



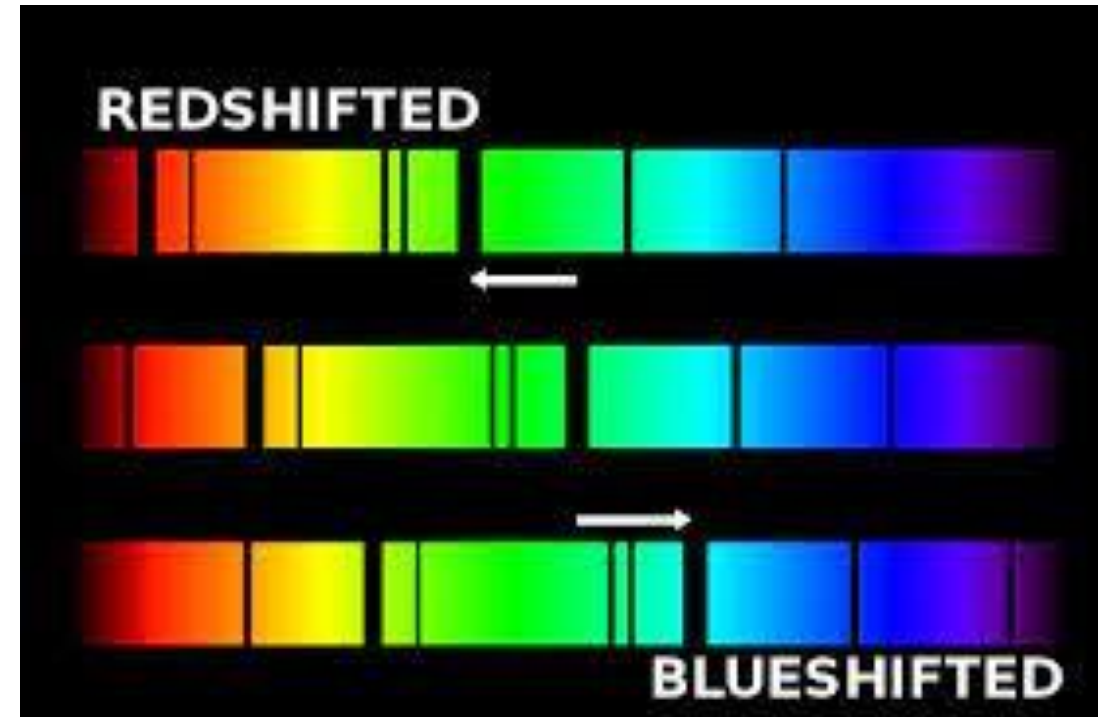
Theories for the Beginning of the Universe



