Title: 13 Quotes from Everettian Papers and Why They Unsettle Me

Date: Sep 24, 2007 11:40 AM

URL: http://pirsa.org/07090068

Abstract: 101 years ago William James wrote this about the Hegelian movement in philosophy: \'The absolute mind which they offer us, the mind that makes our universe by thinking it, might, for aught they show us to the contrary, have made any one of a million other universes just as well as this. You can deduce no single actual particular from the notion of it. It is compatible with any state of things whatever being true here below.\' With some minor changes of phrase---for instance \'mathematical structure\' in place of \'absolute mind\'---one might well imagine morphing this into a remark about Everettian quantum mechanics. This point, coupled with the observation that the Everett interpretation has been declared complete and consistent for the selfsame number of years that its supporters have been trying to complete it, indicate to me that perhaps the Everett approach is more a quantum-independent mindset than a scientific necessity. So be it, but then it should be recognized as such. In this talk, I will try to expand on these suspicions.

W. James, *Pragmatism, a New Name for Some Old Ways of Thinking*, (Longmans, Green and Co., New York, 1922).

The history of philosophy is to a great extent that of a certain clash of human temperaments. Undignified as such a treatment may seem to some of my colleagues, I shall have to take account of this clash and explain a good many of the divergencies of philosophies by it. Of whatever temperament a professional philosopher is, he tries, when philosophizing, to sink the fact of his temperament. Temperament is no conventionally recognized reason, so he urges impersonal reasons only for his conclusions. Yet his temperament really gives him a stronger bias than any of his more strictly objective premises. It loads the evidence for him one way or the other, making a more sentimental or more hard-hearted view of the universe, just as this fact or that principle would. He *trusts* his temperament. Wanting a universe that suits it, he believes in any representation of the universe that does suit it. He feels men of opposite temper to be out of key with the world's character, and in his heart considers them incompetent and 'not in it,' in the philosophic business, even though they may far excel him in dialectical ability.

Yet in the forum he can make no claim, on the bare ground of his temperament, to superior discernment or authority. There arises thus a certain insincerity in our philosophic discussions: the potentest of all our premises is never mentioned. I am sure it would contribute to clearness if in these lectures we should break this rule and mention it, and I accordingly feel free to do so.

13 Everettian Quotes and Why They Unsettle Me

Christopher Fuchs
$\hat{PI}$

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The hypothesis that there is an external world, not dependent on human minds, made of <u>something</u>, is so obviously useful and so strongly confirmed by experience down through the ages that we can say without exaggerating that it is better confirmed than any other empirical hypothesis.

— Martin Gardner

W. James, "The Dilemma of Determinism," in *The Will to Believe and Other Essays in Popular Philosophy*, (Dover, New York, 1956).

... What does determinism profess?

It professes that those parts of the universe already laid down absolutely appoint and decree what the other parts shall be. The future has no ambiguous possibilities bidden in its womb; the part we call the present is compatible with only one totality. Any other future complement than the one fixed from eternity is impossible. The whole is in each and every part, and welds it with the rest into an absolute unity, an iron block, in which there can be no equivocation or shadow of turning. ...

Indeterminism, on the contrary, says that the parts have a certain amount of loose play on one another, so that the laying down of one of them does not necessarily determine what the others shall be. It admits that possibilities may be in excess of actualities, and that things not yet revealed to our knowledge may really in themselves be ambiguous. Of two alternative futures which we conceive, both may now be really possible; and the one become impossible only at the very moment when the other excludes it by becoming real itself. Indeterminism thus denies the world to be one unbending unit of fact. It says there is a certain ultimate pluralism in it; and, so saying, it corroborates our ordinary unsophisticated view of things. To that view, actualities seem to float in a wider sea of possibilities from out of which they are chosen; and, *somewhere*, indeterminism says, such possibilities exist, and form a part of the truth.

The Content of Everettism:

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D. Deutsch, *The Fabric of Reality*, (Penguin Books, New York, 1997).

[Deutsch "explaining" one-particle-at-a-time interference]

So, if the photons do not split into fragments, and are not being deflected by other photons, what does deflect them? When a single photon at a time is passing through the apparatus, what can be coming through the other slits to interfere with it? ...

I shall now start calling the interfering entities 'photons'. That is what they are, though for the moment it does appear that photons come in two sorts, which I shall temporarily call *tangible* photons and *shadow* photons. Tangible photons are the ones we can see, or detect with instruments, whereas shadow photons are intangible (invisible) – detectable only indirectly through their interference effects on tangible photons. ...

Thus we have inferred the existence of a seething, prodigiously complicated, hidden world of shadow photons. They travel at the speed of light, bounce off mirrors, are refracted by lenses, and are stopped by opaque barriers or filters of the wrong colour. Yet they do not trigger even the most sensitive detectors. The only thing in the universe that a shadow photon can be observed to affect is the tangible photon it accompanies. That is the phenomenon of interference. ...

...Thus we have reached the conclusion of the chain of reasoning that begins with strangely shaped shadows and ends with parallel universes. Each step takes the form of noting that the behaviour of objects that we observe can be explained only if there are unobserved objects present, and if those unobserved objects have certain properties.

N. D. Mermin, "From Cbits to Qbits: Teaching Computer Scientists Quantum Mechanics," quant-ph/0207118.

There are nevertheless some who believe that all the amplitudes α_x have acquired the status of objective physical quantities, inaccessible though those quantities may be. Such people then wonder how that vast number of high-precision calculations (10^{30} different amplitudes if you have 100 Qbits) could all have been physically implemented. Those who ask such questions like to provide sensational but fundamentally silly answers involving vast numbers of parallel universes, invoking a point of view known as the *many worlds* interpretation of quantum mechanics. My own opinion is that, imaginative as this vision may appear, it is symptomatic of a lack of a much more subtle kind of imagination, which can grasp the exquisite distinction between quantum states and objective physical properties that quantum physics has forced upon us.

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M. Tegmark, "Parallel Universes" astro-ph/030213, and M. Tegmark, "The Mathematical Universe," arXiv:0704.0646v1.

I survey physics theories involving parallel universes, which form a natural four-level hierarchy of multiverses allowing progressively greater diversity. Level I: A generic prediction of inflation is ... Level III: In unitary quantum mechanics, other branches of the wavefunction add nothing qualitatively new, which is ironic given that this level has historically been the most controversial. Level IV: Other mathematical structures give different fundamental equations of physics. The key question is not whether parallel universes exist ... but how many levels there are.

If the [Theory of Everything] at the top of Figure 1 exists and is one day discovered, then an embarrassing question remains, ...: Why these particular equations, not others? Could there really be a fundamental, unexplained ontological asymmetry built into the very heart of reality, splitting mathematical structures into two classes, those with and without physical existence? After all, a mathematical structure is not "created" and doesn't exist "somewhere". It just exists.

As a way out of this philosophical conundrum, I have suggested that complete mathematical democracy holds: that mathematical existence and physical existence are equivalent, so that all mathematical structures have the same ontological status. ... In the context of the [Mathematical Universe Hypothesis], the existence of the Level IV multiverse is not optional.

Which lead Max to ask, **"Does The Universe In Fact Contain Almost No Information?"** [Found. Phys. Lett. 9, 25–42 (1996)].

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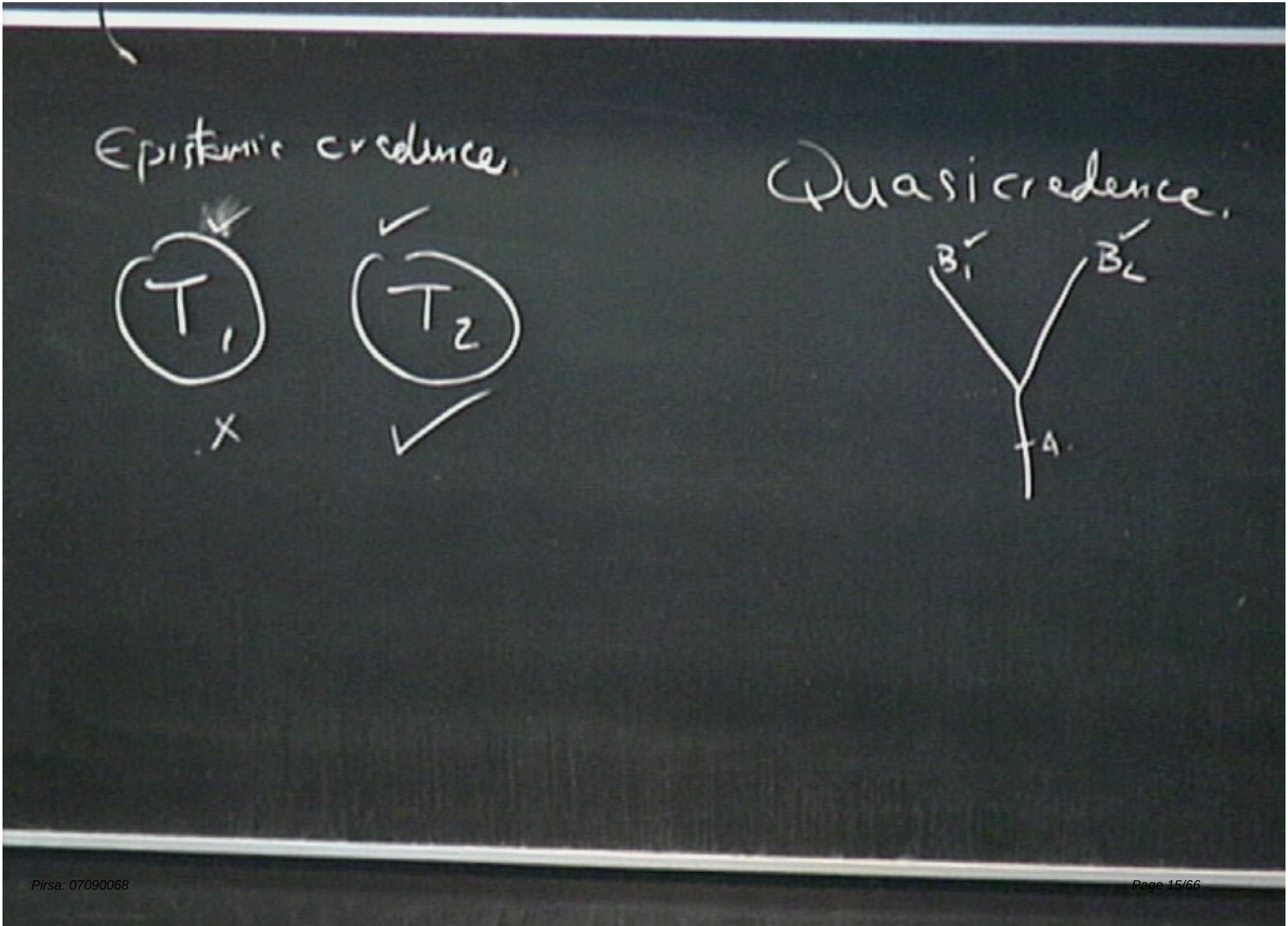
W. James, *Pragmatism, a New Name for Some Old Ways of Thinking*, (Longmans, Green and Co., New York, 1922).

[I]f you are the lovers of facts I have supposed you to be, you find the trail of the serpent of rationalism, of intellectualism, over everything that lies on that side of the line. You escape indeed the materialism that goes with the reigning empiricism; but you pay for your escape by losing contact with the concrete parts of life. The more absolutistic philosophers dwell on so high a level of abstraction that they never even try to come down. The absolute mind which they offer us, the mind that makes our universe by thinking it, might, for aught they show us to the contrary, have made any one of a million other universes just as well as this. You can deduce no single actual particular from the notion of it. It is compatible with any state of things whatever being true here below. And the theistic God is almost as sterile a principle. You have to go to the world which he has created to get any inkling of his actual character: he is the kind of god that has once for all made that kind of a world. The God of the theistic writers lives on as purely abstract heights as does the Absolute. Absolutism has a certain sweep and dash about it, while the usual theism is more insipid, but both are equally remote and vacuous.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Cloning and Broadcasting in Generic Probabilistic Models

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April 18, 2007

Abstract

We prove generic versions of the no-cloning and no-broadcasting theorems, applicable to essentially any non-classical finite-dimensional probabilistic model that satisfies a no-signaling criterion. This includes quantum theory as well as models supporting "super-quantum" correlations that violate the Bell inequalities to a larger extent than quantum theory. The proof of our no-broadcasting theorem is significantly more natural and more self-contained than others we have seen: we show that a set of states is broadcastable if, and only if, it is contained in a simplex whose vertices are cloneable, and therefore distinguishable by a single measurement. This necessary and sufficient condition generalizes the quantum requirement that a broadcastable set of states commute.

