

Machine Learning Steps Towards Training Happiness

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G. Watts (University of Washington/Seattle)

Schedule

- Today
 - ML's relationship to Science
 - Intro of Machine Learning (this)
 - Quick guided demo of ML using the JAX framework
 - Tutorial: Signal and Background Separation in $H \rightarrow WW \rightarrow 2\ell 2\nu$
- Tomorrow
 - The Data Pipeline
 - More formal introduction to neural networks and advanced applications
 - Auto Encoders
 - Tutorial: Auto Encoder with HEP data

How does Machine Learning
and other topics in this
training connect to Scientific
Discovery?

Christopher Tunnell (Rice)
21-May-2024
Delhi University

Discovery through the Ages

Empirical Observations

History of "Light Matter"

Mathematical Modeling

The First "Dark Matter"

Numerical Methods

Dark Matter's N-Body Evidence

Data-Intensive Science

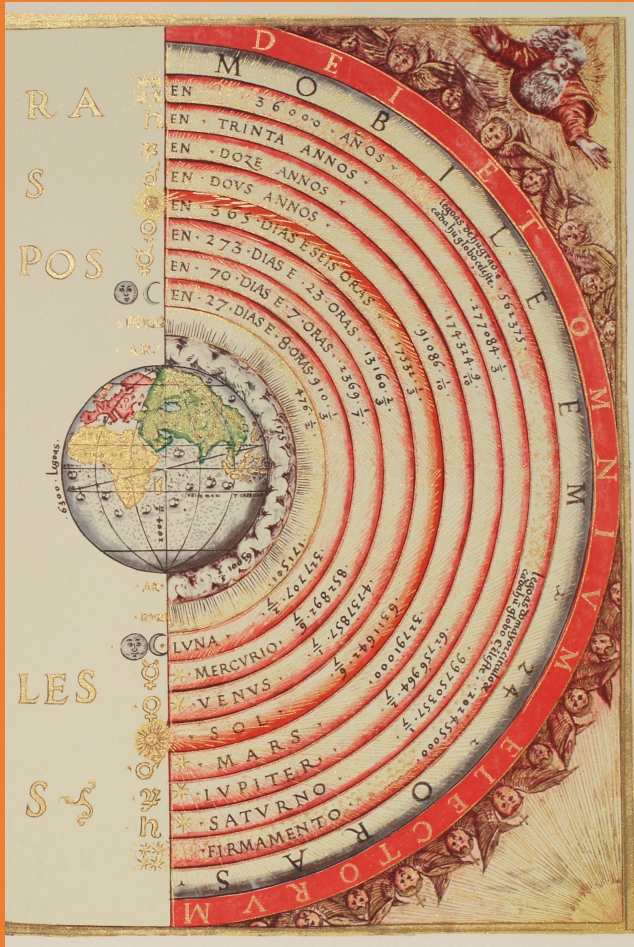
Challenging Dark Matter theory with XENON

AI-Enabled Science

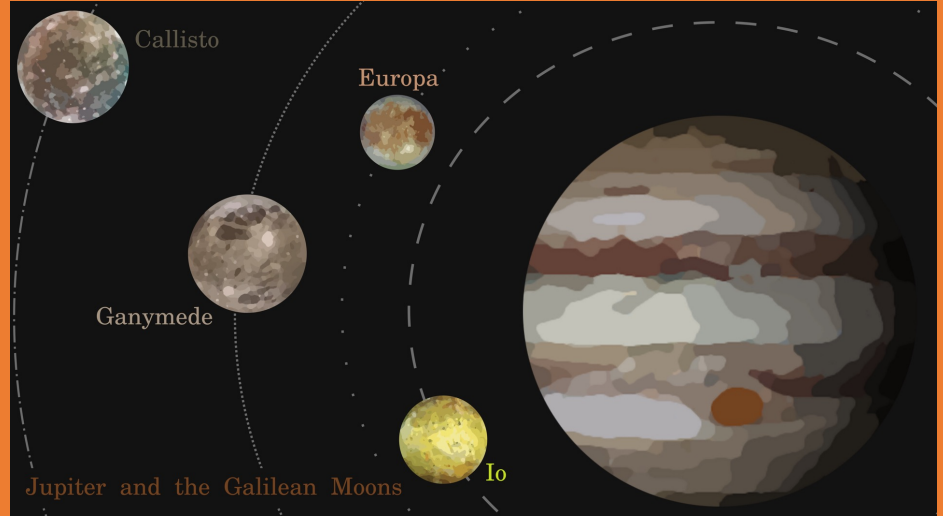
What goes here?

