

BEFORE THE BEGINNING
TO
AFTER THE END

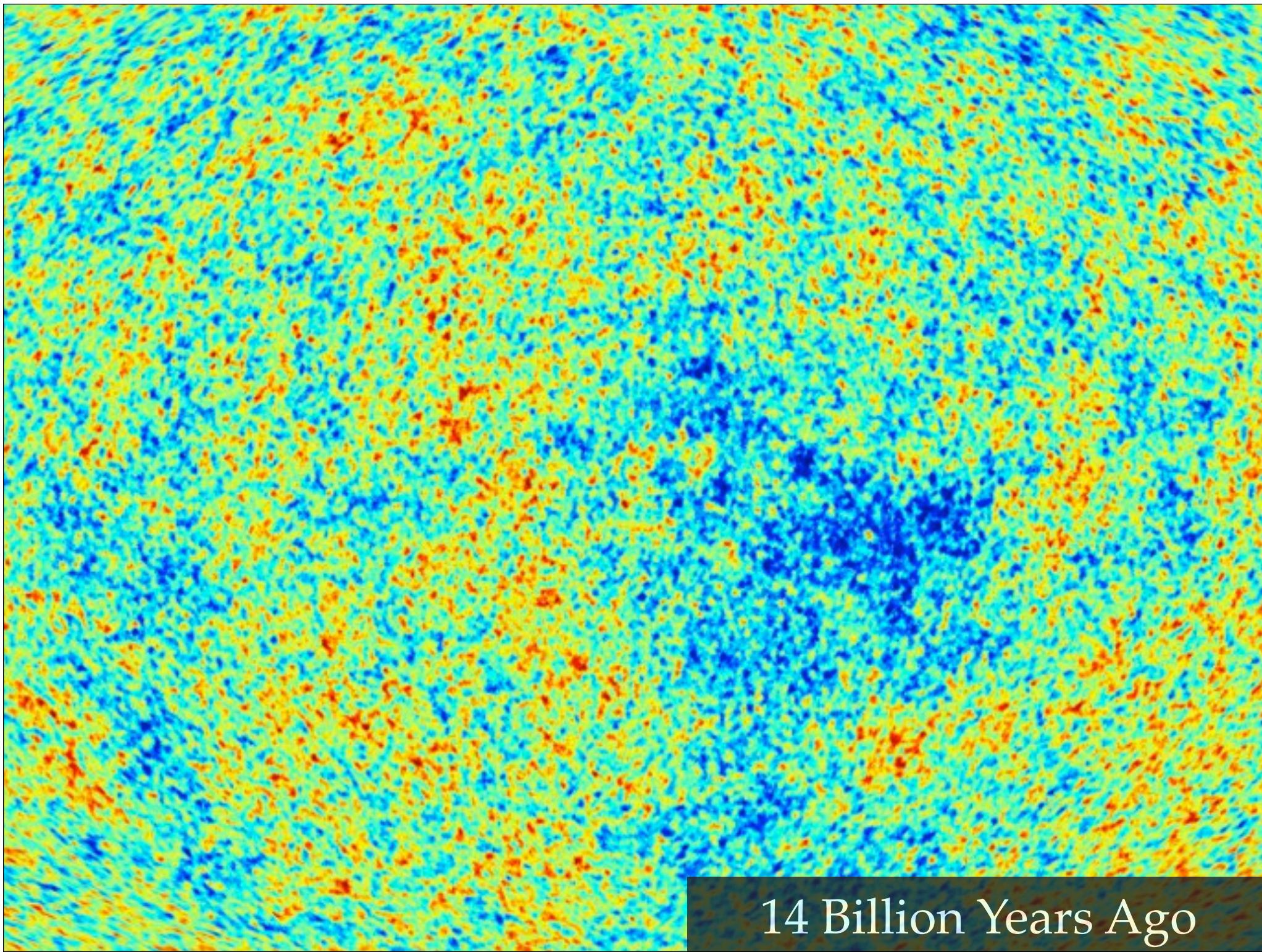
MARK WYMAN

74TH COMPTON LECTURE SERIES





Modern Universe

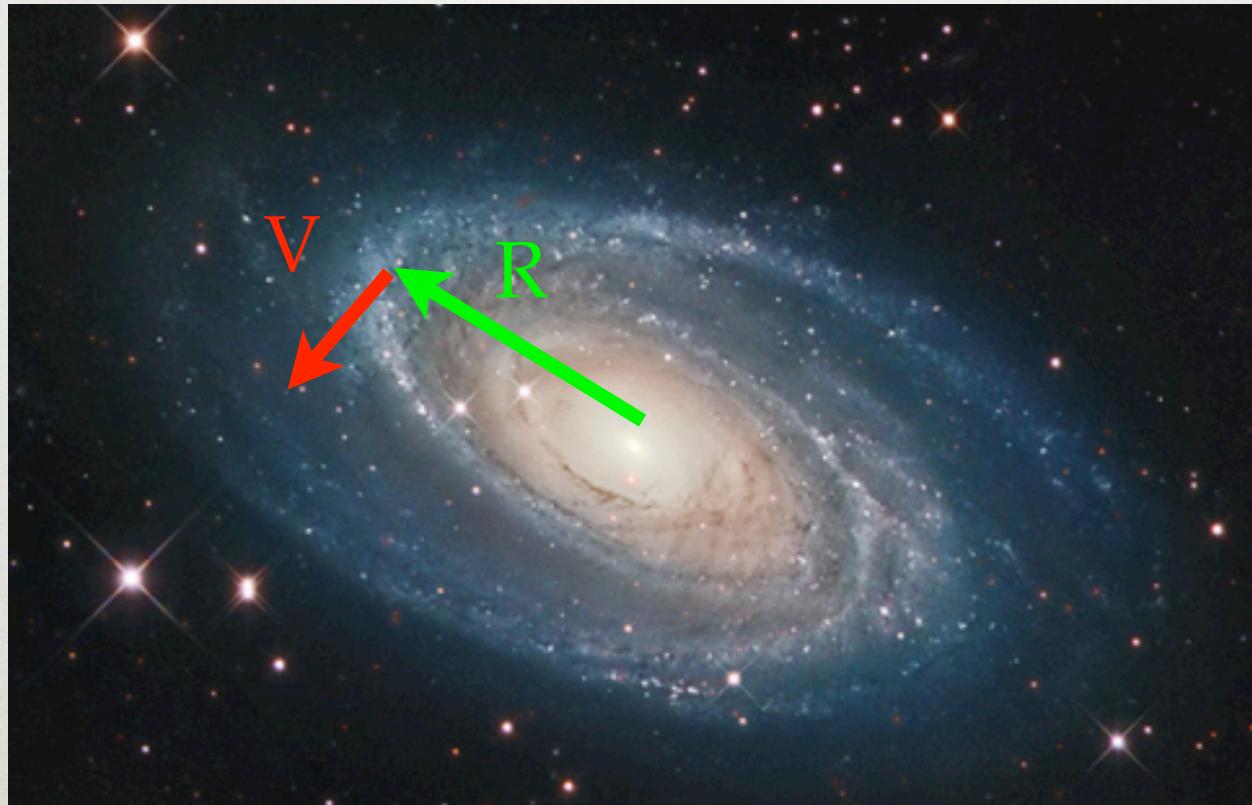


14 Billion Years Ago

THREE KEY BREAKTHROUGHS

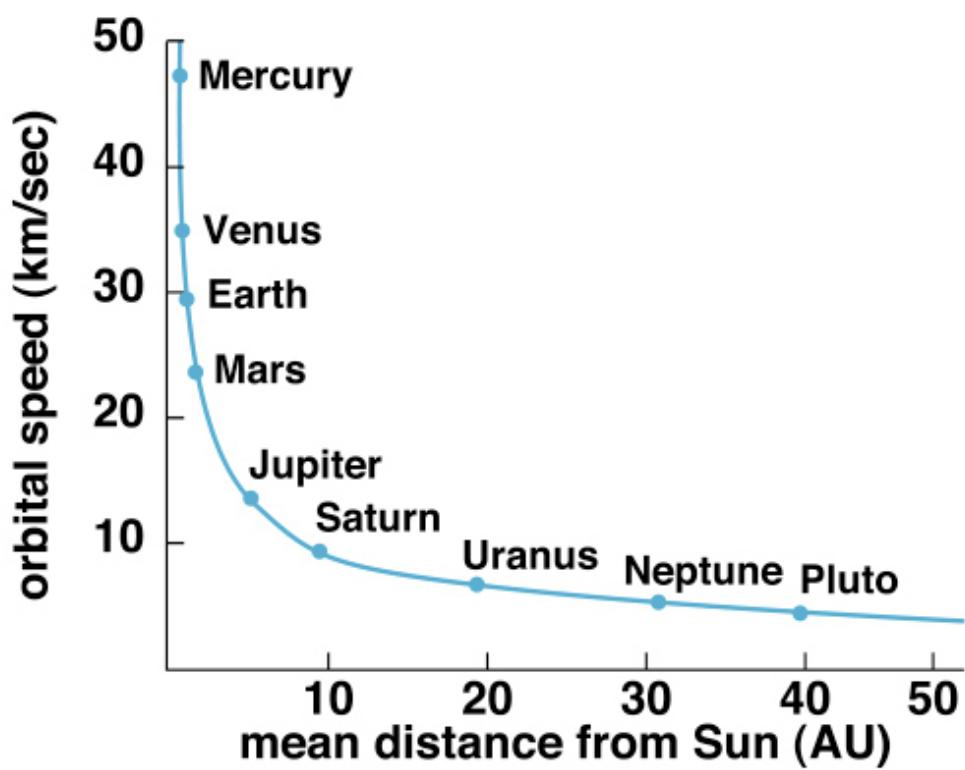
