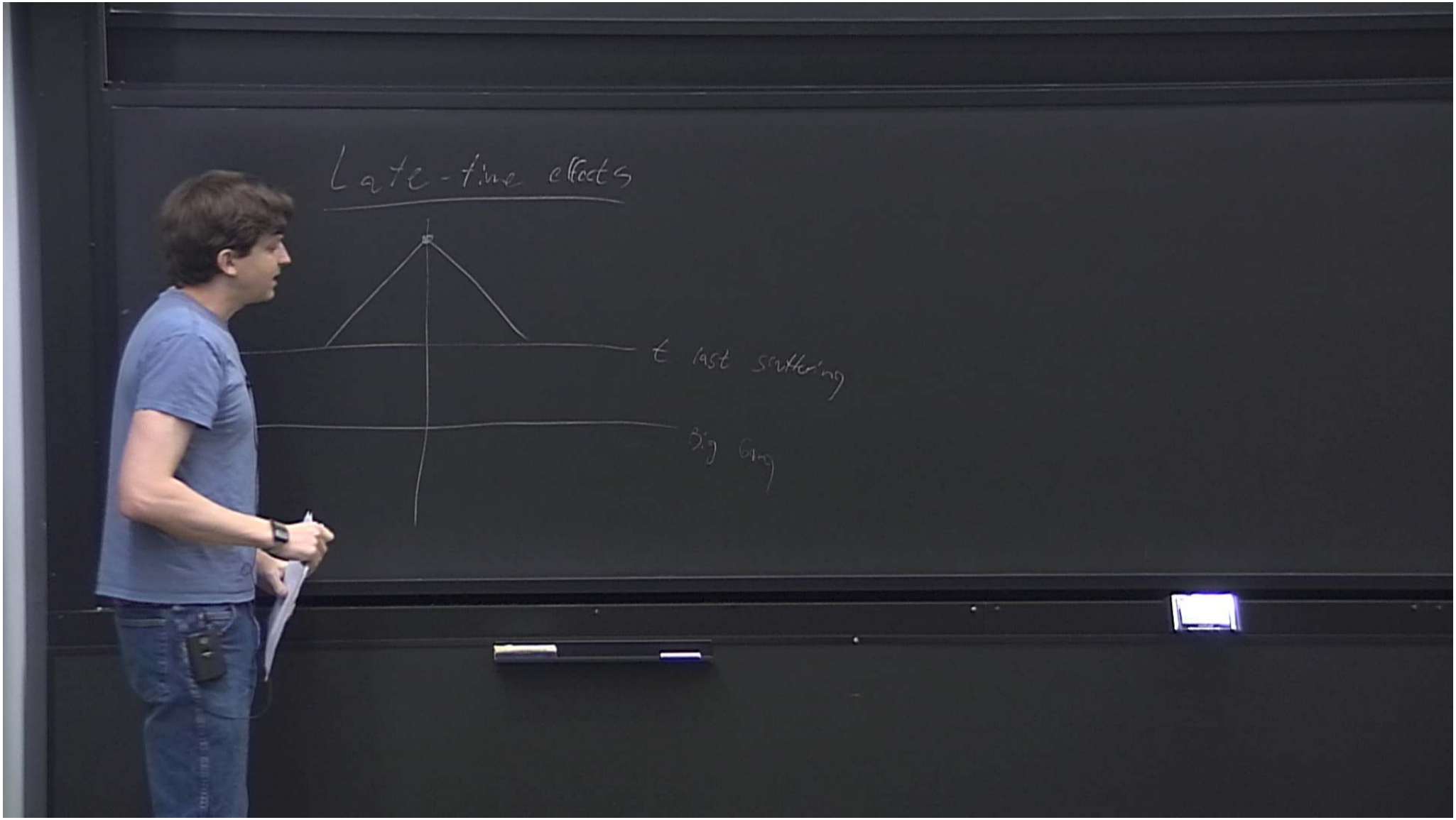
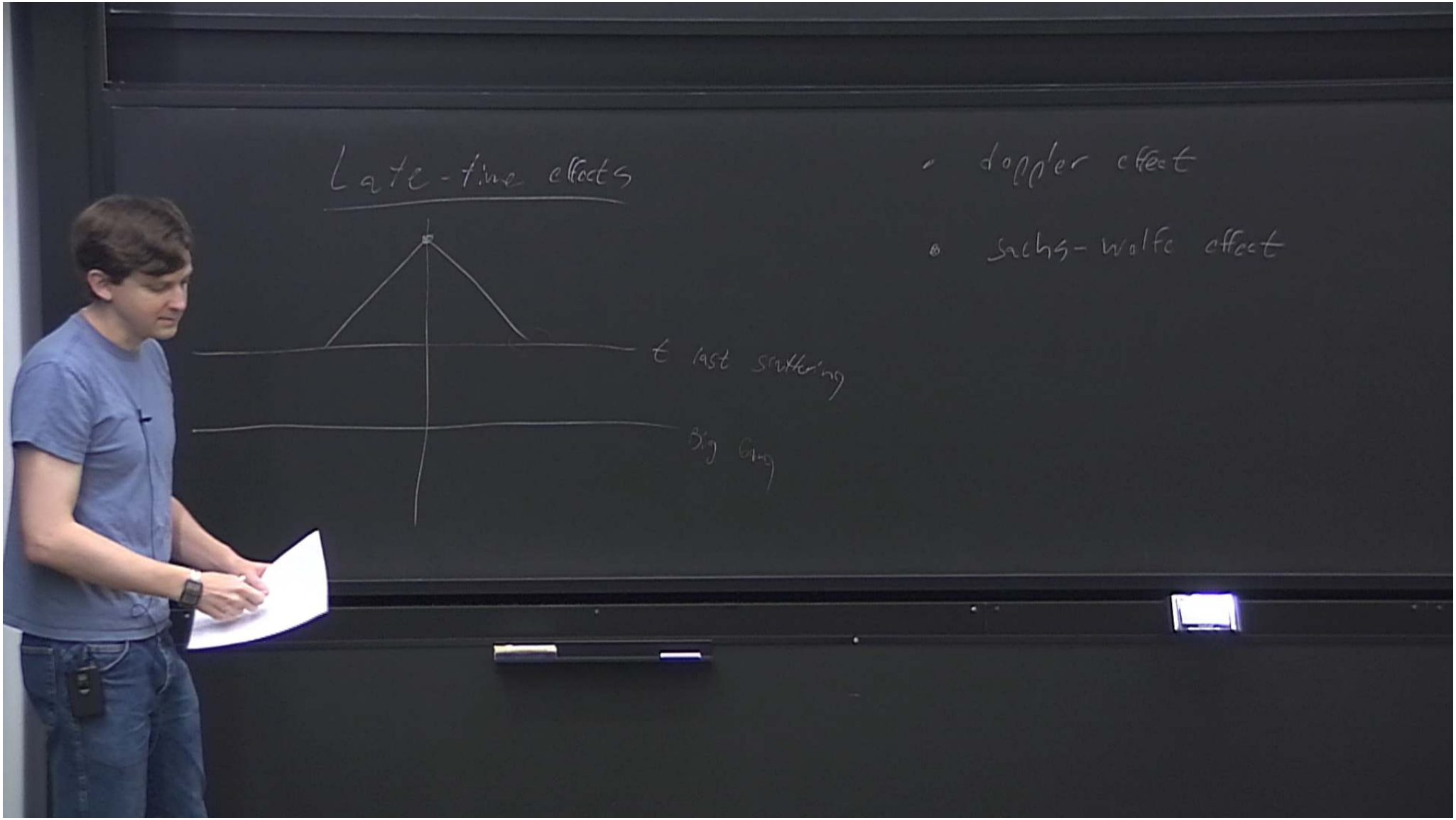
Title: Cosmology Review-15

