November 8, 2010

Exam 4 this Friday, November 12.

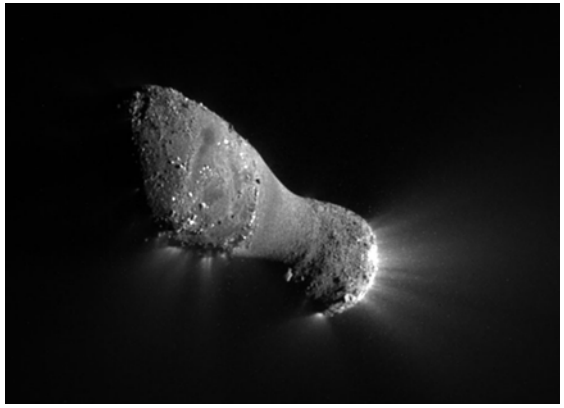
Reading: Chapter 9 - Sections 9.5.2, 9.6.1, 9.6.2, 9.6.3, 9.7, 9.8, Chapter 10 - Sections 10.1-10.4, 10.9, Chapter 11.

Review session Thursday, 5 – 6PM room TBD

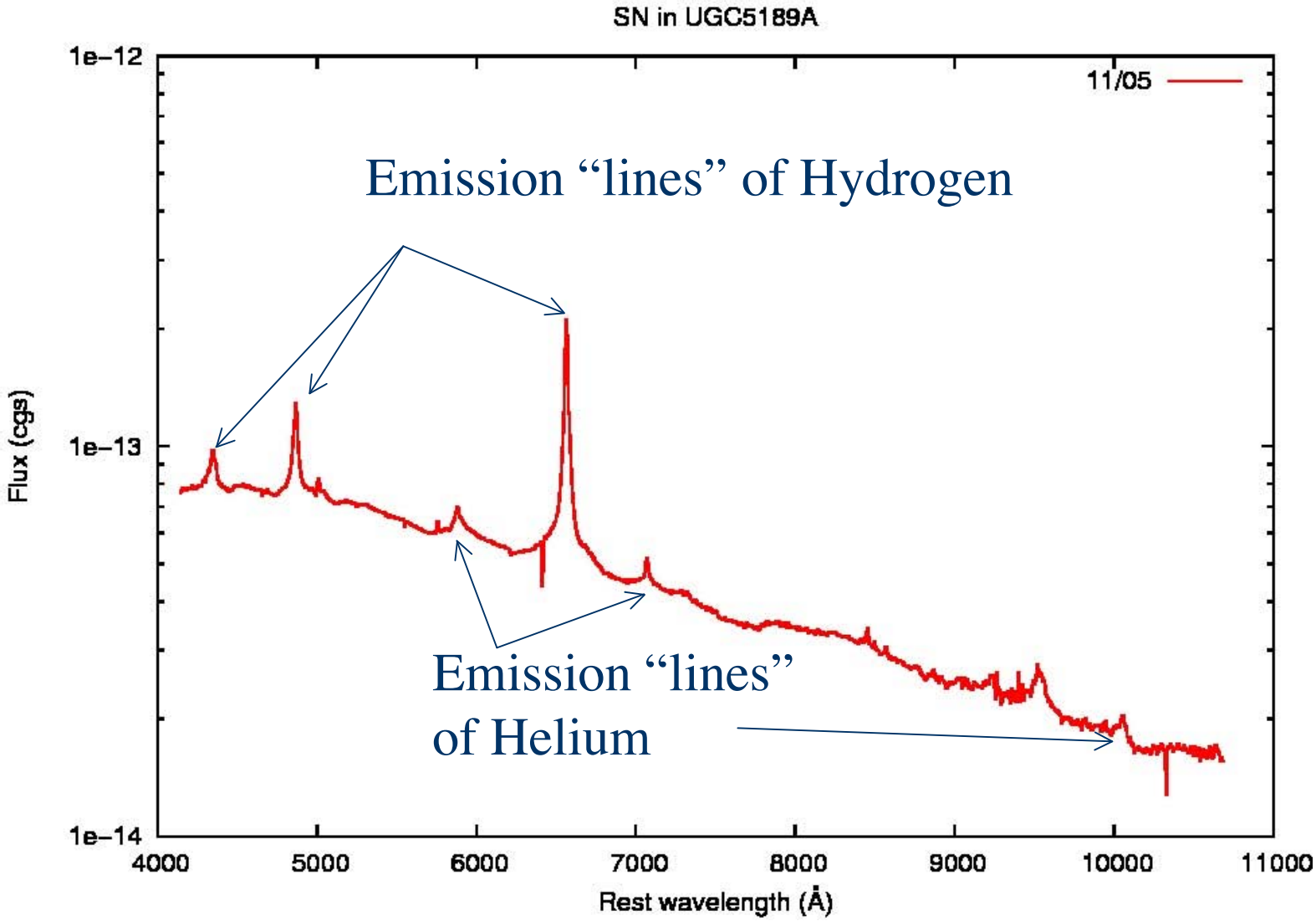
Review Sheet posted today.

