Title: Symmetry Principles in Physics - Lecture 5B

Date: May 12, 2008 12:00 PM

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Abstract:

Poincaré

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1893 "Everyone knows the mechanistic conception of the universe which has seduced so many good men ... [A]re [the hypotheses of the kinetic theory of gases] legitimate, are they self-consistent? I do not believe they are ... there is no need for a long discussion in order to challenge an argument of which the premises are apparently in contradiction with the conclusion, where one finds in effect reversibility in the premises and irreversibility in the conclusion."

more Poincaré

1898 "If we observe, then, that there is not in reality a reversible phenomenon, that the reversibility is only a limiting case – and ideal case which nature can more or less approach but can never attain – we shall be led to conclude that instability is the law of all natural phenomena. Are the movements of the heavenly bodies the only ones to escape?"

Zermelo

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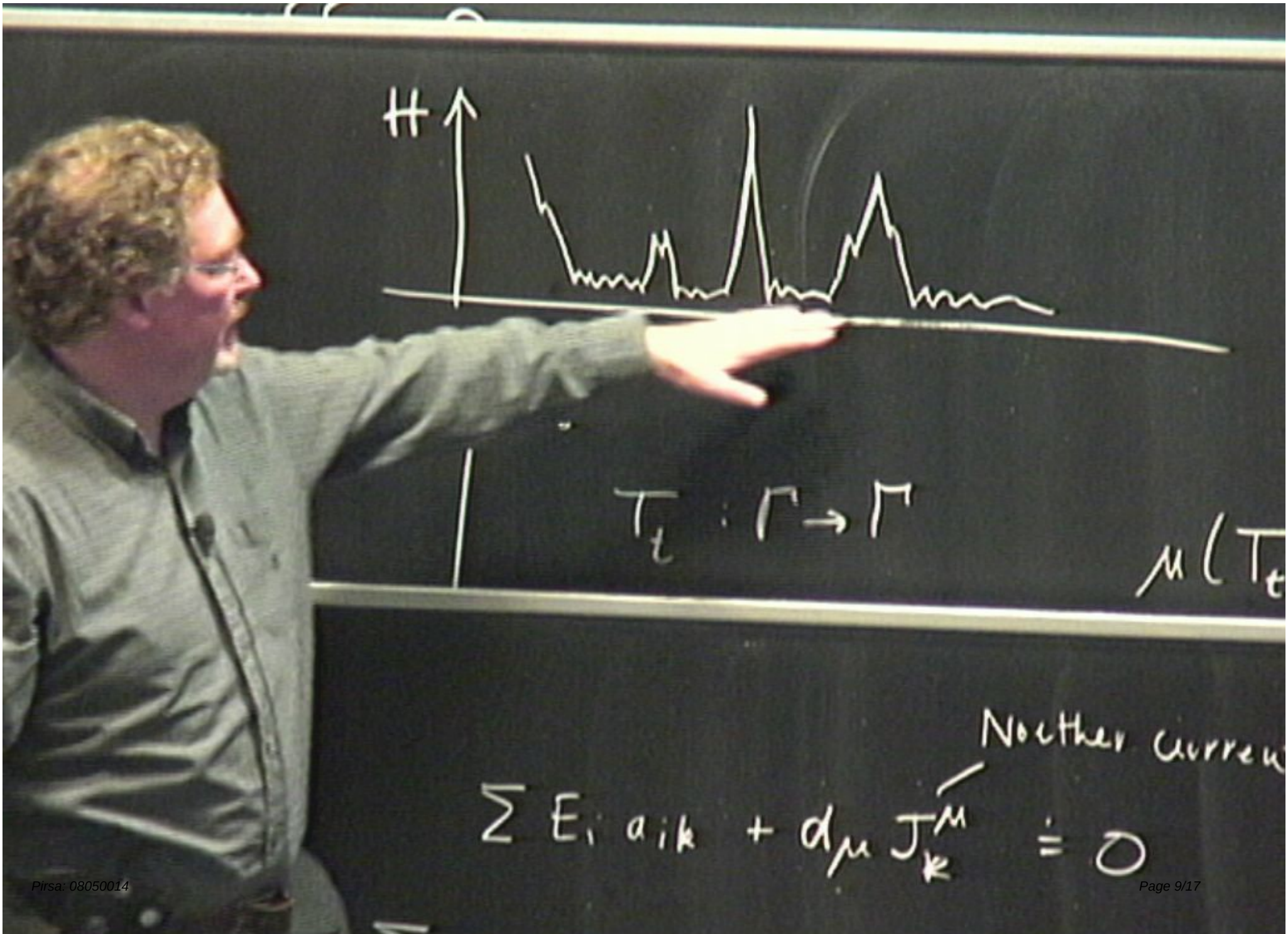
1896b "As for me (and I am not alone in this opinion), I believe that a single principle [the second law] summarizing an abundance of established experimental facts is more reliable than a mathematical theorem [Poincaré's recurrence theorem], which by its nature represents only a theory which can never be directly verified; I prefer to give up the theorem rather than the principle, if the two are inconsistent. ...