THREE NEW
MYSTERIES

1. MORE DARK MATTER THAN NORMAL MATTER



~1960

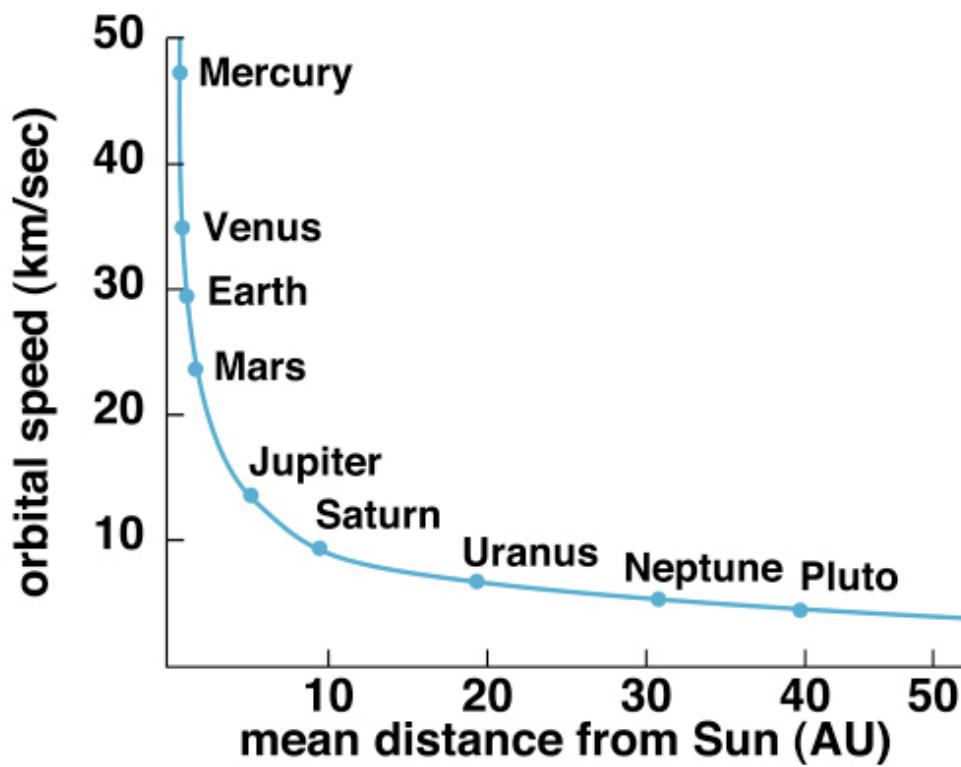
1. MORE DARK MATTER THAN NORMAL MATTER



(b)

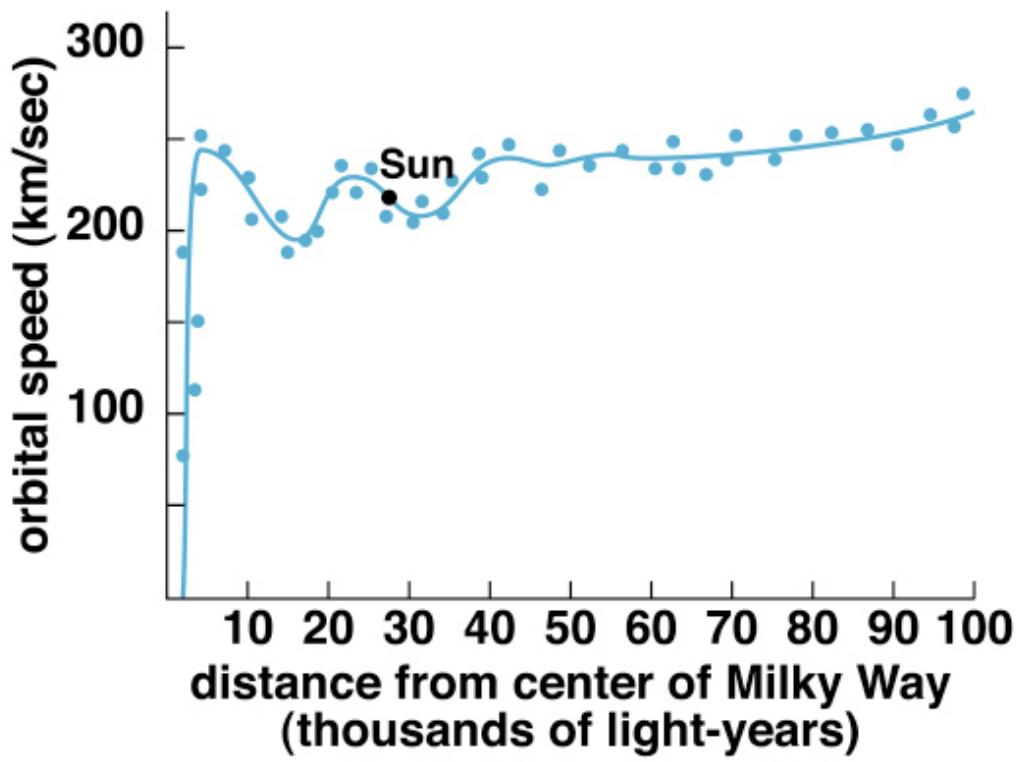
Copyright © Addison Wesley

1. MORE DARK MATTER THAN NORMAL MATTER



(b)

