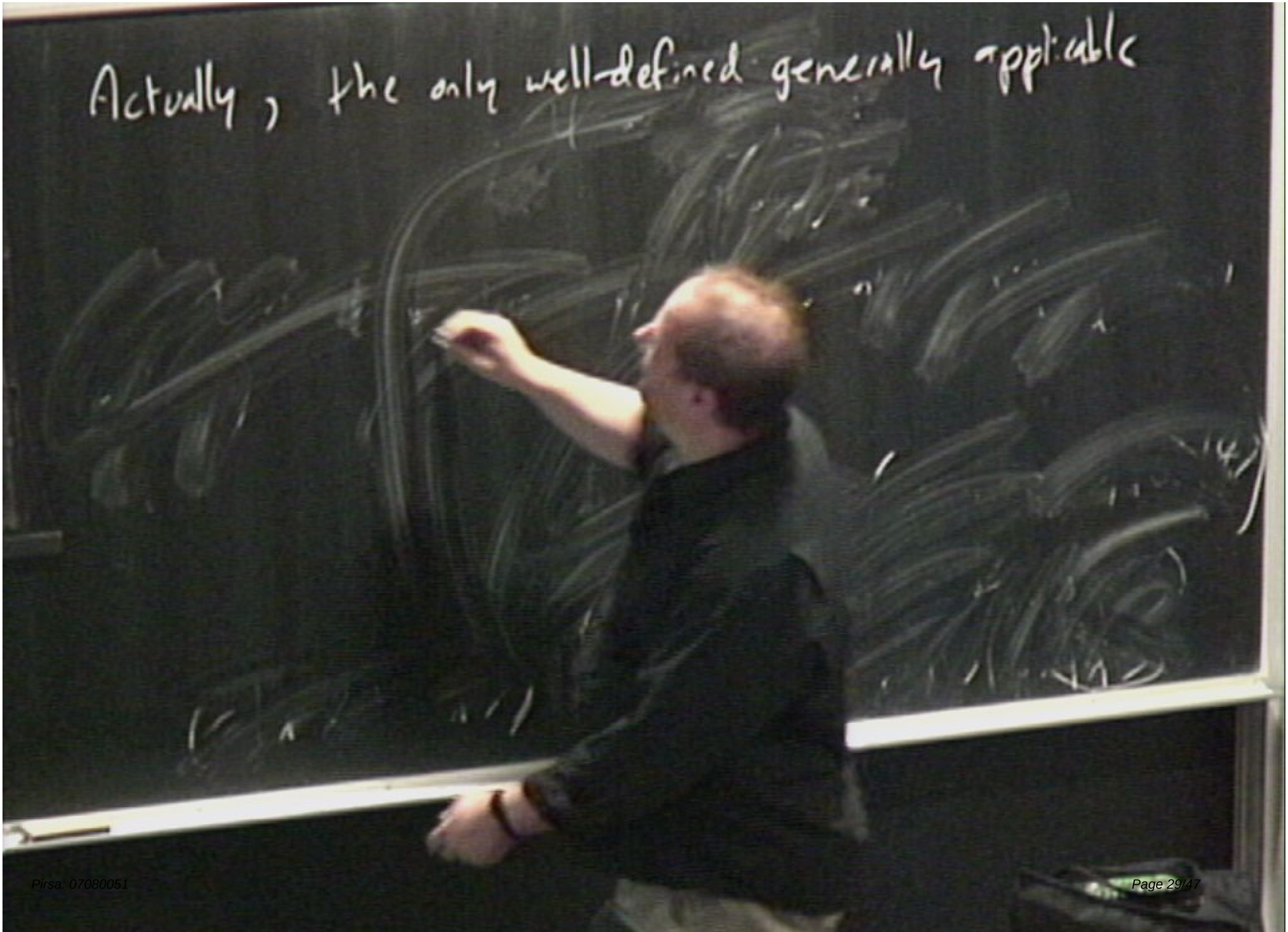
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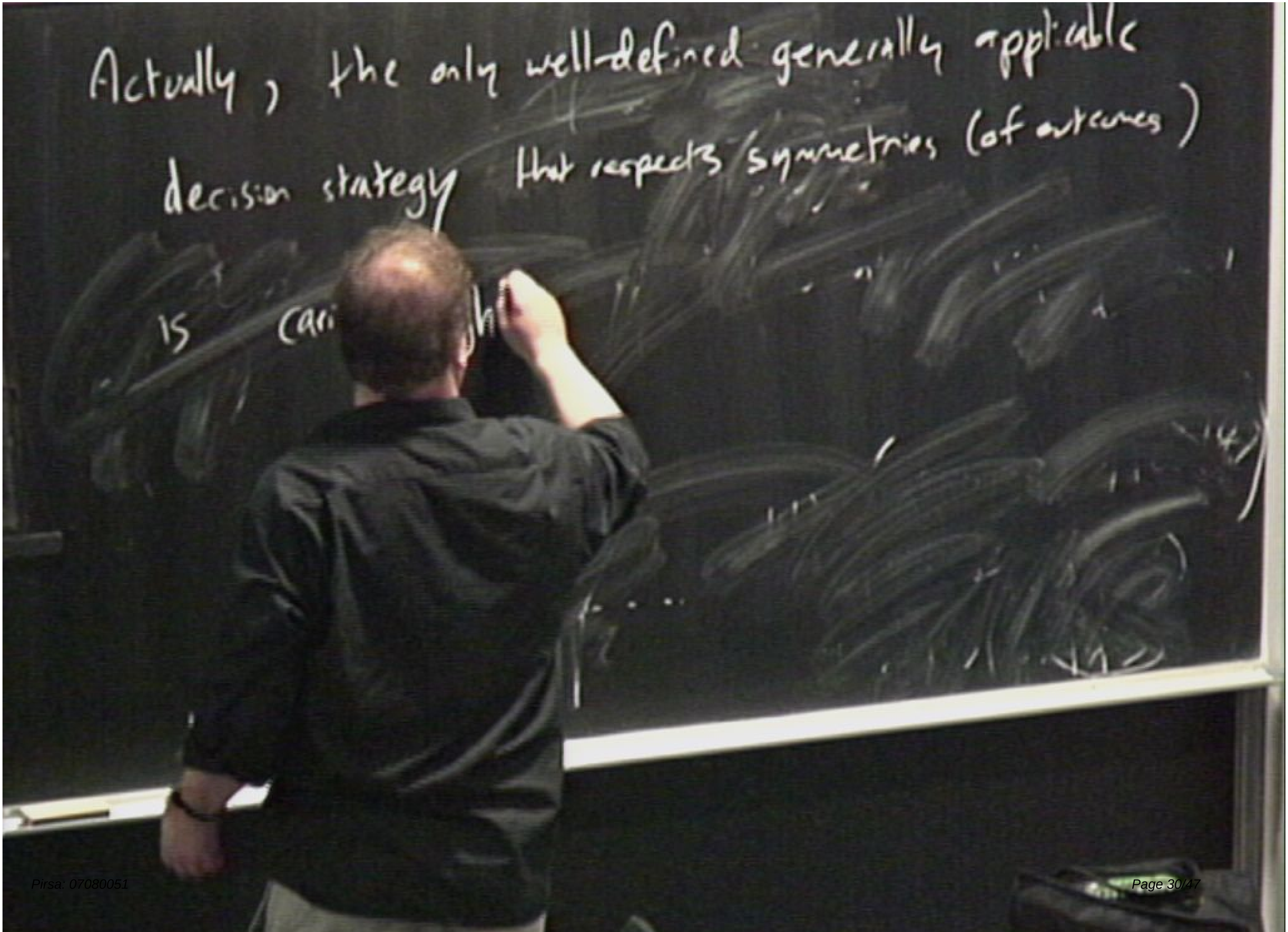
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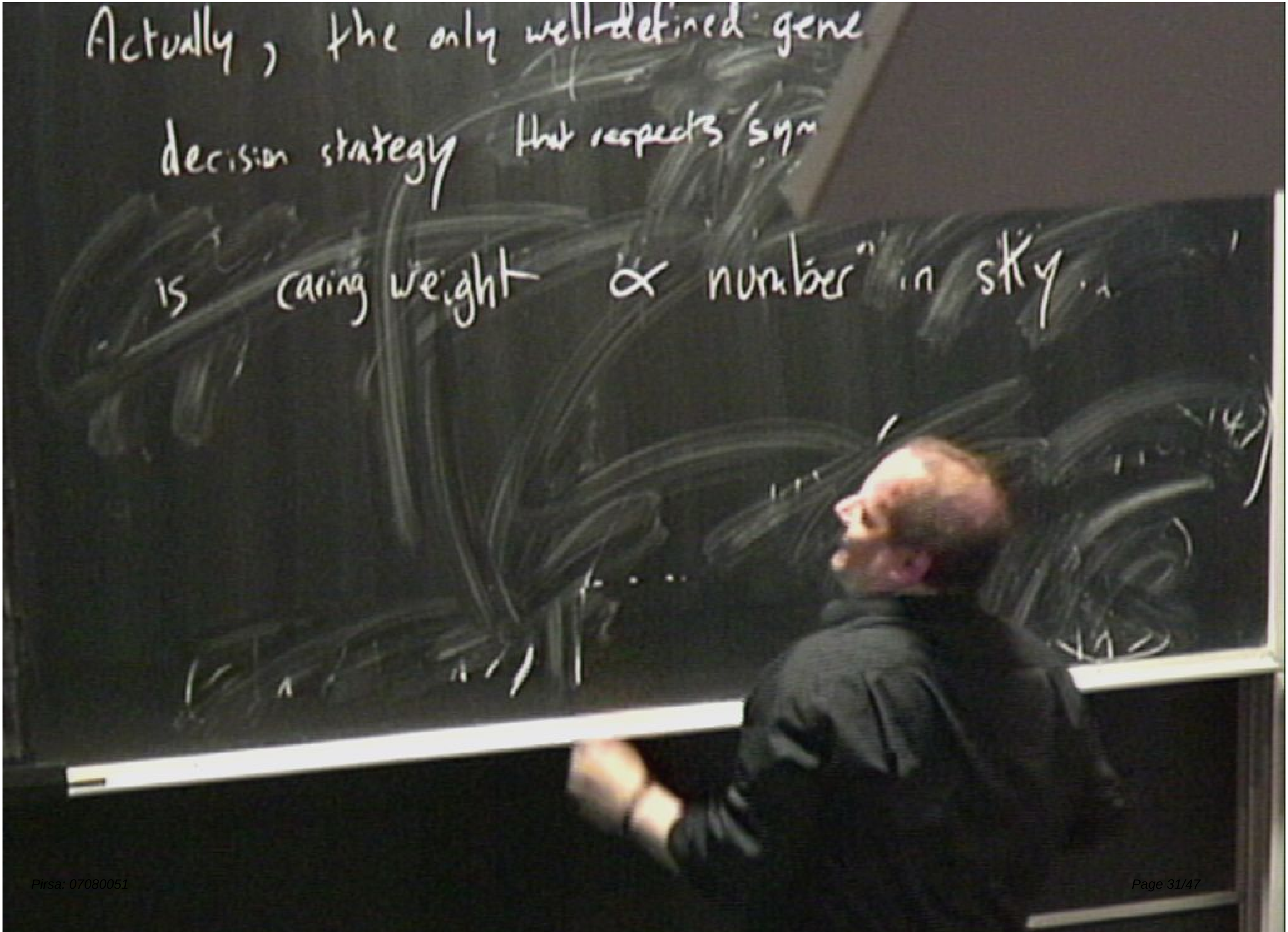