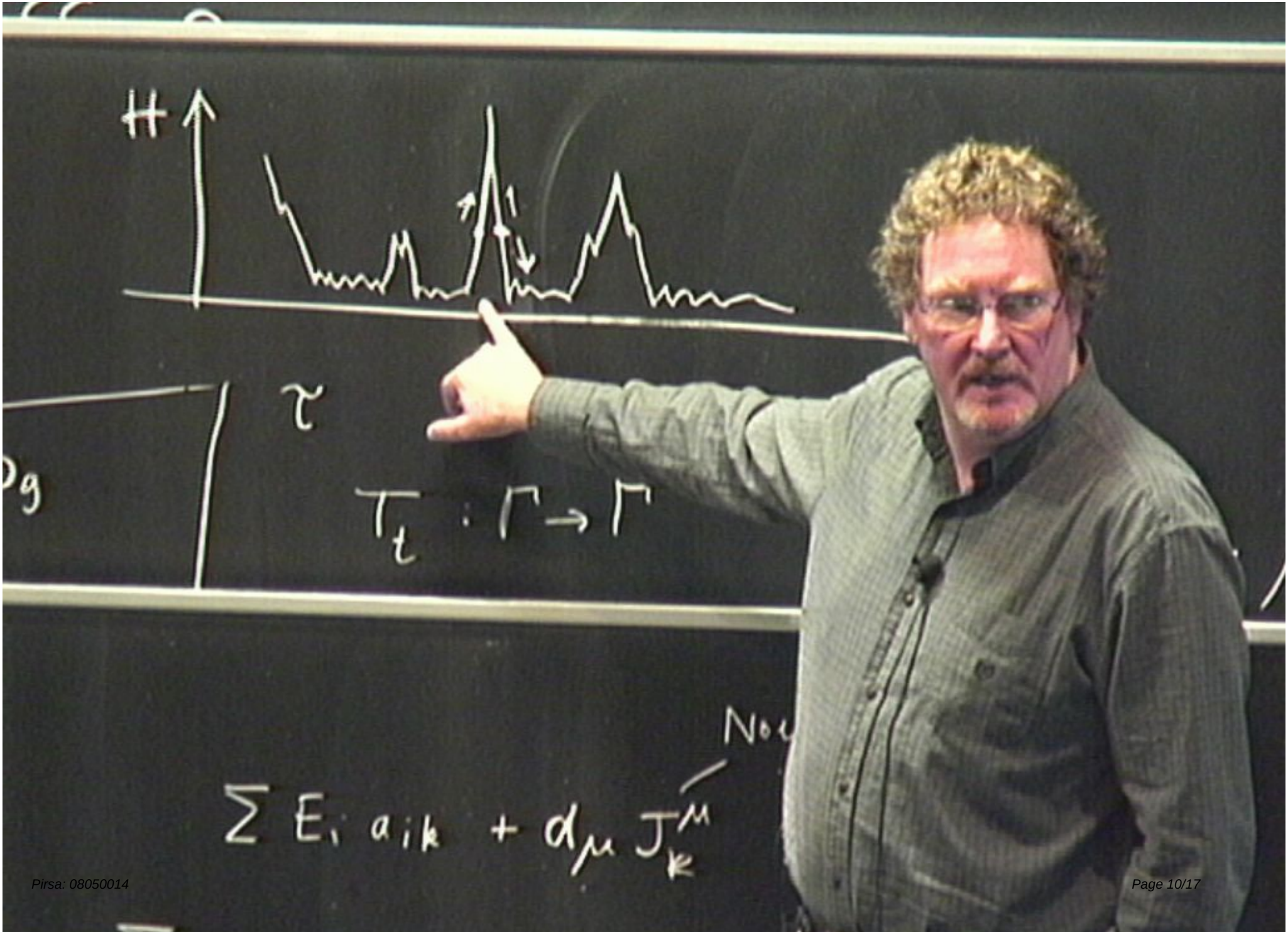
I have therefore not been able to convince myself that Herr Boltzmann's probability arguments ... are in fact able to dispel the doubts of a mechanical explanation of irreversible processes based on Poincaré's theorem, even if one renounces the strict irreversibility in favour of a merely empirical one. Indeed it is clear *a priori* that the probability concept has nothing to do with time and therefore cannot be used to deduce any conclusions about the *direction* of irreversible processes."

