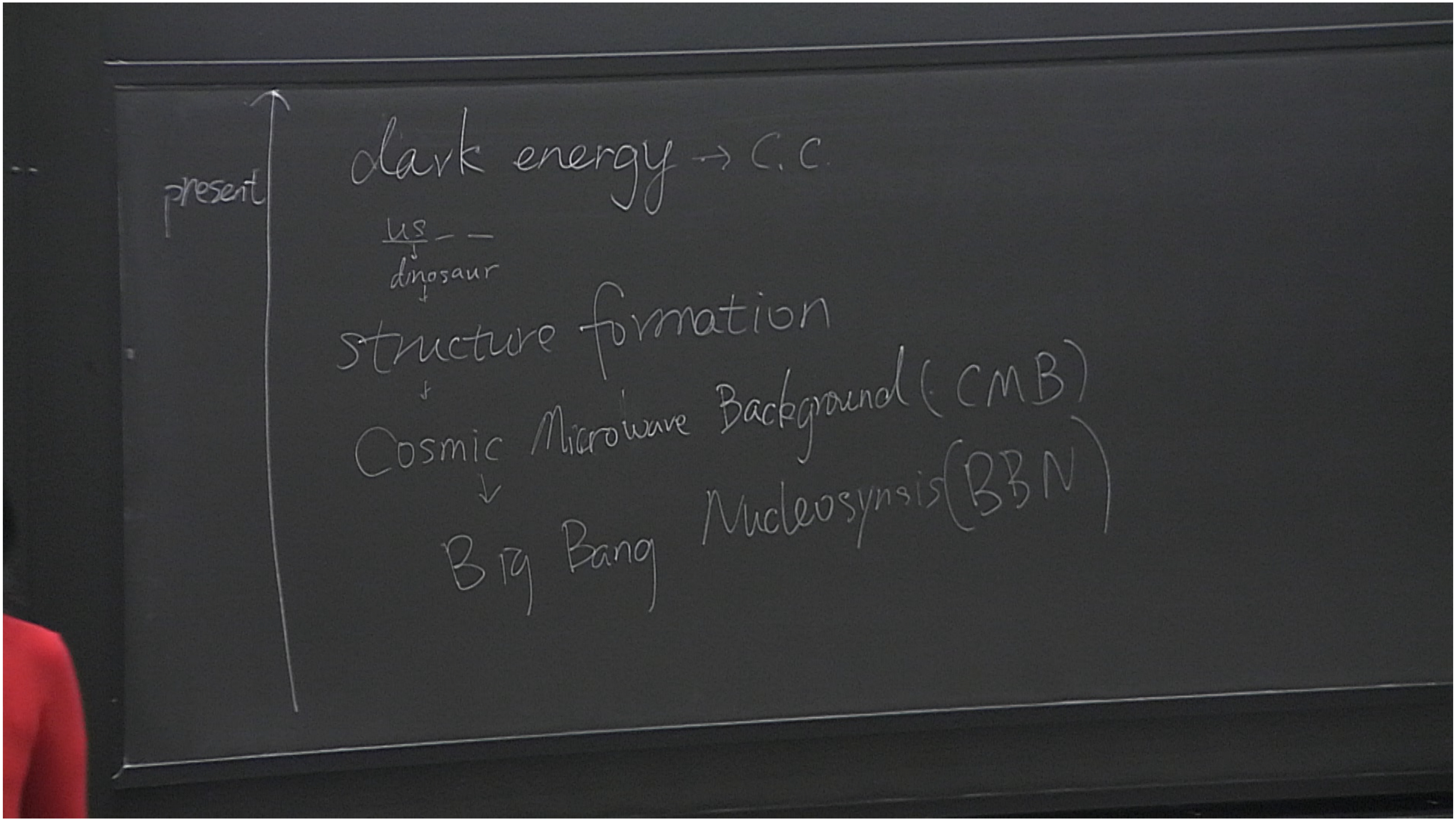
Title: PSI 2018/2019 - Cosmology Review - Lecture 1

Date: Jan 07, 2019 09:00 AM

URL: http://pirsa.org/19010002

Abstract:

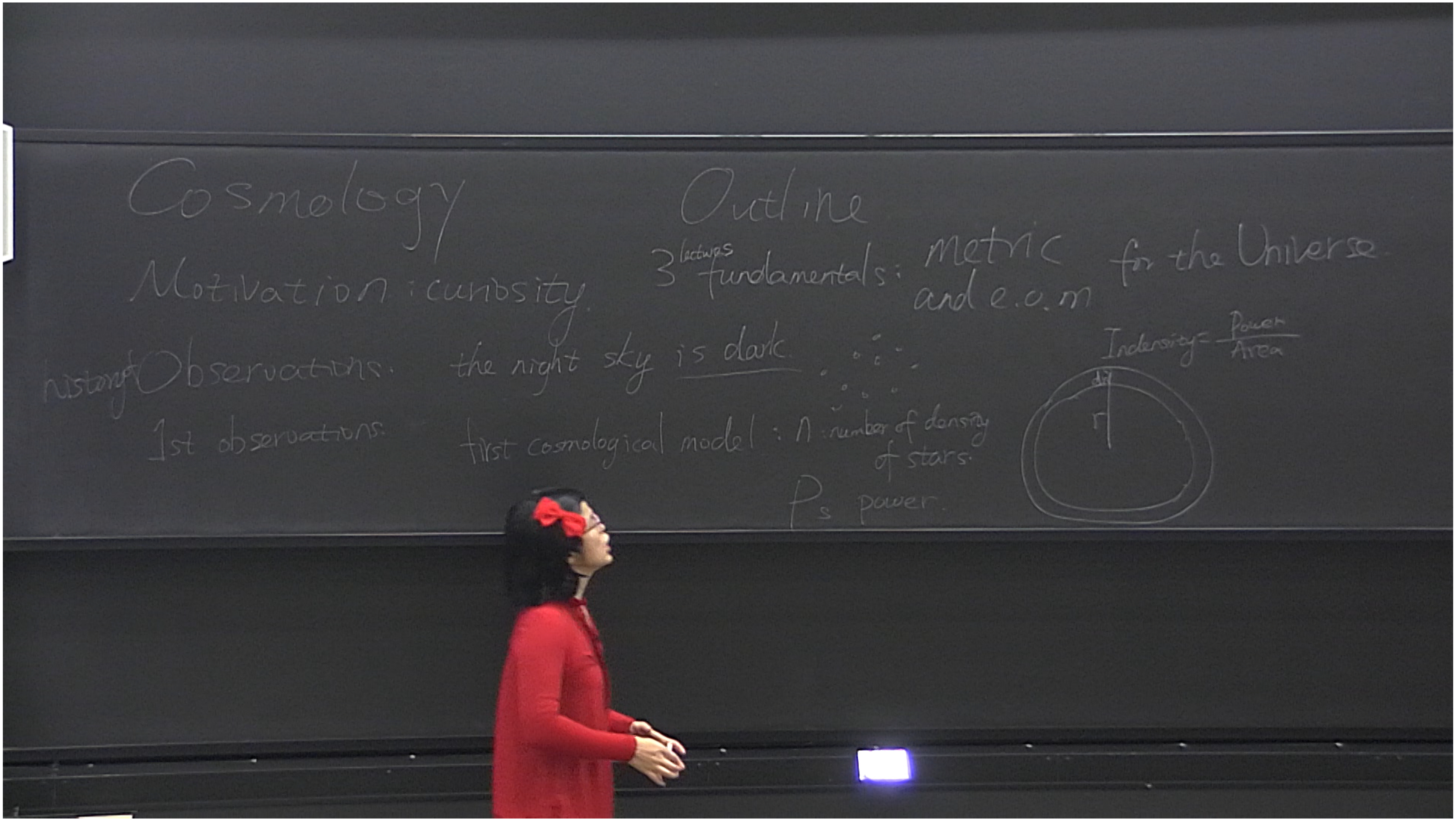

present
dark energy → C.C
us - -
dinosaur
structure formation
Cosmic Microwave Background (CMB)
Big Bang
Nucleosynsis (BBN)