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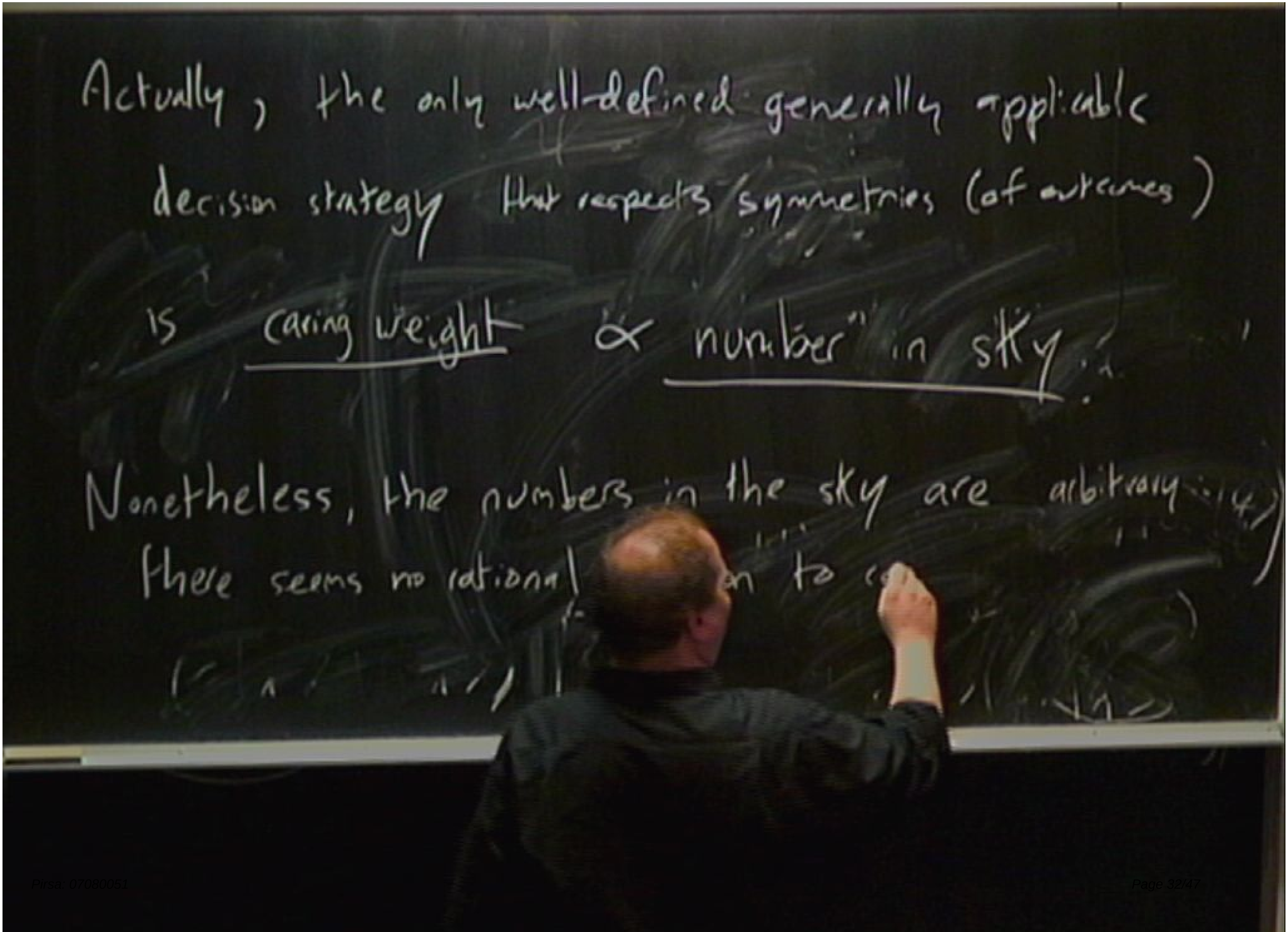

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decision strategy that respects symmetries (of outcomes)
is caring weight ∝ "number" in sky.
