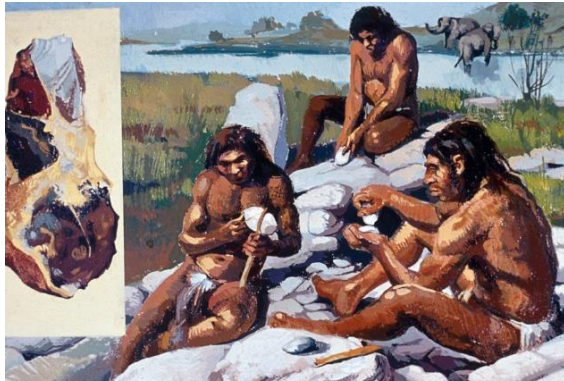




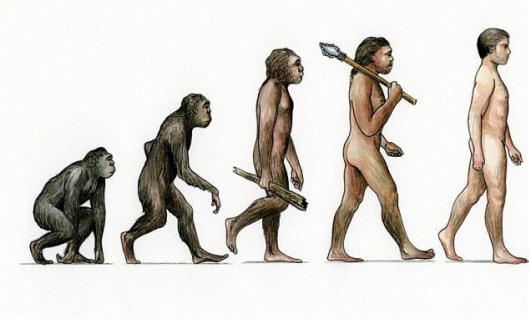
# ASTRONOMY



# The Big Bang Theory



# The Big Bang Theory



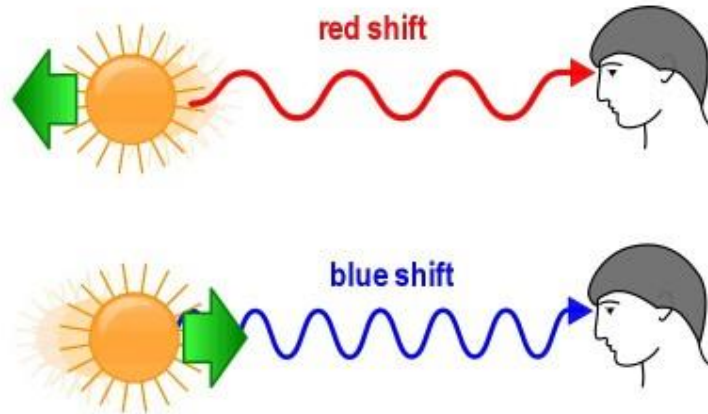
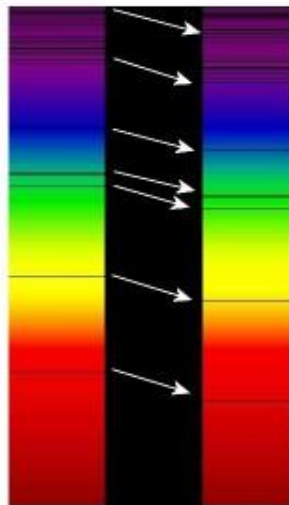
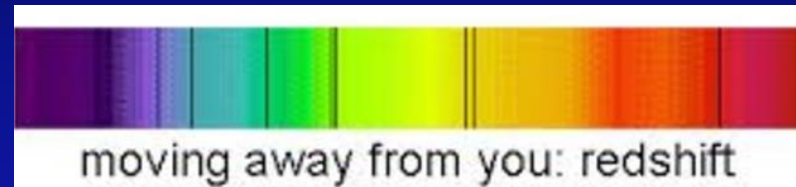
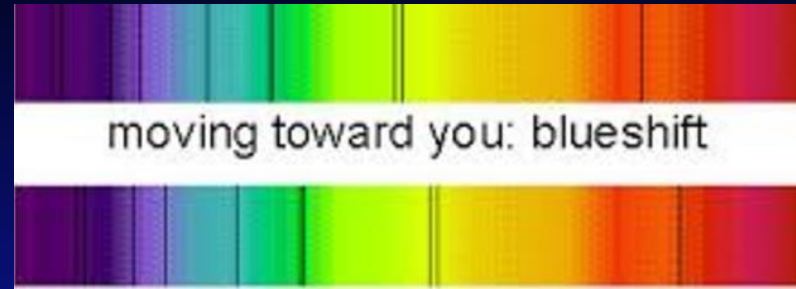


