## Note guide for The Standard Model (The Big Bang)

**The precepts of the Big Bang**

* The laws of Physics are the same throughout the Universe.
* The Universe is expanding
* The Universe is isotropic and homogeneous
* General relativity works.
* The early Universe was hotter than it is today
* The Universe is evolving.
* The Cosmological principle – Any model of the universe that requires us as observers to be in a special place or time in order for it to work is not likely to be correct

**Gamow et al**

**Penzias and Wilson (accidental discovery of the cosmic microwave background radiation (CMBR))**

**COBE – Finds that the cosmic background radiation is black body.**

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| Wien’s Law – Temperature (Hotter is bluer – shorter wavelength)λmax = 2.90 x 10-3 m/K Tλmax = Peak black body wavelengthT = The star’s surface temperature in Kelvins | **Example:** COBE found the “temperature” of the CMBR to be 2.736 K. What is its λmax? |

**COBE Anisotropy findings –**

**BOOMERANG and WMAP – much more accurate version of COBE**

1) the universe was 13.7 billion years old, plus or minus about 200 million years,

2) it is composed of 4% matter, 22% dark matter, and 74% dark energy (later)

3) the Hubble Constant is 71±2.5(km/sec)/MPc not 50 or 100 as some researchers had suggested, and

4) the universe is flat (similar to what the BOOMERANG craft had seen).



Basic concepts:

Adiabatic expansion

Stretching of radiation

Matter becoming energy, Energy becoming matter

Matter as “condensed” energy

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| Wien’s Law – Temperature (Hotter is bluer – shorter wavelength)λmax = 2.90 x 10-3 m/K Tλmax = Peak black body wavelengthT = The star’s surface temperature in KelvinsE = Photon Energy in Jh = Planck’s Constant (6.626x10-34 Js)c = the speed of light (3.00x108 m/s)λ = Peak black body wavelength**1 eV = 1.602x10-19 J** | **Proton creation energy** **= 2x938 MeV ≈ 2GeV****Electron Creation Energy** **= 2x0.511 MeV ≈ 1MeV****Matter Ionisation energy ≈ 1.3 eV** |

**Big Bang Nucleosynthesis theory (BBN theory)**