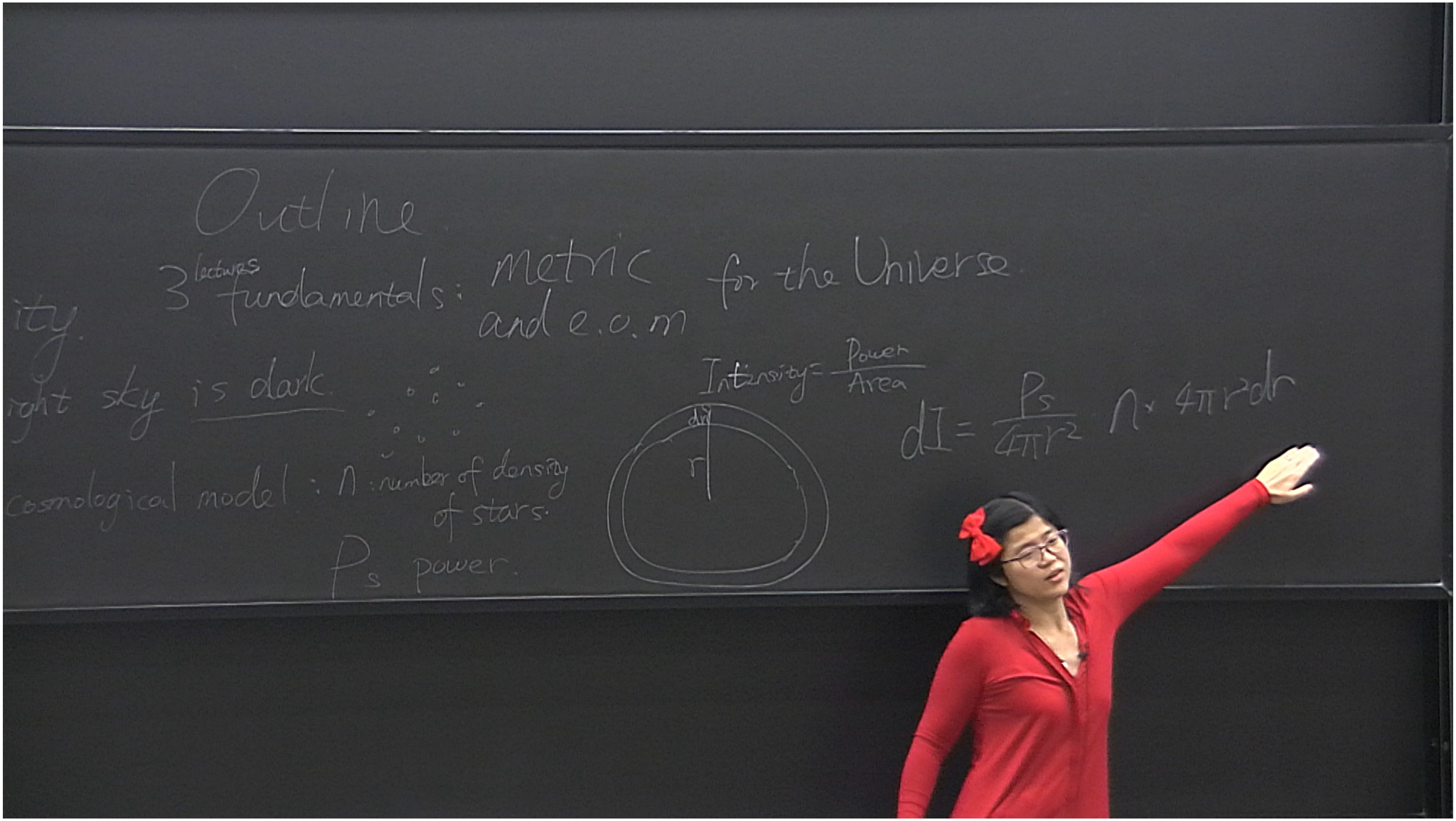
10^{-32}

major proposal: Inflation.

& fluctuations

Angelika Fertig   Bounce cosmology


Cosmology
Outline
3 lectures fundamentals: metric and e.o.m for the Universe.
Motivation: curiosity.
history Observations: the night sky is dark.
Intensity = Power / Area
1st observations.
first cosmological model: n: number of density of stars.
P_s power.
dr
r


Outline
3 lectures fundamentals: metric and e.o.m for the Universe.
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ight sky is dark.
cosmological model: n: number of density of stars.
Ps power.
Intensity = Power / Area
dr
r
dI = Ps / 4πr² n × 4πr²dr

esent

dark energy → C.C.

us - -

dinosaur

structure formation

Cosmic Microwave Background (CMB)

