Title: Symmetry Principles in Physics - Lecture 1B

Date: Apr 14, 2008 12:00 PM

URL: http://pirsa.org/08040051

Abstract:

Einstein's 1905 postulates

(Newtonian) Relativity Principle

"... the same laws of electrodynamics and optics will be valid for all coordinate systems in which the equations of mechanics hold good, as has already been shown for quantities of the first order. We shall raise this conjecture (whose content will hereafter be called 'the principle of relativity') to the status of a postulate. ...
If two coordinate systems are in uniform parallel translational motion relative to each other, the laws according to which the states of a physical system change do not depend on which of the two systems these changes are related to."

Light Postulate

"Every ray of light moves in the "rest" coordinate system with a definite velocity V, independently of whether this ray is emitted by a body at rest or in motion." ("true essence of the old aether point of view", Pauli 1921)

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Spatial isotropy

the role of the relativity principle, isotropy

Einstein 1905

Relativity principle
Light postulate
Poincaré-Einstein synchrony convention

invariance of light-speed
k-Lorentz transformations
(see Bogoslovsky-Budden transformations)

Relativity principle
spatial isotropy

$k = 1$
Lorentz transformations

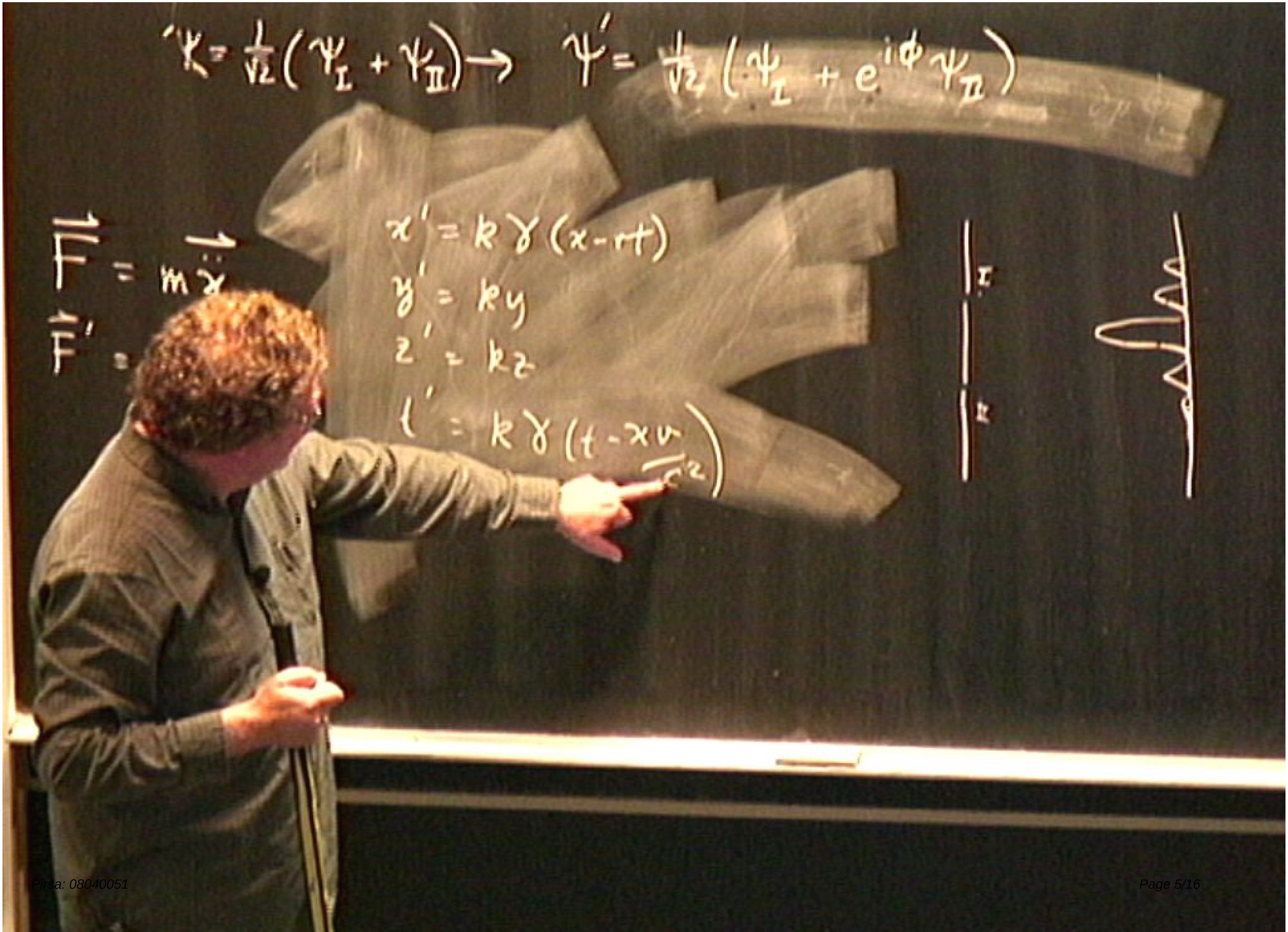
Ignatowski 1910-11

Relativity principle
Synchrony convention
Isotropy
Reciprocity

Existence of invariant speed
Ignatowski transformations

$$x' = (1 - Kv^2)^{-1/2}(x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = (1 - Kv^2)^{-1/2}(t - Kvx)$$

H.R.B. *Physical Relativity* (2005), Chs. 5, 6.