Astronomy in the News? Texas astronomers first in US to identify new supernova, SN 2010jl as Type IIn. Europeans beat us, the Sun set earlier there!

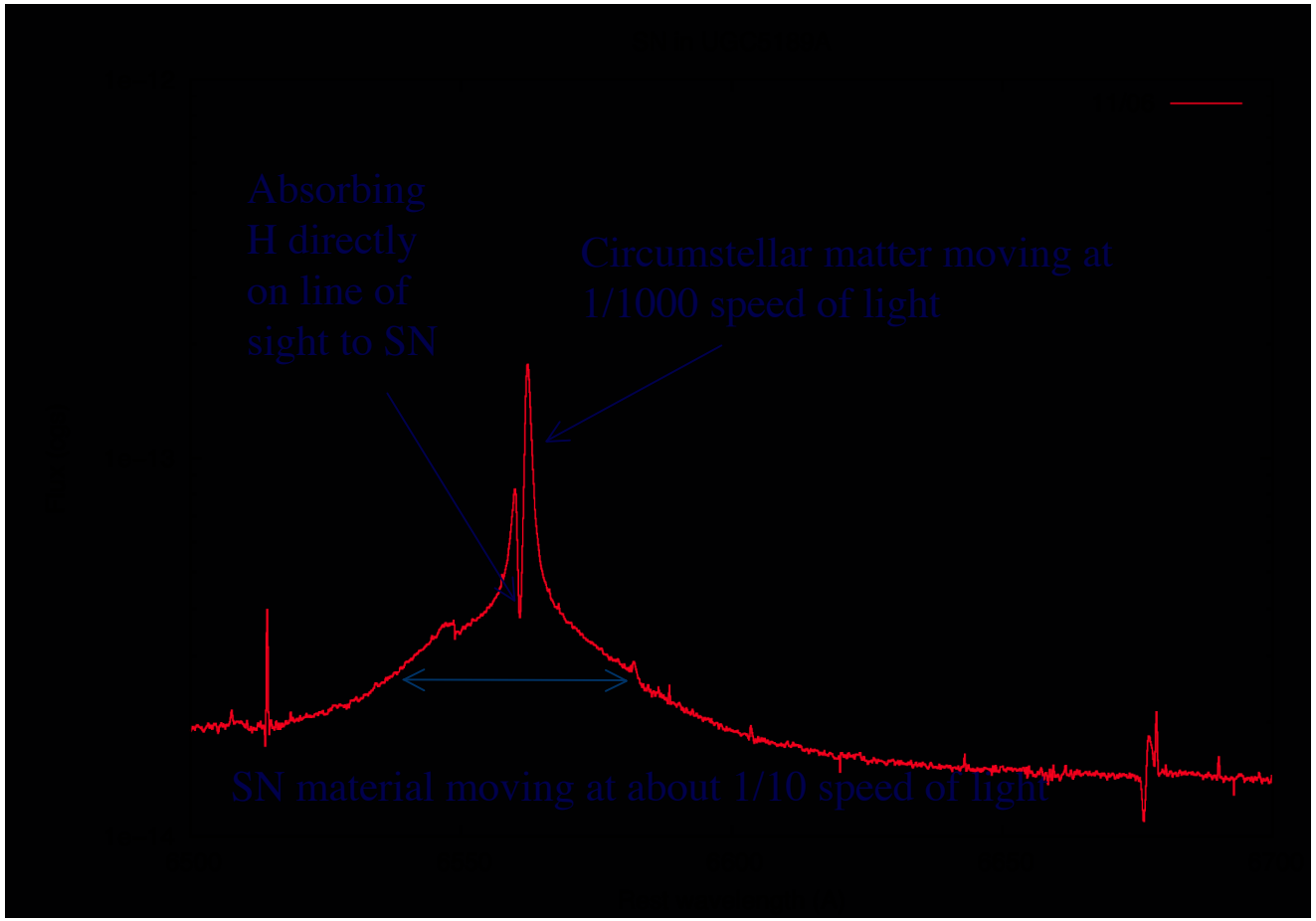
Pic of the Day – Comet Hartley 2: why no craters and what's with that smooth band around the middle?