1 Introduction

The growth of quantum information science has led many to wonder which aspects of quantum mechanics are responsible for its enhanced information processing powers. Some have compared quantum and classical theories in frameworks broad enough to encompass both of them and more [27, 28, 2, 3, 4, 9, 19], and others have constructed toy theories that capture qualitative features of quantum information protocols [26, 51, 50]. Beyond simply understanding the conceptual sources of the power of quantum theory, researchers have become interested in information-processing as a source of axioms that could characterize probabilistic physical theories [23, 24, 17, 2, 3, 51, 9], shedding light on the conceptual essence of quantum mechanics and potentially giving new stimulus to the longstanding program [42, 37, 38, 39, 40, 1] of axiomatic characterization of quantum theory. It has even been suggested that this approach might ease the integration of quantum theory with general relativity and gravitation [29]

2.1 Convex Sets as State Spaces

One approach to a generalized probability theory begins with an abstract convex set Ω of "states". In practice, this will be a convex subset of a real vector space V, though the particular ambient space is largely irrelevant here. Unless otherwise indicated, I'll assume that V is finite-dimensional and that Ω is compact, i.e., closed and bounded. (As remarked below, this allows us a canonical choice for V.) The idea is that, given a finite sequence of states $\alpha_1, ..., \alpha_n \in \Omega$ and a sequence of non-negative coefficients $t_1, ..., t_n$ summing to unity, the convex combination $\alpha = \sum_i t_i \alpha_i \in \Omega$ represents a statistical mixture in which state α_i occurs with probability t_i. A state is said to be *mixed* iff it can be represented in this way as a (non-trivial) convex combination of other states. States not so representable – that is, the extreme points of Ω – are termed *pure states*. [3]

Observables can now be defined in terms of affine (that is, convex combination preserving) functionals from Ω into the real unit interval. More exactly, let $A(\Omega)$ denote the real vector space of bounded, real-valued affine functionals $a : \Omega \to \mathbb{R}$; call such a functional an *effect* iff it takes values in $[0, 1]$. We may interpret an effect a as representing a possible event or occurrence, with $a(\alpha)$ giving the probability of that event in state $\alpha \in \Omega$. Let u denote the *unit effect*, i.e., the constant functional with value 1. Then a discrete observable taking values in a set E is defined to be a mapping $f : E \to A(\Omega)$ such that, for every $x \in E$, $f(x)$ is an effect, and $\sum_{x \in E} f(x) = u$. This definition allows us to pull each state $\alpha \in \Omega$ back to a classical probability weight $f^*(\alpha)(x) = \alpha(f(x))$ on E, which we interpret as giving the statistical distribution of values of the observable when the state is α. The simplest case is that in which E is itself just a set of effects summing to u (in which case the mapping f is just the inclusion mapping). In this case, we may speak of E itself as an observable.

By way of illustration, if E is a finite set, the collection $\Delta(E)$ of probability weights on E is a convex set. Indeed, it is a *simplex*: every probability weight is *uniquely* representable as a convex combination of the extreme points of $\Delta(E)$, which are just the point-masses associated with points of E. Accordingly, an affine functional $f \in A(\Delta(E))$ is uniquely defined by its val-

[3] In our finite-dimensional context, every state is a mixture of pure states. If Ω is infinite-dimensional, this can fail quite dramatically, as Ω may have no pure states at all. Partly for this reason, it is usual to assume that state spaces are compact, though this assumption carries certain costs.

A. Wilce, "Formalism and Interpretation in Quantum Theory," to appear in *Festschrift for Jeffrey Bub's 65th Birthday*.

It has become increasingly clear in recent years [2, 4, 28, 29, 38] that many of the most puzzling "quantum" phenomena—in particular, phenomena associated with entanglement, and including, as I'll show, a version of the measurement problem—are in fact quite generic features of essentially all non-classical probabilistic theories, quantum or otherwise. This suggests that many of the interpretive ideas [*including many-worlds interpretations*] that have been advanced in connection with quantum mechanics can be carried over to a much more general setting. This exercise has something to offer to both foundational projects. On the one hand, an interpretation of quantum mechanics that can't be made sense of absent certain special structural features of quantum mechanics, is potentially a source of fruitful ideas with which to approach the problem of the formalism. On the other hand, if an interpretation can be kept aloft even in the thin atmosphere of a completely general non-classical probabilistic theory, then perhaps it has little to tell us about the physical content of quantum theory. To compress this idea into a slogan: a completely satisfactory interpretation of a physical theory should be capable of yielding (or at least, constraining!) its own formalism.

At the conference, the strongest "Everettian" was physicist David Deutsch of the Center for Quantum Computation at University of Oxford. Deutsch asserted that people have been wasting time for decades debating whether or not the Copenhagen Interpretation is meaningful because, "Only Everett's theory consists of taking quantum mechanics seriously."

— Peter Byrne, "Many Worlds in Oxford," at `blog.sciam.com`

It's sad enough when cranks churn out this tawdry old excuse for refusing to contemplate the implications of science [*i.e., the Everett interpretation*], but when highly competent physicists — quantum physicists — dust it off and proudly repeat it, it's a crying shame.

— David Deutsch, posted on `Fabric-of-Reality@egroups.com`, 16 July 2000, commenting on a paper by Fuchs and Peres

Let quantum be quantum.

— Wojciech Zurek, his talk at this meeting

Taking Quantum Mechanics Seriously

(Simon Saunders version, this meeting)

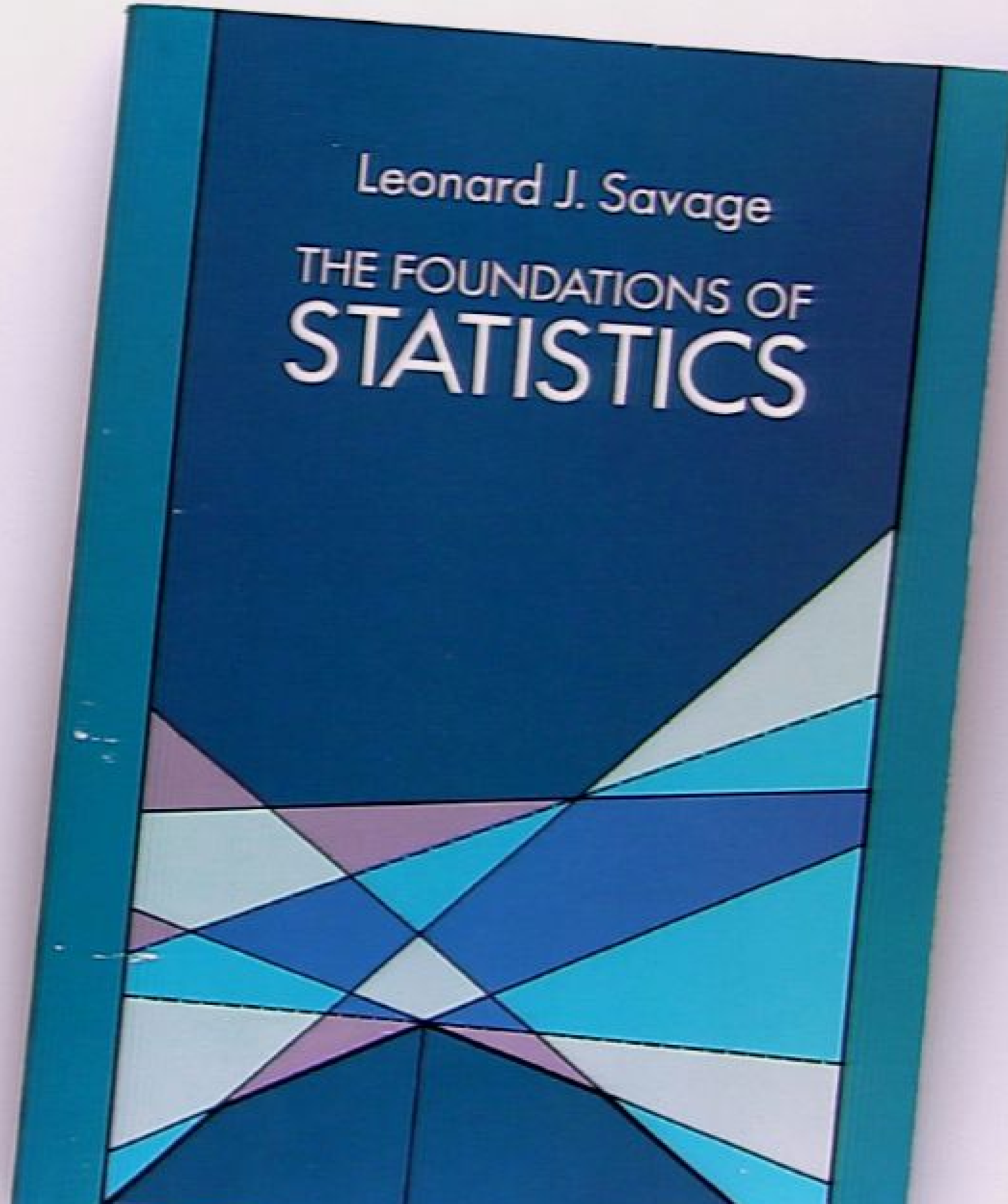
- The theory is to apply universally.
- Without any special mention of 'the observer' or 'measurement'.
- And without any special interpretative assumptions or additional [???] ...

J. A. Wheeler (with K. A. Ford), *Geons, Black Holes, and Quantum Foam: A Life in Physics*, (W. W. Norton, New York, 1998).

Many students of chemistry and physics, entering upon their study of quantum mechanics, are told that quantum mechanics shows its essence in waves, or clouds, of probability. A system such as an atom is described by a wave function. This function satisfies the equation that Erwin Schrödinger published in 1926. The electron, in this description, is no longer a nugget of matter located at a point. It is pictured as a wave spread throughout the volume of the atom (or other region of space).

This picture is all right as far as it goes. It properly emphasizes the central role of probability in quantum mechanics. The wave function tells where the electron might be, not where it is. But, to my mind, the Schrödinger wave fails to capture the true essence of quantum mechanics. That essence, as the delayed-choice experiment shows, is *measurement*. A suitable experiment can, in fact, locate an electron at a particular place within the atom. A different experiment can tell how fast the electron is moving. The wave function is not central to what we actually know about an electron or an atom. It only tells us the likelihood that a particular experiment will yield a particular result It is the experiment that provides the actual information.

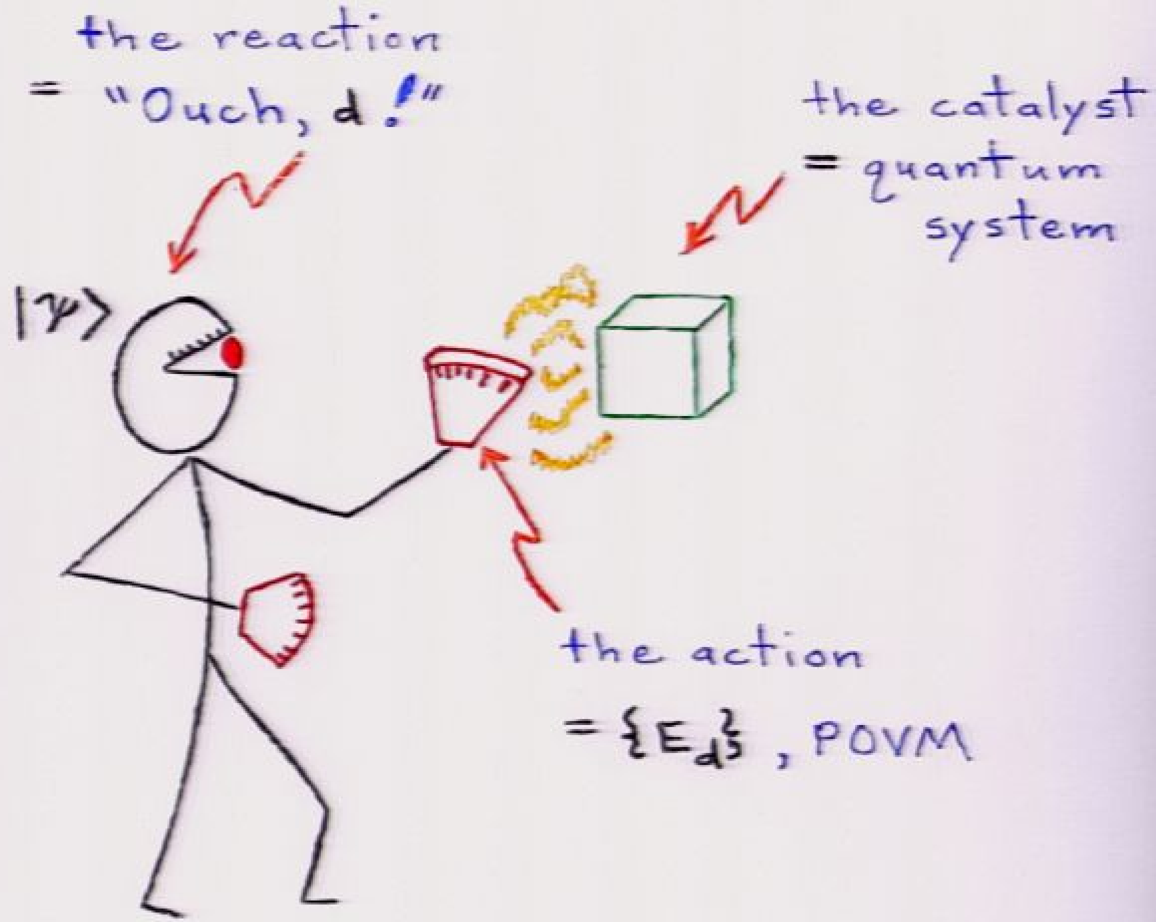
Measurement, the act of turning potentiality into actuality, is an act of choice, choice among possible outcomes. After the measurement, there are roads not taken. Before the measurement, all roads are possible—one can even say that all roads are being taken at once.


