

Non-Perturbative and Topological Aspects of QCD

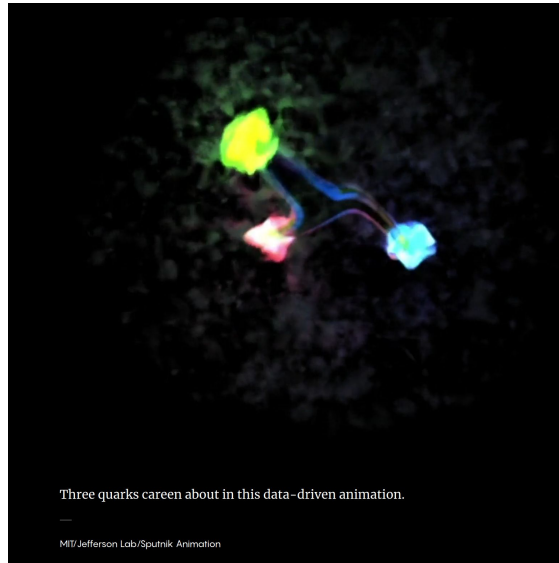
Workshop Introduction

Why This Workshop? (The part where we preach to the choir)

Why this workshop?

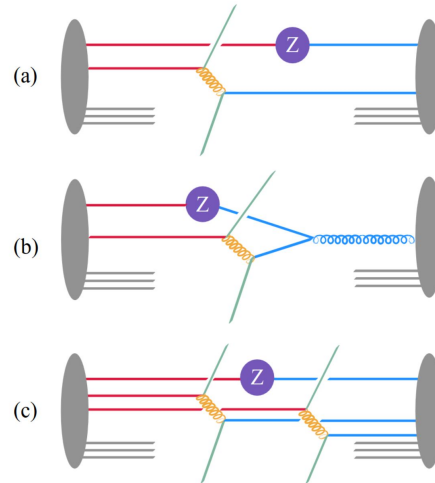
Basic Questions:

What's the structure of hadrons?



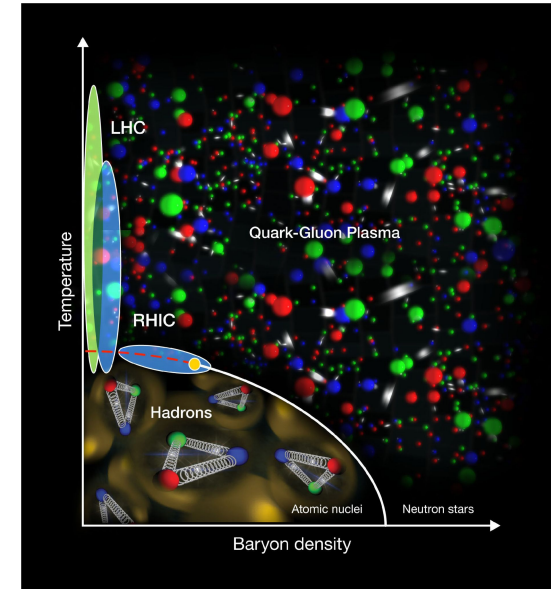
<https://www.quantamagazine.org/inside-the-proton-the-most-complicated-thing-imaginable-20221019/>

What happens when two protons collide?



<https://arxiv.org/abs/2307.05693>

What are the phases of hadronic matter?

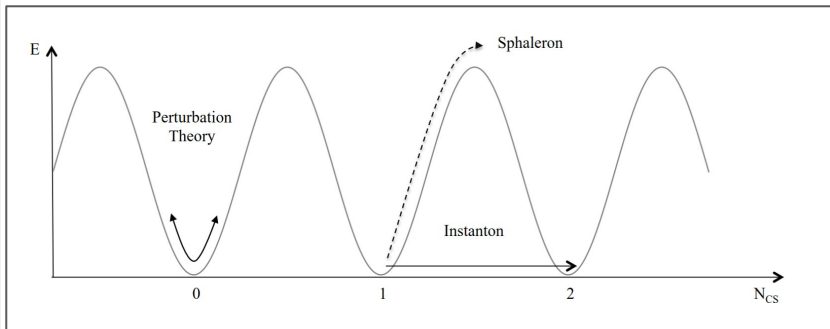


https://irfu.cea.fr/Images/astlmg/610_1.jpg 3

Why this workshop?

