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

Short contribution to EF09/EF10 meeting on dark showers

13 August 2020

Machine learning enhanced Multi-messenger Probes for New Physics and Cosmology in the LHAASO experiment

Maxim Khlopov

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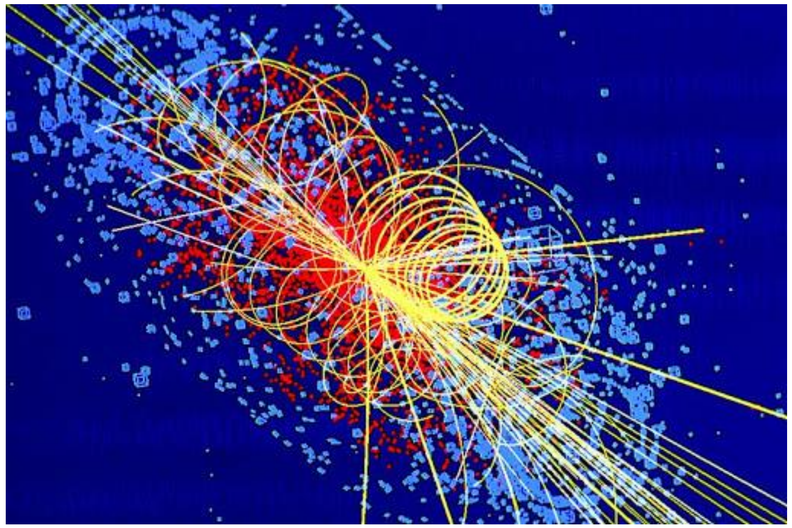
A research project involving two international teams from SFEDU (M. Khlopov) and Fudan University (A. Marciano), including K. Belotsky, V.Beylin, V,Kuksa, V.Korchagin, A,Mayorov, et al from SFEDU part
Z. Berezhiani, S. Giagu, R. Pasechnick, A. Morais, G. Di Sciascio, F. Fabrocini, et al. from Fudan University part

Snowmass 2021, EF09/10 joint meeting on dark showers, 13th August 2020

Higgs composite models



No SUSY particles and no WIMPs as dark matter @ LHC

Higgs mass divergence and origin of electroweak symmetry breaking

Composite Higgs boson models as a solution to these SM problem

Technibaryons & technileptons in Walking Tachnicolor

Higgs boson constituents can bind in stable multiple charged particles.

Stable multiple charged constituents of dark atoms

Stable -2n charged particles excess over their antiparticles

Formation of dark atoms with dark constituents bound with n He nuclei after BBN

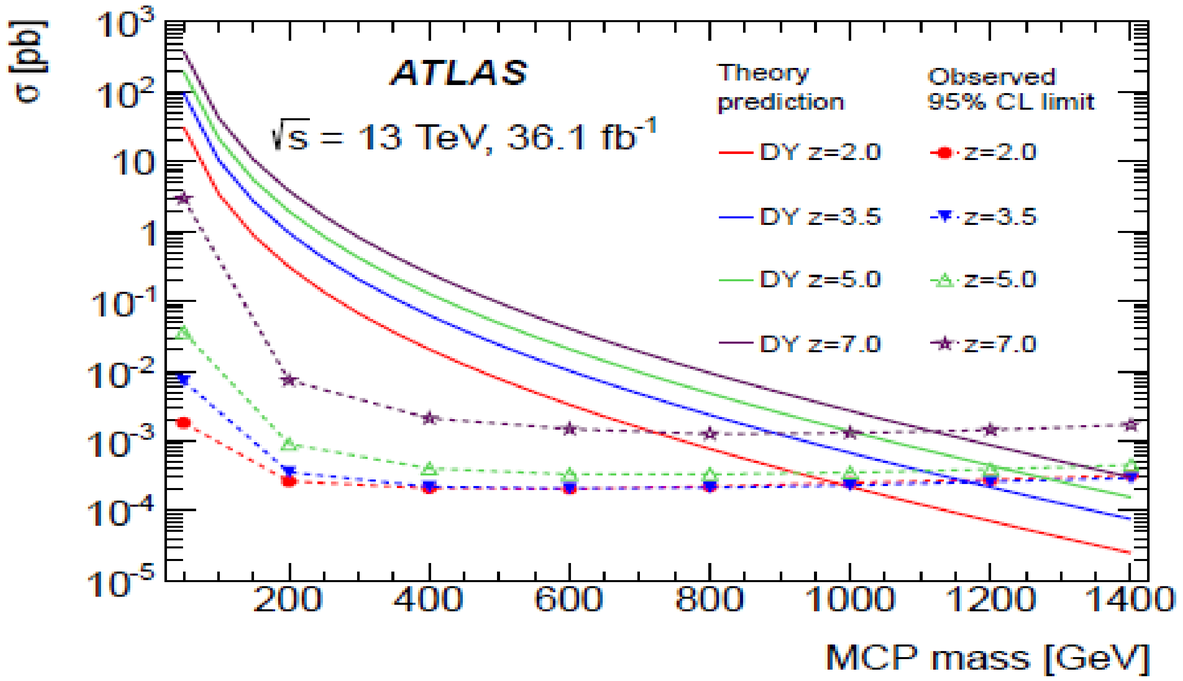
Can play the role of a specific form of strongly interacting dark matter

