

# **Snowmass 2021, EF09/10 joint meeting on dark showers**

## **Report of Contributions**

Contribution ID: 2

Type: **Short contribution**

## Collider and Cosmic ray search for stable multiple charged constituents of dark atoms

*Thursday, 13 August 2020 11:25 (5 minutes)*

Composite Higgs boson models can provide possible solution for SM problem of Higgs mass divergence and origin of electroweak symmetry breaking. Higgs boson constituents can bind in stable multiple charged particles (like technibaryons or technileptons in Walking Technicolor approach). Stable  $-2n$  charged particles excess over their antiparticles results in formation of dark atoms in which such particles are bound with  $n$  He nuclei after BBN and which can play the role of a specific form of strongly interacting dark matter, which can provide solution for the puzzling contradiction in positive results of DAMA group and negative results of other experiments in direct underground search for dark matter. These multiple charged particles have no QCD interaction and thus have signatures of multiple charged stable leptons, offering new strategy for collider studies of dark matter. Accelerated in the Galaxy these particles will lead to specific type of Extensive Air Showers, challenging their search in LHAASO experiment. Combination of collider and cosmic ray studies can provide test for this hypothesis.

### References:

- M.Yu.Khlopov. Dark atom solution for puzzles of direct dark matter searches. IOP Conf. Series: Journal of Physics: Conf. Series 1312 (2019) 012011; doi:10.1088/1742-6596/1312/1/012011
- M.Yu.Khlopov. Cosmoparticle physics of dark matter. EPJ Web of Conferences V. 222, 01006 (2019) Proceedings of QFTHEP2019. E-Print: arXiv:1910.12910; <https://doi.org/10.1051/epjconf/201922201006>
- M.Yu.Khlopov. Removing the conspiracy of BSM physics and BSM cosmology. International Journal of Modern Physics D Vol. 28 (2019) 1941012 (16 pages); DOI: 10.1142/S0218271819410128
- M.Yu.Khlopov Conspiracy of BSM physics and cosmology. Bled Workshops in Physics, V.20 PP.21-35 (2019) e-Print: arXiv:1911.03294.
- V.Beylin, M.Khlopov, V.Kuksa, N.Volchanskiy, Hadronic and Hadron-Like Physics of Dark Matter. Symmetry 11(4), 587 (2019); <https://doi.org/10.3390/sym11040587>. e-Print: arXiv:1904.12013.

**Primary author:** KHLOPOV, Maxim (APC/MEPHI/SFEDU)

**Session Classification:** Contributed ideas

Contribution ID: 3

Type: **Short contribution**

## Benchmark Models for Inclusive Dark Shower Searches

*Thursday, 13 August 2020 11:55 (5 minutes)*

I will talk about work in progress with Simon Knapen and Dong Xu on benchmark model building to support a proposed inclusive search strategy for dark shower searches. We discuss the relevant signature space, with particular focus on production through low-mass portals such as the Higgs boson. We plan to publish a Monte Carlo repository containing several selected benchmark models as part of the project.

**Primary author:** Prof. SHELTON, Jessie (UIUC)

**Presenter:** Prof. SHELTON, Jessie (UIUC)

**Session Classification:** Contributed ideas

Contribution ID: 4

Type: **Expression of interest / thoughts**

## Expression of interest

I am interested in understanding the complementarity of various analyses (dijet, emerging jets, semi-visible jets, monojet...) exploring dark QCD, possibly in the plane of prompt-displaced vs invisible fraction. It would be helpful to agree on some benchmarks models, and link to both the LHC WG on DM and LLP.

I can do generator-level studies in that respect.

**Primary author:** GENEST, Marie-Hélène (LPSC-Grenoble, CNRS/UGA (FR))

Contribution ID: 5

Type: **Expression of interest / thoughts**

## Pythia8: Dark Showers and community input

*Thursday, 13 August 2020 12:25 (20 minutes)*

The Hidden Valley (HV) scenario was developed in Pythia8 to allow the study of visible consequences of radiation in a hidden sector. Furthermore, the complications of hadronization within the Lund string model were addressed. This demonstrates that Pythia8 is flexible enough to handle such models. A dialogue between BSM theorists and event generator practitioners could lead to an accord that would allow the implementation of such models in a streamlined way.