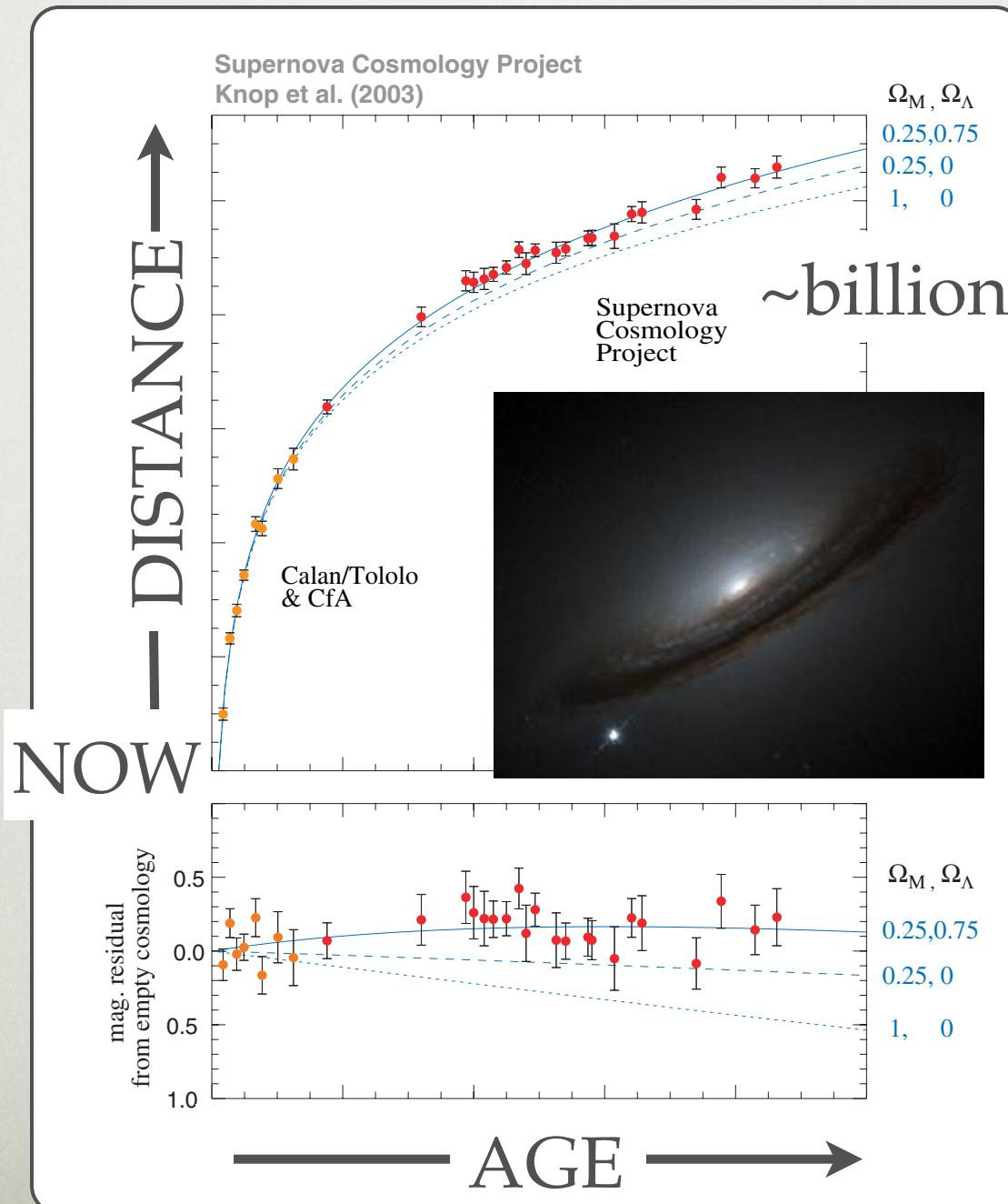
Copyright © Addison Wesley



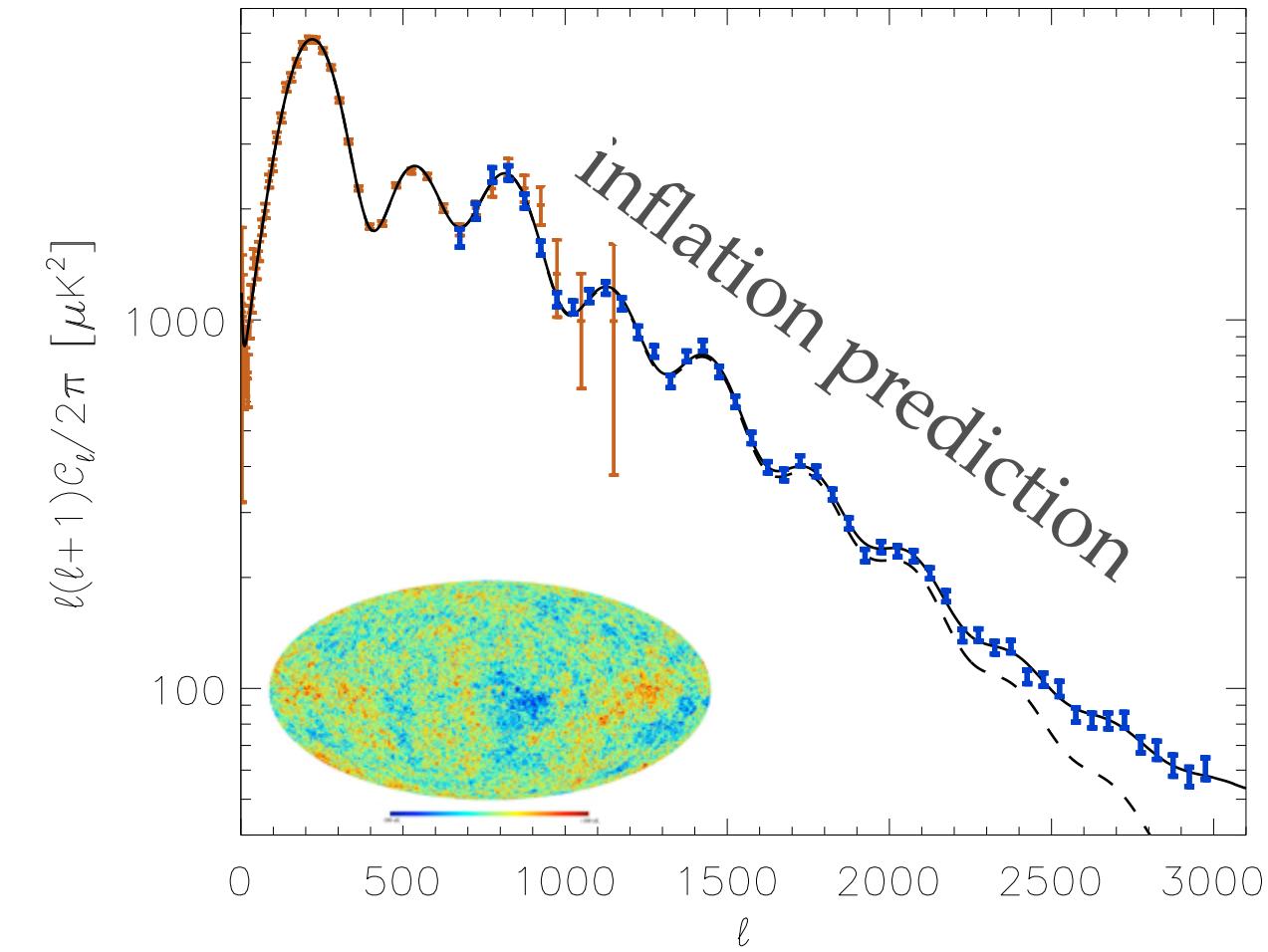
(c)