New areas to explore, many connections:

<https://journals.aps.org/prl/pdf/10.1103/PhysRevLett.38.1440>



<https://arxiv.org/abs/2012.09120>

CP Conservation in the Presence of Pseudoparticles*

R. D. Peccei and Helen R. Quinn†
Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 94305
 (Received 31 March 1977)

We give an explanation of the *CP* conservation of strong interactions which includes the effects of pseudoparticles. We find it is a natural result for any theory where at least one flavor of fermion acquires its mass through a Yukawa coupling to a scalar field which has nonvanishing vacuum expectation value.

It is experimentally obvious that we live in a world where *P* and *CP* are good symmetries at the level of strong interactions. In the context of quantum chromodynamics the strong interactions

grangian.
 If all fermions which couple to the non-Abelian gauge fields are massless then the various θ choices give equivalent theories.^{1,3} This is most

Topological effects, instantons

Axions

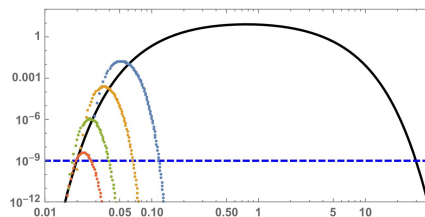


FIG. 1. The sphaleron suppression rates as a function of the sphaleron size ρ in GeV^{-1} . The solid curve corresponds to the unbroken phase $v = 0$ at $T = T_{EW}$. Four sets of points, top to bottom, are for a well broken phase, at $T = 155, 150, 140, 130$ GeV. They are calculated via Ansatz B described in Appendix C, and normalized to lattice-based rates. The horizontal dashed line indicates the Hubble expansion rate relative to these rates.

EW Sphalerons:

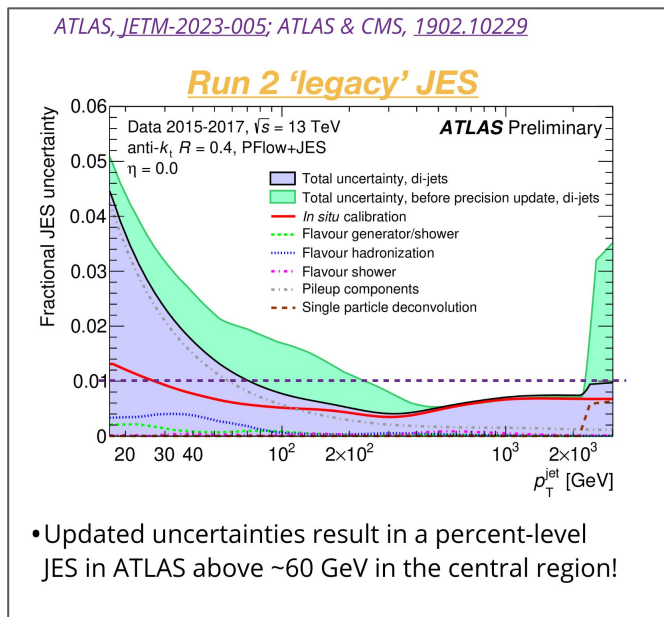
During EW phase transition?
 Matter-Antimatter Symmetry?

<https://journals.aps.org/prd/pdf/10.1103/PhysRevD.102.073003>

Why this workshop?

