

Title: 13/14 PSI - Cosmology Review - Lecture 7

Date: Feb 06, 2014 11:30 AM

URL: <http://pirsa.org/14020013>

Abstract:

Thermodynamics in FRW
→ BBN
CMB

ysics in FRW | SM $\begin{cases} \rightarrow \text{particle} \\ \rightarrow \text{cosmo} \end{cases}$ Λ CDM, scale invariant
primordial
pert.

DM: why believe in DM?

- $\rightarrow$ atoms?
- $\rightarrow$ dark matter?
- $\rightarrow$ modified grav.?

Zwicky Cluster



M_1

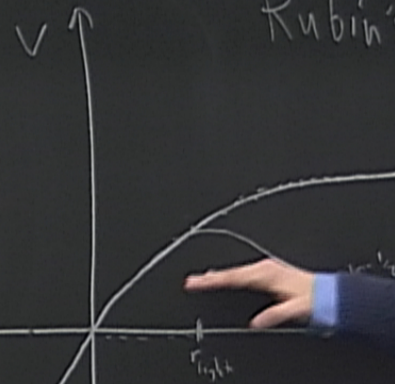
M_2

$$\frac{GM}{r^2} = \frac{v^2}{r}$$

H_0



Rubin's 1970's

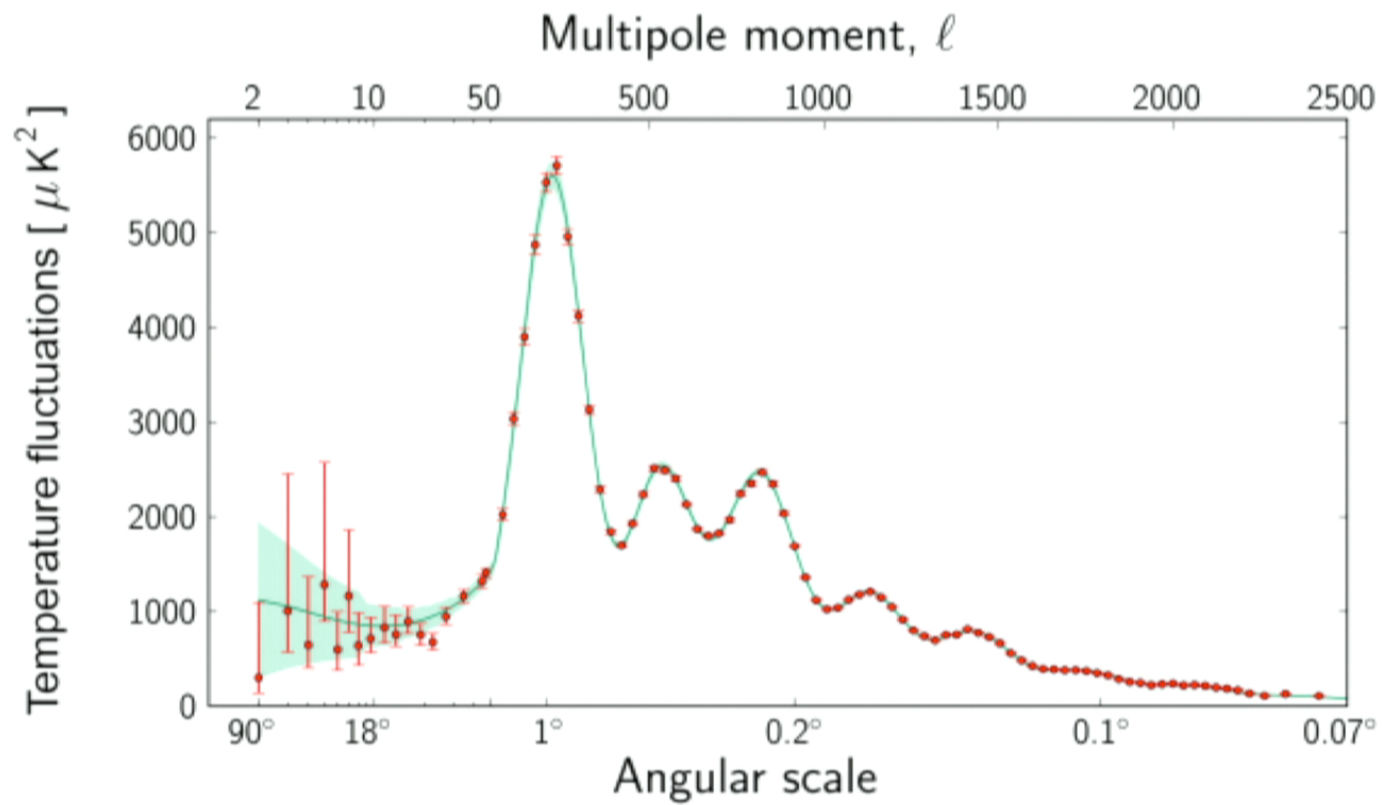