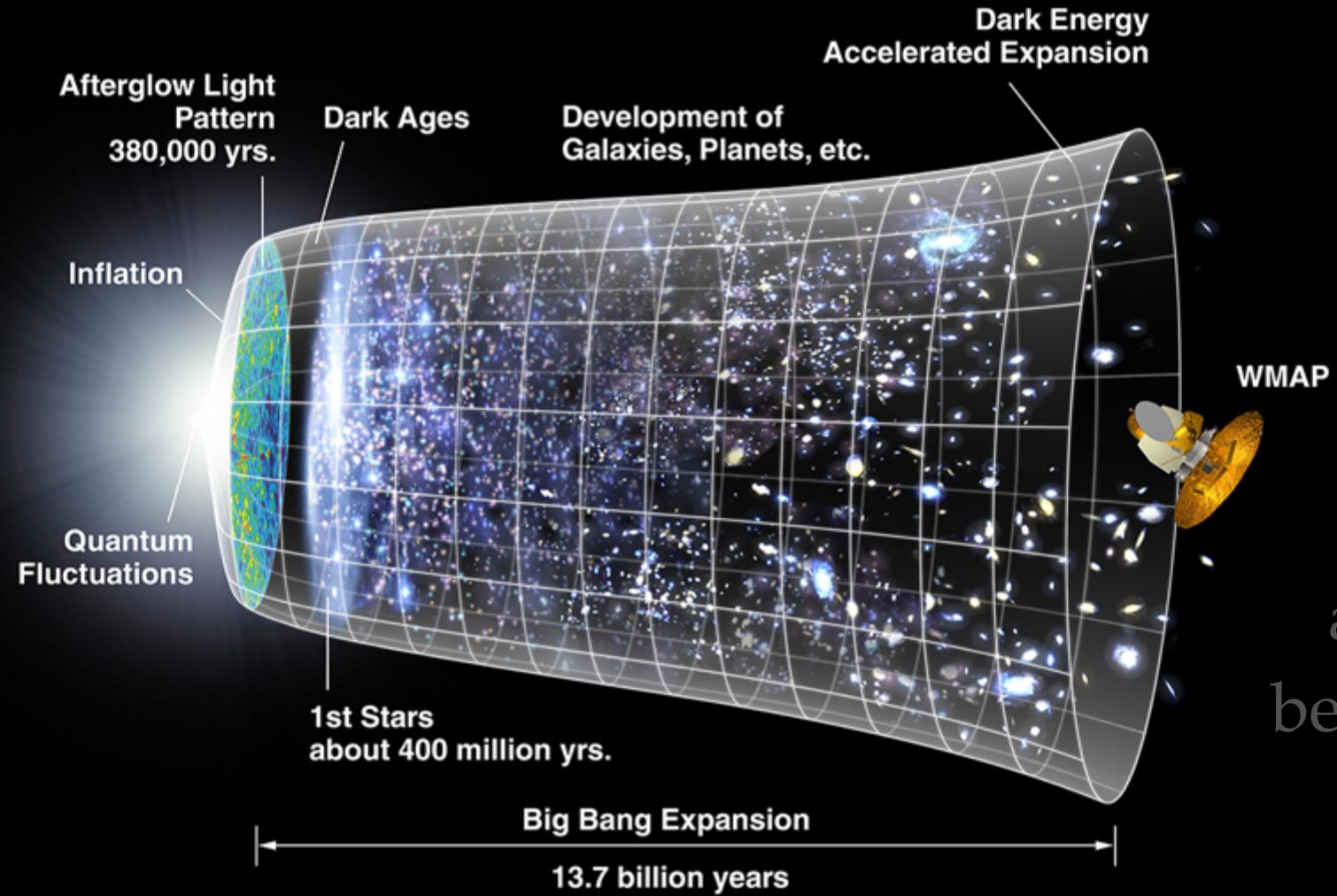
Copyright © Addison Wesley

2. EXPANSION RATE IS ACCELERATING



3. “INFLATION” PRECEDED THE BIG BANG





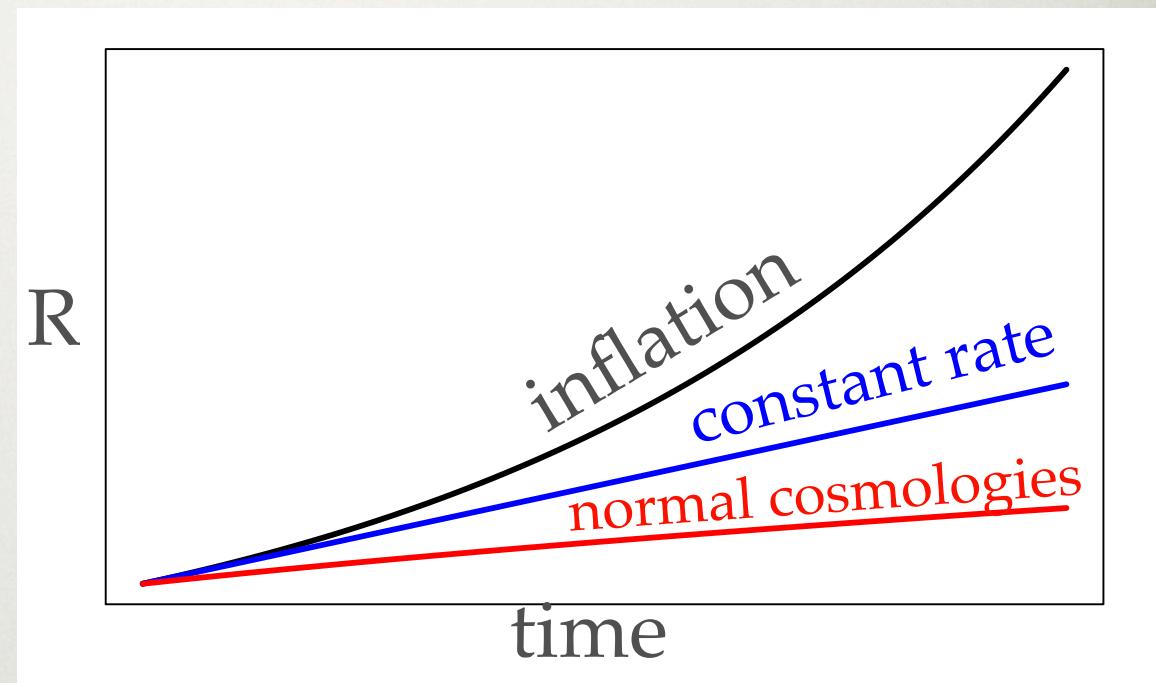
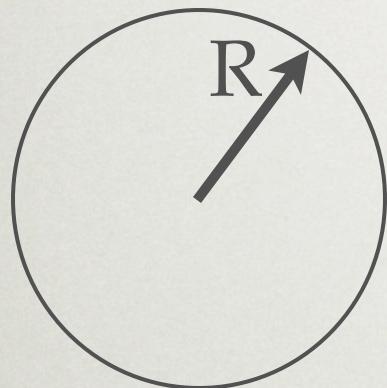
and
beyond

...

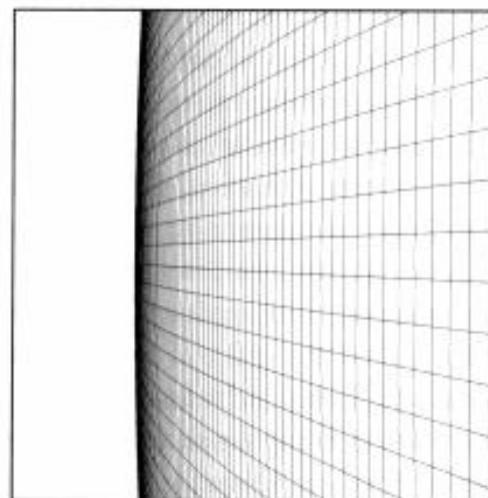
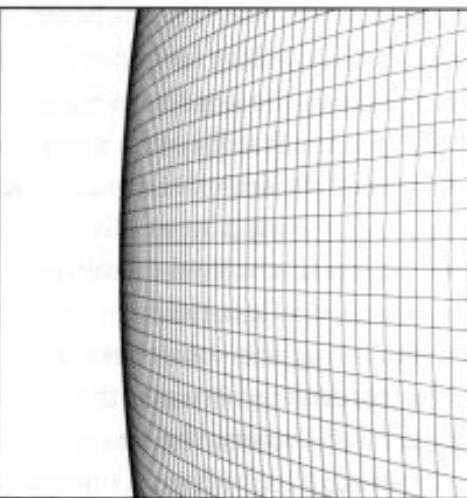
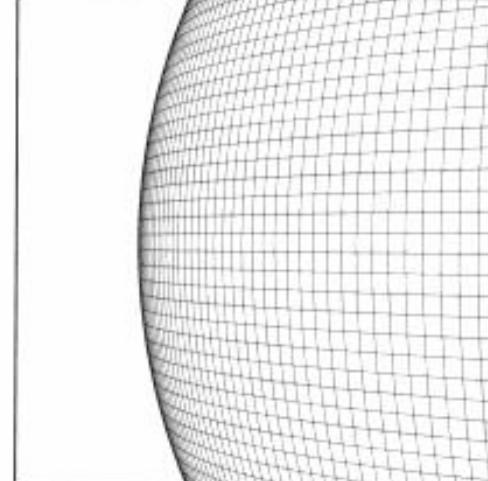
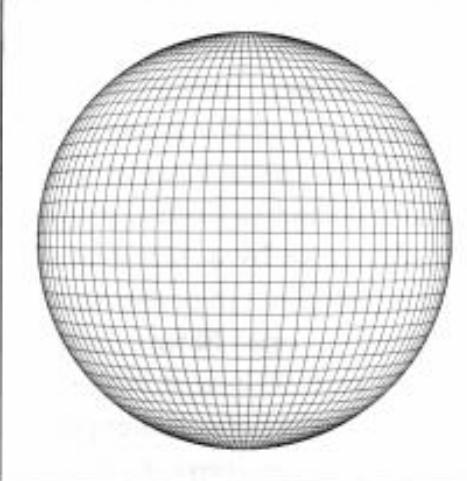
BEFORE THE BEGINNING

