

FUNDAMENTAL PHYSICS:
AN UNPARALLELED SANDBOX FOR
AI AND MODERN MACHINE LEARNING

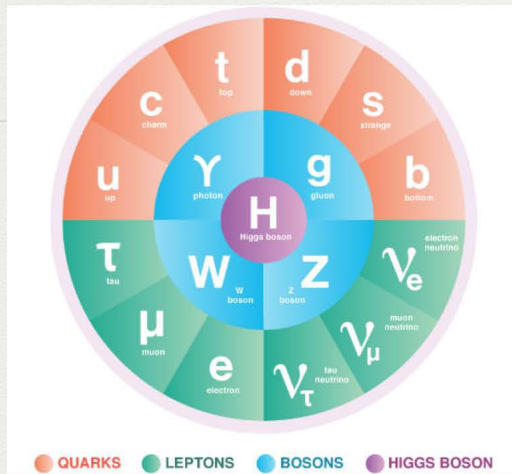
RAD Collaboratory Lightning Talk

David Shih
April 8, 2025

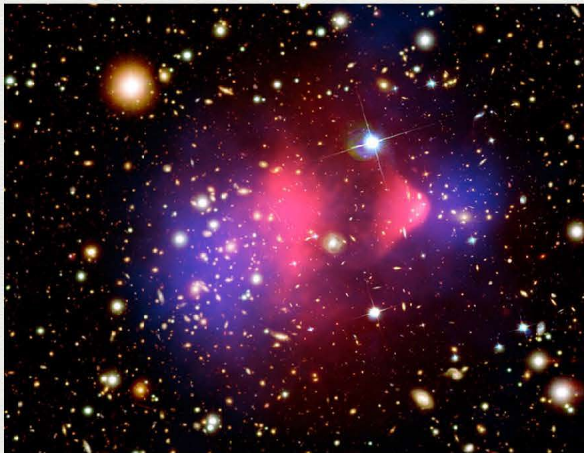


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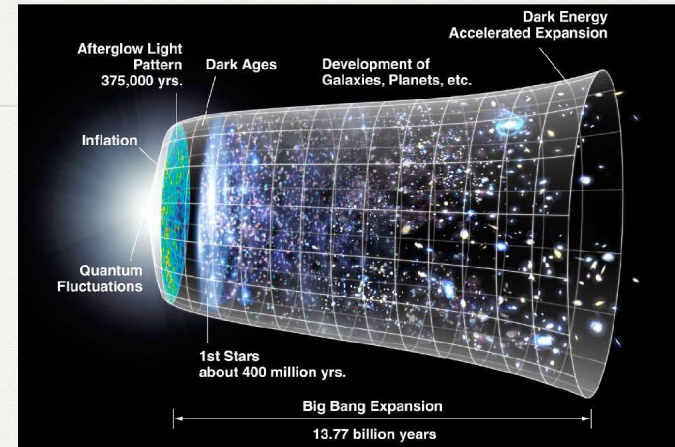
What is Fundamental Physics?



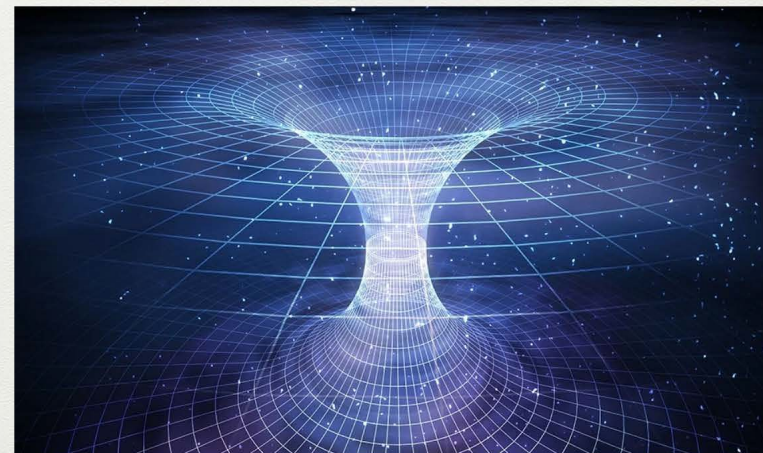
What is the nature of fundamental matter and interactions?



What are dark matter and dark energy?