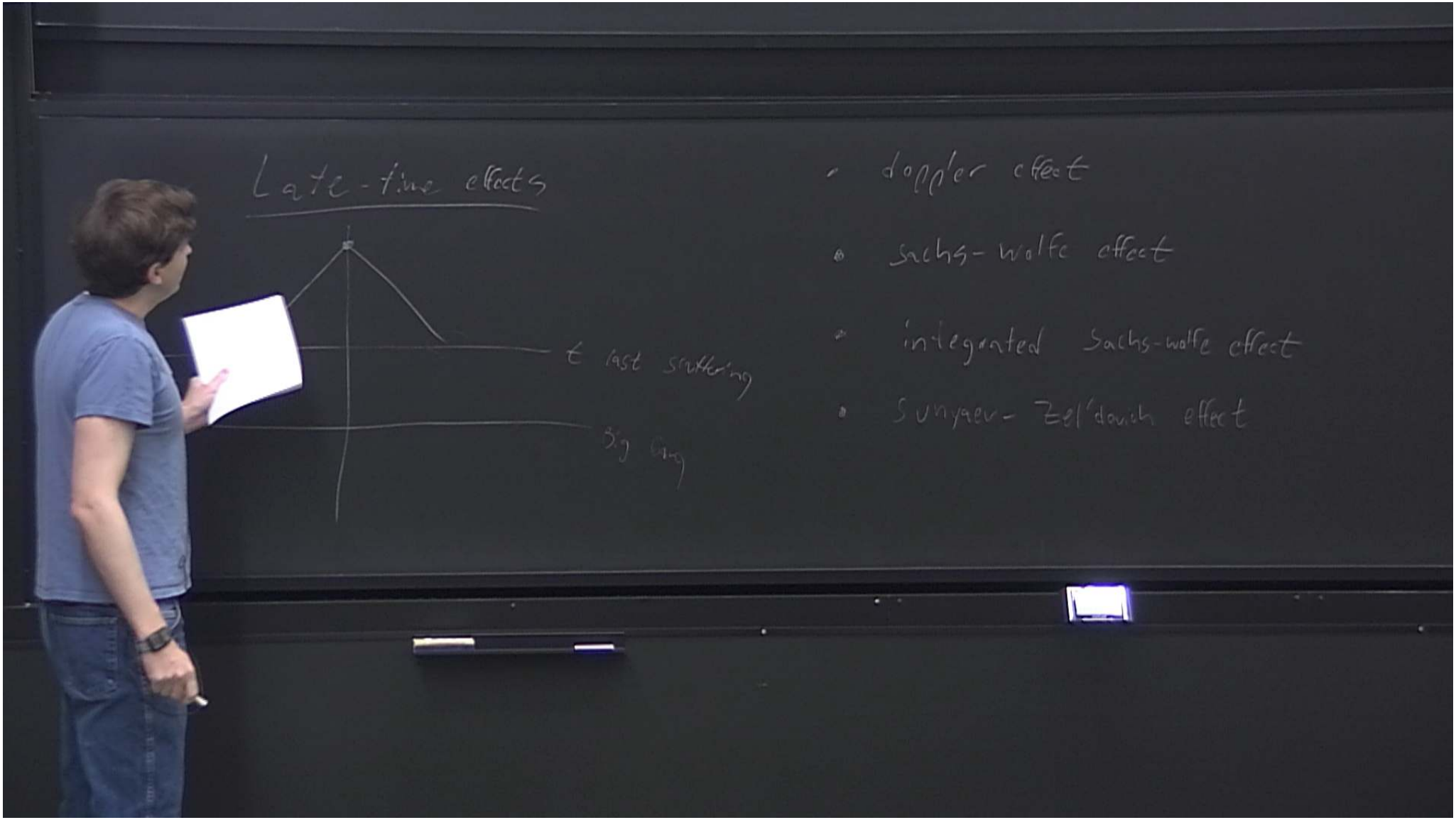
Date: Feb 13, 2015 11:30 AM

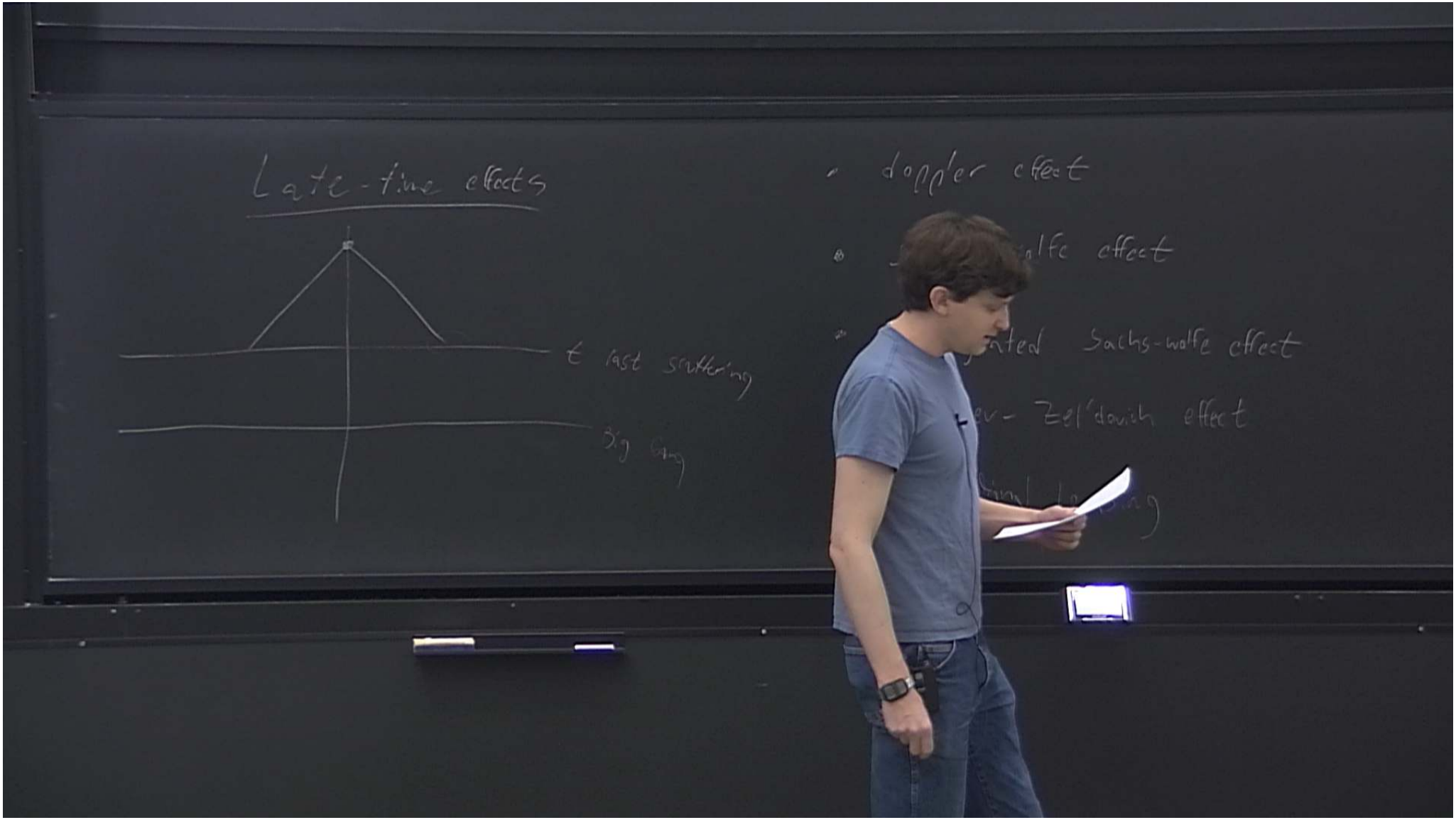
URL: http://pirsa.org/15020038

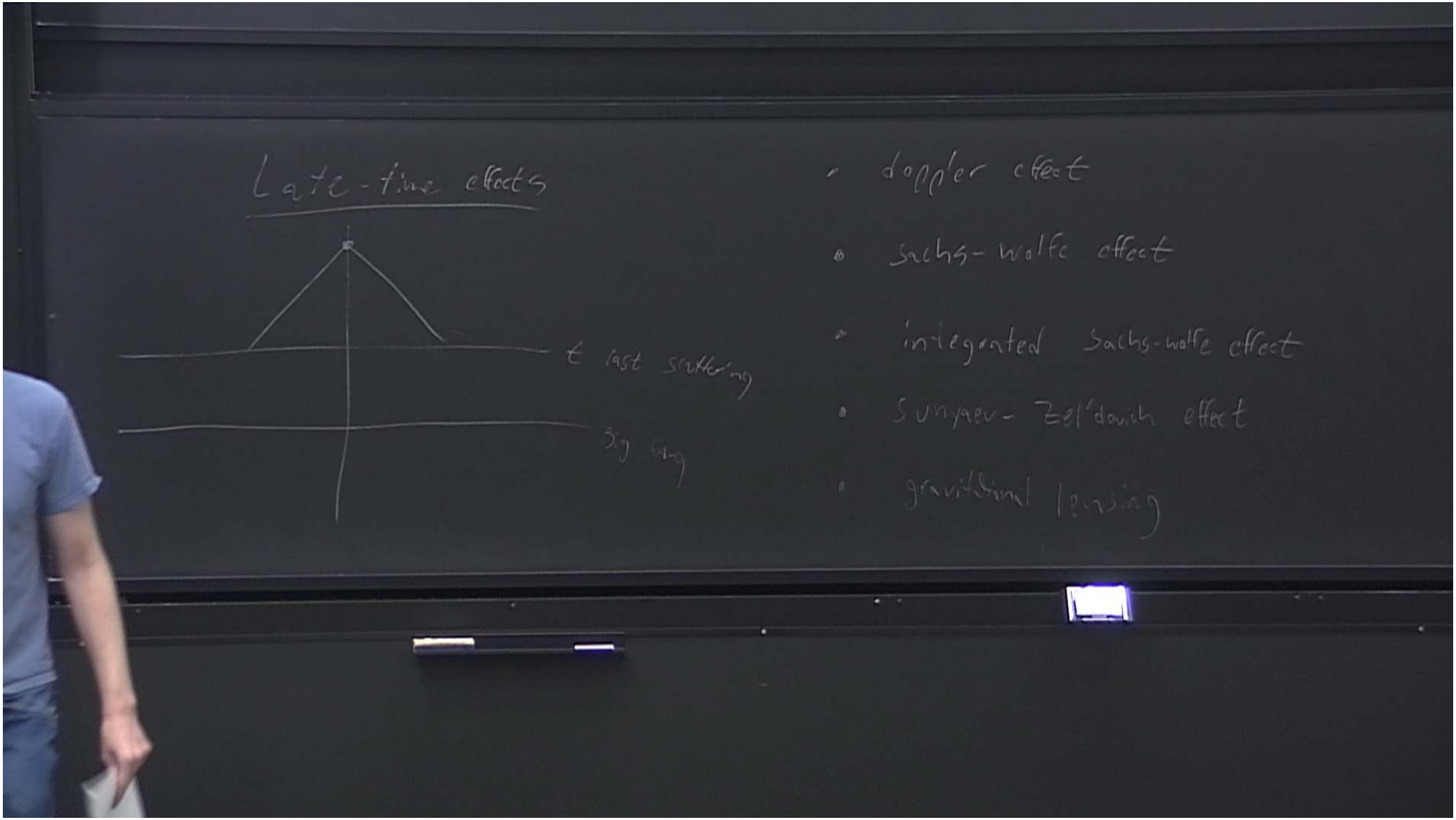
Abstract:

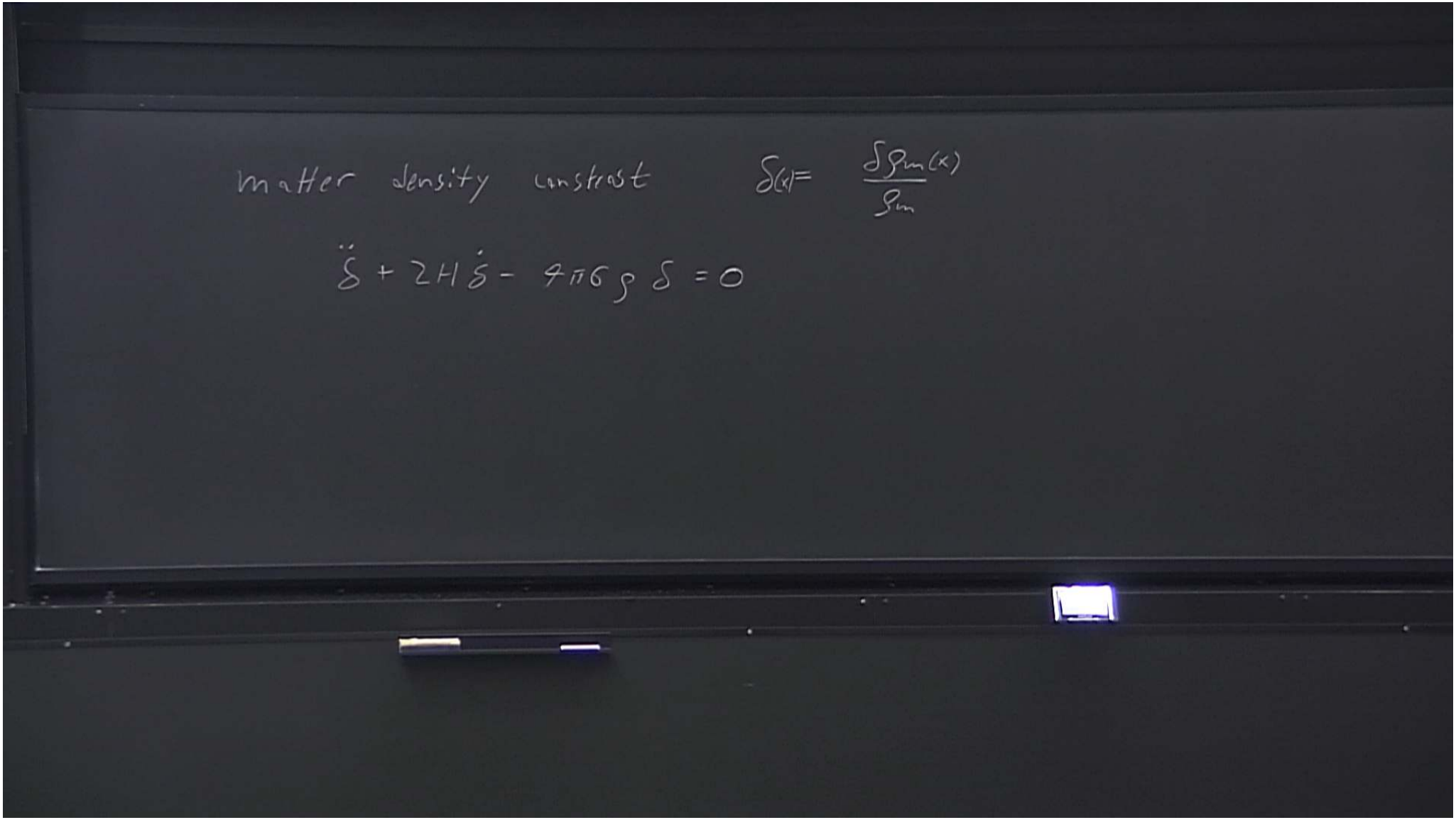

Late-time effects
t last scattering
Big Bang

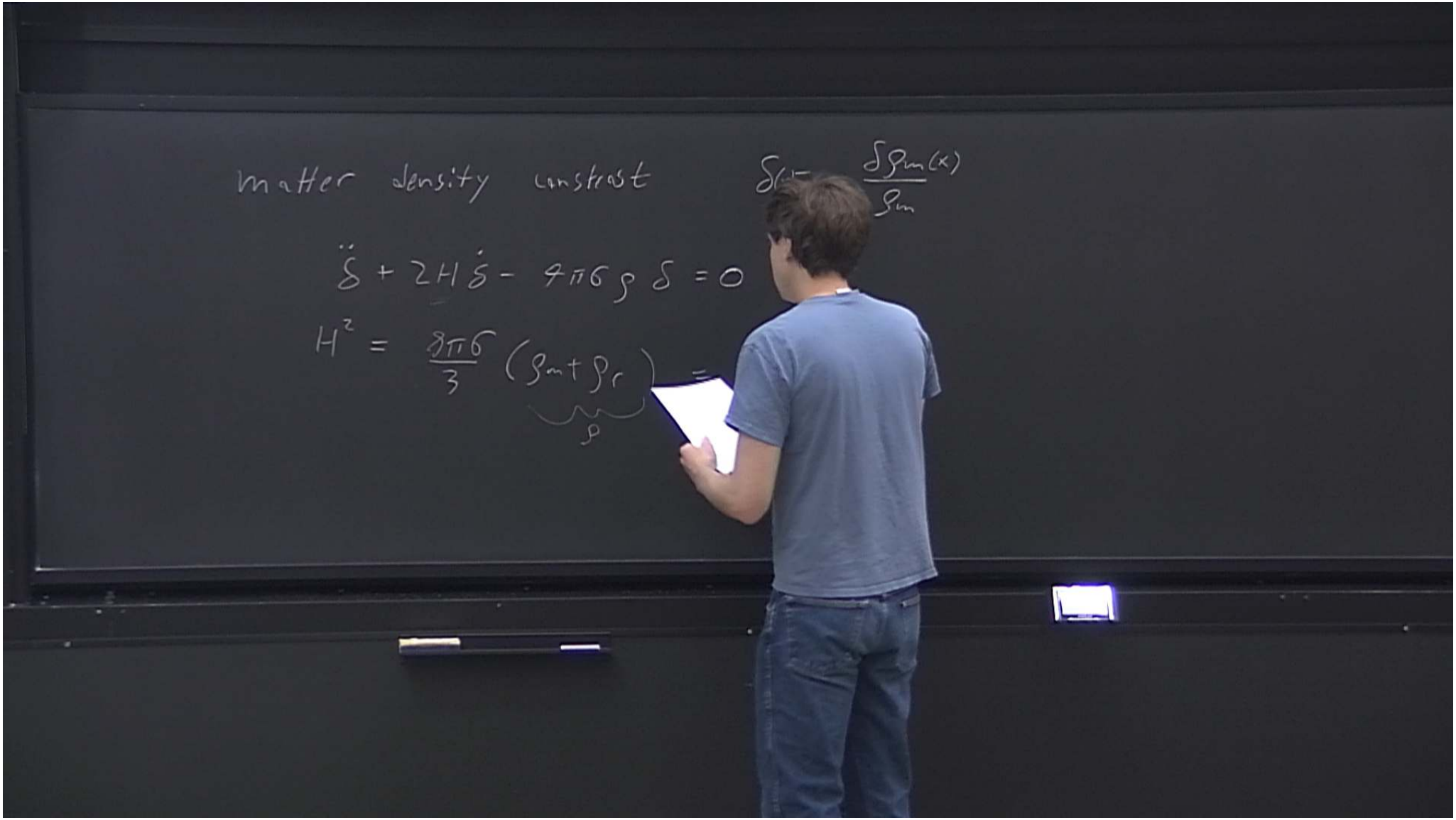

Late-time effects
- doppler effect
- sachs-wolfe effect
t last scattering
Big Bang

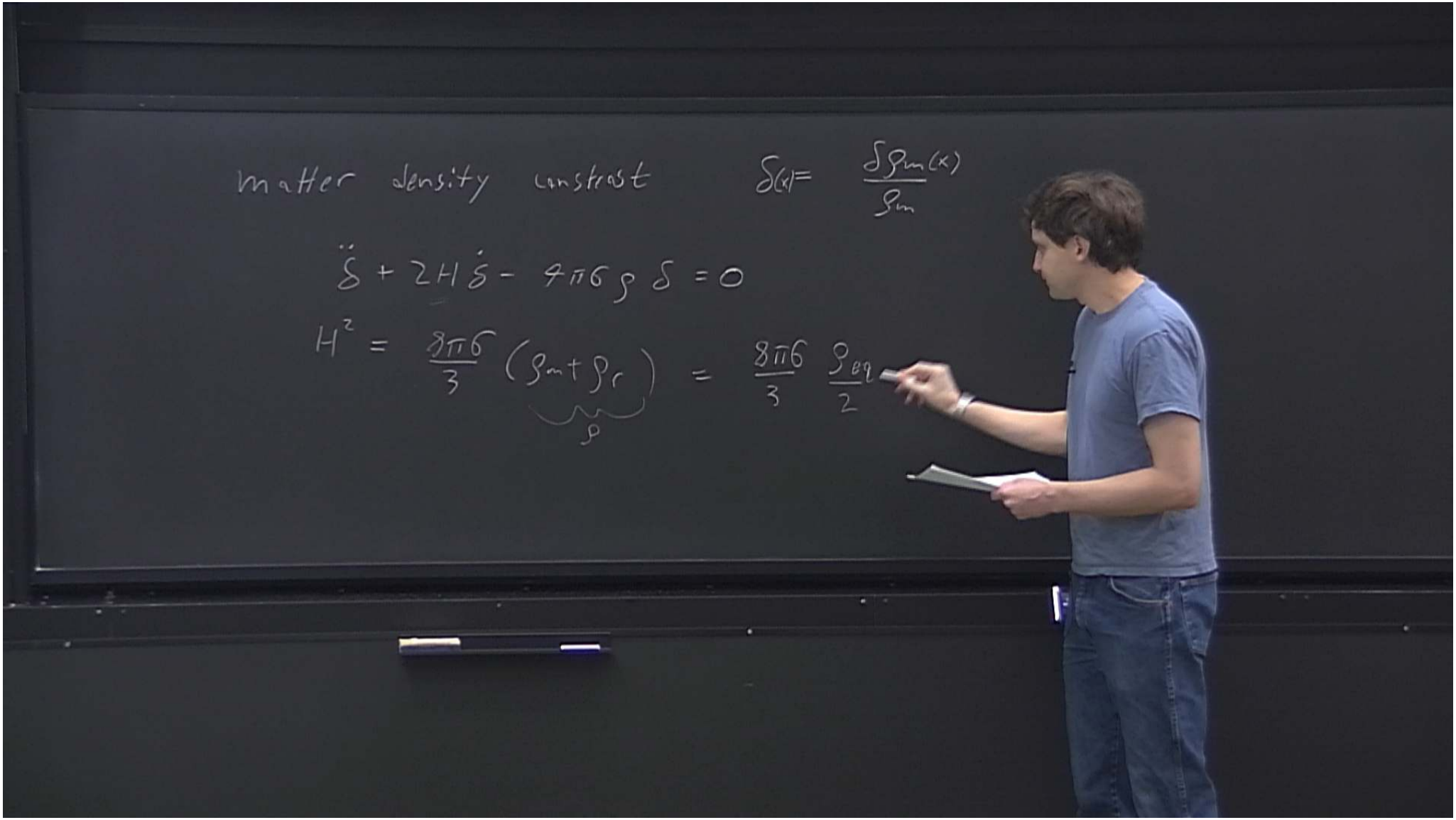

Late-time effects
t last scattering
Big Bang
• doppler effect
• Sachs-Wolfe effect
• integrated Sachs-Wolfe effect
• Sunyaev-Zel'dovich effect