Quiz

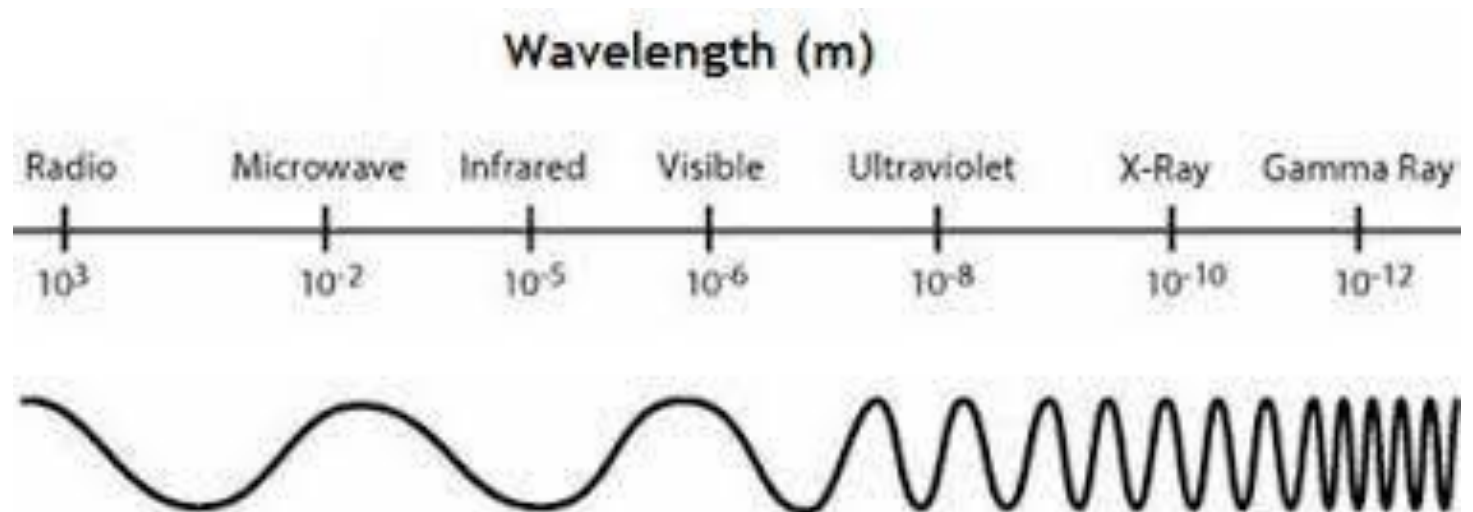
The Doppler Effect

- When an object emitting a wave is moving away, the wave's wavelength increases, when the object is moving towards you the wavelength of the wave decreases.
- E.g. sound waves from sirens
- Stars emit light (a wave)
- This wave's wavelength increases when the star moves away from us.
- Stars around us are red shifted (the wavelength of light emitted from them increases) meaning they are moving away from us so the universe is expanding
- Stars further away are red shifted more so the universe is accelerating outwards.



CMBR Radiation

- Using a telescope that detects microwave radiation you can pick up microwave radiation from all over the sky.
- When the big bang took place gamma radiation was emitted in every direction and this expanded just like the rest of the universe into the microwave radiation it is today.
- Big bang theory predicted CMBR.



Big Bang

- Some misconceptions
- Not a “big bang” that created the universe
- Not the “start” of the universe just a shift in the state of the universe from a **gravitational singularity** to the universe as we know of it today. The matter in this singularity just transitioned into the known universe.
- But the big bang theory had some issues.
- The solution: inflation theory

The Inflation Theory

- Before the inflation today (expansion) there was hyperinflation
- We can see this hyperinflationary period through the CMBR.
- Hyperinflation started from the singularity (something whose physics we don't understand) and ended in a new form of the universe whose physics we do understand. This inflation is often marked as the start of the universe.
- Problems this theory addresses:
 - The universe is flat
 - The entire universe is the same temperature
 - The monopole problem

