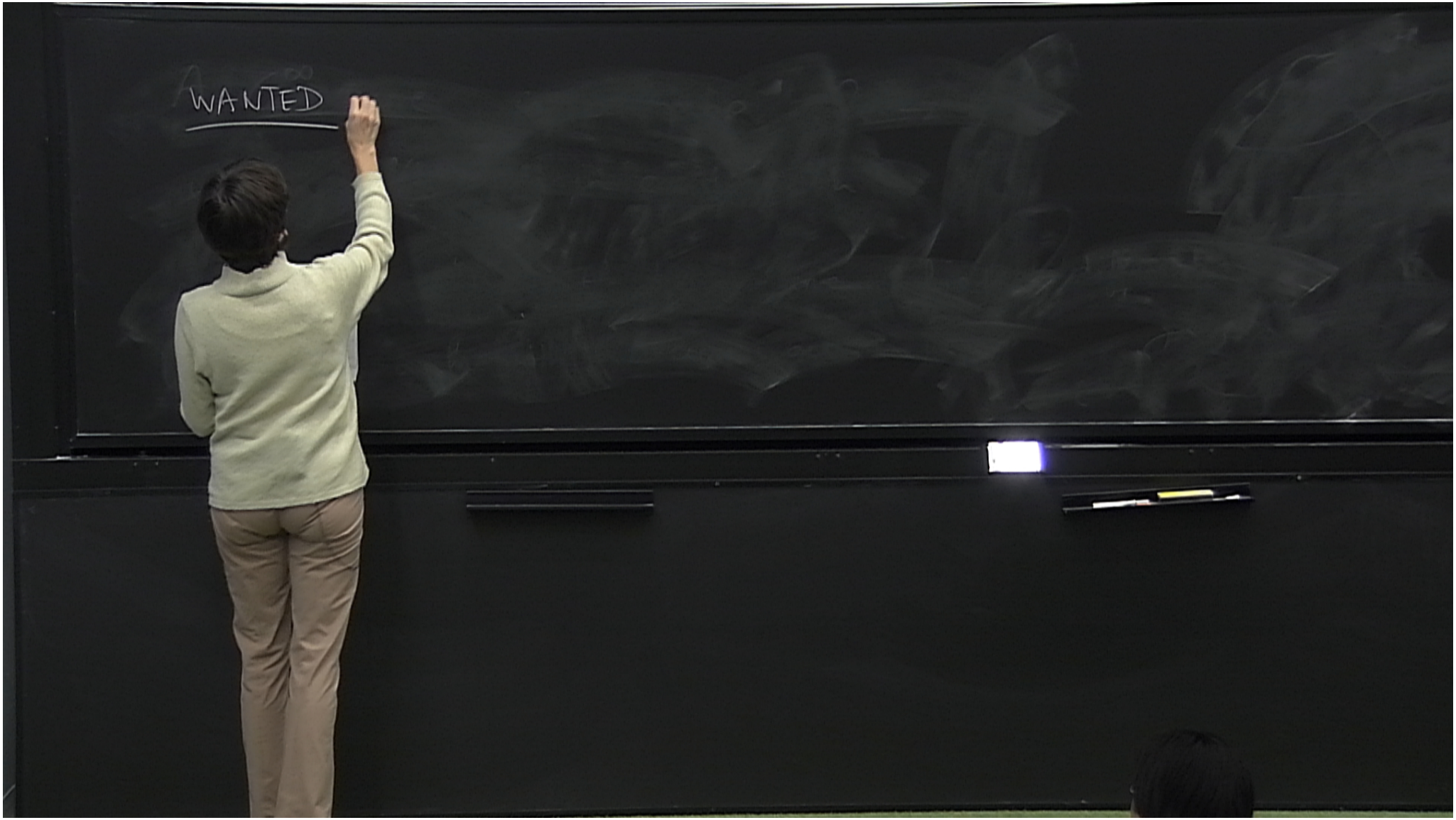
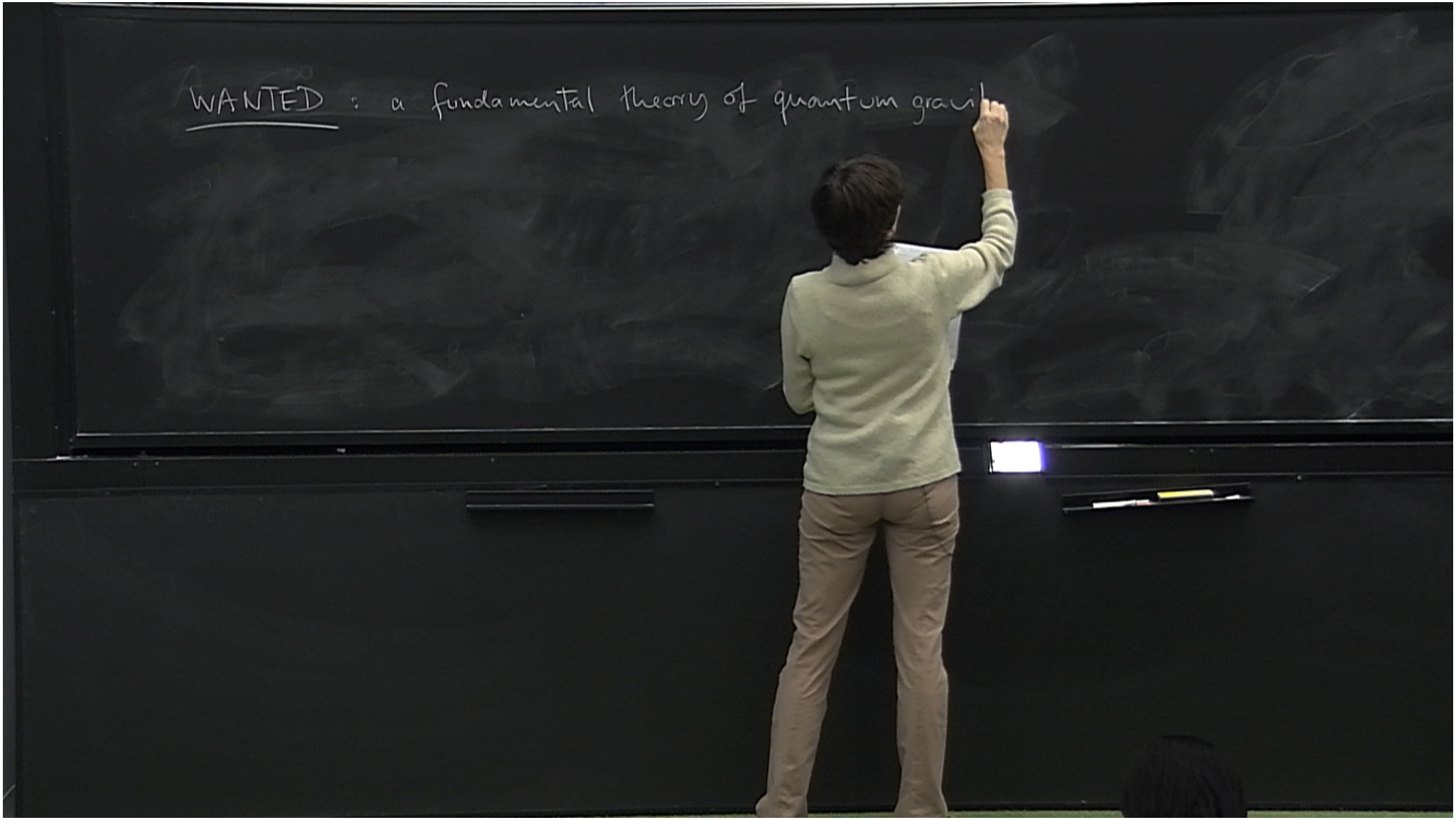
Title: Quantum Gravity (Review) - Lecture 1

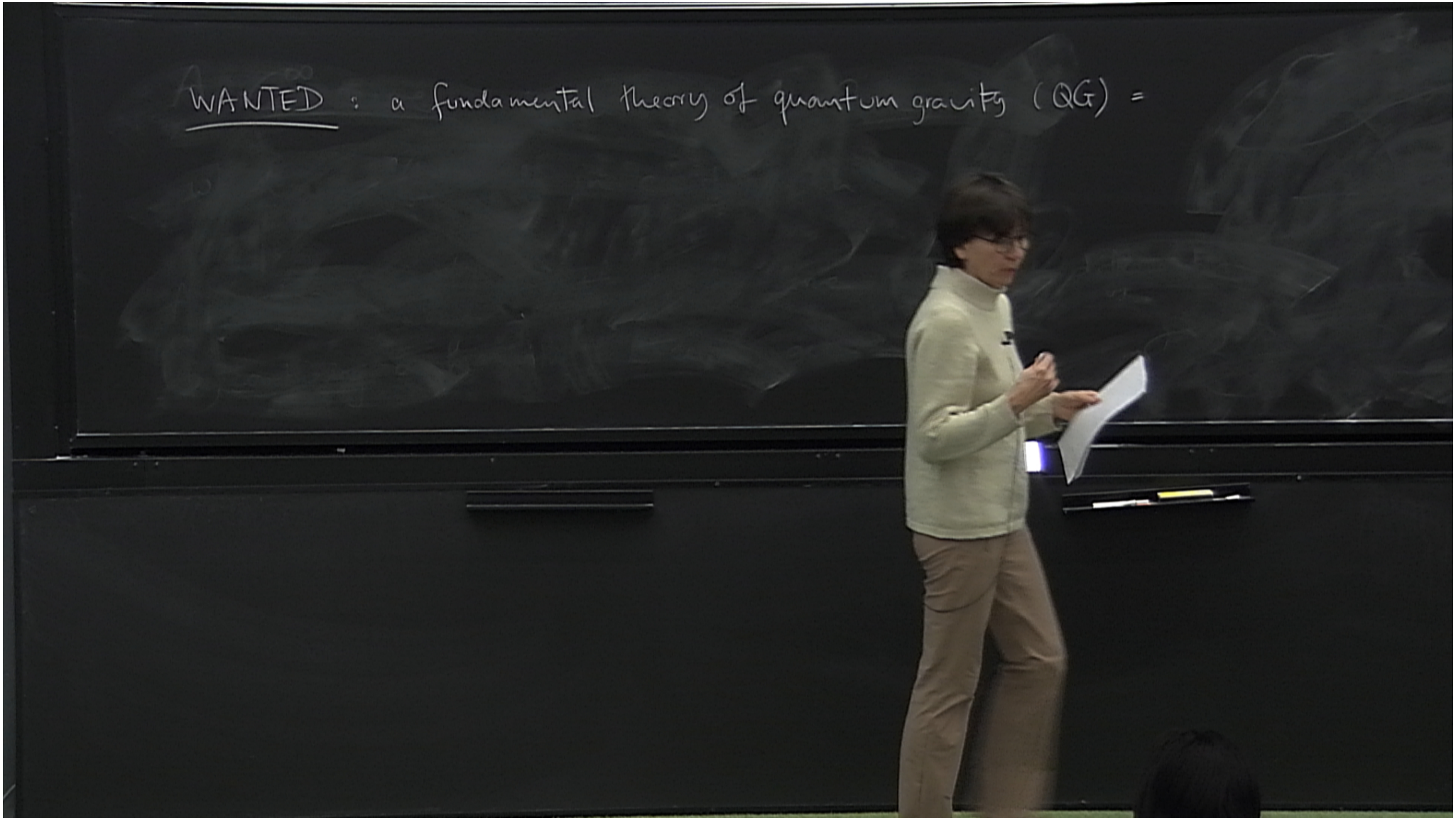
Date: Jan 23, 2012 10:15 AM

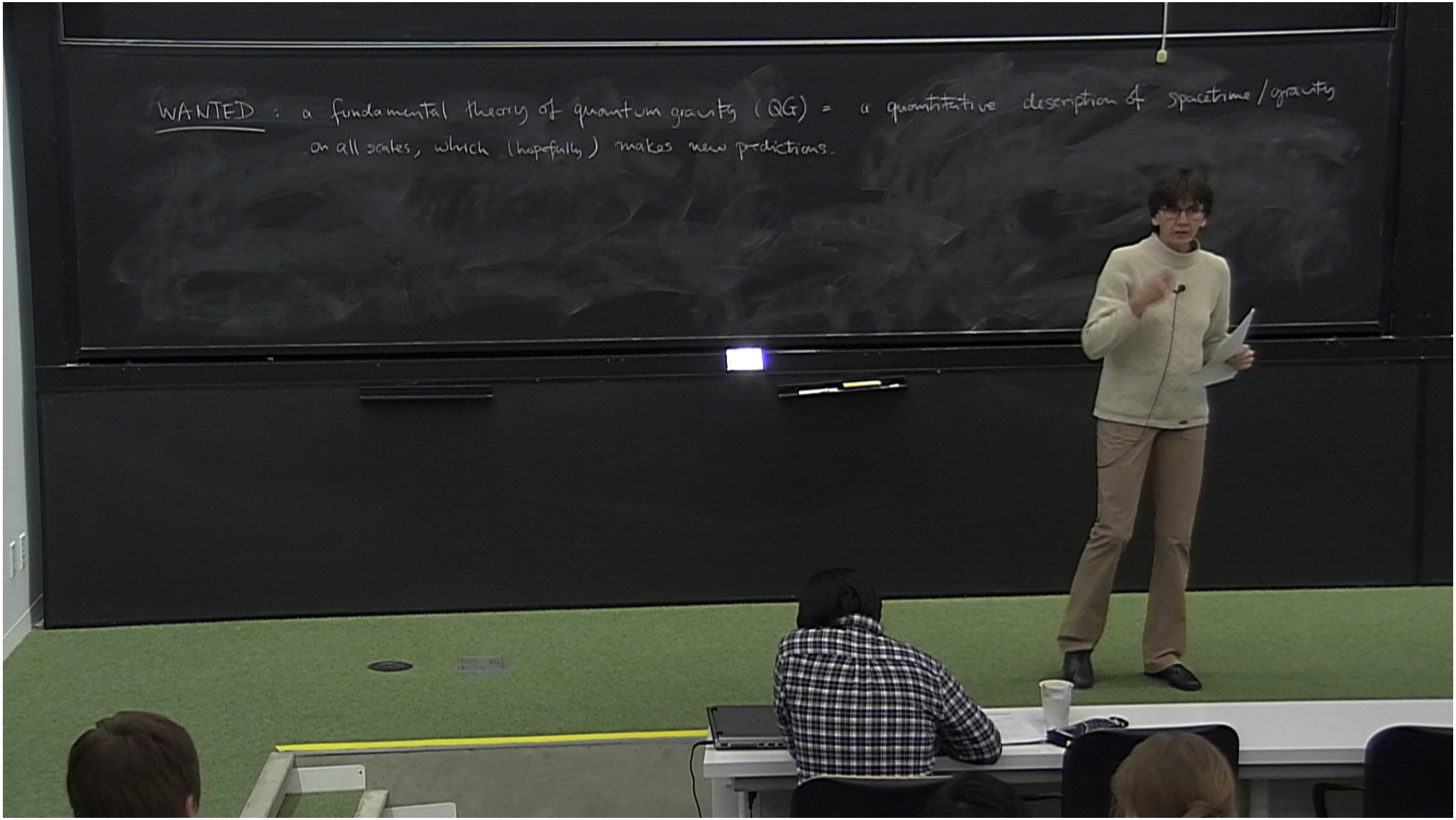
URL: http://pirsa.org/12010057

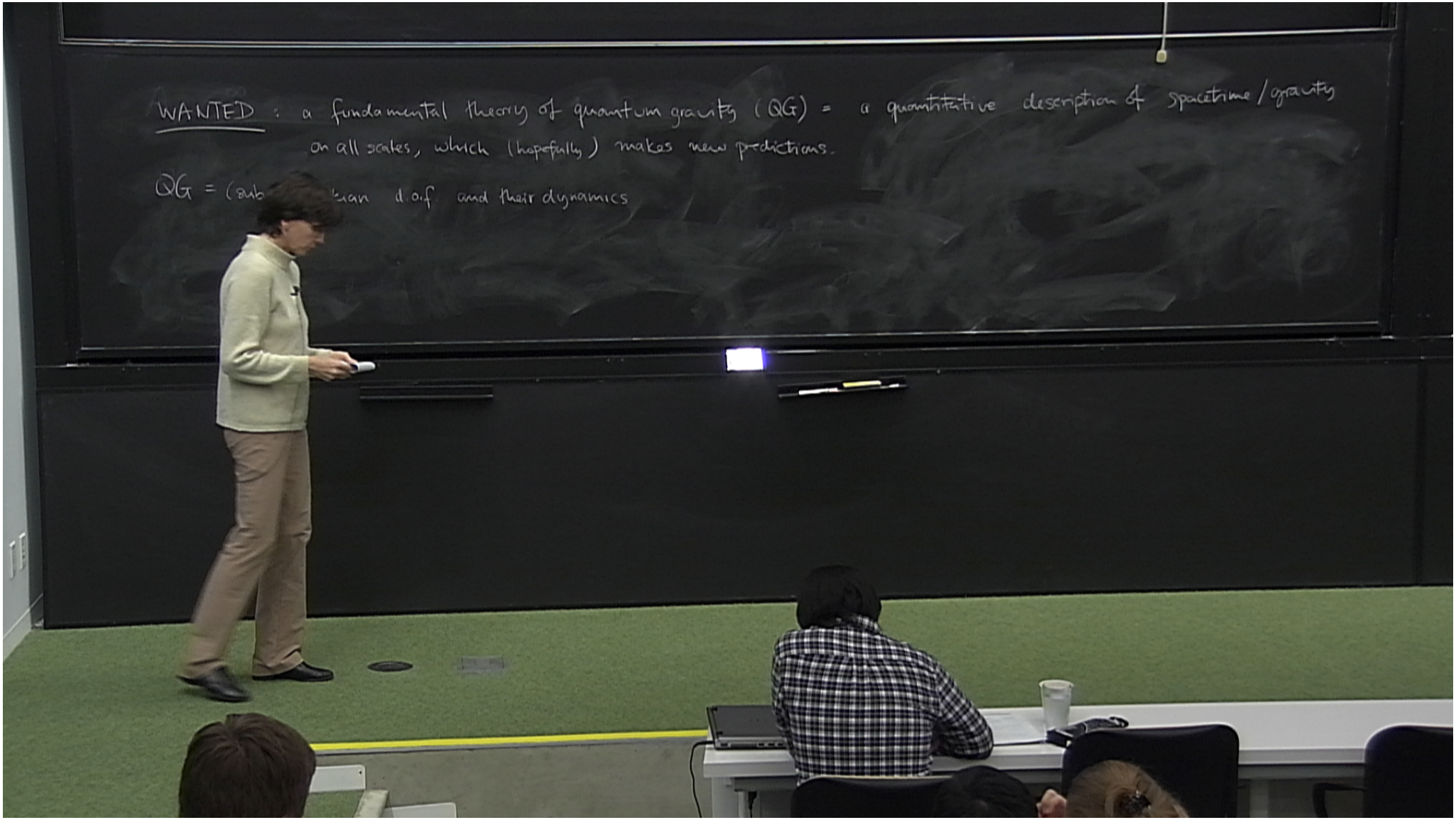
Abstract:


WANTED


WANTED : a fundamental theory of quantum


WANTED : a fundamental theory of quantum gravity (QG) =


WANTED : a fundamental theory of quantum gravity (QG) = a quantitative description of spacetime / gravity
on all scales, which (hopefully) makes new predictions.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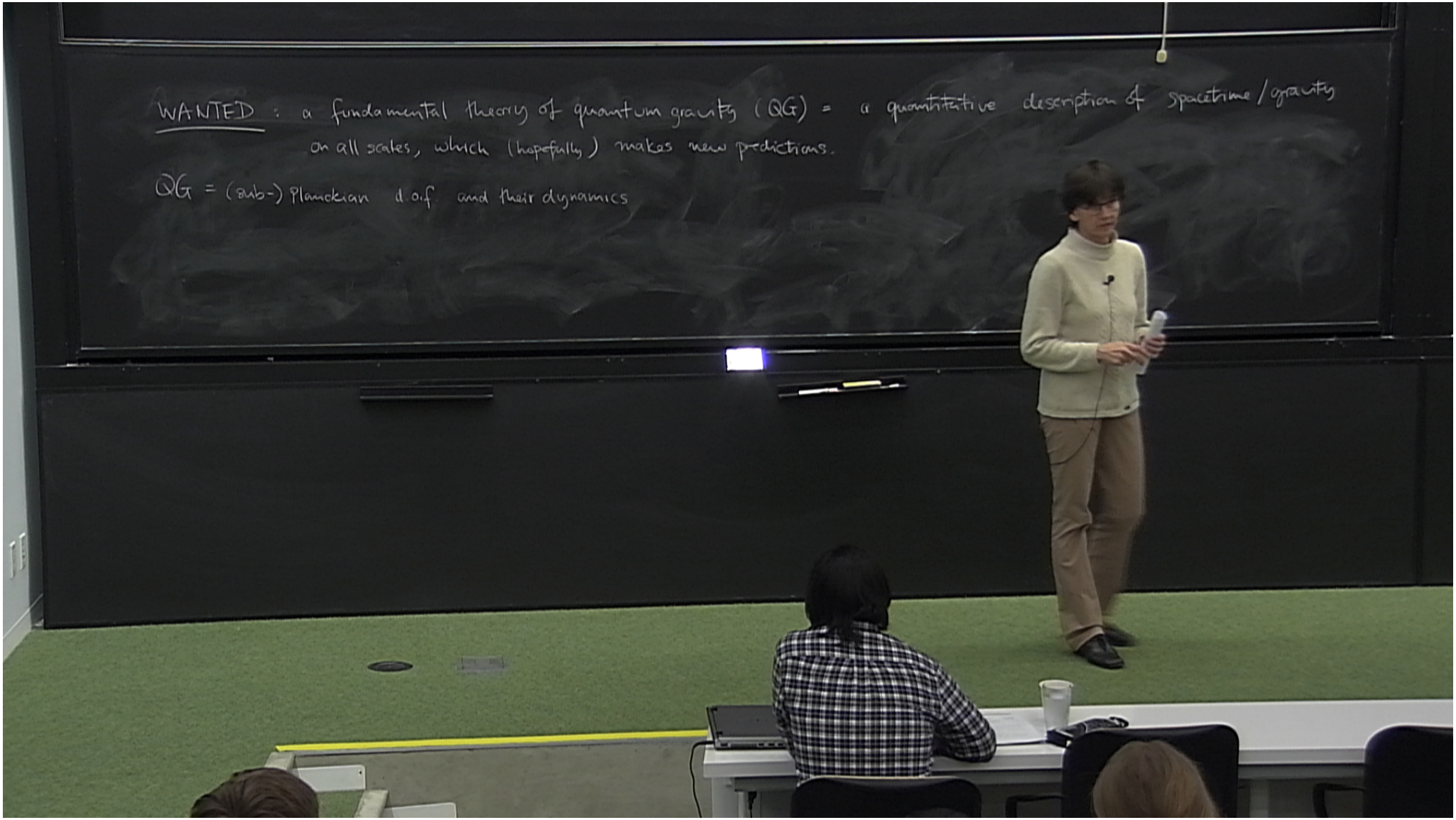
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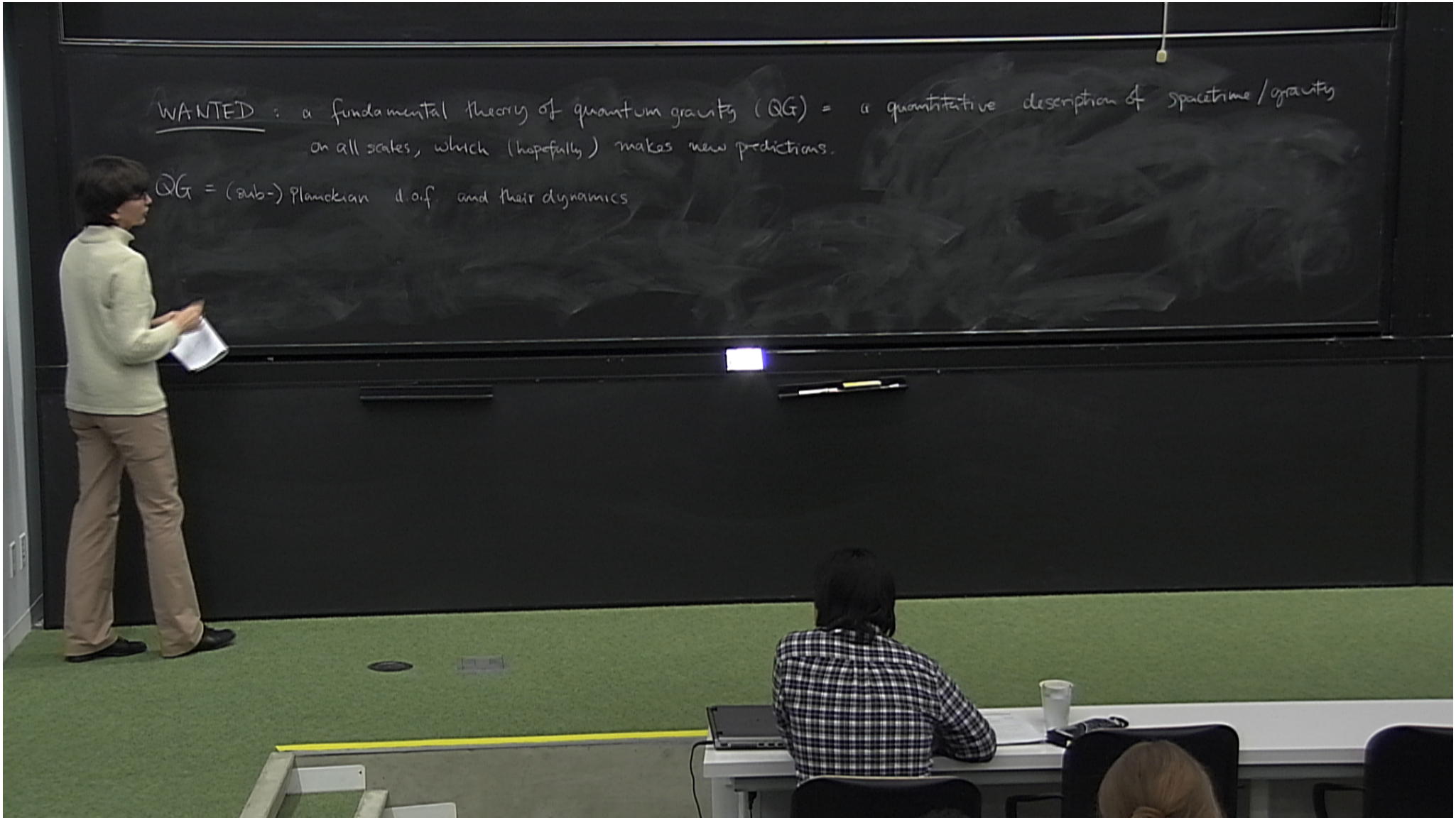
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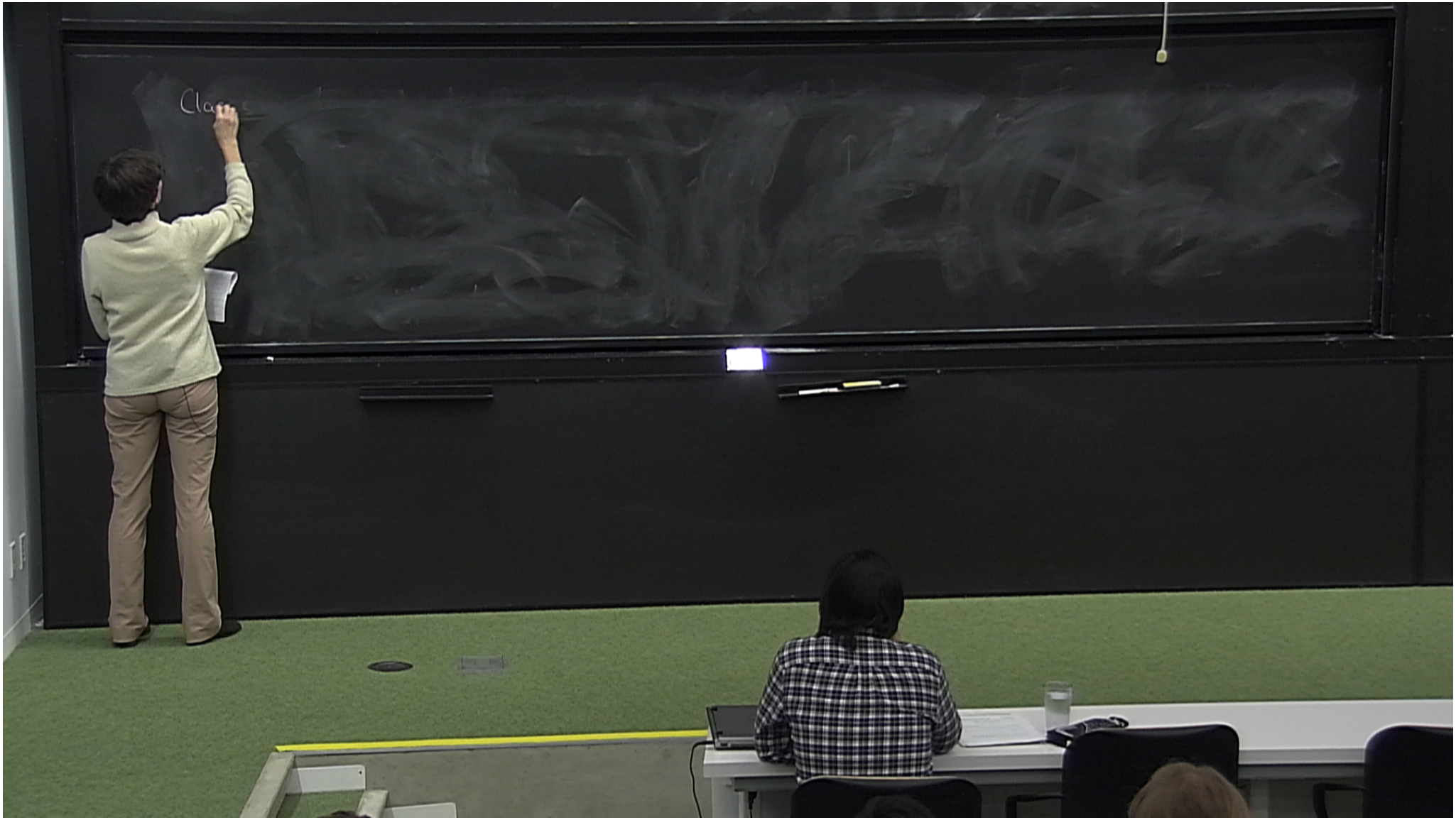
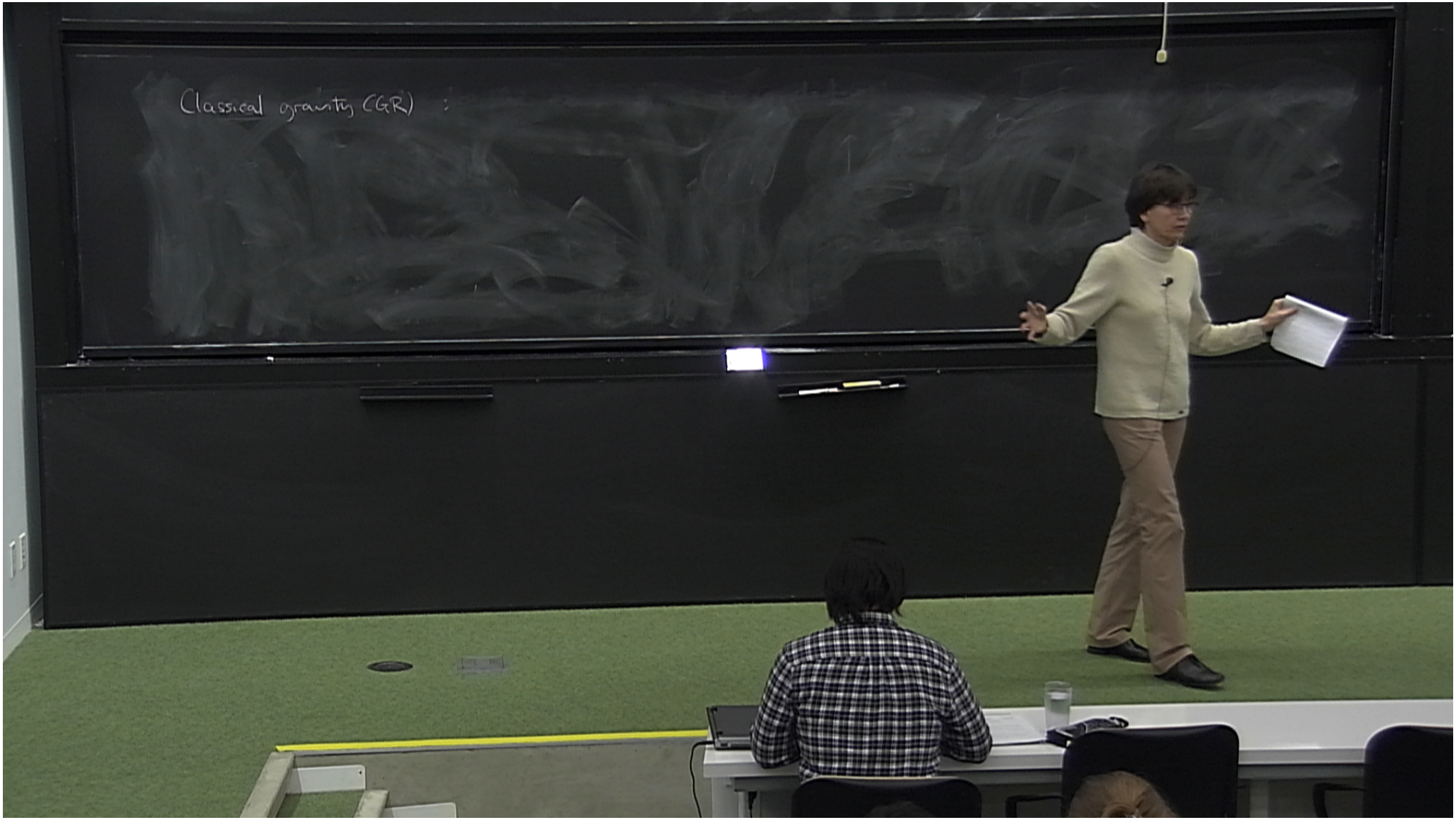
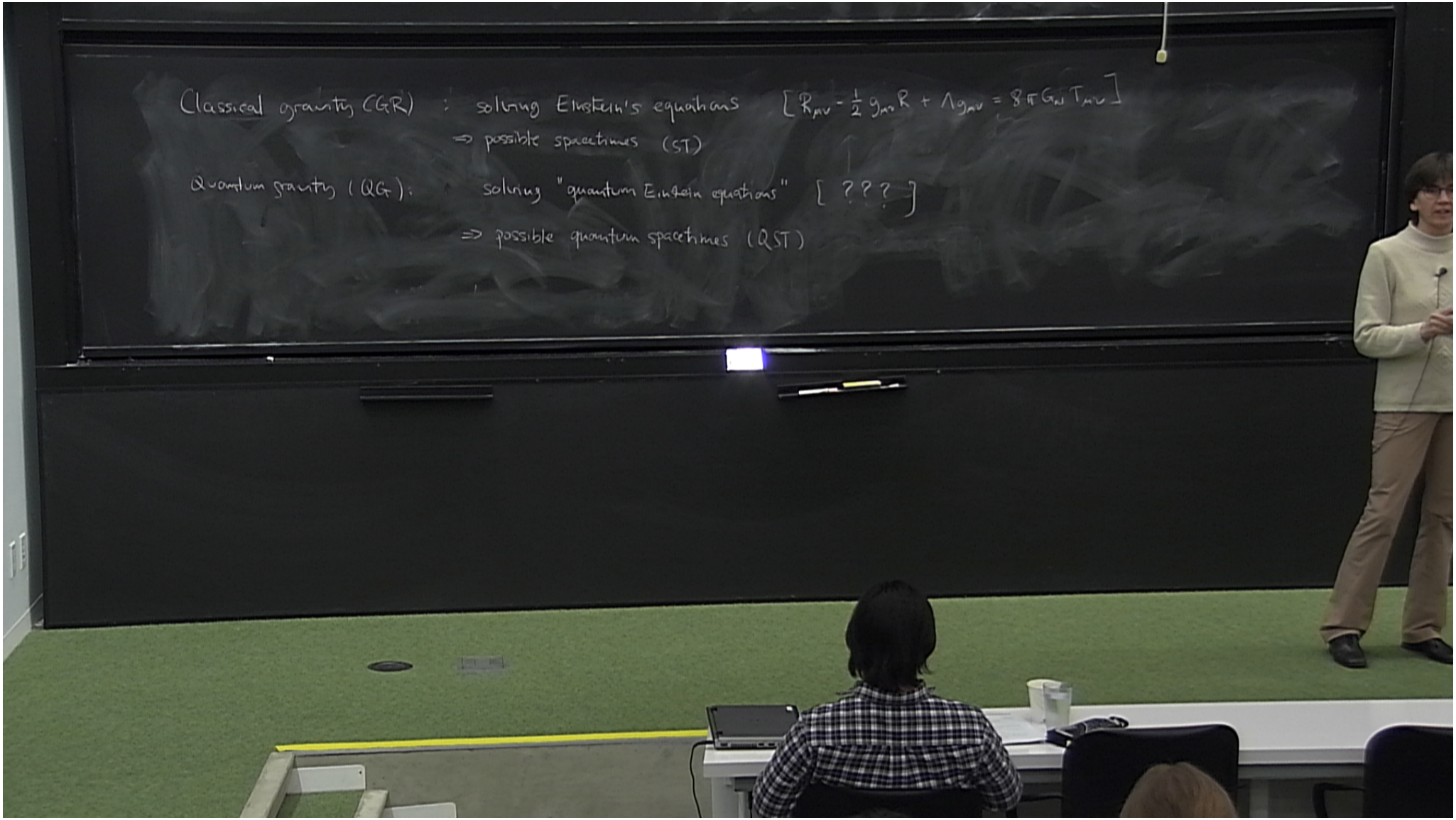
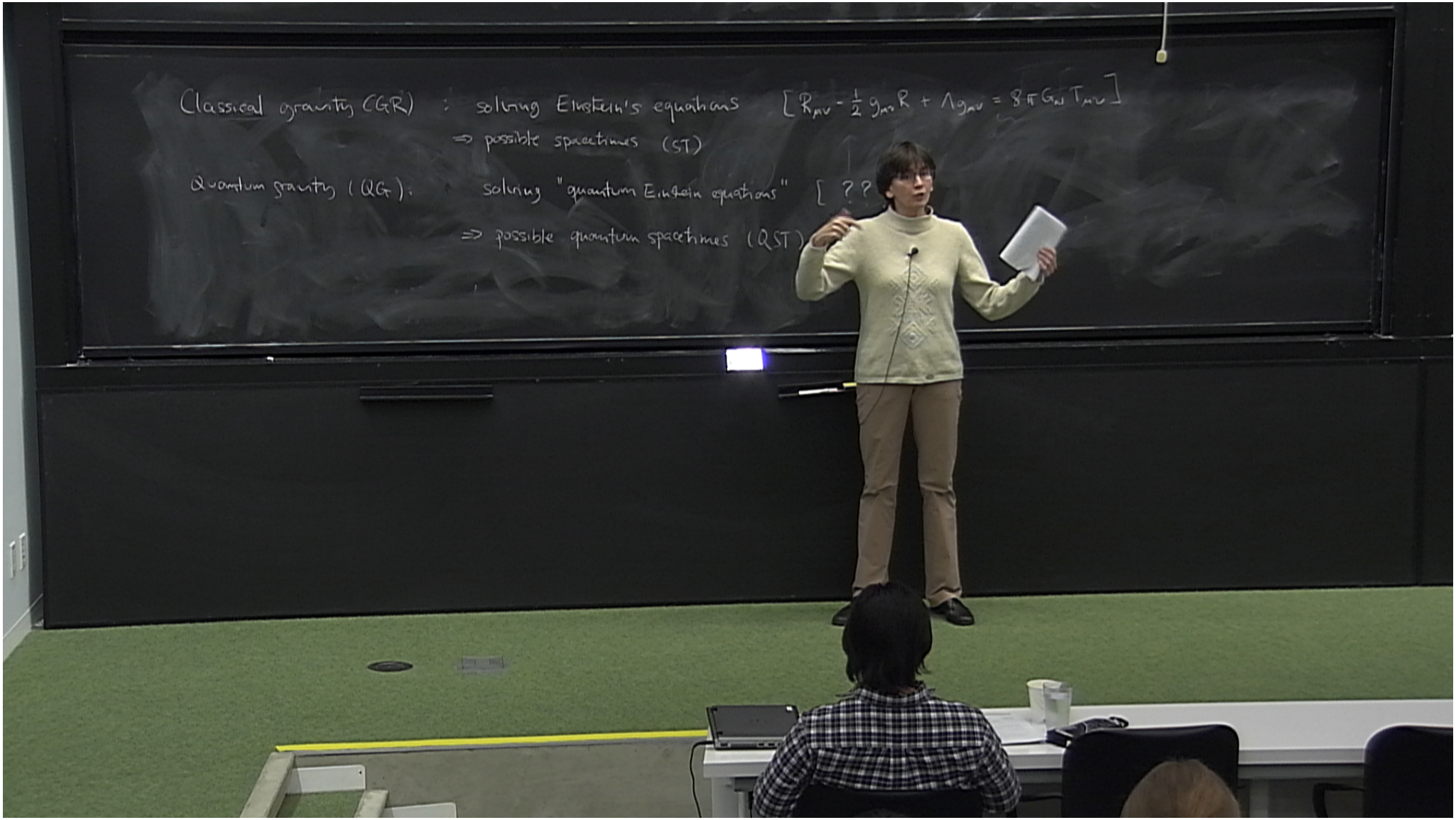



