Title: Special Topics in Physics - Lecture 8A

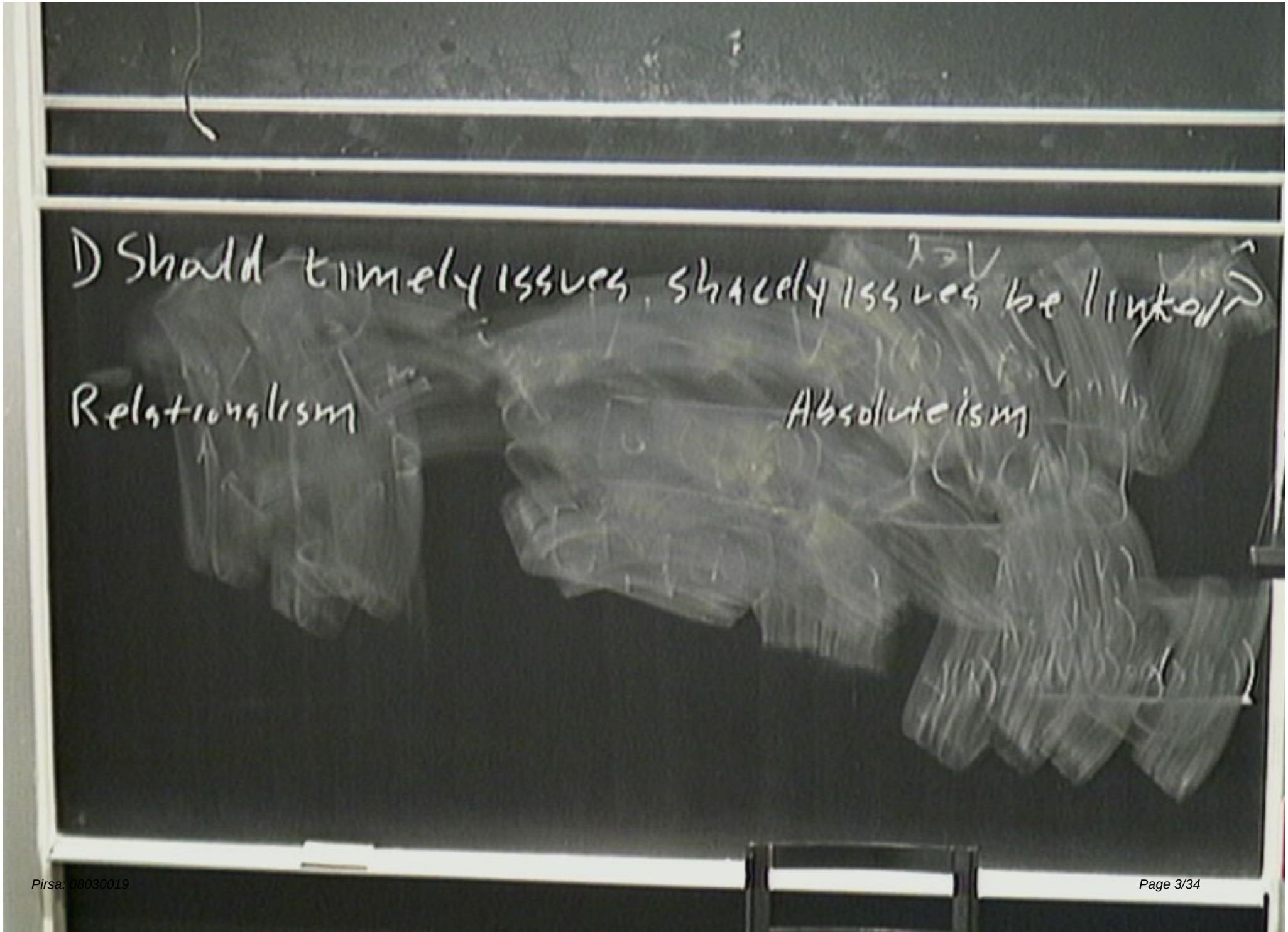
Date: Mar 05, 2008 07:00 PM

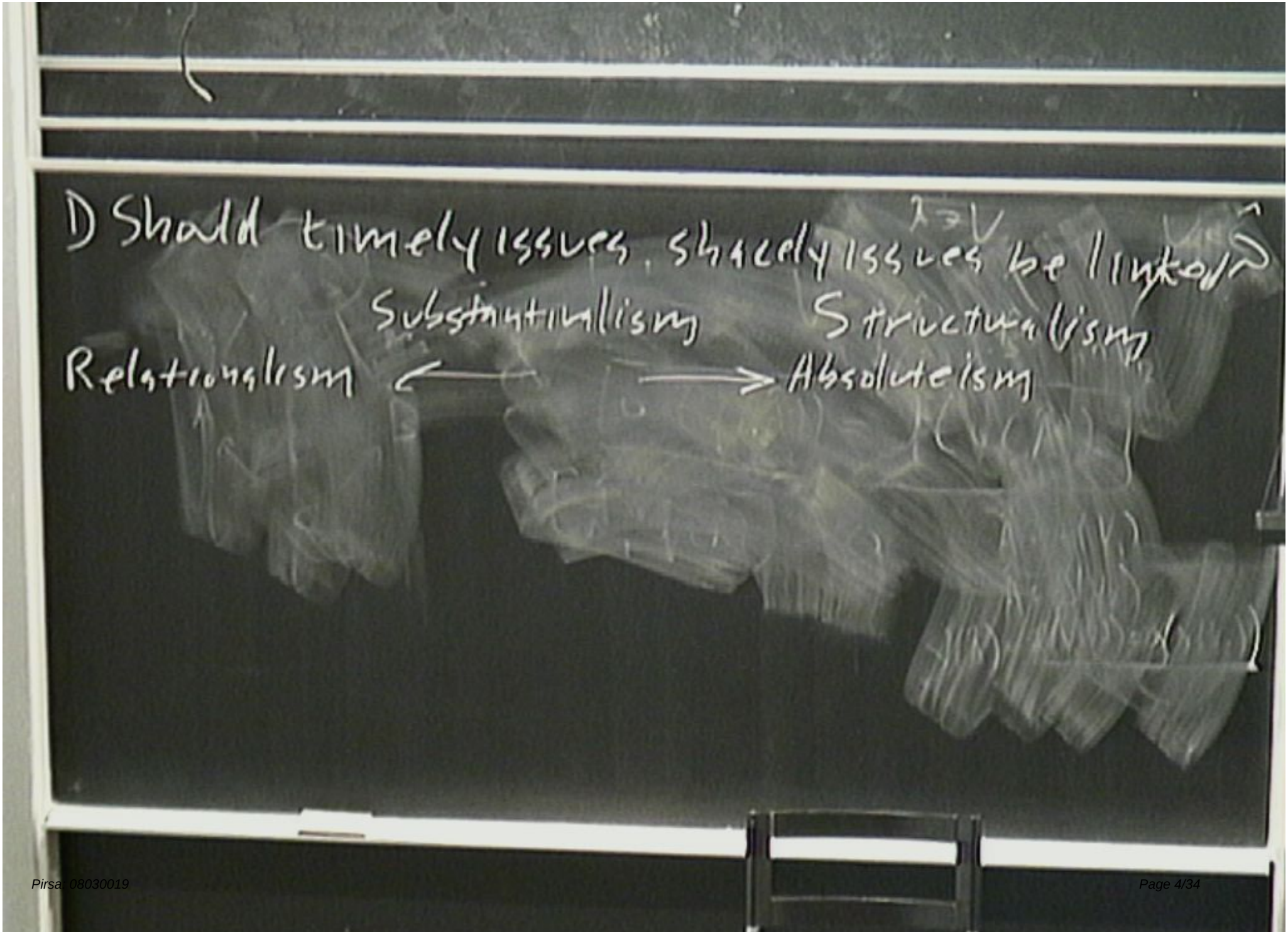
URL: http://pirsa.org/08030019

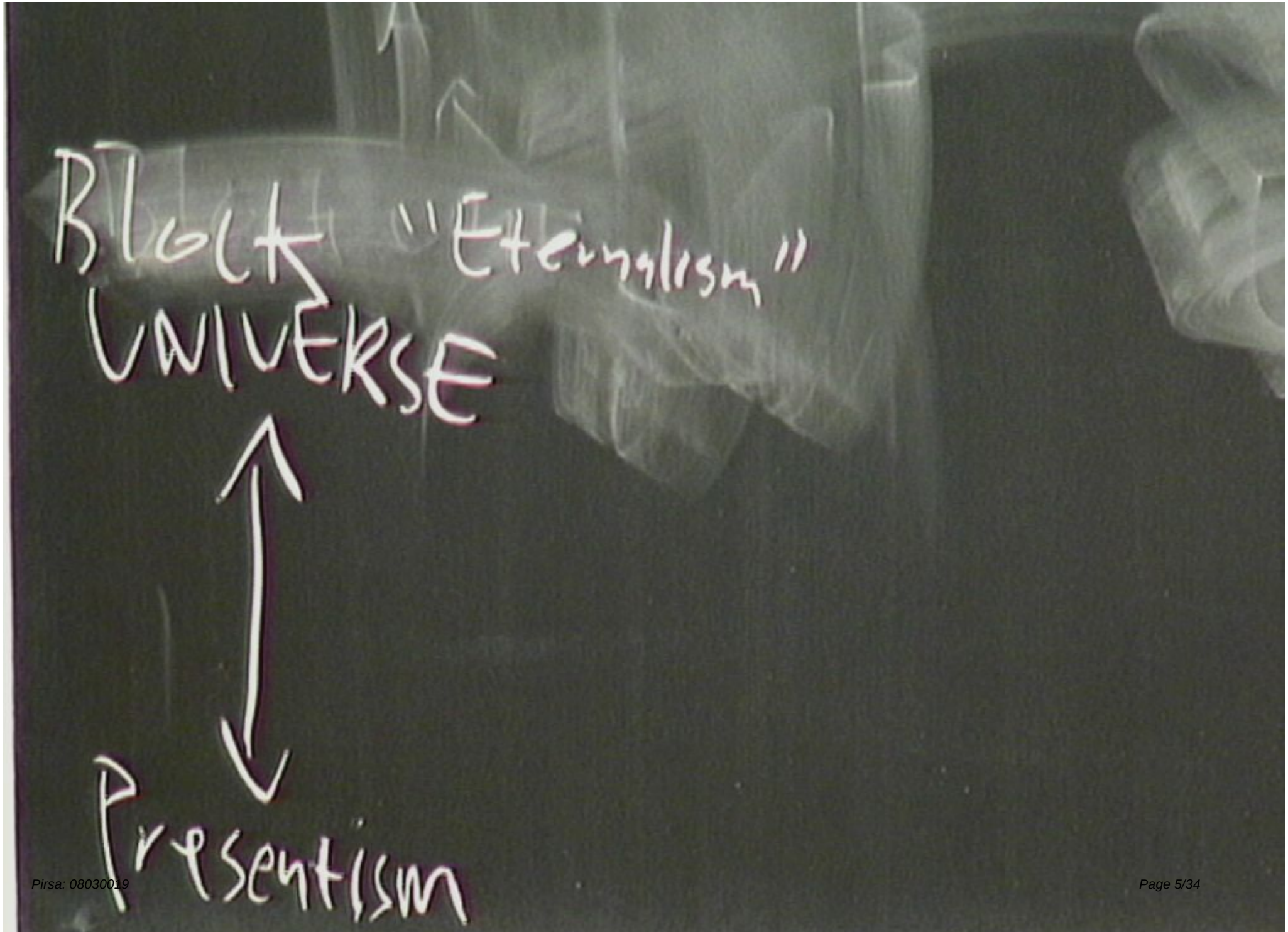
Abstract: The Problem of Time in Quantum Gravity and Cosmology