Nonetheless, the numbers in the sky are arbitrary
there seems no rational
to

is "caring weight" ∝ "number" in sky ?

Nonetheless, the numbers in the sky are arbitrary (?)

there seems no rational reason to correlate them to measures of caring.

impolite [illegible] Copenhagen evolutionary histories are realised in an Everettian cosmology.

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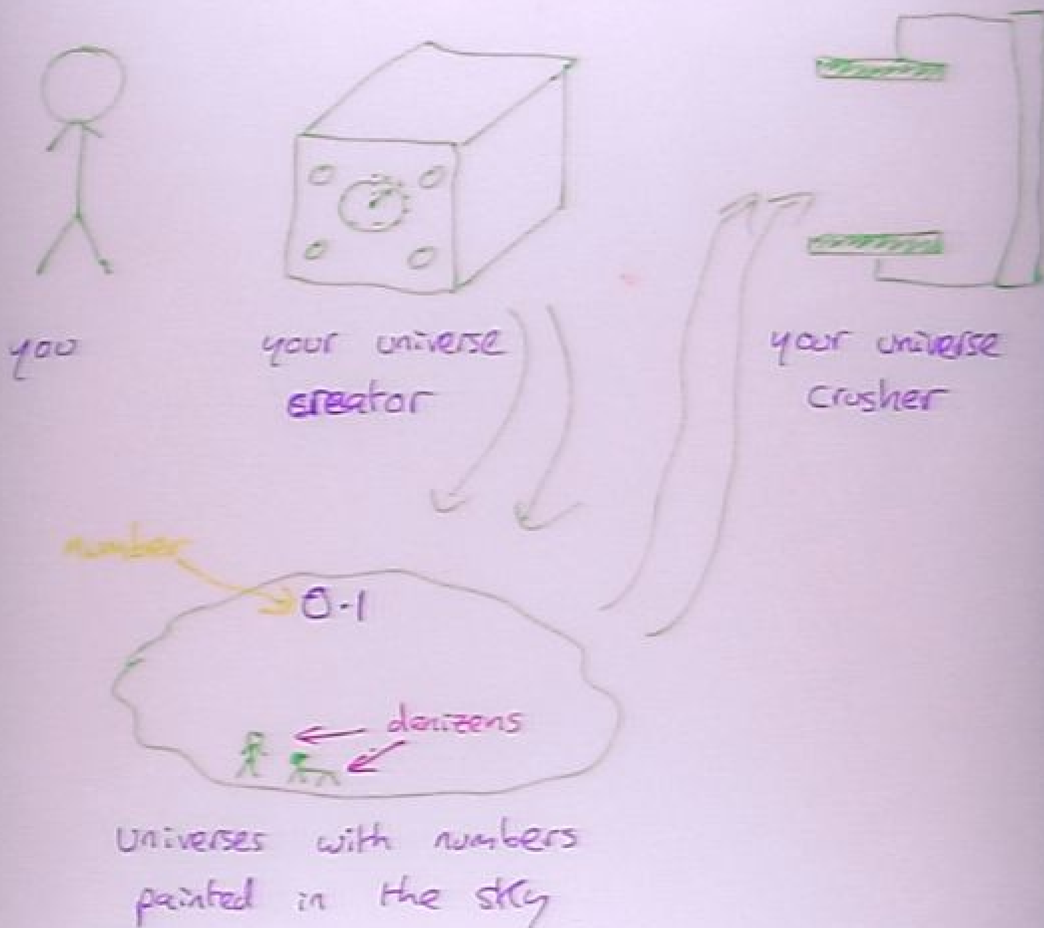
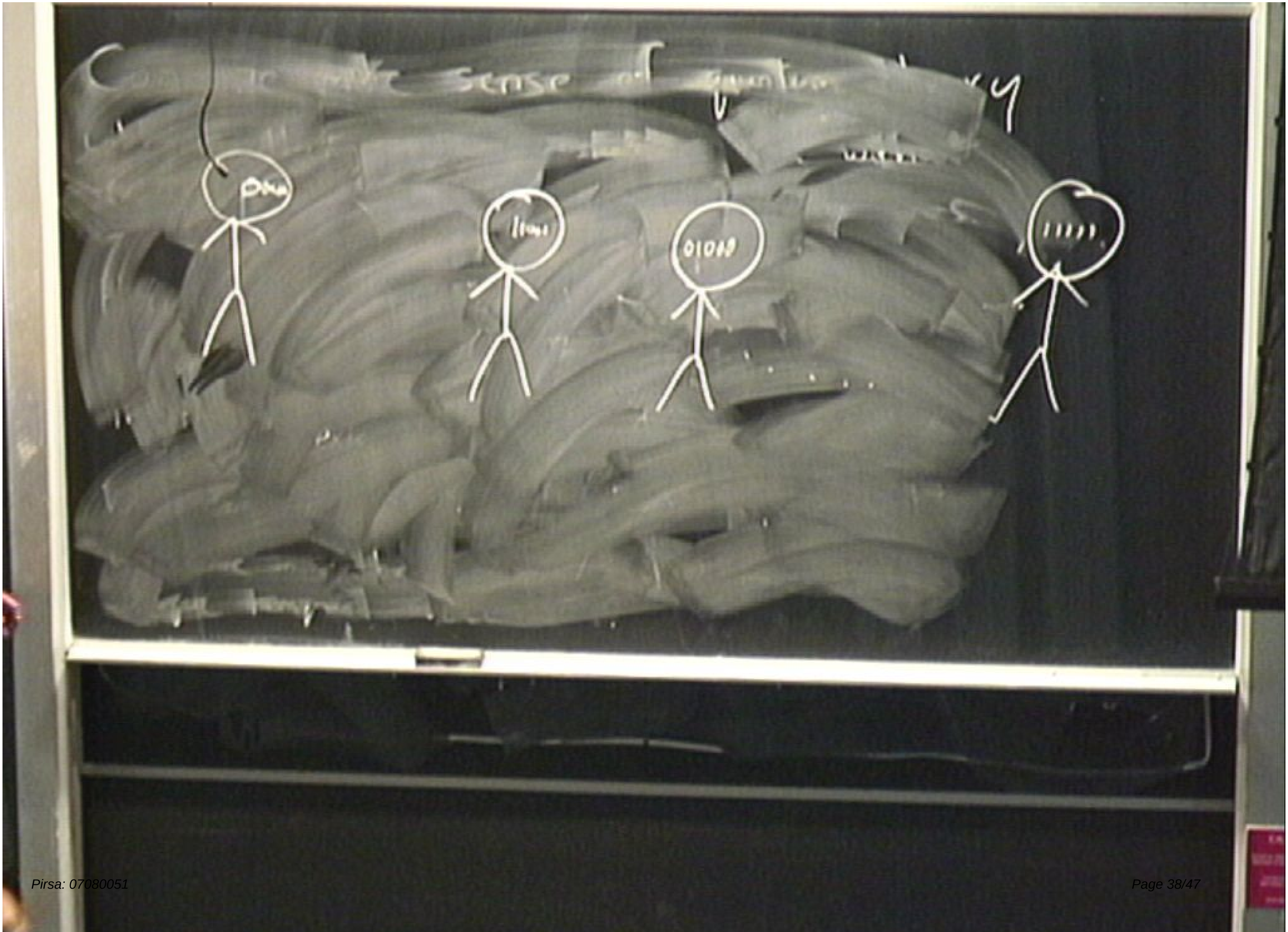


(2) Despite ingenious attempts to argue it so, $|\psi|^2$ doesn't seem to be a unique rational caring weight.

(3) Even if we accepted the conclusion of the caring weight argument, it tells us why it's