Boltzmann's probabilistic turn

"It can never be proved from the equations of motion alone, that the minimum function H must always decrease. It can only be deduced from the laws of probability, that if the initial state is not specially arranged for a certain purpose, but haphazard governs freely, the probability that H decreases is always greater than that it decreases. ... What I have proved in my papers is as follows: It is extremely probable that H is very near to its minimum value; if it is greater, it may increase or decrease, but the probability that it decreases is always greater. Thus, if I obtain a certain value for dH/dt, this result does not hold for every time element dt, but it is only an average value."

Boltzmann 1895


H
$T_t : \Gamma \to \Gamma$
$\mu(T_t$
Noether current
$\sum E_i a_{ik} + \partial_\mu J_k^\mu \doteq 0$


H
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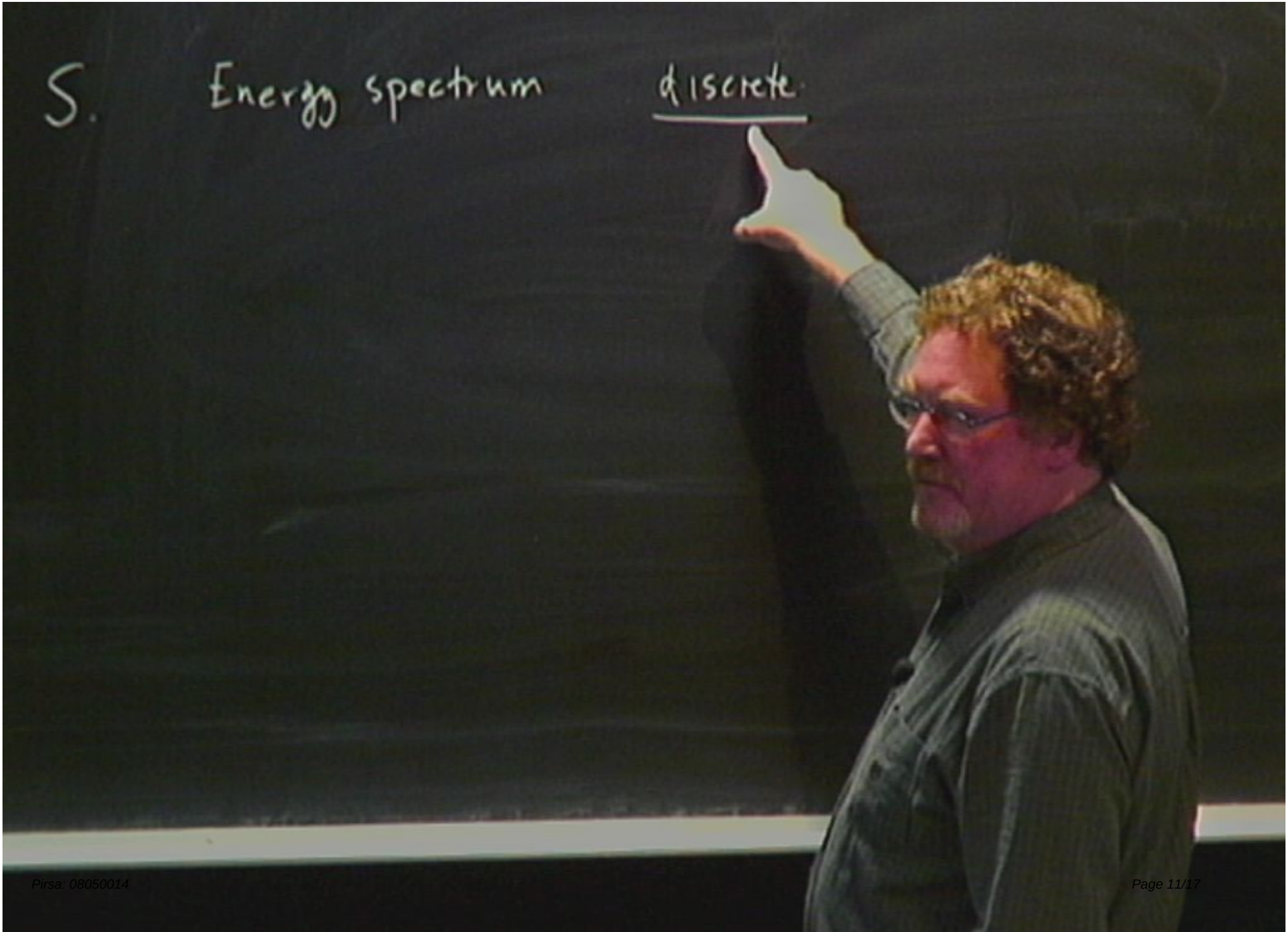
$T_t : \Gamma \to \Gamma$
$\sum E_i a_{ik} + \partial_\mu J_k^\mu$