Direct underground search for dark matter

A solution for puzzling contradictions: positive DAMA results vs other groups negative results

Snowmass 2021, EF09/10 joint meeting on dark showers, 13th August 2020

Searches for multiple charged particles in ATLAS experiment



M>980 GeV
for |q|=2e
at 95% c.l.

[ATLAS Collaboration, Search for heavy long-lived multi-charged particles in proton-proton collisions at √ s= 13 TeV using the ATLAS detector. Phys. Rev. D 99, 052003 (2019)

Experimentum crucis for composite dark matter at the LHC

Coming analysis of results of double charged particle searches at the LHC can cover all the range of masses, at which composite dark matter can explain excess of positron annihilation line in Galactic bulge,

|q|/e	z										
	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
Lower mass limit [TeV]	0.98	1.06	1.13	1.17	1.20	1.22	1.22	1.21	1.19	1.16	1.12

Composite dark matter can explain excess of low energy positrons at M=1.25 TeV and high energy positrons at M<1 TeV. The latter is already excluded for double charged constituents.

[ATLAS Collaboration, Search for heavy long-lived multi-charged particles in proton-proton collisions at $\sqrt{s}$= 13 TeV using the ATLAS detector. Phys. Rev. D 99, 052003 (2019)

Multi-messenger approach & LHAASO

Combination of collider and cosmic ray channels provide a test for this hypothesis

Multiple charged particles with no QCD interaction

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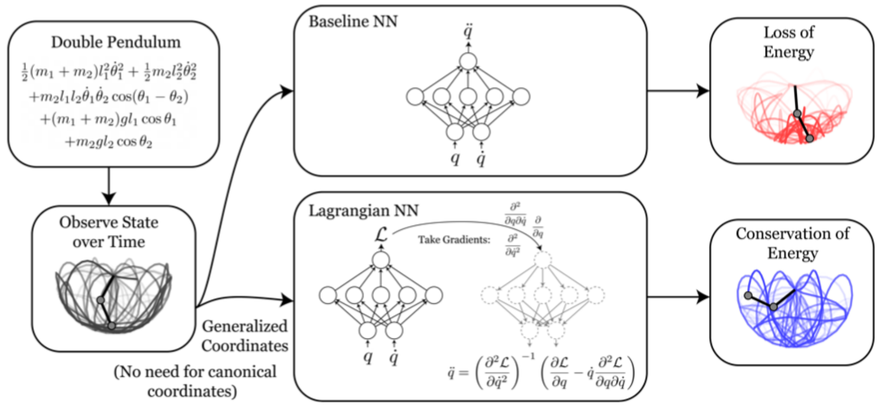
signatures of multiple charged stable leptons: a new strategy for collider studies of dark matter

Galactic acceleration andVHECR: extensive Air Showers (LHAASO)

Machine Learning analysis for LHAASO

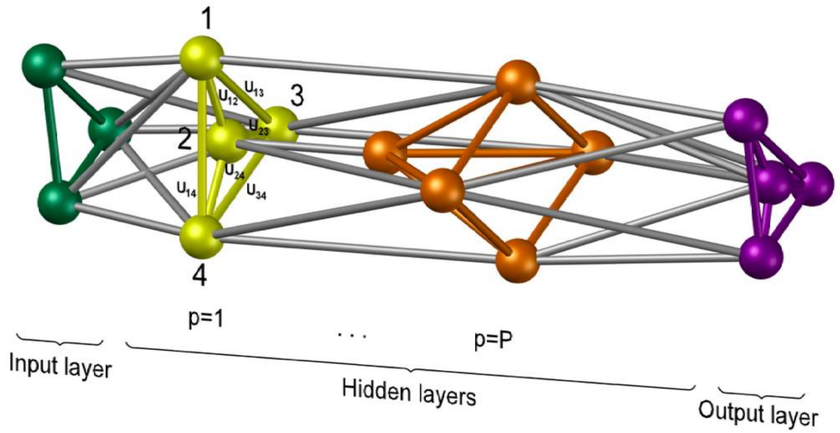


1. Deep Learning approach to simulate nuclear reactions in any energy regime;

2.Assessment of hadronic models for air-shower reconstructions in VHECR observations, i.e. Sybil 2.3c, QGSJet II-04 and EPOS-LHC;