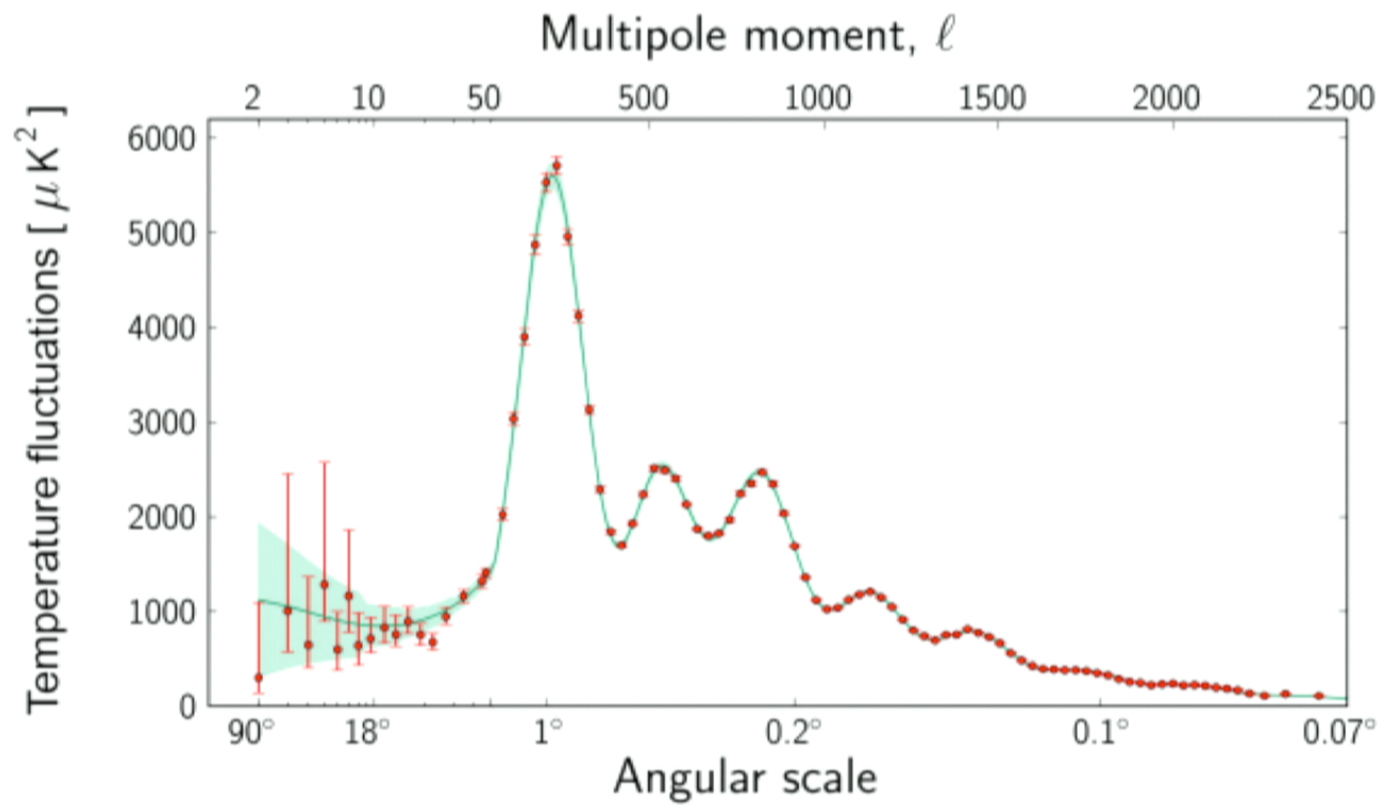


Galaxy Cluster Abell 2218

HST • WFPC2

NASA, A. Fruchter and the ERO Team (STScI, ST-ECF) • STScI-PRC00-08

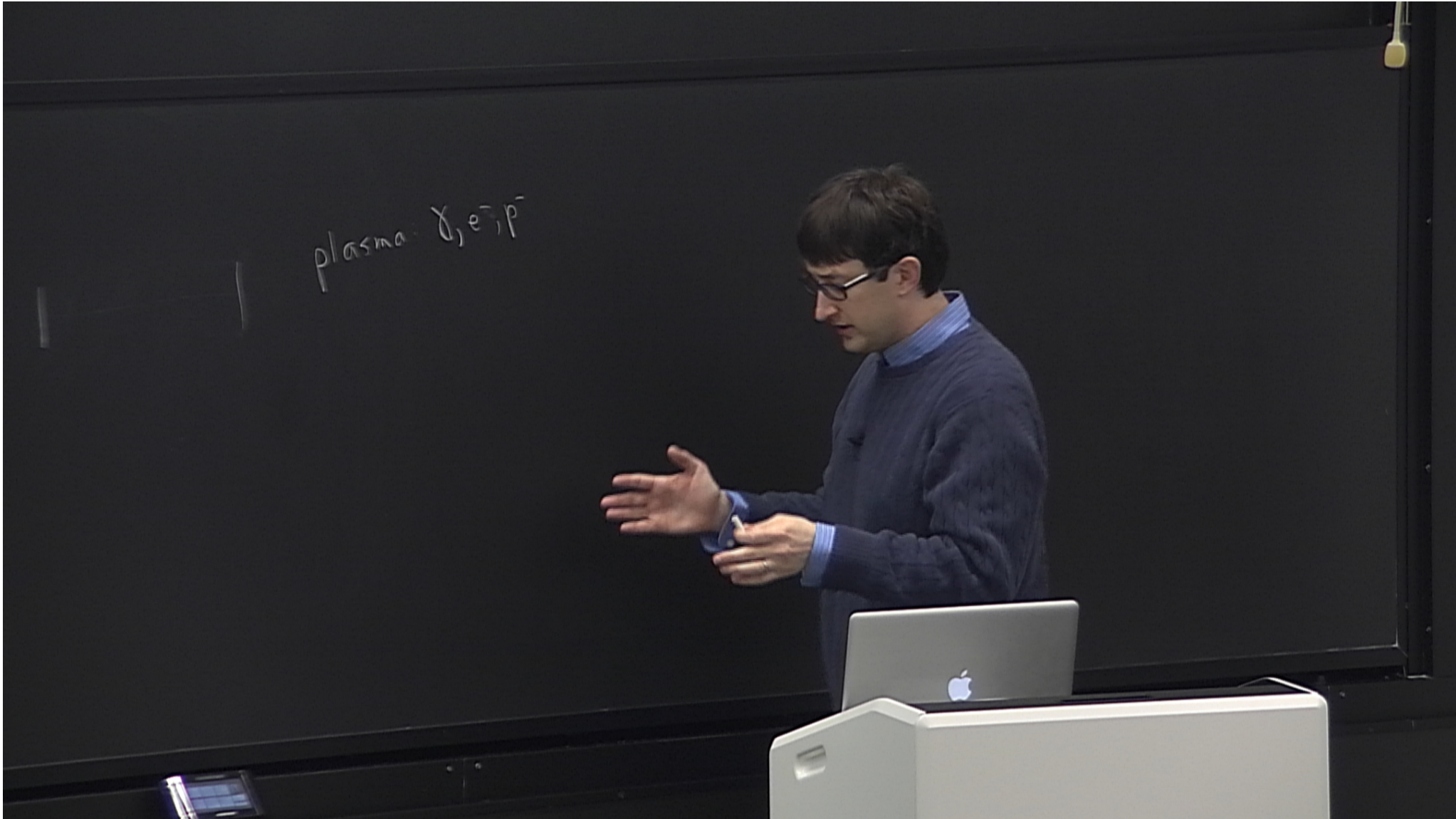