5.
Energy spectrum
discrete

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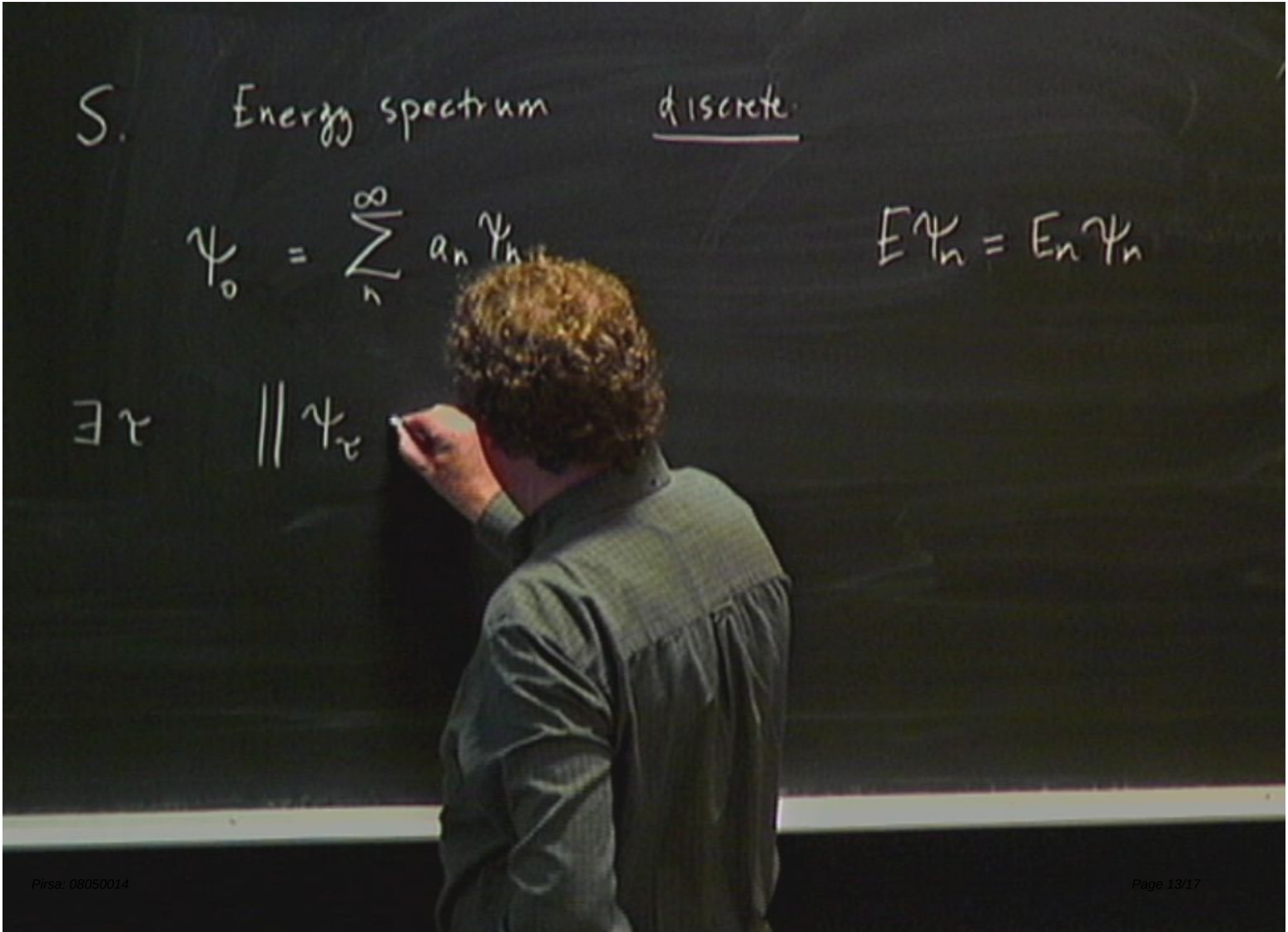
$$\psi_0 = \sum_n^{\infty} a_n \psi_n$$