# Red shift

Spectrum <



Edwin Hubble

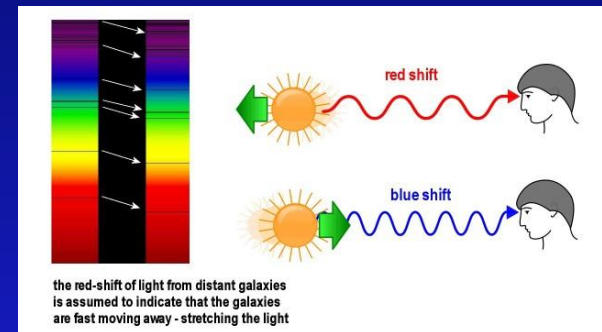
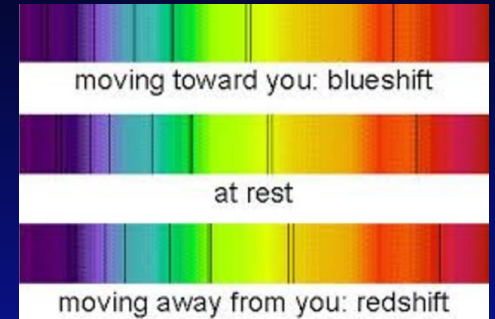


the red-shift of light from distant galaxies is assumed to indicate that the galaxies are fast moving away - stretching the light

# Red shift



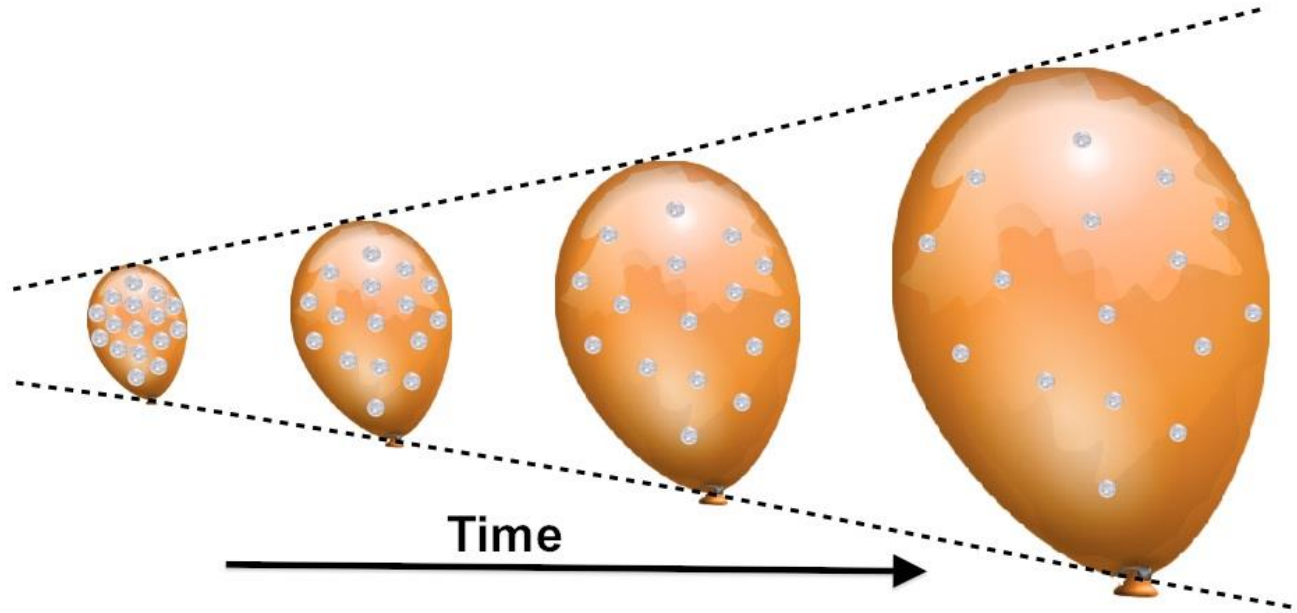
Edwin Hubble



“Galaxies are moving away from us and from each other”