$\Psi = \frac{1}{\sqrt{2}}(\psi_I + \psi_{II}) \rightarrow \psi' = \frac{1}{\sqrt{2}}(\psi_I + e^{i\phi}\psi_{II})$
$\vec{F} = m\ddot{\vec{x}}$
$\vec{F}' =$
$x' = k\gamma(x - vt)$
$y' = ky$
$z' = kz$
$t' = k\gamma(t - \frac{xv}{c^2})$
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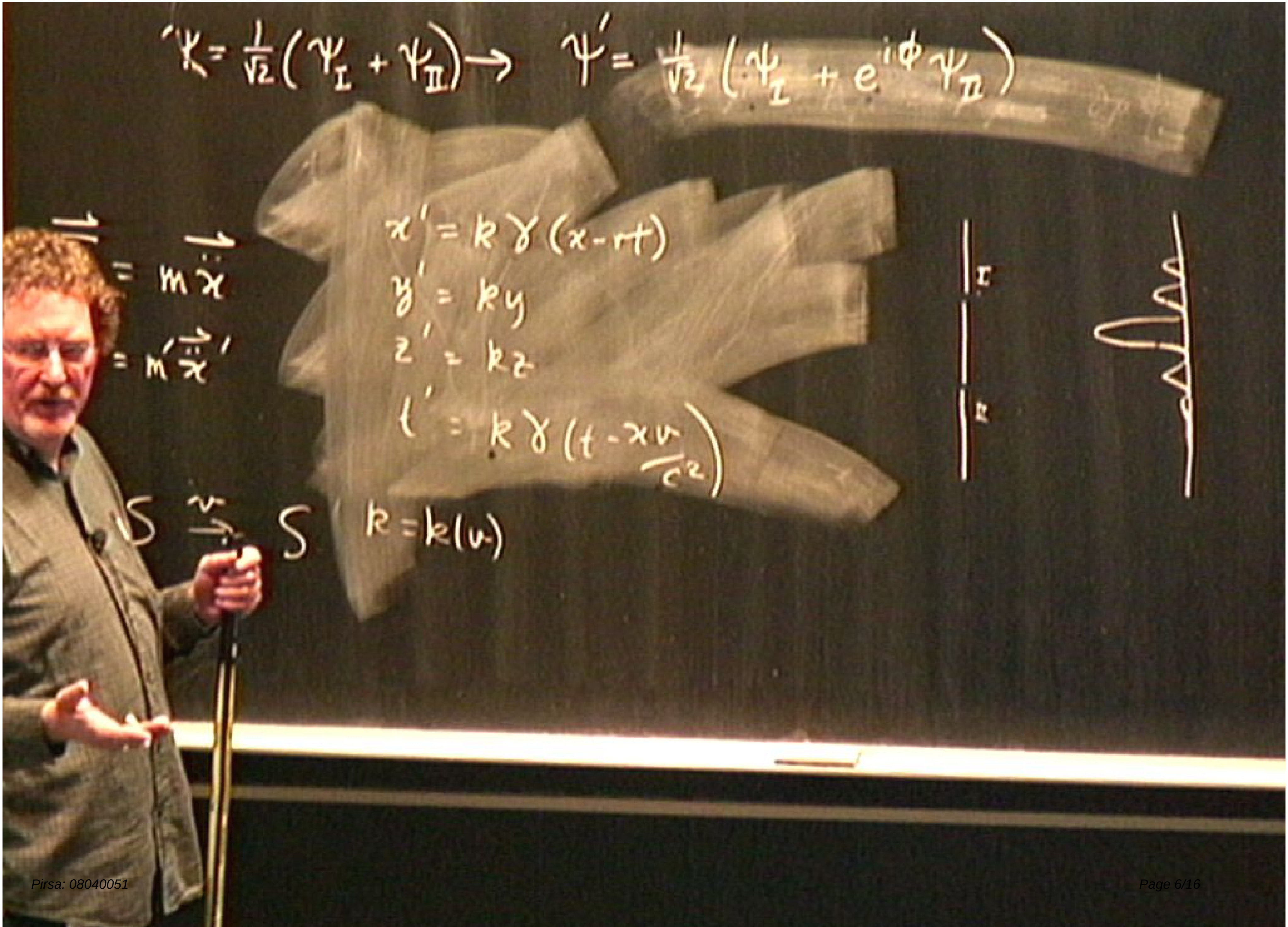