Classical gravity (GR) :


Classical gravity (GR) : solving Einstein's equations [$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R + \Lambda g_{\mu\nu} = 8\pi G_N T_{\mu\nu}$]
⇒ possible spacetimes (ST)
Quantum gravity (QG): solving "quantum Einstein equations" [???]
⇒ possible quantum spacetimes (QST)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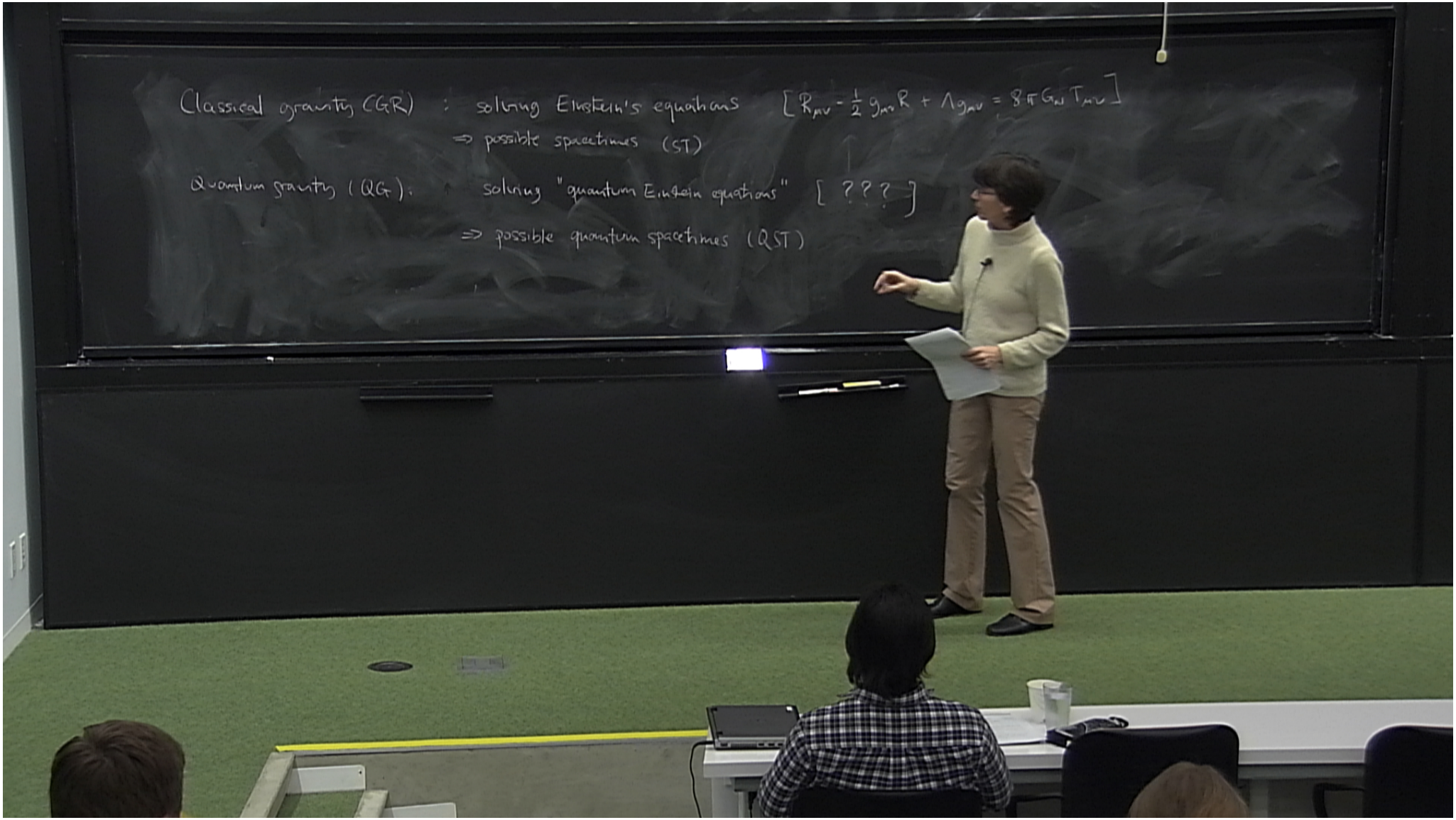