E. Hubble 1929

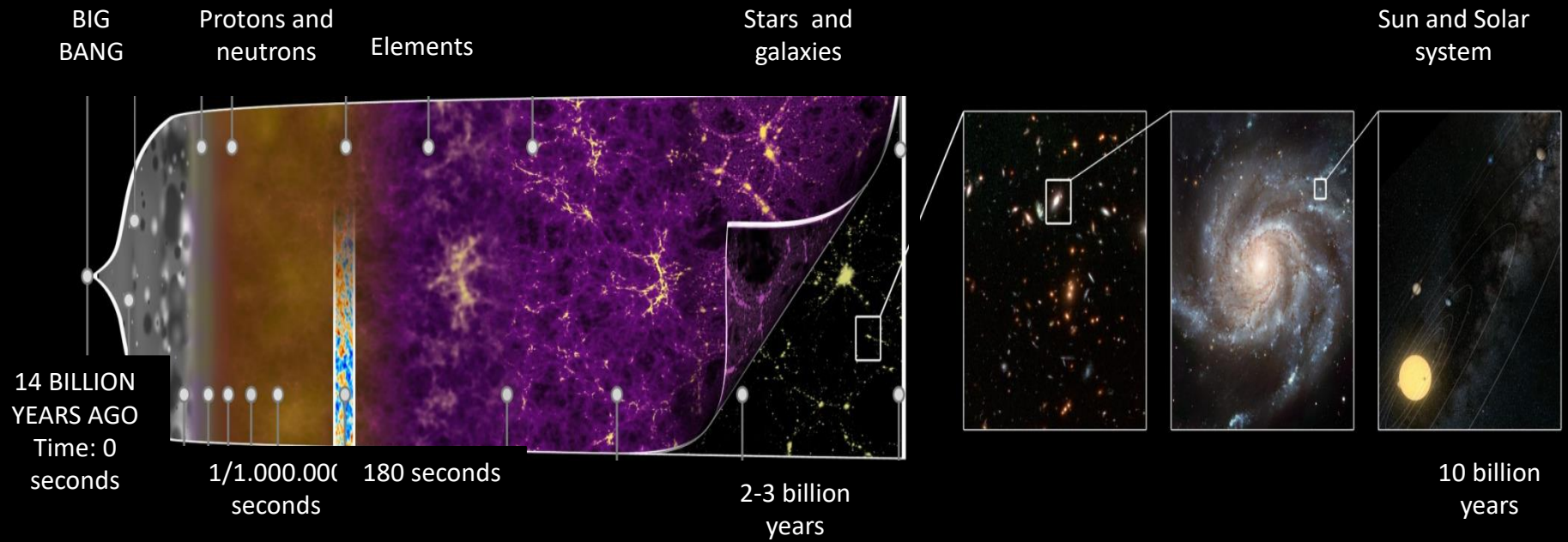
# The Universe is expanding



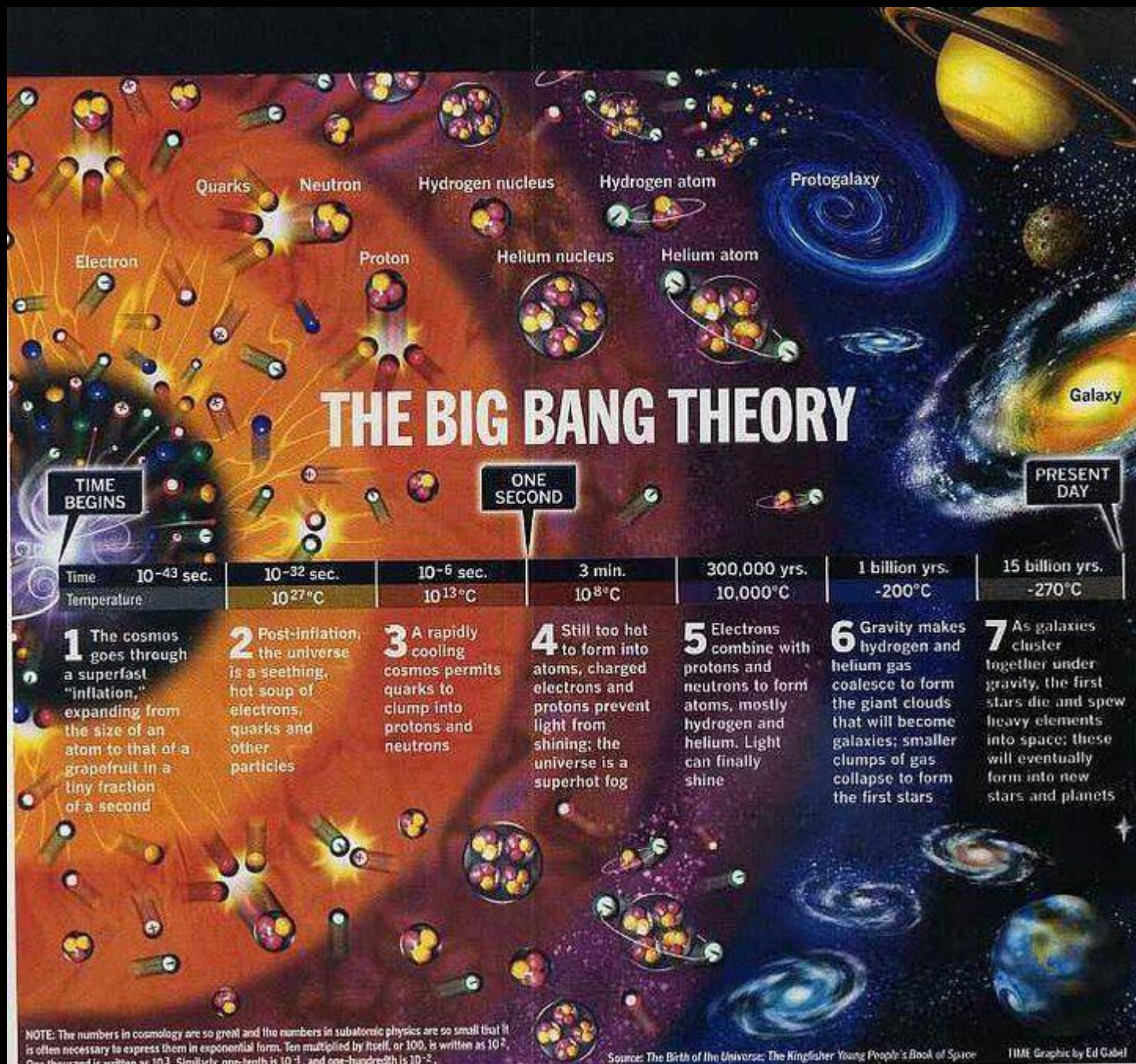
*Our Universe was the size of an atom...*