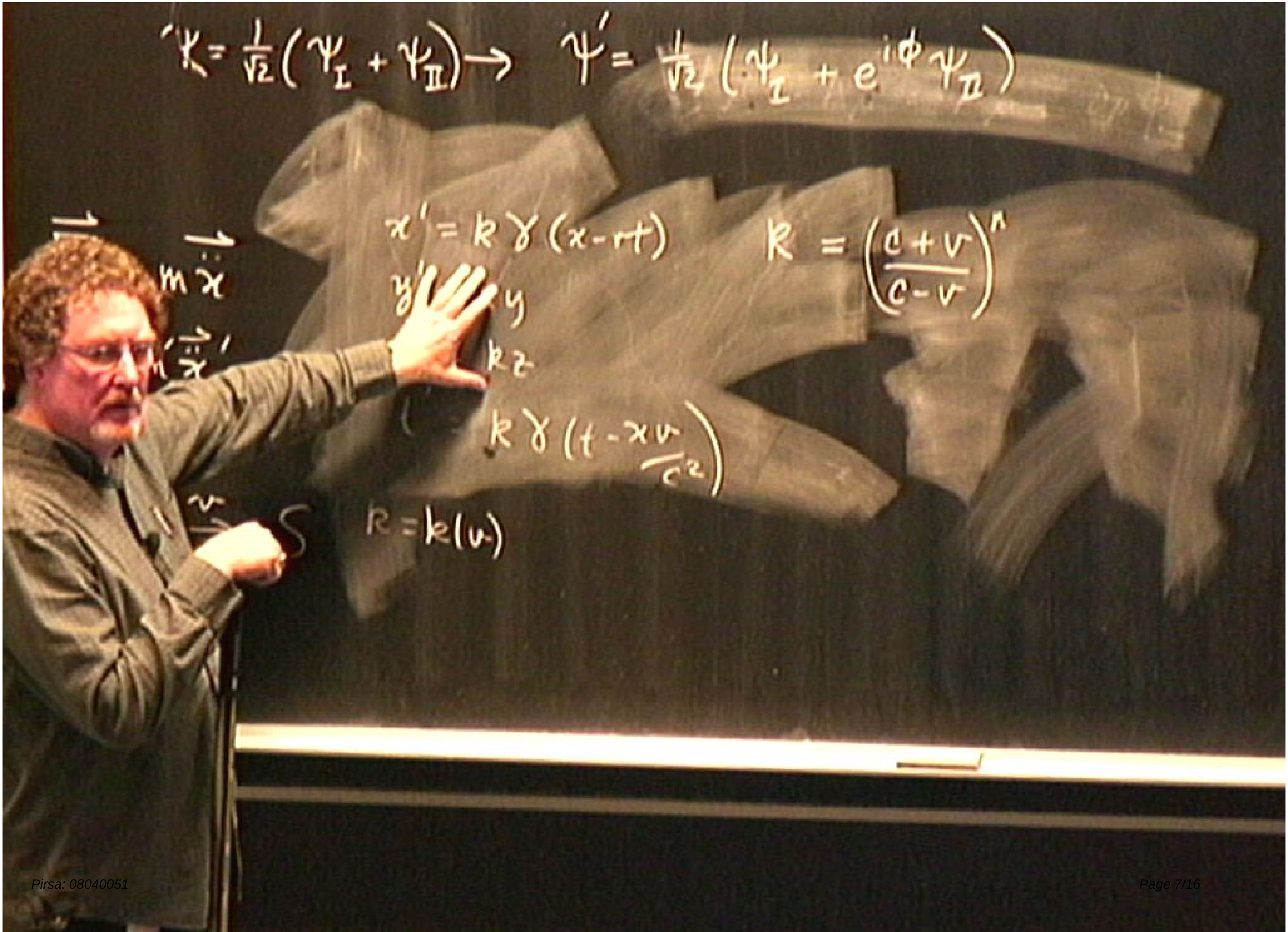
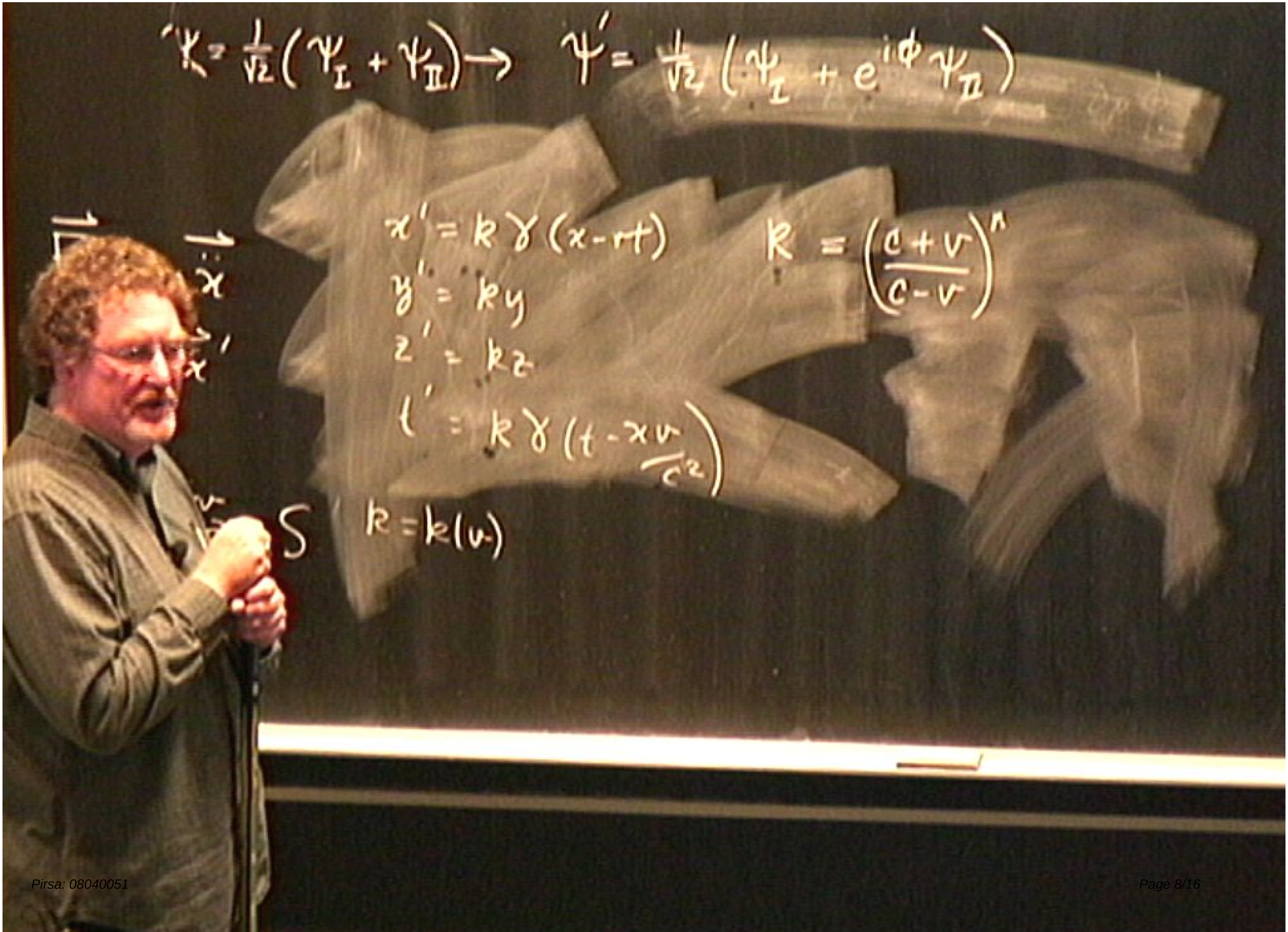
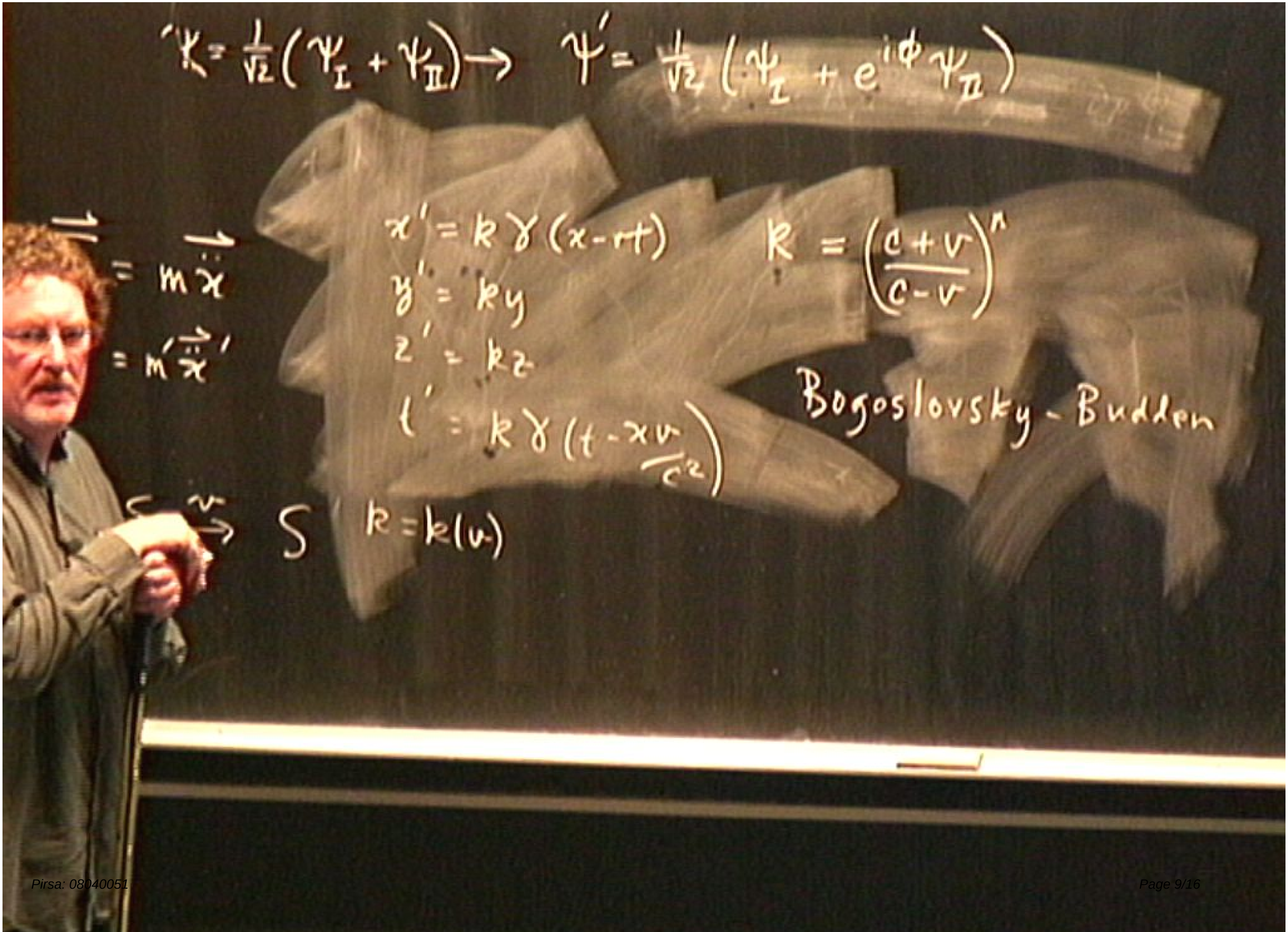