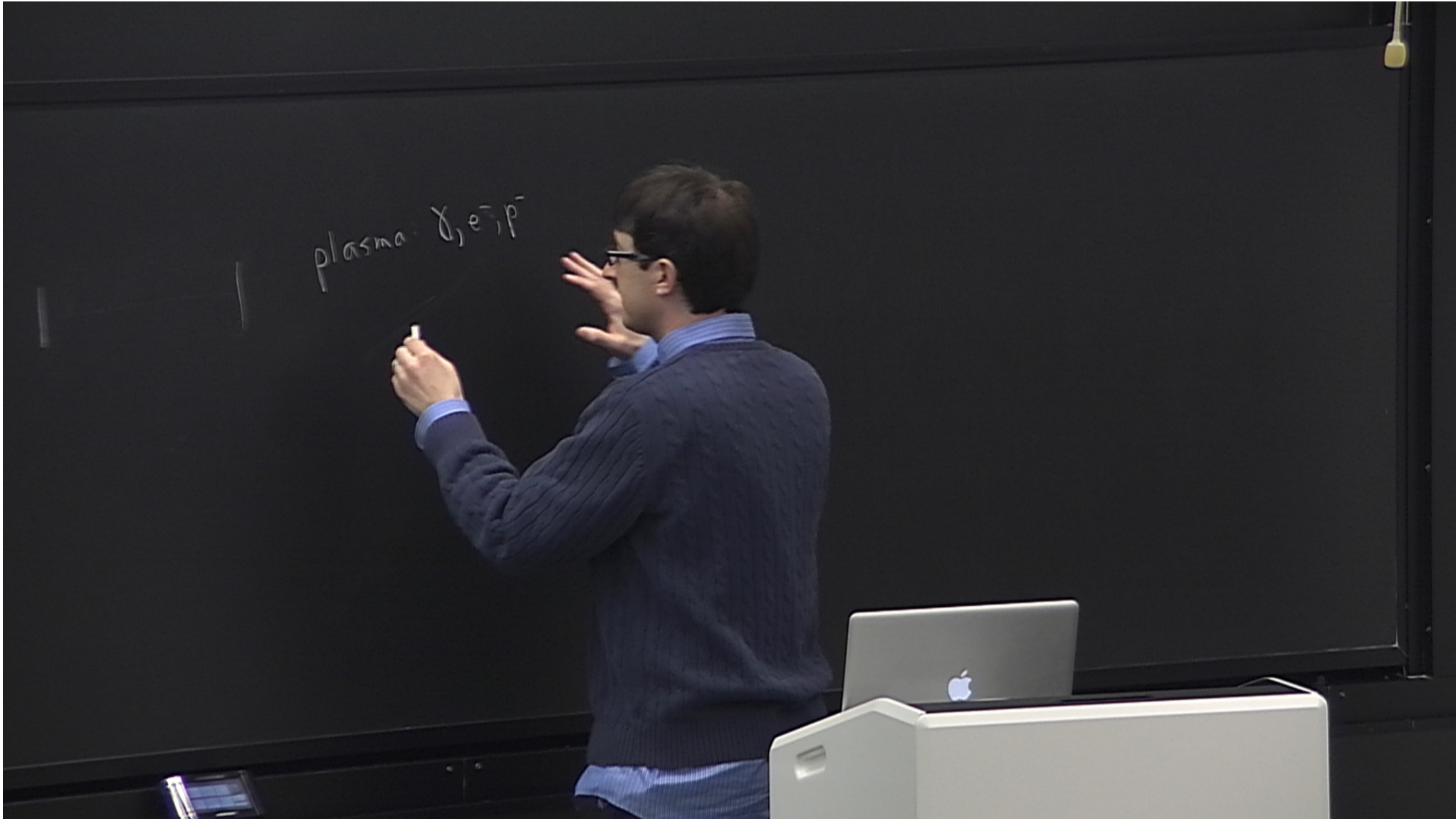


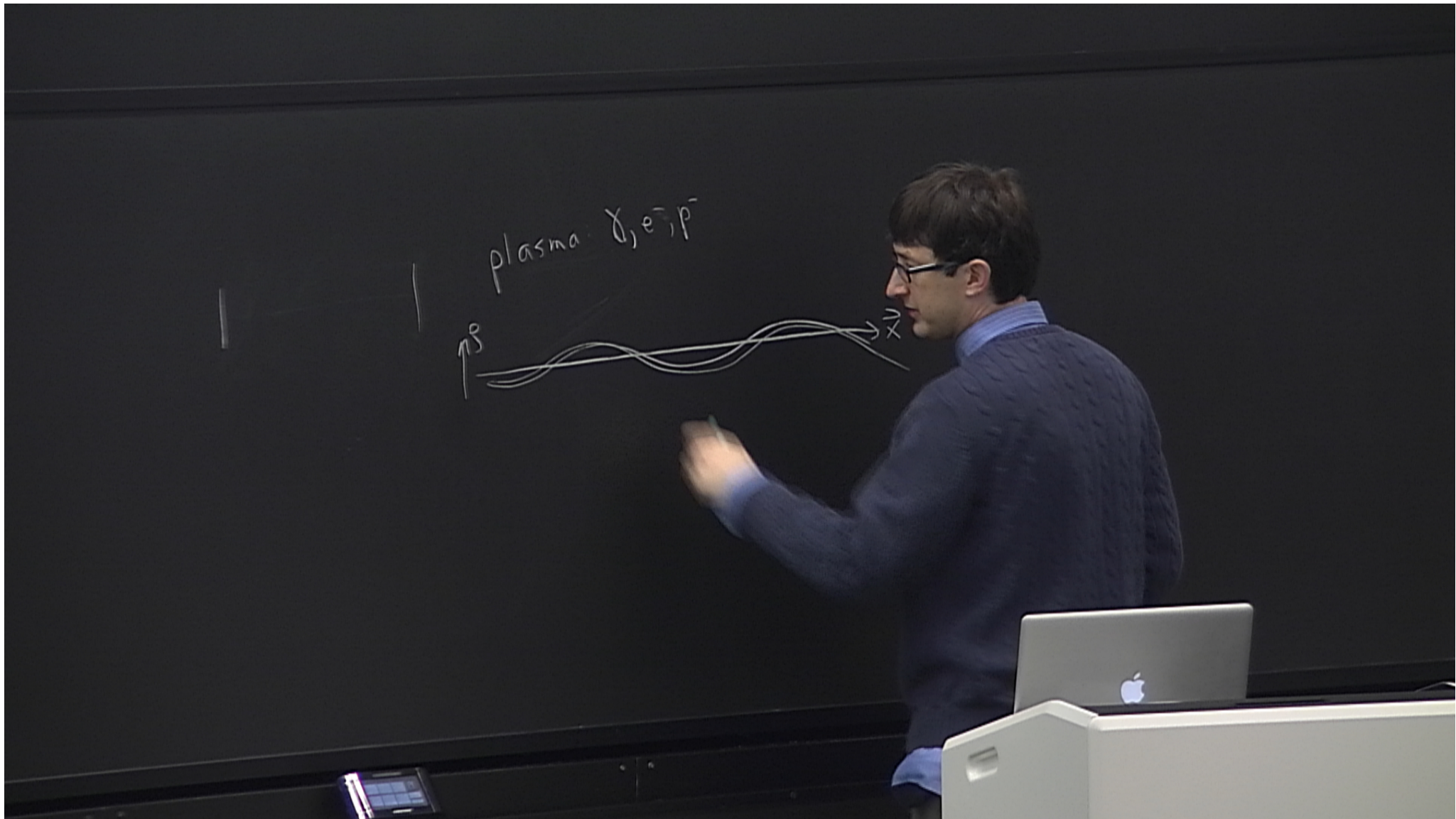
BBN: $T \sim 1 \text{ MeV}$

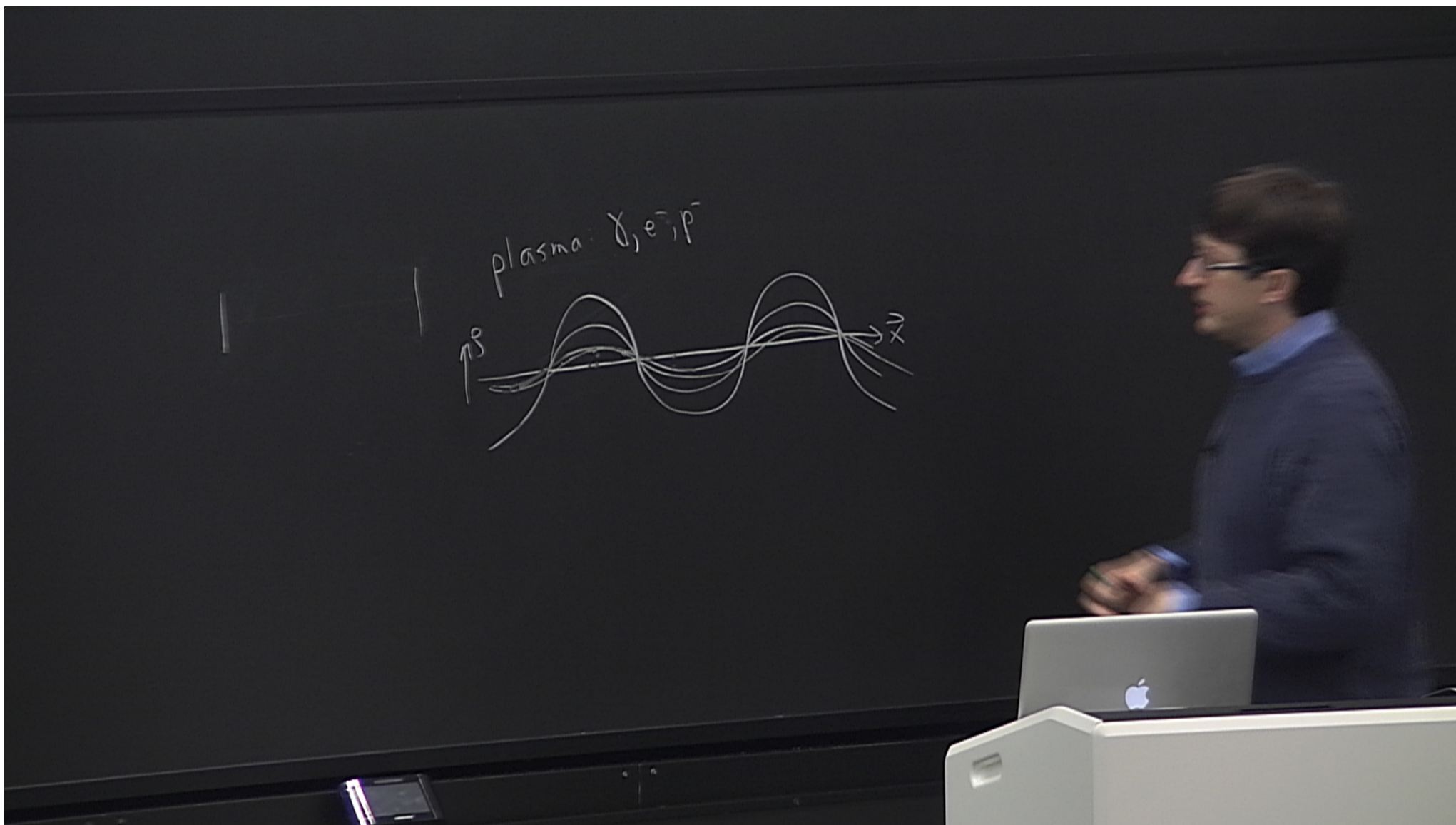
n, p $\rightarrow$ H 75% D