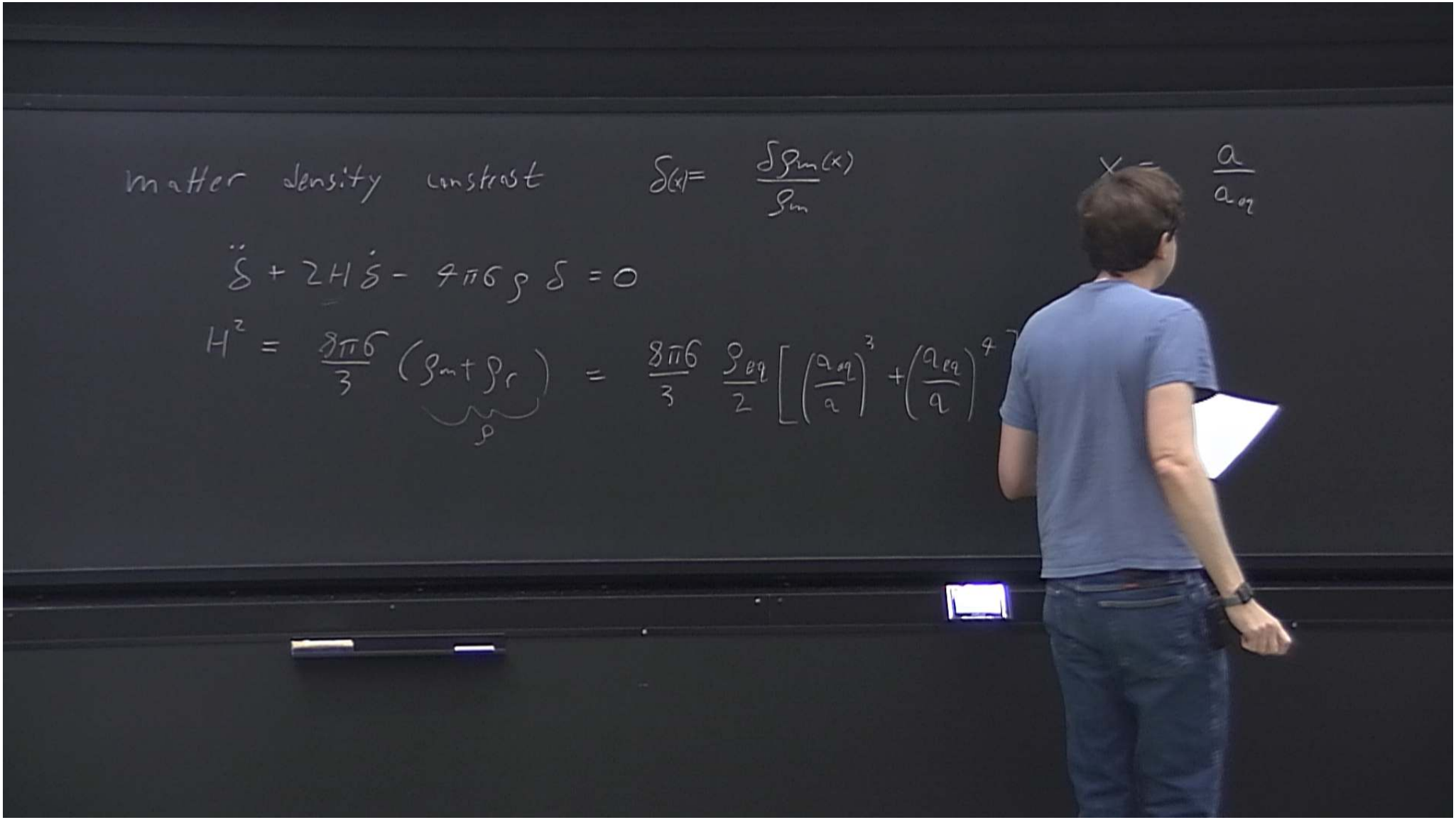

Late-time effects
t last scattering
Big Bang
doppler effect
effect
Sachs-wolfe effect
Zel'dovich effect


Late-time effects
t last scattering
Big Bang
• doppler effect
• Sachs-Wolfe effect
• integrated Sachs-Wolfe effect
• Sunyaev-Zel'dovich effect
• gravitational lensing


matter density constrast $\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$
$\ddot{\delta} + 2H\dot{\delta} - 4\pi G\rho\delta = 0$


matter density constrast
$\delta \equiv \frac{\delta \rho_m(x)}{\rho_m}$
$\ddot{\delta} + 2H\dot{\delta} - 4\pi G \rho \delta = 0$
$H^2 = \frac{8\pi G}{3}(\rho_m + \rho_r) = \rho$

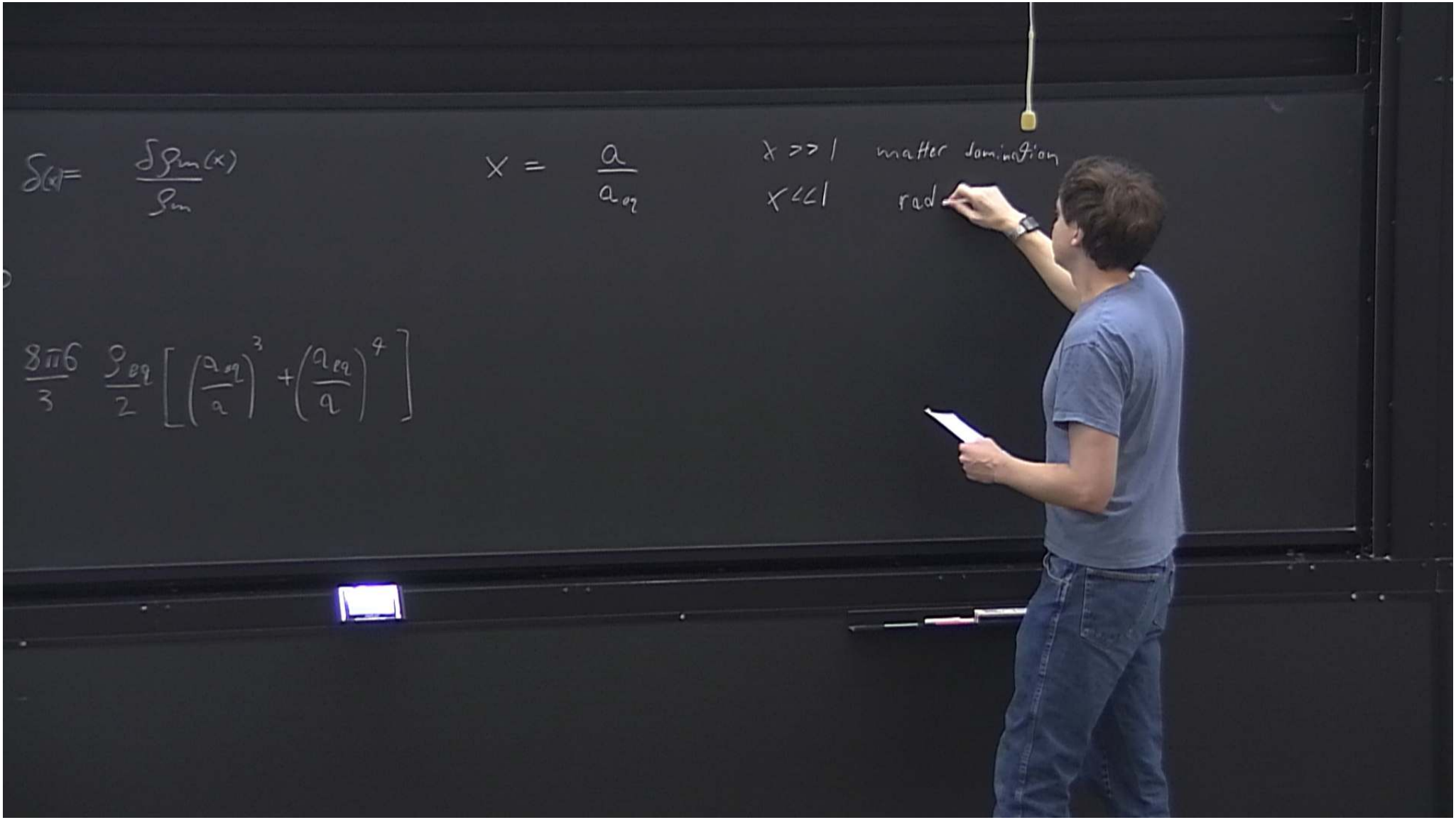

matter density constrast $\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$
$\ddot{\delta} + 2H\dot{\delta} - 4\pi G\rho\delta = 0$
$H^2 = \frac{8\pi G}{3}(\rho_m + \rho_r) = \frac{8\pi G}{3}\frac{\rho_{eq}}{2}$
ρ

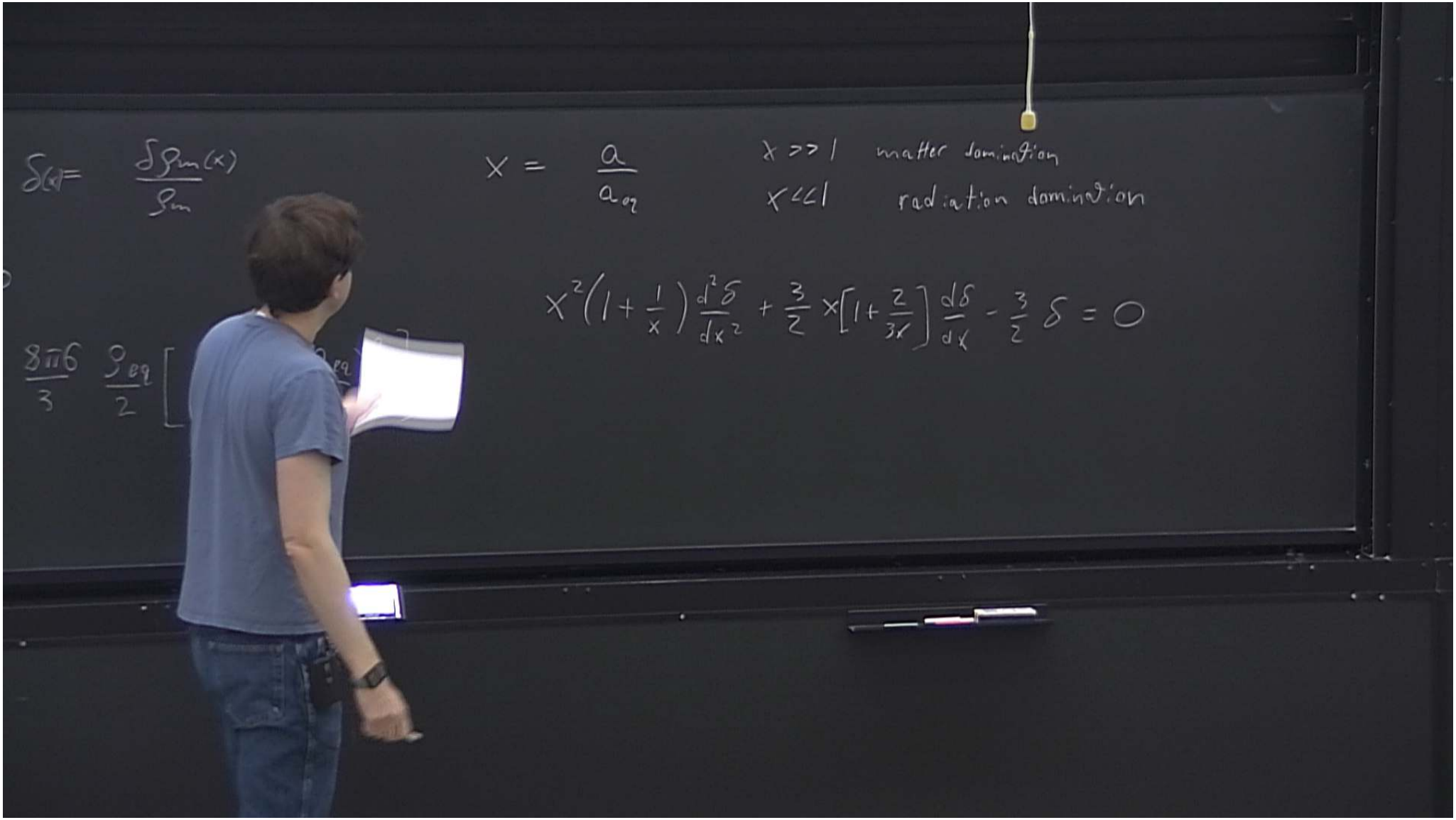

matter density constrast
$\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$
$x = \frac{a}{a_{eq}}$
$\ddot{\delta} + 2H\dot{\delta} - 4\pi G\rho\delta = 0$
$H^2 = \frac{8\pi G}{3}(\rho_m + \rho_r) = \frac{8\pi G}{3}\frac{\rho_{eq}}{2}\left[\left(\frac{a_{eq}}{a}\right)^3 + \left(\frac{a_{eq}}{a}\right)^4\right.$
ρ

matter density constrast $\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$ $\quad x = \frac{a}{a_{eq}}$ $\quad x >>$

$$\ddot{\delta} + 2H\dot{\delta} - 4\pi G\rho\delta = 0$$

$$H^2 = \frac{8\pi G}{3}(\rho_m + \rho_r) = \frac{8\pi G}{3}\frac{\rho_{eq}}{2}\left[\left(\frac{a_{eq}}{a}\right)^3 + \left(\frac{a_{eq}}{a}\right)^4\right]$$

