

Helmholtz International Summer School "COSMOLOGY, STRINGS, NEW PHYSICS"

Sunday, August 4, 2019 - Saturday, August 17, 2019

BLTP JINR

Scientific Program

Lectures
D. Blaschke (Wroclaw Univ. and BLTP JINR)

[Helmholtz schools in Dubna. Opening](#) .pdf

[Helmholtz Association](#) .pdf

J.L. Buchbinder (Tomsk Pedagogical Univ.)
[Introduction to supergravity](#)
[Contents and literature](#) .pdf
[Lectures I and II](#) .pdf
[Lectures III - V](#) .pdf

D. S. Gorbunov (INR RAS)

[Introduction to the Hot Big Bang Theory](#) .pdf

[Baryogenesis in the Early Universe](#) .pdf

[Dark Matter Models](#) .pdf

A. D. Dolgov (ITEP and NSU) [Black holes in the early universe and today](#) (3 lectures)

[Lectures I-III](#) .pdf

D. I. Kazakov (BLTP JINR) [R-operation and renormalization group for non-renormalizable theories](#) (2 lectures)

[N. Krasnikov \(INR\) Search for light dark matter at accelerators. NA64 experiment](#)
[Lecture 1.pdf](#)

[E.T.Musaev \(MIPT\) Branes and string cosmology \(4 lectures\) Contents.pdf](#)
[Lecture notes.pdf](#)
[String theory is known to contain various \$p\$ -dimensional objects called branes in addition to the fundamental string. In these lectures we will consider \$D\$ -branes, which appear in the open string spectrum and find huge amount of applications in string phenomenological models of particle physics and cosmology. The lectures will start with introduction to brane dynamics both from the perturbative \$R\$ -NS string perspective and in the non-perturbative effective action approach. In supergravity approximation the corresponding black \$p\$ -brane solutions and the corresponding BPS will be discussed. Finally, we will turn to applications of \$D\$ -branes and consider some cosmological models based on wrapped and unwrapped brane compactifications.](#)

[K. A. Postnov \(SAI MSU\) Gravitational waves from black holes and neutron star mergers](#)
[Lectures I and II .pdf](#)

[A.A. Starobinsky \(Landau Inst. & BLTP JINR\) Inflation, pre-inflation and post-inflationary heating in modified gravity models \(3 lectures\)](#)
[Lectures I-III .pdf](#)

[V.A. Rubakov \(INR RAS\) Unconventional field theories and their applications to the early Universe models \(2 lectures\)](#)

[Lecture II.pdf](#)

[V.P. Spiridonov \(BLTP JINR and NRU HSE\) Superconformal indices, Seiberg dualities and quantum integrable systems \(2 lectures\)](#)

[survey.pdf](#)

[book.pdf](#)

Superconformal indices of 4d gauge field theories were introduced around 2006. In 2008 Dolan and Osborn showed that they coincide with the elliptic hypergeometric integrals introduced earlier by the lecturer. Consequently, rigorous mathematical results established for such integrals prove Seiberg electro-magnetic dualities in the sector of BPS-states. In particular, the elliptic beta integrals serve as a confinement criterion, since their exact evaluations coincide with superconformal indices of dual theories without gauge fields. Simultaneously, symmetry transformations for 4d superconformal indices serve as the star-triangle, star-star or the Yang-Baxter relations relevant for quantum integrable systems. This leads to the most general known integrable statistical mechanics models. In particular, partition functions of the corresponding 2d lattice systems with continuous spins describe superconformal indices of 4d quiver gauge theories.

A. Vikman (FZU, Prague) *Dark side of the Universe* (3 lectures)
Lecture I .pdf
Lecture II .pdf
Lecture III .pdf

M. Volkov (Univ. Tours) *Massive gravity*
Lectures I-III .pdf
A brief introduction containing the discussion of the linear Fierz-Pauli theory and its non-linear generalisations, the absence of the massless limit (the VDVZ discontinuity), the Vainshtein mechanism, the problem of Boulware-Deser ghost, the ghost-free theories of massive gravity and bigravity, their basic solutions and physical applications.

A. Westphal (DESY) *Aspects of String Cosmology - de Sitter Vacua and Large-Field Inflation in String Theory* (4 lectures)
Lecture I .pdf
Lecture II .pdf
Lecture III .pdf
Lecture IV .pdf
Intermezzo: superfiels.pdf

We wish to connect string-scale physics as closely as possible to observables accessible to current or near-future experiments.

Besides the

*initial cosmological singularity, there are two phenomena in theoretical cosmology which need a fundamental description beyond the reach of effective field theory (EFT) coupled to general relativity: The current epoch of accelerated expansion of the universe ascribed to dark energy, and a very early phase of cosmological inflation. We will discuss in particular the high-scale (UV) sensitivity of inflation (and similarly, of dark energy), requiring a description within a UV complete candidate theory of quantum gravity, for which we pick string theory. Moreover, only inflation at the highest energy scales which are large-field models by necessity, generically produce observable amounts of so-called tensor modes, primordial gravitational waves detectable (and yet to be found) as B-mode polarization of the CMB. *

Weakly coupled string theory contains extra dimensions, leading to the problem of geometric deformations giving rise to massless scalar fields, the moduli. Therefore, embedding inflation and/or dark energy into string theory requires moduli stabilization. We will discuss the core ideas of moduli stabilization, mostly in the context of type IIB string theory, and the subsequent possibilities to 'uplift' the resulting anti-de-Sitter (AdS) vacua to de Sitter (dS) space. Based on such background constructions, we then discuss attempts to realize large-field inflation in string theory. Given the constraints facing such models, this will force us to use axions such as in e.g. axion monodromy inflation, or the decompactification direction among volume moduli as in fibre inflation.

V. Emelyanov (KIT, Karlsruhe) , "Information loss and recovery in black-hole physics " (2 lectures)

Lecture I .pdf

Lecture II .pdf

Talks

Roman Zhokhov, "Dualities of QCD phase diagram" .pdf

Tsvetan Vetsov, "Information aspects of holographic models" .pdf

Avinash Singh, "Growth of Structure in the Presence of Perturbed Tachyon Dark Energy".pdf

Haidar Sheikhahmadi, "Finding a remedy to justify the behaviour of accretion disk and jets in perturbed black holes" .pdf, "Primordial Non-Gaussianities, bispectrum to trispectrum, for multi-field models of inflation"

Abhijit Sen, "On deformations of classical mechanics due to Planck-scale physics" .pdf

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