$$E\psi_n = E_n \psi_n$$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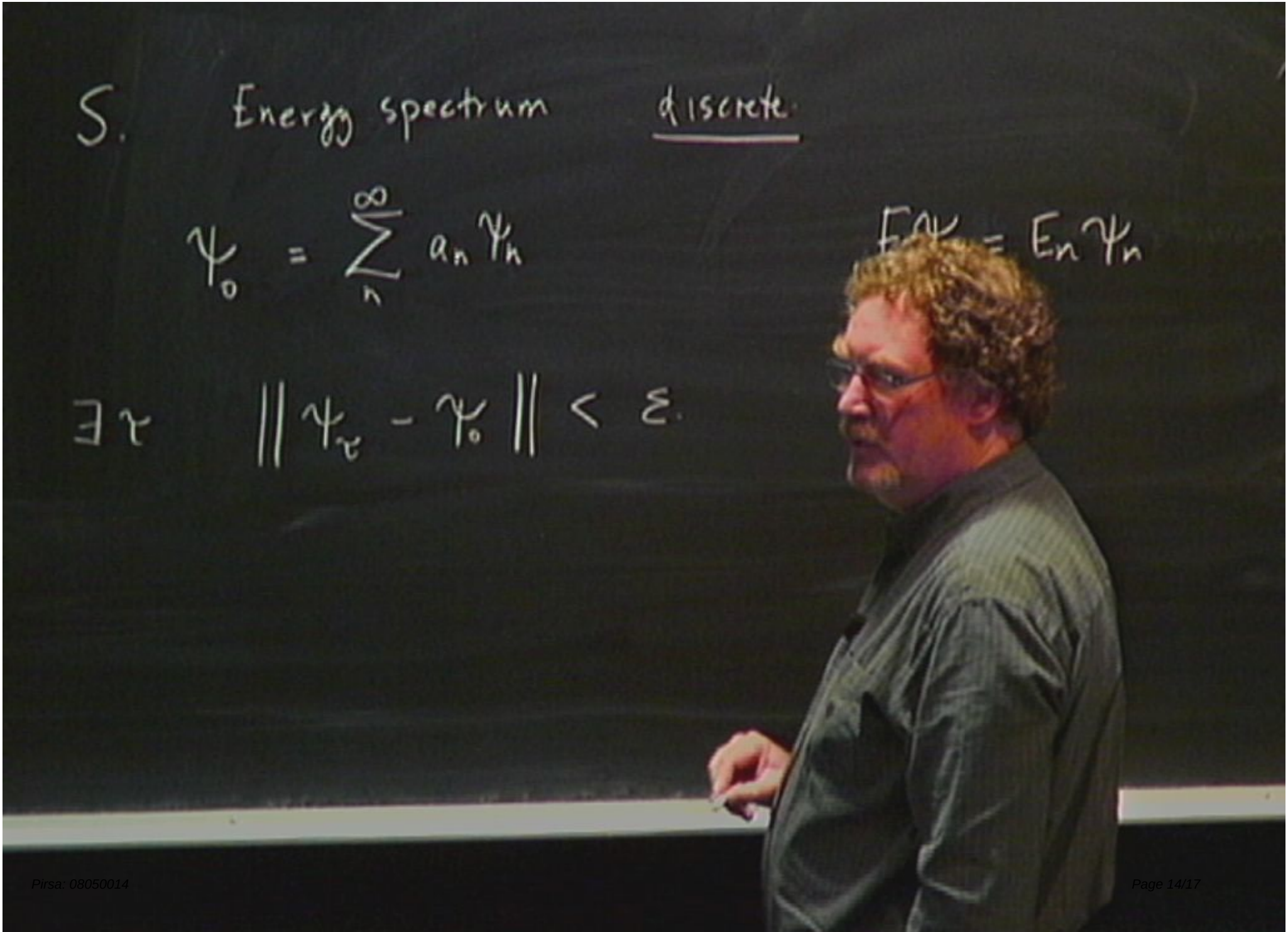
$E\psi_n = E_n \psi_n$