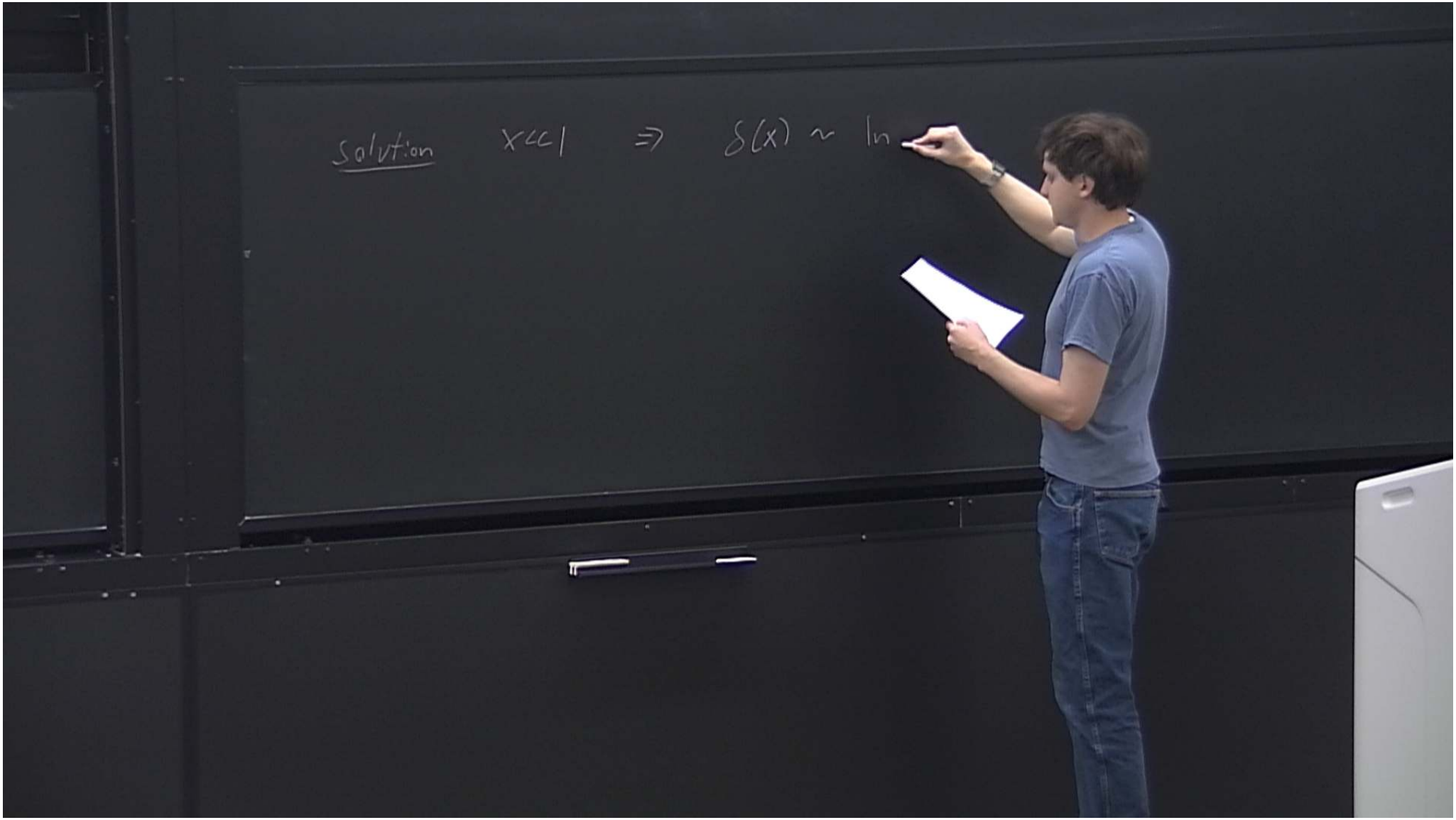

$\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$
$x = \frac{a}{a_{eq}}$
$x >> 1$ matter domination
$x << 1$ rad
$\frac{8\pi G}{3} \frac{\rho_{eq}}{2} \left[\left(\frac{a_{eq}}{a}\right)^3 + \left(\frac{a_{eq}}{a}\right)^4 \right]$

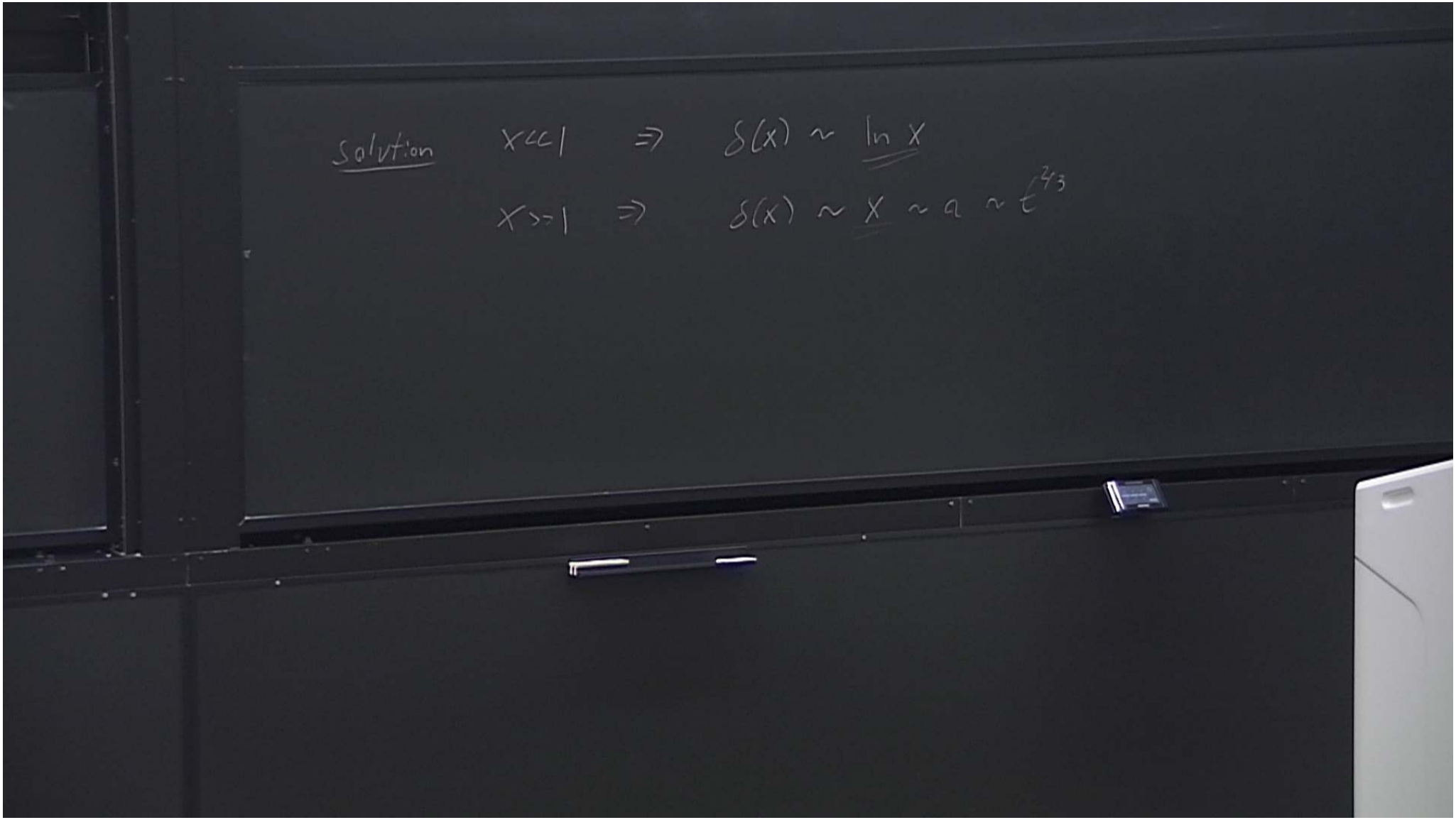

$\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$
$x = \frac{a}{a_{eq}}$
$x >> 1$ matter domination
$x << 1$ radiation domination
$x^2\left(1+\frac{1}{x}\right)\frac{d^2\delta}{dx^2} + \frac{3}{2}x\left[1+\frac{2}{3x}\right]\frac{d\delta}{dx} - \frac{3}{2}\delta = 0$
$\frac{8\pi G}{3}$ $\frac{\rho_{eq}}{2}$

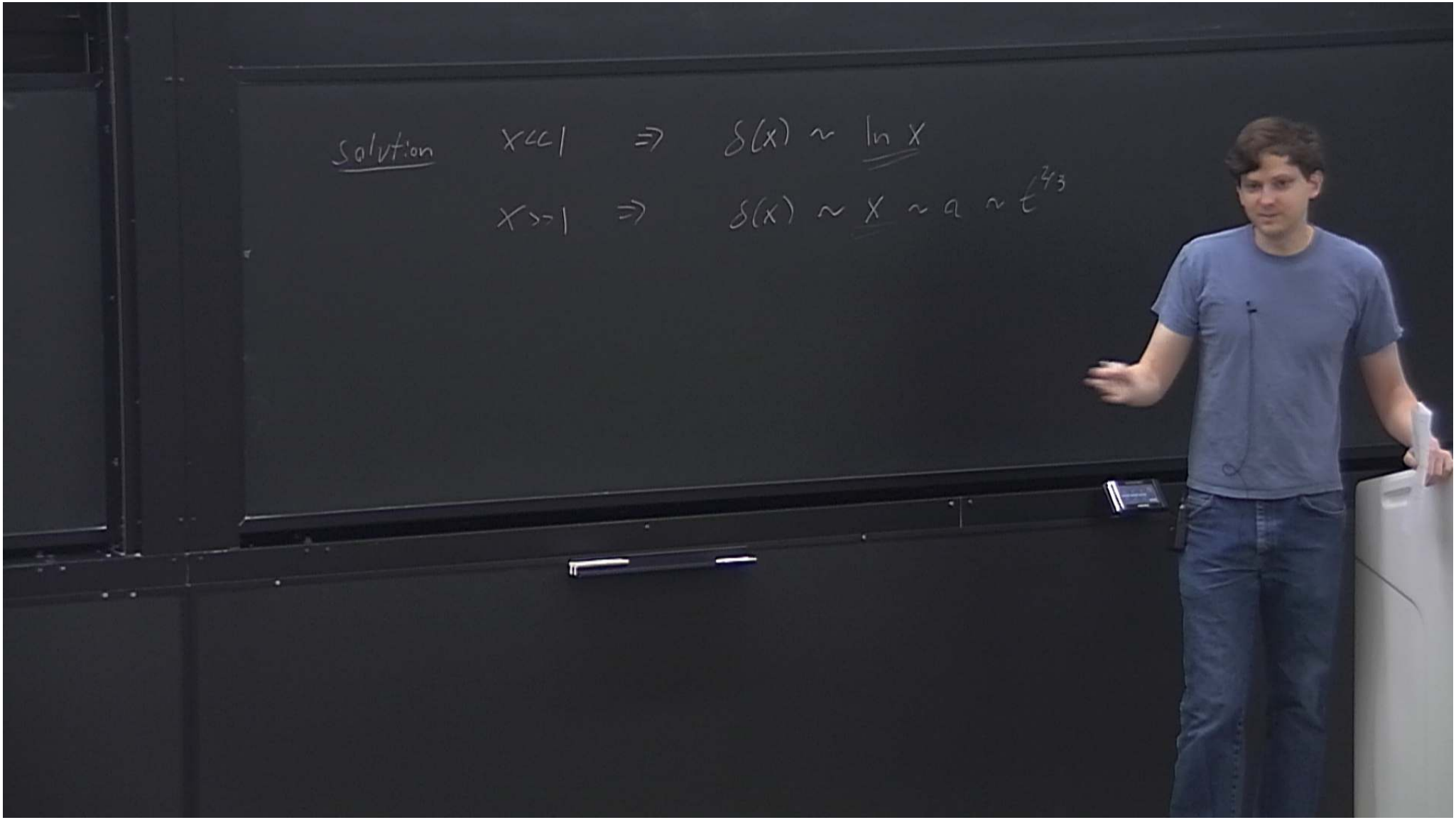
$\delta(x) = \frac{\delta\rho_m(x)}{\rho_m}$ $\quad x = \frac{a}{a_{eq}}$ $\quad x \gg 1$ matter domination $\quad x \ll 1$ radiation domination

$$x^2\left(1+\frac{1}{x}\right)\frac{d^2\delta}{dx^2} + \frac{3}{2}x\left[1+\frac{2}{3x}\right]\frac{d\delta}{dx} - \frac{3}{2}\delta = 0$$

$$\frac{8\pi G}{3}\frac{\rho_{eq}}{2}\left[\left(\frac{a_{eq}}{a}\right)^3 + \left(\frac{a_{eq}}{a}\right)^4\right]$$


Solution x<<1 ⇒ δ(x) ~ ln


Solution
$x \ll 1 \Rightarrow \delta(x) \sim \ln x$
$x \gg 1 \Rightarrow \delta(x) \sim x \sim a \sim t^{2/3}$