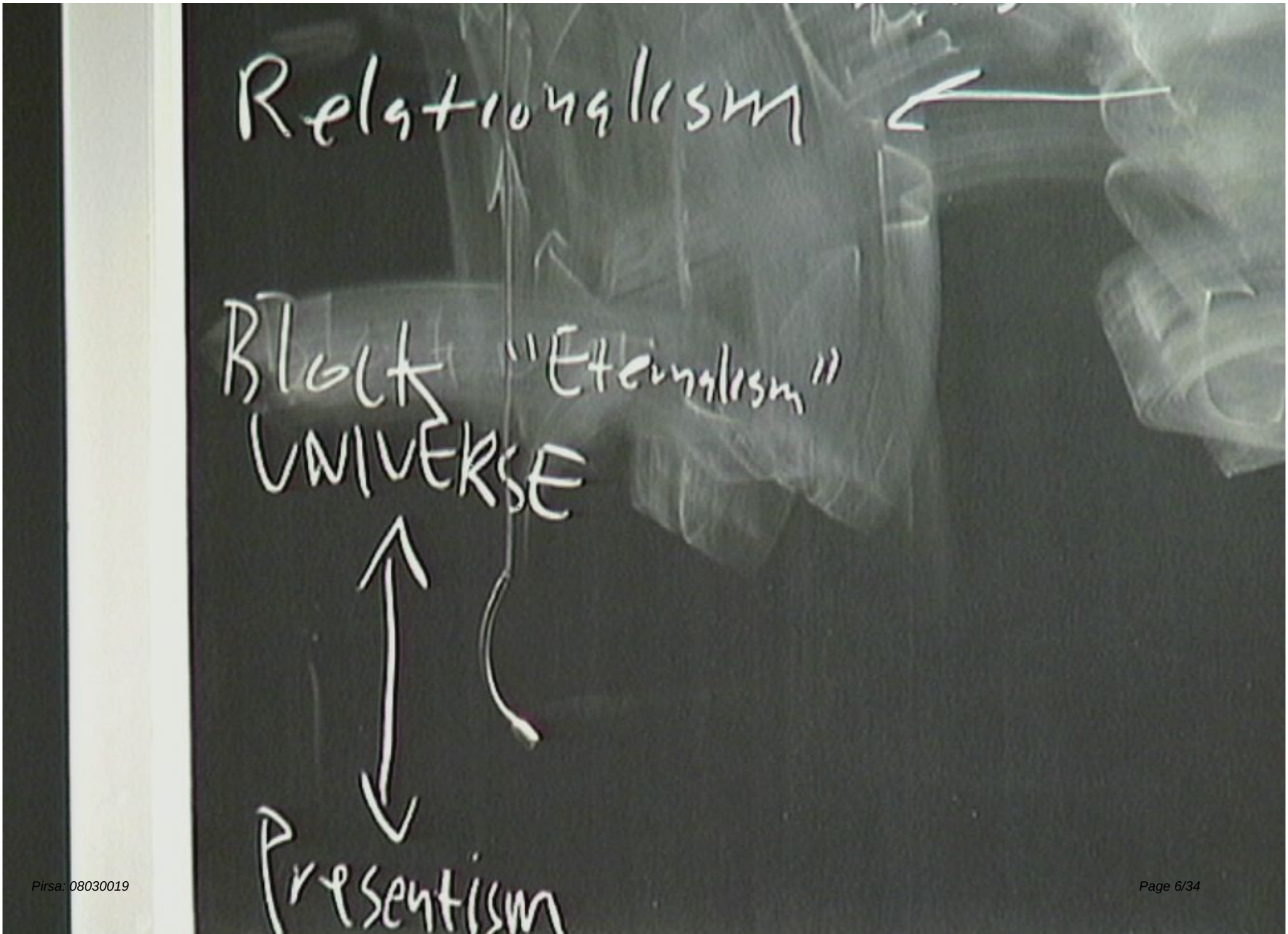
QG class March 5 2008

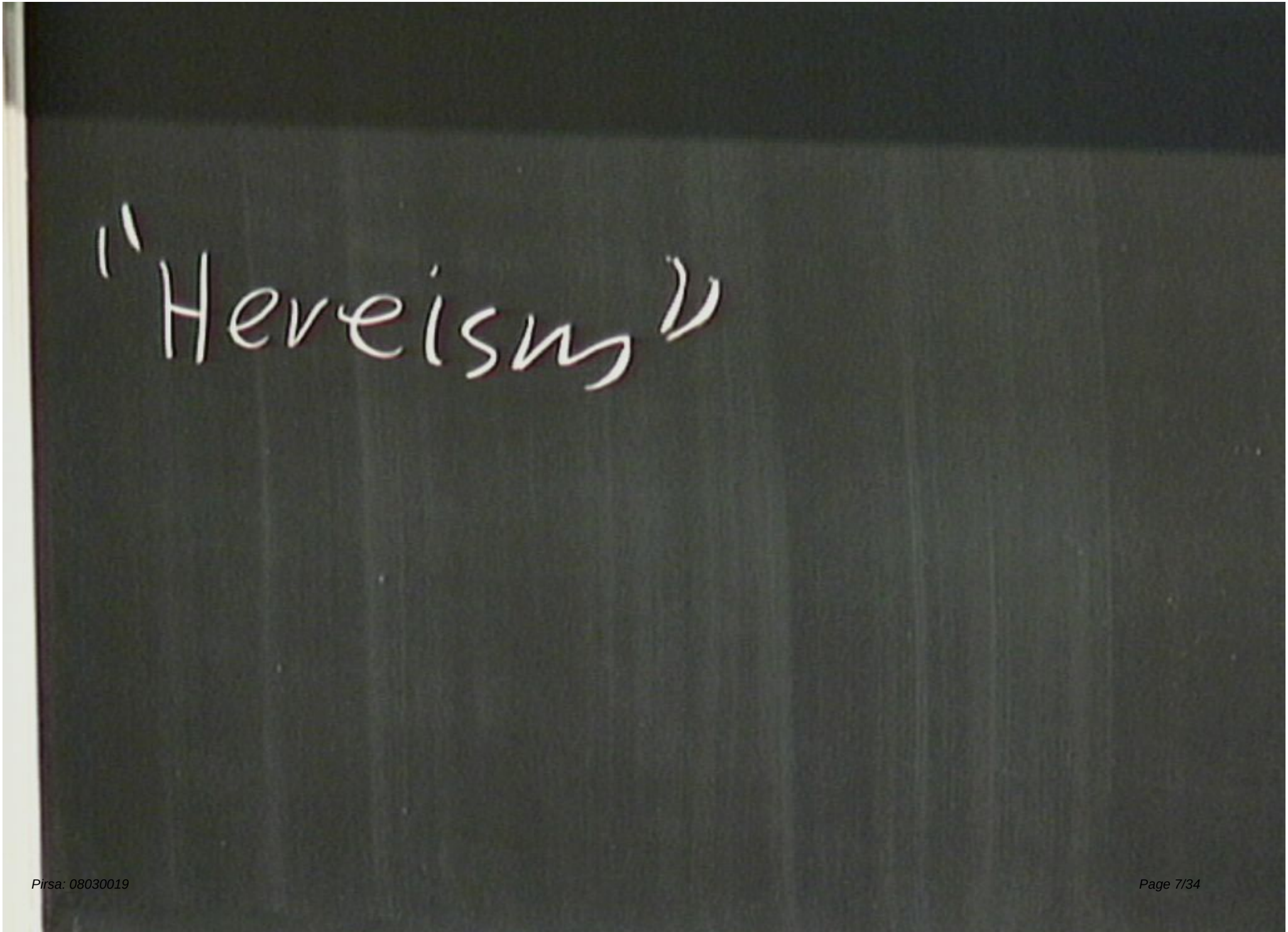
Relationalism: basic definitions

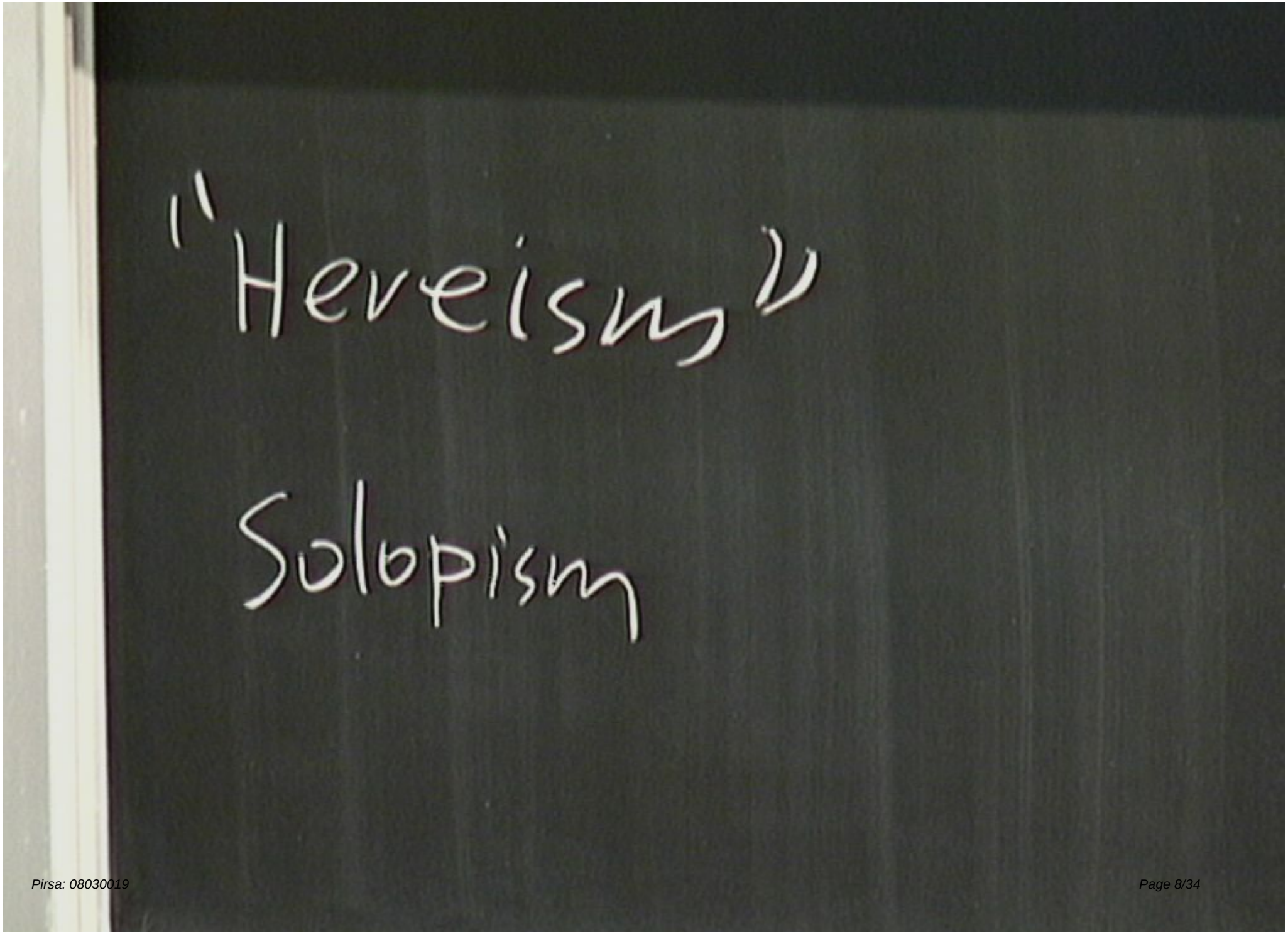