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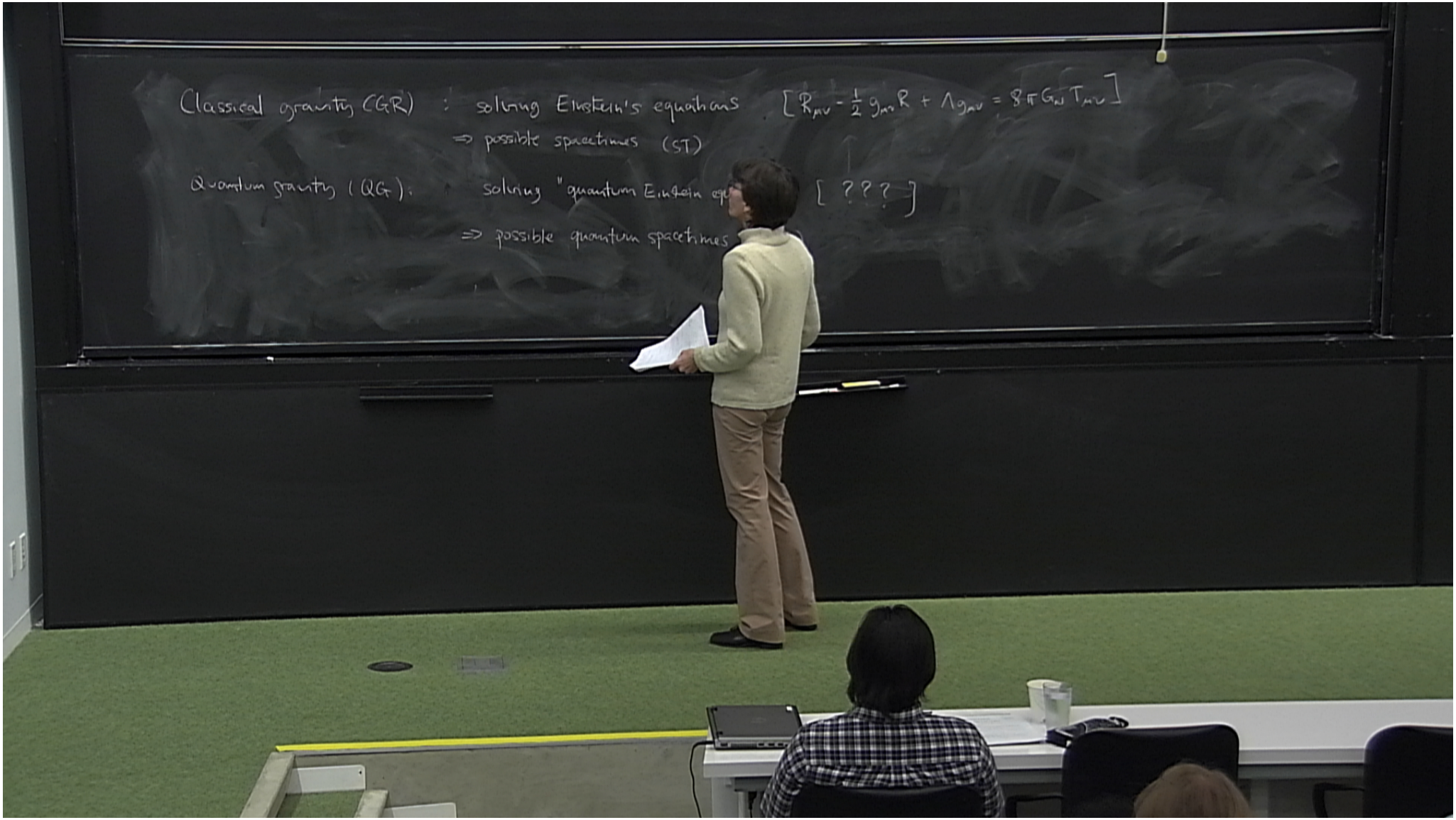
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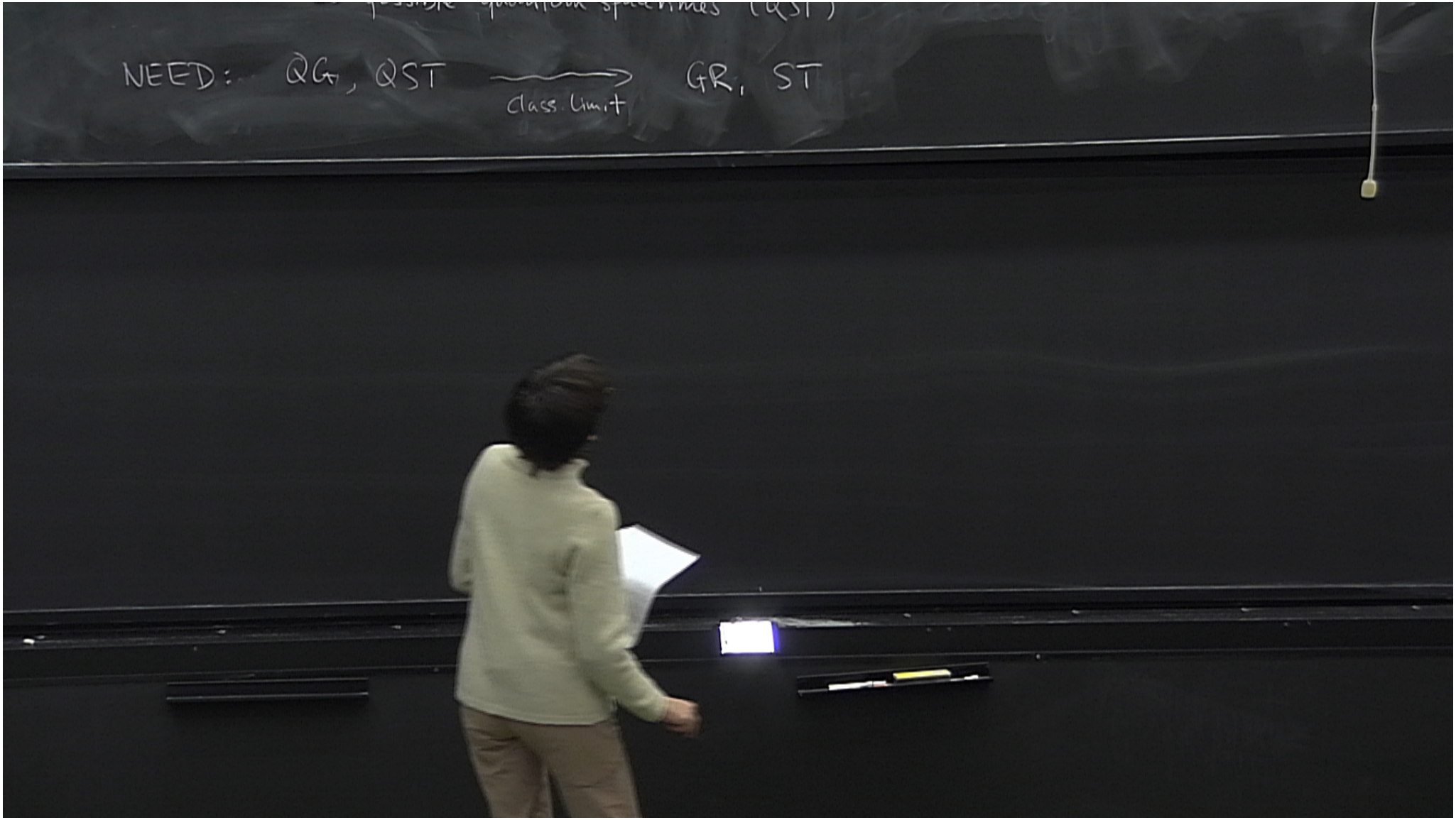
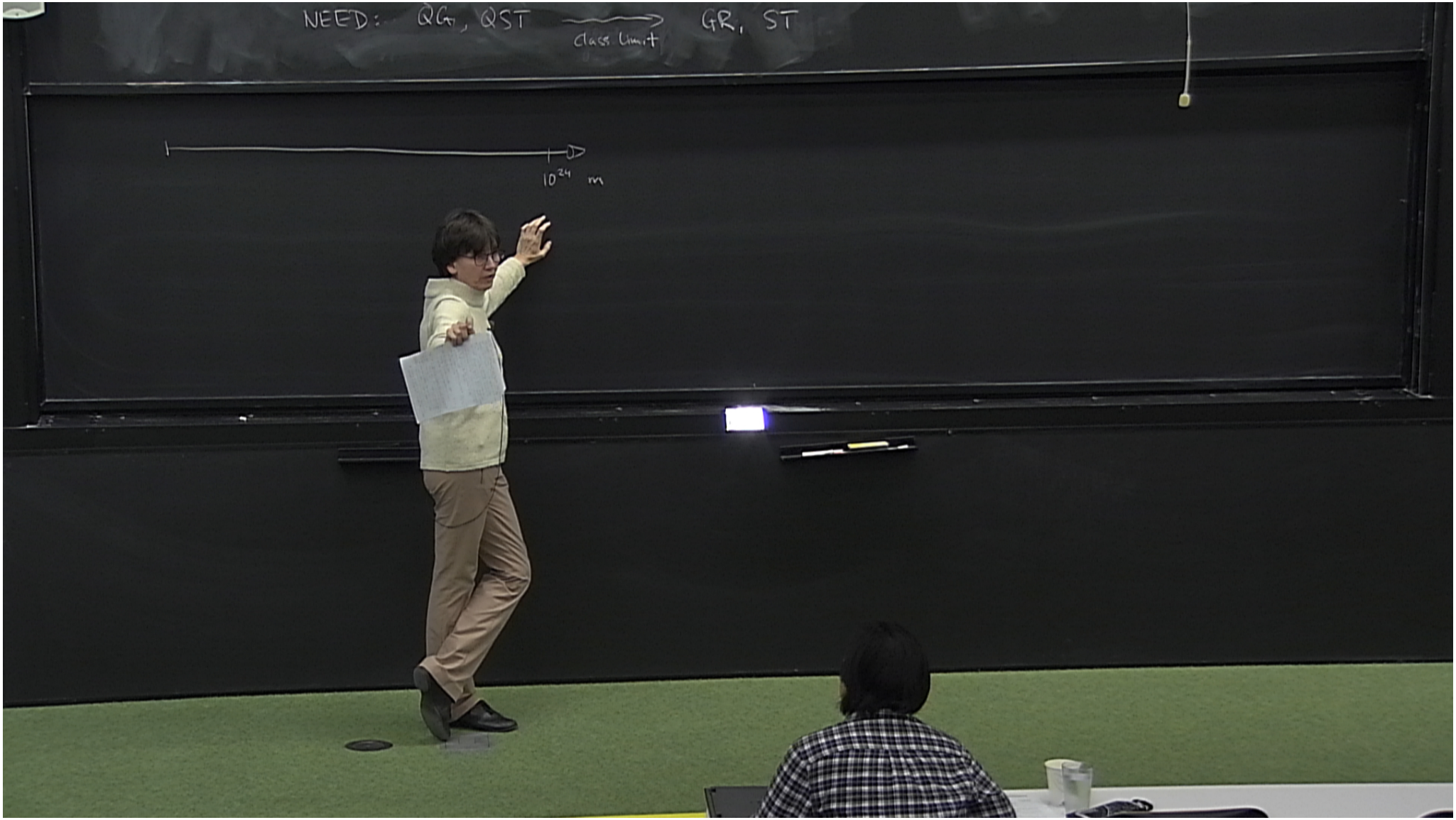
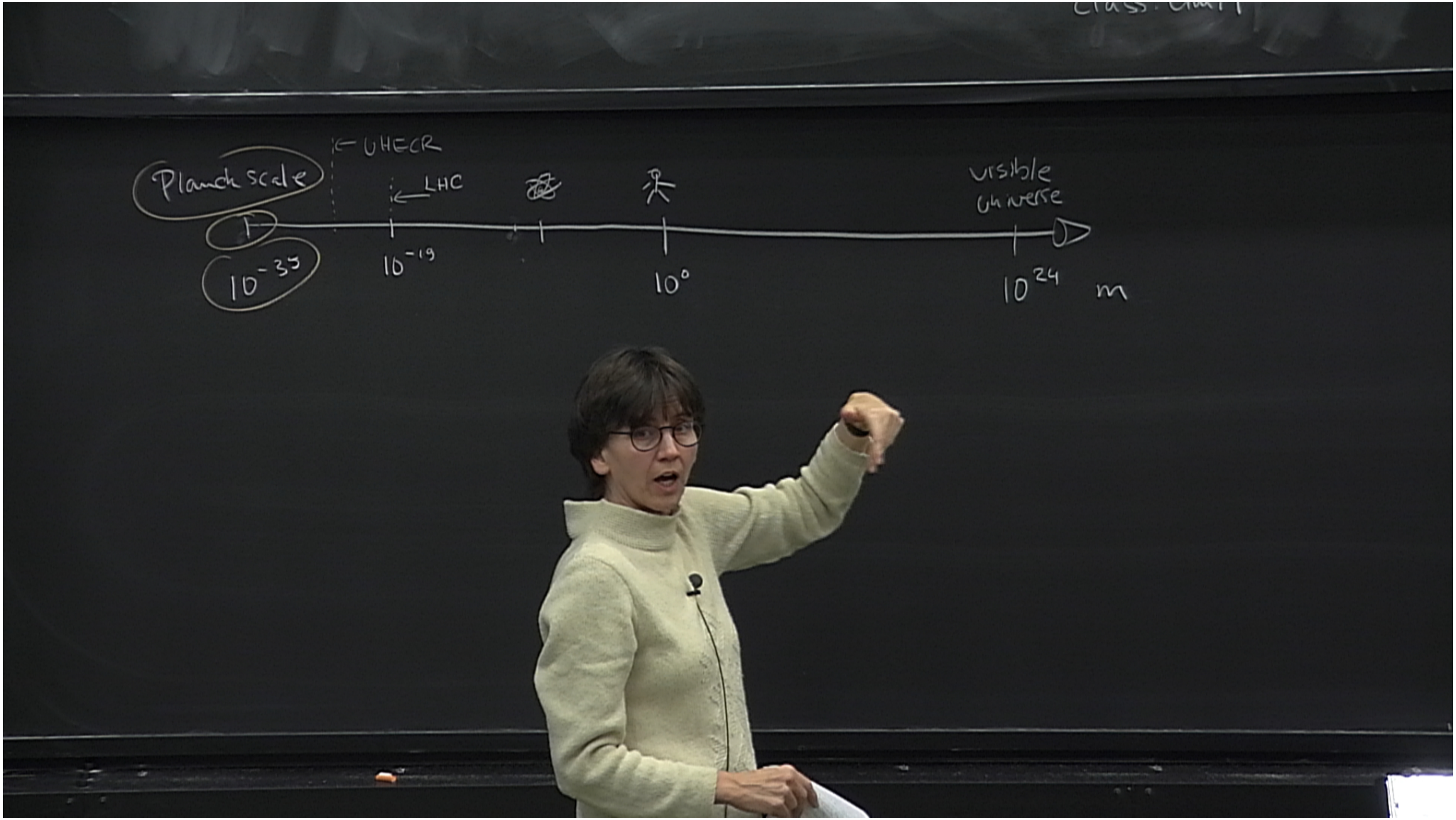
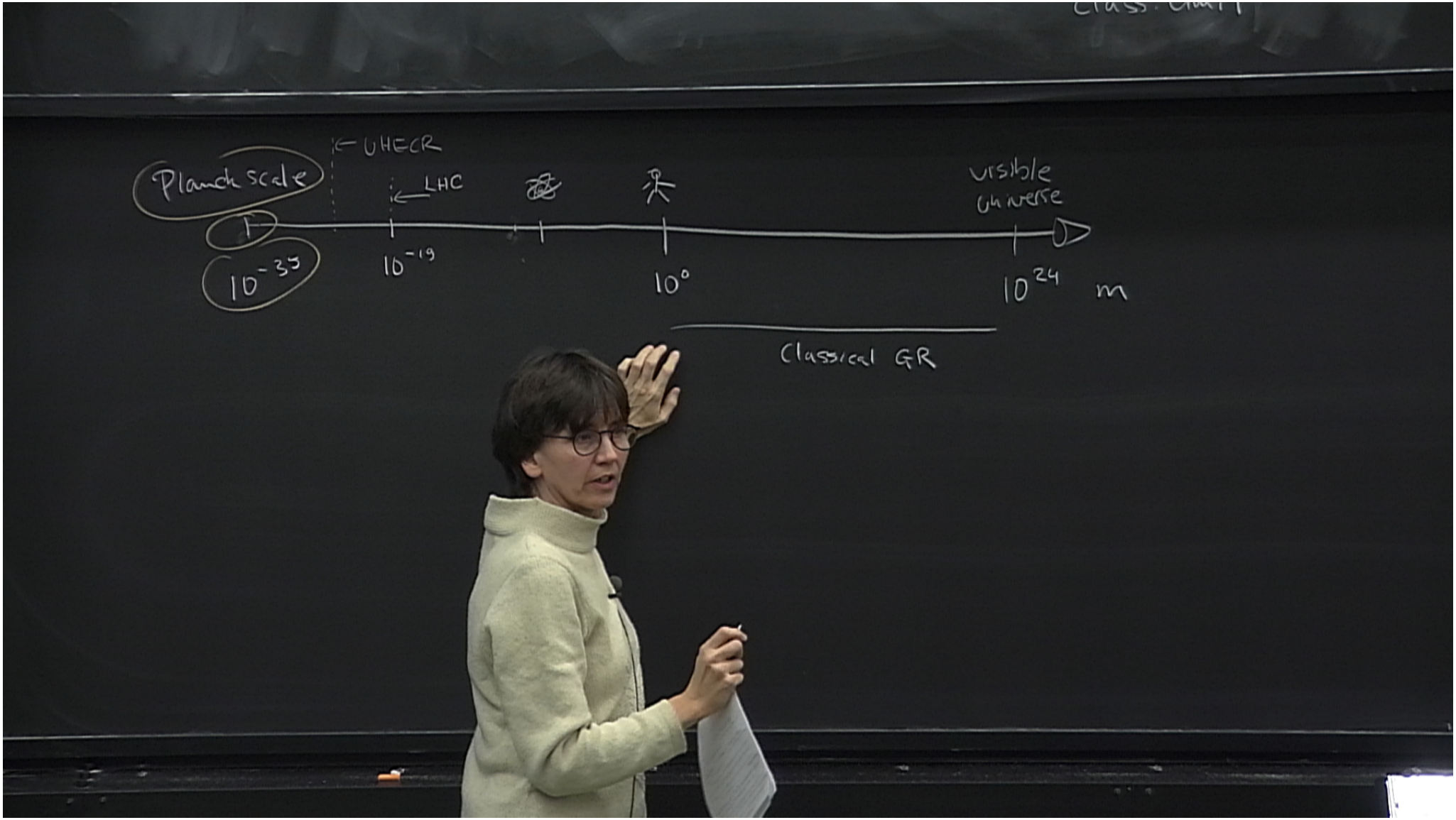
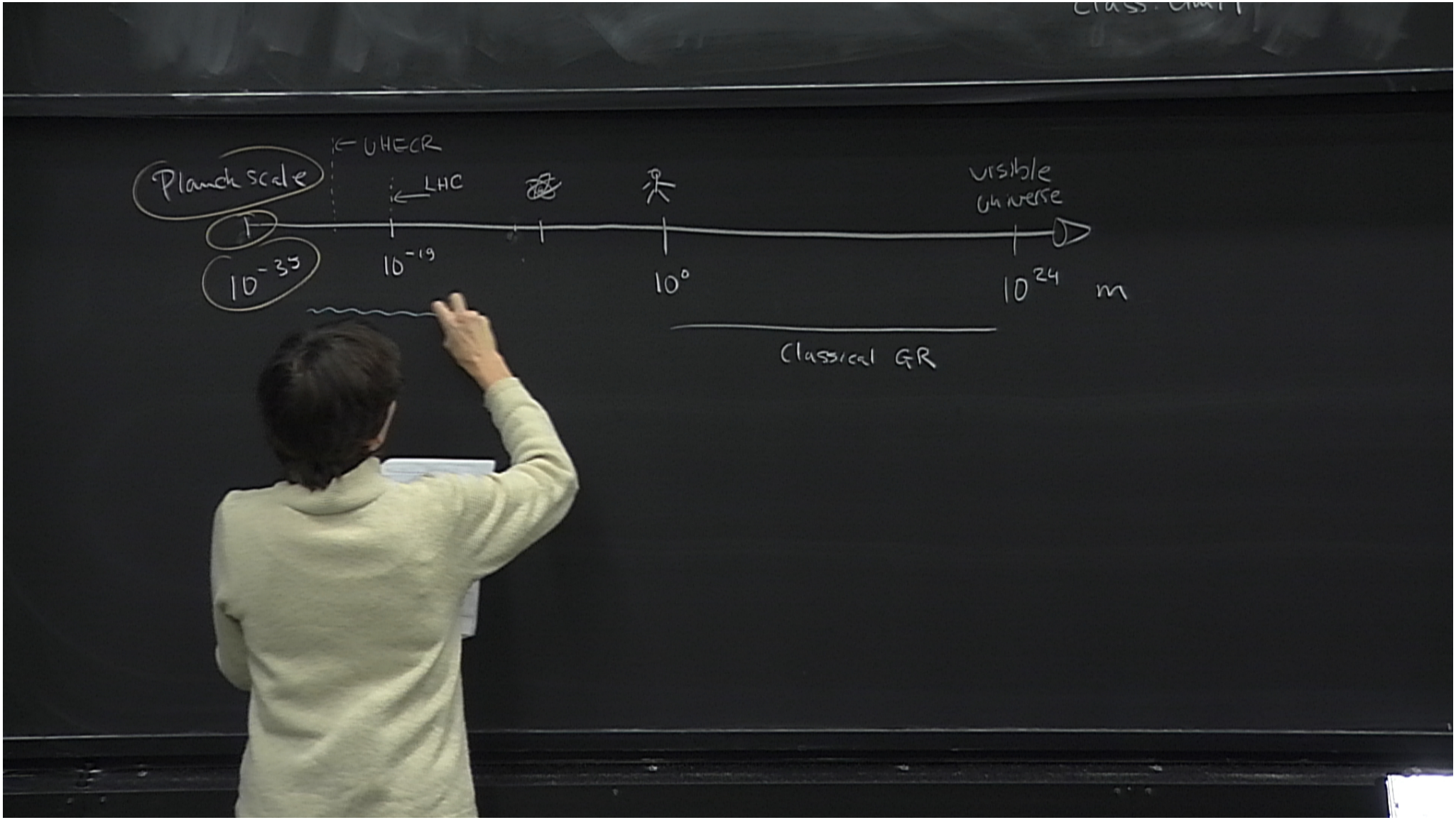
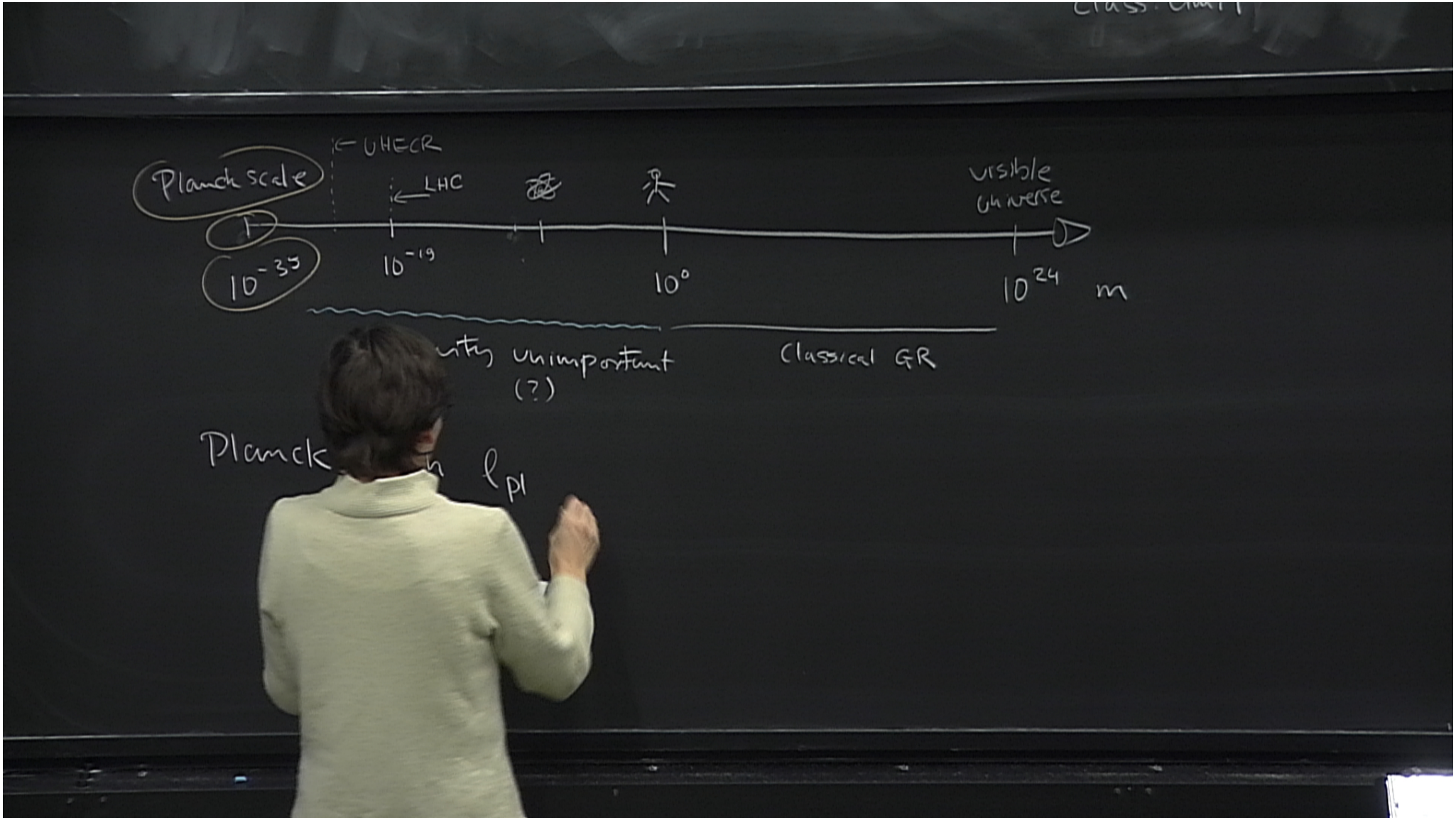

