Report from the lecture presented by Andrei Linde

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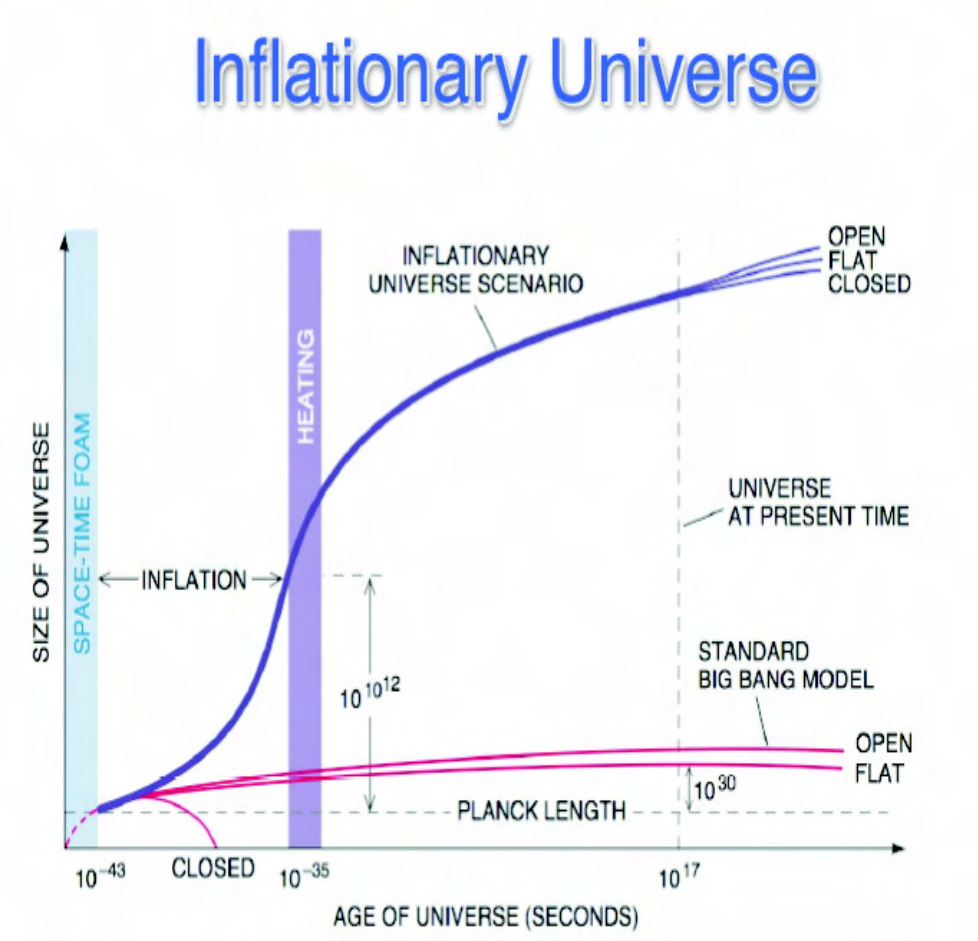
The standard Big Bang theory is far from complete. It does not tell us why different parts of the universe started to expand simultaneously, why the universe is so flat, homogenous and isotropic, and what is the origin of galaxies. The existence of these and several other problems of the Big Bang theory forced cosmologists to reconsider its basic assumptions and invent inflationary cosmology.

According to inflation the early universe went through a period of extremely rapid expansion which made the universe flat and homogenous. Furthermore, during the era of inflation microscopic quantum fluctuations were generated that later were magnified into seeds for galaxy formation. But, intriguingly, inflation also answers another fundamental question: from where does the energy of the universe come?

Contrary to common belief, energy is not conserved in our expanding universe. In a universe filled with ordinary matter and radiation the total amount of energy is decreasing with time. If we estimate the total amount of energy in the universe today we therefore conclude that there existed even more energy a fraction of a second after the Big Bang. But how did it arise? This is where inflation comes to rescue. In an inflating universe, where the pressure is negative, the total mass is actually increasing. Hence a small initial mass generated by a random quantum fluctuation out of nothing can be amplified, thanks to inflation, into a universe like ours.

Inflation is a theory about the origin of the universe which successfully has passed several observational tests. But what is the origin of inflation? To find the answer to this question we are likely to need string theory. In this way inflation may provide us with the first glimpse of the most fundamental laws of physics.



Question session

Are there other universes? It was explained that the existence of other universes is a natural consequence of inflation and string theory. Furthermore, it was emphasized that the laws of physics in these other universes are likely to be very different from the ones in our universe. Ironically, this together with the anthropic principle can help us to understand why our own universe has its particular properties. This includes the smallness of the cosmological constant, why our universe has three dimensions, and the huge mass differences between many particles. It is a fascinating thought that studies of our own universe might yield indirect evidence of the existence of other universes.

The question was also asked whether there ever was a first universe. The answer is that we do not know, but that string theory may help us to find out.

What observations are there in support of inflation? Inflation is the only theory which explains such important observations as the homogeneity and isotropy of the universe. Recent observations confirm the inflationary prediction that the universe should be

flat and that the perturbations produced during inflation – which are responsible for the large scale structure of the universe -- have a flat spectrum and are adiabatic and Gaussian. The most detailed observations have been performed by the WMAP-satellite and involve measurements of the distribution of temperature fluctuations at various scales in the microwave background radiation.

A question was raised whether inflation can help in solving the problem of dark matter and dark energy. The answer is that inflation in itself does not tell us what the constituents of the present universe are. It only predicts that the total amount of matter and energy is such that the spatial geometry is flat.

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