

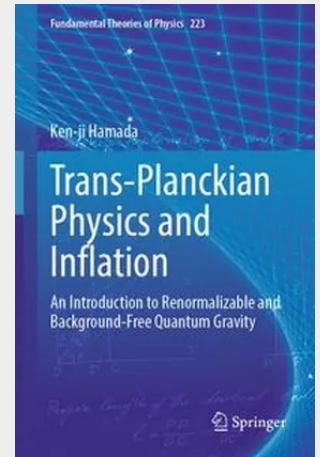
Trans-Planckian Physics and Inflation

An Introduction to Renormalizable and Background-Free Quantum Gravity

This book comprehensively describes recent developments in the research of renormalizable quantum gravity, focusing on its application to physics beyond the Planck scale, particularly in inflationary cosmology. It challenges the notion that the Planck scale is an impassable barrier, addressing issues such as singularity, renormalizability, unitarity, time, primordial fluctuations, and the cosmological constant. To describe the trans-Planckian world, it is necessary to break away from the view of graviton scattering and carry out the quantization of spacetime itself. Utilizing conformal field theory techniques to achieve background freedom, the book presents a renormalizable quantum theory of gravity that overcomes the Planck-scale wall.

Historically, discussions on renormalizability of gravity declined due to ghost issues. However, ghosts are essential in gravitational systems where the total Hamiltonian/momentum vanishes strictly, for aspects such as cosmic entropy, the formation of the universe, and gravitational objects. Quantum gravity approaches known in recent years often break diffeomorphism invariance or sacrifice renormalizability to eliminate ghosts. In contrast, this book presents a novel attempt which maintains that these are guiding principles even in the trans-Planckian domain, but constrains ghosts to be unphysical. The renormalizability implies a new scale that leads to a quantum gravity inflation scenario with a spacetime phase transition as the Big Bang. This book offers fresh insights into the trans-Planckian physics for graduate students and researchers.

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