x' = kγ (x - vt)
kγ (t - xv/c²)
R = k(v)


ψ = 1/√2 (ψ_I + ψ_II) → ψ' = 1/√2 (ψ_I + e^{iφ} ψ_II)
x' = kγ(x - vt)
y' = ky
z' = kz
t' = kγ(t - xv/c²)
k = ((c + v)/(c - v))^n
k = k(v)


$\psi = \frac{1}{\sqrt{2}}(\psi_I + \psi_{II}) \rightarrow \psi' = \frac{1}{\sqrt{2}}(\psi_I + e^{i\phi}\psi_{II})$
$= m\ddot{\vec{x}}$
$= m'\ddot{\vec{x}}'$
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$y' = ky$
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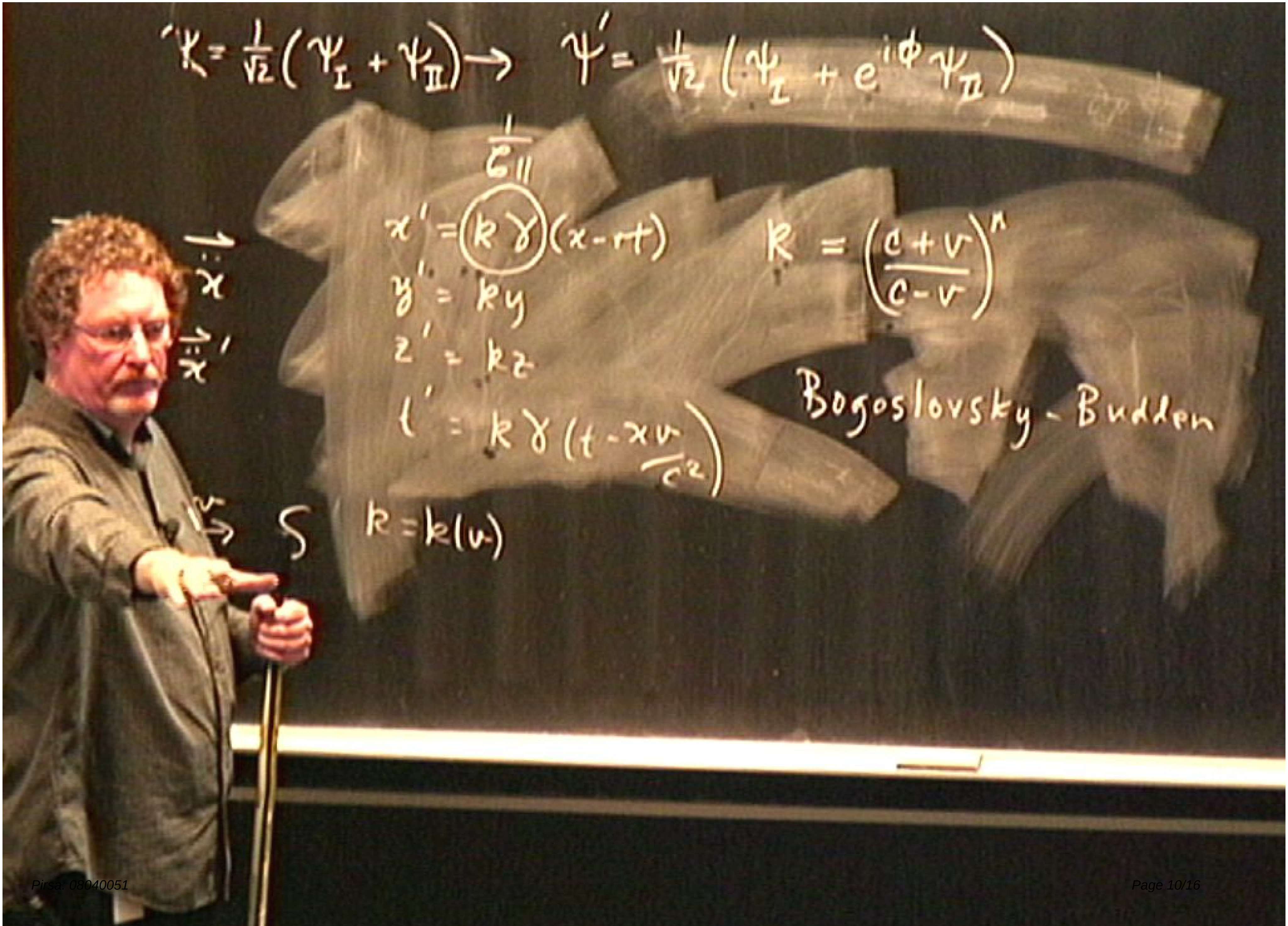
$t' = k\gamma(t - xv/c^2)$
$k = \left(\frac{c+v}{c-v}\right)^n$
Bogoslovsky - Budden
$S \xrightarrow{v} S'$ $k = k(v)$



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the role of the relativity principle, isotropy

