

Meeting 5
Feb. 10, 2021

1. Announcements

a. Comments

- Class a revelation - know all the math
- looking with your eyes
- math adds this false understanding

2. Chapter IV

Main theme: energy thresholds

a. Recap

- The Hubble constant captures the expansion of the universe
- Einstein - H proportional to square root total energy density
- Expansion - a proportional to $t^{1/2}$
- Different forms of energy thin out differently with expansion
 - photons - $1/a^4$
 - matter - $1/a^3$
 - DE - constant
- As the universe expands, different forms dominate at different times
 - photons - before 47,000 y
 - matter - before 9.8 Gy
 - DE - after 9.8 Gy

b. Thresholds

- Important during matter dominated era
- $T=1/t^{1/2}$
- Matter has mass
- Conserved quantities: baryon, lepton, charge, energy
- Mass determines thresholds
 - $T > m$, in equilibrium with photons
 - $T < m$, annihilation happens the feeds, photons, dilutes particles
- Table

3. Annihilation and creation

- Conserved quantities
- Annihilation
- Creation
- Decay
- Proton decay experiments