Leonard J. Savage
THE FOUNDATIONS OF
STATISTICS

J. M. Bernardo and A. F. M. Smith, *Bayesian Theory*. (Wiley, Chichester, 1994).

What is the nature and scope of Bayesian Statistics?

Bayesian Statistics offers a rationalist theory of personalistic beliefs in contexts of uncertainty, with the central aim of characterising how an individual should act in order to avoid certain kinds of undesirable behavioural inconsistencies. The theory establishes that expected utility maximization provides the basis for rational decision making and that Bayes' theorem provides the key to the ways in which beliefs should fit together in the light of changing evidence. The goal, in effect, is to establish rules and procedures for individuals concerned with disciplined uncertainty accounting. The theory is not descriptive, in the sense of claiming to model actual behaviour. Rather, it is prescriptive, in the sense of saying "if you wish to avoid the possibility of these undesirable consequences you must act in the following way."


the reaction
= "Ouch, d!"
the catalyst
= quantum system
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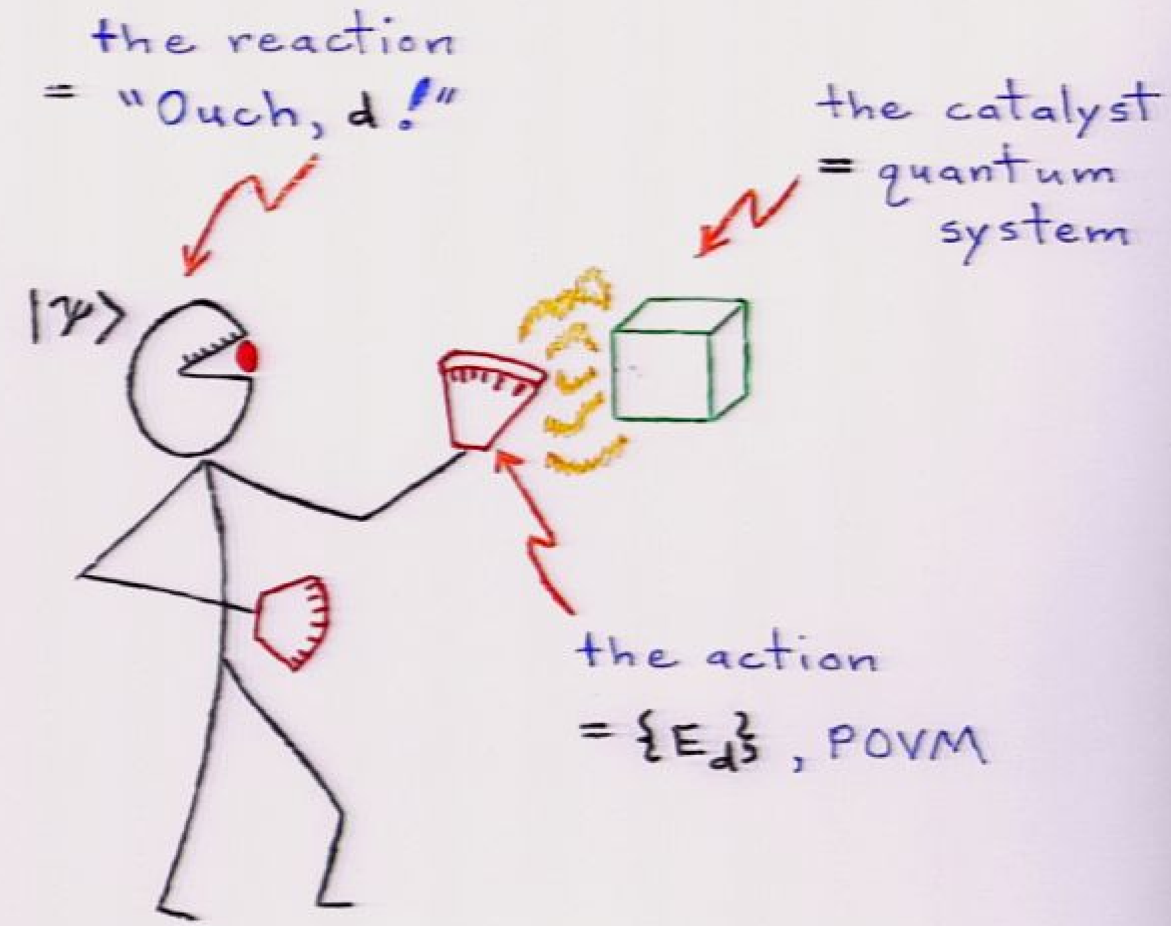

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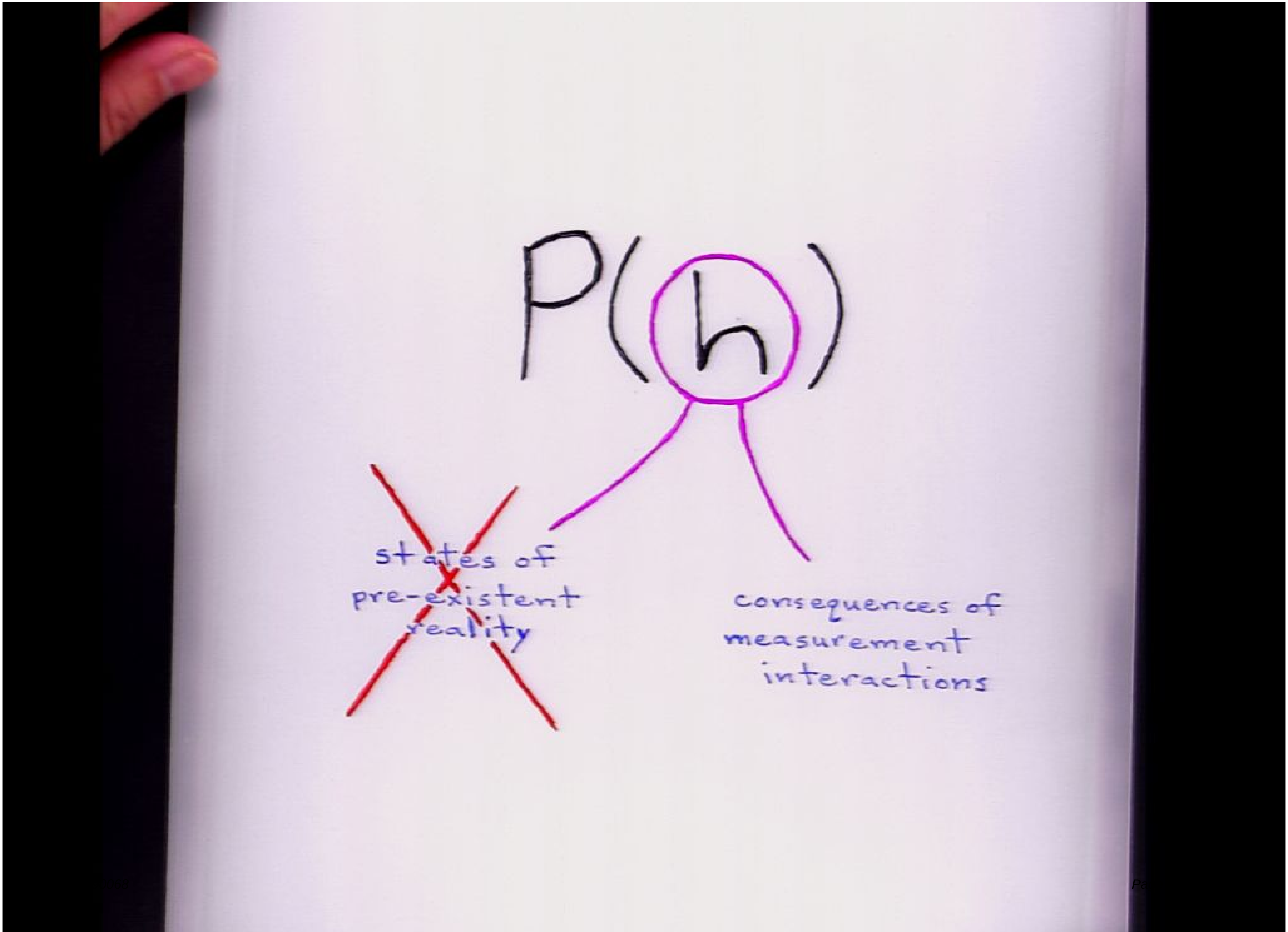
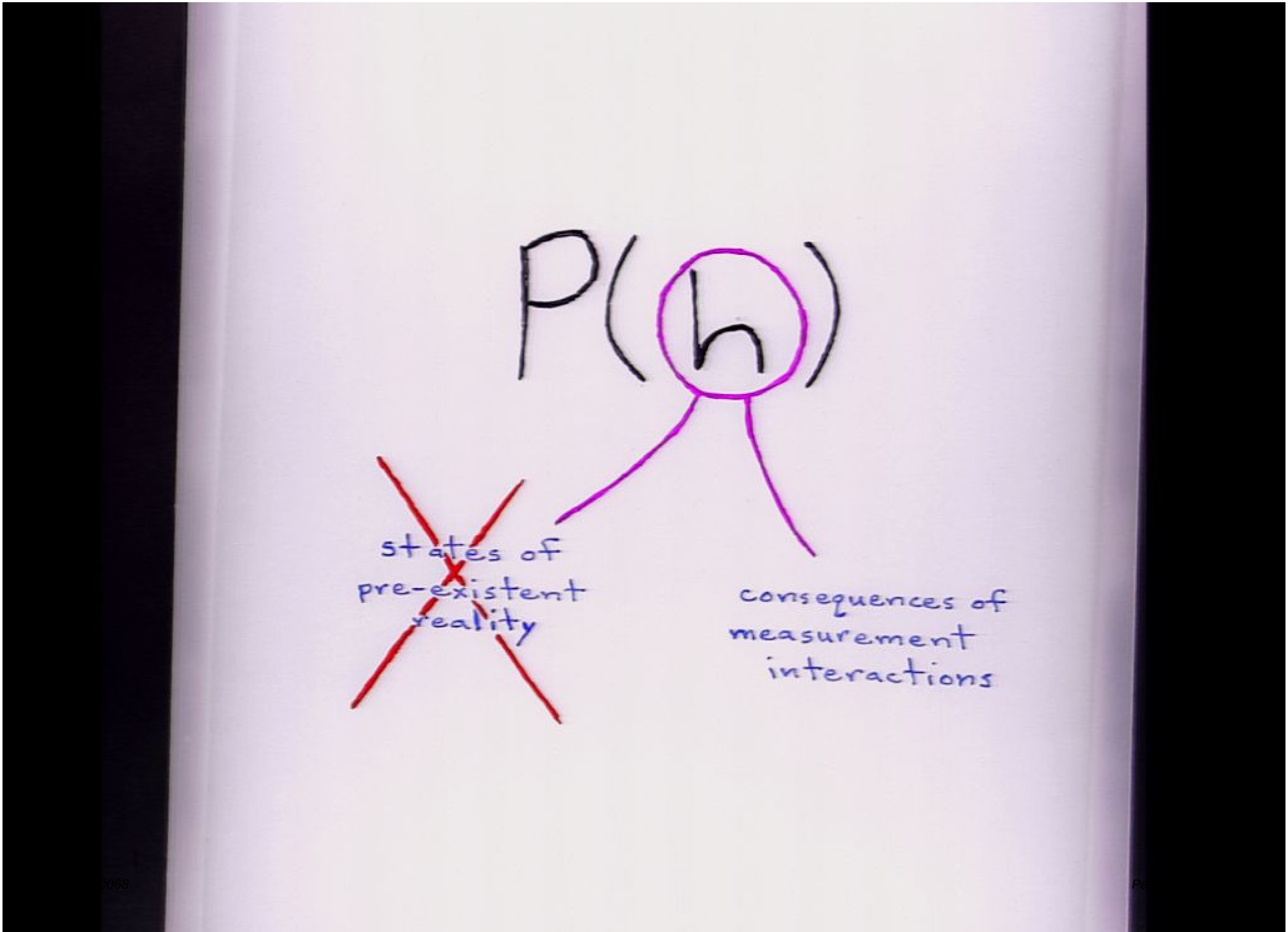