1st Paradigm: Empirical Observation

2c-16c. earth-centric cosmology



"Light Matter"



Galileo



Discovery through the Ages

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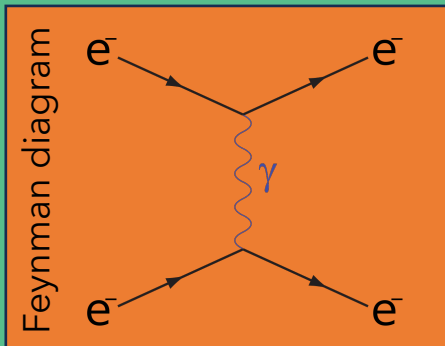
Mathematical Modeling

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2nd Paradigm: Mathematical Modeling

$$F = ma$$

$$\hat{H}|\Psi\rangle = E|\Psi\rangle$$



Paradigms of Discovery

Empirical Observations

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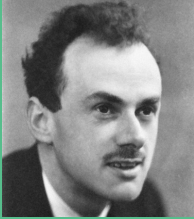
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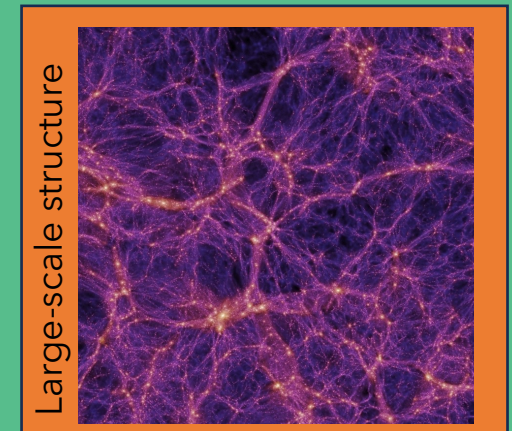
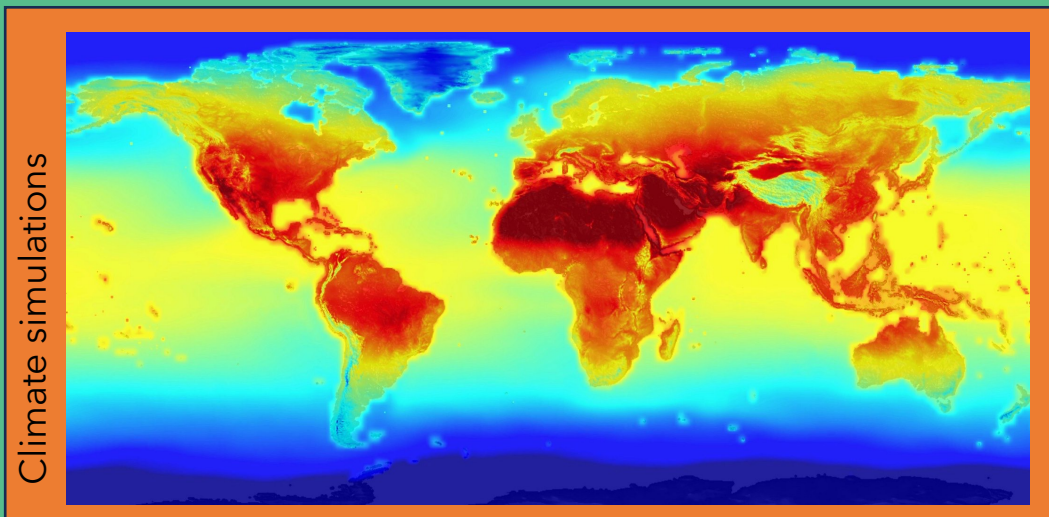
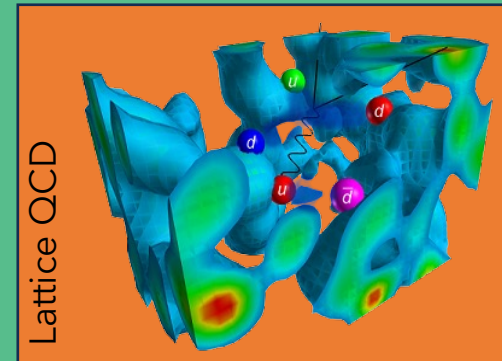
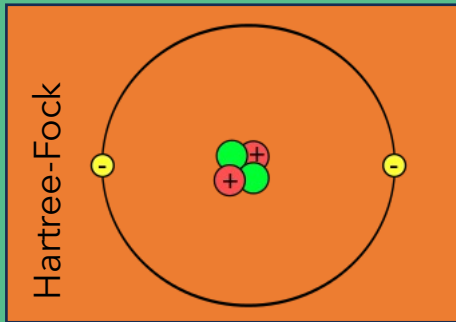
Numerical Methods