*...then, 14 billion years ago, it started to expand...*

# ...it all started with the BIG BANG...







# THE BIG BANG THEORY

TIME BEGINS

ONE SECOND

PRESENT DAY

Time  $10^{-43}$  sec.  
Temperature

$10^{-32}$  sec.  
 $10^{27}$  °C

$10^{-6}$  sec.  
 $10^{13}$  °C

3 min.  
 $10^8$  °C

300,000 yrs.  
 $10,000$  °C

1 billion yrs.  
 $-200$  °C

15 billion yrs.  
 $-270$  °C

**1** The cosmos goes through a superfast "inflation," expanding from the size of an atom to that of a grapefruit in a tiny fraction of a second

**2** Post-inflation, the universe is a seething, hot soup of electrons, quarks and other particles

**3** A rapidly cooling cosmos permits quarks to clump into protons and neutrons

**4** Still too hot to form into atoms, charged electrons and protons prevent light from shining; the universe is a superhot fog

**5** Electrons combine with protons and neutrons to form atoms, mostly hydrogen and helium. Light can finally shine

**6** Gravity makes hydrogen and helium gas coalesce to form the giant clouds that will become galaxies; smaller clumps of gas collapse to form the first stars

**7** As galaxies cluster together under gravity, the first stars die and spew heavy elements into space; these will eventually form into new stars and planets

NOTE: The numbers in cosmology are so great and the numbers in subatomic physics are so small that it is often necessary to express them in exponential form. Ten multiplied by itself, or 100, is written as  $10^2$ . One thousand is written as  $10^3$ . Similarly, one-tenth is  $10^{-1}$ , and one-hundredth is  $10^{-2}$ .