rational to wager according to Born rule probabilities in an Everettian universe, given that we believe the universe <u>is</u> Everettian.

On the face of it, this says nothing about why we are among the universe-dwellers who were ever in a position to infer Copenhagen q.m. and (hence, later) Everett q.m. — the key question mentioned earlier remains unanswered.


Sense of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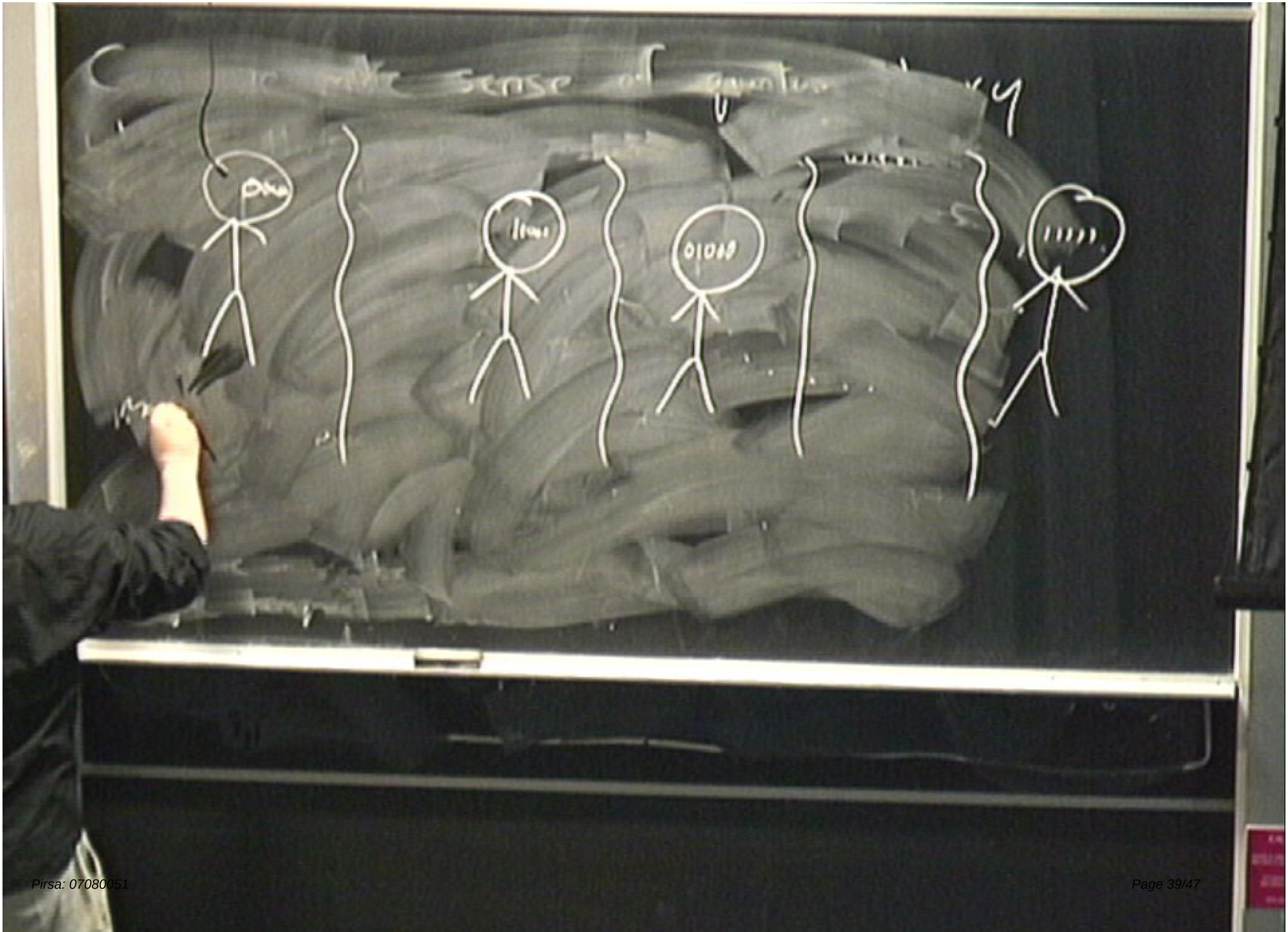
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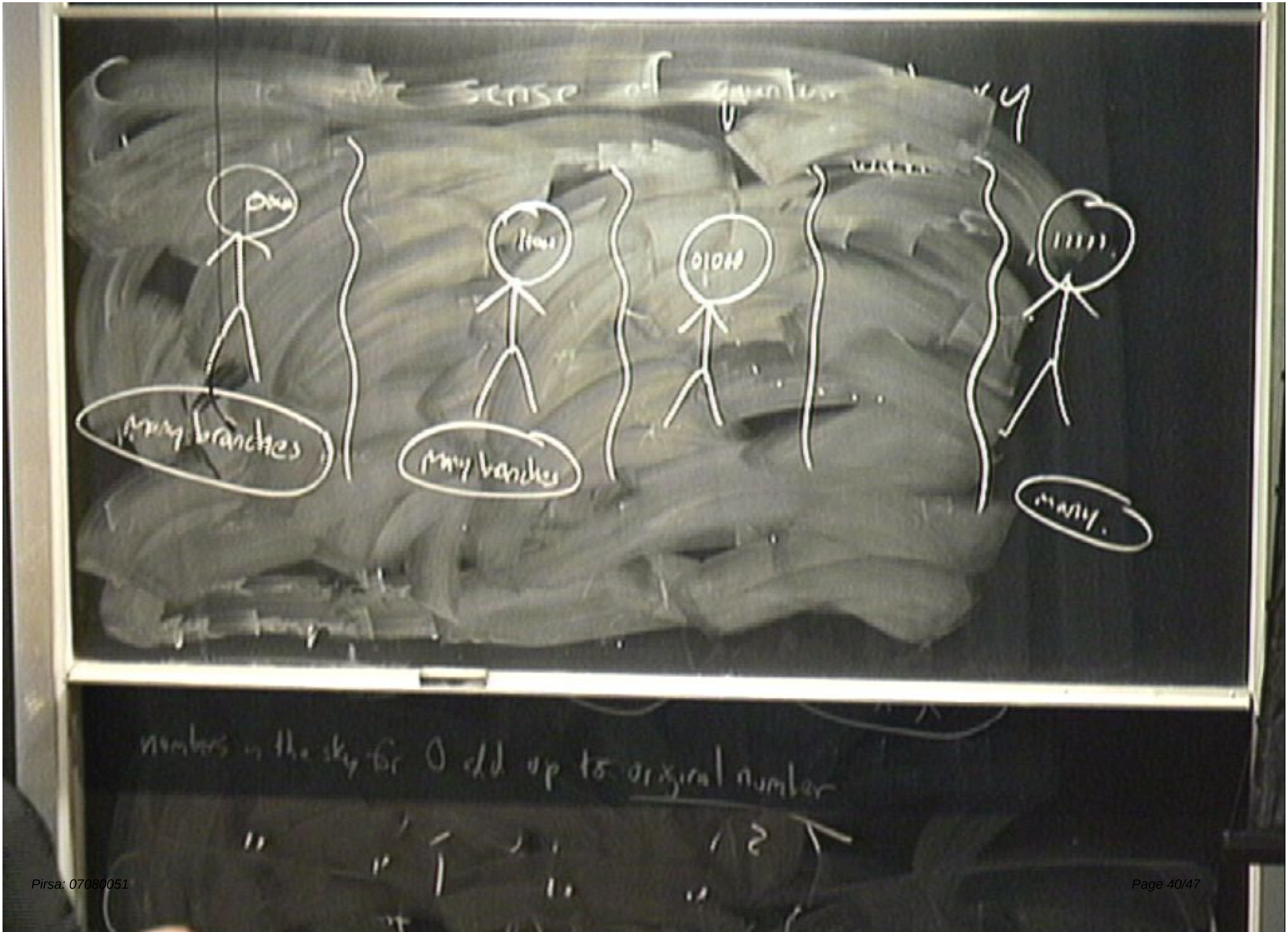
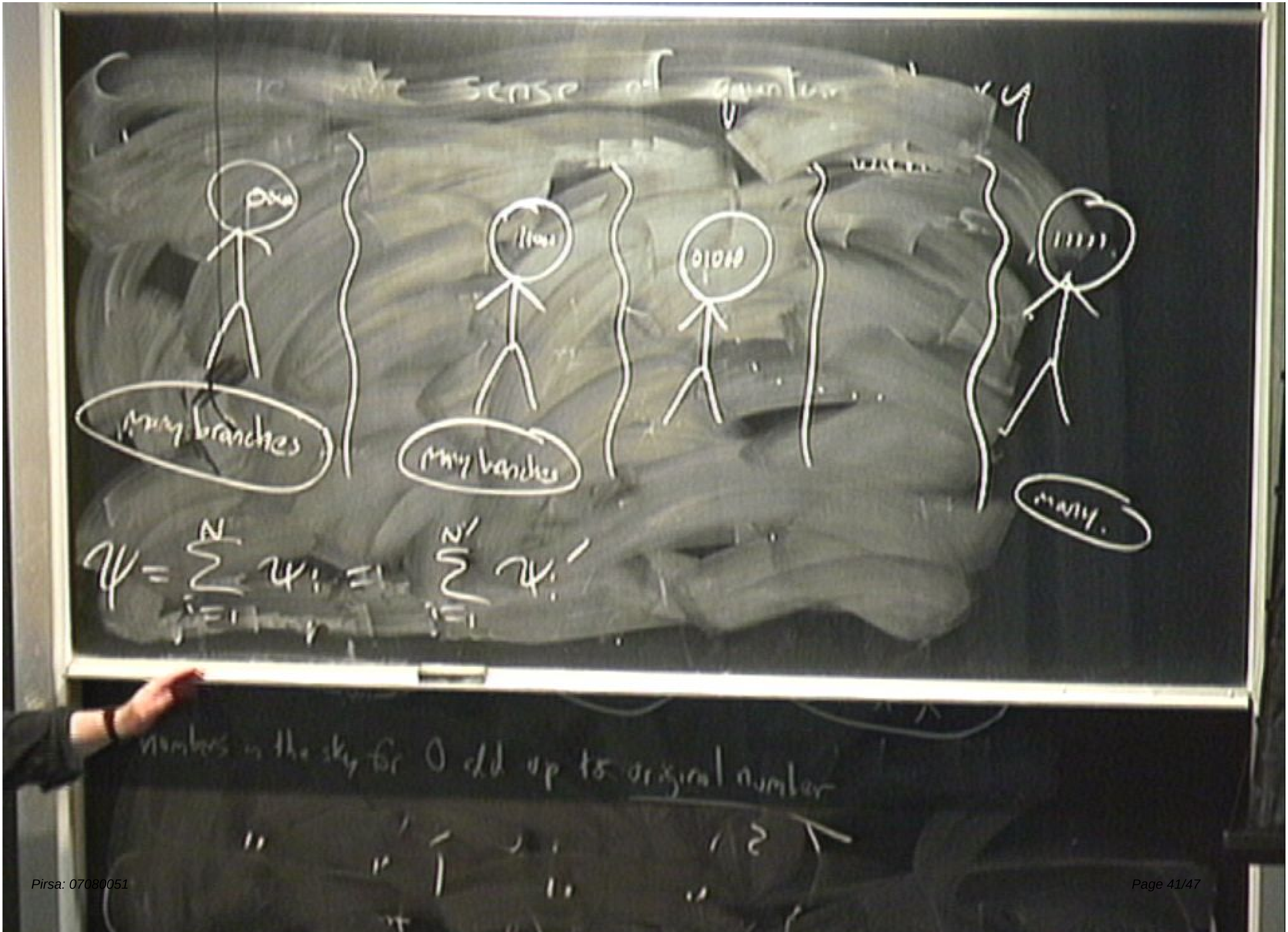
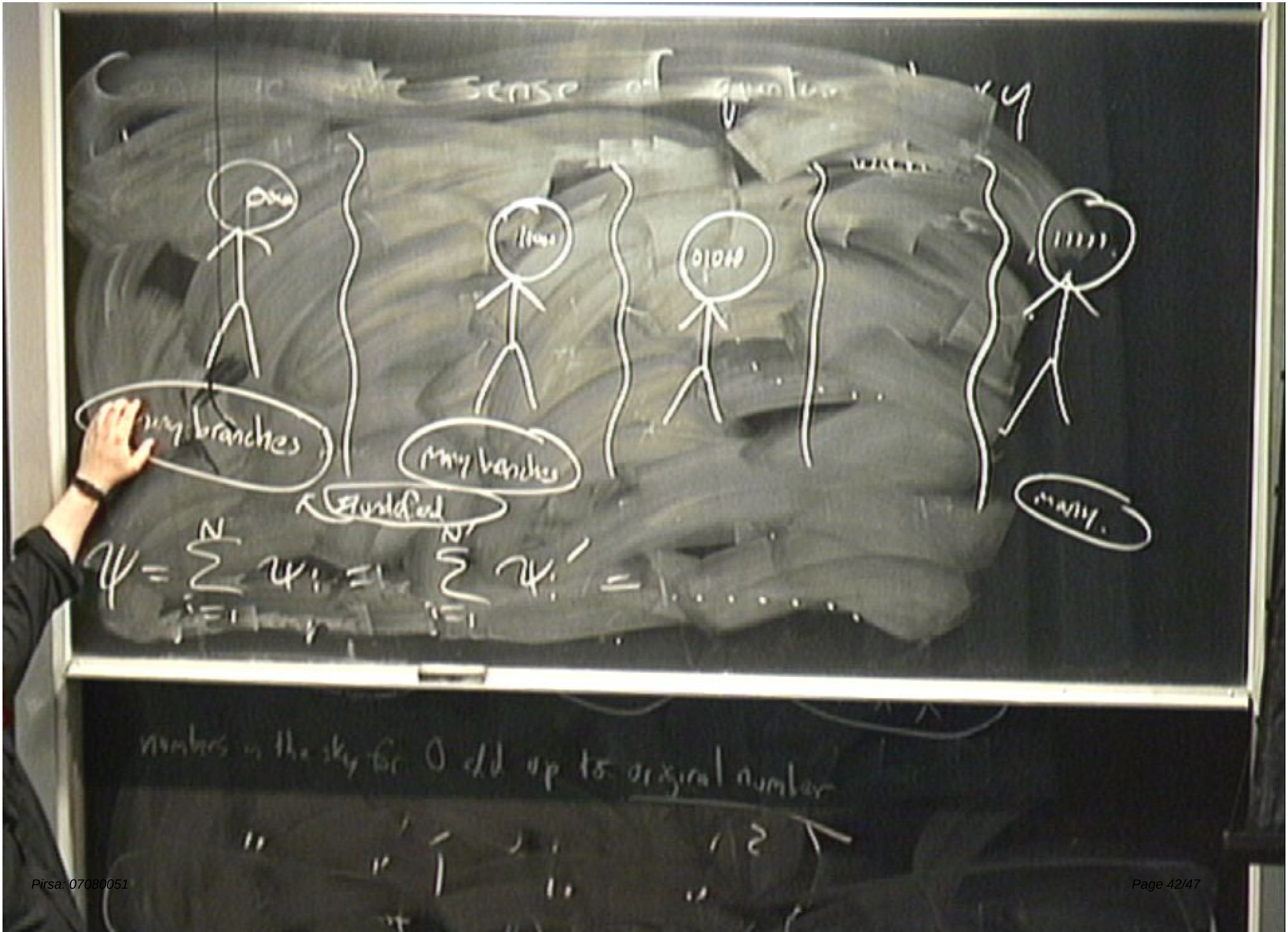

many branches
many branches
many.