D Should timely issues, shacely issues be limited?
Relationalism
Absoluteism

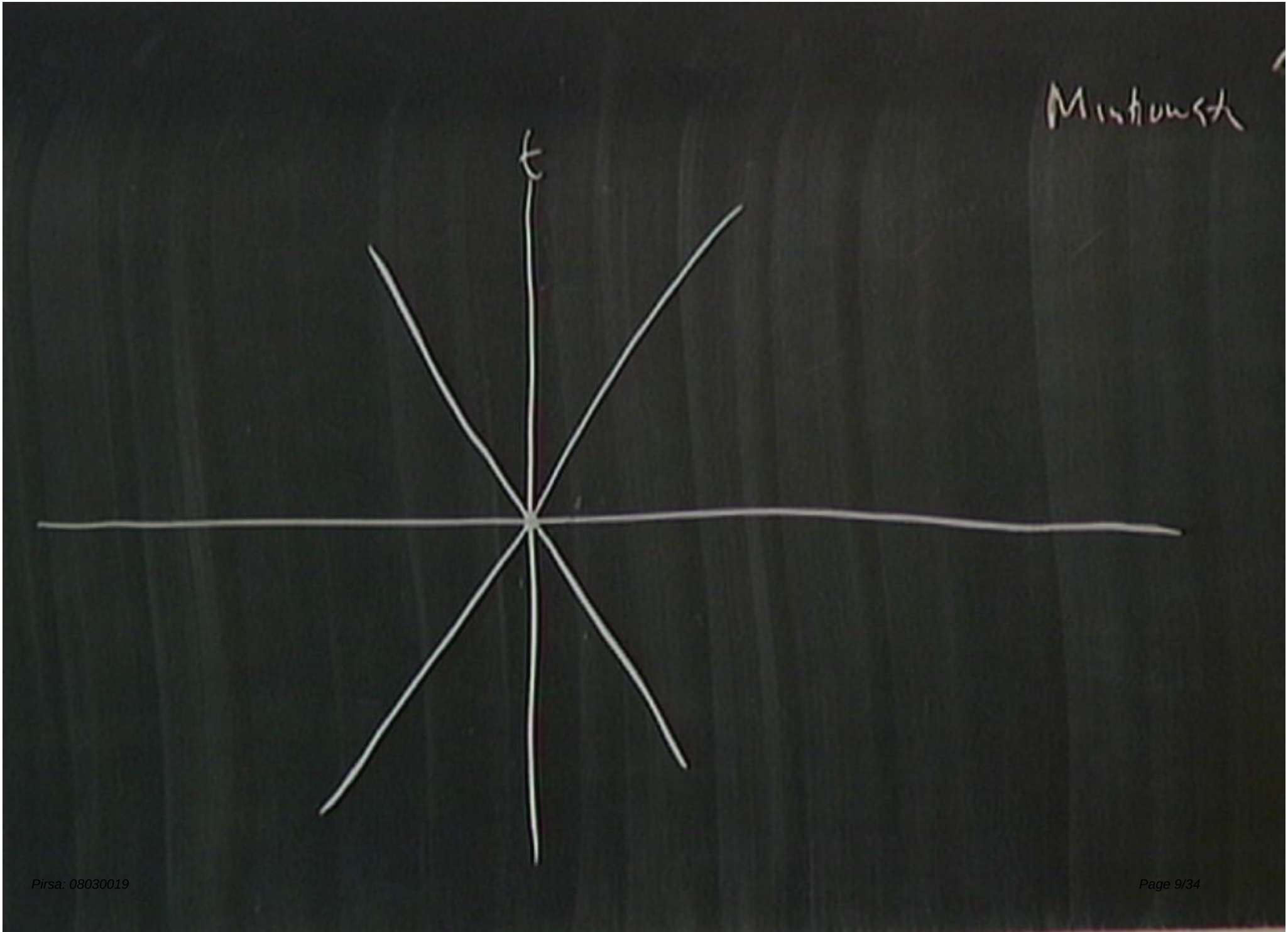

D Should timely issues, shacaly issues be linked?
Substantivalism
Structuralism
Relationalism
Absoluteism