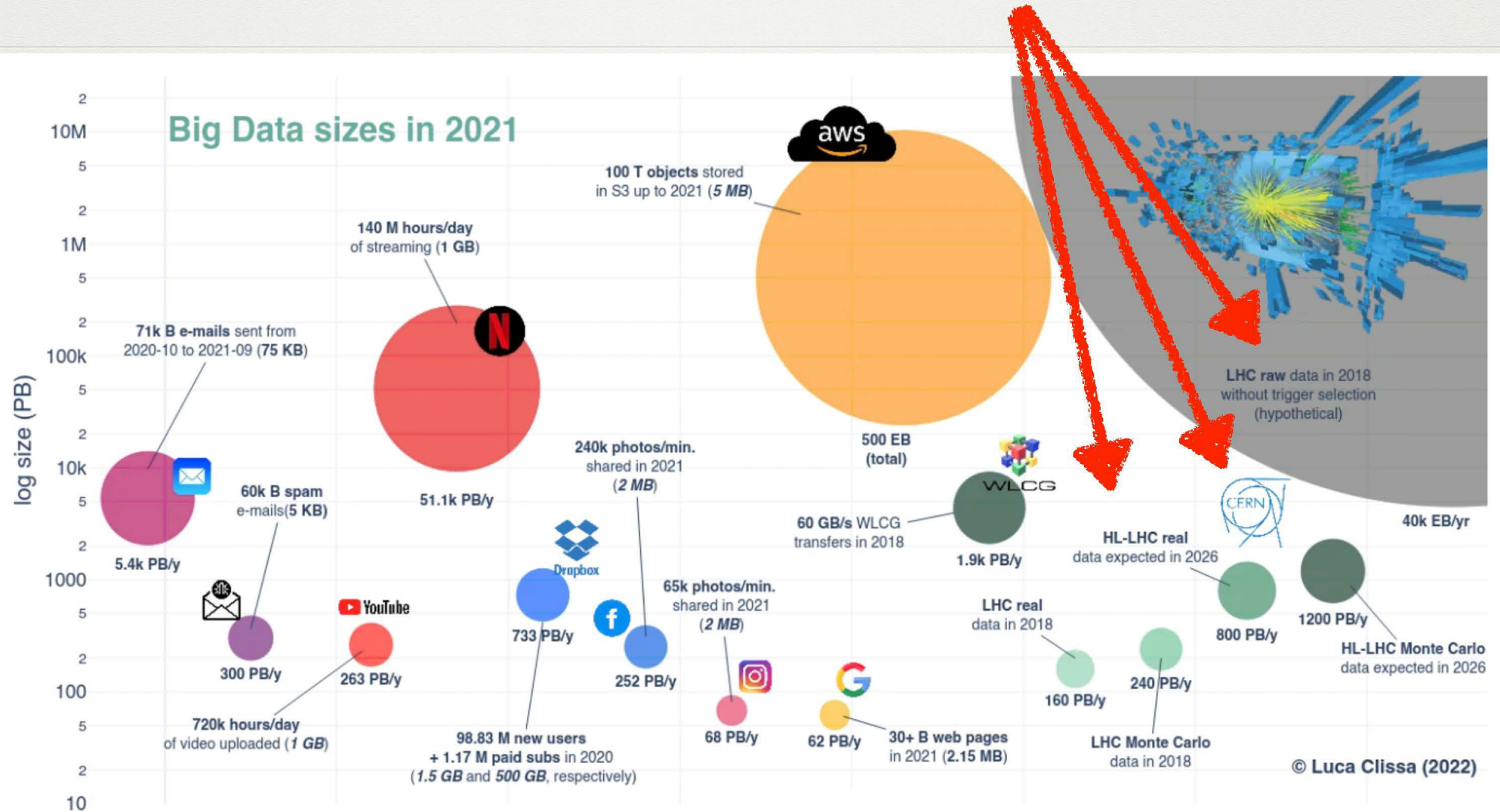


What are the origins of the Universe?

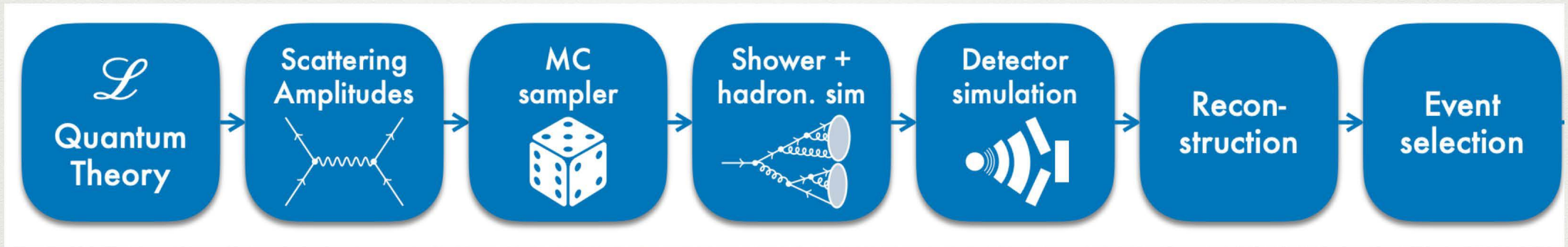


How can gravity and quantum mechanics be unified?