**Afterglow Light
Pattern
375,000 yrs.**

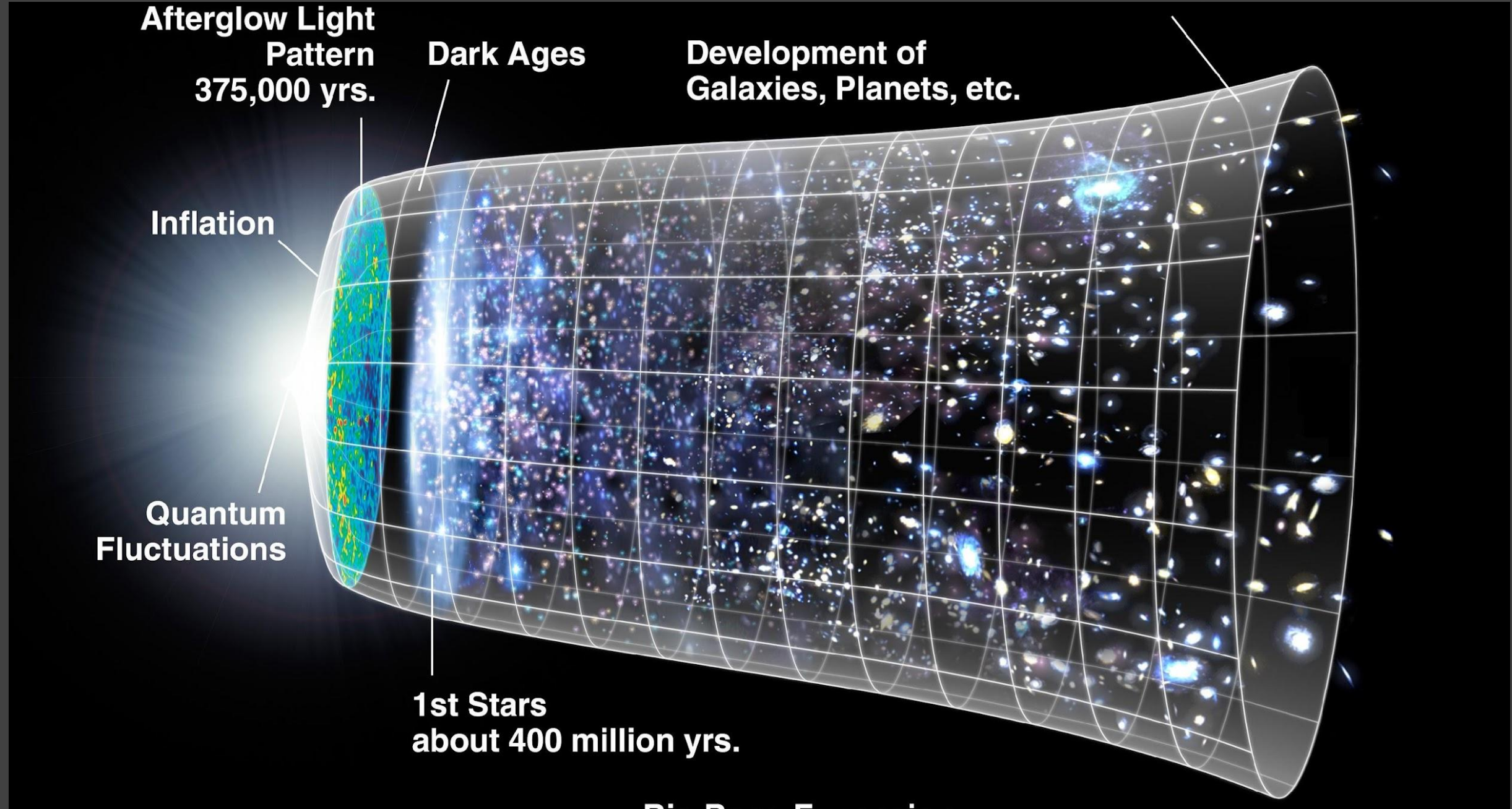
Dark Ages

**Development of
Galaxies, Planets, etc.**

Inflation

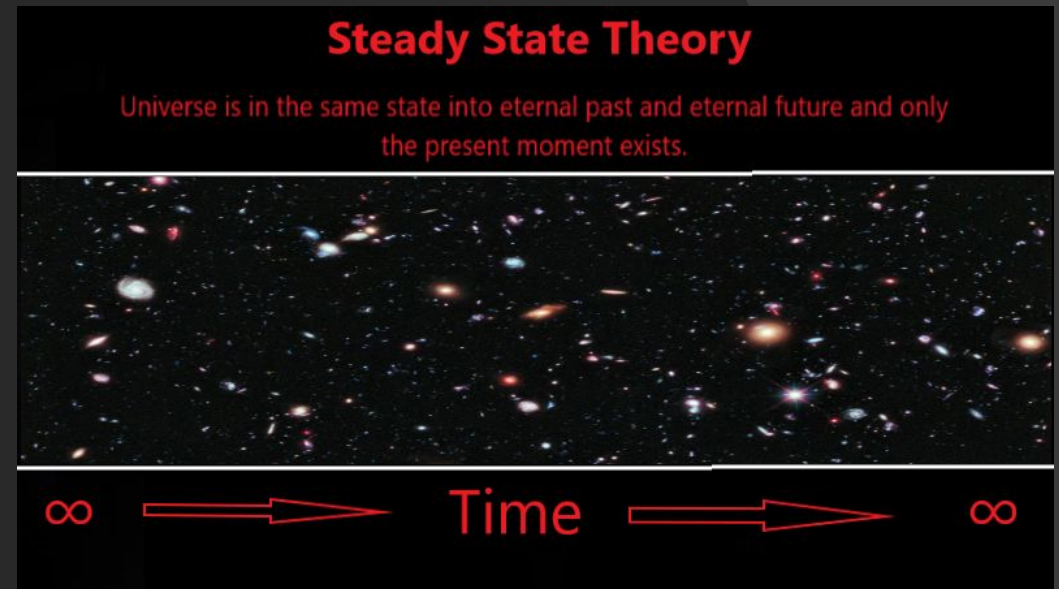
**Quantum
Fluctuations**

**1st Stars
about 400 million yrs.**



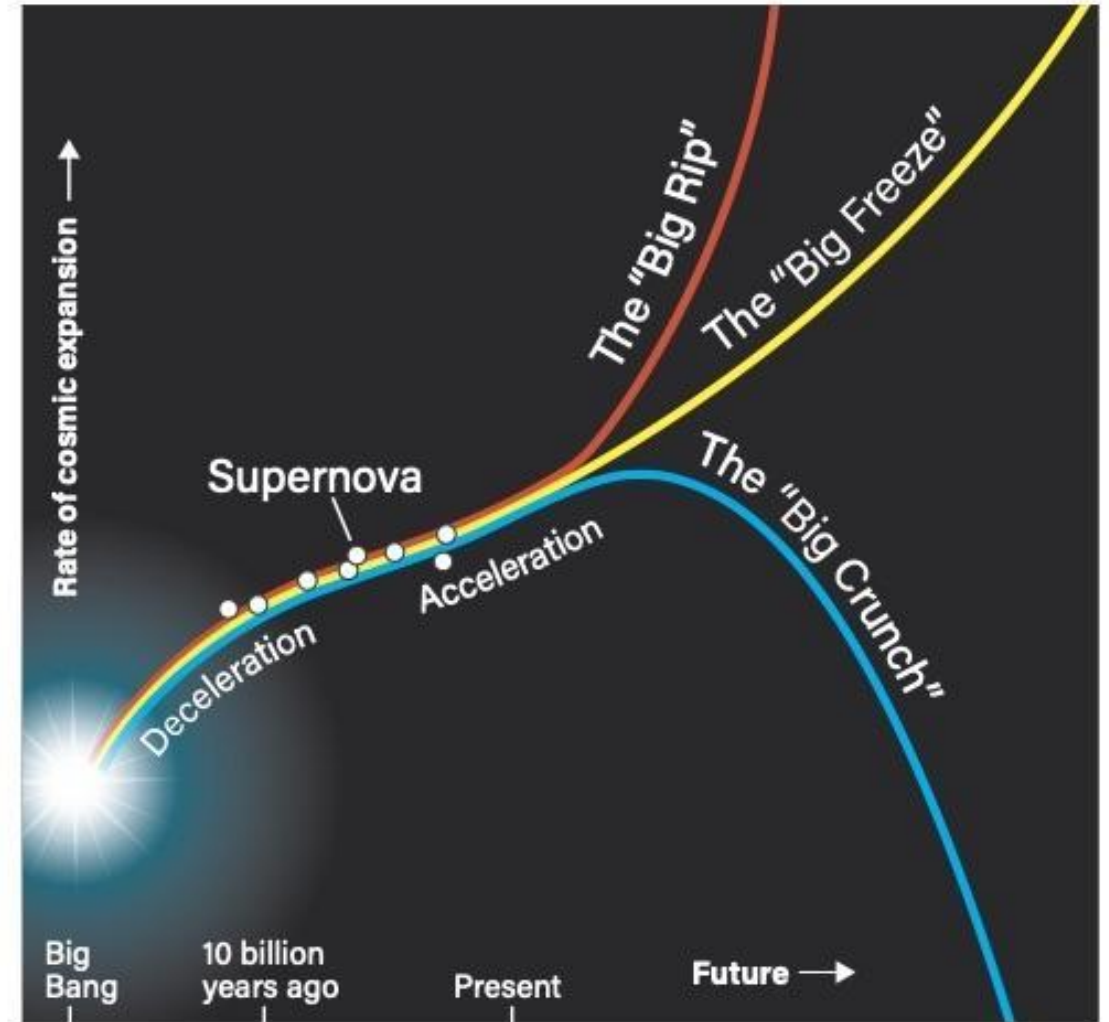
Steady State Theory

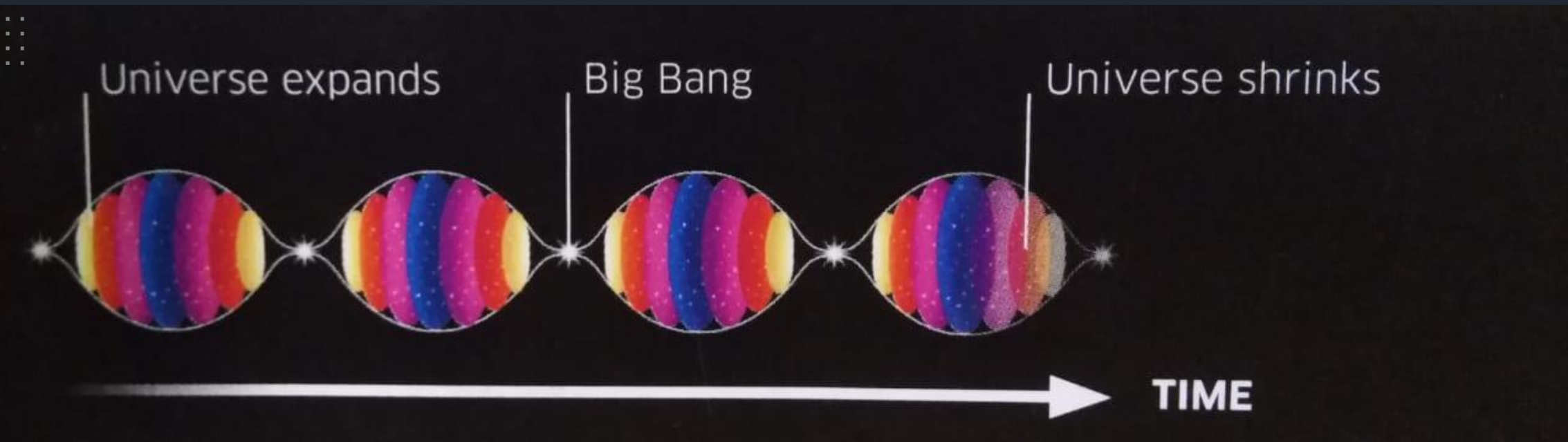
- The steady state theory is a view that the universe is always expanding but maintaining a constant average density, with matter being continuously created to form new stars and galaxies. A steady-state universe has no beginning or end in time, and from any point within it the view on the grand scale—i.e., the average density and arrangement of galaxies—is the same.
- However, the observation of cosmic microwave background radiation serves as evidence that contradicts this model. The CMBR shows evidence that there was in fact a beginning to the universe and this radiation. The cosmic microwave background (CMB) is thought to be leftover radiation from the explosion at the beginning of the universe.



Fate of the Universe