numbers in the sky for 0 add up to original number



$$\psi = \sum_{i=1}^{N} \psi_i = \sum_{i=1}^{N'} \psi_i'$$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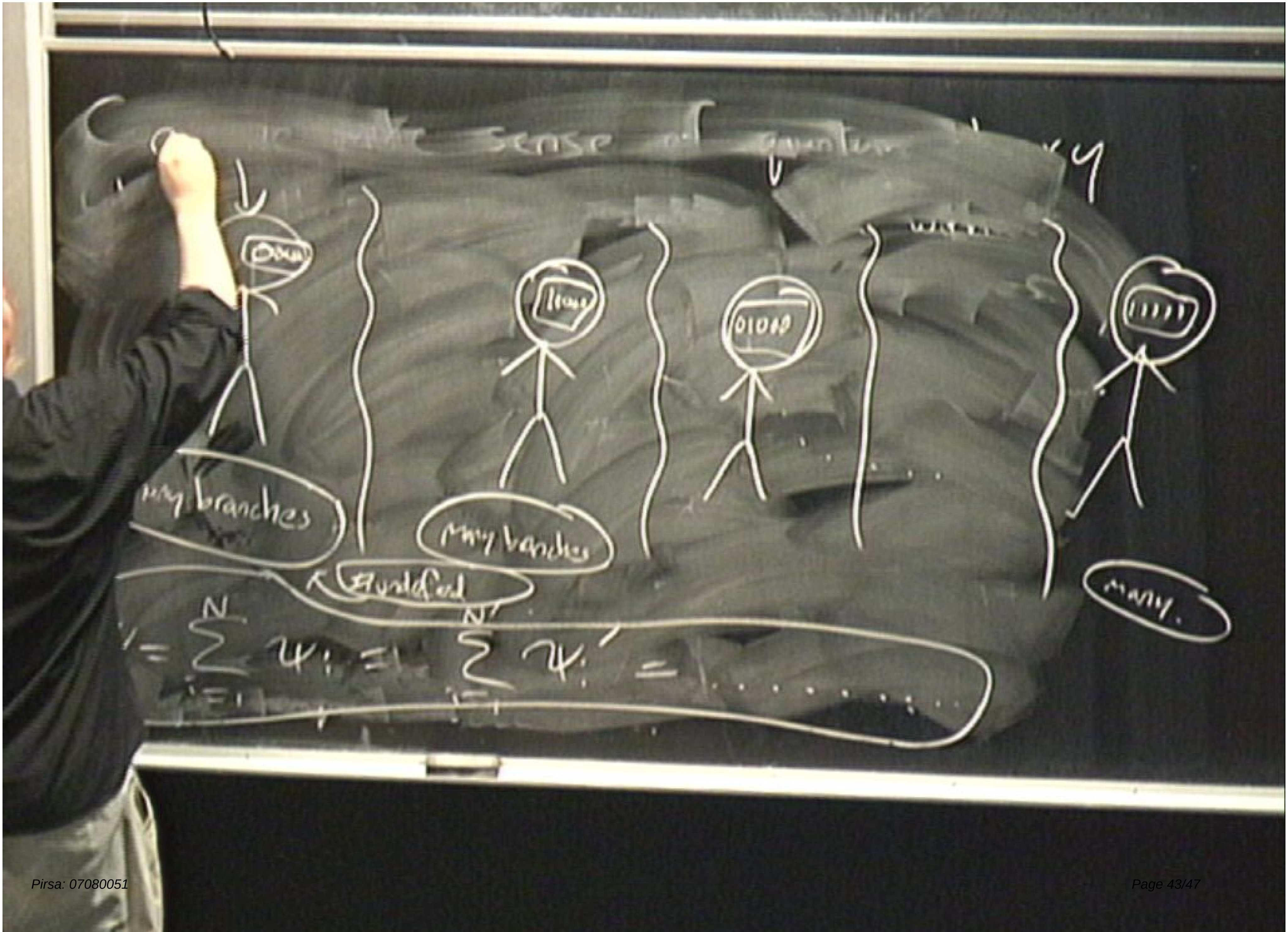
numbers in the sky for 0 add up to original number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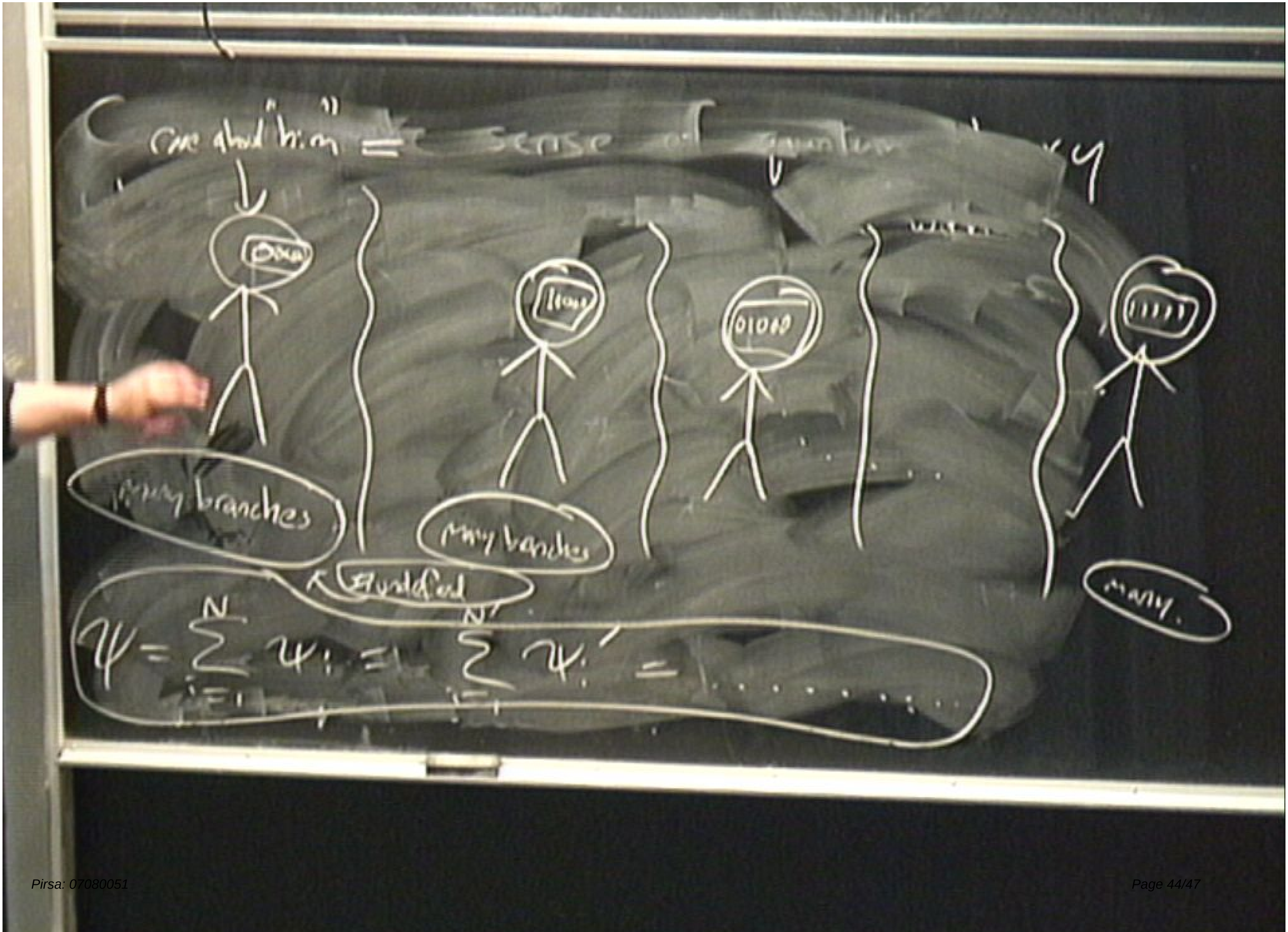