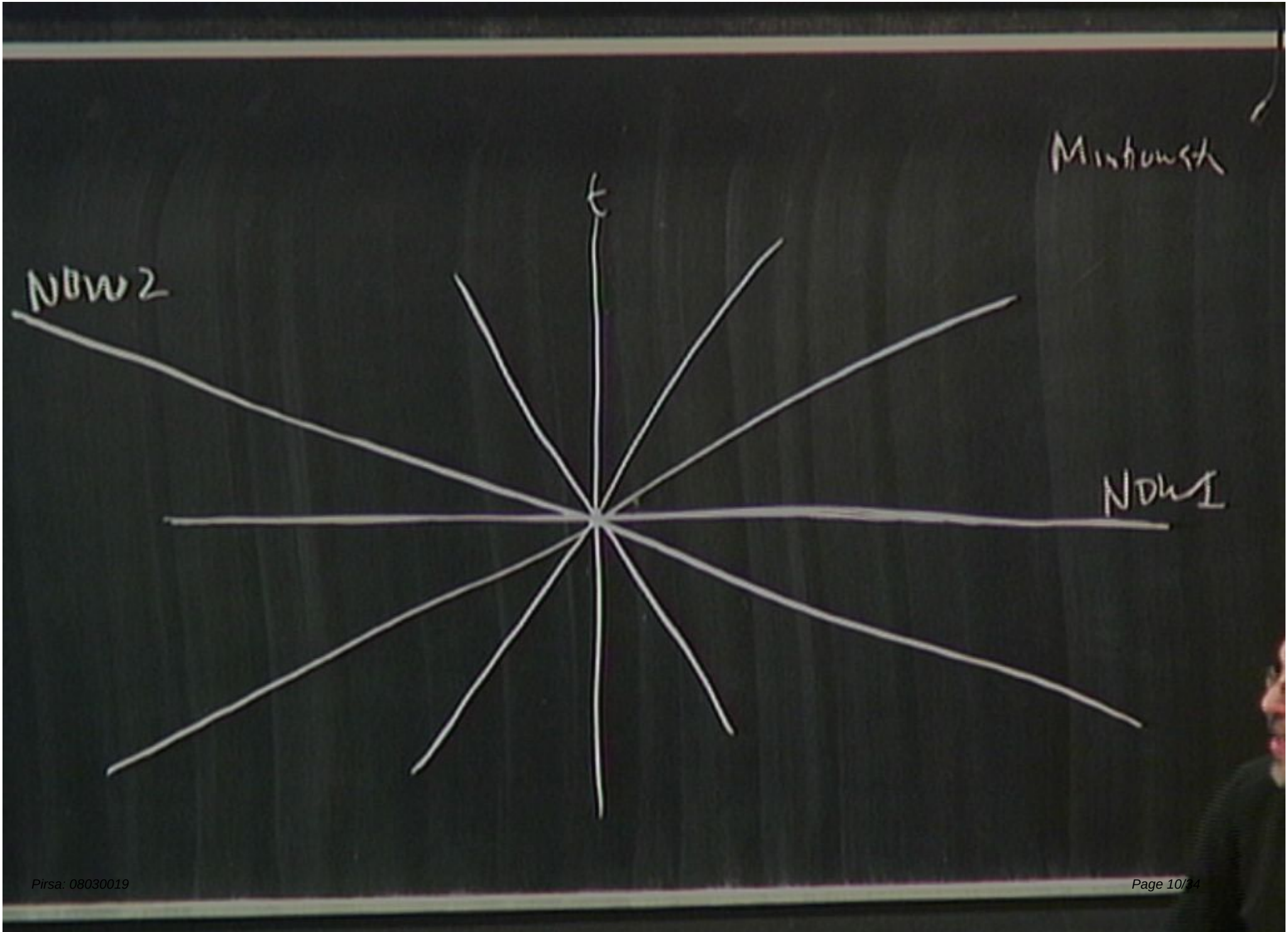

Block "Eternalism"
UNIVERSE
Presentism

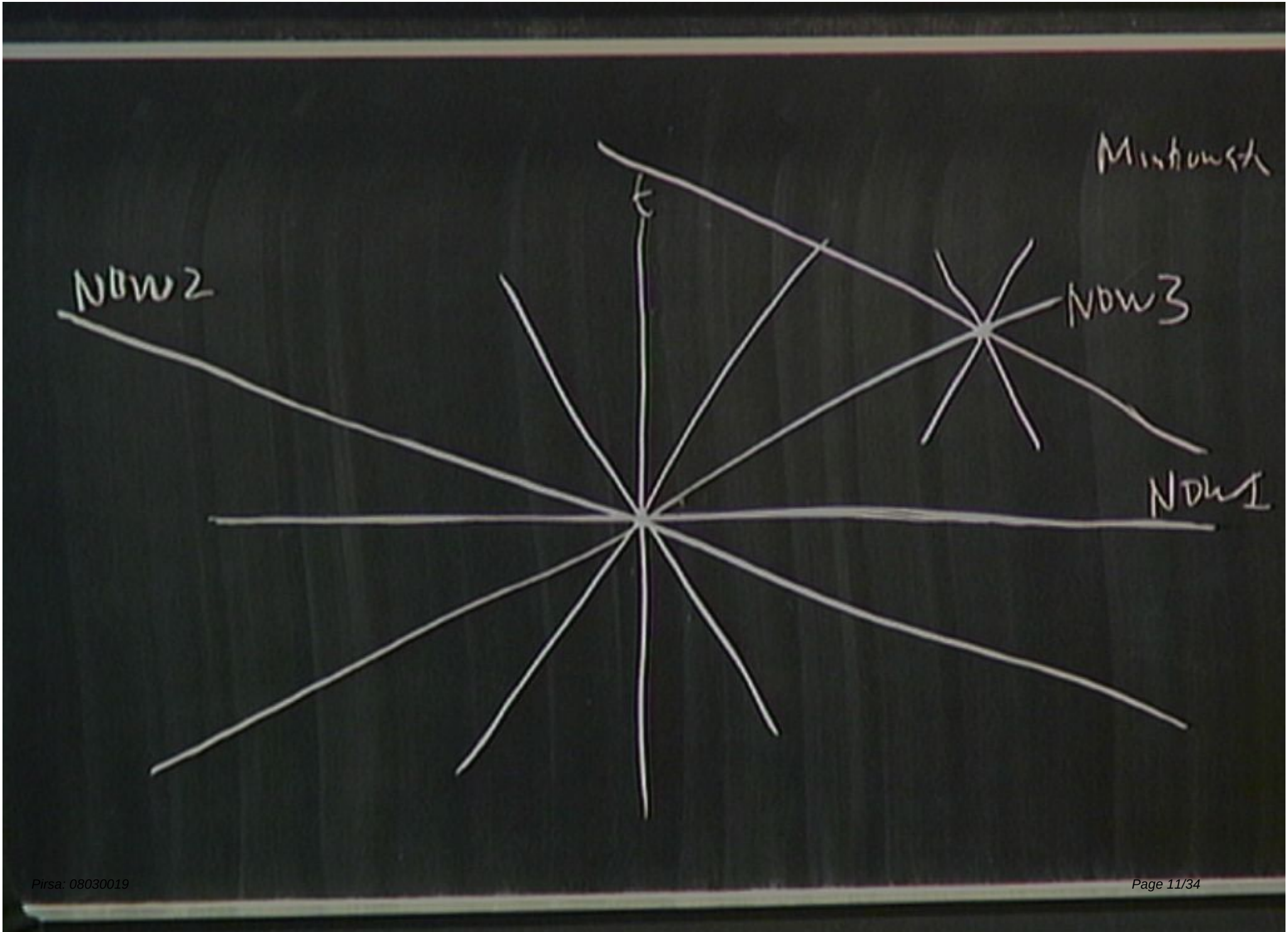

Relationalism
Block "Eternalism"
UNIVERSE
Presentism

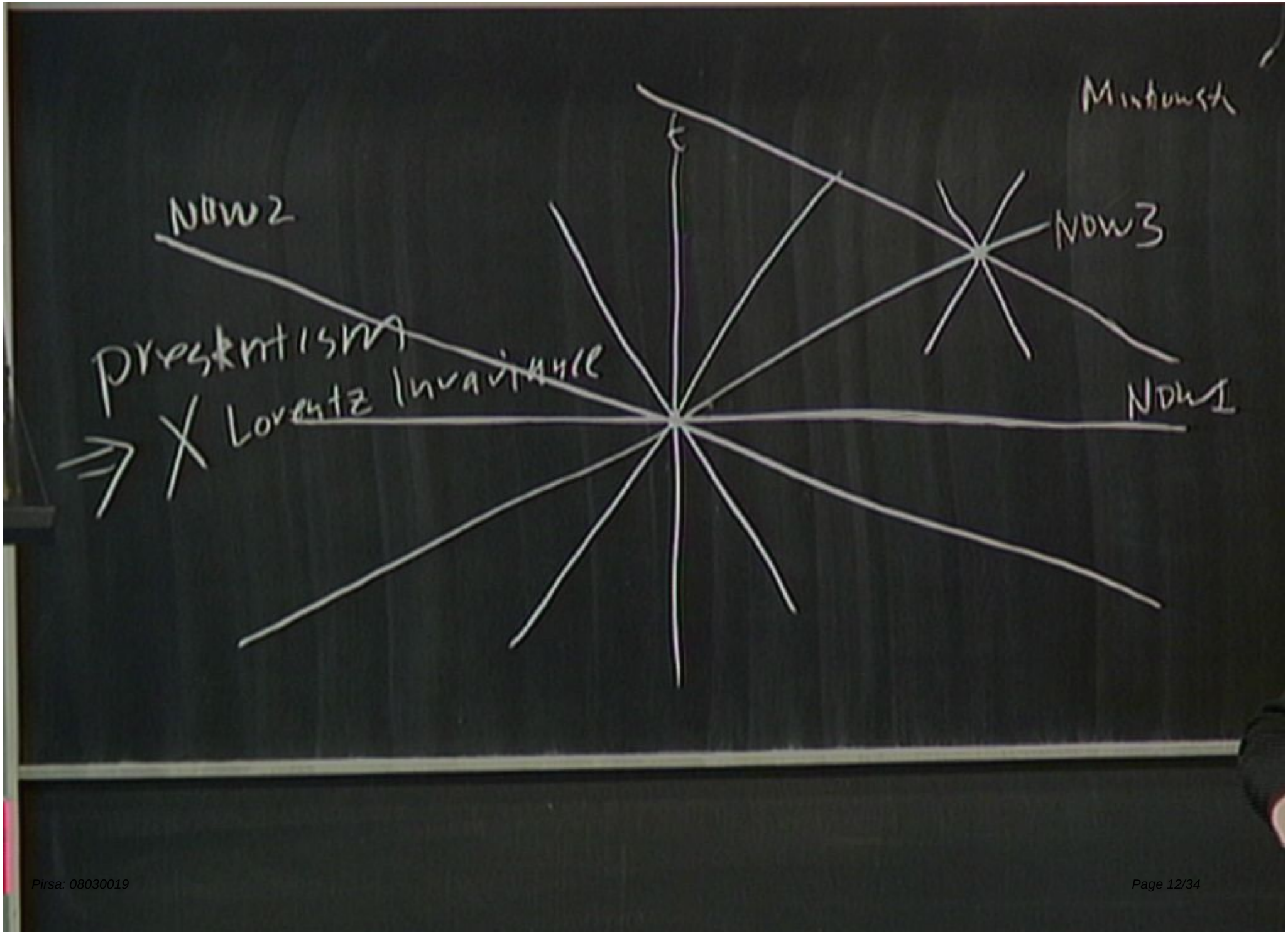

"Hereism"

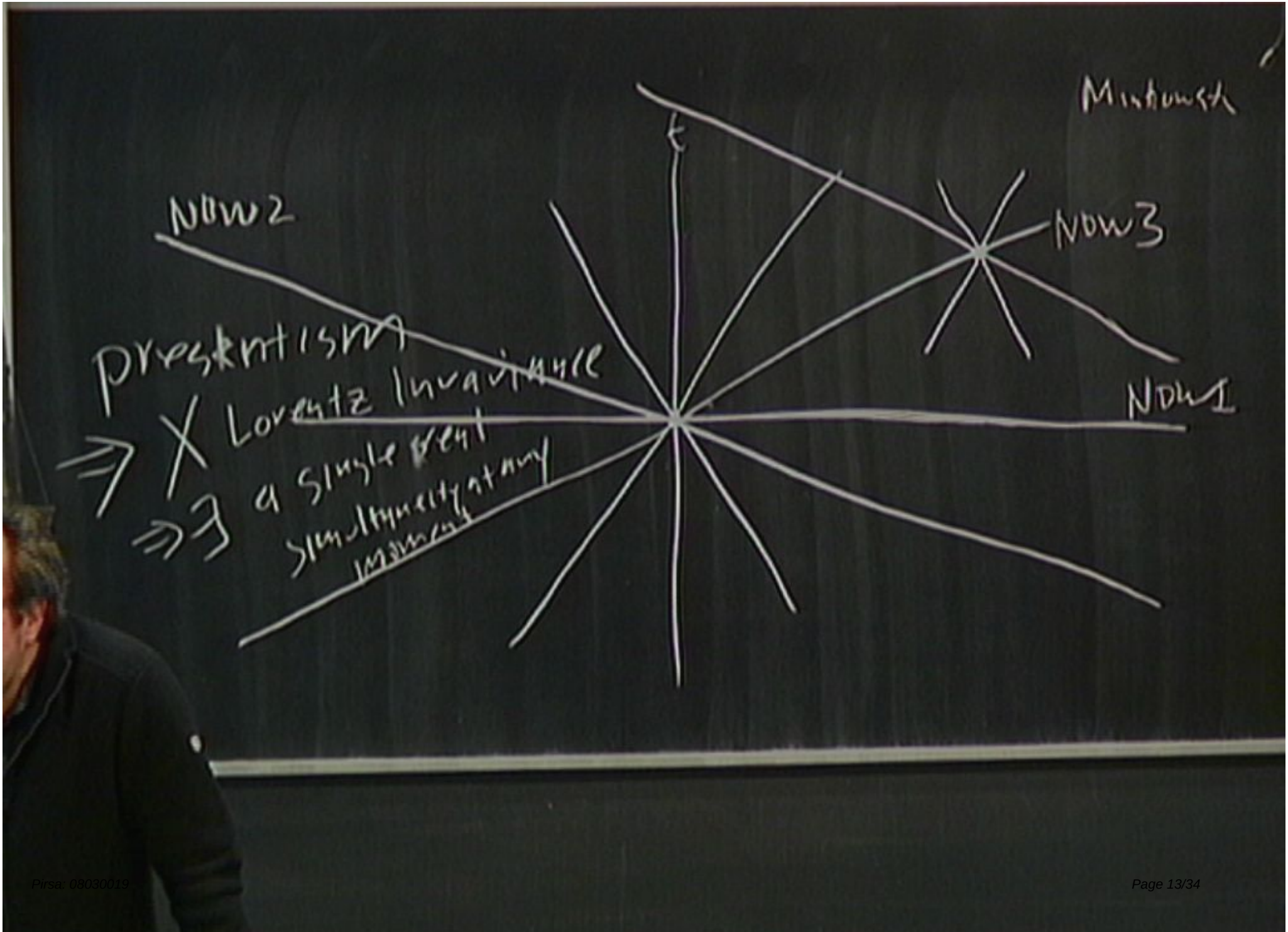

"Hereism"
Solopism


Minkowski
t


Minkowski
t
NOW 2
NOW 1


Minkowski
E
Now2
Now3
Now1


Minkowski
E
NOW 2
NOW 3
NOW 1
presentism
Lorentz Invariance


Minkowski
E
NOW 2
NOW 3
NOW 1
presentism
Lorentz Invariance
a single present
simultaneity at any
instant

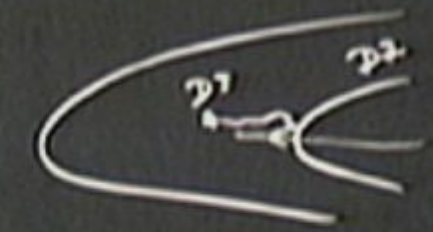
Presentism

"Hereism"

Solopism

m(ϕ) n

"box lightcone (sing)"



ir Isaac Newton: Principia Mathematica (1687)

CHOLIUM ON ABSOLUTE SPACE AND TIME

. Hitherto I have laid down the definitions of such words as are less known, nd explained the sense in which I would have them to be understood in the ollowing discourse. I do not define time, space, place and motion, as being ell known to all. Only I must observe, that the vulgar conceive those quantities nder no other notions but from the relation they bear to sensible objects. And nence arise certain prejudices, for the removing of which, it will be convenient o distinguish them into absolute and relative, true and apparent, mathematical nd common.

. Absolute, true, and mathematical time, of itself, and from its own nature ows equably without regard to anything external, and by another name is alled duration: [Absolute time is to be contrasted with] relative, apparent, and ommon time, [which] is some sensible and external (whether accurate or nequable) measure of duration by the means of motion, which is commonly sed instead of true time; such as an hour, a day, a month, a year.