P(h)
states of pre-existent reality
consequences of measurement interactions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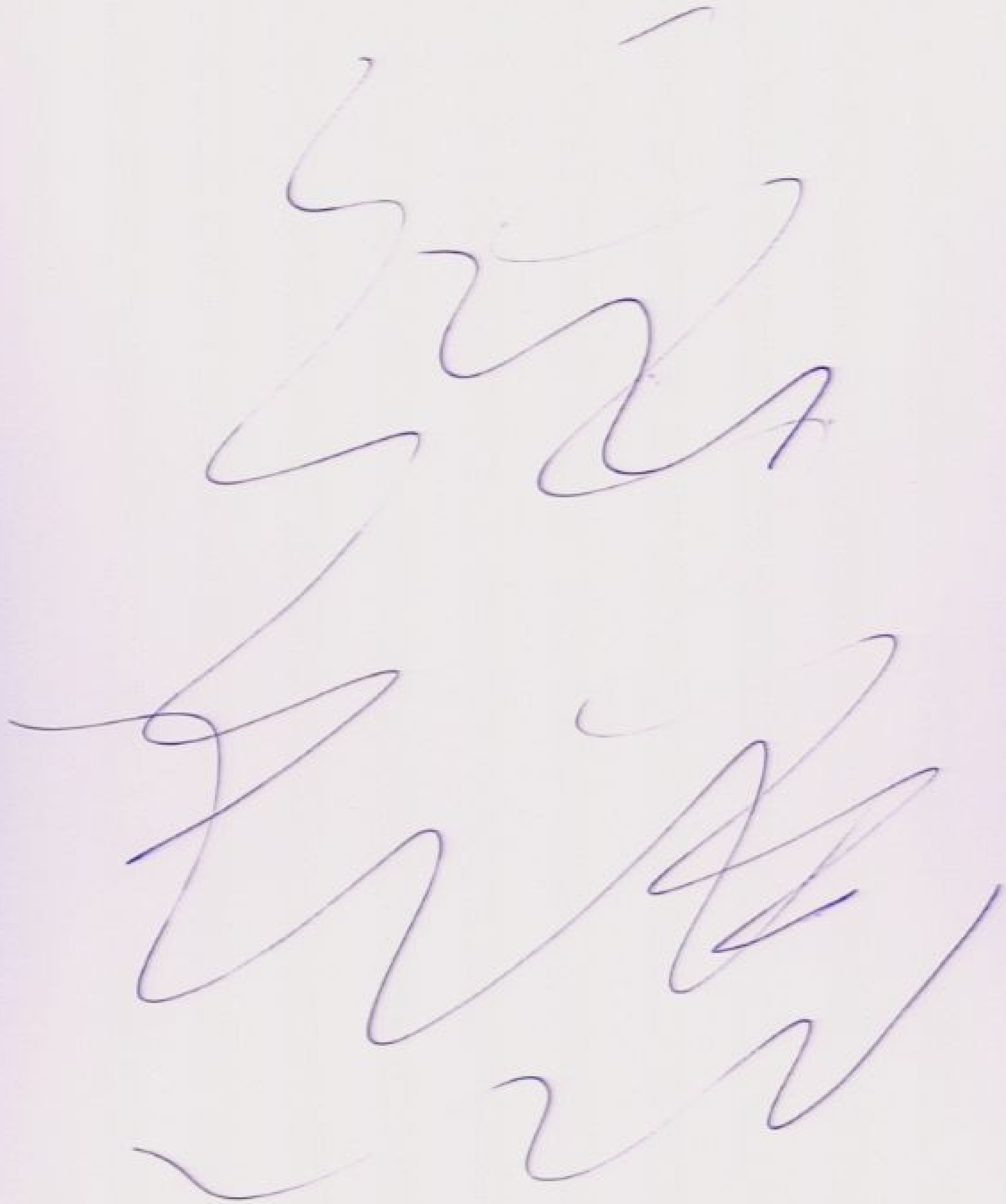