$\exists \tau \quad \| \psi_\tau$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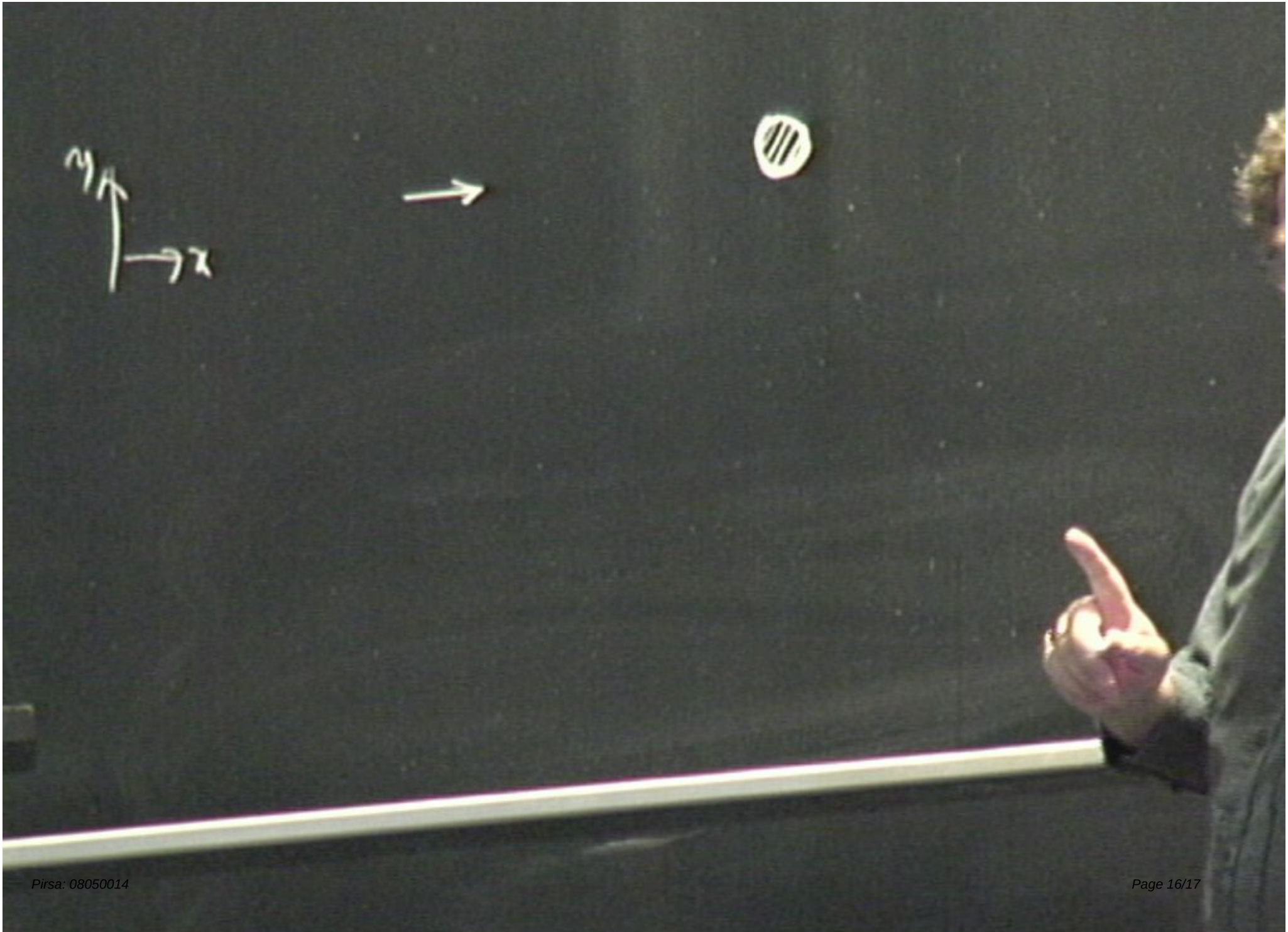
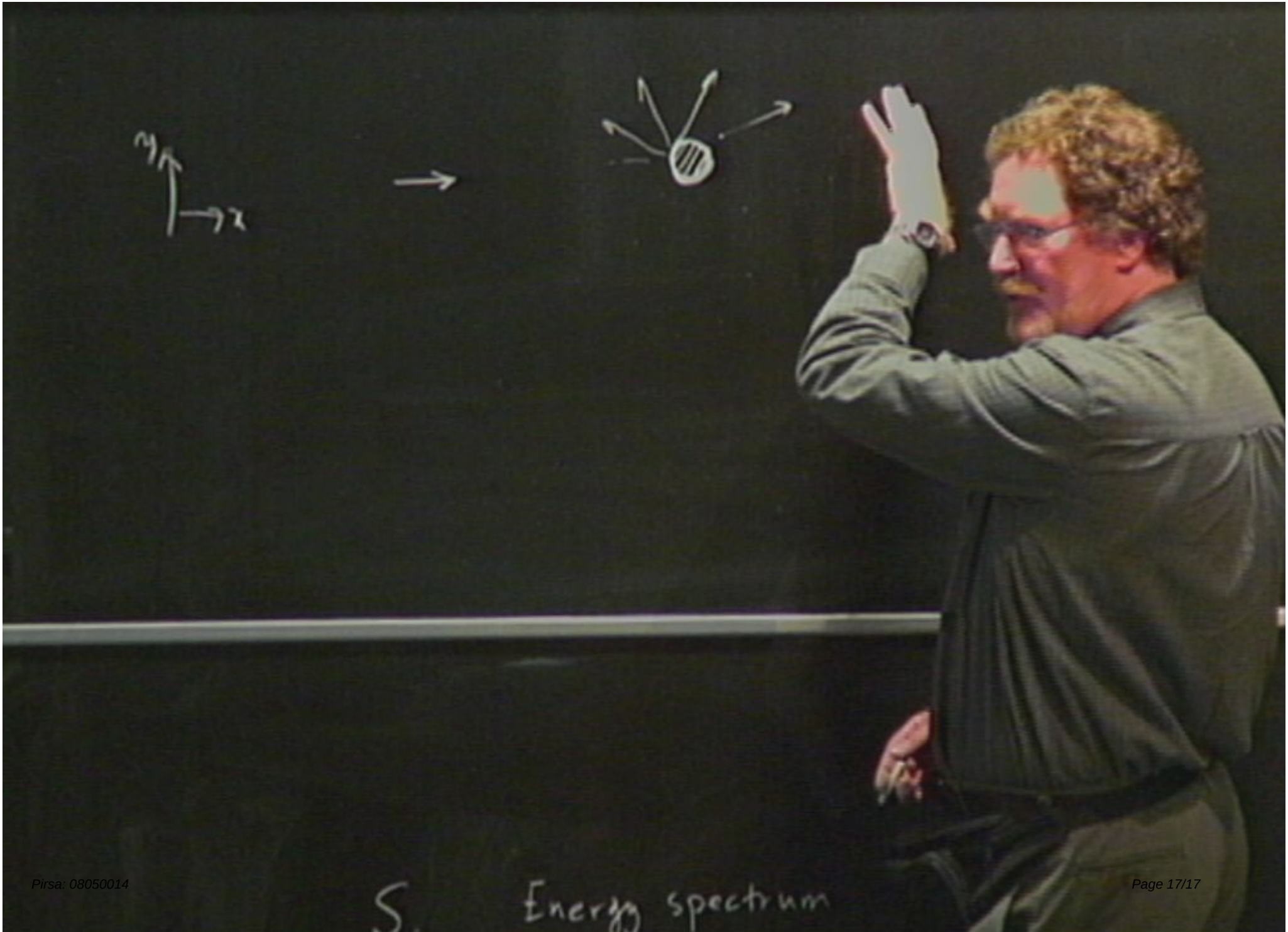
$\psi_0 = \sum_n^\infty a_n \psi_n$
$E\psi_n = E_n \psi_n$
$\exists \tau \quad \| \psi_\tau - \psi_0 \| < \varepsilon$




Energy spectrum