# Future of our Universe

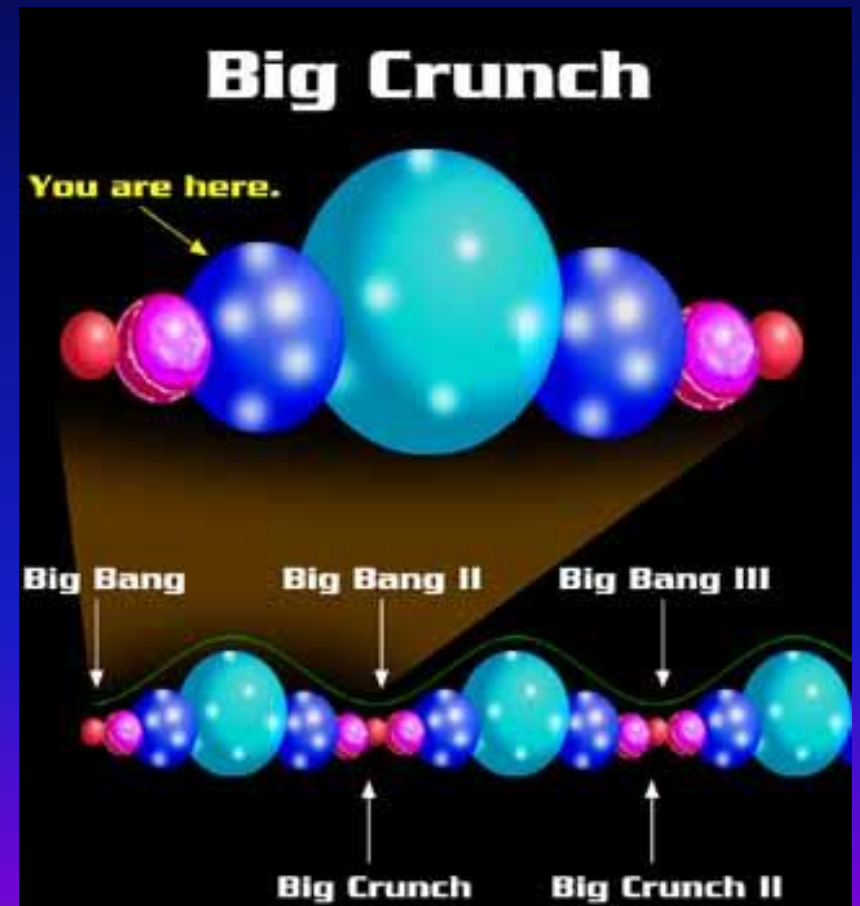
→ Gravity is opposing to the expansion of the Universe

**3 scenarios (depending on the Density of the Universe):**



# Future of our Universe

- 1) **BIG CRUNCH THEORY:** the Universe will stop expanding and start collapsing...until it again occupies a single hot and dense spot.





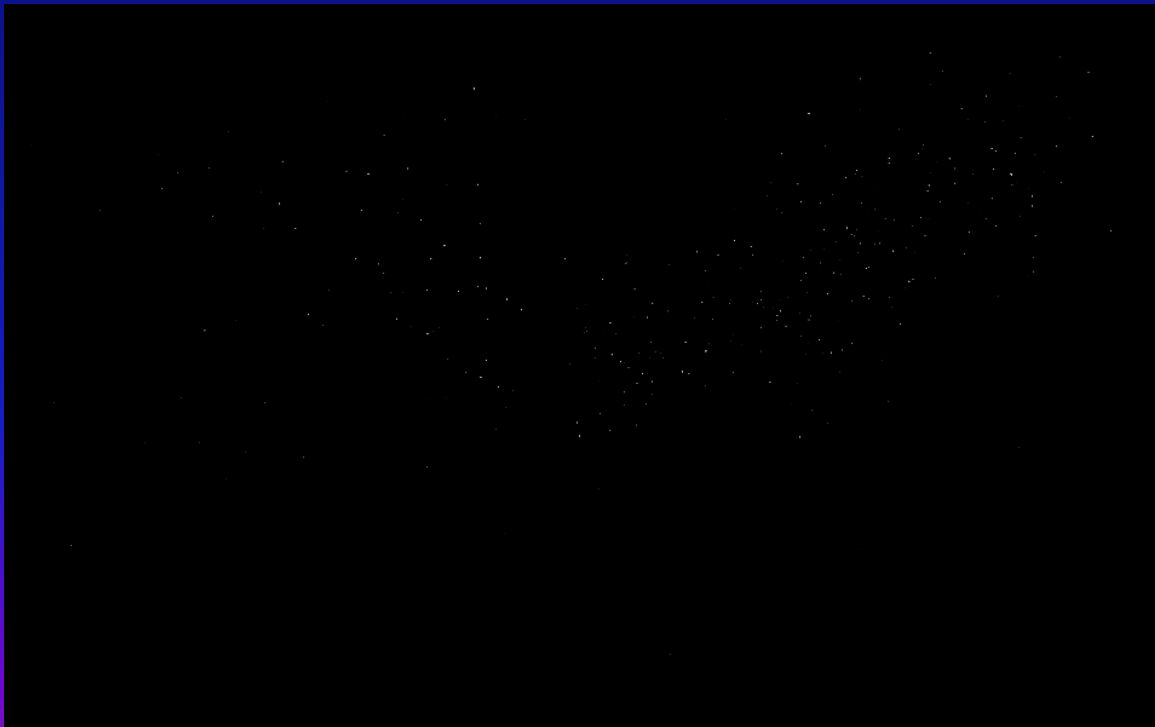
# Future of our Universe



2) BIG RIP THEORY: the Universe will start expanding even faster, and the space itself will be ripped apart.