Solution
$x \ll 1 \Rightarrow \delta(x) \sim \ln x$
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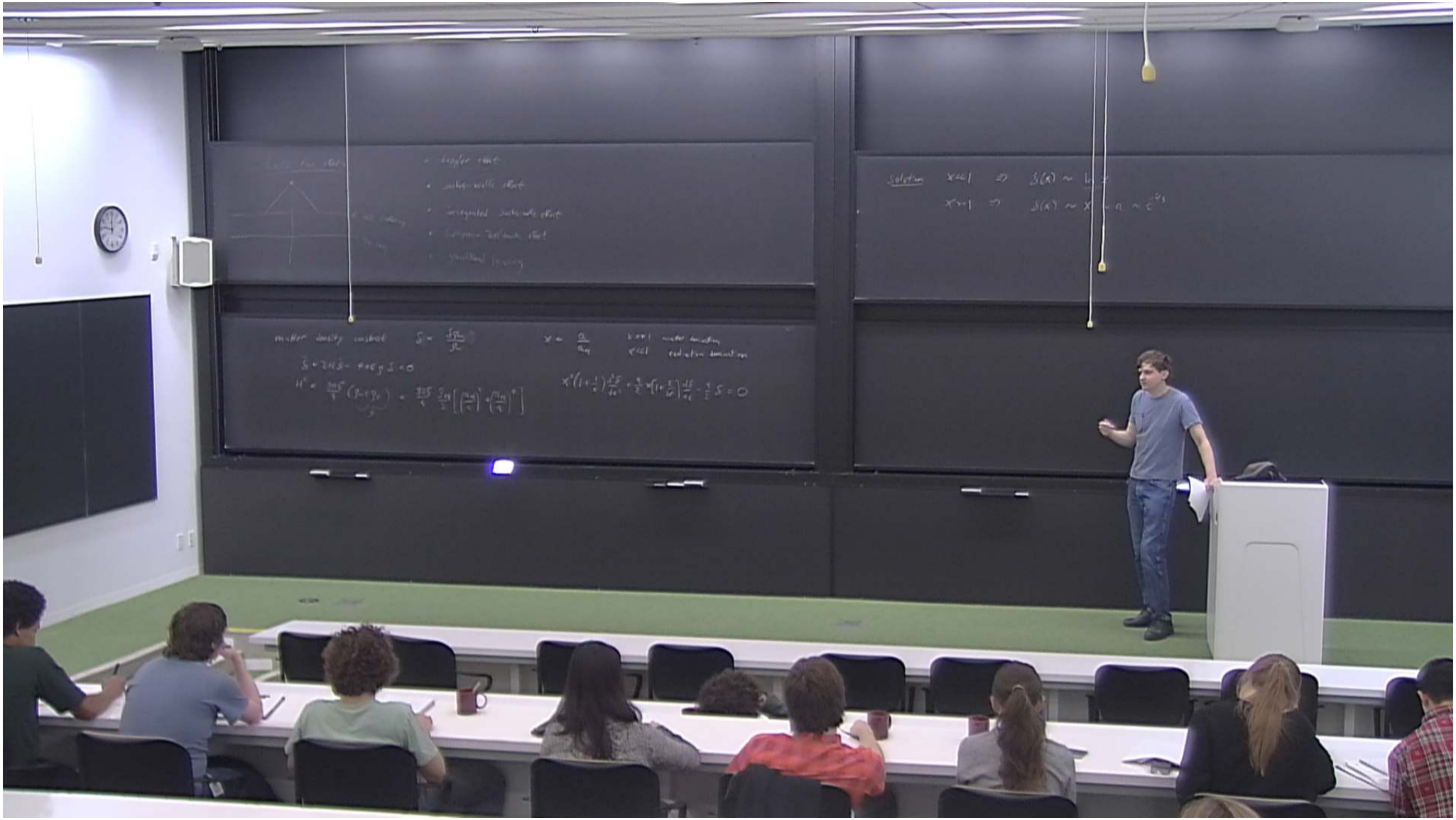
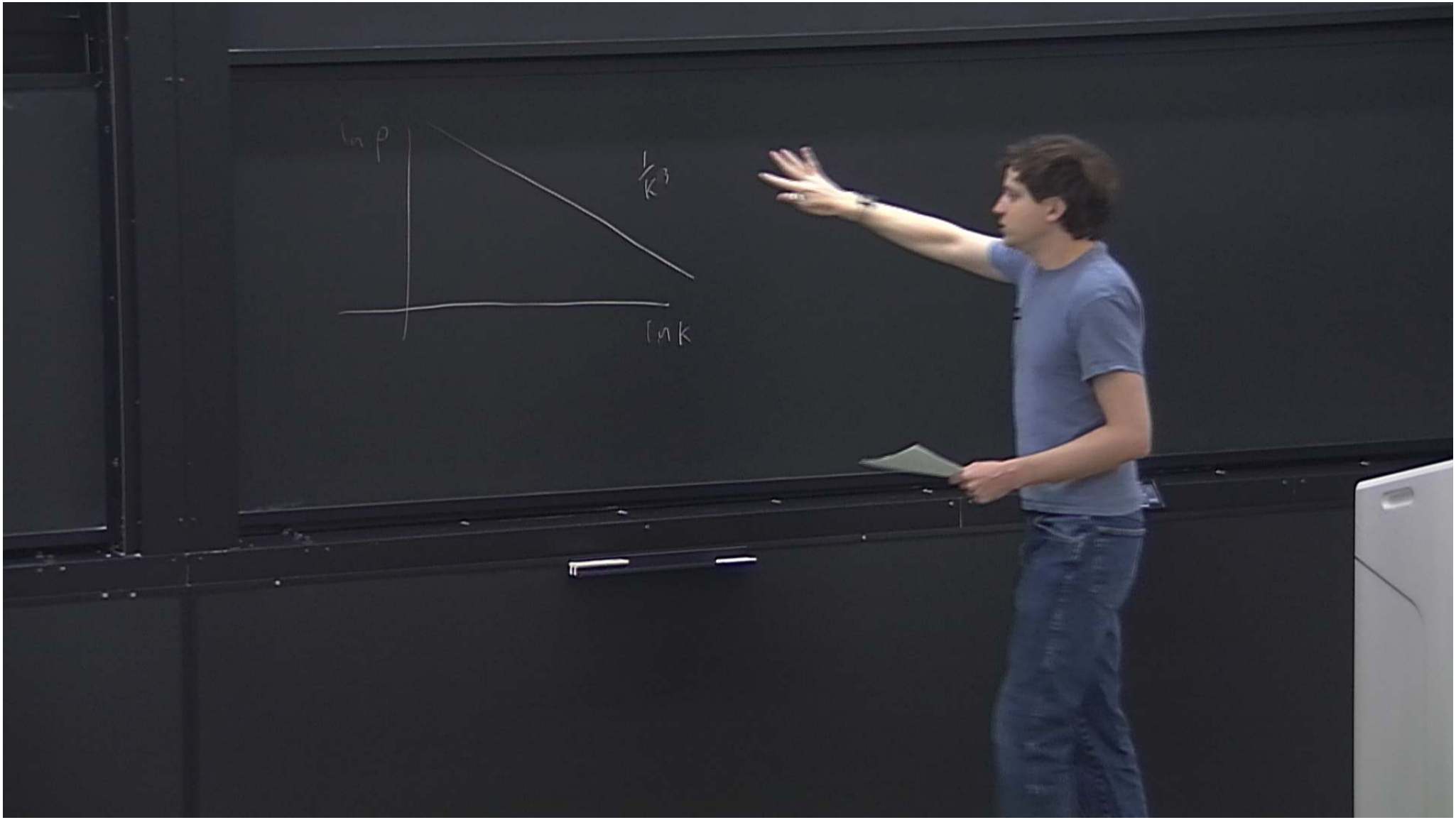
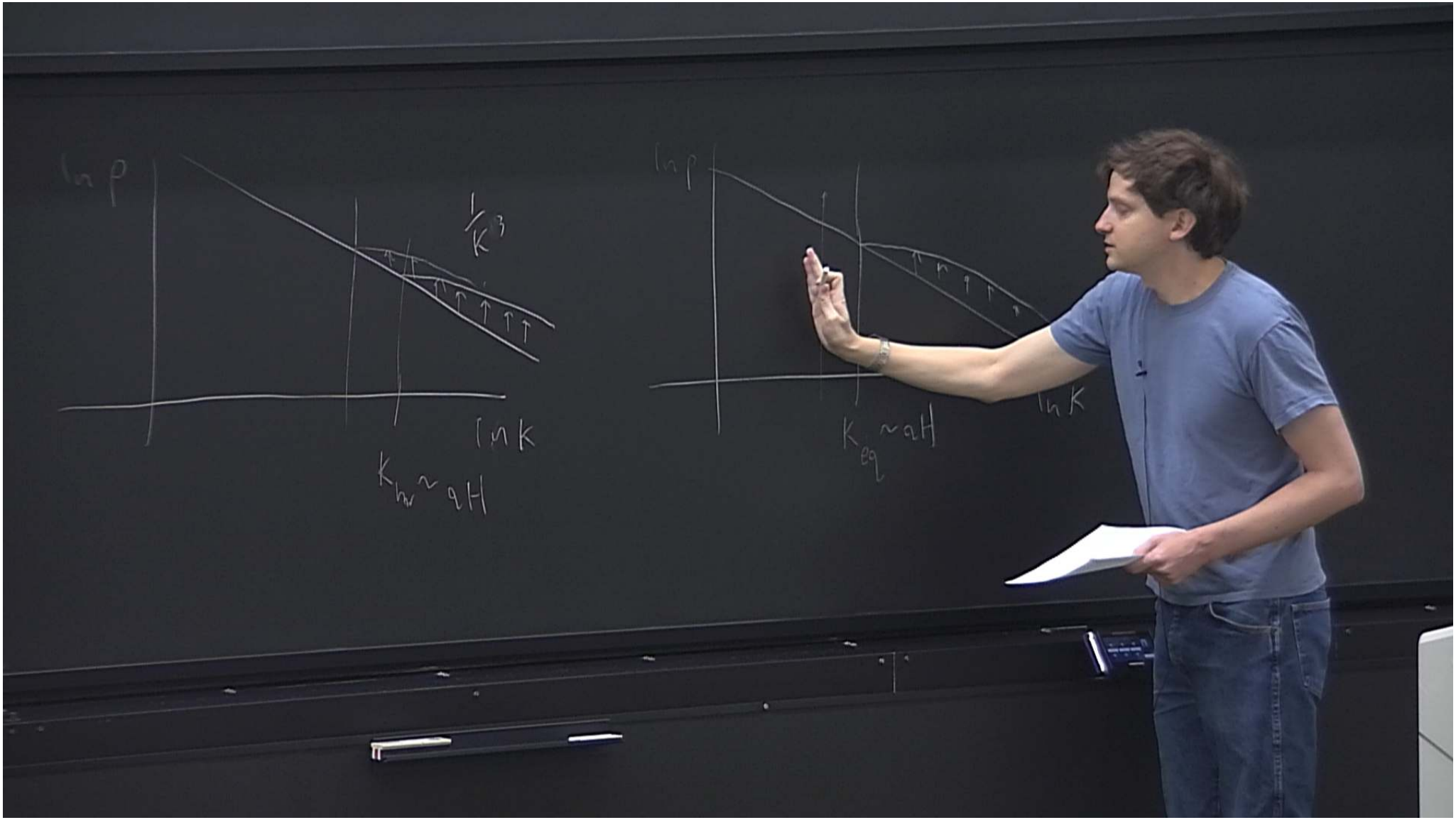
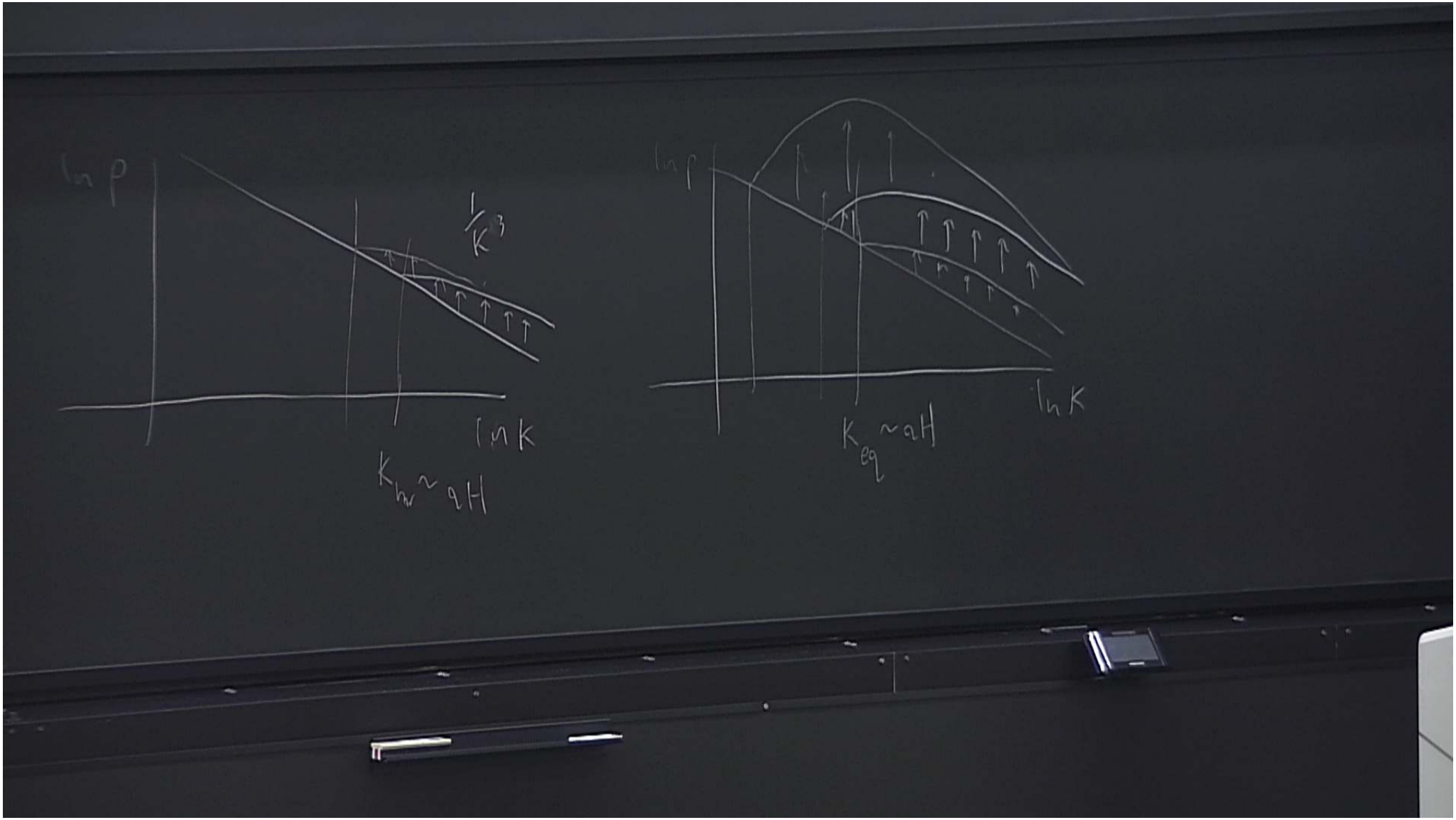
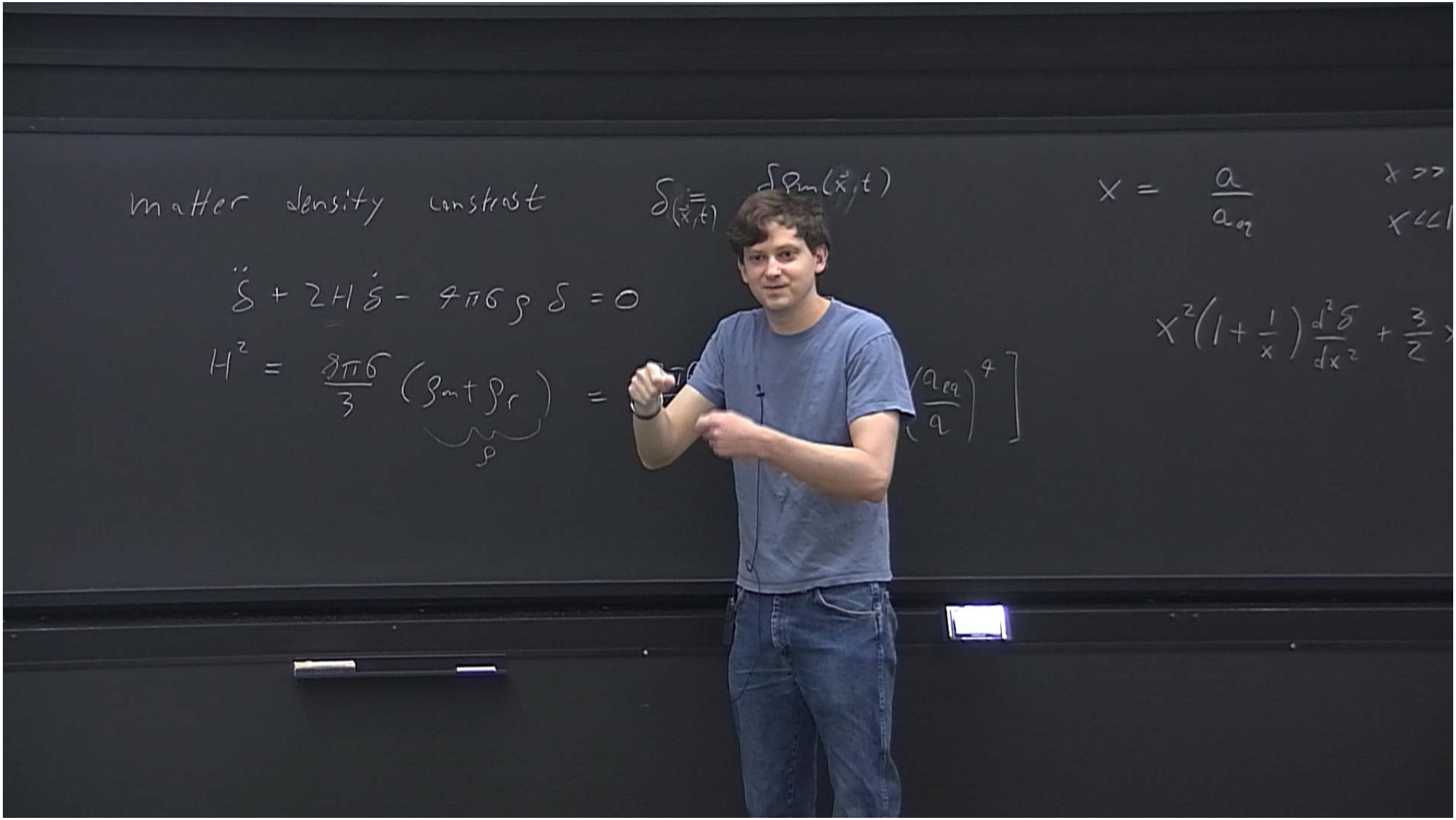
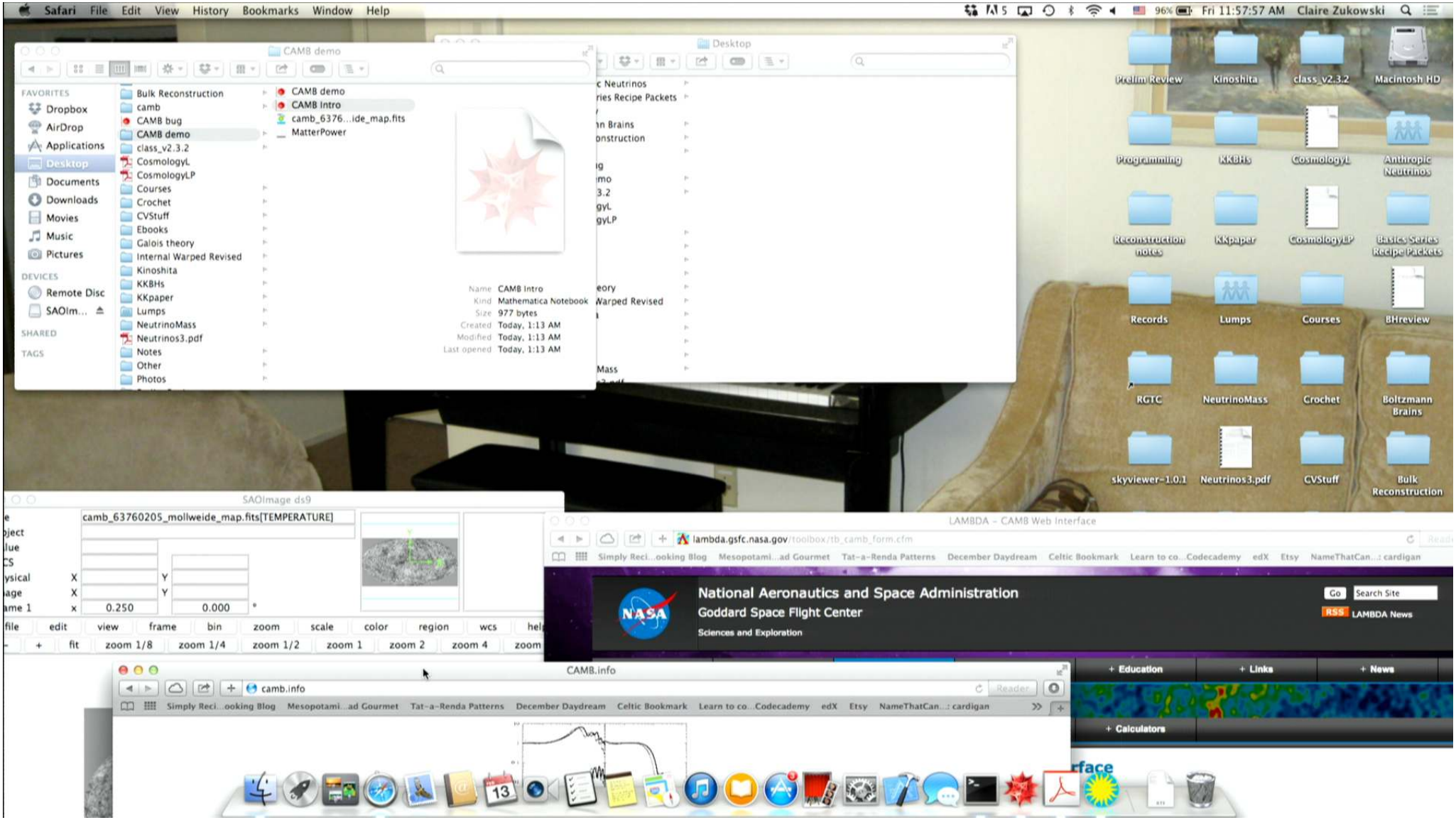