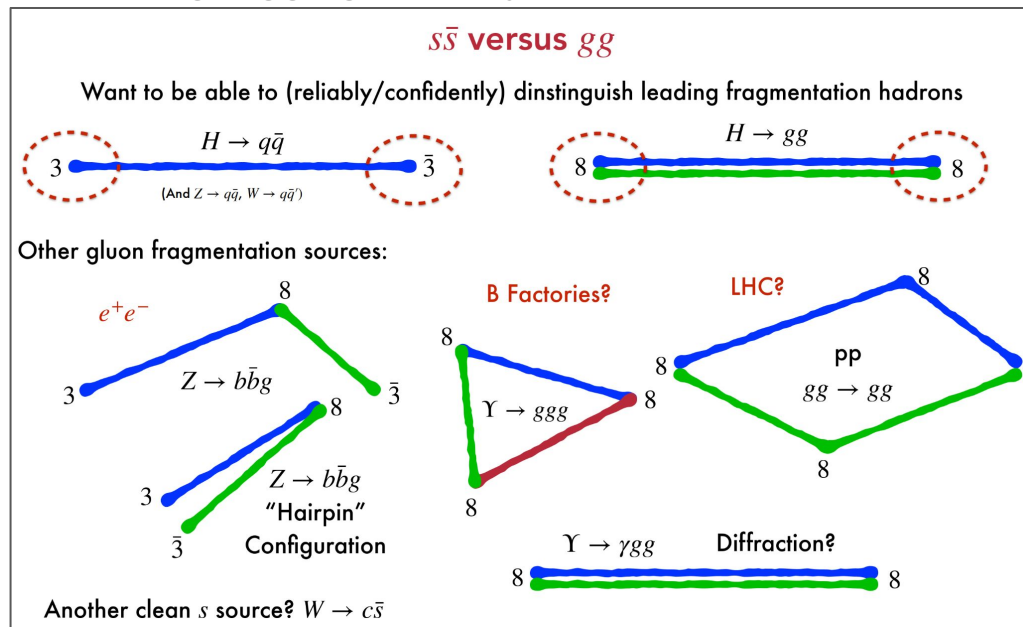
Important for improving experiments:

Improving detector calibration + response



M. LeBlanc

Improving tagging and physics reach ($H \rightarrow ss$?)



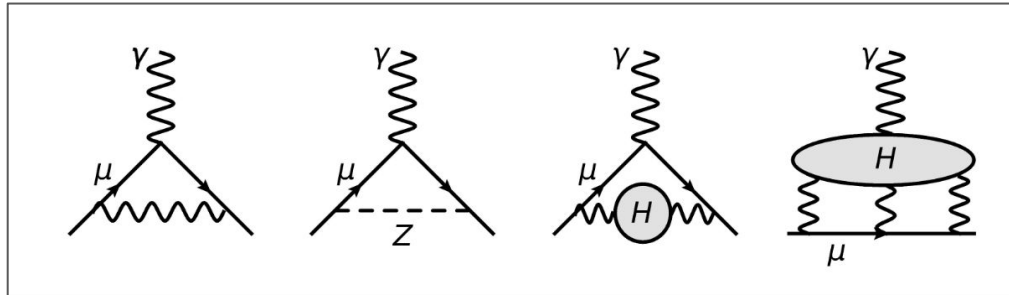
P. Skands

Why this workshop?

Important for better experiments, and understanding them better:

Even important for Electro-weak precision measurements!

<https://arxiv.org/abs/2106.06723>



<https://www.science.org/doi/10.1126/science.abk1781>

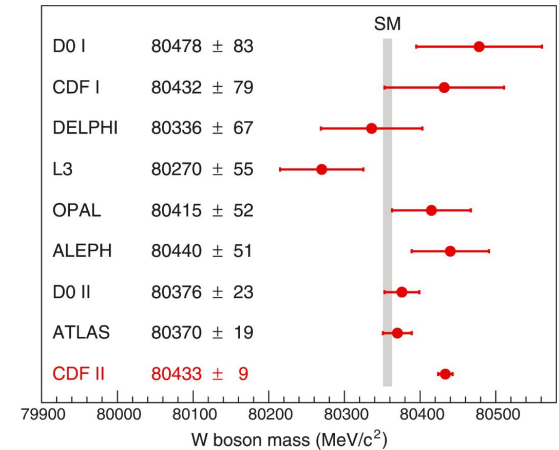


Fig. 5. Comparison of this CDF II measurement and past M_W measurements with the SM expectation.