Sir Isaac Newton: Principia Mathematica (1687)

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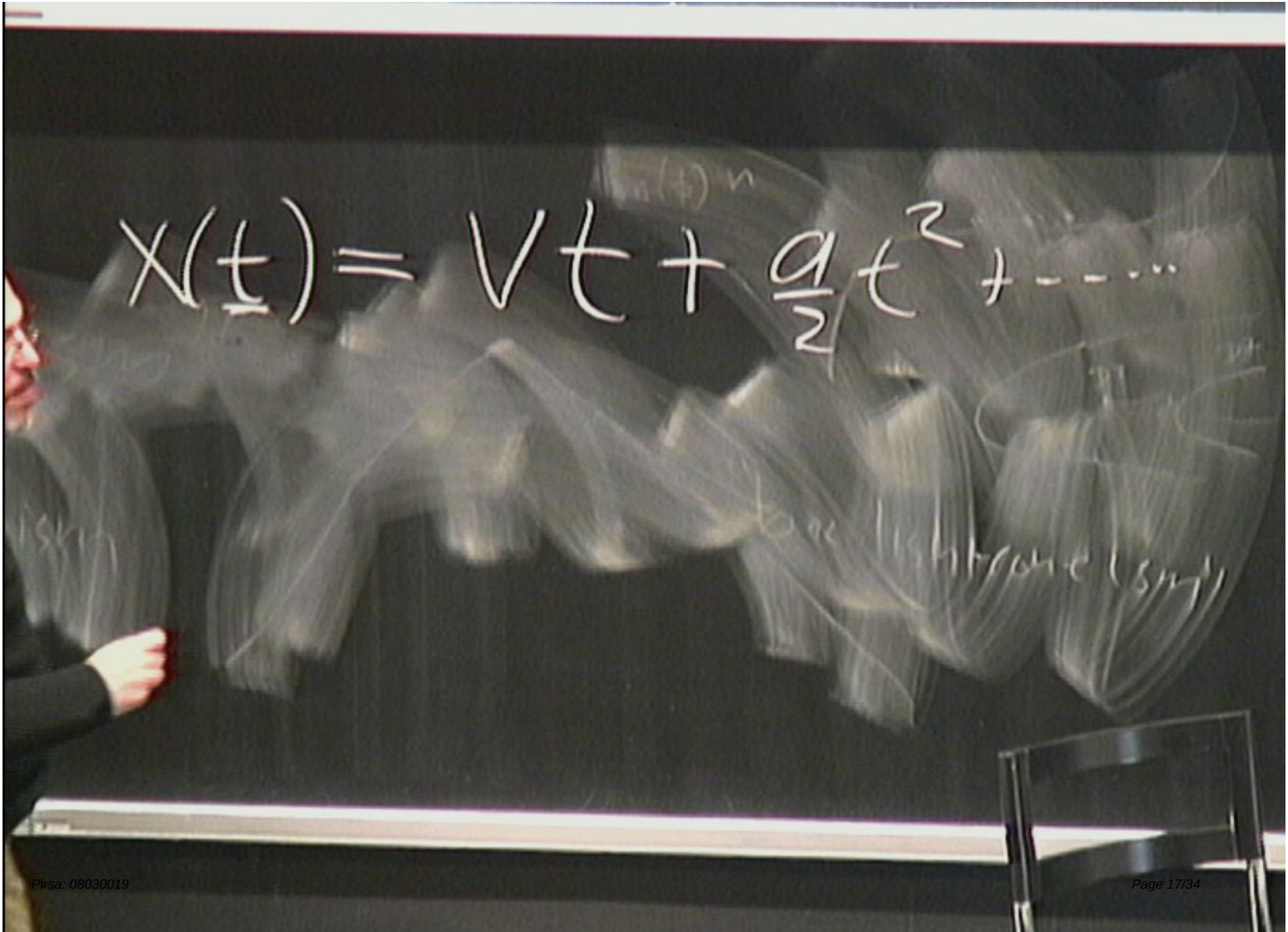
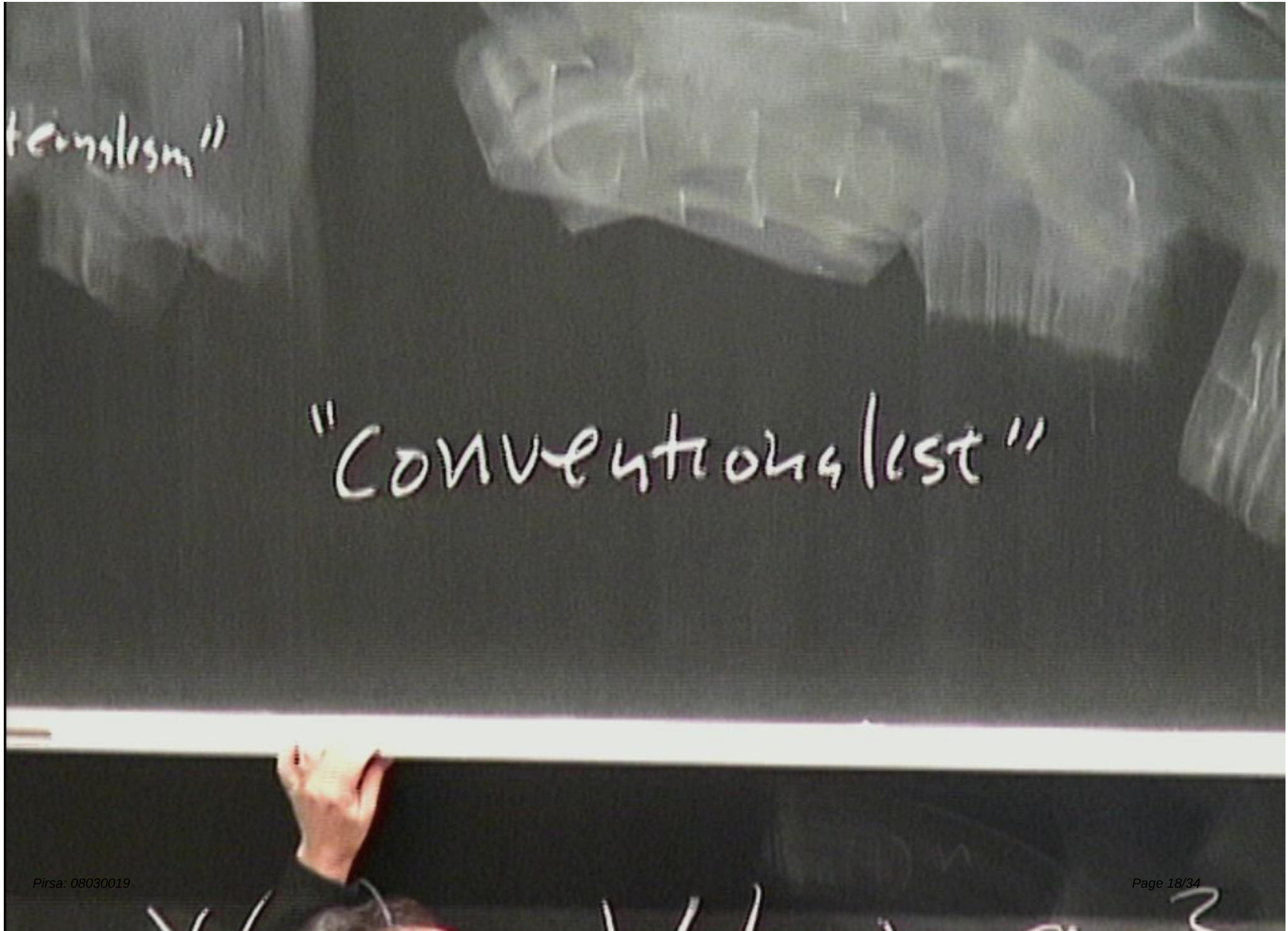
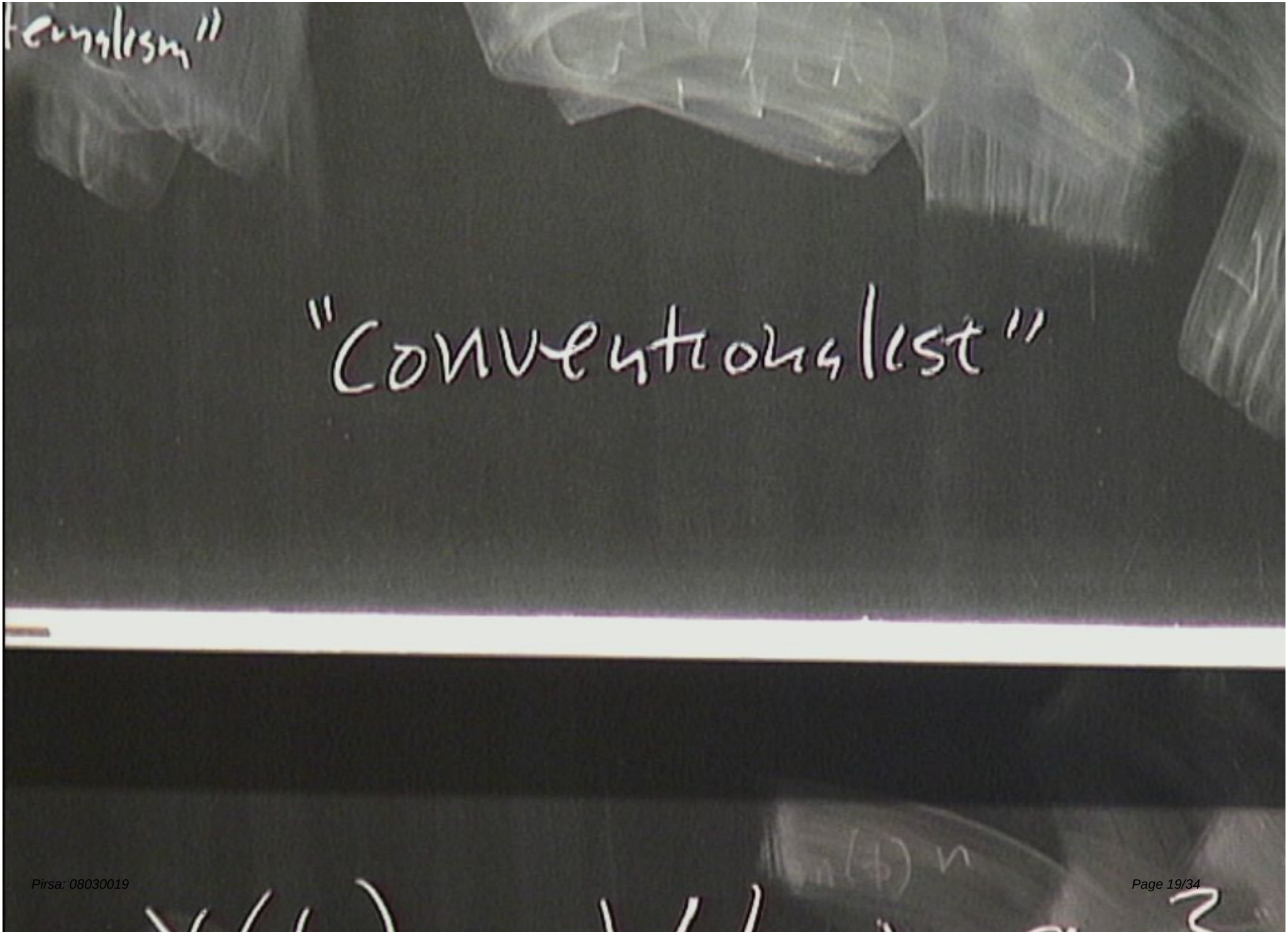
II. Absolute, true, and mathematical time, of itself, and from its own nature flows equably without regard to anything external, and by another name is called duration: [Absolute time is to be contrasted with] relative, apparent, and common time, [which] is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year.