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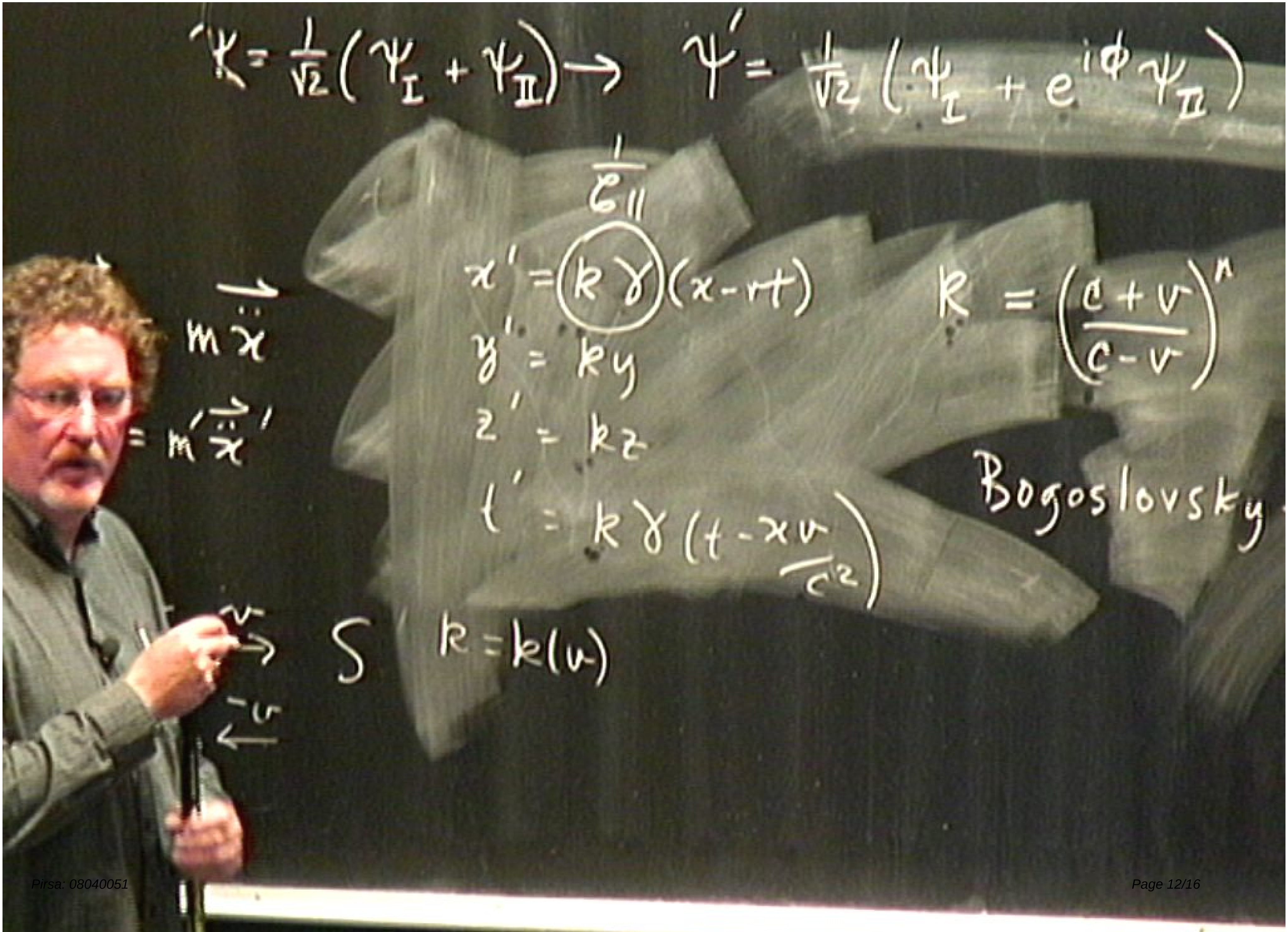
H.R.B. *Physical Relativity* (2005), Chs. 5, 6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Bogoslovsky
m x⃗̈
= m' x⃗̈'
S
k = k(v)