SN 2010jl


SN in UGC5189A
11/05
Emission "lines" of Hydrogen
Emission "lines"
of Helium
Flux (cgs)
1e−12
1e−13
1e−14
4000
5000
6000
7000
8000
9000
10000
11000
Rest wavelength (Å)

SN 2010jl
High Resolution Spectrum obtained Saturday night of Hydrogen alpha “line”



Goal:

To understand the energy in gamma-ray bursts and why it is important that the energy is “beamed.”

BUT

Light bulb versus laser pointer or flash light

Bursts do not radiate in all directions!

They are strongly focused into jets!

Bursts are focused into only about 1/100 of total sky

Typical gamma-ray burst energy ~ 1/3 supernova kinetic energy

But send matter at 99.997% of the speed of light

Supernova energy into a mass equivalent to Jupiter, not the mass of the Sun, as for supernovae

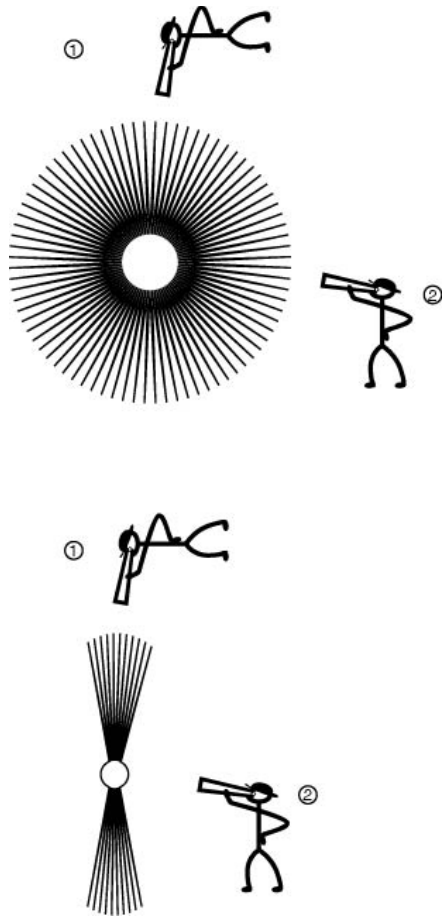


Figure 11.4

They explode ~100 times more often than observed (could observe about 2 per day if looked in all directions, all the time) because most have the jet aimed away from us.

Goal:

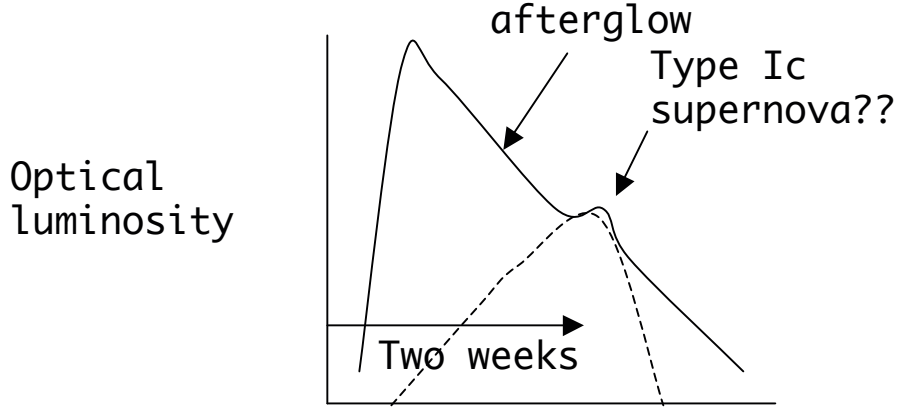
To understand how gamma-ray bursts are connected to supernovae.