NEED: QG, QST
Class. Limit
GR, ST

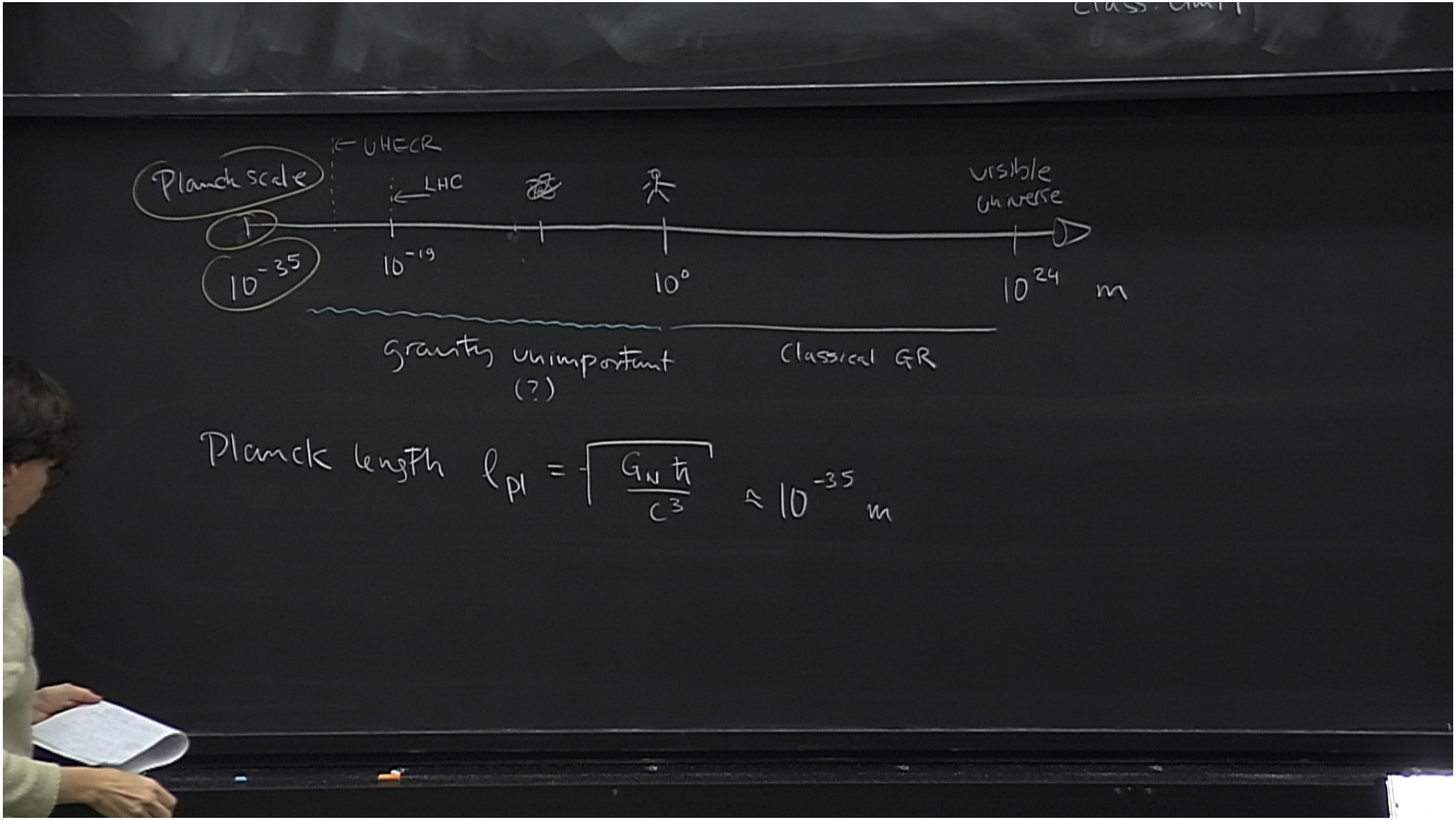

NEED: QG, QST
Class. Limit
GR, ST
10^{24} m

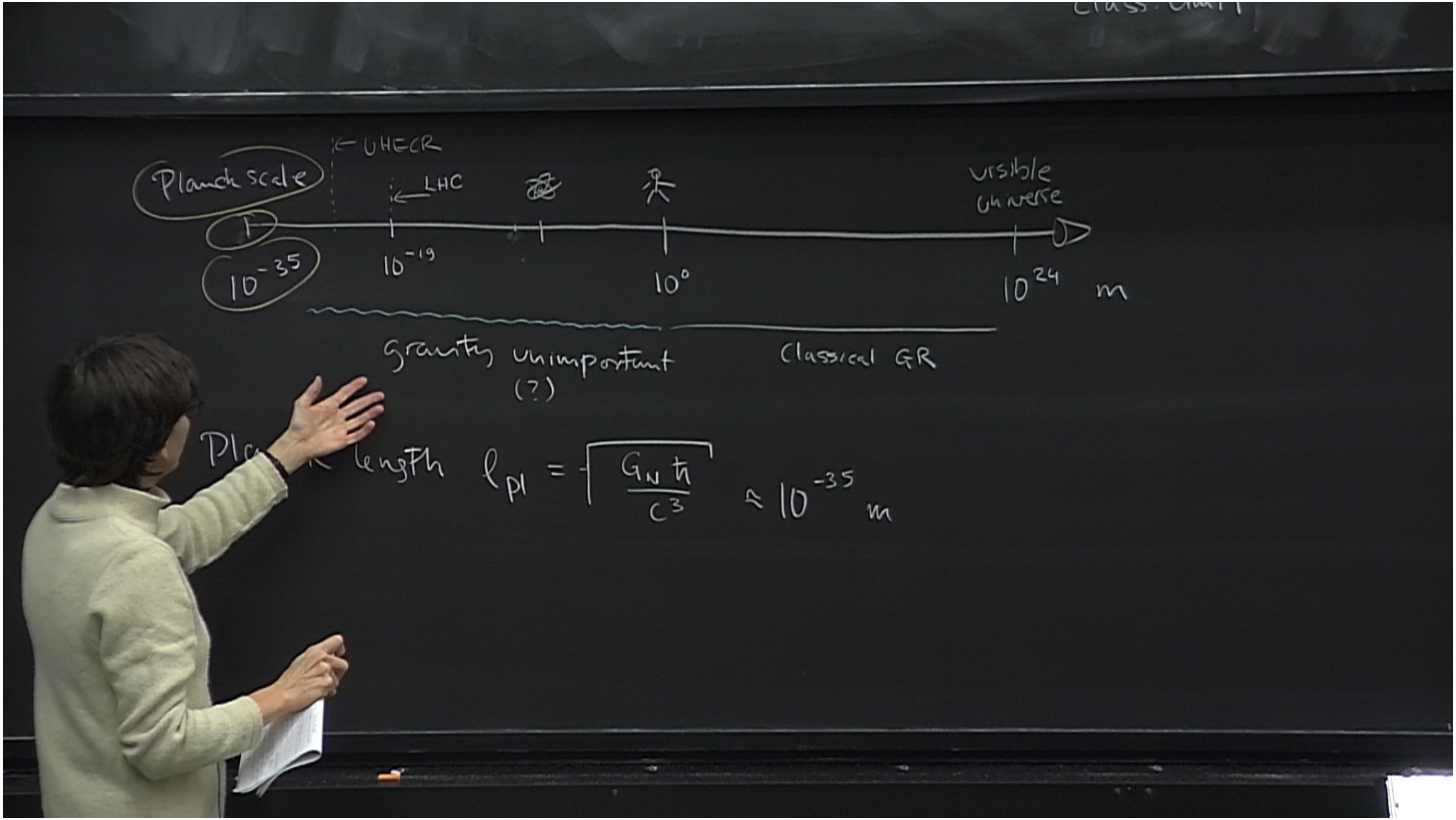

Planck scale
UHECR
LHC
visible universe
10^{-35}
10^{-19}
10^{0}
10^{24}
m


Planck scale
UHECR
LHC
visible universe
10^{-35}
10^{-19}
10^{0}
10^{24}
m
Classical GR


UHECR
Planck scale
LHC
visible universe
10^{-35}
10^{-19}
10^{0}
10^{24}
m
Classical GR


UHECR
Planck scale
LHC
visible universe
1
10^{-35}
10^{-19}
10^{0}
10^{24}
m
unimportant
(?)
Classical GR
Planck
ℓ_{Pl}


UHECR
Planck scale
LHC
visible universe
10^{-35}
10^{-19}
10^{0}
10^{24} m
gravity unimportant (?)
Classical GR
Planck length $\ell_{Pl} = \sqrt{\frac{G_N \hbar}{c^3}} \approx 10^{-35}$ m