Dark Matter's N-Body Evidence

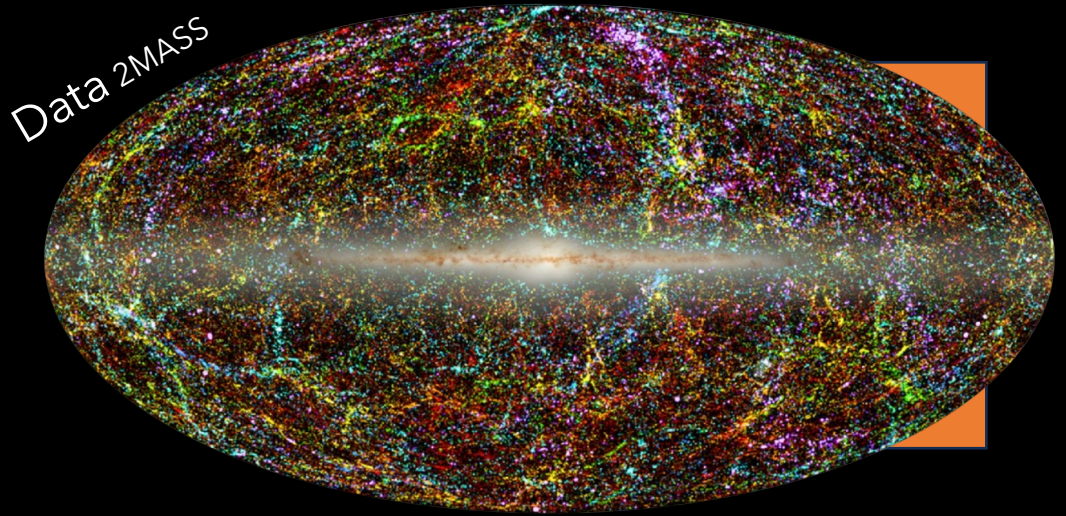
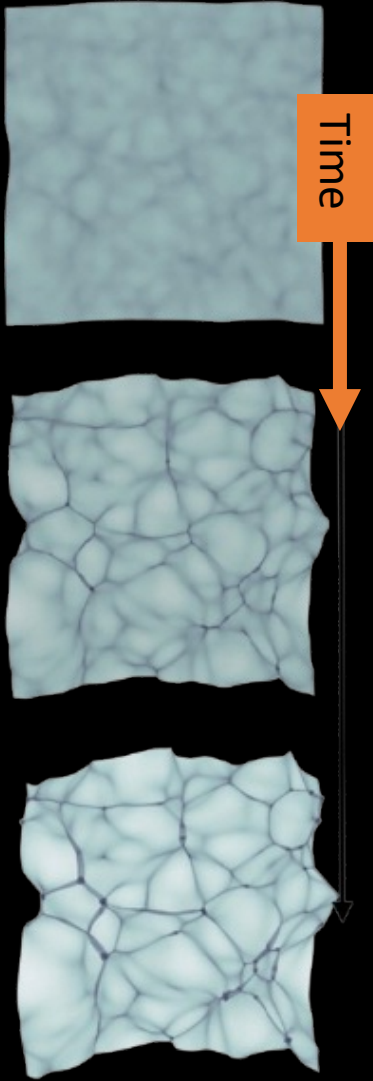
3rd Paradigm: Numerical Methods