He 25%

$$\rightarrow \eta = 10^{-9} \frac{n+p}{\gamma}$$









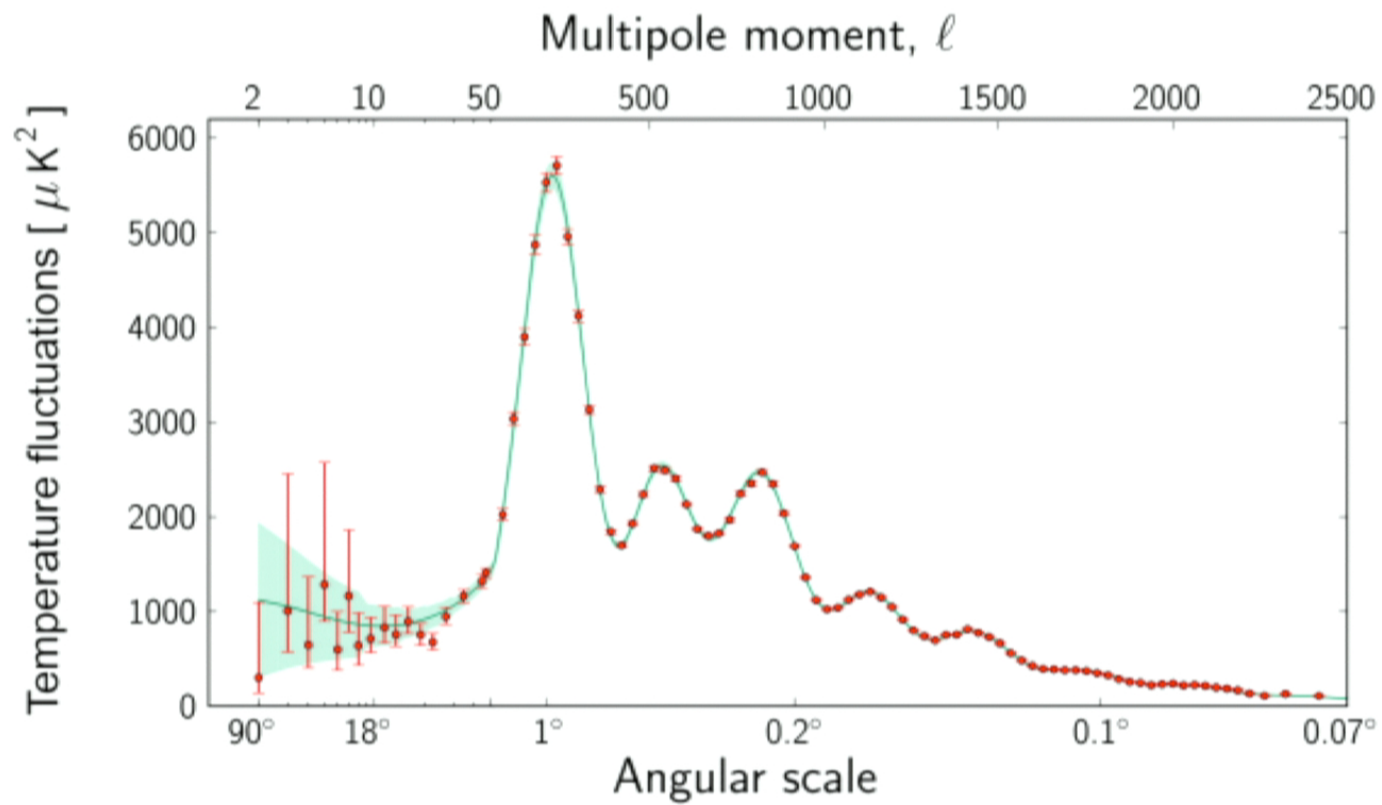
$$T(\theta, \varphi) = \sum_{l,m} a_{lm} Y_{l,m}(\theta, \varphi)$$