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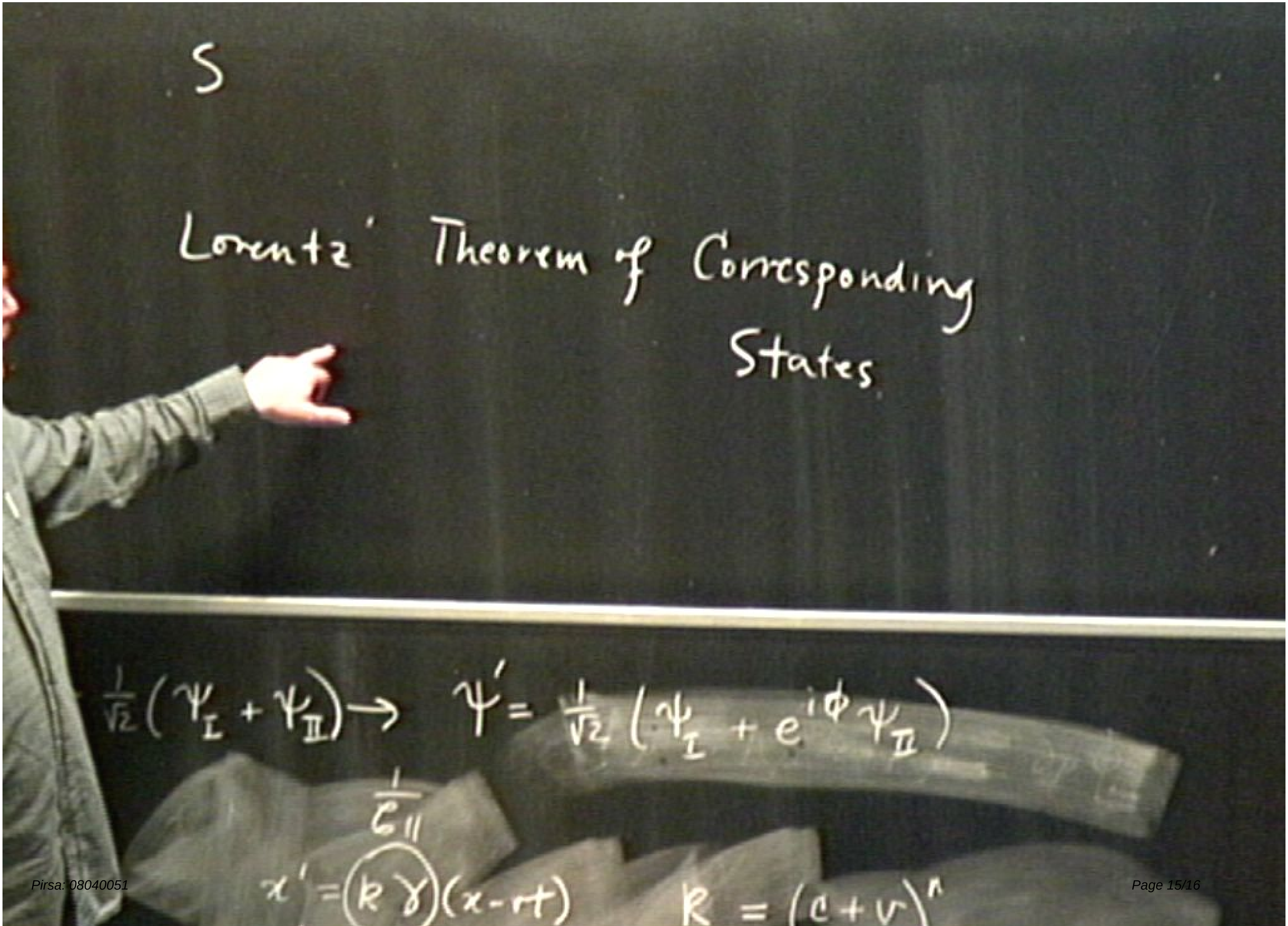
RP in general relativity

In special relativity, Einstein defines RP in relation to the Galilean-Newtonian inertial frames.

In general relativity, RP is valid for local (free-fall) inertial (Lorentz) frames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Lorentz' Theorem of Corresponding States
$\frac{1}{\sqrt{2}}(\psi_I + \psi_{II}) \rightarrow \psi' = \frac{1}{\sqrt{2}}(\psi_I + e^{i\phi}\psi_{II})$
$\frac{1}{\epsilon_{11}}$
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S $\quad\quad k = 1$ $\quad\quad \left\{ \begin{array}{l} \text{Rel Principle} \\ \text{isotropy} \end{array} \right.$

Lorentz' Theorem of Corresponding States

$$\Psi = \frac{1}{\sqrt{2}}(\Psi_I + \Psi_{II}) \to \Psi' = \frac{1}{\sqrt{2}}(\Psi_I + e^{i\phi}\Psi_{II})$$

$$\frac{1}{\mathcal{E}_{11}}$$

$$x' = (k\gamma)(x - vt) \quad\quad K = (c+v)^n$$