Fundamental Physics Data is Extremely Large and Complex

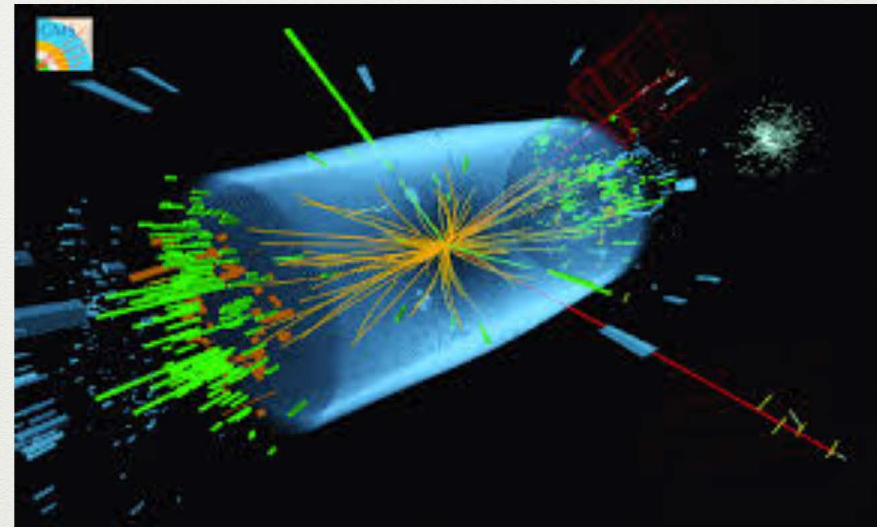


Ready Availability of High Quality, Open-source Simulations



**Fundamental Physics:
an ideal playground for
advanced AI/ML techniques!**

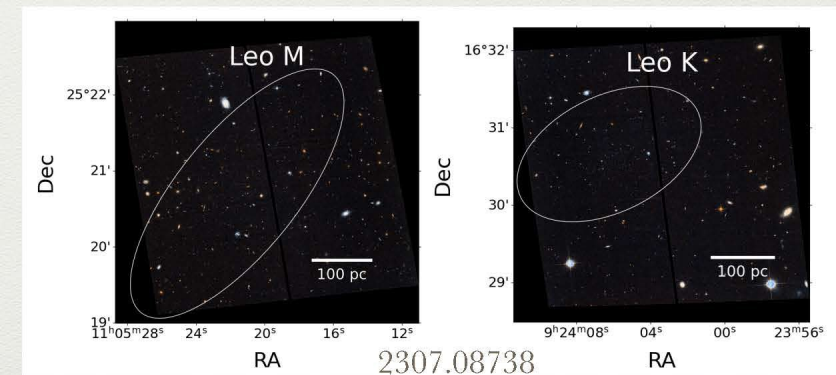
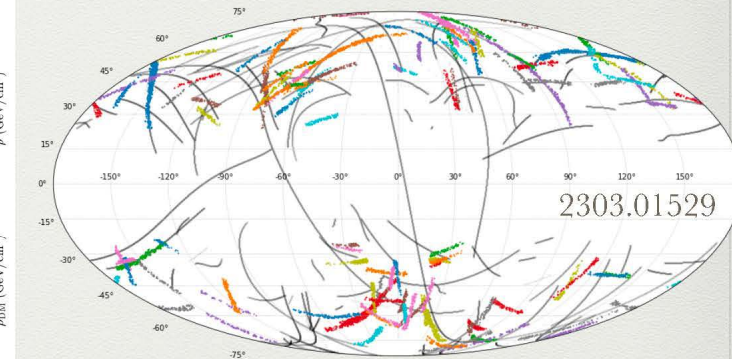
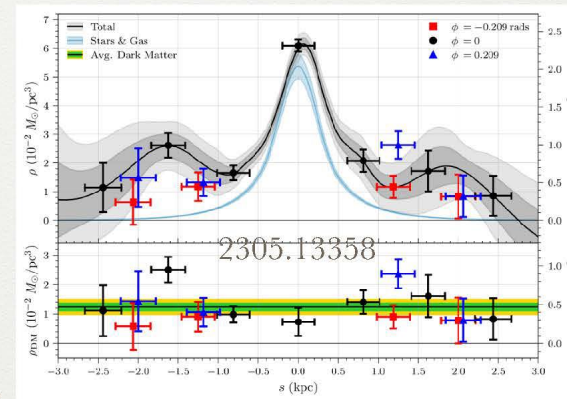
“ML4HEP”