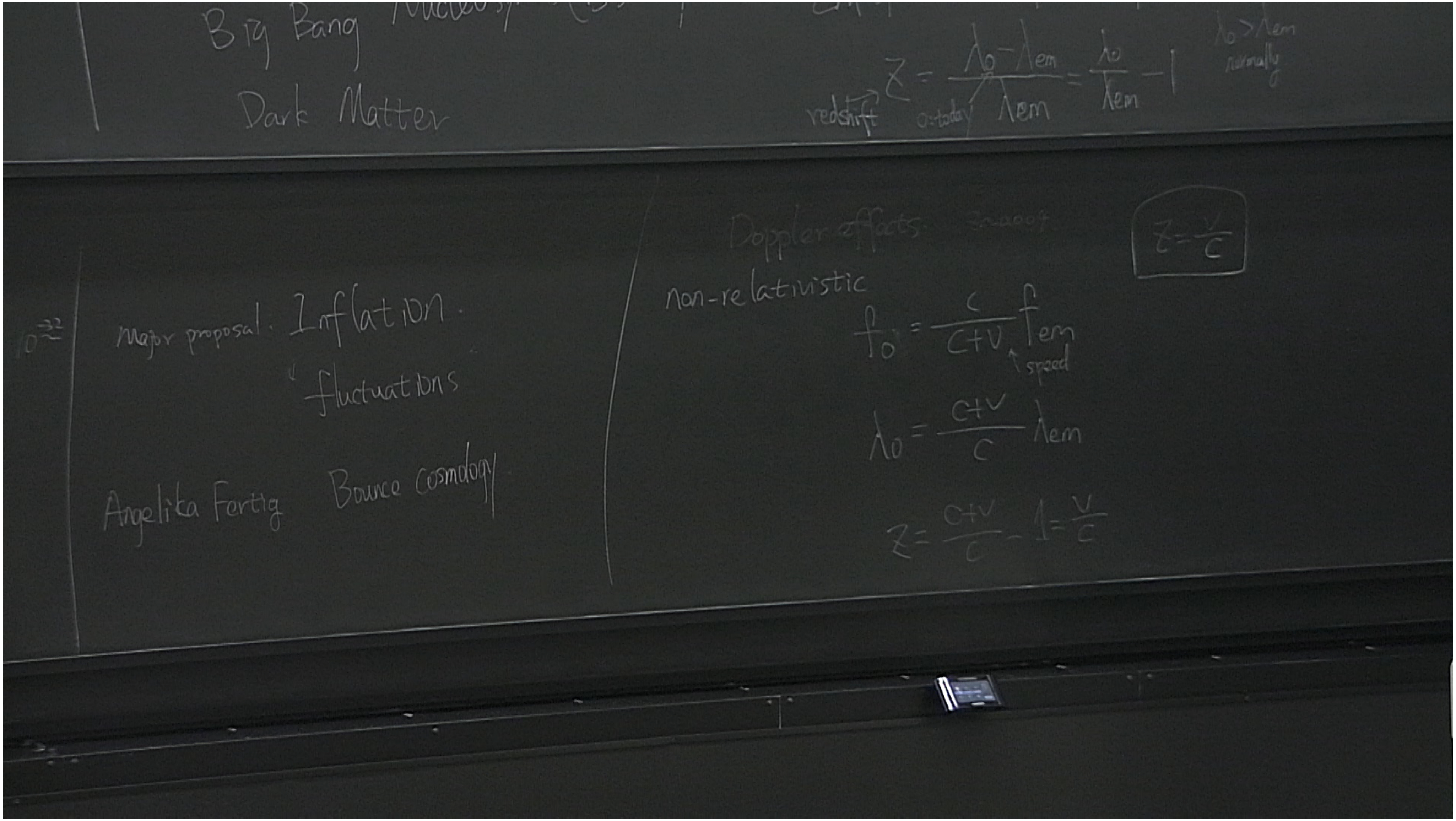
Big Bang Nucleosynsis (BBN)

Dark Matter

$$\int_0^{t_{age}\cdot c} dI = \text{dark}$$

age of univere is finite.

1900's. redshift


Big Bang
Dark Matter
redshift
0=today
$z = \frac{\lambda_0 - \lambda_{em}}{\lambda_{em}} = \frac{\lambda_0}{\lambda_{em}} - 1$
$\lambda_0 > \lambda_{em}$ normally
Doppler effects
$\boxed{z = \frac{v}{c}}$
non-relativistic
$f_0 = \frac{c}{c+v} f_{em}$
speed
$\lambda_0 = \frac{c+v}{c} \lambda_{em}$
$z = \frac{c+v}{c} - 1 = \frac{v}{c}$
10^{-32}
Major proposal. Inflation.
fluctuations
Angelika Fertig
Bounce cosmology

redshift 0: today λ_{em}

Doppler effects: $z \sim 0.004$

$$\boxed{z = \frac{v}{c}}$$

non-relativistic

$$f_0 = \frac{c}{c+v} f_{em}$$

↑ speed

1929 Hubble

v km/s

$$\lambda_0 = \frac{c+v}{c} \lambda_{em}$$

$$z = \frac{c+v}{c} - 1 = \frac{v}{c}$$

redshift → $z = \frac{\lambda_0 - \lambda_{em}}{\lambda_{em}} = \frac{\lambda_0}{\lambda_{em}} - 1$ normally