ln P
$\frac{1}{k^3}$
ln k


ln ρ
1/k³
ln k
k_hor ~ aH
ln ρ
ln k
k_eq ~ aH


ln P
1/k^3
ln k
k_hor ~ aH
ln P
ln k
k_eq ~ aH


matter density constrast
$\ddot{\delta} + 2H\dot{\delta} - 4\pi G\rho\delta = 0$
$H^2 = \frac{8\pi G}{3}(\rho_m + \rho_r)$
$x = \frac{a}{a_{eq}}$
$x^2\left(1+\frac{1}{x}\right)\frac{d^2\delta}{dx^2} + \frac{3}{2}$


Safari File Edit View History Bookmarks Window Help
Fri 11:57:57 AM Claire Zukowski
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Music
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Remote Disc
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Bulk Reconstruction
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National Aeronautics and Space Administration
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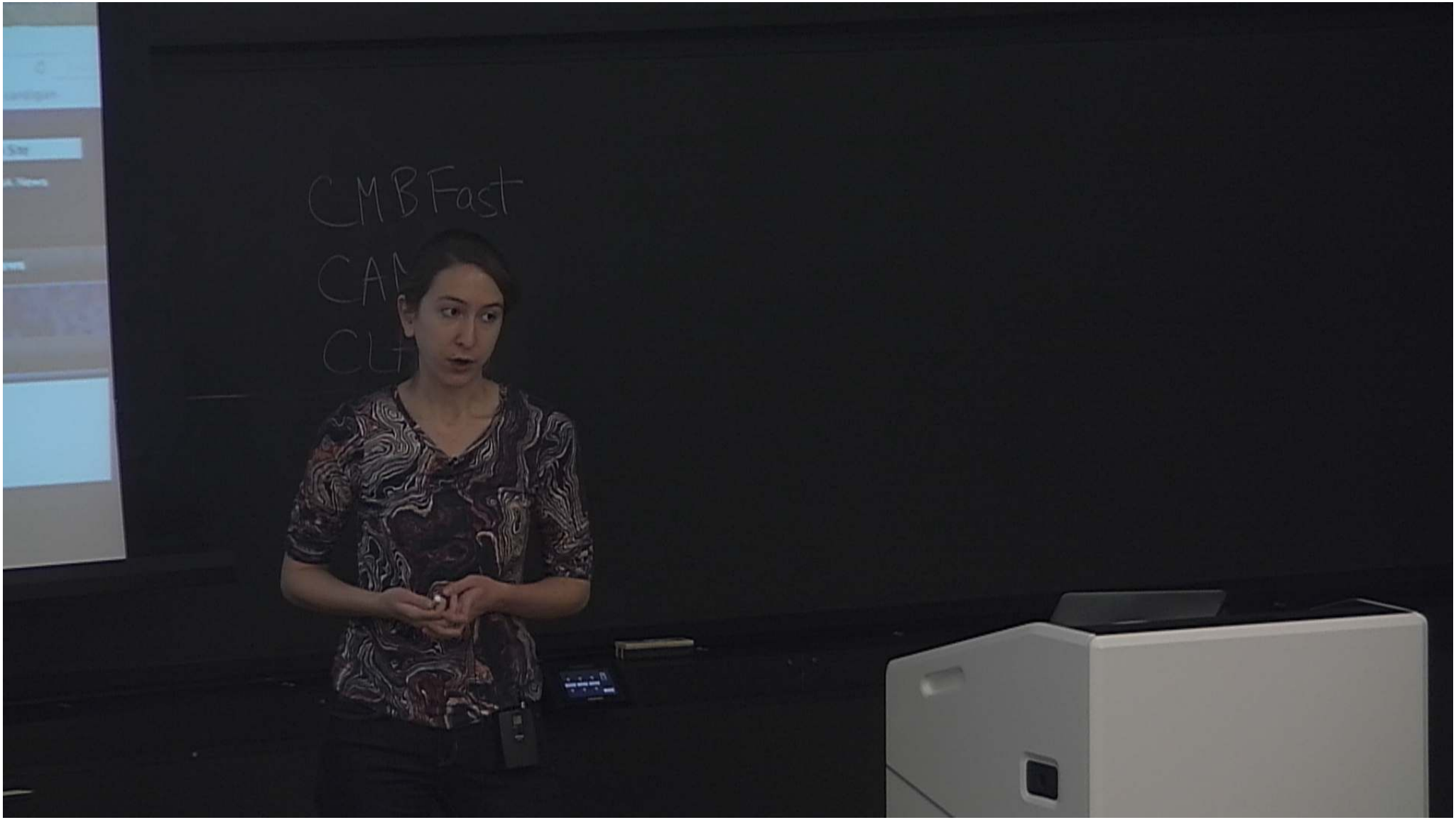
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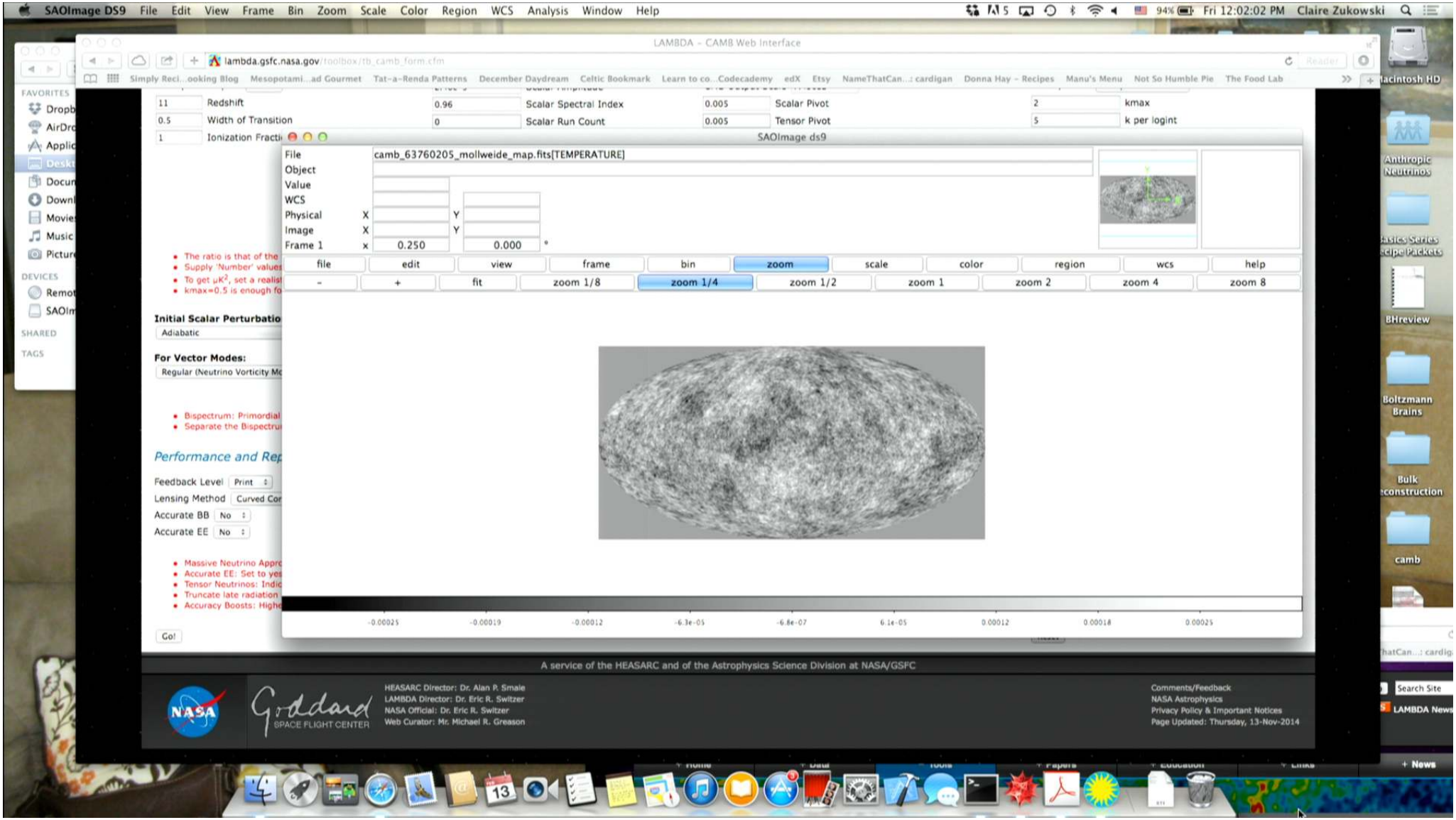
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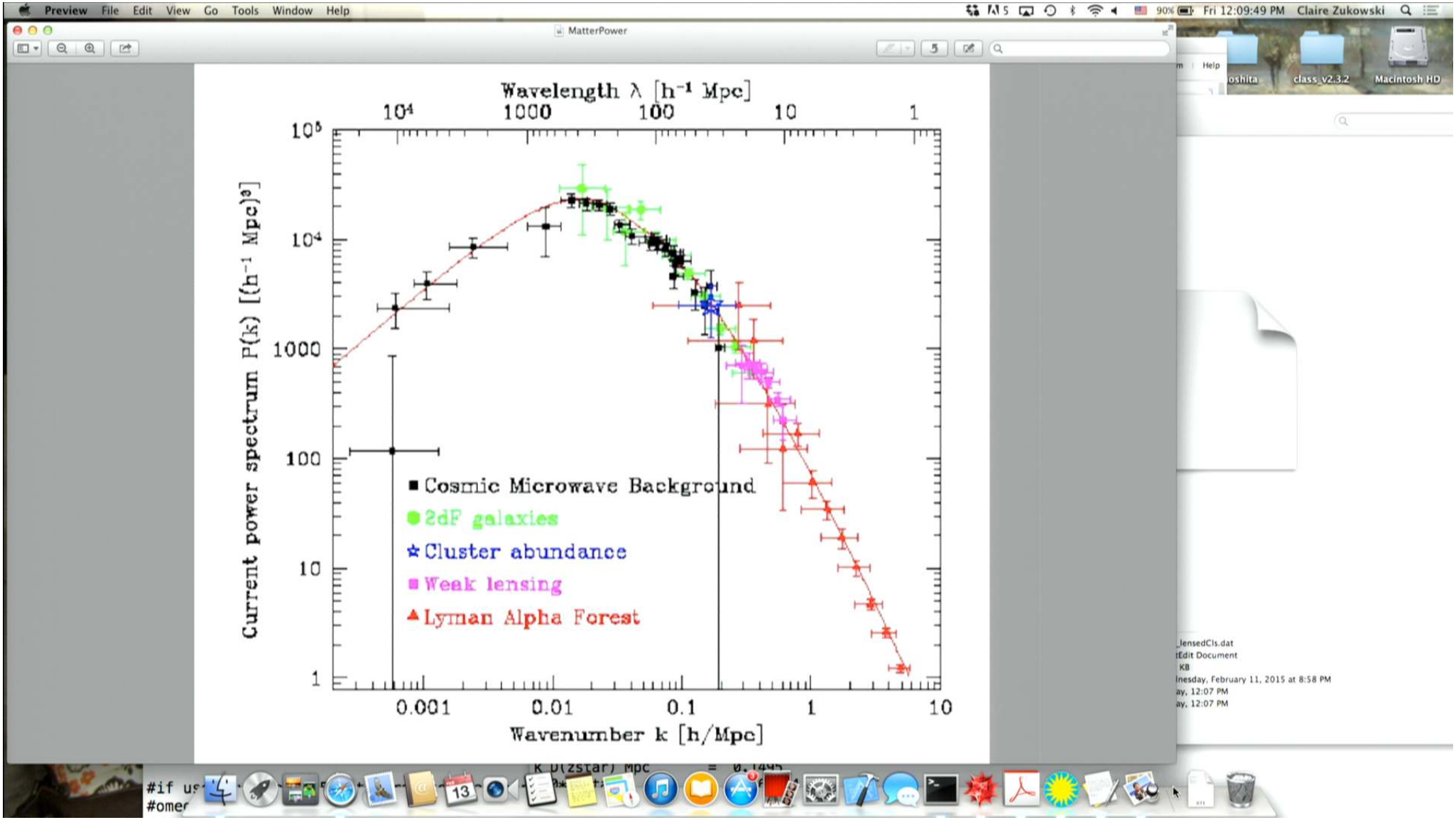
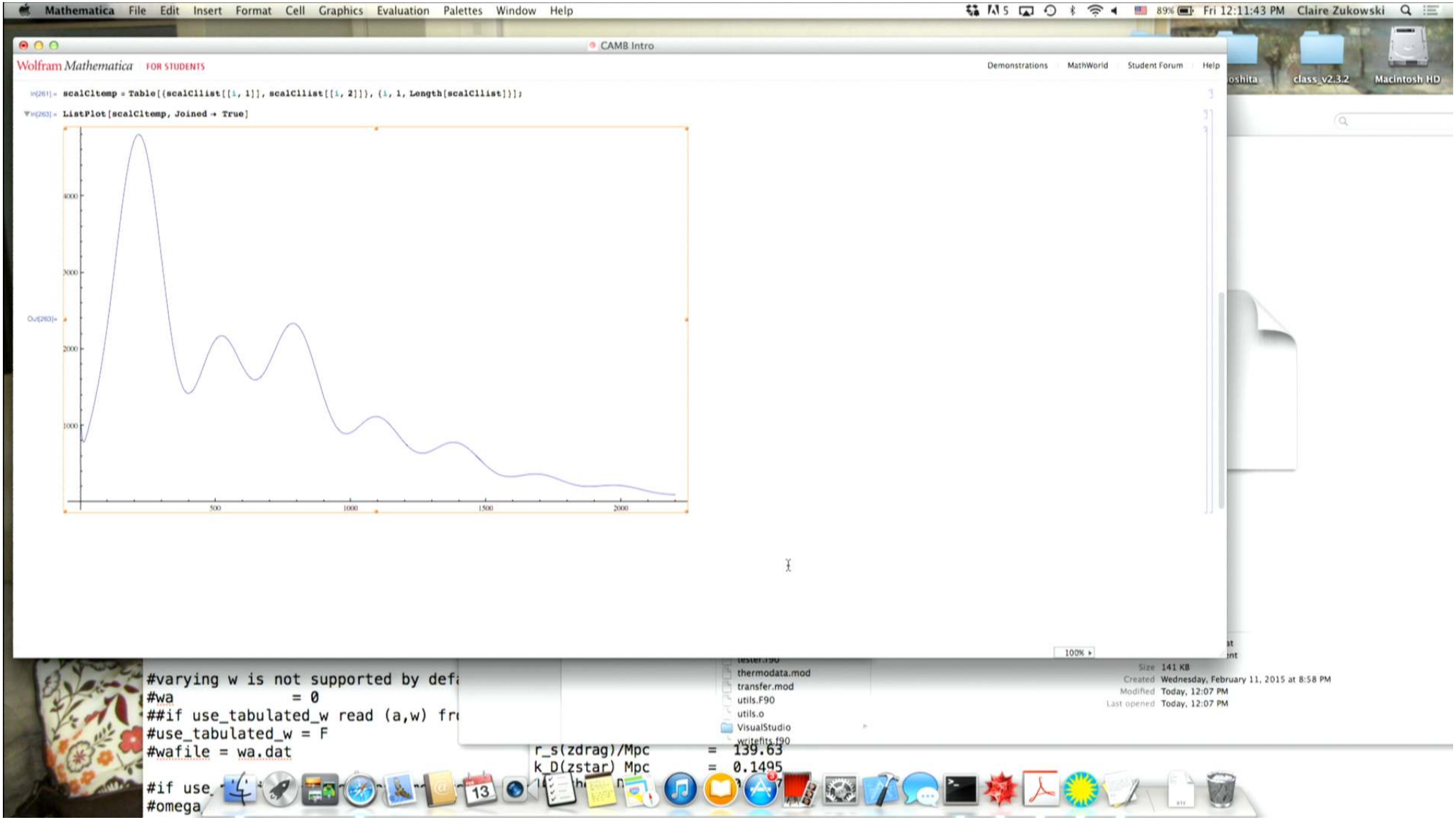

