Project Plan

February 23, 2017

1 Project Plan - Lithium Problem

During the initial stages of the Big Bang besides nucleosynthesis, nuclear reactions were also taking place due to the high temperatures. The abundance of helium and hydrogen as calculated from the hot Big Bang Theory fits nicely with the observational data. Things gets ugly when we estimate the amount of lithium. The expected amount of lithium is three times than that observed. This is referred to as the lithium problem.

Recently researchers from China have published a paper that may have solved the puzzle. They argued that the assumption of the Big Bang Theory that the universe was in thermodynamic equilibrium may be wrong and thus we cannot apply Maxwell-Boltzmann distribution as it applies for ideal gases only and we deal with real gases which behave differently.

The authors have used non-extensive statistics to solve the problem. This does not directly gives the abundance of lithium but it predicts the amount of beryllium that can then be used to calculate the amount of lithium.

The goals of our project are:-

- To study Maxwell-Boltzmann Distribution and how is it applied in the Big Bang Theory to explain the abundances of various elements.
- To study how the data gathered by WMAP is incorporated into the Big Bang theory - We will study how WMAP data helps us in finding out the baryonic number and some other cosmological constants that were needed to fully describe the Big Bang Theory
- To study about Tsallis non-extensive statistics.
- To apply Tsallis non-extensive statistics to explain how it could be used to overcome the shortcomings of Big Bang Theory in explaining the lithium abundances.
- To explore other theories about the explanation of lithium problem

The other theories that we intend to explore are:-

- Diffusion Theory
- Presence of BBNCRs
- Due to incomplete nuclear physics input for the BBN calculations

2 Tasks for March

- Study about Maxwell-Boltzmann Distribution
- Apply it in the Big Bang Theory and calculate abundance of light elements which are believed to be formed during big bang nucleosynthesis
- Study how WMAP data can be used to find out the baryonic number and some other cosmological constants that are needed to describe the Big Bang Theory
- Study about Tsallis non-extensive statistics

3 Tasks for April

- Apply the Tsallis non-extensive statistics to the nuclei in the plasma of the early photon period of the universe and get the densities of hydrogen, helium and beryllium and lithium
- Study about diffusion theory and apply it to get the density of Hydrogen, Helium and Lithium.
- Assume the presence of BBNCRs and redo the calculations for finding densities assuming Maxwell-Boltzmann distribution
- Assume that information about nuclear physics is incomplete at present and analyze how this assumption affects our calculations
- Compare the results we get from all the above four methods and also compare these to the first calculation we have done assuming initial state to behave like ideal gas

4 2nd - 8th March

This week our goal is:

- Study about Maxwell-Boltzmann Distribution
- See how it can be applied to the Big Bang Theory and
- Calculate abundance of Helium assuming that particles follow M-B distribution in Early Universe and most of the elements formed were H_2 and He

5 8th - 15th March

This week our goal is:

- Calculate abundance of Lithium and Hydrogen assuming that particles follow M-B distribution
- Study about WMAP experiment

Last week we said we would accomplish:

- Study about Maxwell-Boltzmann Distribution (Complete)
- See how it can be applied to the Big Bang Theory (Partially complete)
- Calculate abundance of Helium assuming that particles follow M-B distribution in Early Universe and most of the elements formed were H_2 and He (Complete)

6 16th - 23th March

This week our goal is:

- To use WMAP data to find out the baryonic number
- Study the basics of Tsallis non-extensive statistics

Last week we said we would accomplish:

- Calculate abundance of Lithium and Hydrogen assuming that particles follow M-B distribution (complete)
- Study about WMAP experiment (complete)

7 24th-30th March

This week our goal is:

- To study possible Possible Generalization of Boltzmann-Gibbs Statistics
- To study the link between Nonextensive statistical mechanics and astronomical phenomena

Last week we said we would accomplish:

- To use WAMP data to find out the baryonic number (complete)
- Study the basics of Tsallis non-extensive statistics (incomplete)

8 31st March - 6th April

This week our goal is:

- Apply the Tsallis non-extensive statistics to the nuclei in the plasma of the early photon period of the universe and get the densities of hydrogen, helium and beryllium and lithium
- Study about diffusion theory and apply it to get the density of hydrogen, helium and lithium

Last week we said we would accomplish:

- To study possible Possible Generalization of Boltzmann-Gibbs Statistics (complete)
- To study the link between Nonextensive statistical mechanics and astronomical phenomena (complete)

9 7th - 13th April

This week our goal is:

- Assume the presence of BBNCRs and redo the calculations for finding densities assuming Maxwell-Boltzmann distribution
- Assume that information about nuclear physics is incomplete at present and analyze how this assumption affects our calculations

Last week we said we would accomplish:

- Apply the Tsallis non-extensive statistics to the nuclei in the plasma of the early photon period of the universe and get the densities of hydrogen, helium and beryllium and lithium (incomplete)
- Study about diffusion theory and apply it to get the density of hydrogen helium and lithium (partially complete)

10 14th - 20th April

This week our goal is:

- Compare the results obtained from different theory
- Summarize all the studies done

Last week we said we would accomplish:

- Assume the presence of BBNCRs and redo the calculations for finding densities assuming Maxwell-Boltzmann distribution (complete)
- Assume that information about nuclear physics is incomplete at present and analyze how this assumption affects our calculations (complete)