0 = today

Doppler effects

relativistic

$$\boxed{z = \frac{v}{c}}$$

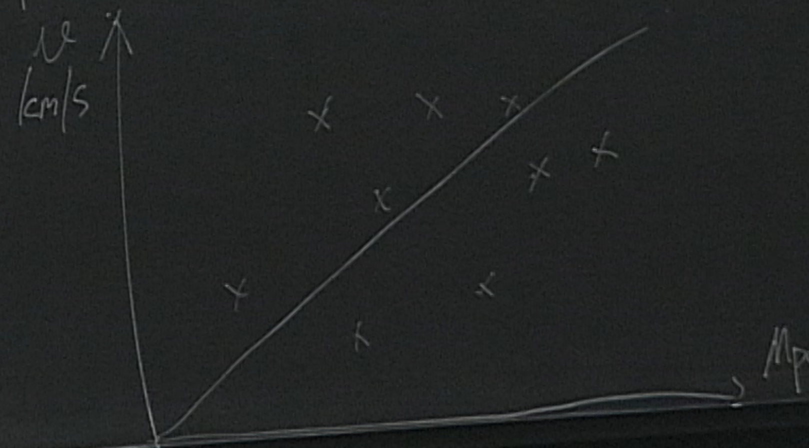
$$f_0 = \frac{c}{c+v} f_{em}$$

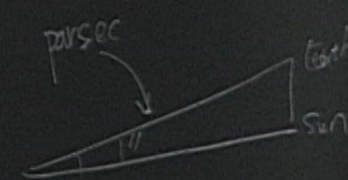
↑ speed

1929 Hubble

$$\lambda_0 = \frac{c+v}{c} \lambda_{em}$$

$$z = \frac{c+v}{c} - 1 = \frac{v}{c}$$





$$v = H_0 d$$

Hubble constant

$$H_0 = \frac{v}{d} \qquad \text{unit } \frac{km/s}{Mpc} \qquad \simeq 70 \, \frac{km/s}{Mpc} = \frac{1}{\simeq 14 \text{ Gyr}}$$

Cosmological principle

Large scale homogeneous.

isotropic $\sim 100\,\mathrm{Mpc}$

yr

1964 Penzias Wilson CMB

Metric of universe

space of universe $\quad dl^2 = \delta_{ij}\, dx^i dx^j$

Ricci scalar R $\quad \left\langle \begin{array}{l} R > 0 \\ R = 0 \longrightarrow \text{flat} \\ R < 0 \end{array} \right.$

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$z = \frac{c+v}{c} - 1 = \frac{v}{c}$

3 - sphere:

$$d\ell^2 = d\vec{x}^2 + du^2 \qquad \vec{x}^2 + u^2 = a^2 \qquad \vec{x} \to a\vec{x} \quad u \to au \qquad \vec{x}^2 + u^2 = 1$$