UHECR
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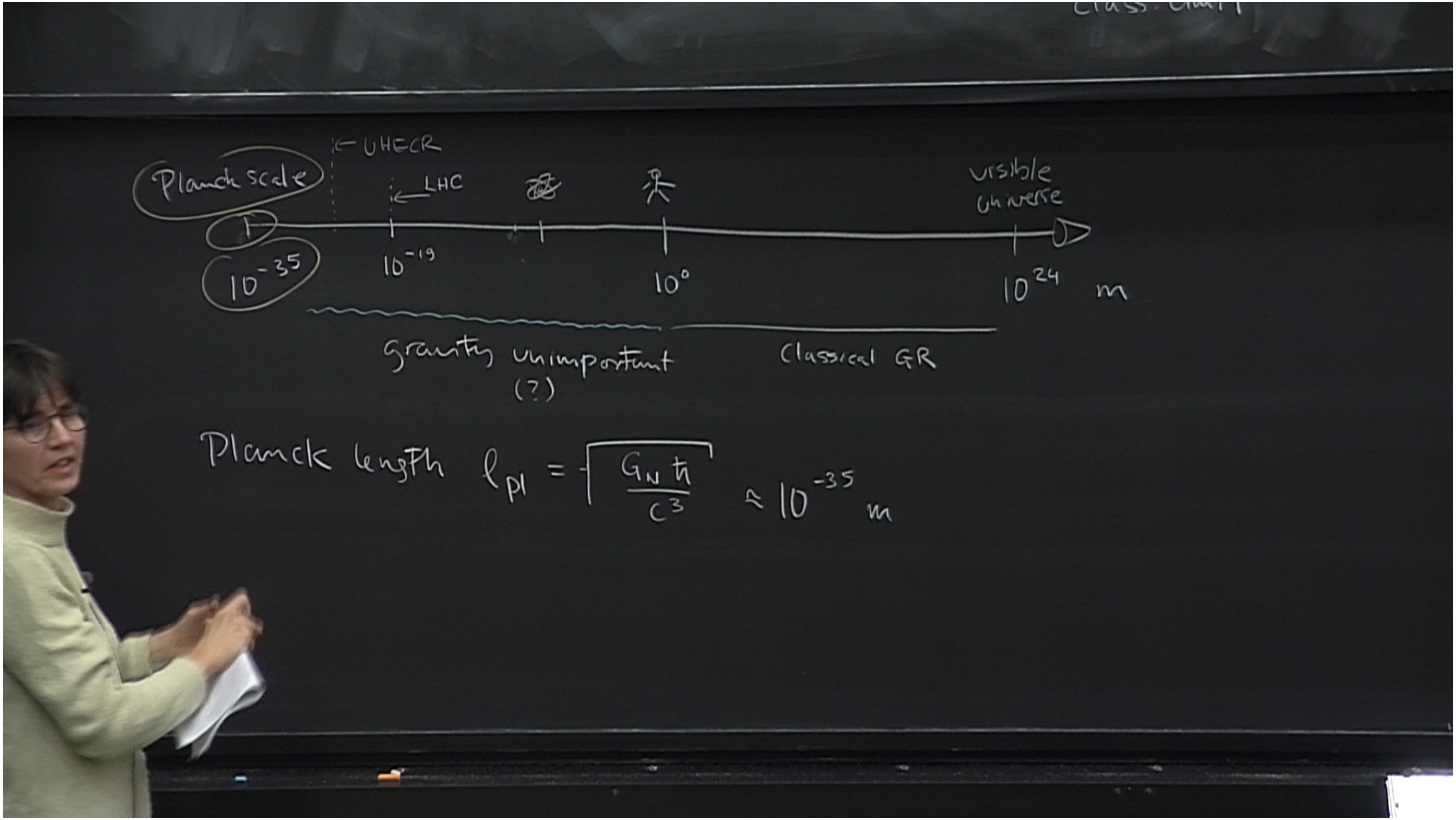
UHECR
Planck scale
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visible universe
1
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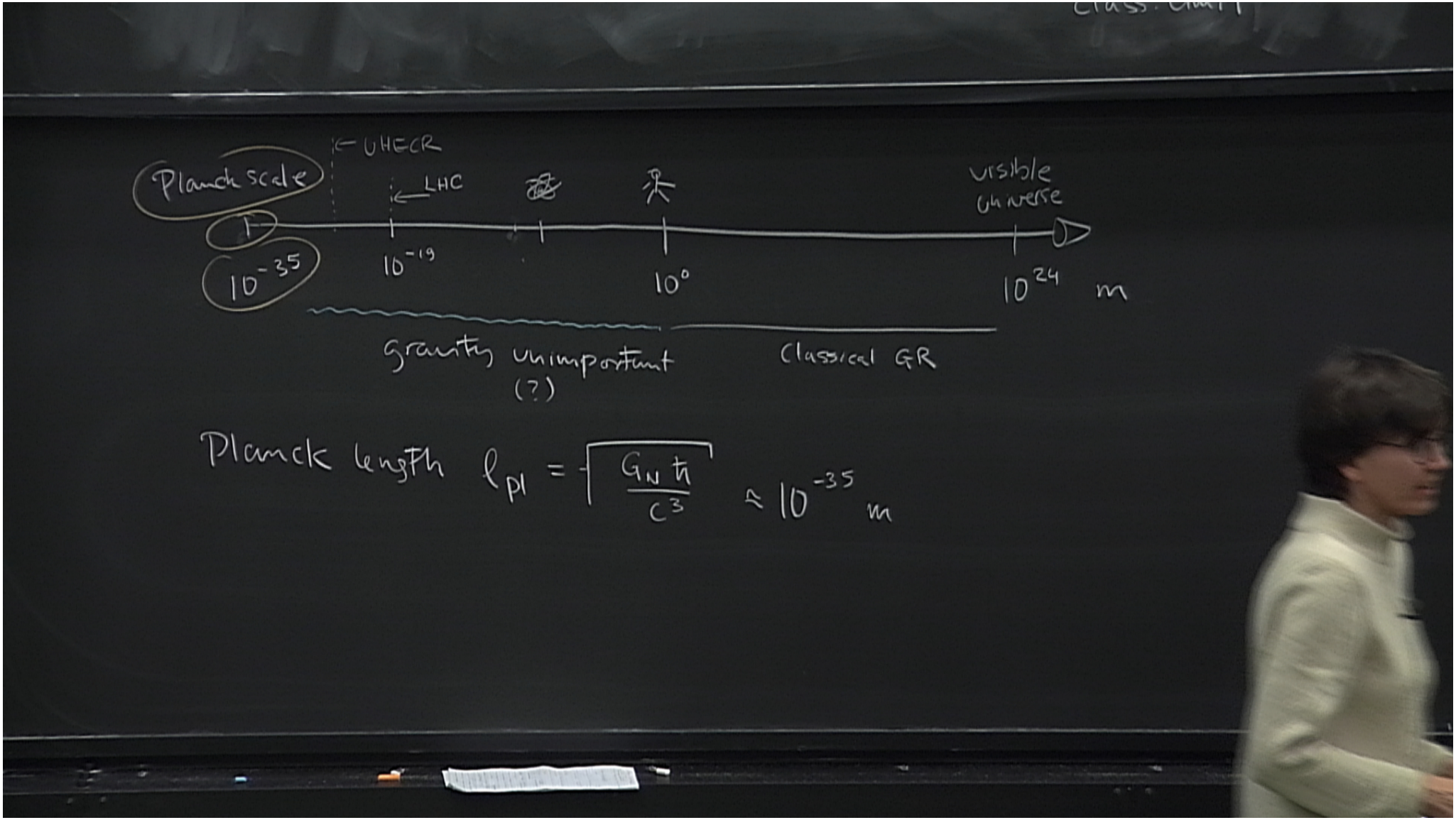
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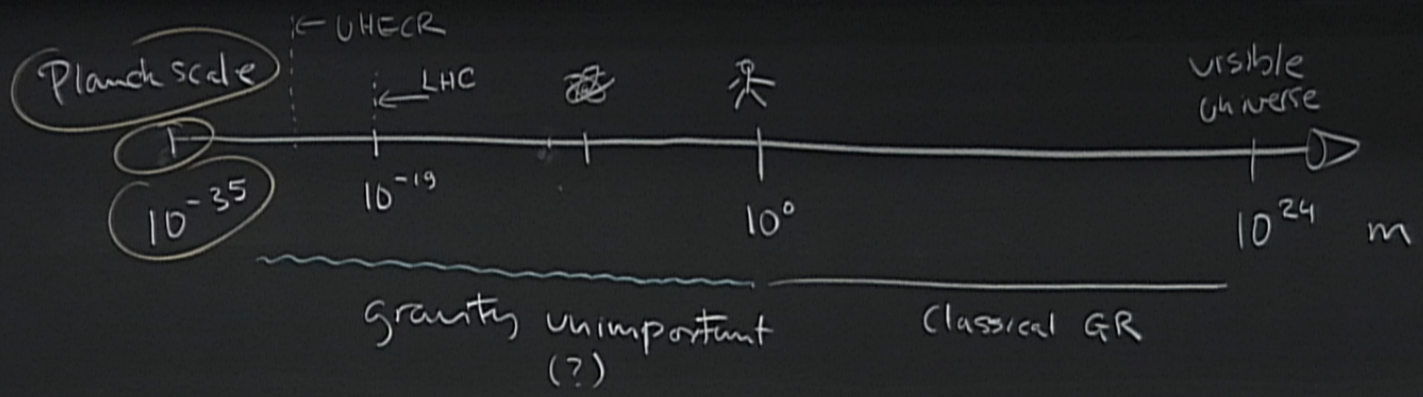

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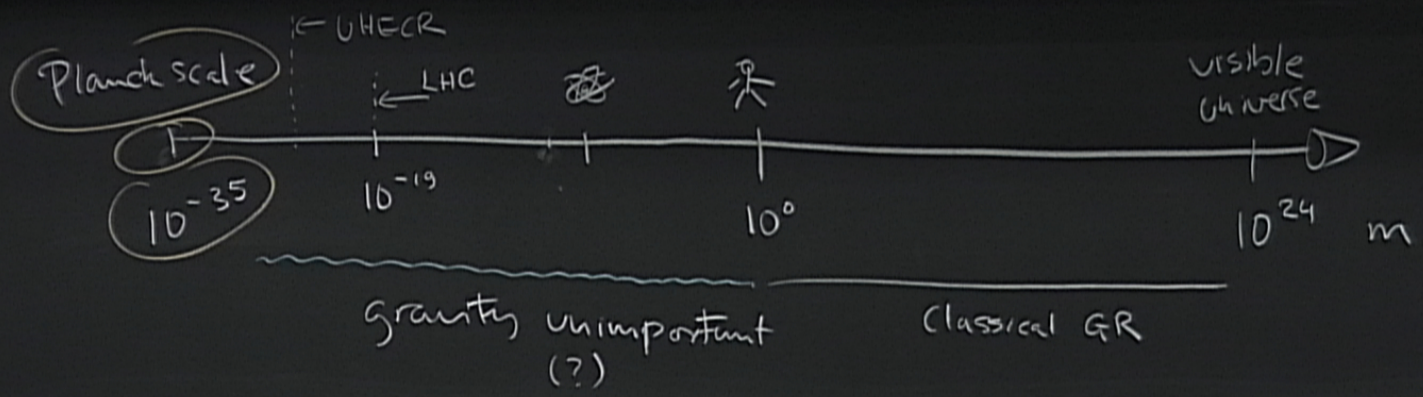

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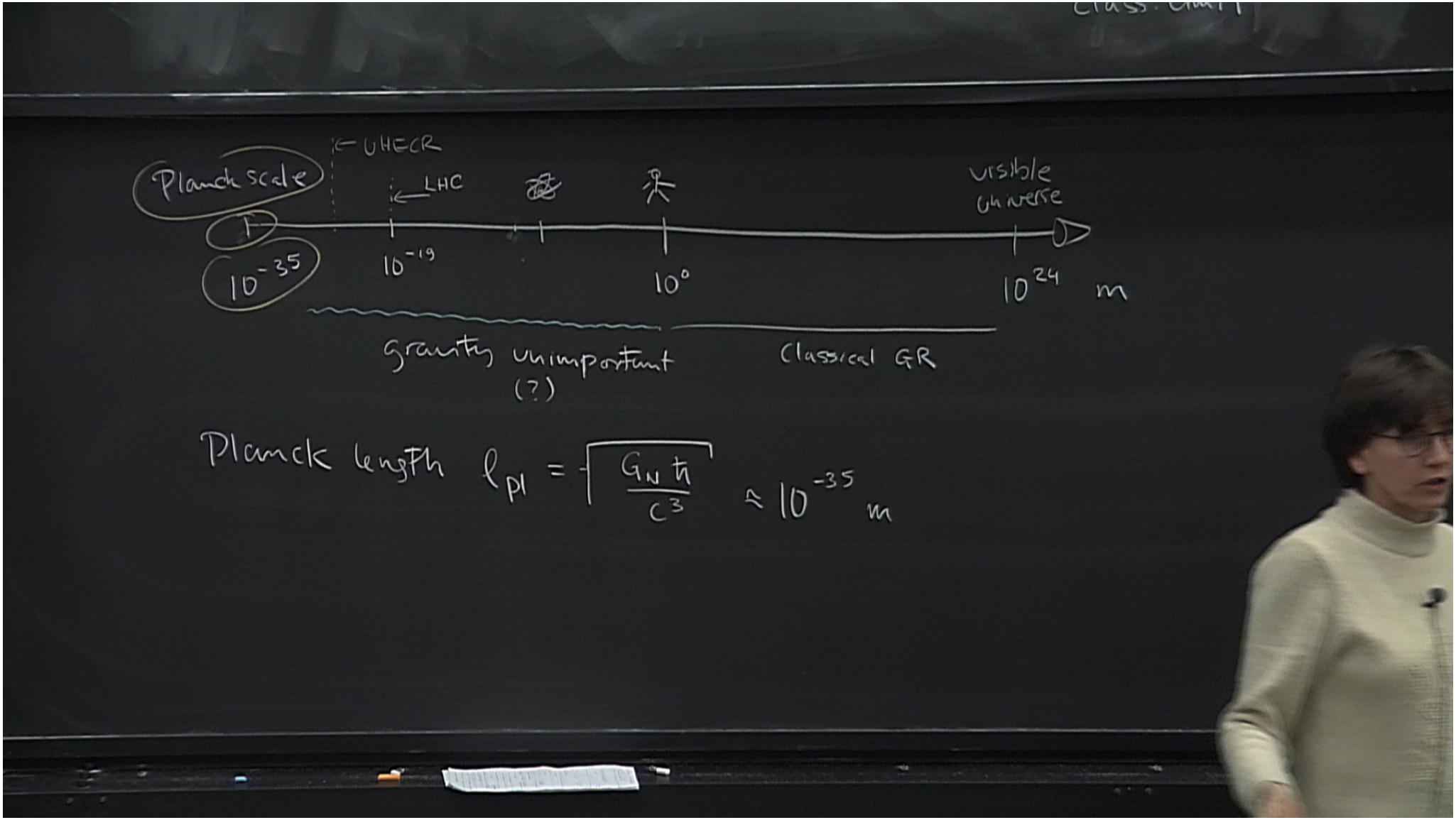
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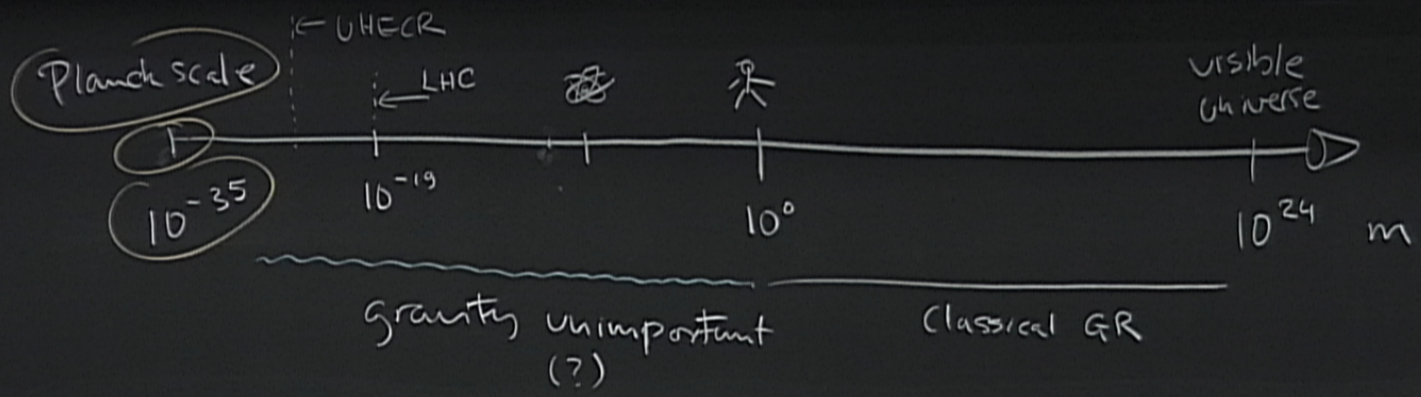

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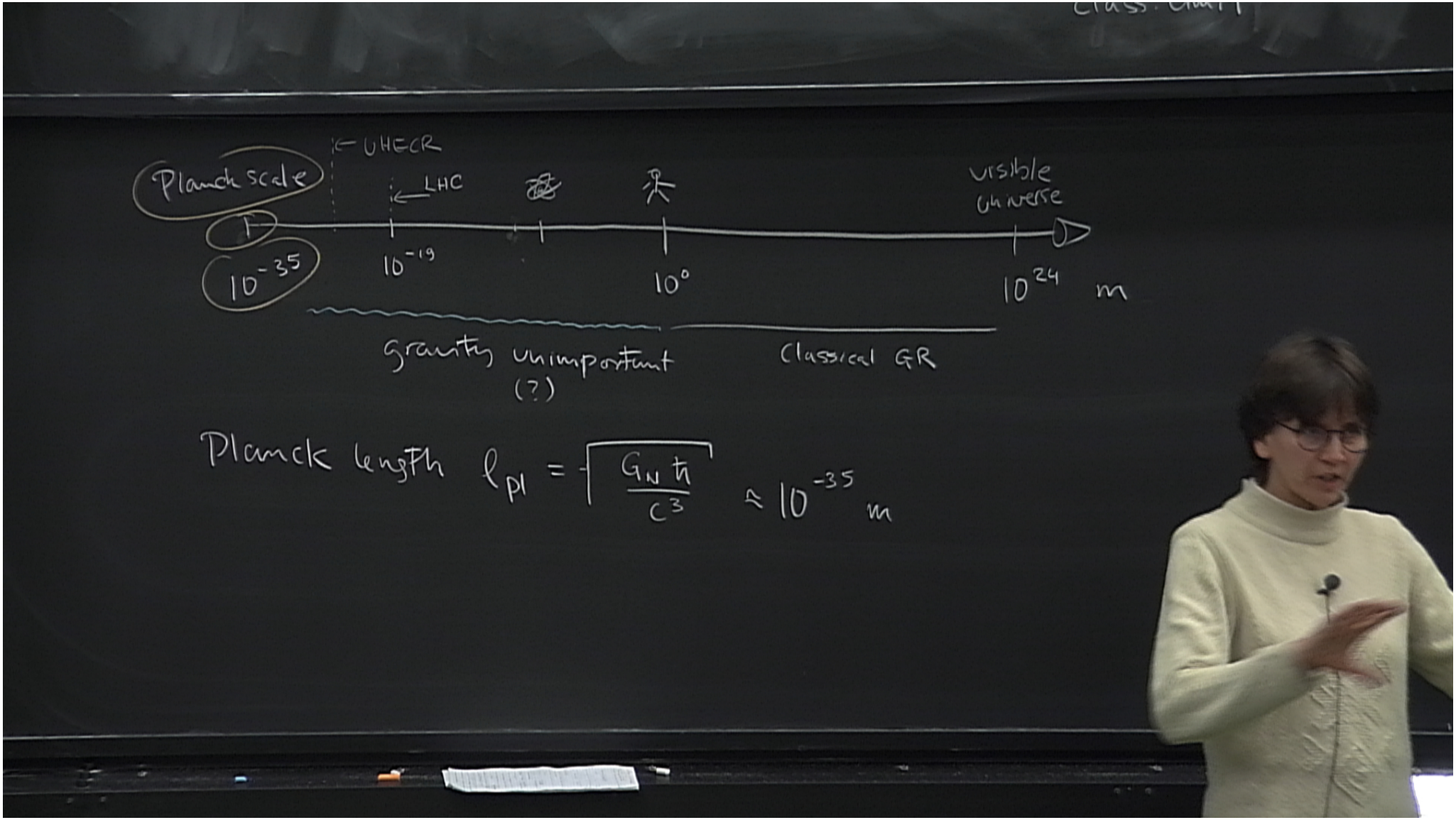
Planck scale
UHECR
LHC
visible universe
1
10^{-35}
10^{-19}
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10^{24} m
gravity unimportant (?)
Classical GR
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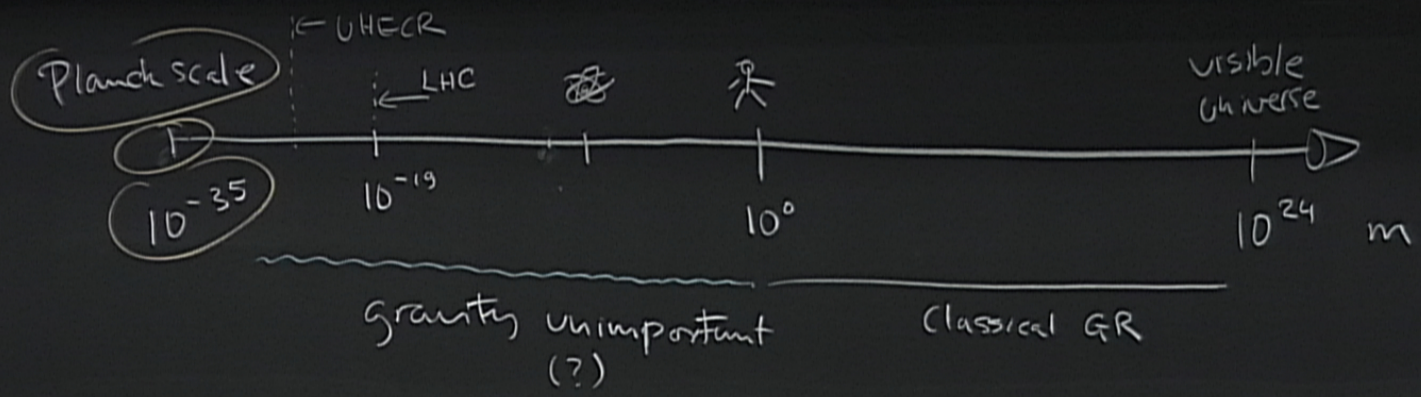