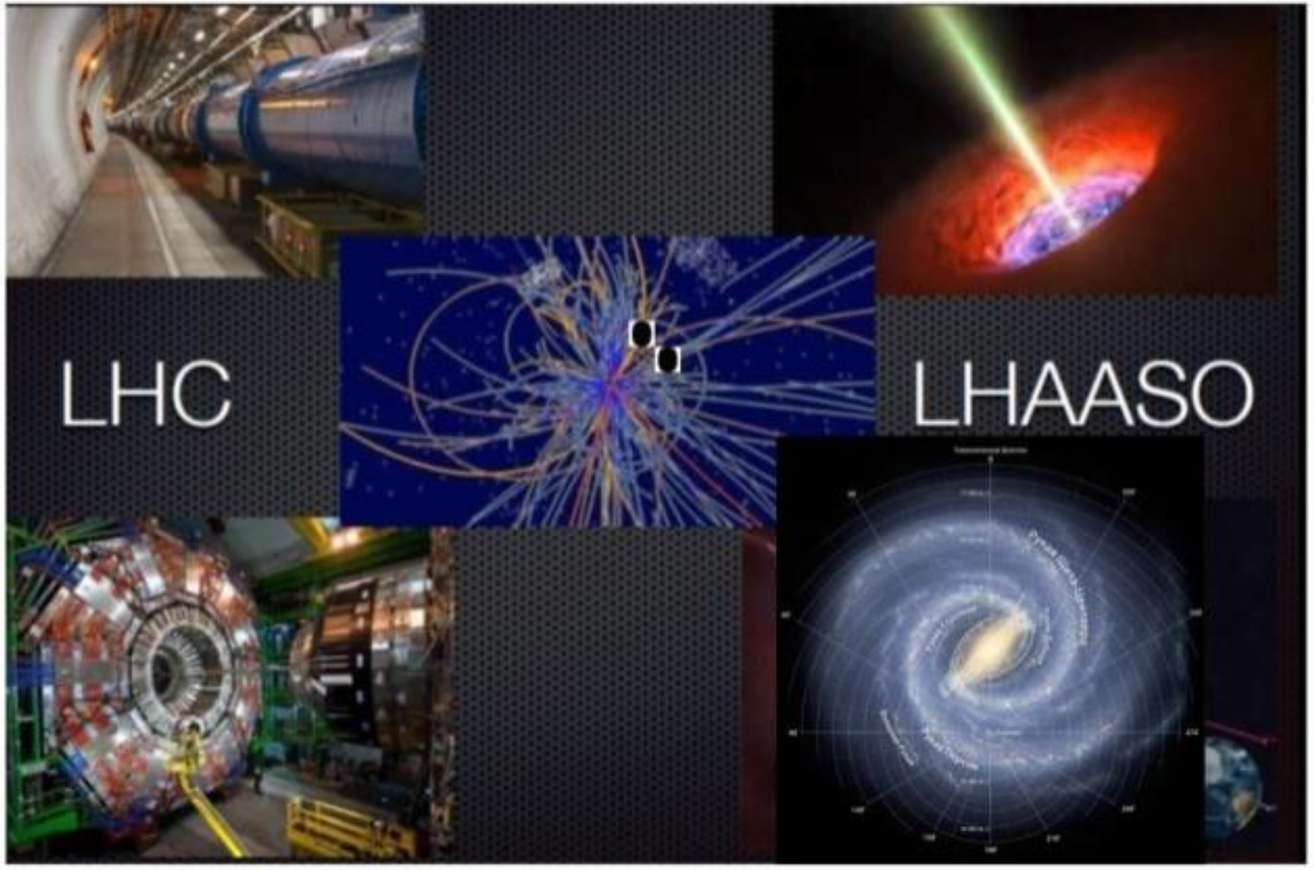
3. Scan of the output space with deep neural networks based on graph-neural network (e.g. classification and regression of hadronic showers (jet) of @ LHC).

Graph Neural Net-work (GNN) techniques to enhance sensitivities through machine learning, while maintaining the transparency of the involved section processes



Interface model building and Monte-Carlo software tools while applying DL techniques: combine all available theoretical and phenomenological information.

Laboratory of Cosmoparticle studies of structure and dynamics of The Galaxy



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Main areas of research:
Theoretical and Particle Physics, Gravitational Physics, Cosmology and Astroparticle Physics, Topological Quantum Field Theory and Quantum Neural Networks

Scientific collaborations
@VIP, LHAASO
Editor
@Universe, Frontiers in Physics, SYMMETRY

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