Seminar: String Compactifications and their Experimental Signatures

Organisational Meeting, 15.10.2019

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Motivation

- Which kind of beyond the Standard Model physics does string theory predict?

- What could be experimental signatures?

- Are there general limitations on the theories attainable within string theory?

Organisation

- Seminars in December: current suggestion Saturdays (7th and 14th) to avoid clashes with your classes.
- Talks should be 50 minutes + 10 minutes for questions.
- The aim of your talk is to explain the topic to your fellow students. This will be important for the grade.
- You should have your talk ready end of November to discuss it with me. Once we fix a date, I would like to have the slides two days before that via email.
- Before that I will be available for questions on the topic (appointments via email).

Topic list

1. Brane model building
2. Flux compactifications and GKP
3. KKLT and LVS
4. Inflation in string theory:
    1. D-brane inflation
    2. closed string inflation
5. GWs from phase transitions
6. GWs from cosmic strings
7. General properties of string compactifications
8. Axions in string theory
9. Non compact throat solutions
10. Moduli Problem
11. Weak gravity conjecture
12. Distance conjecture

Brane Model Building

- Aim: Summary of D-brane constructions (in IIA, IIB, F-theory). How to get the Standard Model or extensions thereof at low energies in string theory?
- Literature: Ibanez & Uranga (Chapter 10 &11), Maharana & Palti (1212.0555)

Flux compactifications and GKP

- Aim: How do fluxes generate potential for moduli? Introduce the proposal to generate hierarchies via fluxes (GKP). What's the flux landscape (10^{500})?

- Literature: GKP (hep-th/0105097), Flux compactifications (hep-th/0610102), Ibanez & Uranga (chapter 14)

KKLT and LVS

- Aim: Introduce the two most prominent scenarios for moduli stabilisation in IIB string theory, KKLT and LVS. How do moduli get a potential? What is the associated 4D EFT?

- Literature: KKLT (hep-th/0301240), LVS (hep-th/0502058), Joseph Conlon (PhD thesis: hep-th/0611039)

Inflation in string theory

- Aim: How can a period of inflation be achieved in string theory? What are the challenges and which constructions are around?

- At least material for 2 talks:
  Short introduction of slow-roll inflation
  Introducing string inflation (chapter 4)
  Examples of string inflation (chapter 5)

- Baumann & McAllister book (CUP and 1404.2601)

GW from phase transitions

- Aim: How can a phase transition in the Early Universe lead to an observable gravitational wave background?

- Literature: Kolb & Turner (Chapter 7: Early Universe), Chiara Caprini and Figueroa (1801.04268, in particular Chapter 8), 1512.06239, 1504.07263

GWs from Cosmic strings

- Aim: What are cosmic strings (e.g. in the context of scalar field theories)? How can they produce gravitational waves? How do cosmic strings arising in string theory differ from field theory strings?

- Literature: Kolb and Turner (Early Universe), 1412.0579, 1712.05060

General properties of string compatifications

- Aim: limitations of the gauge group, matter representations, fractionally charged particles, absence of continuous global symmetries, further constraints from quantum gravity

- Literature: Ibanez & Uranga (chapter 17.1) and references therein

Axions in String Theory

- Aim: What are axions (QCD axion, axion-like particles)? How do axions appear in string theory? Mis-alignement mechanism. How to search for axions in the lab and in the sky?

- Literature: 1510.07633, 1206.0819, 0905.4720, hep-th/0602233

Non-compact throat solutions

- Aim: (Deformed) Conifold solution (with fluxes), supersymmetry breaking in the conifold, Standard Model on the throat

- Literature: Ibanez & Uranga (6.4, 14.1.3), references therein, hep-th/0112197

Moduli problem

- Aim: What are cosmological constraints on moduli fields (i.e. why do moduli have to decay before BBN or have to be too light)? What are typical masses of moduli fields?

- Literature: hep-ph/9308325, hep-ph/9308292, Coughlan et al. (1983), 0804.1073

Weak gravity conjecture

- Aim: introduce the idea of why gravity should be the weakest force.

- Literature: hep-th/0601001

Distance conjecture

- Aim: Introduce the conjecture that when moving a distance ϕ in field space an infinite tower of states becomes light.

- Literature: hep-th/0605264, 1903.06239

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