Find all gamma-ray bursts in regions of massive young stars (spiral arms of spiral galaxies, irregular star-forming galaxies like the LMC)
Something to do with death of massive stars

Explode once every 10^4-10^5 years in a given galaxy versus about once per 10^2 years for ordinary supernovae, so relatively rare.

Most popular guess is that gamma-ray bursts represent the birth of a *black hole* in the collapse of a massive star. Alternative suggestion - might be a highly magnetized neutron star or *magnetar* (Chapter 8)

Early circumstantial evidence for several bursts associated with supernovae.



Are gamma-ray bursts produced in some form of core-collapse supernova?

Circumstantial evidence was followed by proof:

GRB 030329 was nearby, only 3 BILLION light years away! Relatively bright, an ideal target.

SN2003dh was discovered a week later! Spectrum of a Type Ic supernova

By now many associated supernovae have been found: **all are Type Ic supernovae**

But all Type Ic supernovae are not gamma-ray bursts

The current picture: Gamma-ray bursts result from the collapse of a massive star from which the hydrogen and most of the helium have been stripped, probably to produce a black hole (but maybe a magnetar), that emits a tightly focused, highly relativistic jet.

Every burst, twice a day somewhere in the Universe - the birth of a black hole aiming its jet at us?

~100 aimed elsewhere for every one aimed at us.

Have not yet proven that black holes are involved. Tough problem!

NASA Animation: Black Hole Forming in Star, producing jet and Gamma-Ray Burst

One Minute Exam

It is important to understand that gamma-ray bursts emit their energy in tightly collimated beams because otherwise

Estimates of the distance will be wrong

Estimates of the mass of the black hole formed will be wrong

Estimates of the energy emitted will be wrong

Estimates of the type of supernova in which they explode will be wrong.

Goal:

To understand what the “Dark Ages” of the Universe were, why they came to an end, and what gamma-ray bursts have to do with that.

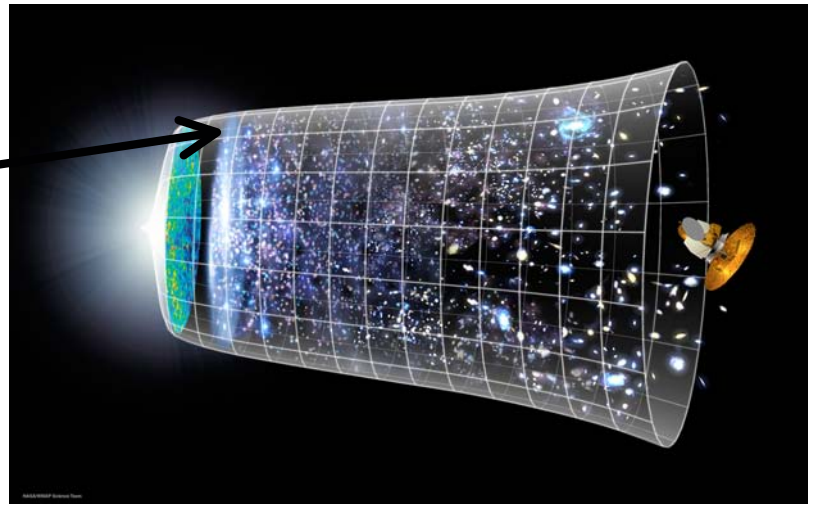
Gamma-ray bursts are intensely bright lights