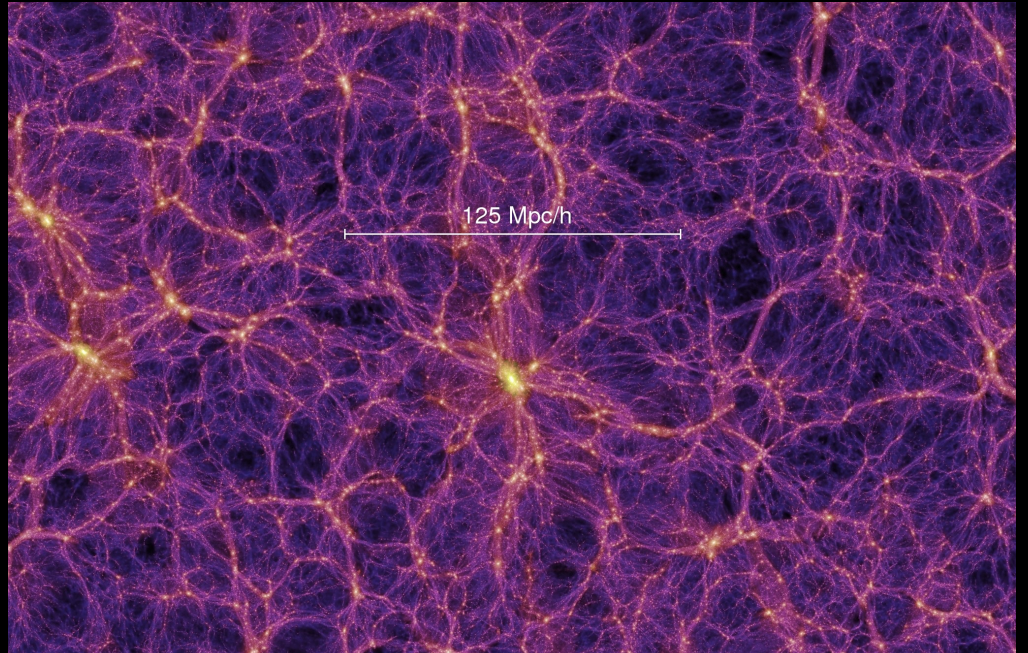
"The underlying physical laws necessary for the mathematical theory of the whole of chemistry are thus completely known, and the difficulty is only that the exact application of these laws leads to equations much too complicated to be soluble."