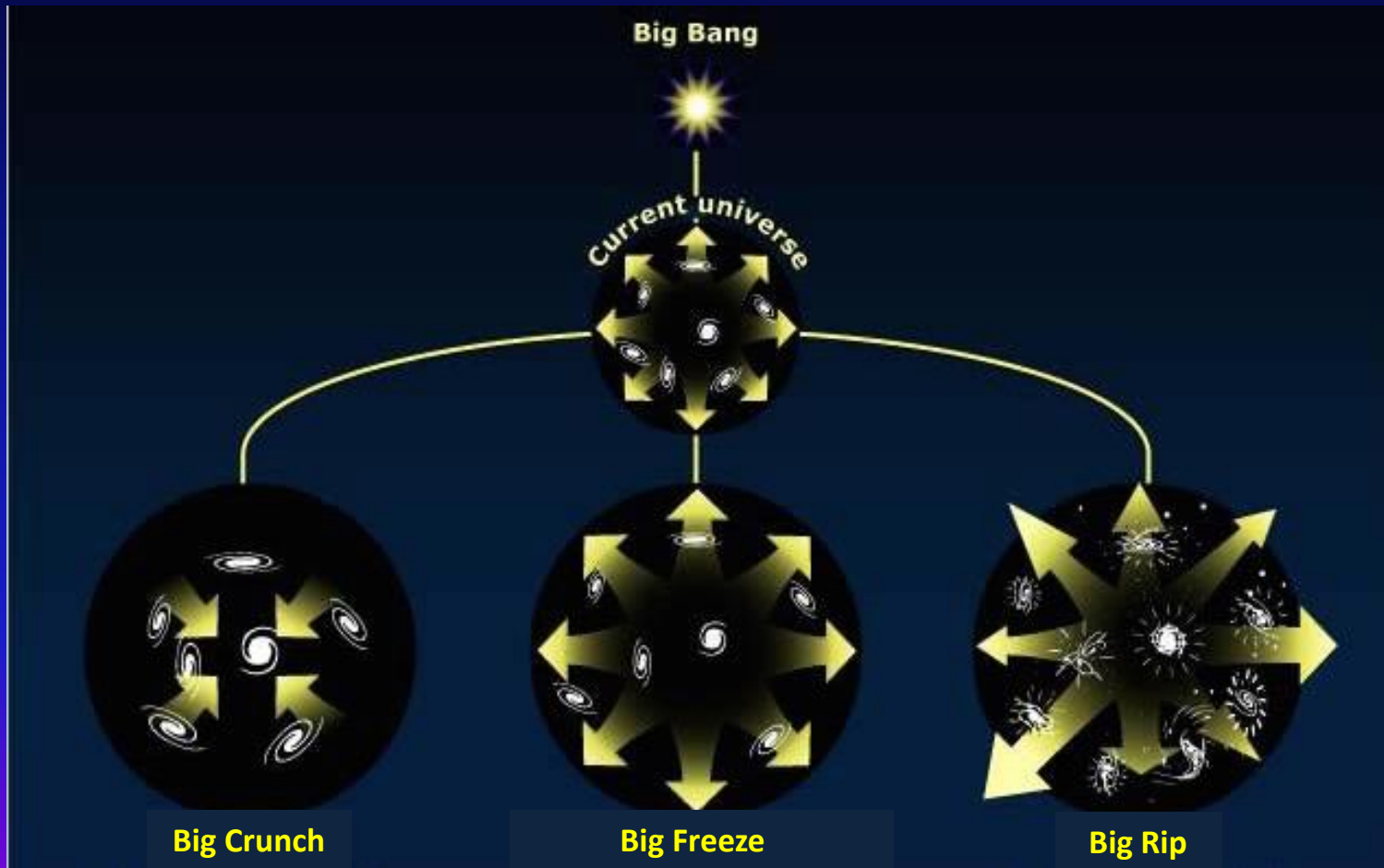
# Future of our Universe

3) BIG FREEZE THEORY: the Universe will expand more slowly, becoming colder and darker.





# Future of our Universe



# Future of our Universe