**Primary author:** MRENNNA, Stephen (Fermilab)

**Session Classification:** Discussion

Contribution ID: 6

Type: **Short contribution**

## Exploring Jet Substructure in Semi-visible jets

*Thursday, 13 August 2020 11:45 (5 minutes)*

In this work, several jet substructure observables have been examined to compare semi-visible jets and light quark/gluon jets. These comparisons were performed using different dark hadron fraction in the semi-visible jets (signal). The extreme scenarios where signal consists either of entirely dark hadrons or visible hadrons offers a chance to understand the effect of the specific dark shower model employed in these comparisons. We attempt to decouple the behaviour of jet-substructure observables due to inherent semi-visible jet properties, from model dependence owing to the existence of only one dark shower model.

**Primary authors:** KAR, Deepak (University of Witwatersrand); SINHA, Sukanya (University of Witwatersrand)

**Presenter:** KAR, Deepak (University of Witwatersrand)

**Session Classification:** Contributed ideas

Contribution ID: 7

Type: **Short contribution**

## Pythia8 plug-in for strongly coupled dark showers

*Thursday, 13 August 2020 12:05 (5 minutes)*

I will present a pythia 8 plugin which generates events for strongly coupled, quasi-conformal hidden valleys, also known as “soft bombs” or “Soft Unclustered Energy Patterns (SUEP)”. The code can be extended easily to handle other dark showers that are currently not yet included in pythia 8.

**Primary authors:** KNAPEN, Simon (Lawrence Berkeley National Lab and UC Berkeley); PAGAN GRISO, Simone (Lawrence Berkeley National Laboratory)

**Presenter:** KNAPEN, Simon (Lawrence Berkeley National Lab and UC Berkeley)

**Session Classification:** Contributed ideas

Contribution ID: 8

Type: **not specified**

## Overview of dark shower landscape

*Thursday, 13 August 2020 11:05 (20 minutes)*

**Primary author:** COHEN, Tim (University of Oregon)

**Presenter:** COHEN, Tim (University of Oregon)

**Session Classification:** Introduction



Contribution ID: 9

Type: **Expression of interest / thoughts**

## Evidence for dark gluon bremsstrahlung in three dark showers event

*Thursday, 13 August 2020 11:35 (5 minutes)*

Exporting dark QCD via different portal models at the LHC is an exciting prospect. As we known, the dark gluon( $g_v$ ) is an indispensable ingredient in dark QCD. However, the popular two dark showers event with two dark quarks ( $q_v\bar{q}_v$ ) in the final state cannot directly look for the evidence of dark gluon at the LHC. Inspired from the  $e^+e^- \rightarrow q\bar{q}g$  process at lepton colliders for the three jet event, we propose to search the three dark showers event ( $q_v\bar{q}_vg_v$ ) at the LHC for the evidence of dark gluon. Furthermore, the three dark showers event may also indicate the spin of dark gluon via the type of Ellis–Karliner angle and distinguish the production mode either from s-channel portal or t-channel portal.

**Primary authors:** LU, Chih-Ting (KIAS); Prof. CHEUNG, Kingman (NTHU); Mr CHENG, Po-Jen (NTHU); HSU, Shih-Chieh (University of Washington); Mr CHUNG, Yi-Lun (NTHU)

**Presenter:** LU, Chih-Ting (KIAS)

**Session Classification:** Contributed ideas

Contribution ID: **10**

Type: **not specified**

## **Introduction to the meeting and to the Snowmass SEC EF10 liaisons**

*Thursday, 13 August 2020 11:00 (5 minutes)*

**Primary authors:** KULKARNI, Suchita; BALUNAS, William (University of Oxford)

**Presenters:** DOGLIONI, Caterina (Lund University); WANG, Liantao (University of Chicago); PANGAN GRISO, Simone (Lawrence Berkeley National Laboratory); KULKARNI, Suchita; BOSE, Tulika (University of Wisconsin-Madison); BALUNAS, William (University of Oxford); LIU, Zhen (University of Maryland)

**Session Classification:** Introduction

Contribution ID: 12

Type: **not specified**

## Discussion points

*Thursday, 13 August 2020 12:45 (20 minutes)*

**Session Classification:** Discussion