| |
plasma: $\chi, e^-(p)$

$$\langle a_{lm} a_{l'm'} \rangle = C_l \delta_{l,l'} \delta_{m,m'}$$

↑ ↑

$$C_l = \frac{1}{2l+1} \sum_{m=-l}^l |a_{lm}|^2$$



$$T(\theta, \varphi) = \sum_{l,m} a_{lm} Y_{l,m}(\theta, \varphi)$$

| |
 plasma $\chi, e^-(p)$

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↑

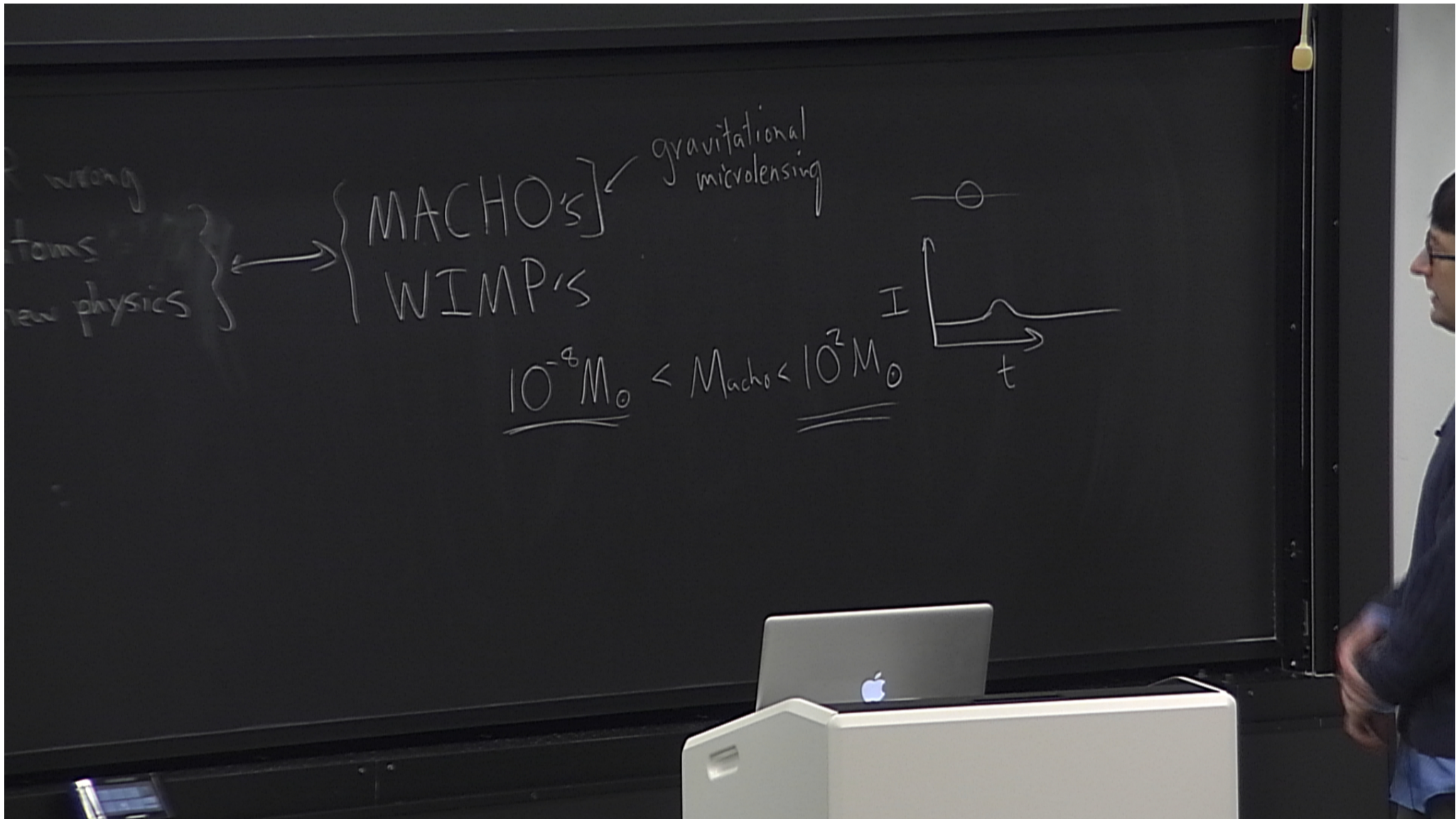
$$C_l = \frac{1}{2l+1} \sum_{m=-l}^l |a_{lm}|^2$$