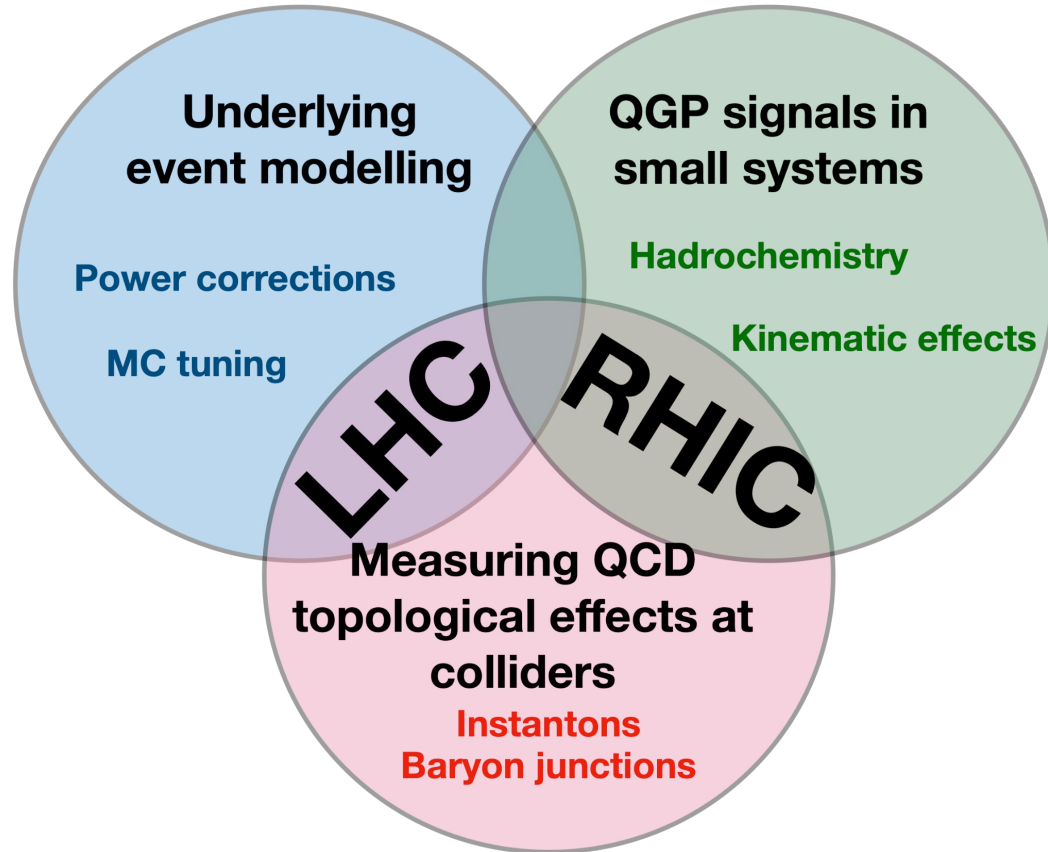
The latter includes the published estimates of the uncertainty (4 MeV) due to missing higher-order quantum corrections, as well as the uncertainty (4 MeV) from other global measurements used as input to the calculation, such as m_t , c , speed of light in a vacuum.

Why this workshop?

Many more things we cannot possibly cover in a couple of days

But let's use this time to meet, discuss, brainstorm, and start some next steps

Highly interdisciplinary workshop



Info on discussion sessions

After each session, there will be a time-slot dedicated to brainstorm

If there is any point that you would like to raise for the discussion session feel free to add it here:

<https://docs.google.com/document/d/1-C-IRZ-esSvHPBlyHIn1haIAYY3JQOQOL83t9puJiaQ/edit?usp=sharing>

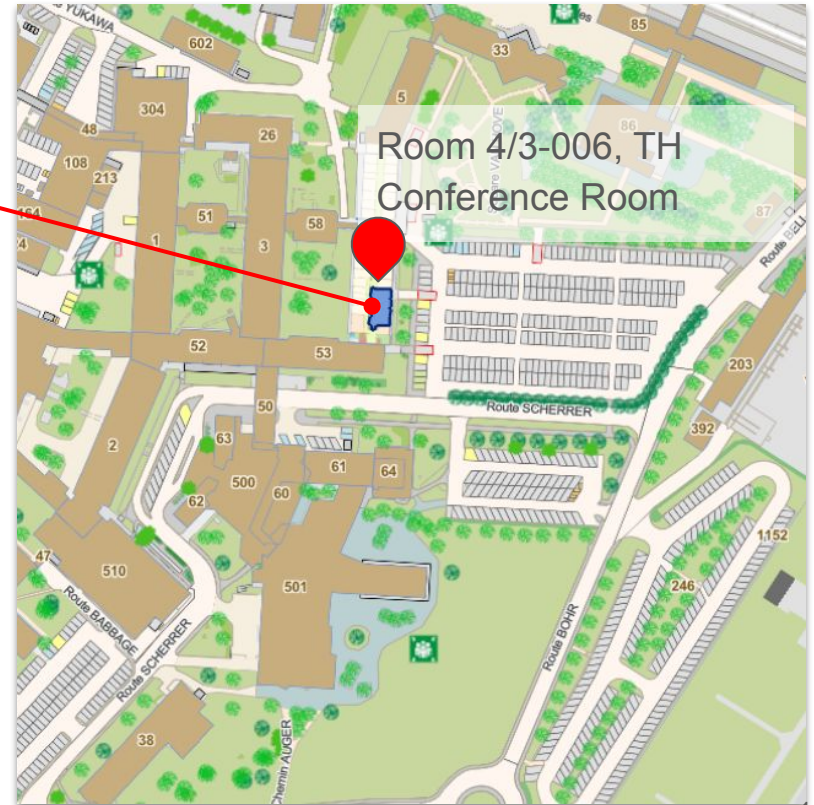
Concrete questions for the speakers are also welcome (even anonymously)

