

PITT PACC Workshop: Non-Standard Cosmological Epochs and Expansion Histories

Block Descriptions

Block I

Connection to Observation: Overview

Co-Discussion Leaders:
Andrew Long, Kuver Sinha

This block is focused broadly on observational methods which can be used to probe the expansion history of the universe – potentially including probes which are potentially promising yet underappreciated – and how experimental efforts over the next decade or so are likely to improve our understanding of that expansion history on various fronts. However, gravitational waves, which are of course an important probe of early-universe dynamics, will be the focus of a separate, dedicated block (Block III).

Block II

Early Matter-Dominated Eras

Co-Discussion Leaders:
Adrienne Erickcek, Jessie Shelton

This block is focused on early matter-dominated eras (EMDEs) and their phenomenological/observational consequences, including implications for dark-matter production and for structure on small scales.

Block III

Gravitational-Wave Signals in Modified Cosmologies

Co-Discussion Leaders:
Kim Boddy, Lauren Pearce

This block is focused on the gravitational-wave signatures that can arise in cosmological scenarios involving modified expansion histories and the manner in which these signals may be correlated with other observational signatures which might arise in such scenarios.

Block IV

Scalar Fields and Non-Standard Expansion Histories I (Top-Down Realizations and Implications for Structure Formation)

Co-Discussion Leaders:
Rouzbeh Allahverdi, Sten Delos

This is the first of two blocks focused on modifications to the cosmological expansion history which can arise in the presence of additional scalar fields (other than epochs of early matter domination, which are not unique to scalars and thus will be covered in a different block). Such modifications include, for example, early dark energy, but would also include kination epochs and other epochs wherein the universe is dominated by a fluid with a 'stiff' ($w > 1/3$) equation of state. The discussion during this block will focus on two main topics related to these themes. The first is how cosmologies involving early dark energy or cosmological components with stiff equations of state can emerge in top-down constructions involving moduli and other light scalars. The second is how the evolution of cosmological perturbations is modified in the resulting cosmologies and how such modifications can affect the matter power spectrum and the development of structure on small scales.

Block V Scalar Fields and Non-Standard Expansion Histories II (Specific Models)

Co-Discussion Leaders:
Akshay Ghalsasi, Tristan Smith

This is the second of two blocks focused on modifications to the cosmological expansion history which can arise in the presence of additional scalar fields (other than epochs of early matter domination, which are not unique to scalars and thus will be covered in a different block). Such modifications include, for example, early dark energy, but would also include kination epochs and other epochs wherein the universe is dominated by a fluid with a 'stiff' ($w > 1/3$) equation of state. The discussion during this block will focus on specific models which give rise to modifications along these lines (including axion kination and early-dark-energy scenarios) which are motivated by phenomenological and observational considerations such as the dark-matter problem, baryogenesis, and tensions between measurements made at early and late times.

Block VI Connections to Fundamental Theory

Co-Discussion Leaders:
Jim Halverson, Gary Shiu

This block is focused on the connections between non-standard expansion histories and fundamental theory. To what extent do different top-down scenarios for physics beyond the Standard Model, including string theory, predict departures from the standard cosmology? Conversely, were we to obtain observational evidence that indeed the expansion history of our universe differs from that of the standard cosmology, what would this tell us about fundamental physics at high scales?

Block VII

How Inflation Ends: Non-Standard Possibilities

Co-Discussion Leaders:
Mustafa Amin, Tom Giblin

This block is focused on the manner in which inflation ends and on the modifications to the subsequent cosmological timeline that can take place in particular kinds of inflationary scenarios. This includes scenarios in which reheating takes place at late times/low temperatures, and also scenarios in which states/structures produced at the end of inflation subsequently come to dominate the energy density of the universe or affect the expansion history in other ways.

Block VIII

Cosmological Stasis

Co-Discussion Leaders:
Fei Huang

This block is focused on cosmological stasis, its realizations within the context of particular scenarios beyond the Standard Model, and its potential observational consequences.

Block IX

Primordial Black-Hole Domination

Co-Discussion Leaders:
Barmak Shams Es Haghi

This block is focused on epochs of primordial-black-hole (PBH) domination and their potential consequences – including, for example, possible implications for dark-matter physics, gravitational-wave physics, and the generation of the baryon asymmetry of the universe. An early matter-dominated eras (EMDEs) can of course arise within the cosmological timeline when PBHs dominate. Since such eras will be the focus of a separate, dedicated block (Block II), the focus of this block will primarily be on other

possible consequences of PBHs on the cosmological expansion history or on distinctive potential implications of PBH-dominated eras which are not realized in other EMDEs.