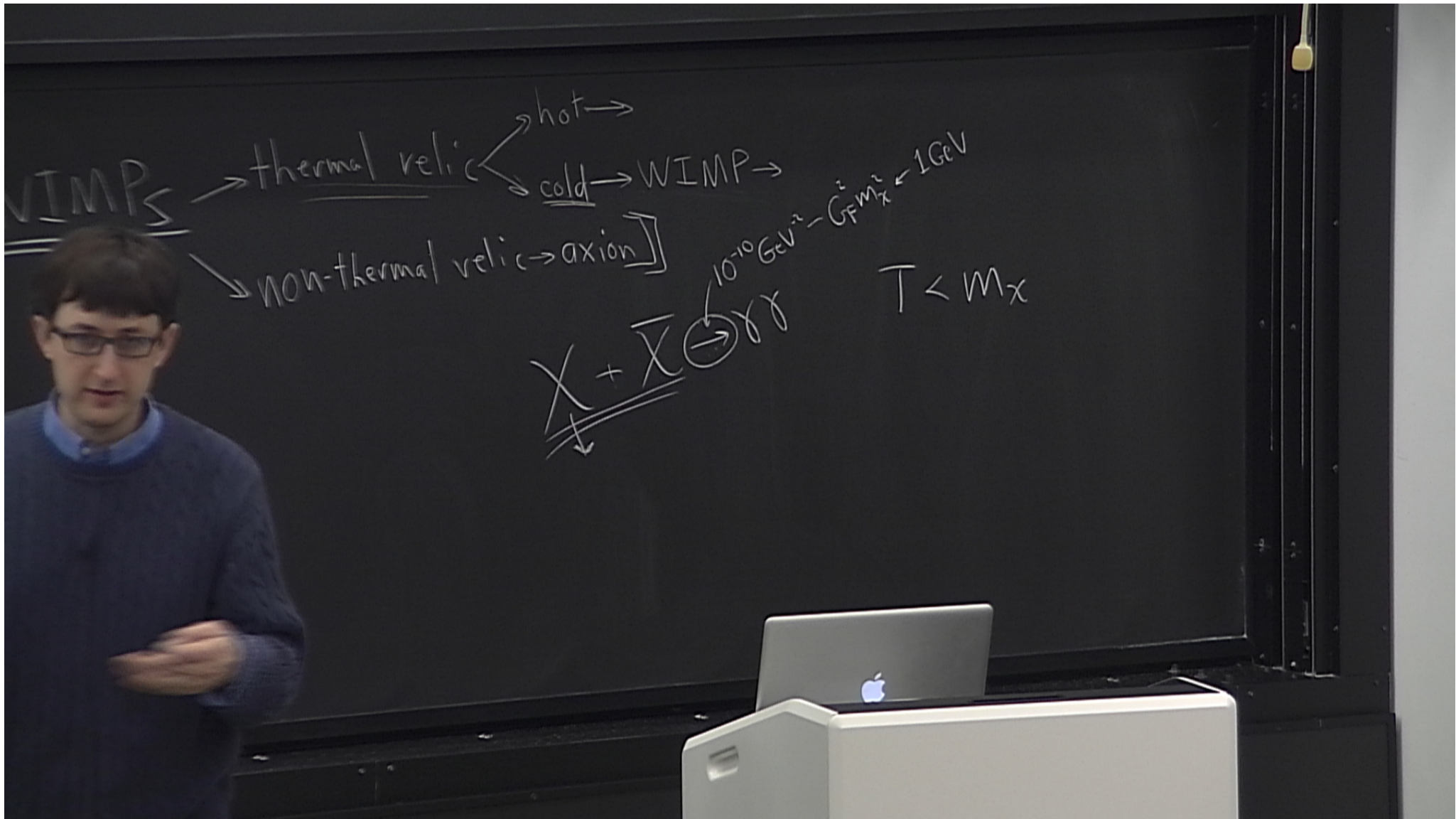
1) GR wrong
2) atoms
new physics

↔ { MACHO's
WIMP's

gravitational
microlensing







$$\underline{n(T)} \quad \Gamma(T) < H$$

$$n(T_f) \quad n_f$$

$$\frac{n}{s} = \frac{n_f}{s_f} = \frac{n_0}{s_0}$$

$$s_0 = (1) \cdot T_0^3$$

$$n = \frac{\#}{V} \propto a^{-3} \quad V \propto a^3 \quad s \propto a^{-3}$$

$$n_0 = s_0 \frac{n_f}{s_f}$$

$$n_f \sim (1) T_f^3$$

$$s_f \sim (1) T_f^3$$

$$\rho_0 = m_x n_0$$

$$J = m_x T_0^3$$

$$\underline{m_x < 10 \text{ eV}}$$

$$f_{\text{crit}} = \frac{3 H_0^2}{8 \pi G_N}$$