Can be seen at great distance

Probe cosmology, the early Universe

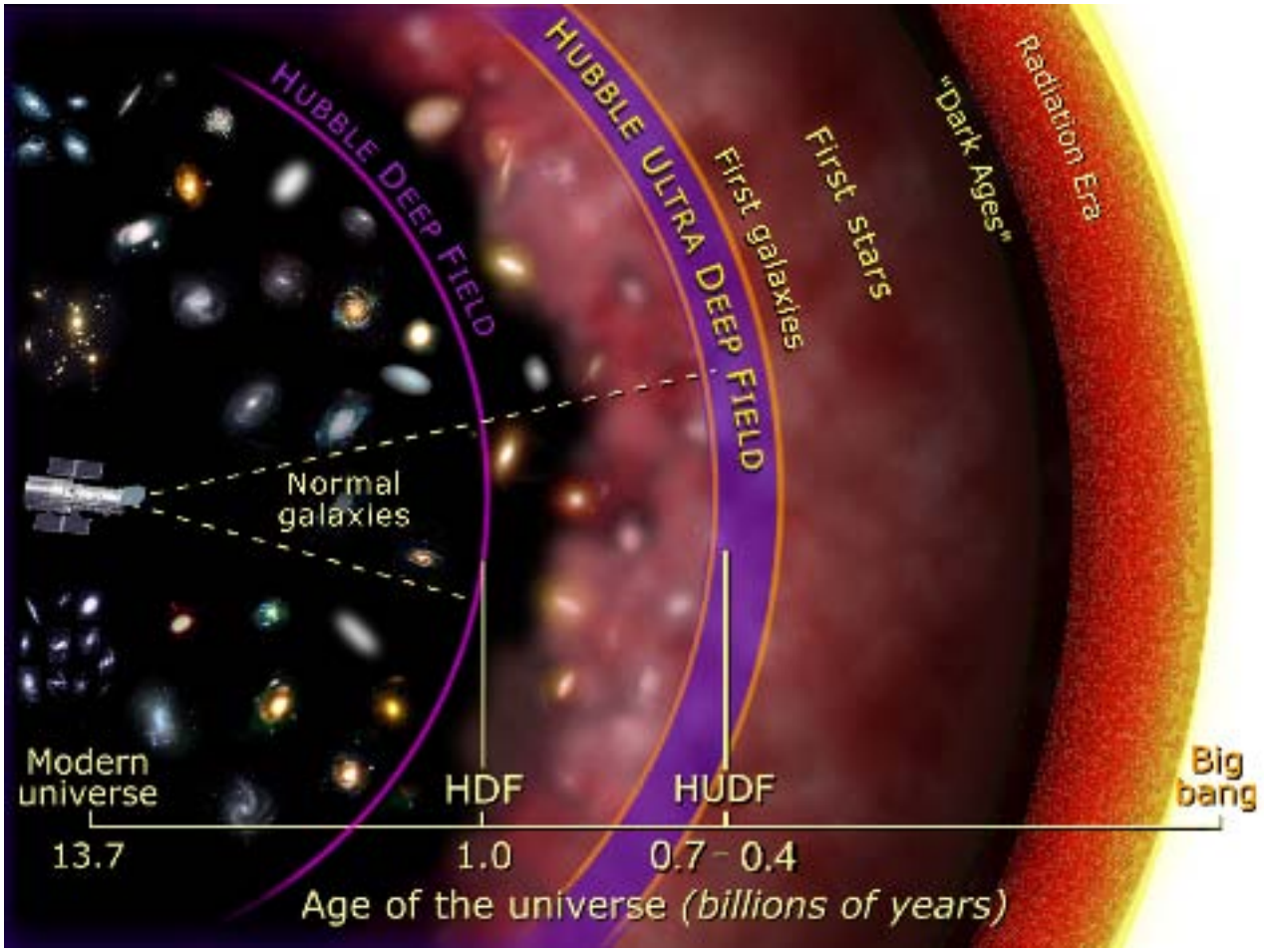
Dark Ages, after the Universe cooled off a million years after the Big Bang, before stars and Galaxies first formed half a billion years later