Wavelength λ [h⁻¹ Mpc]
10⁴
1000
100
10
1
Current power spectrum P(k) [(h⁻¹ Mpc)³]
10⁵
10⁴
1000
100
10
1
Cosmic Microwave Background
2dF galaxies
Cluster abundance
Weak lensing
Lyman Alpha Forest
0.001
0.01
0.1
1
10
Wavenumber k [h/Mpc]


Mathematica File Edit Insert Format Cell Graphics Evaluation Palettes Window Help
Fri 12:11:43 PM Claire Zukowski
CAMB Intro
Wolfram Mathematica FOR STUDENTS
Demonstrations MathWorld Student Forum Help
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Macintosh HD
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#use_tabulated_w = F
#wafile = wa.dat
#if use
#omega
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k_D(zstar) Mpc = 0.1495
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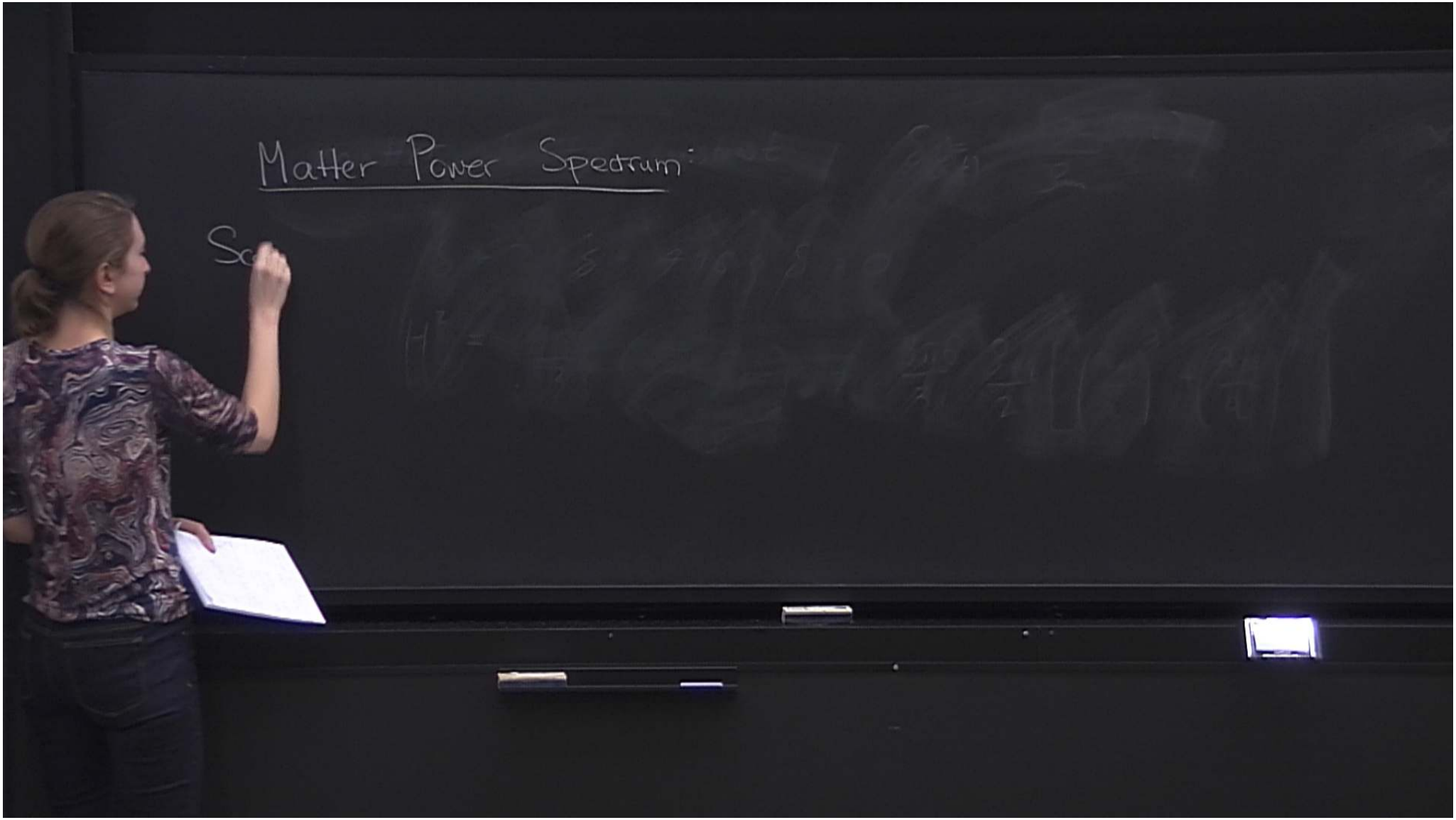
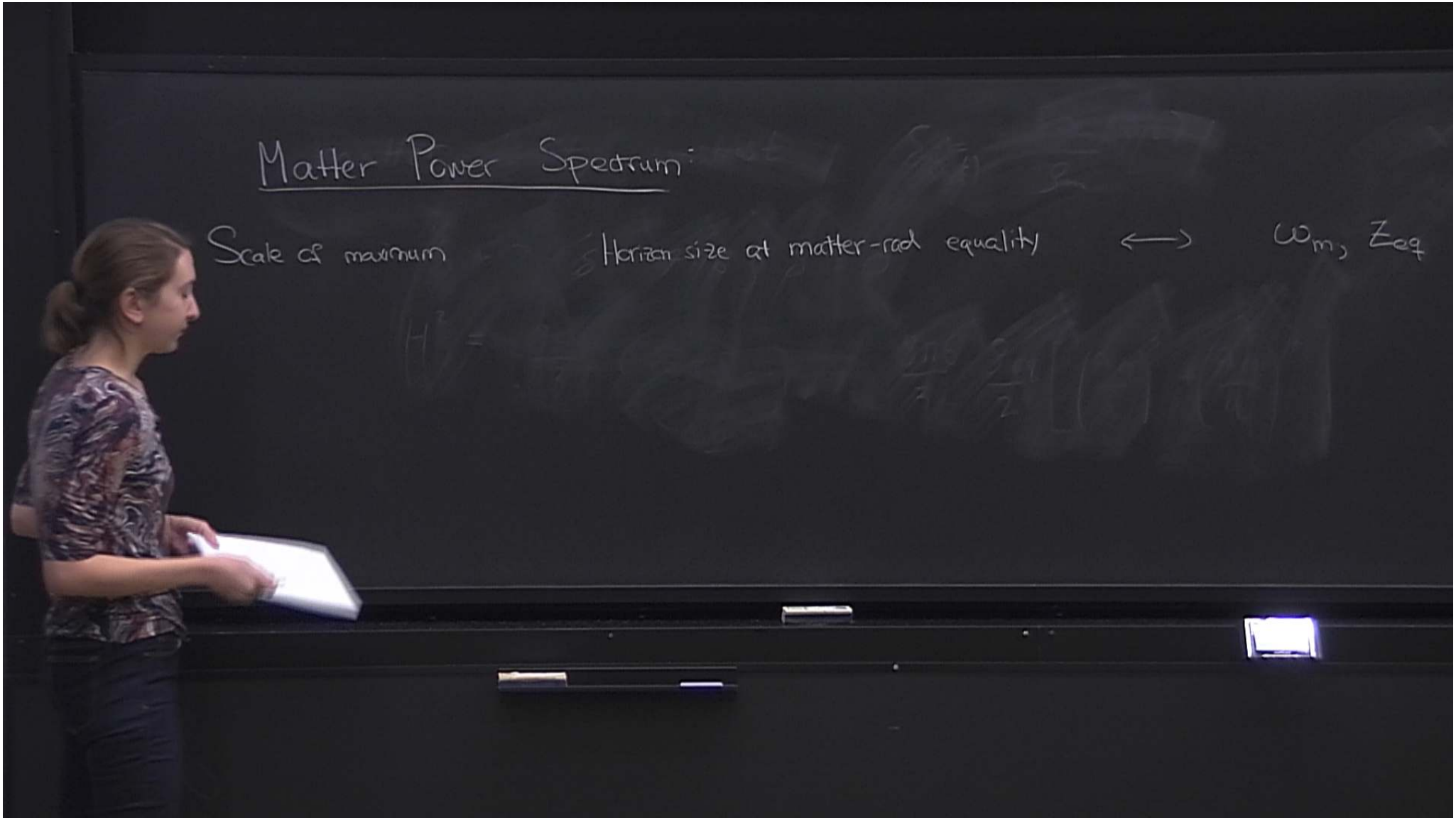
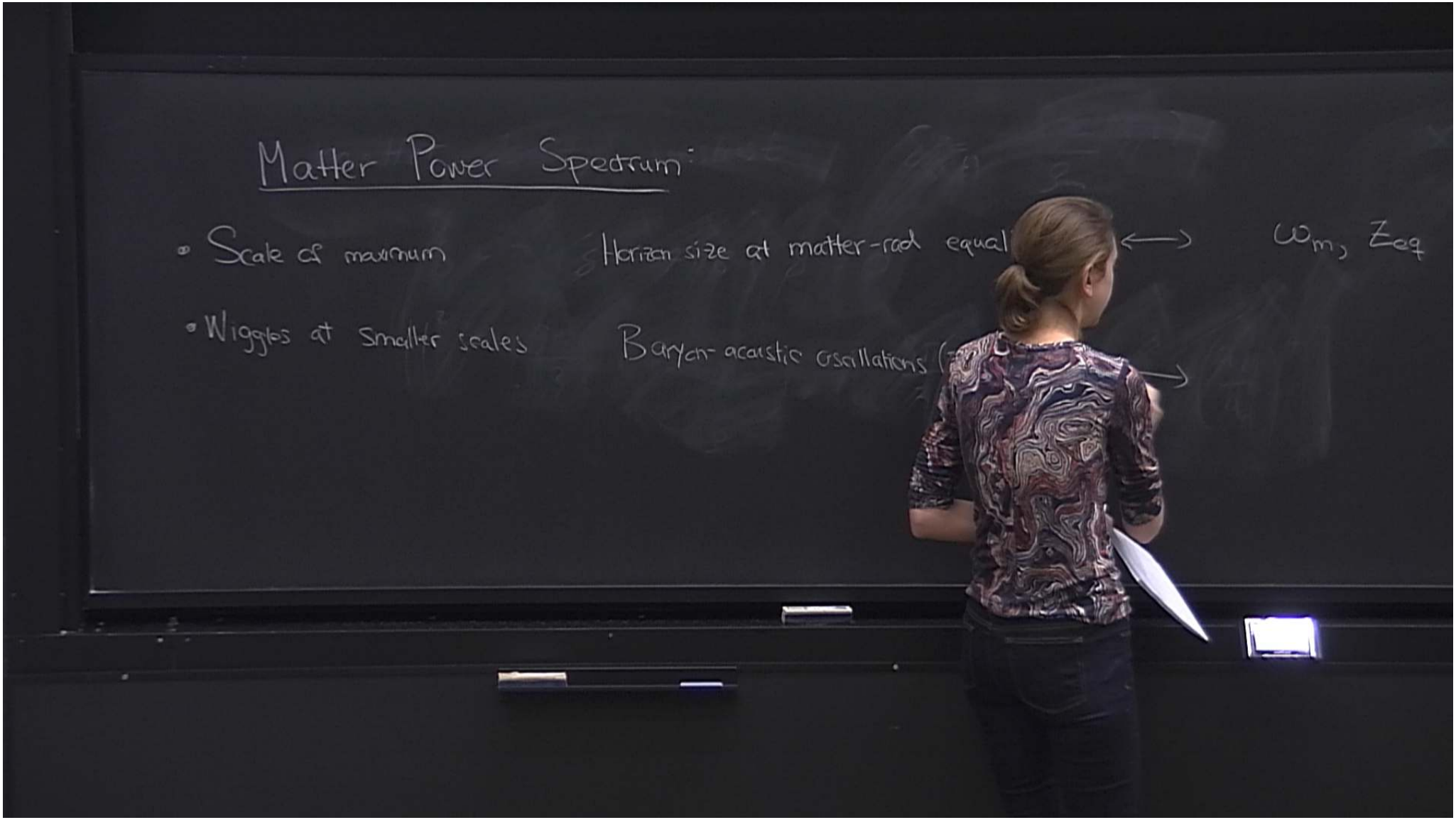
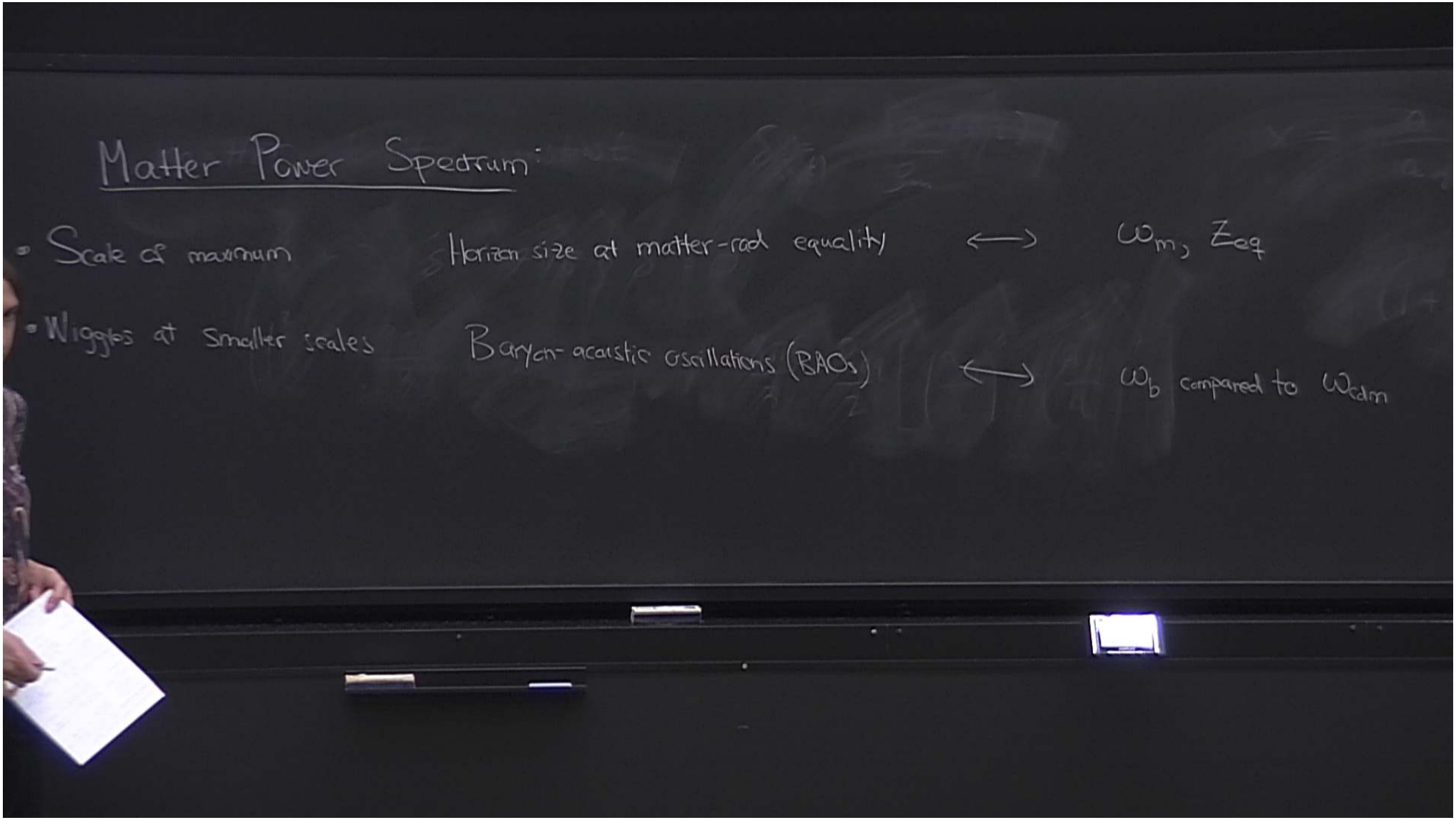
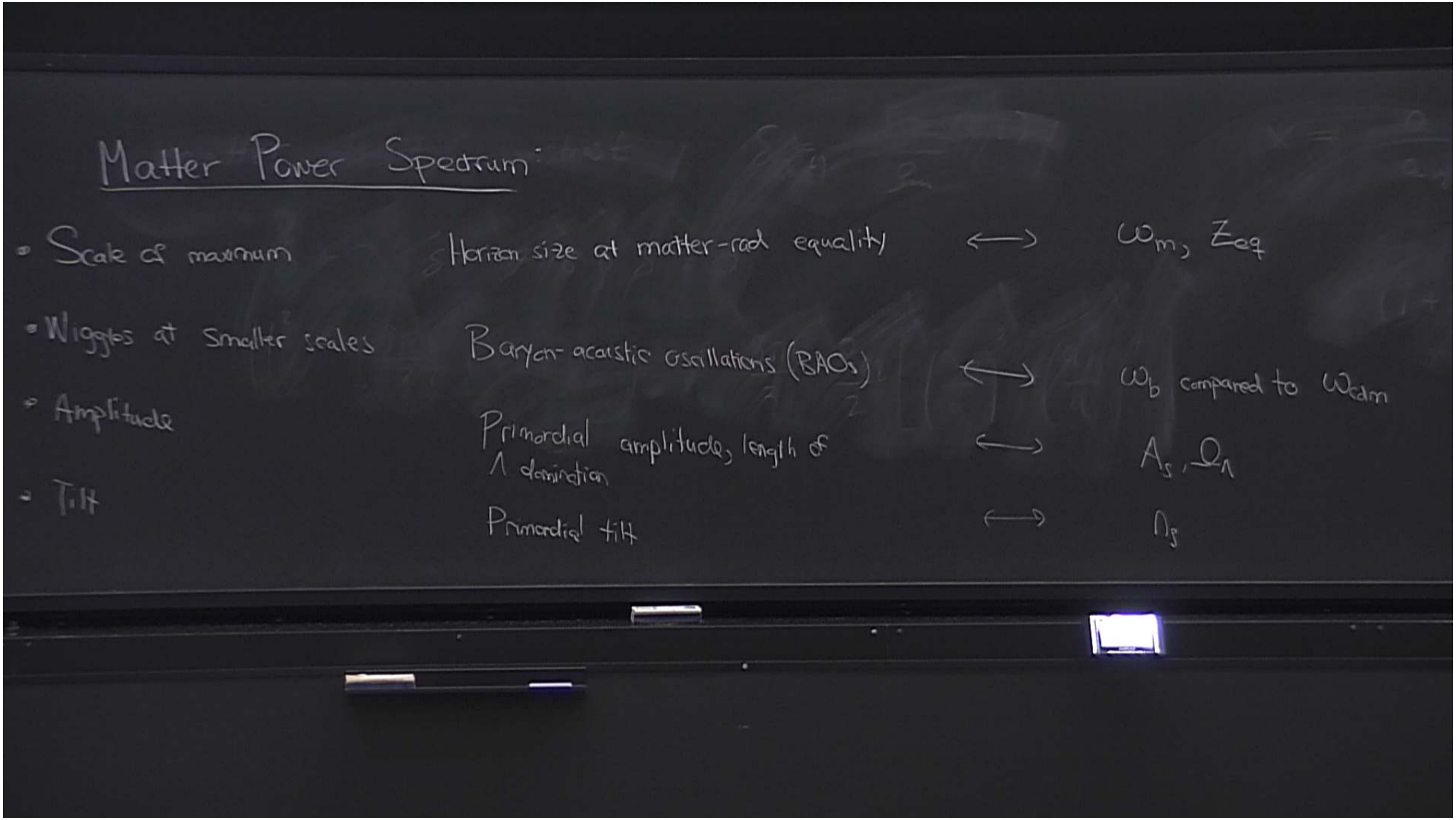