Inflation

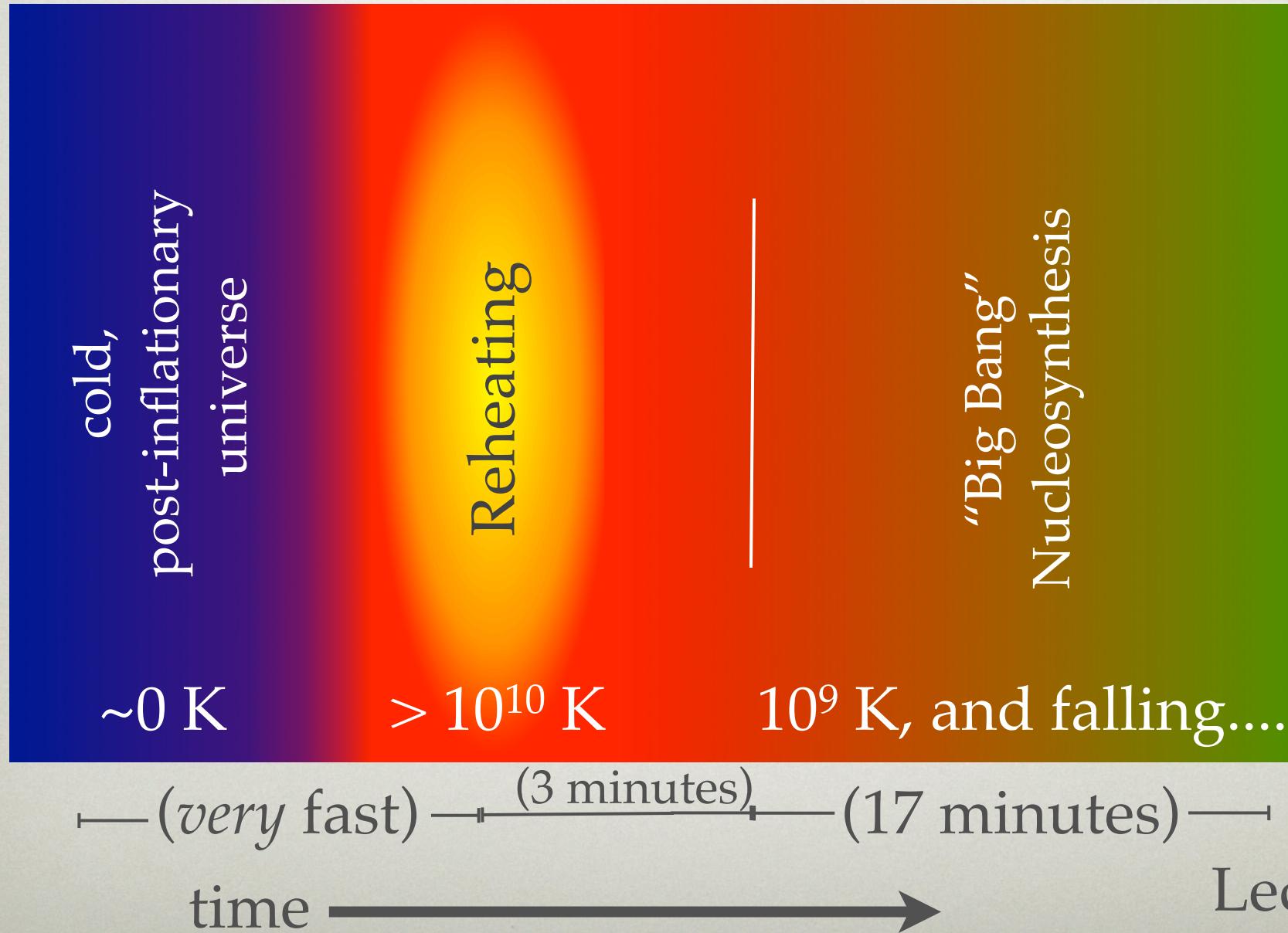
INFLATION



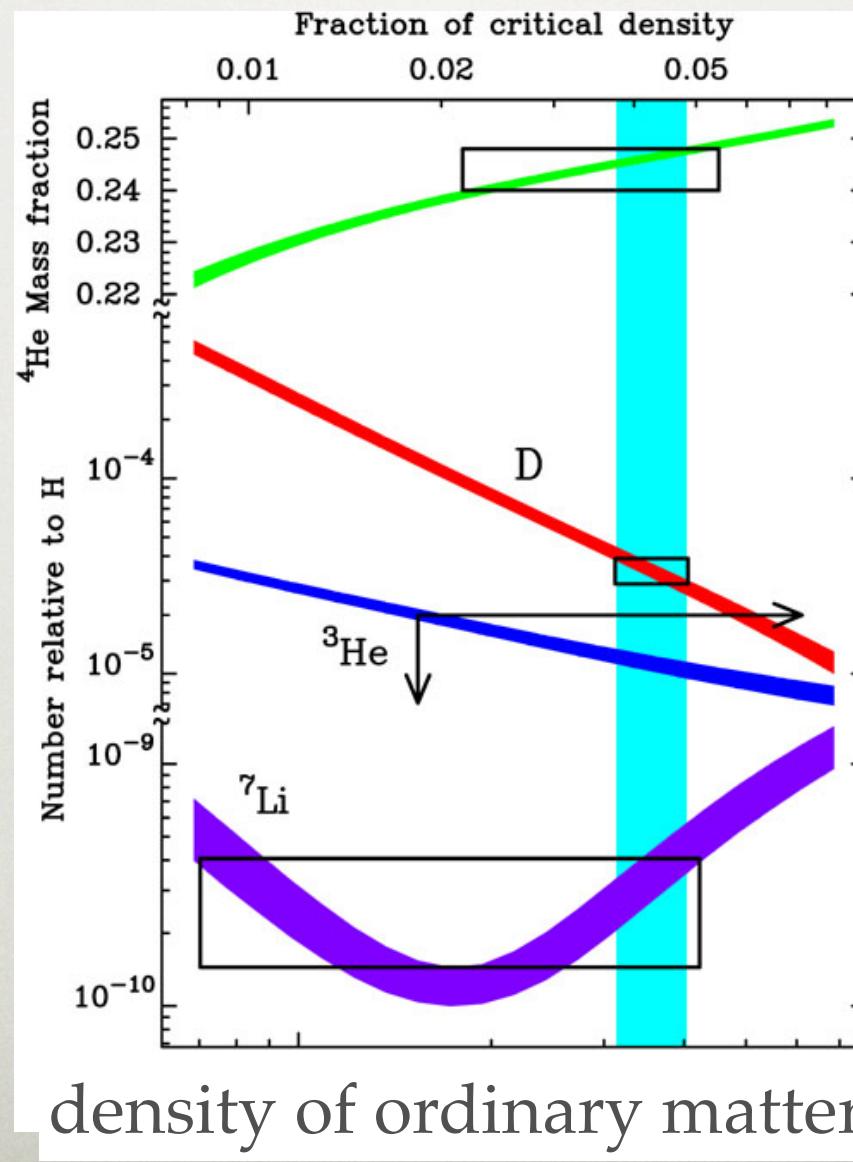
INFLATION



THE BIG BANG



NUCLEOSYNTHESIS

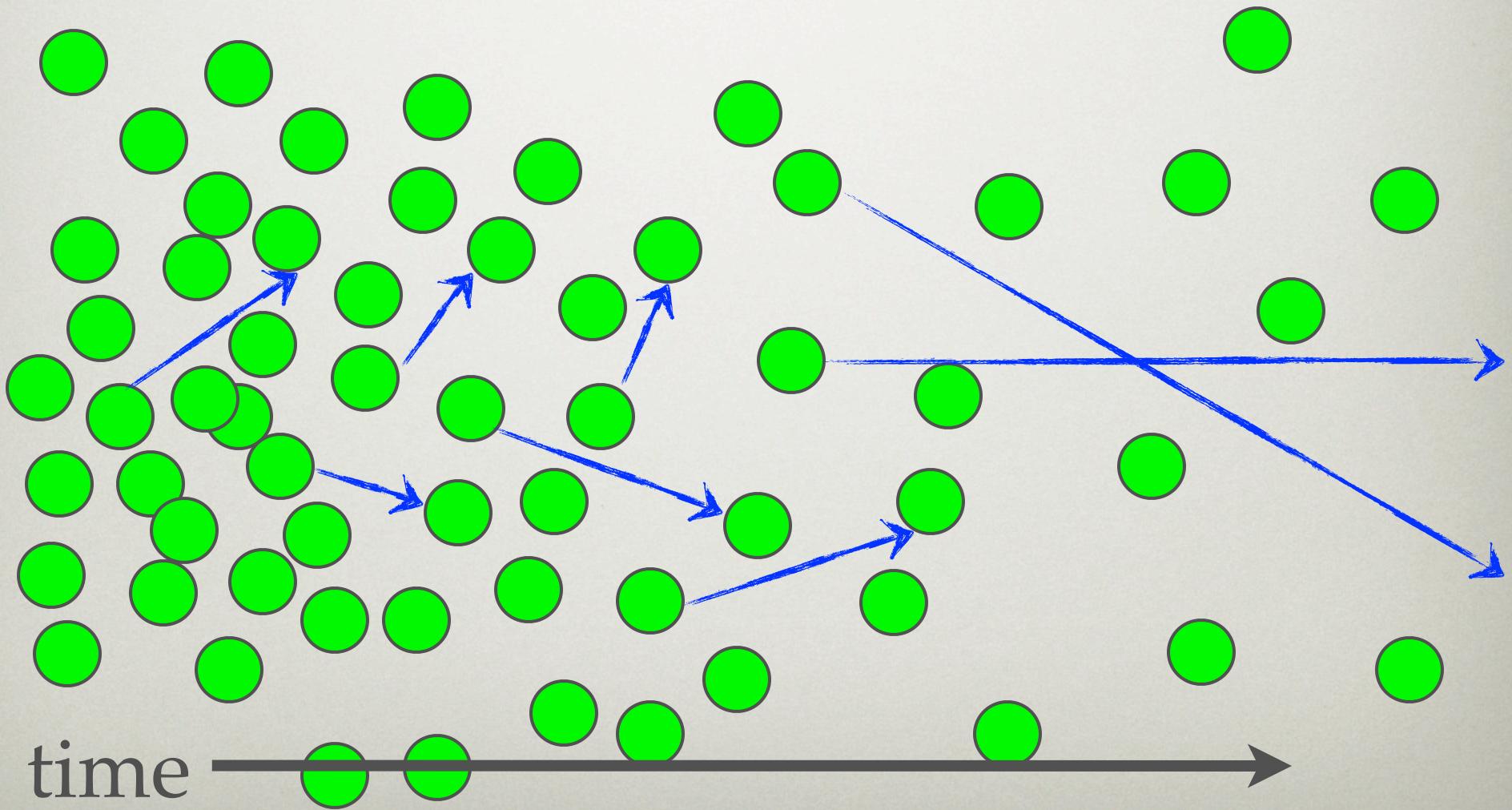


NEXT:
400,000 YEARS
OF SLOWLY COOLING