- Everything in the universe exerts a gravitational pull on everything else, and this slows down the universal expansion. The ultimate fate of the universe depends on the amount of mass contained within it, that is, the *mean density* of the universe. There is a *critical density*, which if reached will be sufficient to just stop the expansion of the universe.
- **The Universe will expand forever (Big freeze):** If the mean density is less than the critical density, then there is insufficient mass within the universe to stop the expansion - the universe will expand forever. Ultimately, the galaxies will move increasingly further apart. Star formation within the galaxies will eventually cease as the star forming material is exhausted. The universe will slowly cool to absolute zero: a heat death will occur. Life will be unable to exist.
- **The Universe will collapse in on itself:** If the mean density exceeds the critical density, then the expansion of the universe will eventually cease, and the universe will begin to contract. Eventually, a fireball like that which initiated the universe's expansion will result. This is referred to as the "*Big Crunch*". If this were to happen, it is estimated that it is some 50 thousand million years in the future (at least ten times the remaining life of the Sun). It may be that the universe expands and contracts in a cyclic way and may, indeed, have been doing so in the past - this is the so-called "*Oscillating Theory of the Universe*".





Big Bounce

- In the Big Bounce model, the universe begins with a "big bang" and ends with a "big crunch." After the big bang, the universe expands until gravitational forces force it to stop. At this point, the universe contracts until it implodes into a singularity. A gravitational singularity is a point where gravitational forces are infinite. After this contraction occurs, the cycle begins again with a new big bang.
- This theory, however, conflicts with the established laws of thermodynamics, which state that entropy in a system can only increase.
- The collapse of the universe into a big crunch results in a loss of entropy.
- Newer models solve this problem by factoring in dark energy.
- This theory is not the currently accepted theory about the origin and end of the universe, but does explain some shortcomings of other theories. Most prominently, it solves the thermal state problem: how the universe begins at such a high temperature. In the big bounce theory, the implosion of all matter and energy in the universe into a singularity produces the required energy to initiate a big bang.