$$= a^2(d\vec{x}^2 + du^2) \qquad 2\vec{x}\cdot d\vec{x} + 2u\,du = 0$$

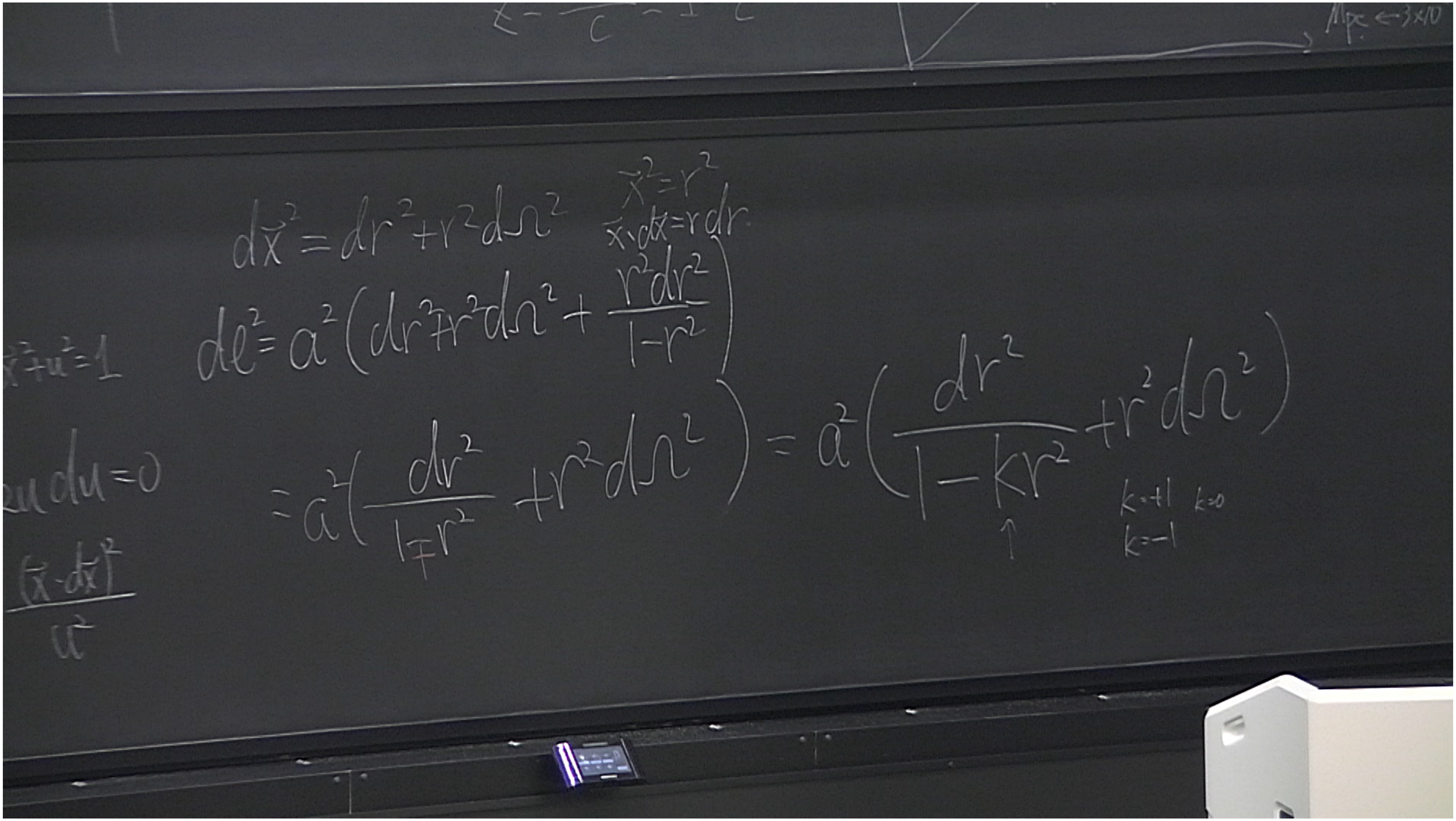
$$du^2 = \frac{(\vec{x}\cdot d\vec{x})^2}{u^2}$$

$$= a^2\left(d\vec{x}^2 + \frac{(\vec{x}\cdot d\vec{x})^2}{1-\vec{x}^2}\right)$$

$$d\vec{x}^2 = dr^2 + r^2 d\Omega^2 \qquad \vec{x}^2 = r^2 \qquad \vec{x}\cdot d\vec{x} = r\,dr$$

$$d\ell^2 = a^2\left(dr^2 + r^2 d\Omega^2 + \frac{r^2 dr^2}{1-r^2}\right)$$

$$= a^2\left(\frac{dr^2}{1-r^2} + r^2 d\Omega^2\right)$$


$\vec{x}^2 + u^2 = 1$
$2u\,du = 0$
$\frac{(\vec{x}\cdot d\vec{x})^2}{u^2}$
$\vec{x}^2 = r^2$
$\vec{x}\cdot d\vec{x} = r\,dr$
$d\vec{x}^2 = dr^2 + r^2 d\Omega^2$
$d\ell^2 = a^2\left(dr^2 + r^2 d\Omega^2 + \frac{r^2 dr^2}{1-r^2}\right)$
$= a^2\left(\frac{dr^2}{1\mp r^2} + r^2 d\Omega^2\right) = a^2\left(\frac{dr^2}{1-kr^2} + r^2 d\Omega^2\right)$
$k=+1$ $k=0$
$k=-1$