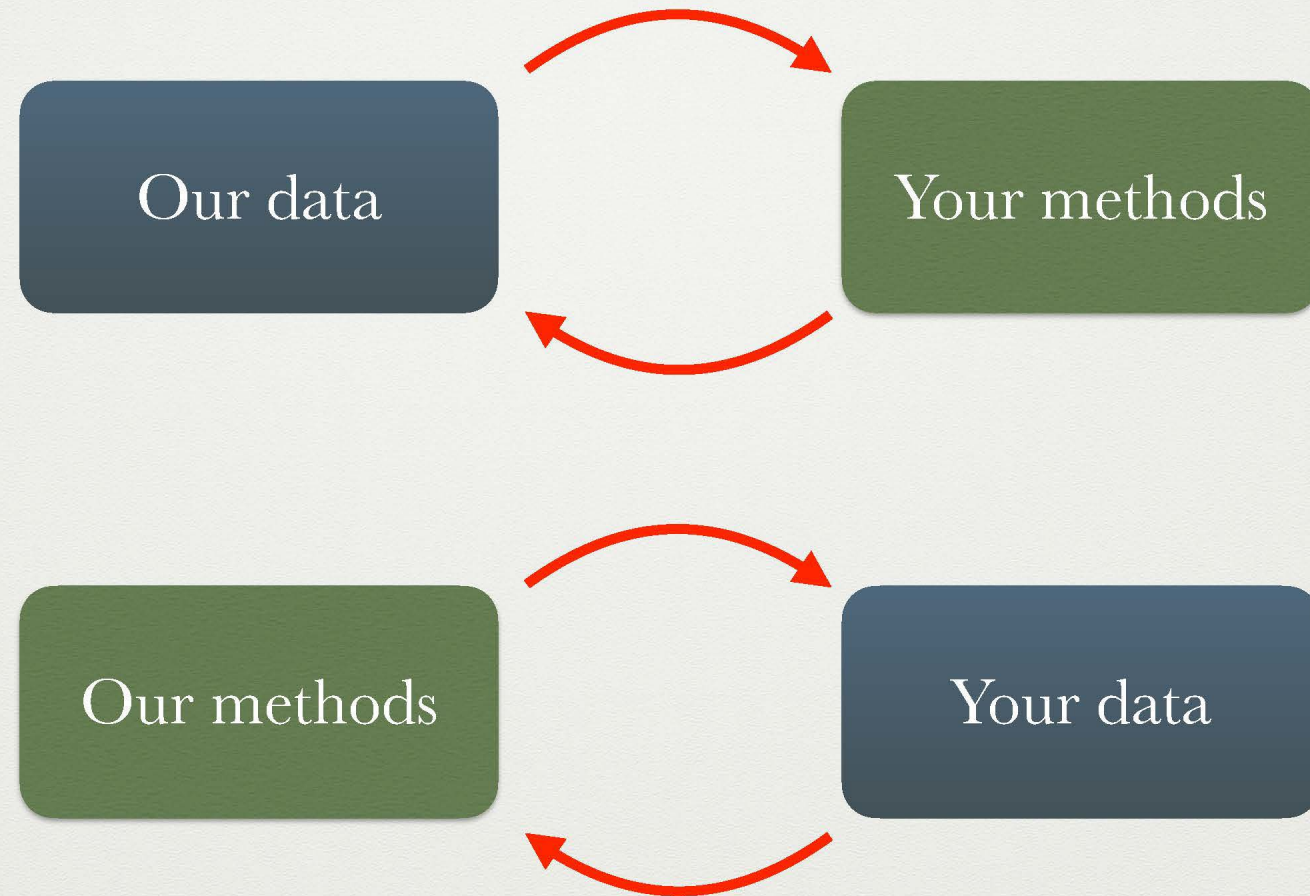
Rutgers: A World Leader in ML4HEP

- Here at Rutgers, we are a world-leader in the rapidly growing ML4HEP subfield.

- Anomaly Detection
- Surrogate Modeling
- Simulation Based Inference
- Foundation Models
- Interpretability, Robustness, AI Fairness
- ...



Many Opportunities for Collaboration!



Resources

- **HEP-ML Living Review**
<https://iml-wg.github.io/HEPML-LivingReview/>
- **LHC Olympics 2020 Anomaly Detection Data Challenge**
<https://arxiv.org/abs/2101.08320>
<https://doi.org/10.5281/zenodo.2629072>
- **Fast Calorimeter Simulation Data Challenge**
<https://arxiv.org/abs/2410.21611>
<https://calochallenge.github.io/homepage/>
- **AspenOpenJets: 150M jets from CMS OpenData**
<https://arxiv.org/abs/2412.10504>
<https://www.fdr.uni-hamburg.de/record/16505>

Come find me if you're interested!