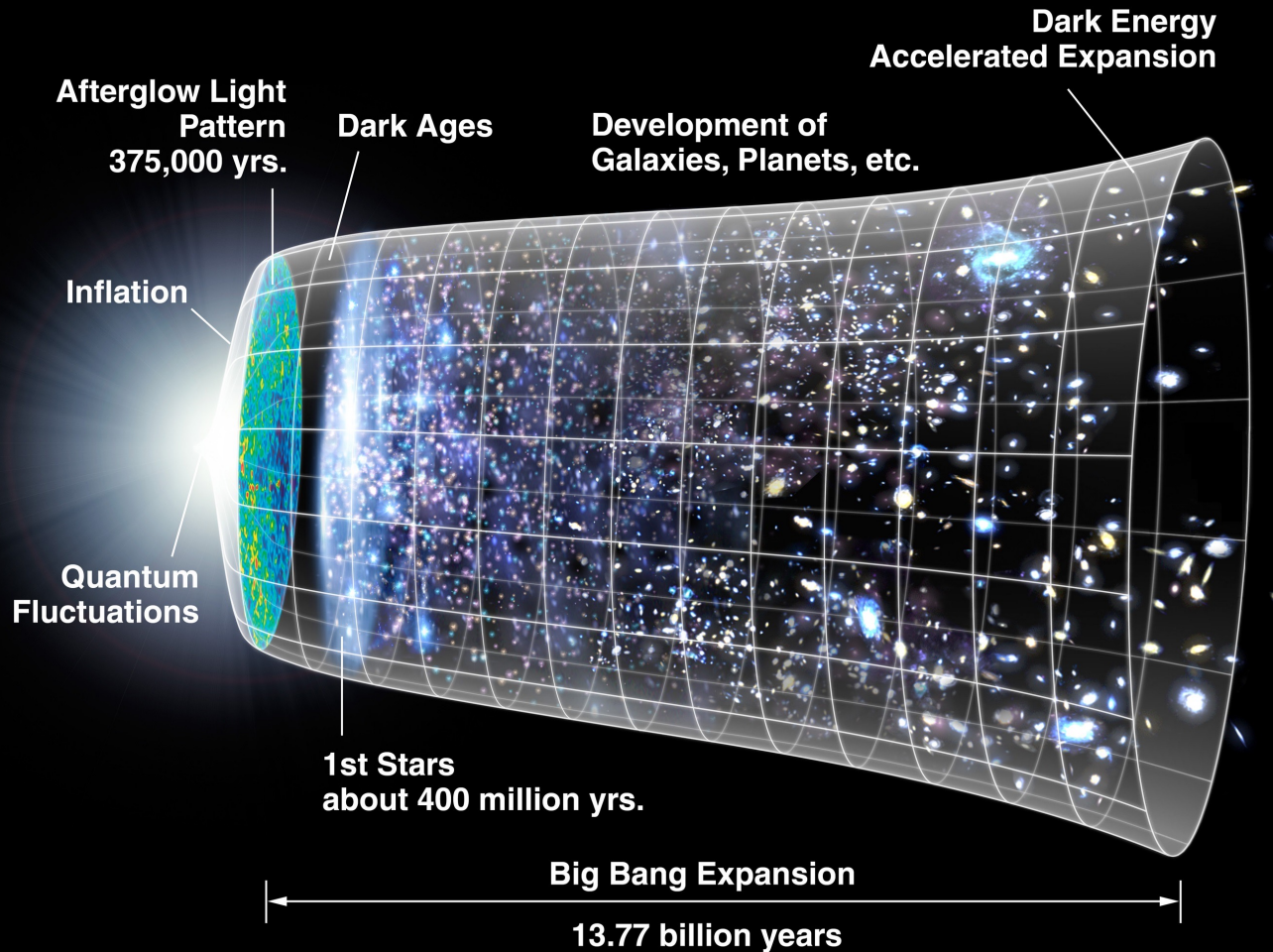
3rd Paradigm: Numerical Methods



Simulation Millenium (or Flamingo)



Galactic accretion requires Dark Matter.



Paradigms of Discovery

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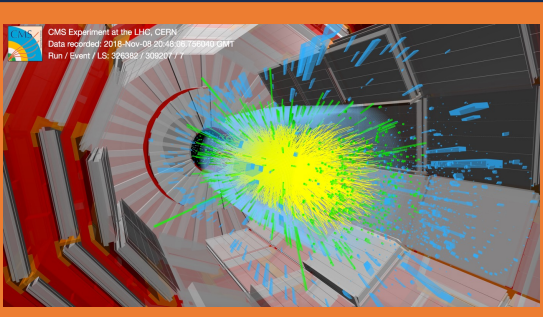
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4th Paradigm: Data-intensive Science