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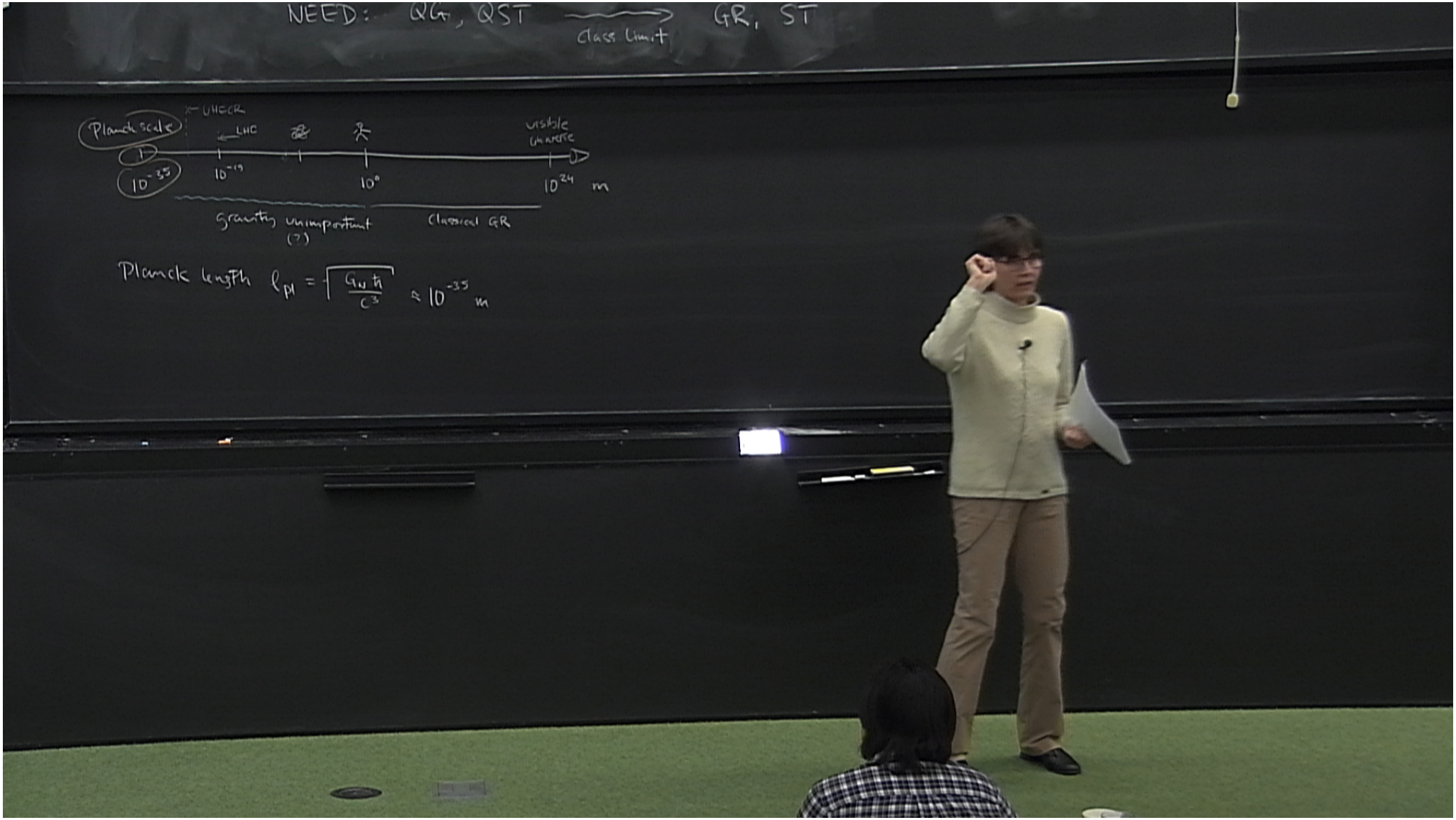
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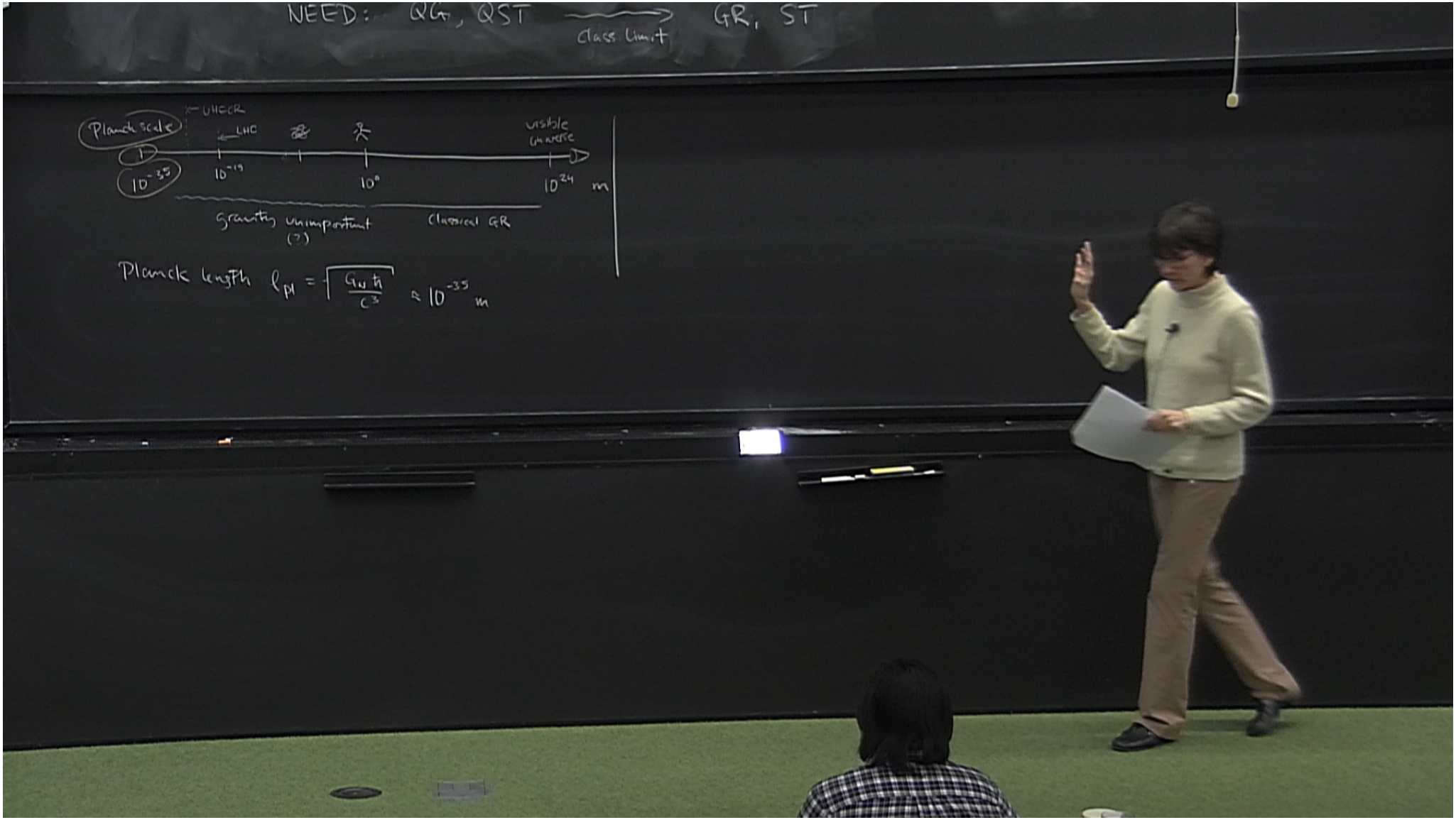
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10^{0}
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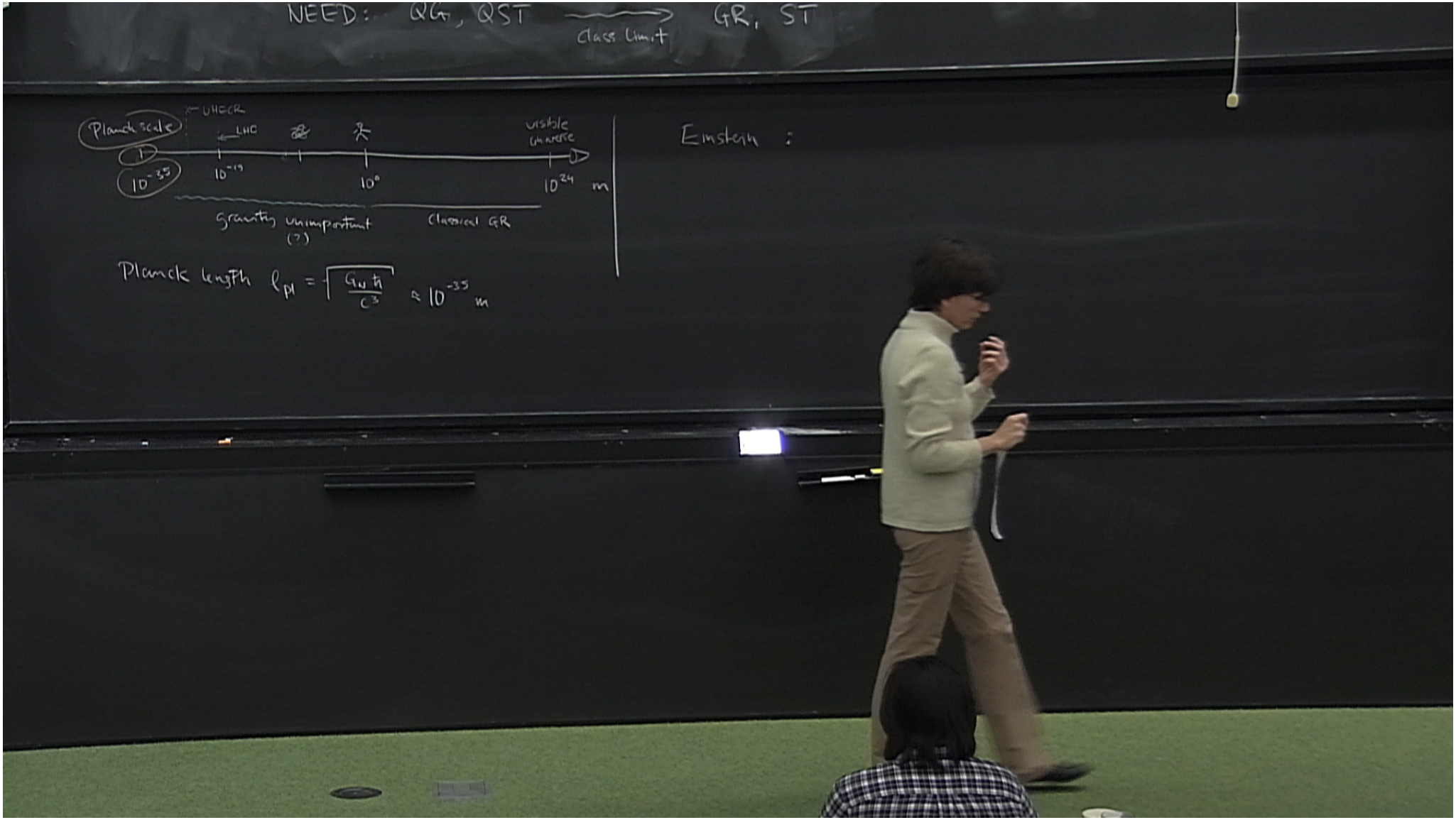
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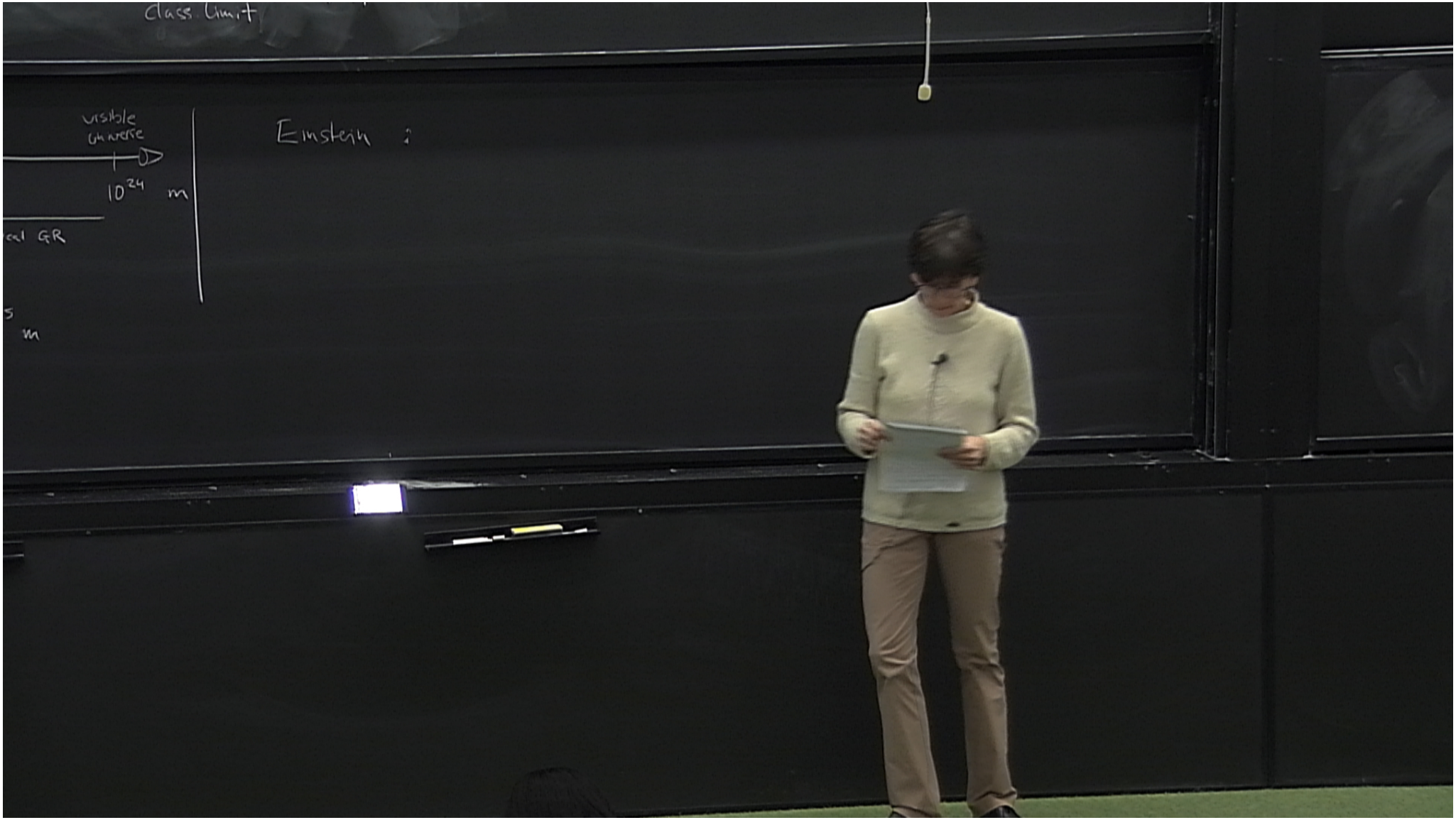
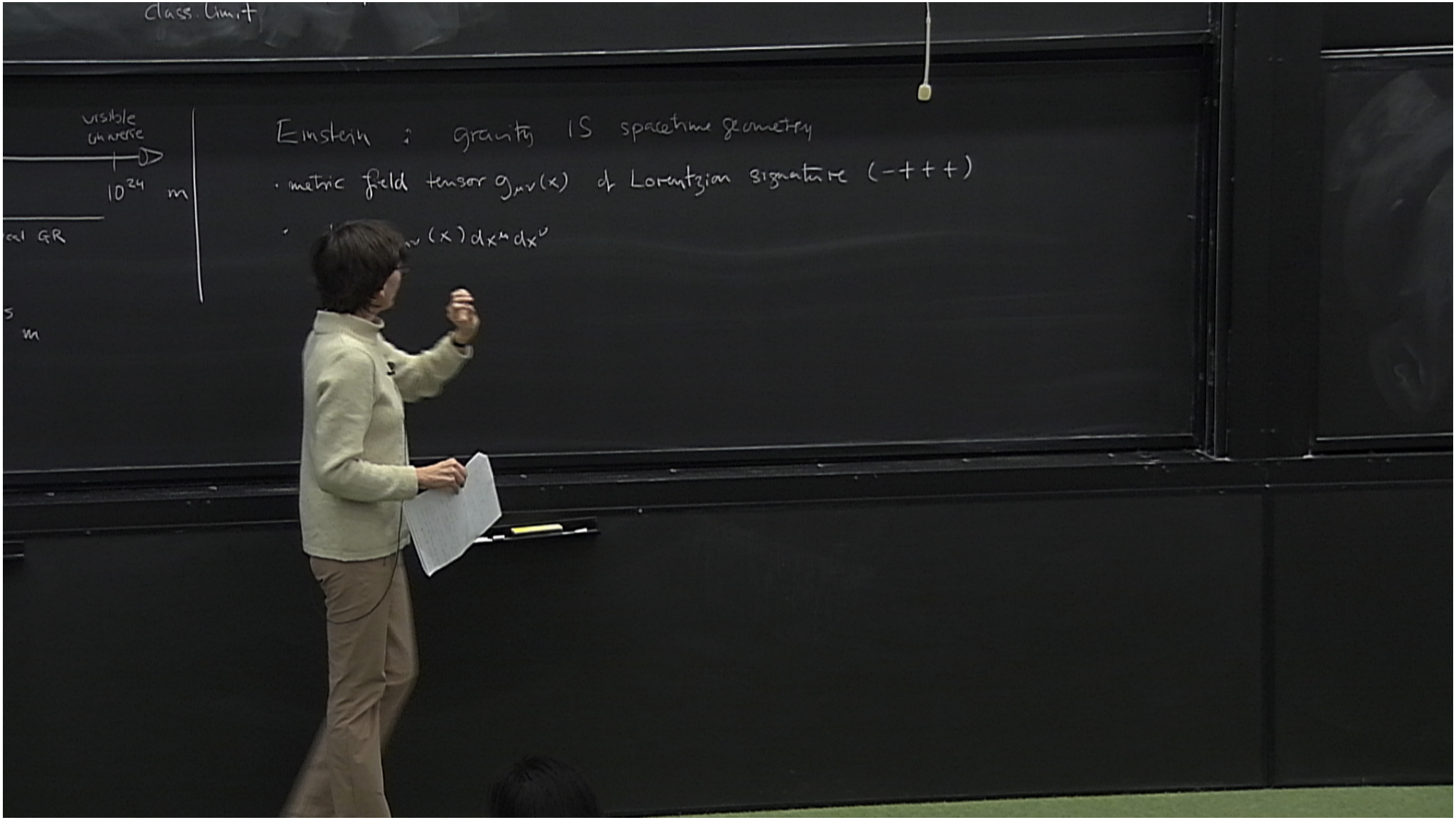
Einstein :