PLASMA

AND THEN ...

TRANSPARENCY!

aka Last Scattering

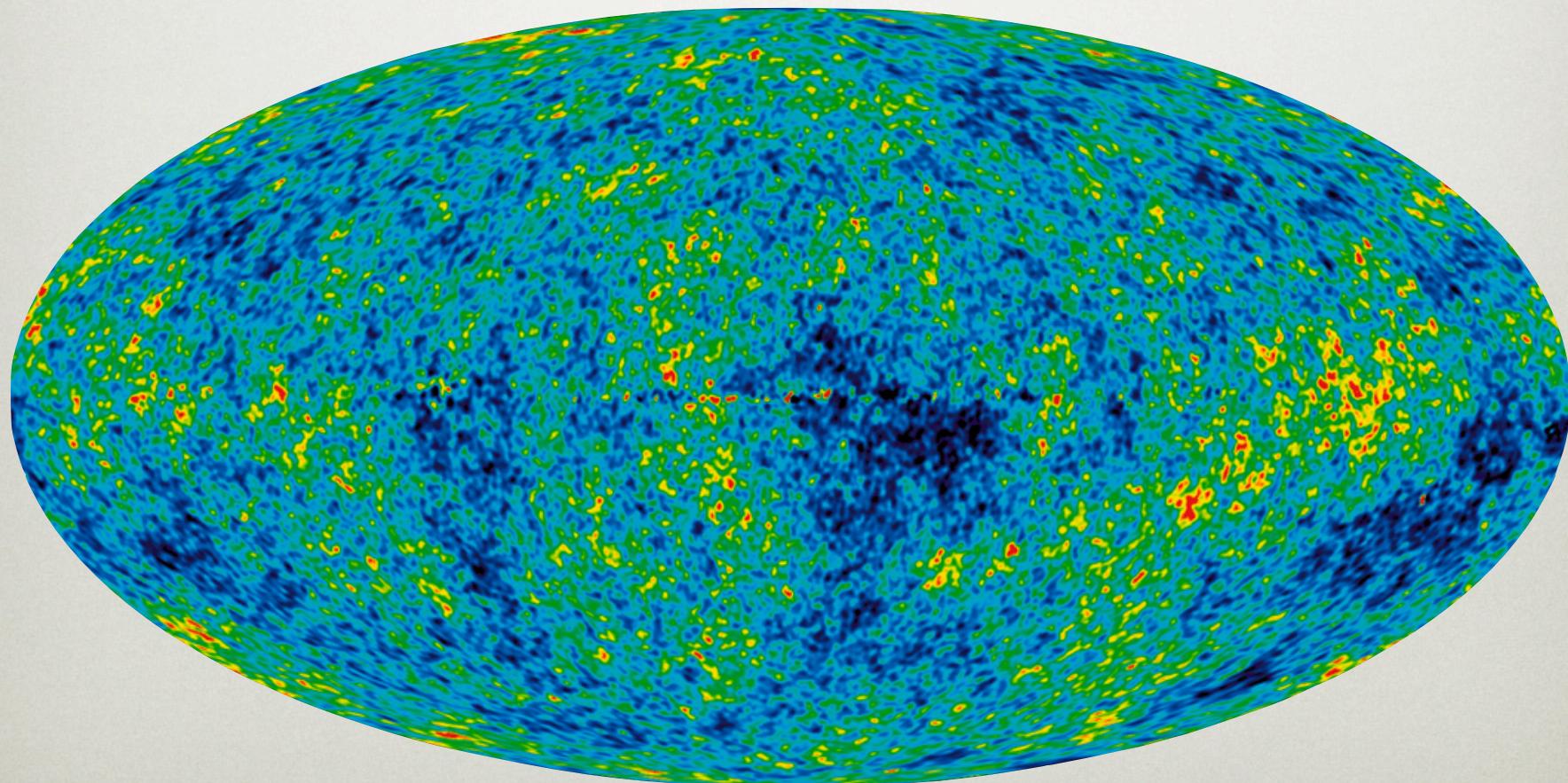


**(THIS IS HOW WE SEE
CLOUDS, TOO)**



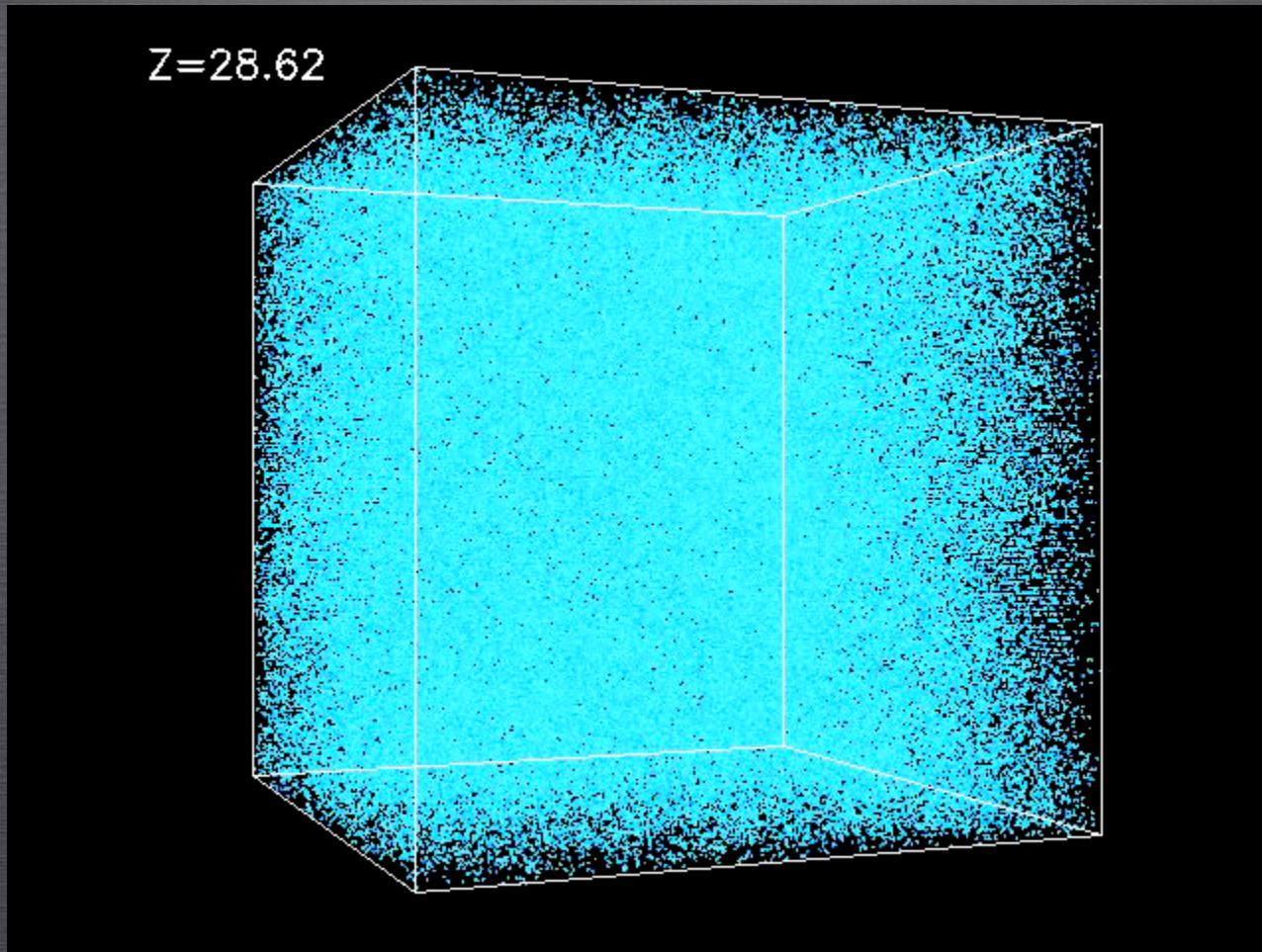
THE COSMIC MICROWAVE BACKGROUND RADIATION

