

BSM summary and literature

Wednesday, 26 July 2023 21:24

Previously

- Lessons from SM development :
 - 1) Beauty is not an economy of particle multiplicities
 - 2) Perceived prospects of experimental confirmation is not a useful criteria for what is true
 - 3) Keep an open mind
- Aesthetic / unnatural / inconsistent shortcomings of the SM
- SM EFT as a low-energy approximation to BSM theory at higher energies

Final topics

- Supersymmetry motivations :
 - Generalising symmetries
 - Calculable, less arbitrary Higgs
 - Naturalness
 - WIMP DM
 - GUTs
 - Consistency of massless amplitudes
 - Some other ways in which theoretical self-consistency limits possibilities :
 - Weinberg's soft theorems
 - Finite high energy behaviour
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Some literature on these topics (note these are all graduate-level):

BSM lecture notes

BSM Matthew McCullough - <https://inspirehep.net/literature/1684708>

BSM Andrea Wulzer - <https://arxiv.org/abs/1901.01017>

Supersymmetry Hitoshi Murayama - <https://arxiv.org/abs/hep-ph/0002232>

Papers on consistency of massless scattering amplitudes

<https://arxiv.org/abs/1709.04891>

<https://arxiv.org/abs/0705.4305>

Finiteness of energy growth of amplitudes

Chris Quigg textbook - gauge theories of the strong, weak, and electromagnetic interactions, chapter 6

Weinberg's soft theorems

Weinberg QFT textbook vol I, chapter 13.1

Conclusion / Take-home message

- The universe is a source of wonder, and we are privileged to live in a time where we are unravelling its fundamental laws.
- As Einstein said, "The most incomprehensible thing about the world is that it is at all comprehensible". It did not have to be so.
- We glean the hidden structure of reality through observation, experiment, analysis, and synthesis.
- What we find are objective, fundamental truths (validated by quantitative agreement between the theory and data) that we are discovering, not inventing.
- "Not only is the universe stranger than we think, it is stranger than we can think" - Heisenberg
- BSM is imagination in a straight-jacket; creativity constrained by experimental data and theoretical consistency.
- Have fun thinking about it!