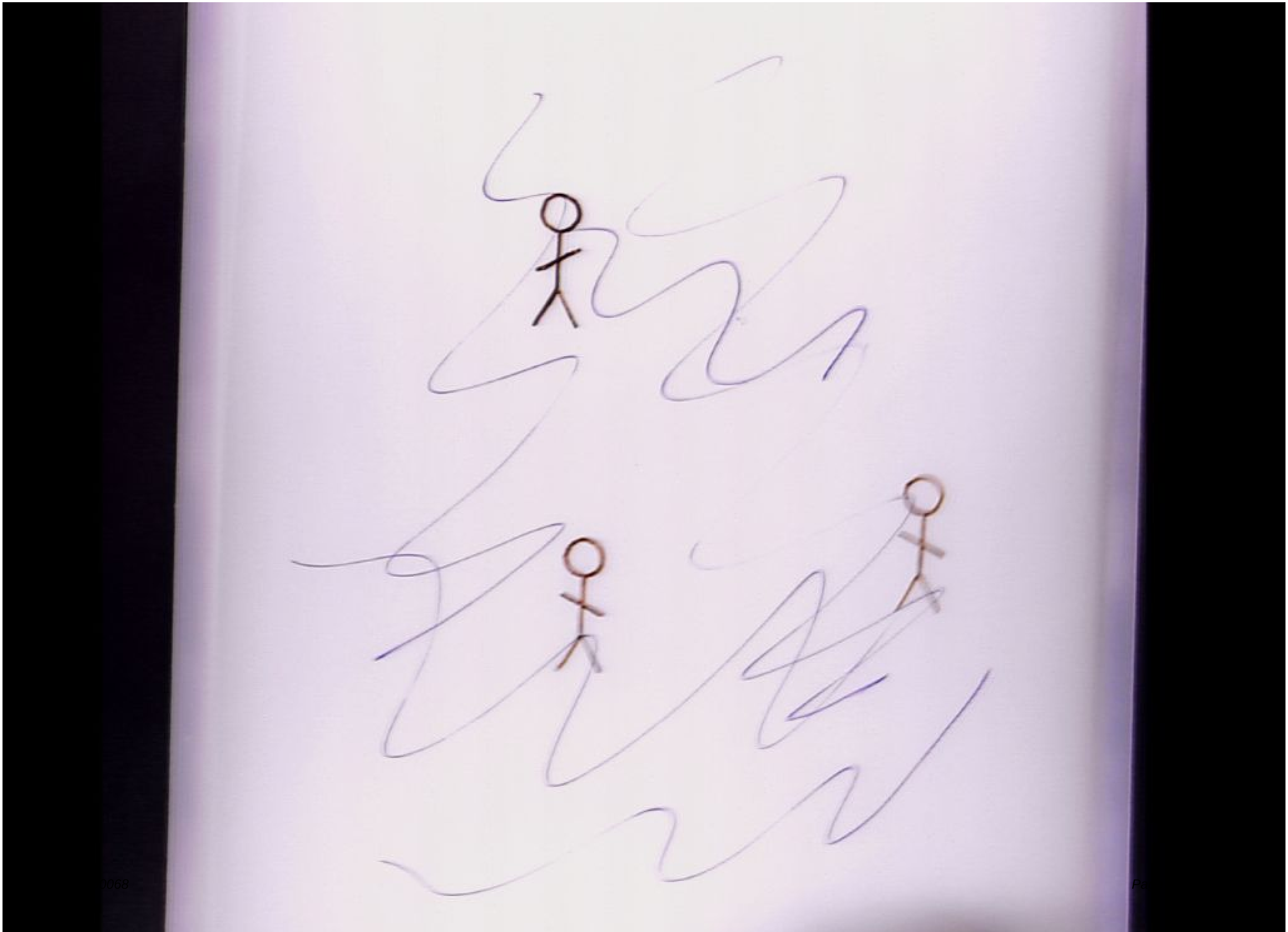

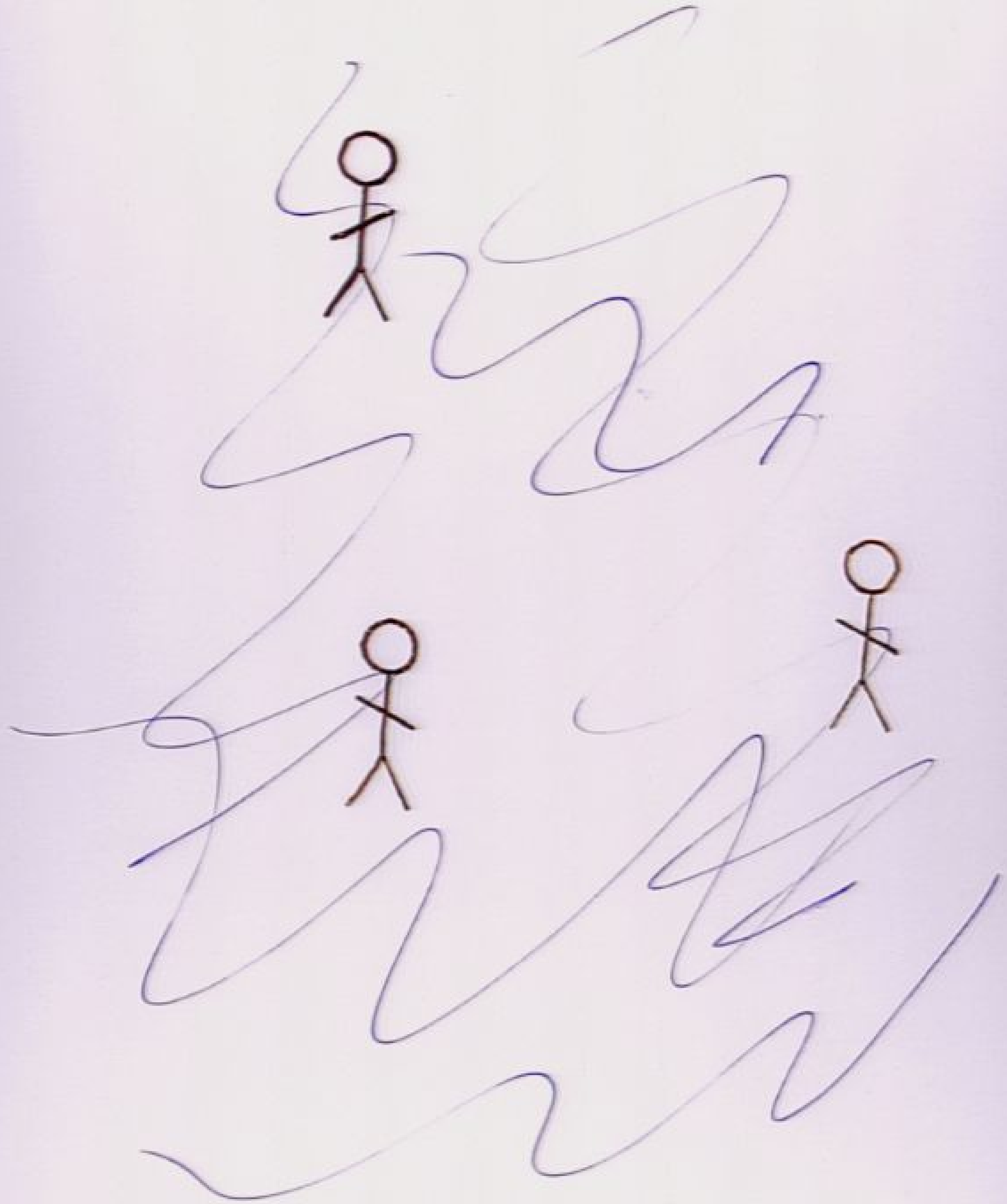

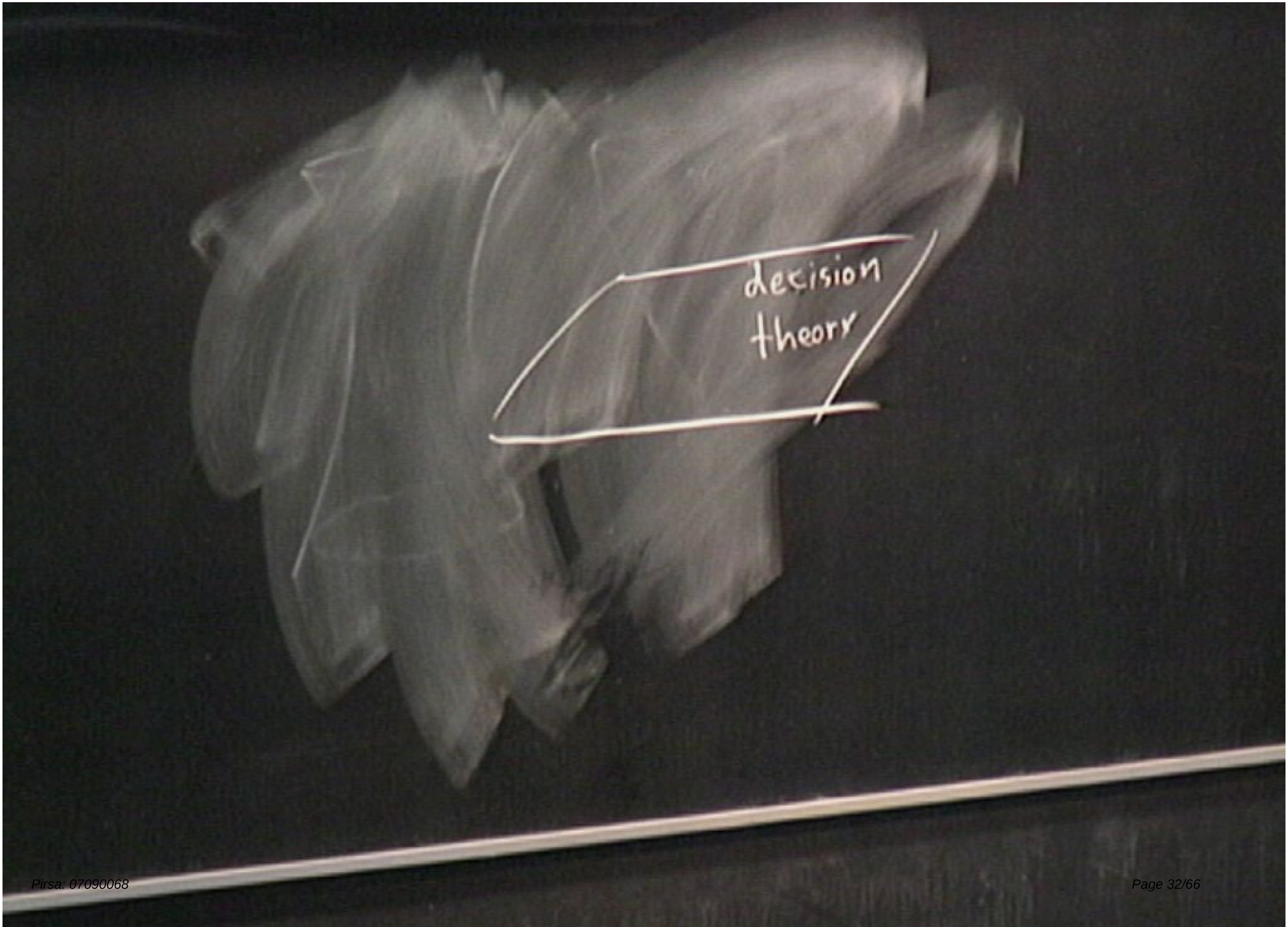
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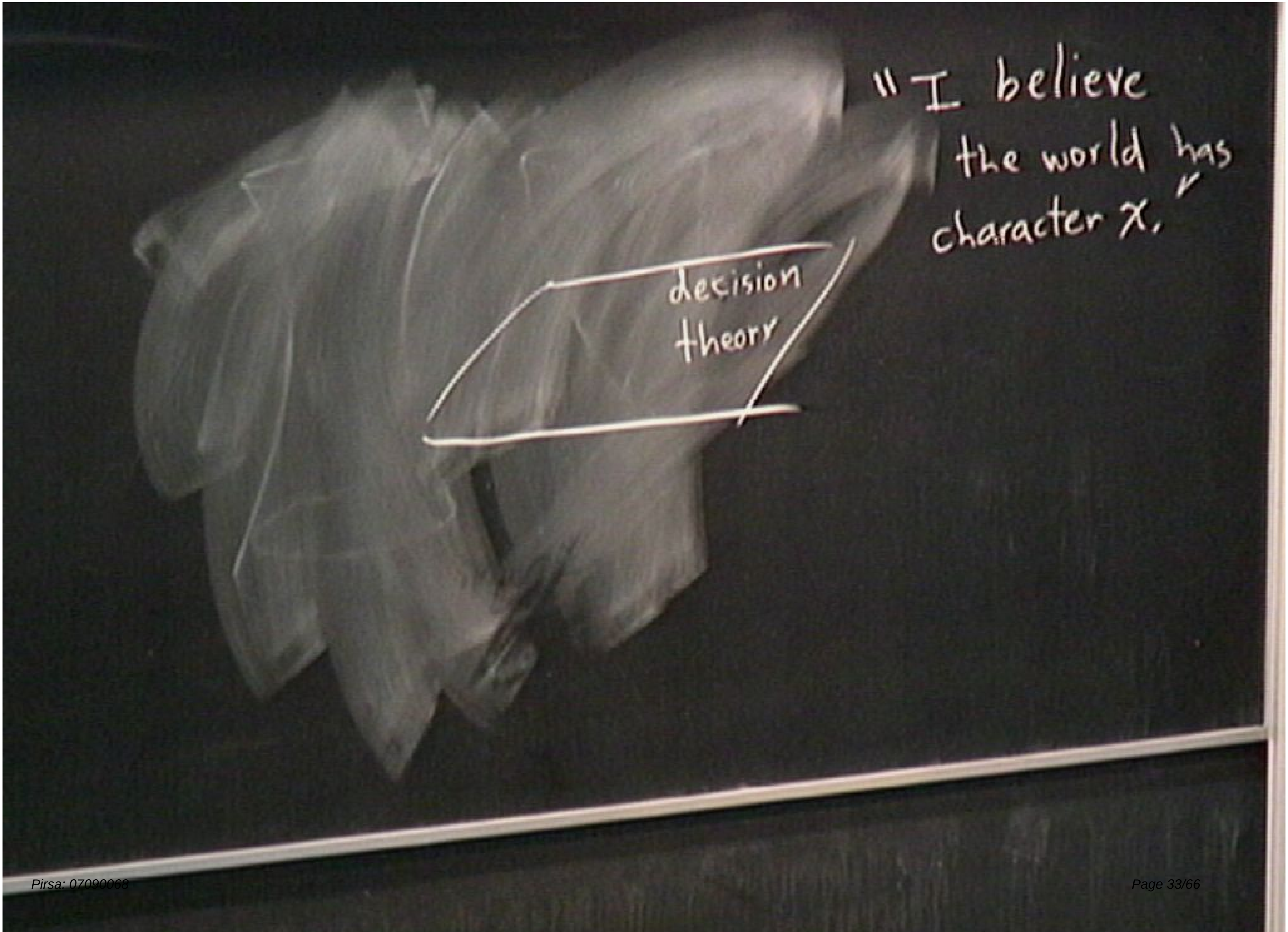
"I believe the world has character X."
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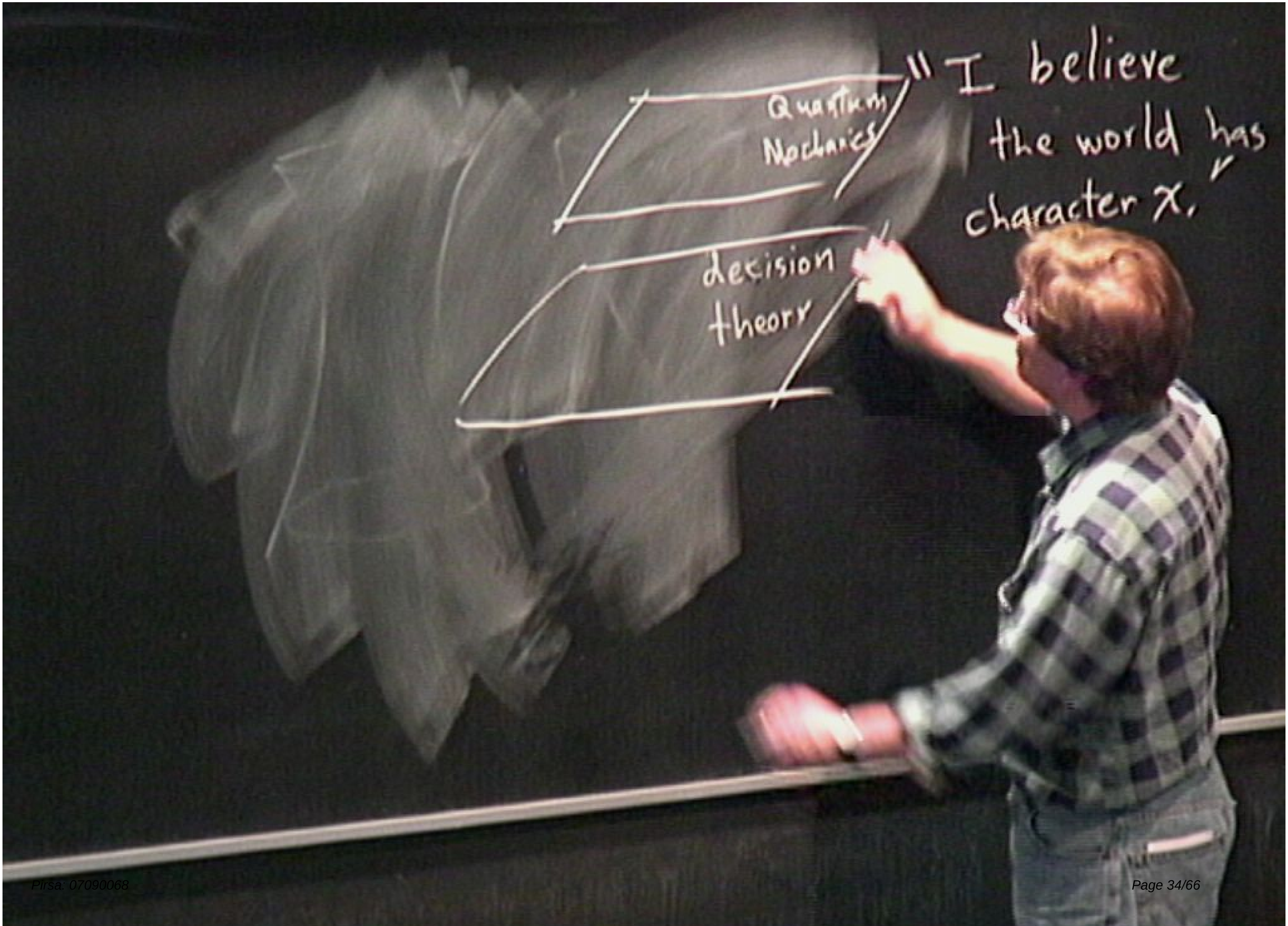
"I believe the world has character X."
Quantum Mechanics
decision theory

Gleason's Theorem

Let $\mathbb{P}(\mathcal{H}_d)$ be the set of 1-D projectors onto a (real or complex) vector space $\mathcal{H}_d$ of dimension $d \geq 3$.

Suppose there exists a function $f: \mathbb{P}(\mathcal{H}_d) \to [0,1]$ such that

$$\sum_i f(\Pi_i) = 1$$

whenever $\{\Pi_i\}$ forms a complete orthogonal set.

Theorem: Then there exists a density operator ρ, such that

$$f(\Pi) = \mathrm{tr}\, \rho \Pi .$$

Main Assumptions (my take):

1. Measurements are incompatible. No good notion of measuring $\{\Pi_i\}$ AND $\{\tilde{\Pi}_i\}$.
2. Noncontextuality of probabilit

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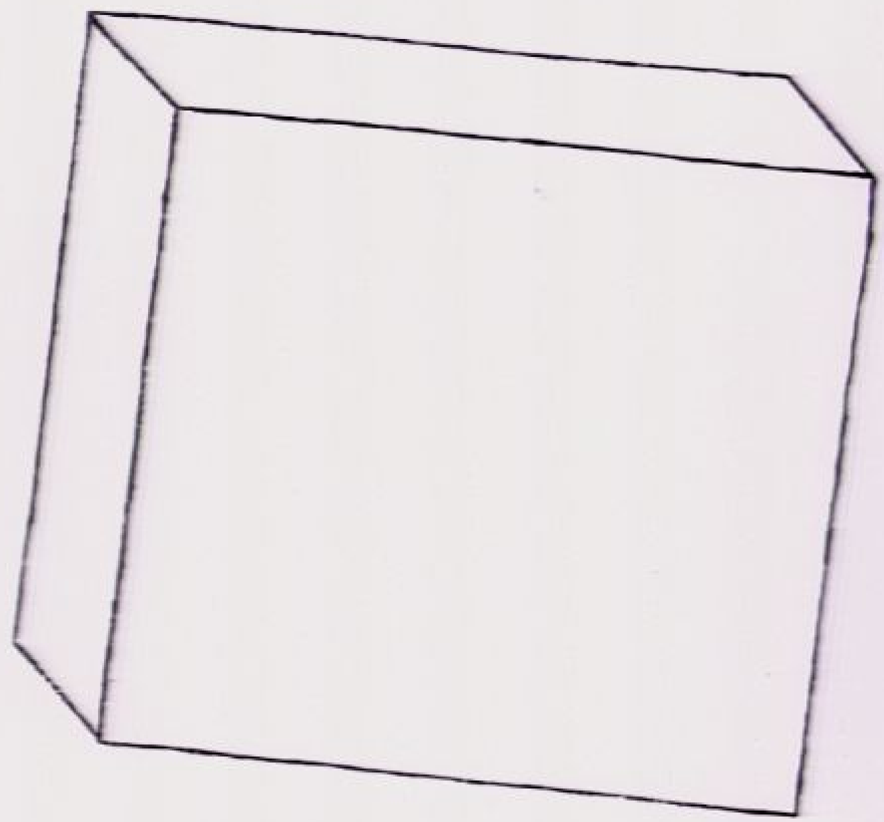

