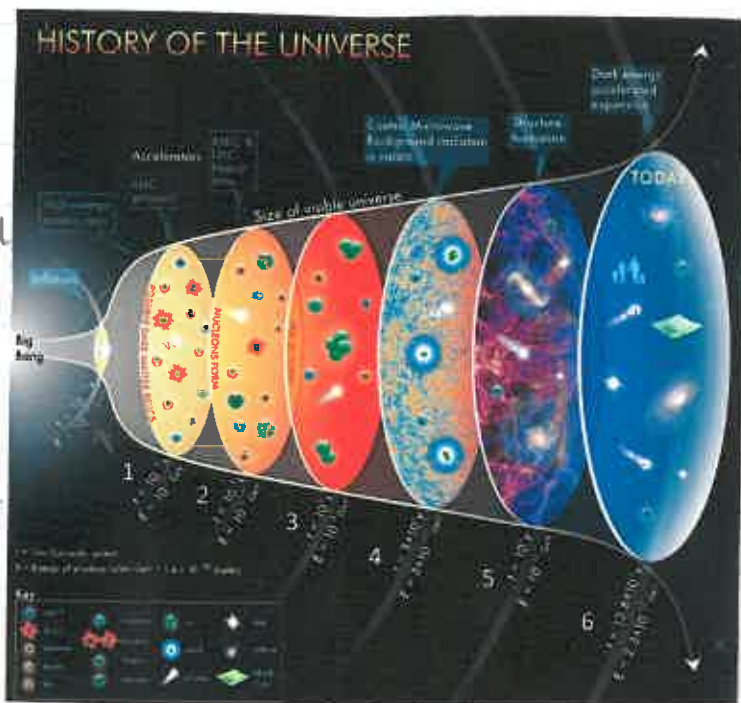


The Origins of the Universe

- **The Big Bang:** In the 1920's it was discovered that our galaxy and the millions of galaxies that surround it are all moving away from each other because the universe is expanding. This implies that the galaxies all began close together, billions of years ago.
- The idea that the universe started as a hot burst of energy in the distant past was widely accepted once the remains of that energy was observed in the 1960's.
- In the 13.7 billion years since the universe began, that energy has cooled to -270°C , and is now known as Cosmic Microwave Background Radiation (CMBR).



10^{-36} seconds

- ① universe undergoes an enormous increase in its rate of expansion, called inflation, and emits a huge amount of heat and radiation.

10^{-10} seconds

- ② Electromagnetic and weak forces become distinct. The universe is cooling rapidly and forming a soup of primitive particles.

0.0001 seconds

- ③ Matter is formed, as sub-atomic particles, and most of these destroy each other.

100 seconds

- ④ As the universe continues to cool, the remaining particles are mostly protons, neutrons, electrons and neutrinos.

- ⑤ The universe is cool enough for atoms to form. Space becomes transparent, because there are fewer particles to obstruct photons of light.

- ⑥ stars and galaxies form... to present day.

Red Shift

Galaxies exist in clusters and a key piece of evidence for the Big Bang is that these clusters are all moving apart which means the Universe is expanding.

Astronomers know this because they can split the light from the galaxies into spectra which are like rainbows containing lines of light or dark that can tell us the substances present.

In the spectra from distant galaxies, the positions of the lines are all shifted towards the red end (longer wavelengths). This means that the majority of the galaxies are moving away from us.

