38th INTERNATIONAL CONFERENCE
ON HIGH ENERGY PHYSICS
AUGUST 3 - 10, 2016
CHICAGO

Contribution ID: **1052**

Type: **Poster**

Inflationary Dynamics Reconstruction via Inverse-Scattering Theory

Saturday, 6 August 2016 18:00 (2 hours)

The seminal works of Guth and Sato established that an early period of accelerated cosmic expansion, referred to as inflation, can successfully account for many of the observed large scale properties of our Universe. Most importantly, the inflationary paradigm provides a natural and appealing mechanism for the generation of primordial density perturbations responsible for seeding the growth of structure in the Universe. However, despite the concordance between observations and the predictions of an inflationary scenario, the physics responsible for driving inflation is still a subject of debate and remains largely speculative. In this work I explore how the interface between inflation and inverse-scattering theory can shed light on the stress-energy which drove inflationary expansion. In particular, I study two inflationary models and show how the inverse-scattering framework allows one to reconstruct the Universe's expansion history during inflation to a reasonable accuracy under the assumptions of access to the complete primordial power spectrum of density fluctuations, $P(k)$, and the amplitude and slope of the primordial tensor power spectrum at cosmic microwave background scales. These results, however, constitute an idealization as practical limitations prohibit a survey of the primordial density power spectrum for all scales. Notwithstanding, this preliminary analysis is the basis for an extended reconstruction procedure which will take into account only the partial existing data on the primordial power spectrum. Looking forward, I discuss how such an extended procedure could be built from a statistical treatment of the function space of possible $P(k)$, as well as the constraints it could place on the evolution and equation of state of the inflaton field.

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Session Classification: Poster Session

Track Classification: Astro-particle Physics and Cosmology