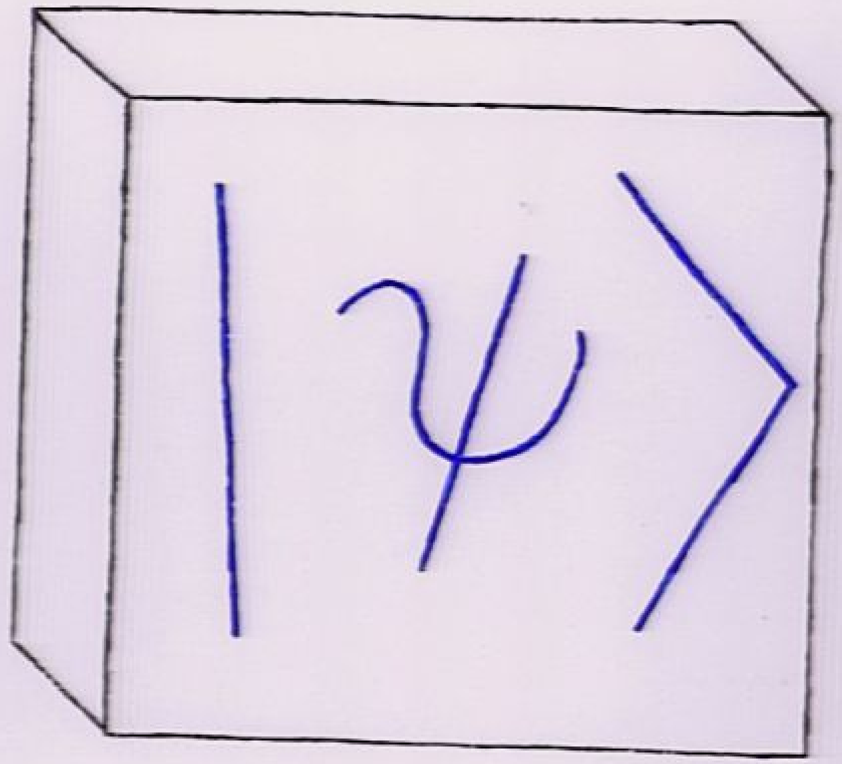
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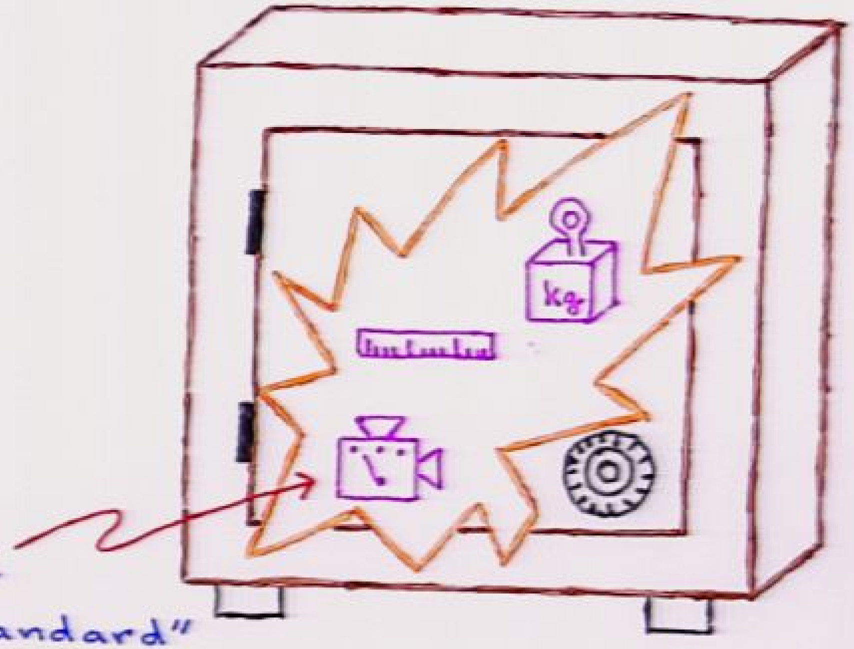

the
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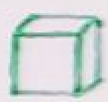

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Informational Completeness

quantum states

$\rho \in \mathcal{L}(\mathcal{H}_D)$ — D^2-dimensional vector space

Choose POVM $\{E_h\}$, $h = 1, \ldots, D^2$, with E_h all linearly independent. (Can be done.)

D^2 numbers $p(h) = \mathrm{tr}\,\rho E_h$ determine ρ.

↑ projection of ρ onto E_h

Any such $\{E_h\}$ can be the standard quantum measurement.

Informational Completeness

quantum states

$\rho \in \mathcal{L}(\mathcal{H}_D)$ — D^2-dimensional vector space

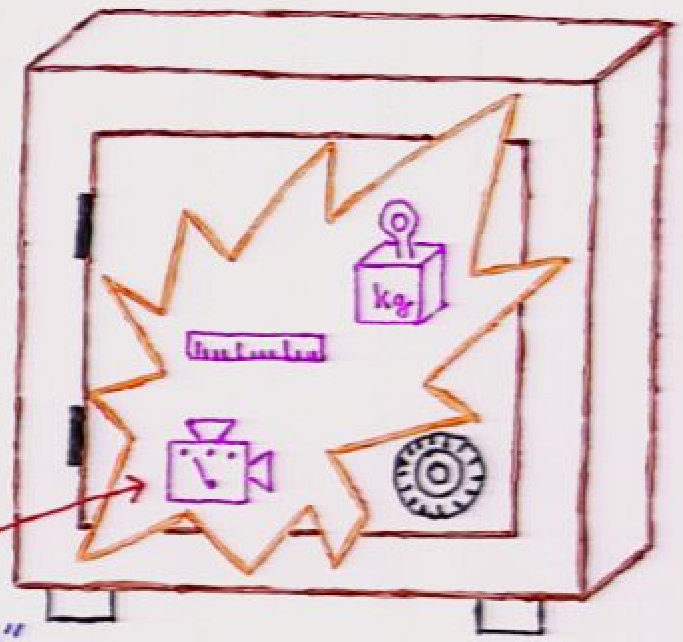
Choose POVM $\{E_h\}$, $h = 1, \ldots, D^2$, with E_h all linearly independent.
(Can be done.)

D^2 numbers $p(h) = \mathrm{tr}\,\rho E_h$ determine ρ.

(projection of ρ onto E_h)

Any such $\{E_h\}$ can be the standard quantum measurement.

Bureau of Standards



the "standard" quantum measurement

A Very Fundamental Mmt ?

Caves, 1999

Suppose d^2 projectors $\Pi_i = |\psi_i\rangle\langle\psi_i|$ satisfying

$$\mathrm{tr}\,\Pi_i \Pi_j = \frac{1}{d+1} \quad , \quad i \neq j$$

exist.

Can prove:

1) the Π_i linearly independent

2) $\sum_i \frac{1}{d} \Pi_i = I$

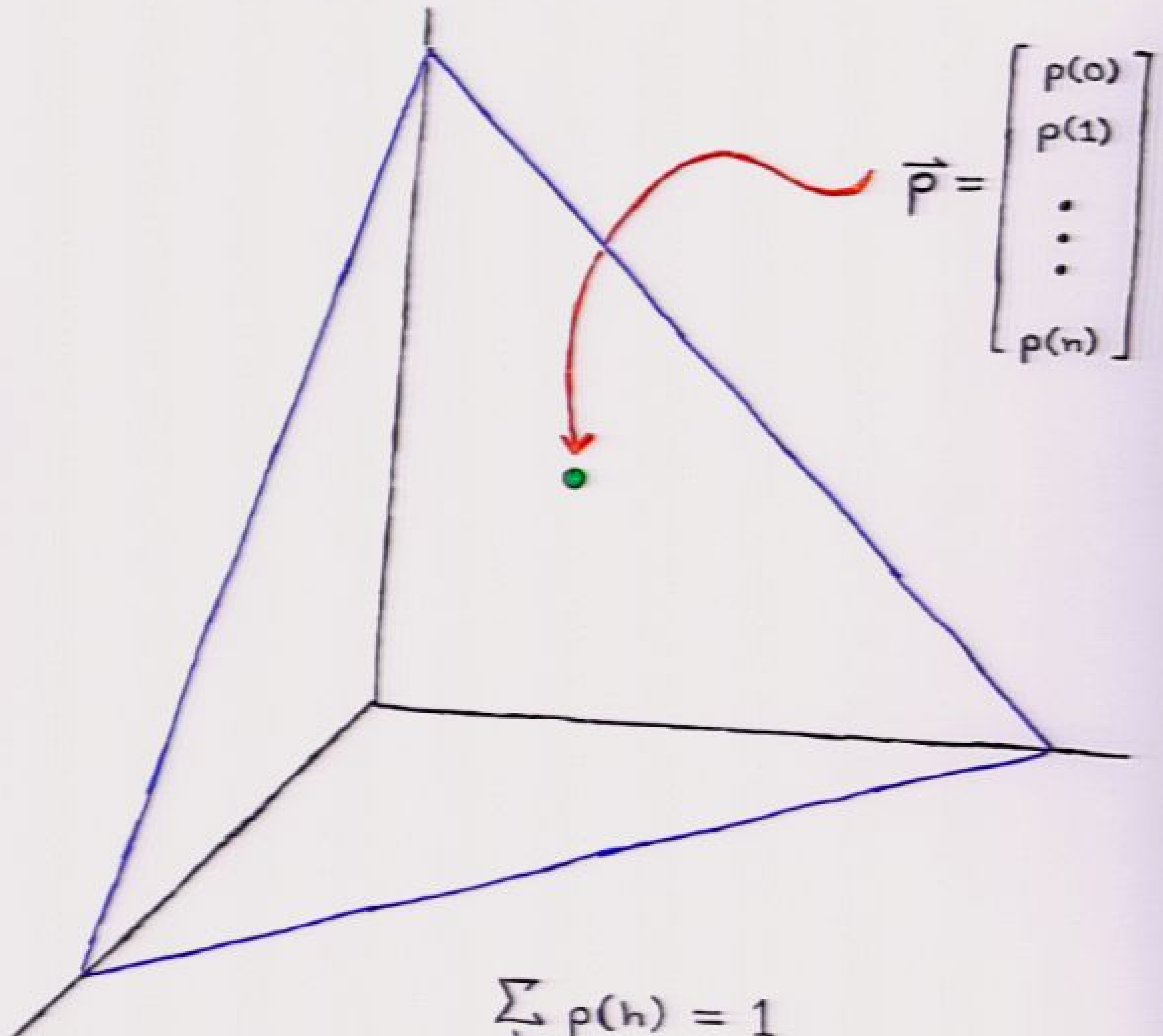
So good for Bureau of Standards.

Also

$$p(i) = \frac{1}{d}\,\mathrm{tr}\,\rho \Pi_i$$

$$\rho = \sum_i \left[(d+1)p(i) - \frac{1}{d}\right] \Pi_i$$

Probability Simplex



$$\sum_h p(h) = 1$$

$$p(h) \geq 0 \quad \forall h$$

Role of the Born Rule

quantum state ρ

measurement $\{E_h\}$

$$q(h) = \mathrm{tr}\, \rho E_h$$

To transform or relate probabilities!

$$q(h) = \sum_i \left[(d+1)\, p(i) - \frac{1}{d} \right] \mathrm{tr}\, \Pi_i E_h$$

Taking Quantum Mechanics Seriously

(Quantum Bayesian Version)

- The decision theory should be a normative ideal for all physical agents, universally.
- Without any special mention of a speculative ontology behind the agent's experiences (at least before the first necessary moment).
- And without any additional ad hoc structures introduced for the fuzzy feeling of an *ontologized* dynamics (i.e., that which is usually called "unitarity").