Dark Ages



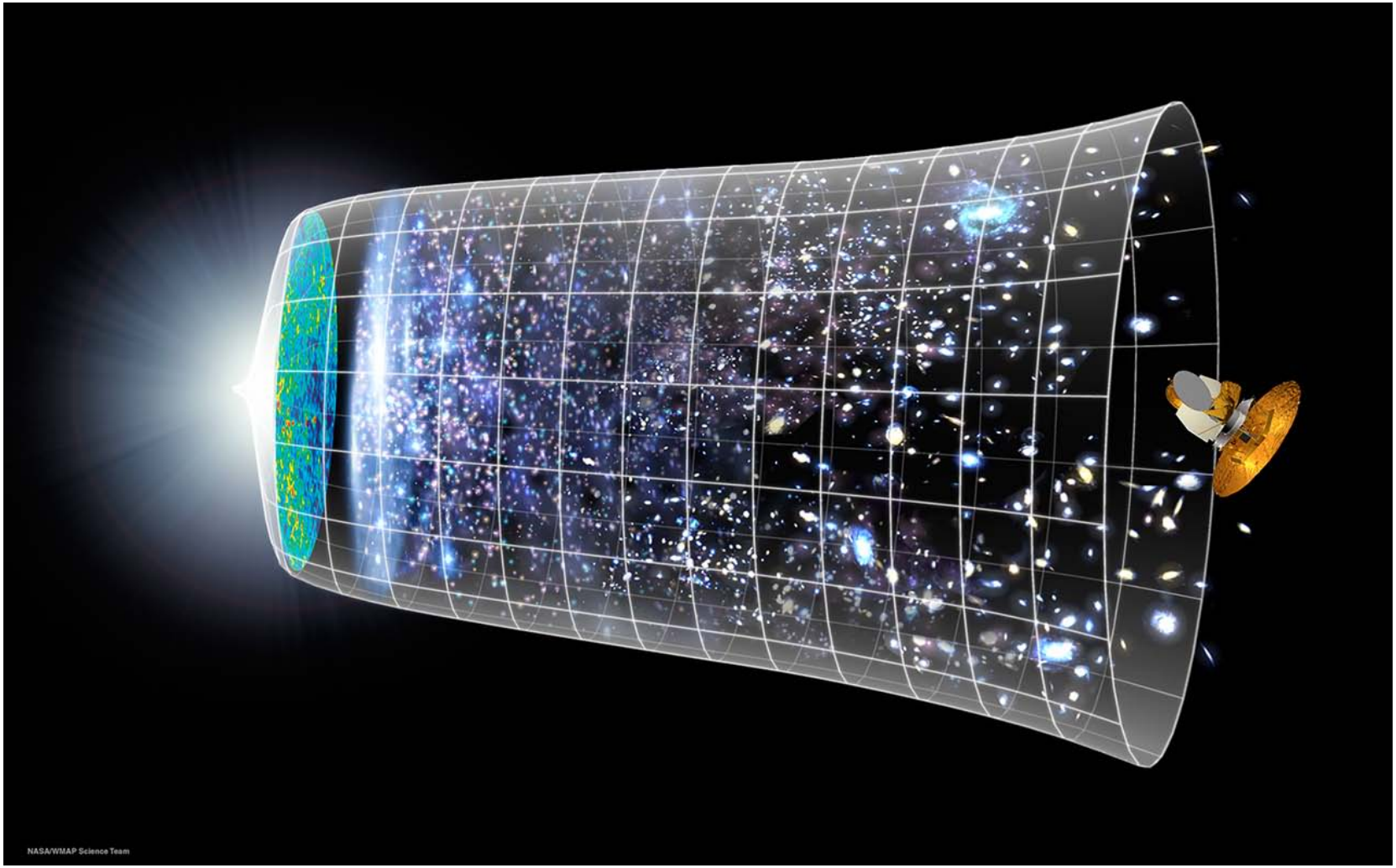
Point toward the Big Bang.

The past is all around us, in every direction, out in space, back in time.



Gamma-ray bursts could be among the first objects seen at the end of the Dark Ages as the first stars are born and die, over 13 billion years ago. GRB 090423 is the first example.

From the Big Bang to Now



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