or CMB for short



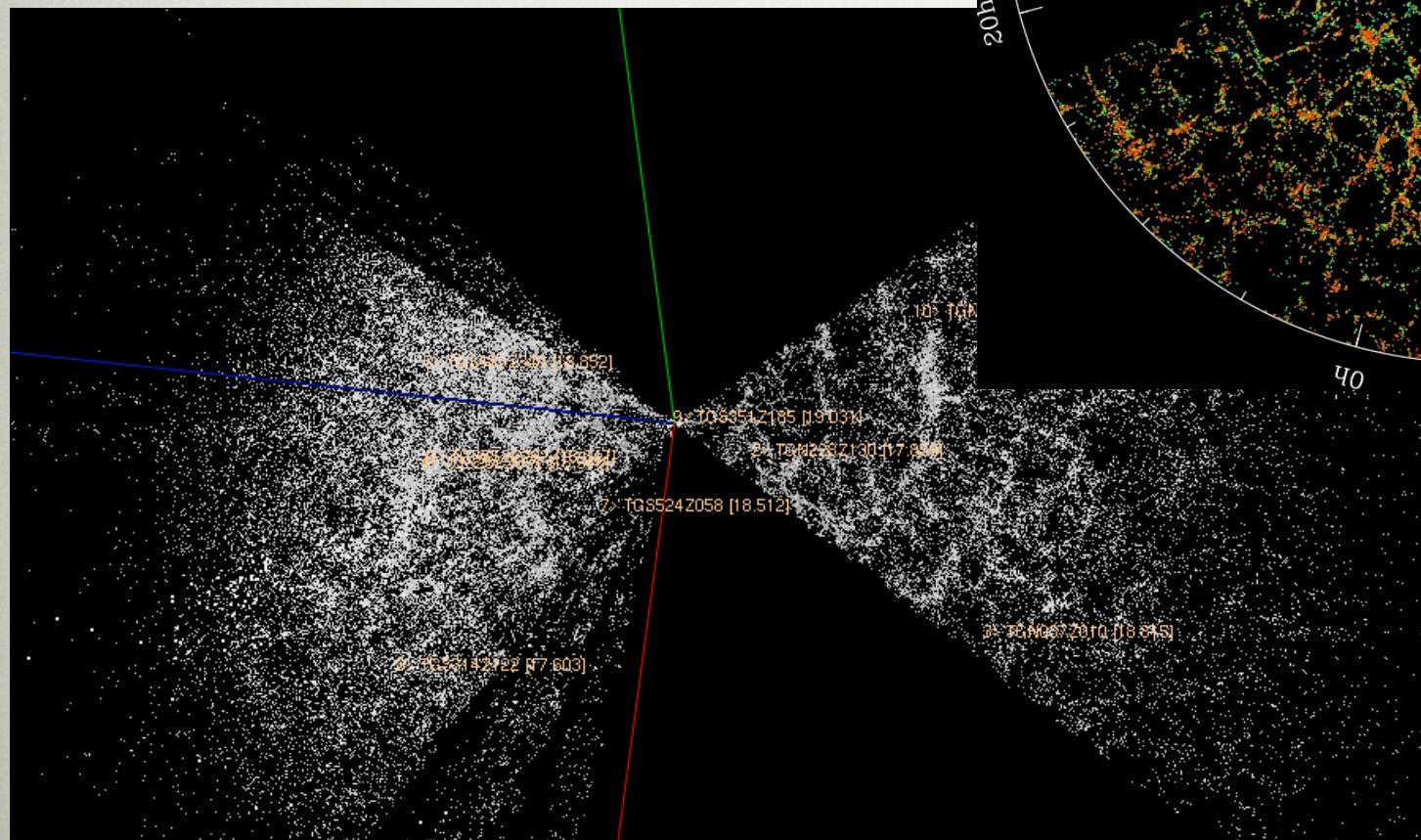
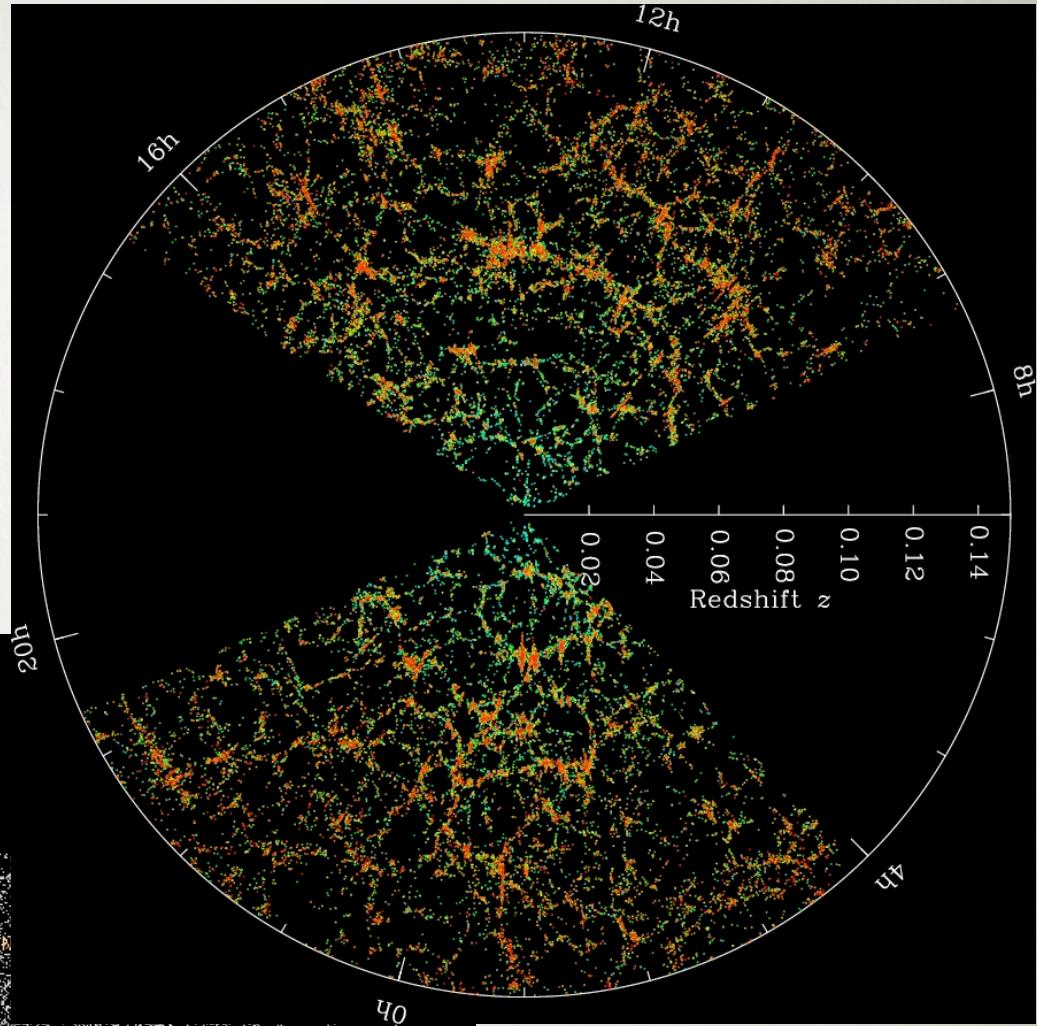
THE DARK AGES

