2023 Summer School on Cosmology and Particle Physics

Monday, 31 July 2023 - Friday, 4 August 2023

CTPU PTC

Scientific Programme

□□□: Beyond the Standard Model
Basic features of Standard Model
Symmetries of SM and its extensions: massive neutrinos
Electroweak precision ad Beyond Standard Model: rho parameter and custodial symmetry.
Two Higgs Doublet Model: dark matter
Chiral symmetry and QCD effective theory
U(1)_A problem and strong CP problem
PQ mechanism and axions.
(Reference) Reviews of PDG https://pdg.lbl.gov/

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Very Short Summary of the Standard Model
Observational Evidence of Dark Matter
Relic Abundance of Dark Matter
Direct Detection of Dark Matter - Target particle recoil
Indirect Detection of Dark Matter - Cosmic rays
Direct Production of Dark Matter - Collider
New Approaches

References:
1. https://arxiv.org/abs/1605.04909 --> History
2. https://arxiv.org/abs/1703.07364 --> General w/ Models
3. https://arxiv.org/abs/1705.01987 --> General
4. https://arxiv.org/abs/1903.03026 --> Direct Detection
5. https://arxiv.org/abs/1904.07915 --> Direct Detection
6. https://arxiv.org/abs/1710.05137 --> Indirect Detection
7. https://arxiv.org/abs/1812.02029 --> Indirect Detection
8. https://arxiv.org/abs/2109.02696 --> Indirect Detection (Extension of 6)
9. https://arxiv.org/abs/1912.04727 --> Cosmology

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"Axion searches"
1. Overview of axion physics
2. Current status of axion physics
3. Experimental searches on axion
4. Astrophysical searches on axion
5. Cosmological searches on axion

Refs:
1. https://arxiv.org/abs/1812.02669 - overview 1
2. https://arxiv.org/abs/2012.05029 - overview 2
3. https://pdg.lbl.gov/2023/web/viewer.html?file=../reviews/rpp2022-rev-axions.pdf - current status 1
4. https://cajohare.github.io/AxionLimits/ - current status 2
5. https://arxiv.org/abs/1801.08127 - searches for axions 1
6. Georg G. Raffelt, “Stars as laboratories for fundamental physics: The astrophysics of neutrinos, axions, and other weakly interacting particles” (open-source: https://wwwth.mpp.mpg.de/members/raffelt/mypapers/Stars.pdf) - searches for axions 2

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Introduction to Machine Learning
Classification using neural networks
Generative models and density estimation: normalizing flows and diffusion models

review: 1908.09257, 1912.02762
Example: mapping dark matter density of the Milky Way from its stellar distribution
review: 2305.13358

General references:
David Shih's TASI lecture: https://sites.google.com/colorado.edu/tasi-2022-wiki/lecture-topics?authuser=0
HEP ML Living review: https://iml-wg.github.io/HEPML-LivingReview/