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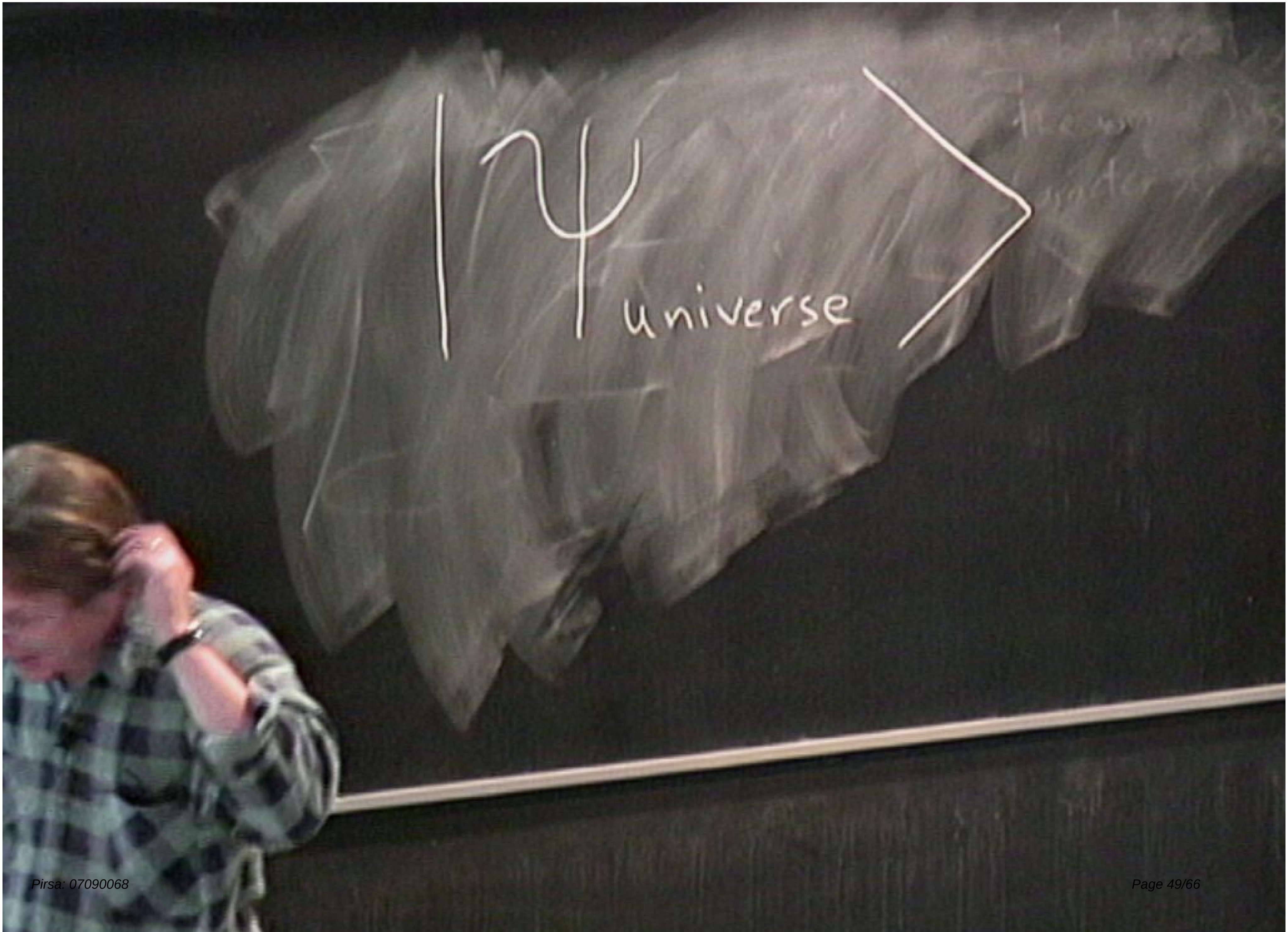
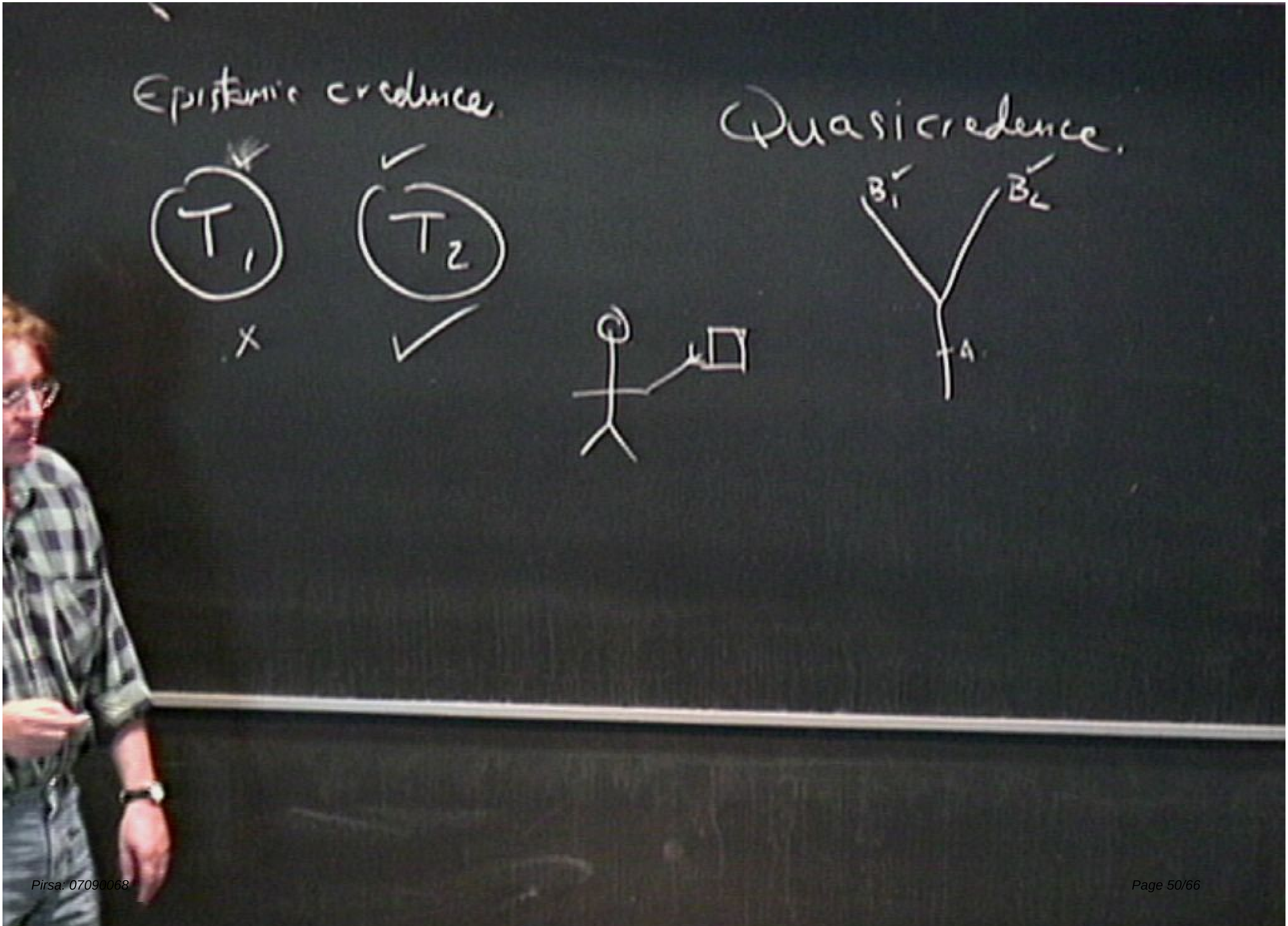
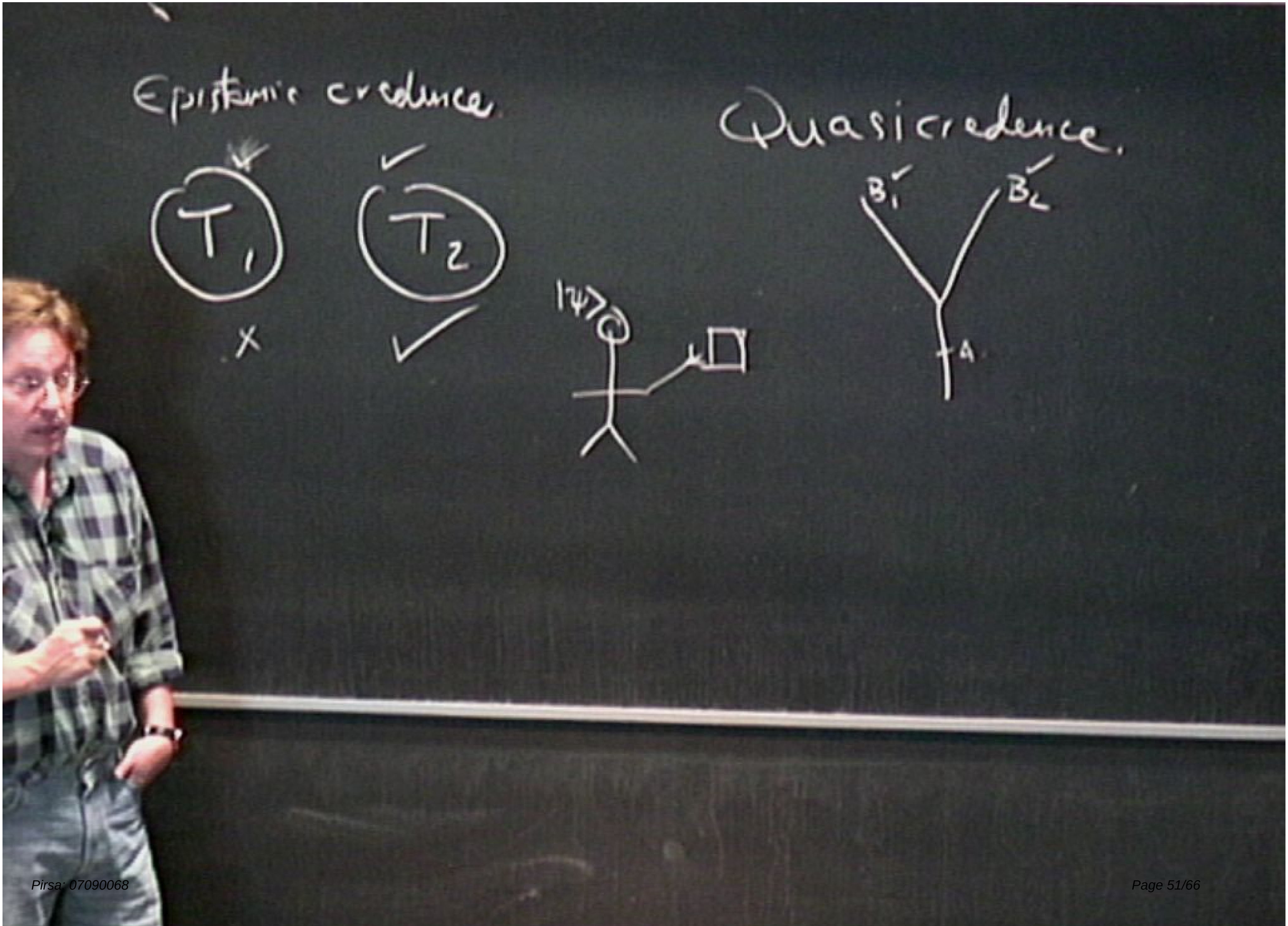
D. Deutsch, in *The Ghost in the Atom*, edited by P.C.W. Davies and J. R. Brown, (Cambridge U. Press, 1986).

[T]he best physical reason for adopting the Everett interpretation lies in quantum cosmology. There one tries to apply quantum theory to the universe as a whole, considering the universe as a dynamical object starting with a big bang, evolving to form galaxies and so on. Then when one tries, for example by looking in a textbook, to ask what the symbols in the quantum theory mean, how does one use the wave function of the universe and the other mathematical objects that quantum theory employs to describe reality? One reads there, 'The meaning of these mathematical objects is as follows: first consider an observer outside the quantum system under consideration ....' And immediately one has to stop short. Postulating an outside observer is all very well when we're talking about a laboratory: we can imagine an observer sitting outside the experimental apparatus looking at it, but when the experimental apparatus – the object being described by quantum theory – is the entire universe, it's logically inconsistent to imagine an observer sitting outside it. Therefore the standard interpretation fails. It fails completely to describe quantum cosmology. Even if we knew how to write down the theory of quantum cosmology, which is quite hard incidentally, we literally wouldn't know what the symbols meant under any interpretation other than the Everett interpretation.