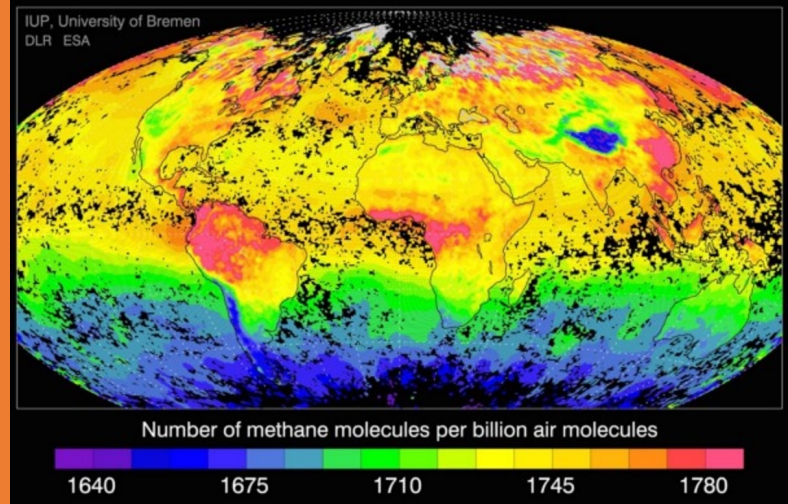
CMS PbPb



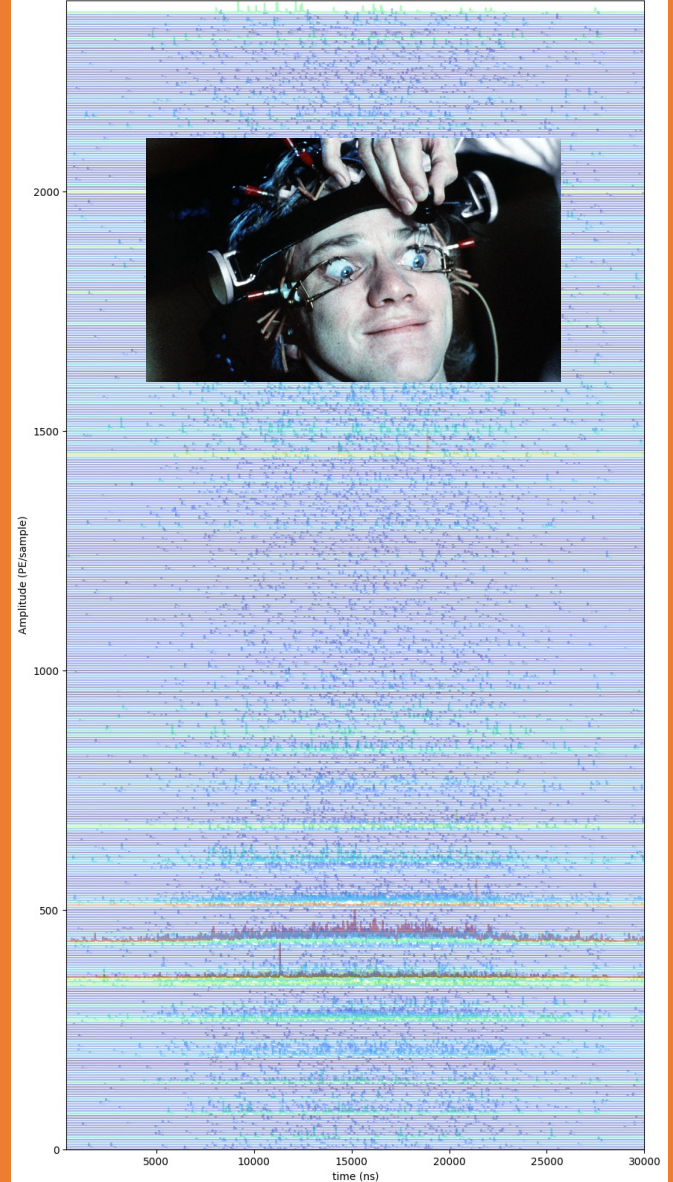
HST Abell 1689



Methane vs coal



XENONnT watch 30 Hz with 55 people for 100 years



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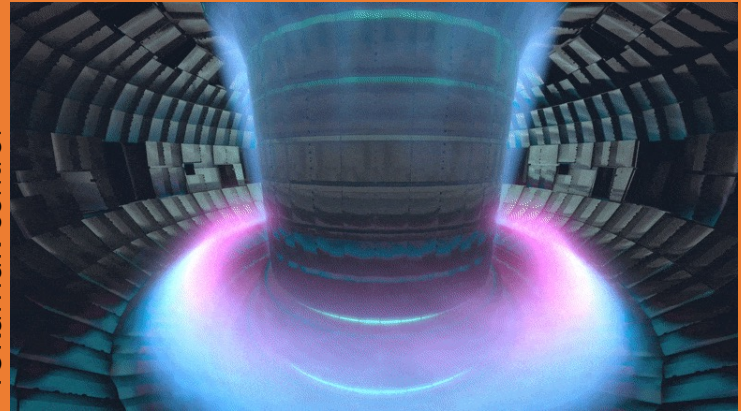
What goes here?

5th Paradigm: AI-enabled science

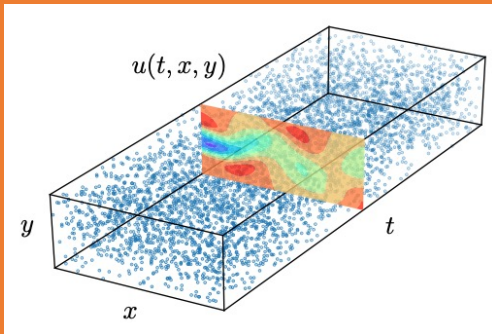
AlphaFold. Protein folding



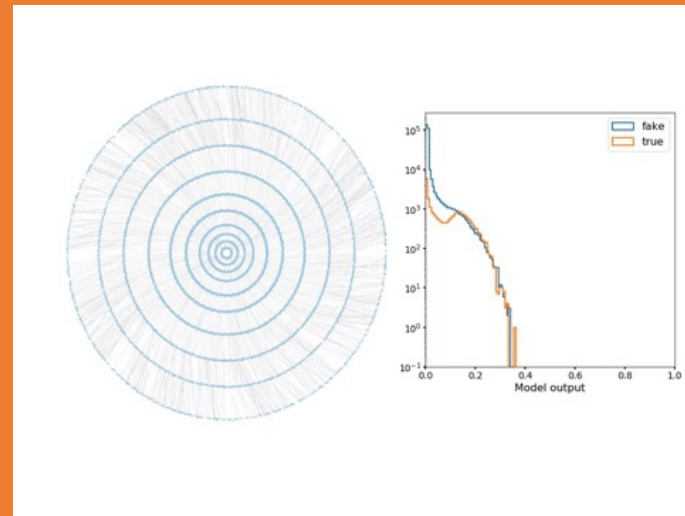
Tokamak control



PDEs / Physics-Informed NNs



Exa.TrkX. CMS track finding



Casual Forward Model

Inverse Problem