Class. Limit
visible
universe
10^{24} m
Einstein :


class. limit
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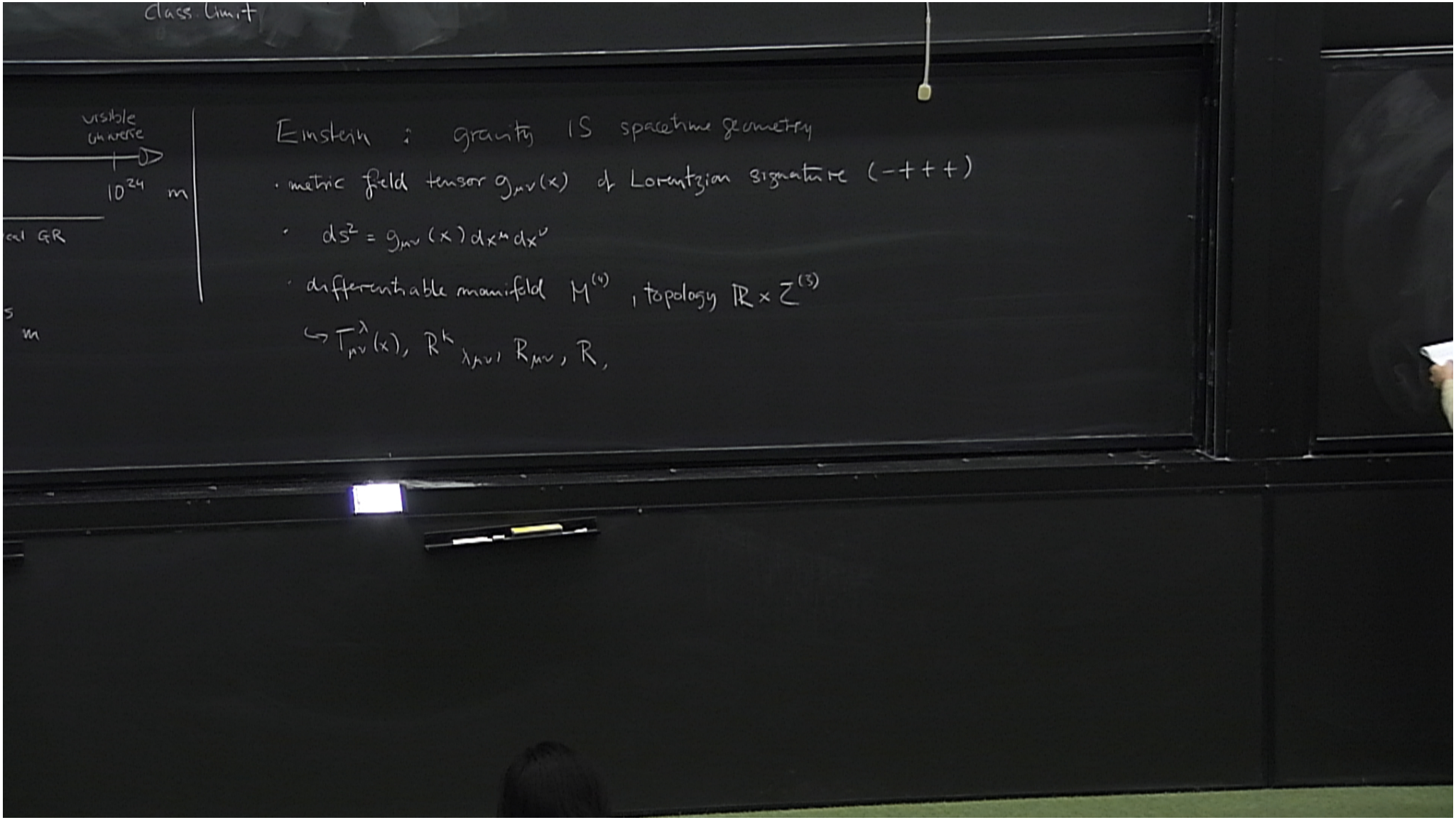
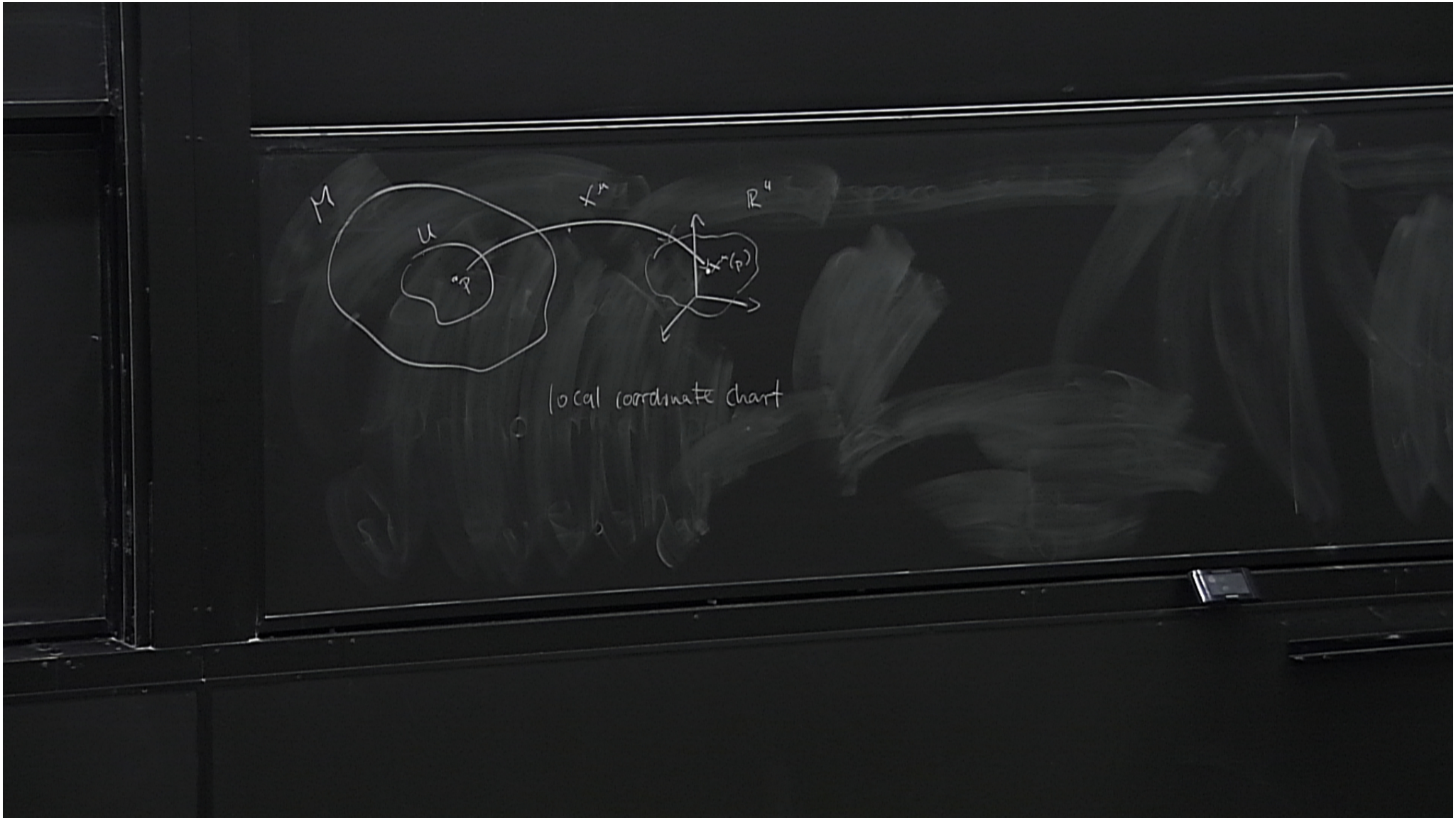
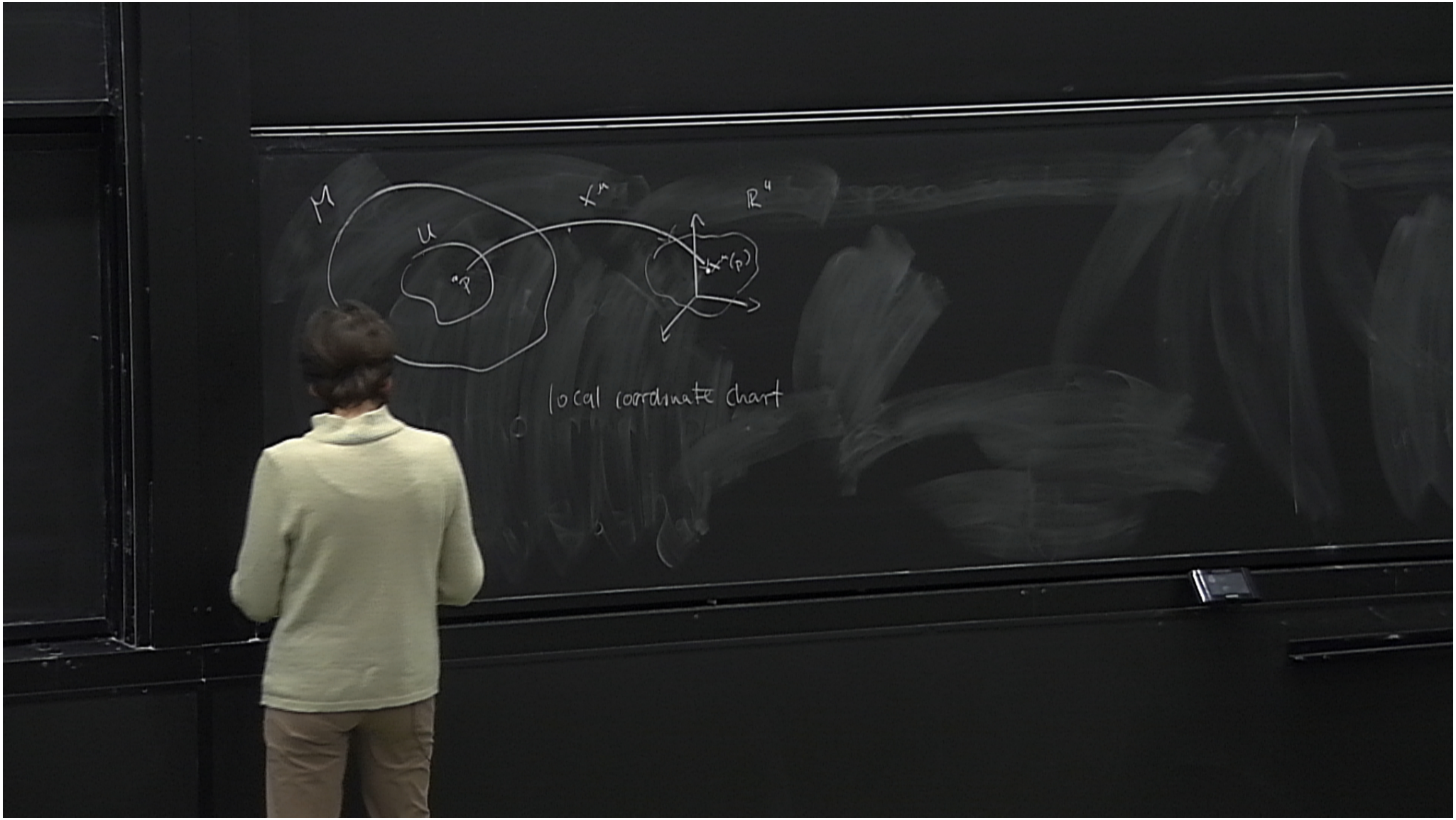
10^{24} m
Einstein : gravity IS spacetime geometry
· metric field tensor $g_{\mu\nu}(x)$ of Lorentzian signature $(-+++)$
$(x)\,dx^\mu dx^\nu$


Class. Limit
visible universe
10^{24} m
cal GR
m
Einstein : gravity IS spacetime geometry
· metric field tensor $g_{\mu\nu}(x)$ of Lorentzian signature $(-+++)$
· $ds^2 = g_{\mu\nu}(x)\,dx^\mu dx^\nu$
· differentiable manifold $M^{(4)}$, topology $\mathbb{R}\times\Sigma^{(3)}$
↳ $\Gamma^\lambda_{\mu\nu}(x)$, $R^\lambda{}_{\kappa\mu\nu}$, $R_{\mu\nu}$, R,



local coordinate chart


M
U
p
x^μ
$\mathbb{R}^4$
$x^\mu(p)$
local coordinate chart