$|\Psi_{universe}\rangle$


Epistemic credence
Quasicredence
T1
T2
B1
B2
A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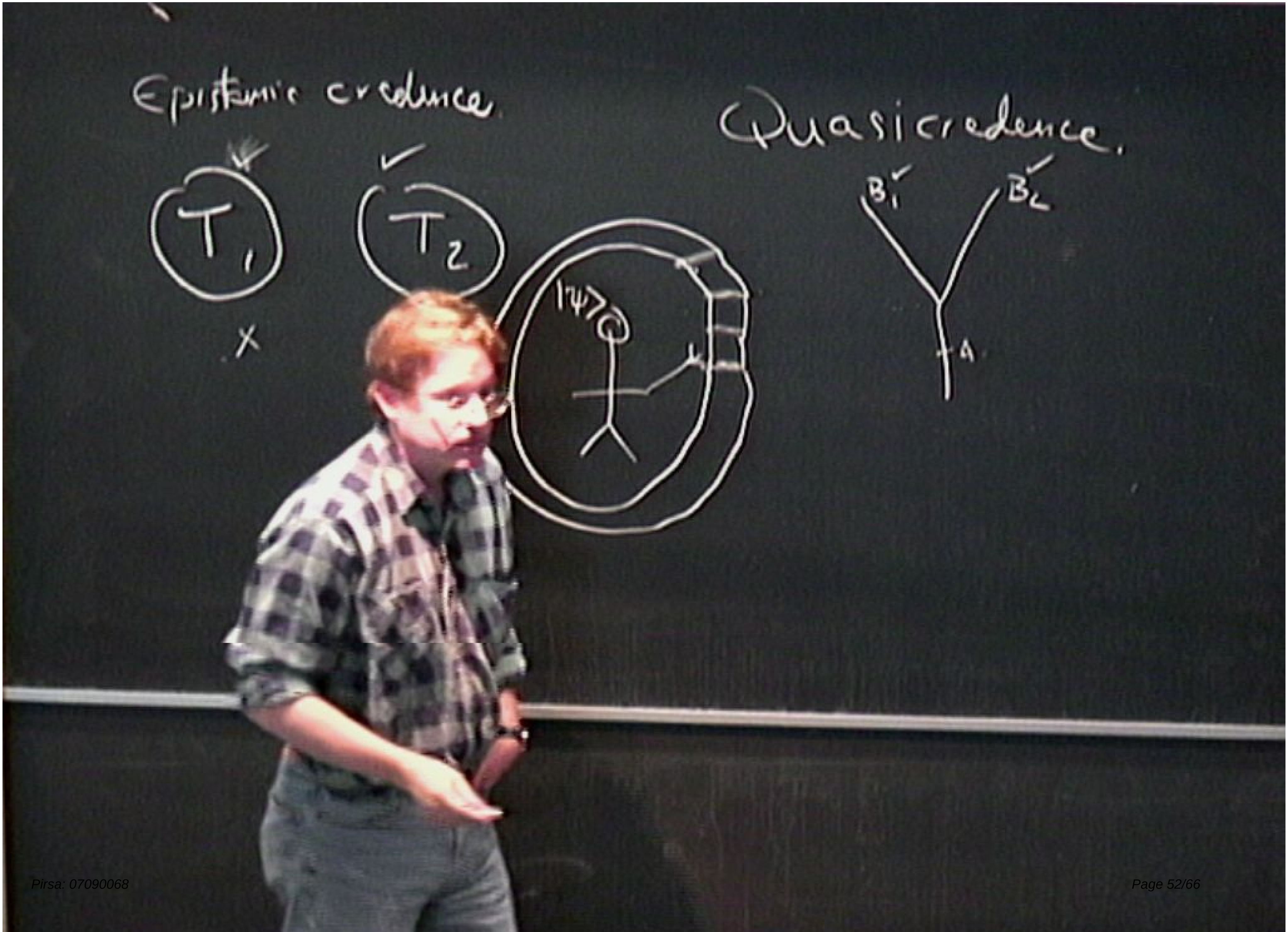
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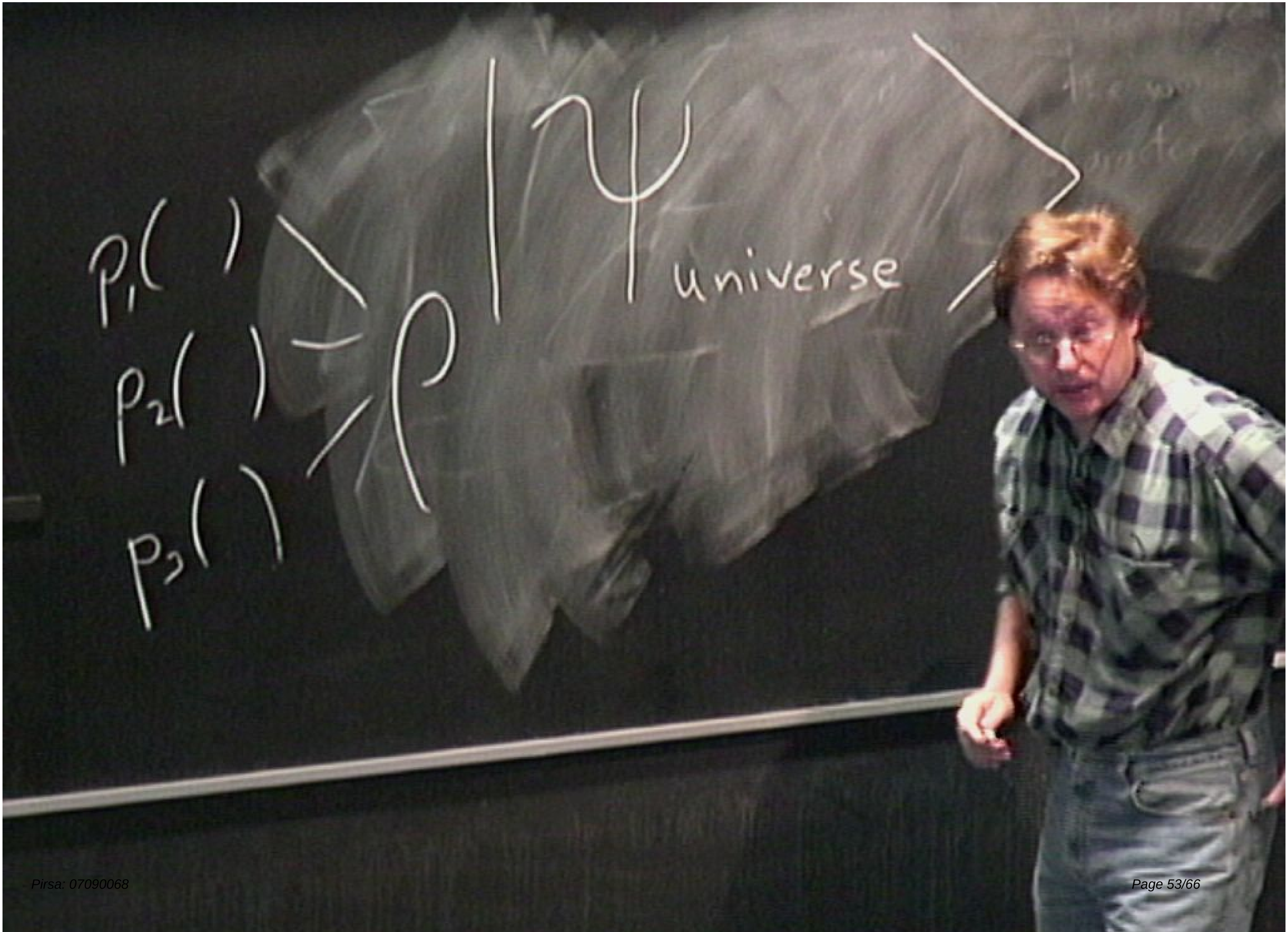
universe

H have been touched on in the Introduction and treated for static phenomena in Chapters 4 and 5. More will be said later in this chapter and in Chapter 7.

The units employed in writing the Maxwell equations (6.28) are those of the previous chapters, namely, Gaussian. For the reader more at home in other units, such as MKSA, Table 2 of the Appendix summarizes essential equations in the commoner systems. Table 3 of the Appendix allows the conversion of any equation from Gaussian to MKSA units, while Table 4 gives the corresponding conversions for given amounts of any variable.

6.4 Vector and Scalar Potentials

The Maxwell equations consist of a set of coupled first-order partial differential equations relating the various components of electric and magnetic fields. They can be solved as they stand in simple situations. But it is often convenient to introduce potentials, obtaining a smaller number of second-order equations, while satisfying some of the Maxwell equations identically. We are already familiar with this concept in electrostatics and magnetostatics, where we used the scalar potential Φ and the vector potential $\mathbf{A}$.

Since $\nabla \cdot \mathbf{B}=0$ still holds, we can define $\mathbf{B}$ in terms of a vector potential:

$$\mathbf{B}=\nabla\times\mathbf{A} \tag{6.29}$$

Then the other homogeneous equation in (6.28), Faraday's law, can be written

$$\nabla\times\left(\mathbf{E}+\frac{1}{c}\frac{\partial\mathbf{A}}{\partial t}\right)=0 \tag{6.30}$$

This means that the quantity with vanishing curl in (6.30) can be written as the gradient of some scalar function, namely, a scalar potential Φ:

$$\left.\begin{aligned}\mathbf{E}+\frac{1}{c}\frac{\partial\mathbf{A}}{\partial t}&=-\nabla\Phi\\ \text{or}\qquad \mathbf{E}&=-\nabla\Phi-\frac{1}{c}\frac{\partial\mathbf{A}}{\partial t}\end{aligned}\right\} \tag{6.31}$$

The definition of **B** and **E** in terms of the potentials **A** and Φ according to (6.29) and (6.31) satisfies identically the two homogeneous Maxwell equations. The dynamic behavior of **A** and Φ will be determined by the two inhomogeneous equations in (6.28).

At this stage it is convenient to restrict our considerations to the vacuum form of the Maxwell equations. Then the inhomogeneous equations in (6.28) can

D. Deutsch, "The Structure of the Multiverse," quant-ph/0104033.

The idea that quantum theory is a true description of physical reality led Everett and many subsequent investigators to explain quantum-mechanical phenomena in terms of the simultaneous existence of parallel universes or histories. Similarly I and others have explained the power of quantum computation in terms of 'quantum parallelism' (many classical computations occurring in parallel).

D. Deutsch, *The Fabric of Reality*, (Penguin Books, New York, 1997).

When a quantum factorization engine is factorizing a 250-digit number, the number of interfering universes will be of the order of 10^{500}—that is, ten to the power of 500. This staggeringly large number is the reason why Shor's algorithm makes factorization tractable. I said that the algorithm requires only a few thousand arithmetic operations. I meant, of course, a few thousand operations *in each universe* that contributes to the answer. All those computations are performed in parallel, in different universes, and share their results through interference.

1. Did you know of the Everett interpretation before starting work on your factoring algorithm?

   Yes.

2. If so, was the many-worlds view or the idea of "parallel computations via parallel worlds" something that was integral to your thinking for finding the algorithm? If it was part of the main imagery that steered your mathematics, can you say in what way? If it wasn't part of your main imagery, can you say what was?

   No, the idea was really more to use periodicity, and inspired by Simon's algorithm.

3. Would you say that the developments in quantum information and computation are evidence that something is really right about the Everett view? Or do you think the developments in QI are relatively neutral toward it?

   You should have heard my after-dinner talk in Japan. Both the Evertt view and the Copenhagen view are misleading in thinking about quantum computation (although misleading in quite different ways). Computer scientists who hear about the Everett interpretation construct a mental model that a quantum computer is many worlds in parallel that can all interact, so that you should be able to do polynomial-depth exponential number of processors classical computation. This is the exponential analog of the complexity class NC, and is much, much more powerful computationally than the real class BQP.

Quantum Computing Questionnaire, Dan Simon

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   Who's Everett, and what's his interpretation? .

2. If so, was the many-worlds view or the idea of "parallel computations via parallel worlds" something that was integral to your thinking for finding the algorithm? If it was part of the main imagery that steered your mathematics, can you say in what way? If it wasn't part of your main imagery, can you say what was?

   I was approaching the problem purely from a computer scientist's perspective. I learned the absolute bare minimum of physics I needed to be able to understand the computer science question, which (as I saw it) was, "these crazy people are claiming that if you add these very-weird-yet-theoretically-physically-implementable functions to a computer, then you should be able to do amazing things with them. Prove them right or wrong." I actually started out trying to prove that quantum computing was useless, and eventually narrowed down the difficult, unsimulateable part to, "rotate, compute, rotate". That helped guide my search for a computationally interesting quantum algorithm.

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Quantum Computing Questionnaire, David Deutsch

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   I've known of the Everett interpretation since the mid 1970's and never really adopted/liked it, even from outset. It always was (and still is) a very vague and incomplete framework to me.

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A. Wilce, "Formalism and Interpretation in Quantum Theory," to appear in *Festschrift for Jeffrey Bub's 65th Birthday*.

It has become increasingly clear in recent years [2, 4, 28, 29, 38] that many of the most puzzling "quantum" phenomena—in particular, phenomena associated with entanglement, and including, as I'll show, a version of the measurement problem—are in fact quite generic features of essentially all non-classical probabilistic theories, quantum or otherwise. This suggests that many of the interpretive ideas [*including many-worlds interpretations*] that have been advanced in connection with quantum mechanics can be carried over to a much more general setting. This exercise has something to offer to both foundational projects. On the one hand, an interpretation of quantum mechanics that can't be made sense of absent certain special structural features of quantum mechanics, is potentially a source of fruitful ideas with which to approach the problem of the formalism. On the other hand, if an interpretation can be kept aloft even in the thin atmosphere of a completely general non-classical probabilistic theory, then perhaps it has little to tell us about the physical content of quantum theory. To compress this idea into a slogan: a completely satisfactory interpretation of a physical theory should be capable of yielding (or at least, constraining!) its own formalism.