Many branches
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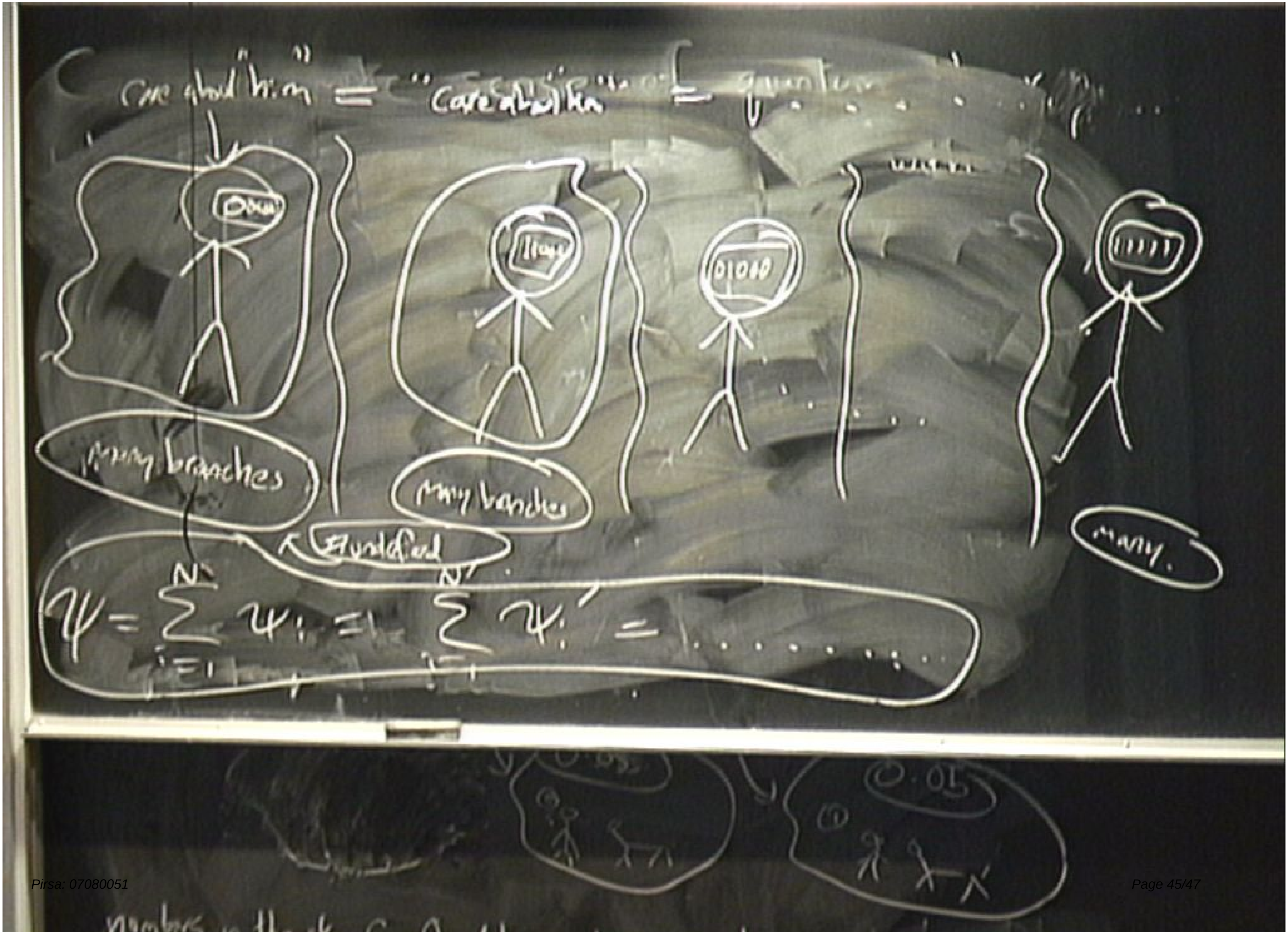
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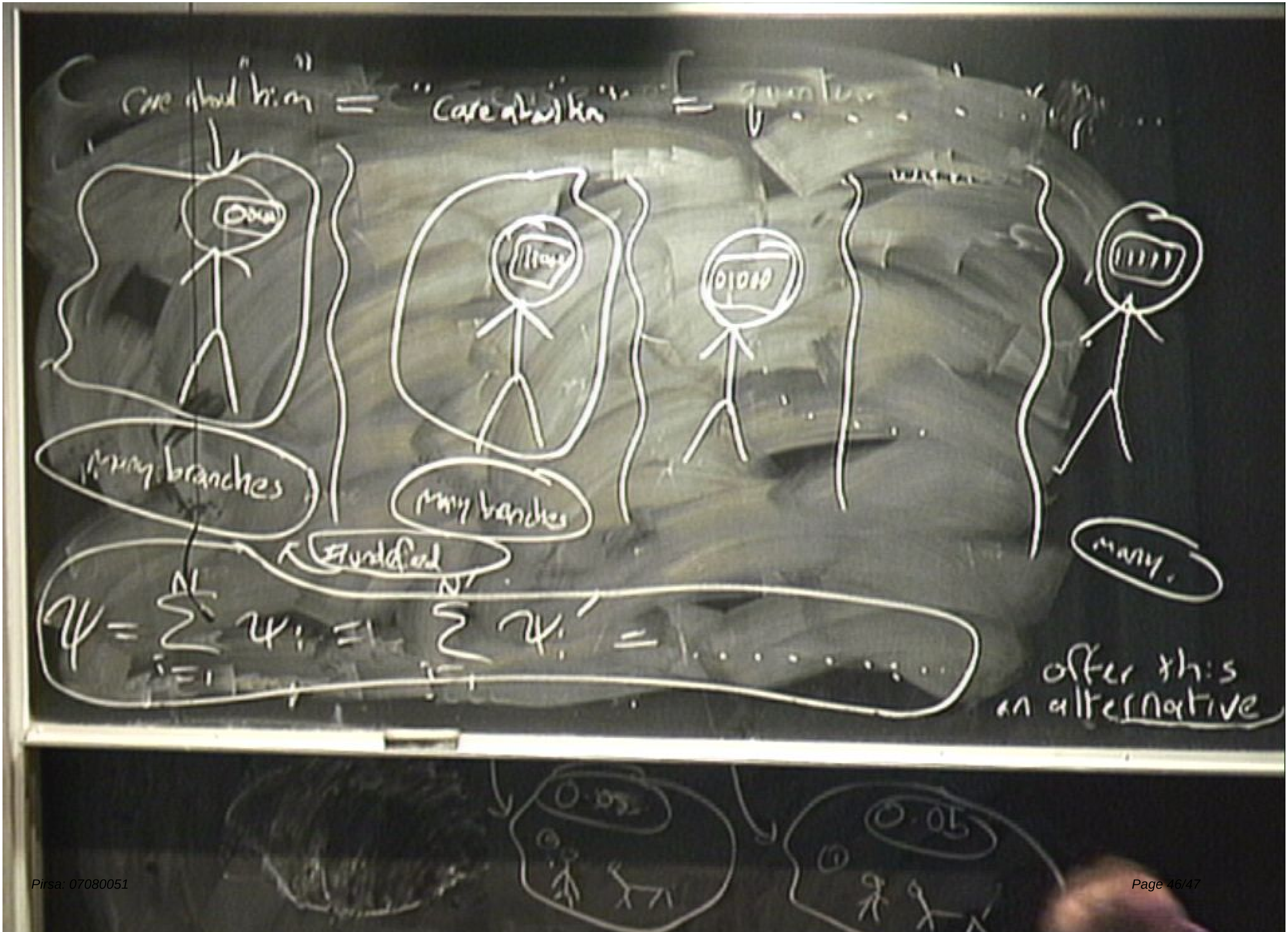
many branches
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an alternative

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