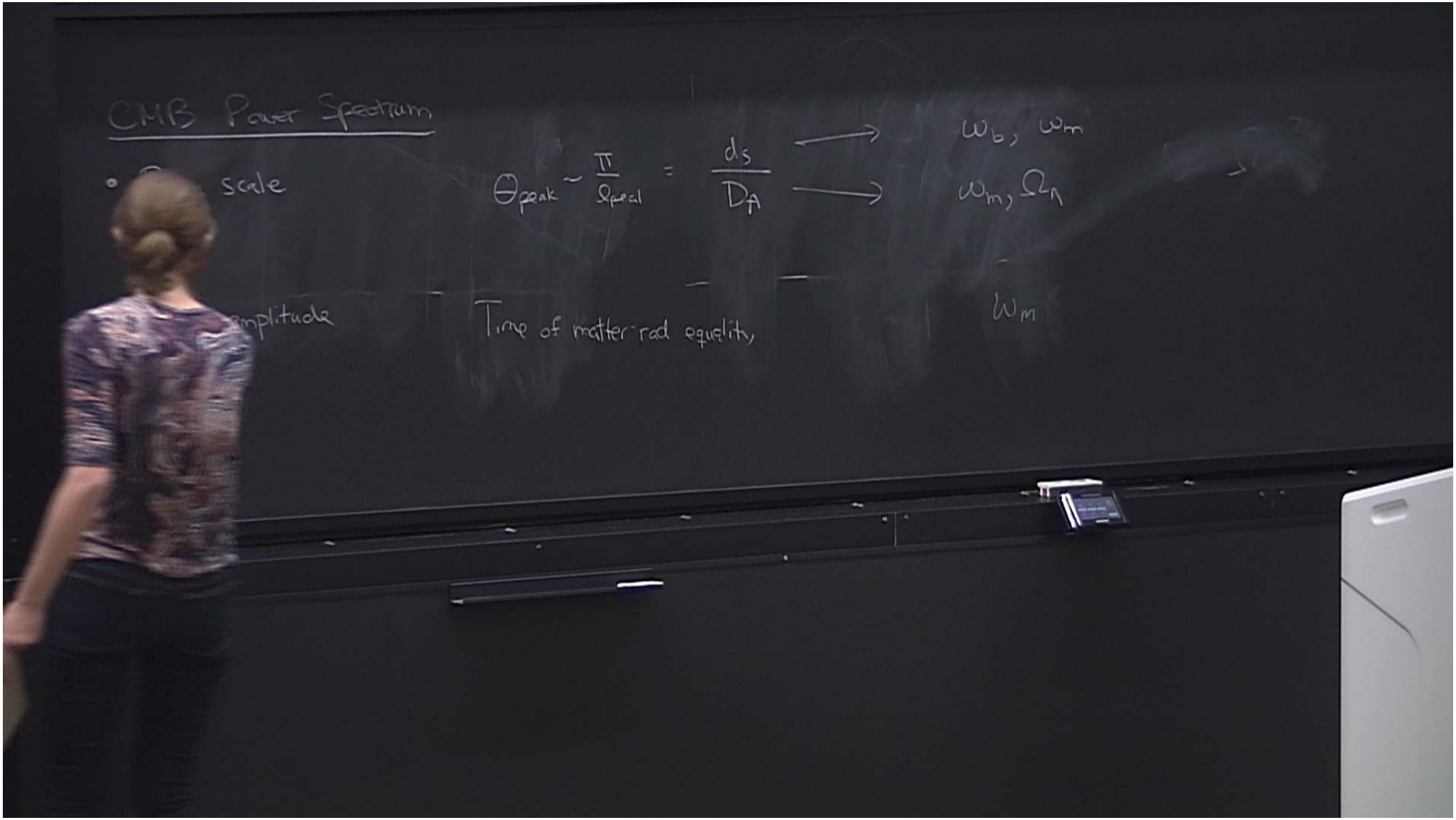

Matter Power Spectrum:


Matter Power Spectrum:
Scale of maximum
Horizon size at matter-rad equality
ω_m, z_{eq}


Matter Power Spectrum:
• Scale of maximum
Horizon size at matter-rad equal
ω_m, z_{eq}
• Wiggles at smaller scales
Baryon-acoustic oscillations


Matter Power Spectrum:
• Scale of maximum
Horizon size at matter-rad equality
ω_m, z_{eq}
• Wiggles at smaller scales
Baryon-acoustic oscillations (BAOs)
ω_b compared to ω_{cdm}


Matter Power Spectrum:
• Scale of maximum
• Wiggles at smaller scales
• Amplitude
• Tilt
Horizon size at matter-rad equality ⟷ ω_m, z_{eq}
Baryon-acoustic oscillations (BAOs) ⟷ ω_b compared to ω_{cdm}
Primordial amplitude, length of Λ domination ⟷ A_s, Ω_Λ
Primordial tilt ⟷ n_s


CMB Power Spectrum
scale
$\theta_{peak} \sim \frac{\pi}{\ell_{peak}} = \frac{d_s}{D_A}$
ω_b, ω_m
ω_m, Ω_Λ
amplitude
Time of matter-rad equality
ω_m