Practical Information

You are here at CERN

Unless you are on [Zoom](#)

Coffee breaks in CERN theory
break room on 2nd floor



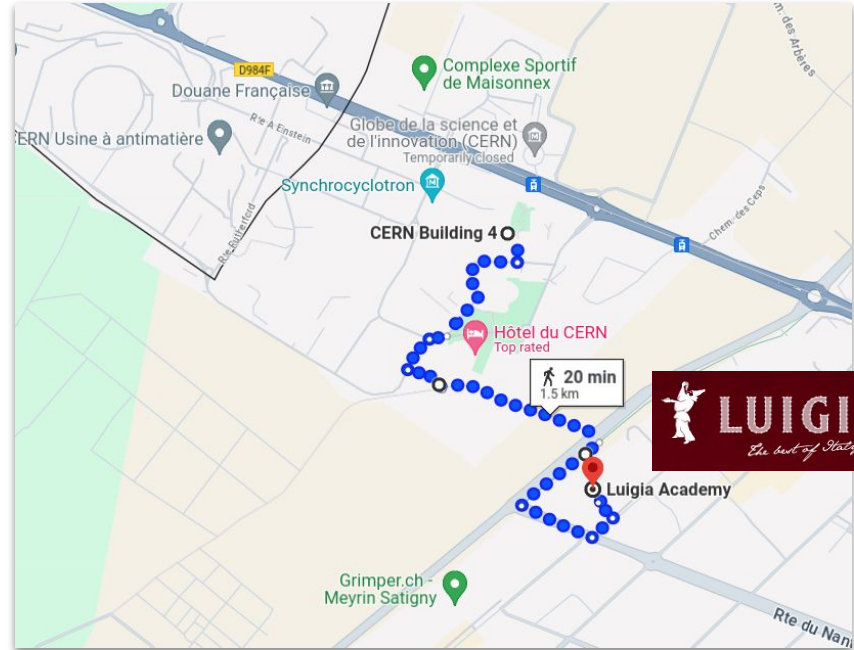
Social Dinner Info

7 pm, Thursday @ Luigia Academy
(a classic for CERN workshops)

[Menu](#)

[Google Maps directions](#)

Most convenient to exit CERN via
Route Maxwell (right figure) or
Route Bell [[CERN Maps](#)]



Social Dinner Info

If you'd like to join, **please fill out this newdle poll today**, by indicating that you are available in that time slot

<https://newdle.cern.ch/newdle/SC8pDvT9>

This page is personal and its URL should not be shared. Please use the shareable link above to share the newdle with others.

K Kyle Cormier

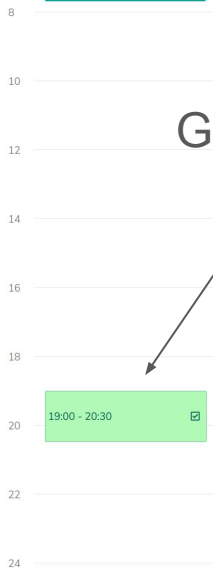
May 2024

| Mo | Tu | We | Th | Fr | Sa | Su |
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| 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 27 | 28 | 29 | 30 | 31 | | |

Accept all options where I'm available

Europe/Zurich

Thursday 30 May



Green = yes, I'll come

Click here to confirm response

1 out of 1 option chosen

Leave a comment...

Update your answer

Any Questions:



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