VERY LITTLE LIGHT FOR 100S OF MILLIONS OF YEARS

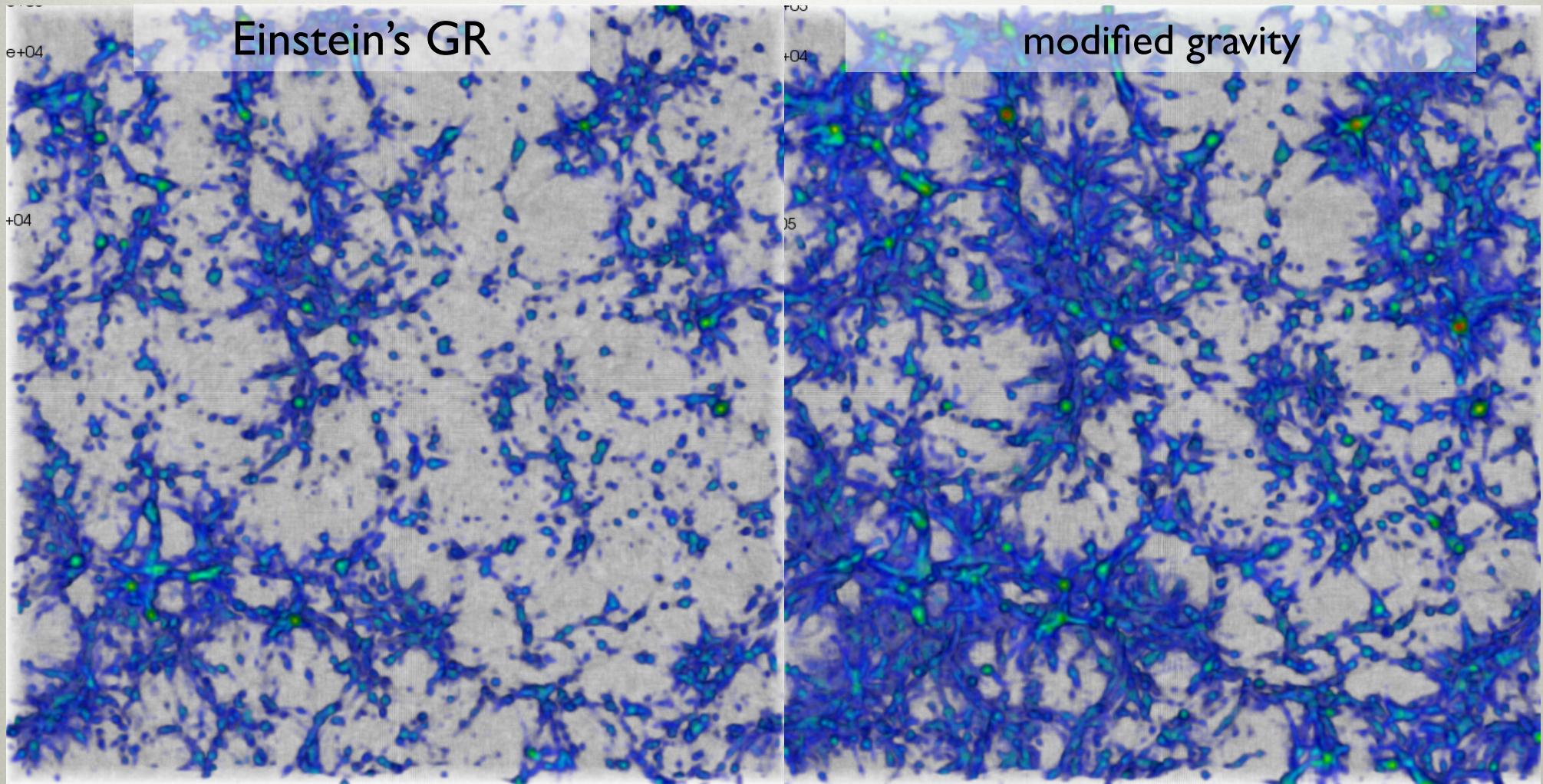


STRUCTURE THE RISE (AND INFALL) OF DARK MATTER

LECTURE 5



I USE THESE OBSERVATIONS TO TEST THEORIES OF GRAVITY



THE DARK ENERGY CRISIS

LECTURE 6

WE DON'T UNDERSTAND ACCELERATION

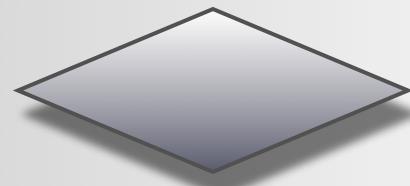
$\frac{\text{theoretical prediction}}{\text{observed value}} \sim 10^{121}$

Λ

MASSIVE
GRAVITY

QUINTESSENCE

Multiverse

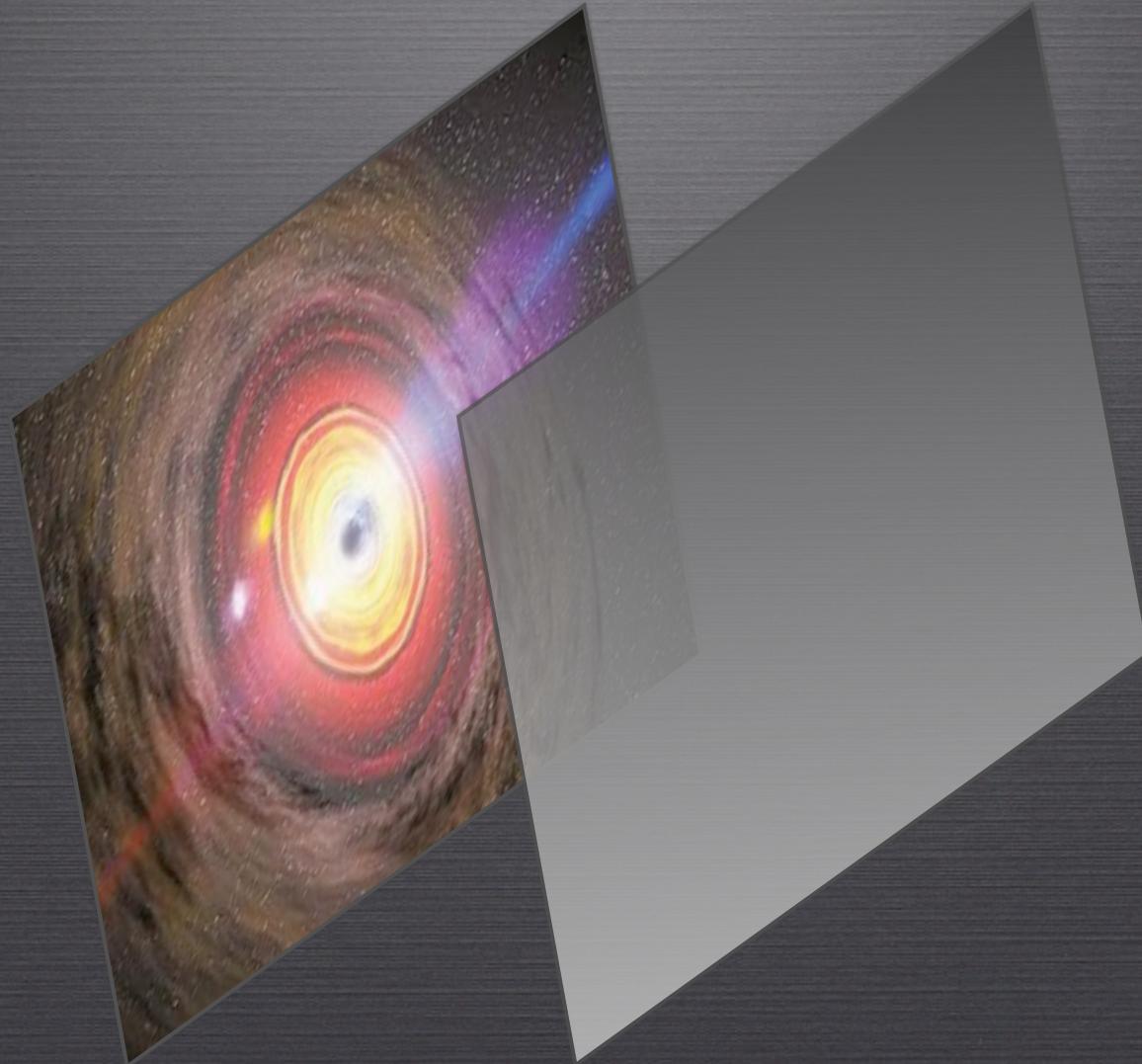


Braneworld

LECTURE 6

BRANEWORLD

SPECULATIONS IN COSMOLOGY I



LECTURE 7

MASSIVE GRAVITY

SPECULATIONS IN COSMOLOGY II



W. PAULI



M. FIERZ

$$m_g \neq 0?$$

LECTURE 8

THE ETERNAL SILENCE OF THESE
INFINITE SPACES TERRIFIES ME*



THE FUTURE OF THE UNIVERSE

*BLAISE PASCAL

FINAL LECTURE (#9)



Heat Death

Big Crunch

Cyclic Rebirth

Big Rip

ABOUT THOSE NEUTRINOS