$x(t) = vt + \frac{a}{2}t^2 + \cdots$


"Conventionalist"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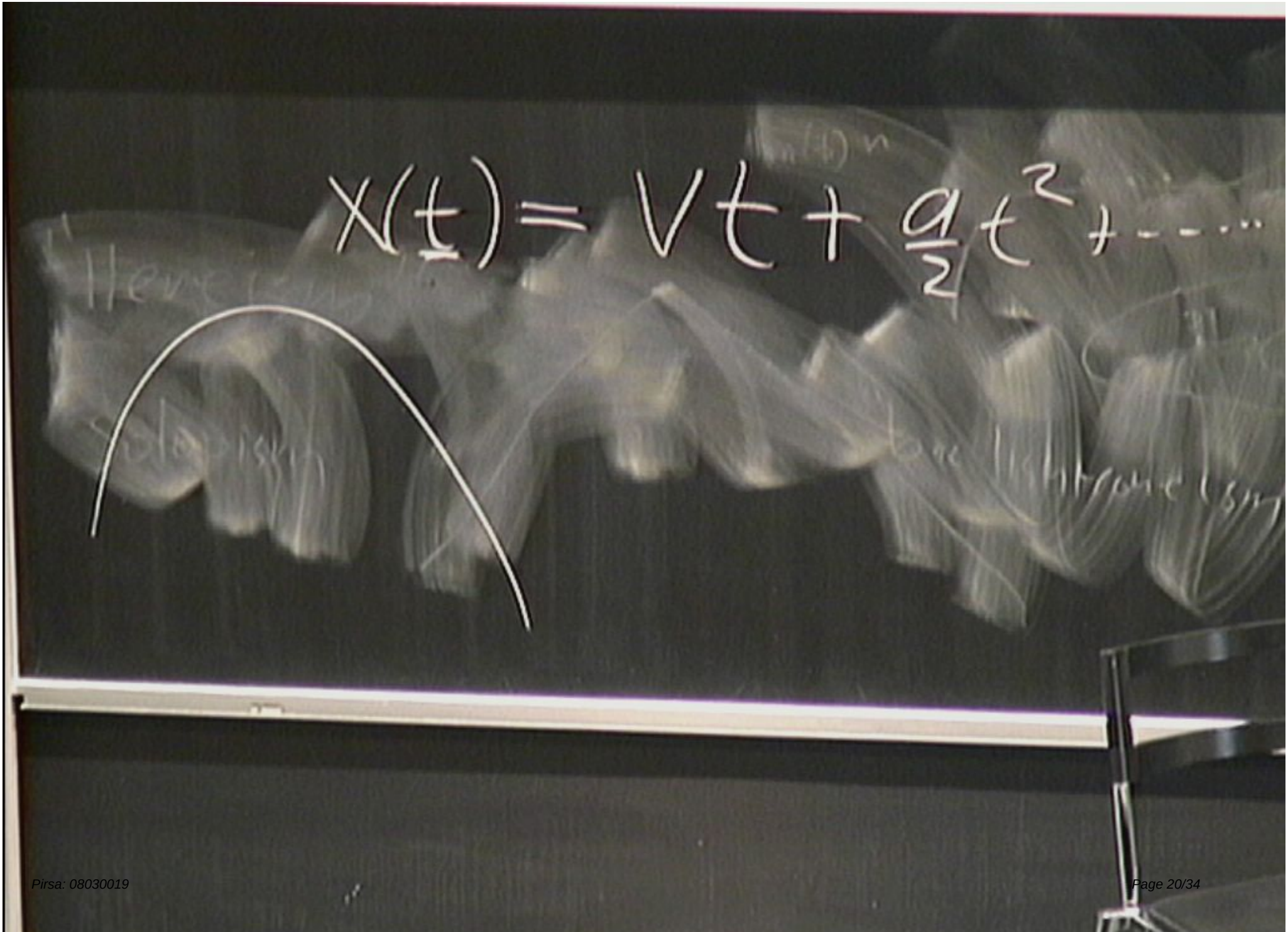
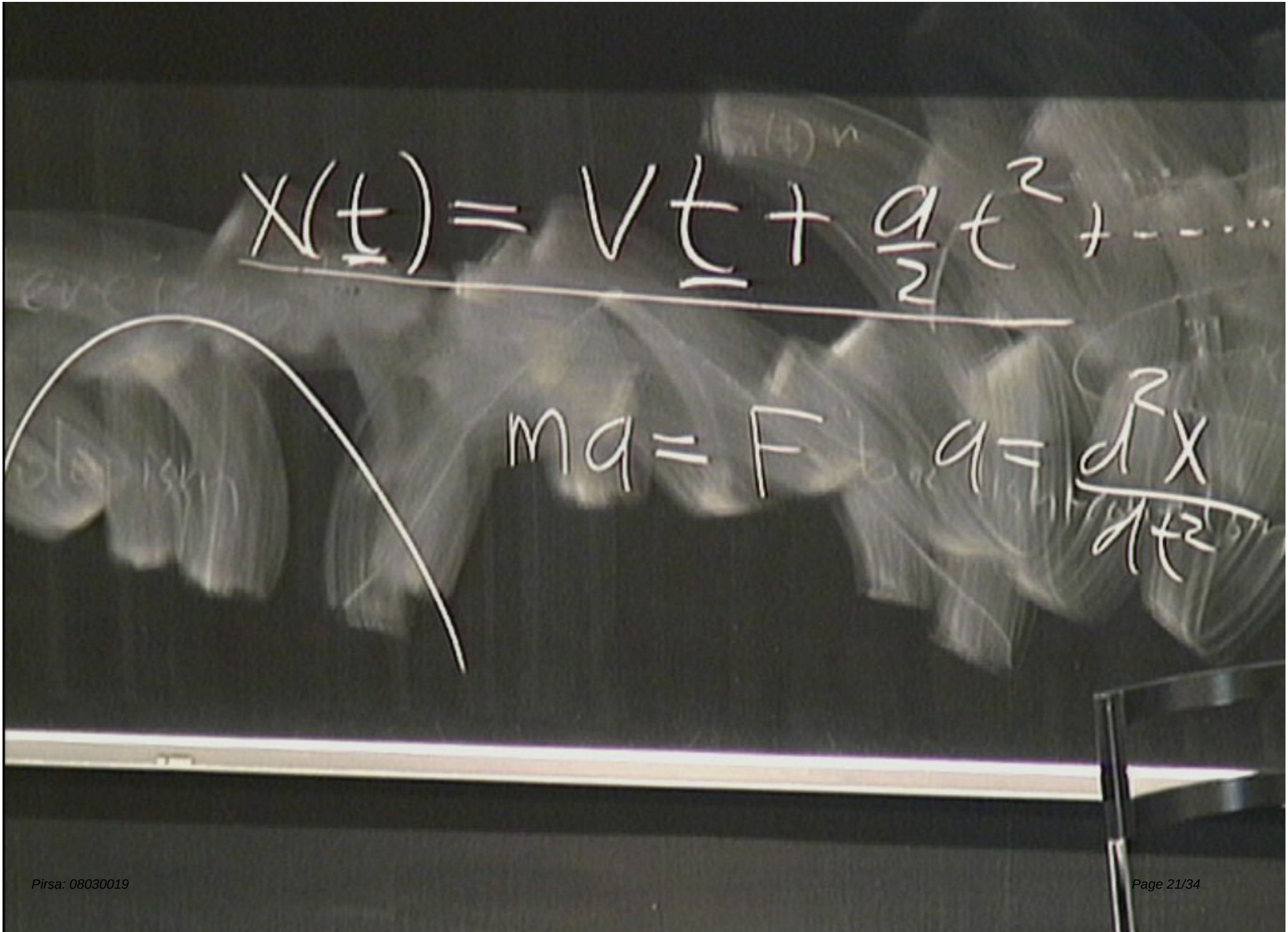

