Aspects of Quantum Field Theory in Phenomenology of Early Universe

A THESIS

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by

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Year of submission: 2011

To

Maa, Bapi

&

Jethubaba

CERTIFICATE

I feel great pleasure in certifying that the thesis entitled, ***"Aspects of Quantum Field Theory in Phenomenology of Early Universe"*** *embodies a record of the results of investigations carried out by Mrs. Suratna Das under my guidance.*

She has completed the following requirements as per Ph.D. regulations of the University.

(a) Course work as per the university rules.

(b) Residential requirements of the university.

(c) Presented her work in the departmental committee.

(d) Published minimum of two research papers in a referred research journal.

I am satisfied with the analysis of data, interpretation of results and conclusions drawn.

I recommend the submission of thesis.

Date : May 25, 2011

Subhendra Mohanty
Professor
(Thesis Supervisor)

Countersigned by
Head of the Department

DECLARATION

I, ***Mrs. Suratna Das****, D/O Mr. Saroj Kumar Das, resident of D-108, PRL residences, Navrangpura, Ahmedabad, 380009, hereby declare that the work incorporated in the present thesis entitled,* ***"Aspects of Quantum Field Theory in Phenomenology of Early Universe"*** *is my own and original. This work (in part or in full) has not been submitted to any University for the award of a Degree or a Diploma.*

Date : May 25, 2011

(Suratna Das)

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Abstract

In this thesis, our main focus is on applications of various Quantum Field Theoretic (QFT) treatments in analyzing early Universe phenomena primarily related to the inflationary paradigm [1].

It is shown that non-perturbative QFT technique for calculating two-point correlation in flat space, known as Källén-Lehmann spectral representation, can be used to calculate the power spectrum of interacting scalar fields where the interactions are short-ranged. Decaying inflaton and composite inflaton are two such cases where our method of calculating power spectrum can be applied. Decaying inflaton suppresses the long-distance correlation while the composite inflaton yields some oscillatory features in the low l region of the TT spectrum of CMBR, which may be observed by WMAP or in the future observations with PLANCK.

We investigate whether an exotic quantum field, named the *unparticle*, can play the role of an inflaton and drive inflation. Such exotic fields yields long-range forces due to its anomalous dimension and such anomalous dimension of tensor and vector unparticle is constrained from Mercury's perihelion precession data. Signature of a scalar unparticle inflaton is the suppression of low l modes in the anisotropy spectrum in the CMBR which can be observed by WMAP or PLANCK.

Effects of pre-inflationary radiation era on the primordial non-Gaussianity is also studied using Thermal Field Theory techniques. The bispectrum contribution is enhanced by a factor of 65-90 from that of single-field slow-roll inflationary model. Thermal averaging yields trispectrum non-Gaussianity which does not depend up on the slow-roll parameters and thus can be as large as -42. Signature of such a pre-inflationary radiation era is a large trispectrum non-Gaussianity compared to the bispectrum non-Gaussianity.

[1]**keywords** : Inflation, CMBR anisotropies, Power spectrum, Källén-Lehmann spectral representation, Unparticle, Primordial non-Gaussianity, Thermal Field Theory

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