$x(t) = Vt + \frac{a}{2}t^2 + \cdots$


$x(t) = vt + \frac{a}{2}t^2 + \cdots$
$ma = F$
$a = \frac{d^2x}{dt^2}$

3. Absolute space, in its own nature, without regard to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute spaces; which our senses determine by its position to bodies; and which is vulgarly taken for immovable space; such is the dimension of a subterranean, an æreal, or celestial space, determined by its position in respect of the earth. Absolute and relative space, are the same in figure and magnitude; but they do not remain always numerically the same. For if the earth, for instance, moves, a space of our air, which relatively and in respect of the earth remains always the same, will at one time be one part of the absolute space into which the air passes; at another time it will be another part of the same, and so, absolutely understood, it will be perpetually mutable.

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Leibniz

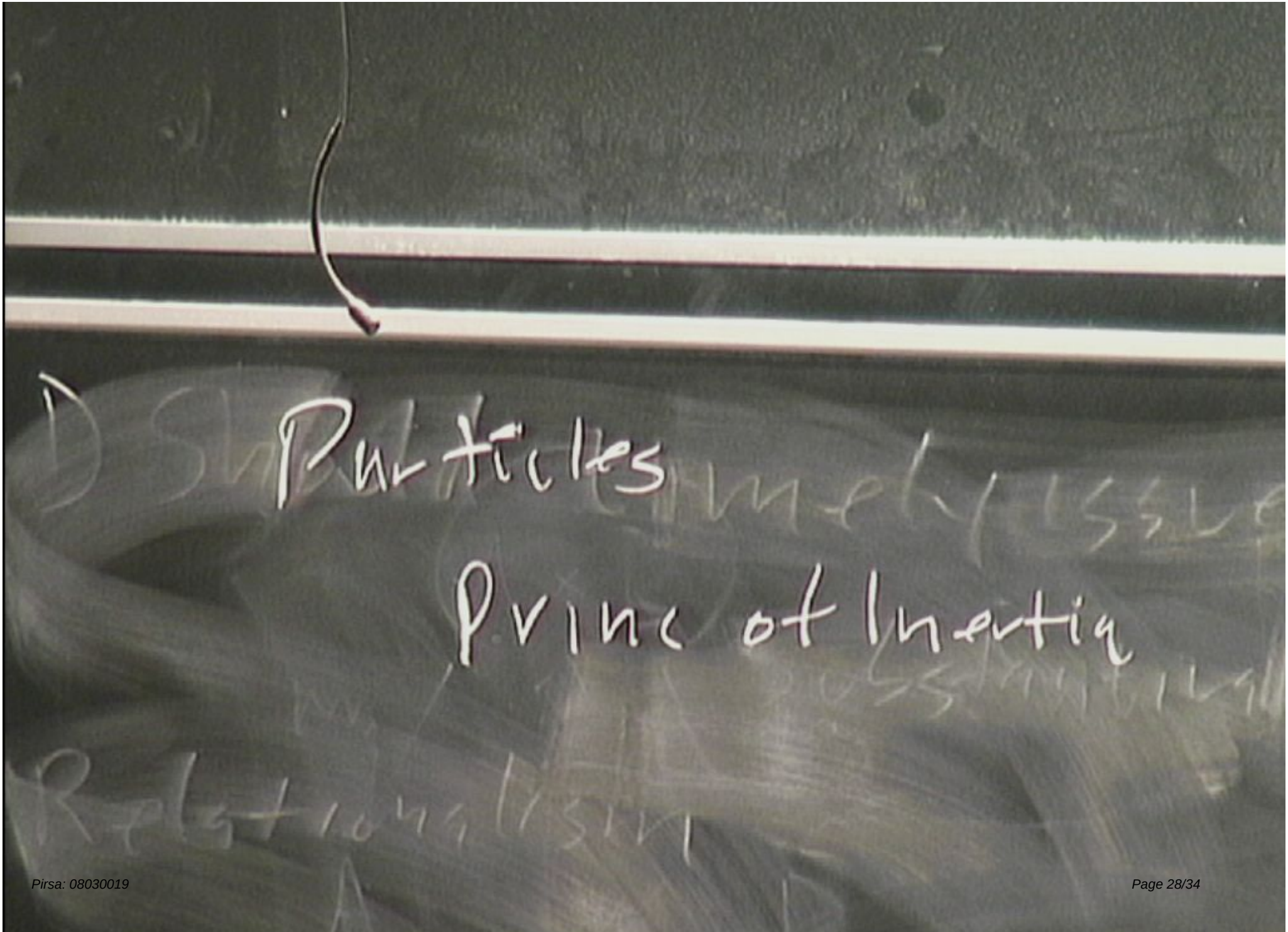
The great foundation of mathematics is the principle of contradiction, or identity, that is, that a proposition cannot be true and false at the same time; and that therefore A is A, and cannot be not A. This single principle is sufficient to demonstrate every part of arithmetic and geometry, that is, all mathematical principles.

But in order to proceed from mathematics to natural philosophy, another principle is requisite, as I have observed in my Theodicy: I mean, the principle of a sufficient reason, viz. that nothing happens without a reason why it should be so, rather than otherwise.

Now, by that single principle, viz. that there ought to be a sufficient reason why things should be so, and not otherwise, one may demonstrate the being of God, and all the other parts of metaphysics or natural theology; and even, in some measure, those principles of natural philosophy, that are independent upon mathematics: I mean, the dynamical principles, or the principles of force.

As for my own opinion, I have said more than once, that I hold space to be something merely relative, as time is; that I hold it to be an order of coexistences as time is an order of successions. For space denotes, in terms of possibility, an order of things which exist at the same time, considered as existing together; without enquiring into their manner of existing. And when many things are seen together, one perceives that order of things among themselves.

say then, that if space was an absolute being, there would something happen for which it would be impossible there should be a sufficient reason. Which is against my axiom. And I prove it thus. Space is something absolutely uniform; and, without the things placed in it, one point of space does not absolutely differ in any respect whatsoever from another point of space. Now from hence it follows, (supposing space to be something in itself, besides the order of bodies among themselves,) that 'tis impossible there should be a reason, why God, preserving the same situations of bodies among themselves, should have placed them in space after one certain particular manner, and not otherwise; why every thing was not placed the quite contrary way, for instance, by changing East into West. But if space is nothing else, but that order or relation and is nothing at all without bodies, but the possibility of placing them; then those two states, the one such as it now is, the other supposed to be the quite contrary way, would not at all differ from one another. Their difference therefore is only to be found in our chimerical supposition of the reality of space in itself. But in truth the one would exactly be the same thing as the other, they being absolutely indiscernible; and consequently there is no room to enquire after a reason of the preference of the one to the other.


Particles
Princ of Inertia

Particles

1) Princ of Inertia

No forces $\Rightarrow$ V^a = constant

2) $\epsilon \geq 0$

3) When forces $a^a = \frac{F^a}{m}$

Particles

(1) Prince of Inertia

No forces $\Rightarrow$ V^a = constant

3) $\in \geq 0$

2) When forces $a^a = \frac{F^a}{m}$

Symmetries:

Translations in space

Translations in Time

Changes of Inertial frame

$$a = \frac{d^2 x}{dt^2}$$

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5. The case is the same with respect to time. Supposing any one should ask, why God did not create every thing a year sooner; and the same person should nfer from thence, that God has done something, concerning which 'tis not possible there should be a reason, why he did it so, and not otherwise: the answer is, that his inference would be right, if time was any thing distinct from hings existing in time. For it would be impossible there should be any reason, why things should be applied to such particular instants, rather than to others, heir succession continuing the same. But then the same argument proves, that nstants, consider'd without the things, are nothing at all; and that they consist only in the successive order of things; which order remaining the same, one of he two states, viz. that of a supposed anticipation would not at all differ, nor could be discerned from, the other which now is.

Leibniz's 3rd Paper, Alexander 1956, 25-7)

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