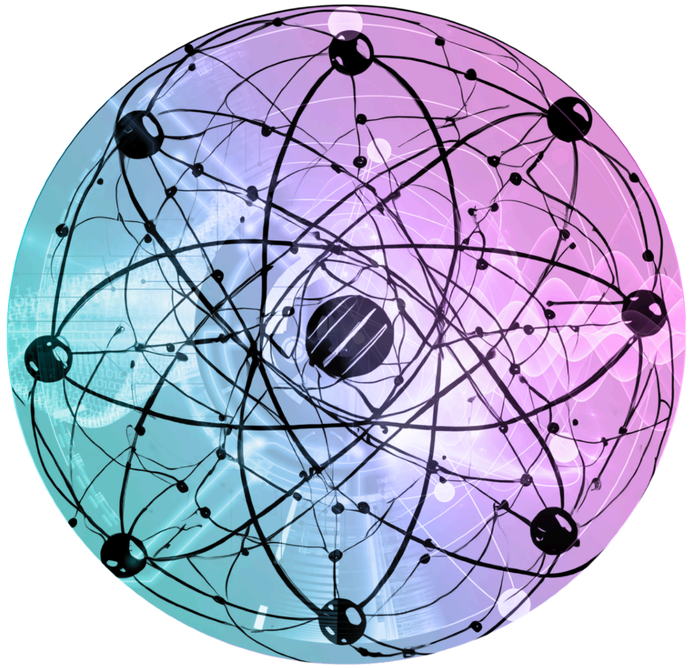
Symposium on the Impact of Generative AI in the Physical Sciences



IAIFI | MIT

MIT Schwarzman College of Computing
March 14–15, 2024

Sponsored by MIT Office of the Provost

Additional support
a3d3.ai

Siddharth Mishra-Sharma
IAIFI Fellow
(smsharma.io/@kdqg1)

Mapping out the future of Generative AI at MIT

July 2023

This symposium: Gen AI + physical sciences

October 2023

Call for proposals: Impact papers on generative AI

July 13, 2023

Sally Kornbluth, President | **Cynthia Barnhart**, Provost

Dear colleagues,

Given the rapid evolution and mounting societal impact of generative AI, we believ
has an opportunity to promote the technology's responsible and publicly beneficia
inform the public conversation, and foster wise, farsighted policy. As articulated a
inauguration, we must help society "come to grips with the tectonic forces of artif
intelligence, containing its risks and harnessing its power for good."

With the goal of marshaling MIT's expertise in this arena to inform public discours
development and application of generative AI, we are pleased to announce **a call**
proposals: We seek to fund the work of individual PIs or groups of faculty to d
impact papers that articulate effective roadmaps, policy recommendations, a
action across the broad domain of generative AI. Our goal will be to disseminat
papers widely to industry leaders, other academic institutions, policymakers, and

New call for proposals: Impact papers on generative AI

October 24, 2023

Sally Kornbluth, President | **Cynthia Barnhart**, Provost

Dear colleagues,

Over the summer, we wrote you to invite proposals to develop impact papers that articulate effective roadmaps, policy recommendations, and calls for action across the broad domain of generative AI.

The response was beyond anything we could have predicted – a total of 75 proposals, across a broad swath of topics. From the first round, 27 proposals were selected for funding.

But the groundswell of interest and the caliber of the ideas overall made clear that a second round was in order – so we write with excitement to announce that today.

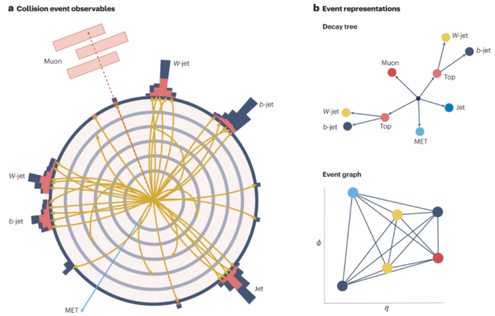
We encourage you to submit a proposal, as an individual or as a group, provided you were not part of one of the proposals selected in the first round.

Multidisciplinary teams are particularly welcome, especially in those realms where generative AI intersects with education, with scientific discovery, or with design and creativity. We encourage school, college, and DLCI leadership to help identify and foster multidisciplinary

Noticeably missing: science!

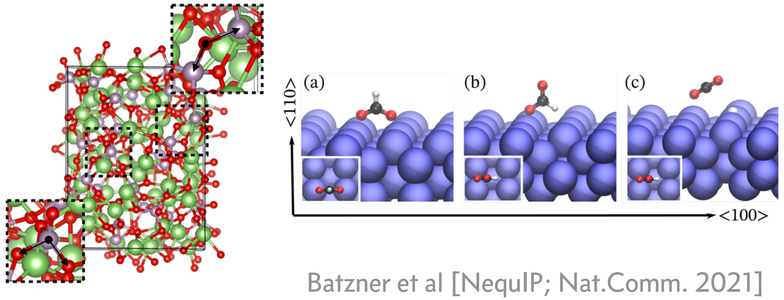
AI + Science: *A growing movement*

Particle physics



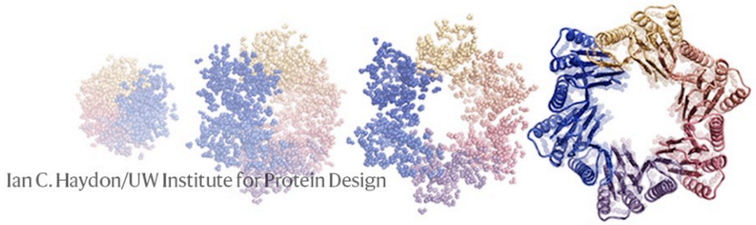
DeZoort et al [Nat.Rev.Phys. 2023]

Molecules & materials



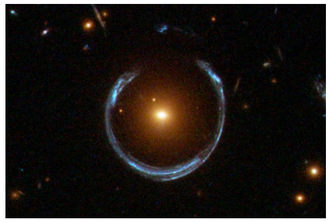
Batzner et al [NequIP; Nat.Comm. 2021]

Proteins

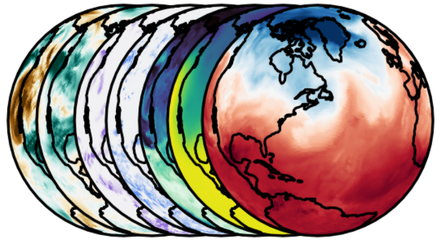


Watson et al [RFDiffusion; Nature. 2023]

Astrophysics

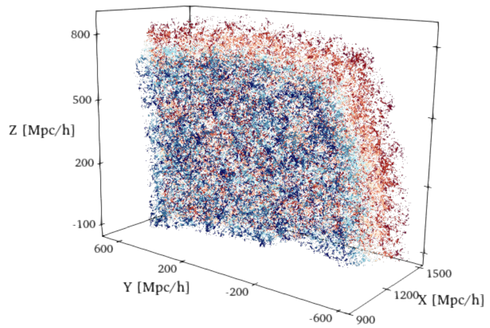


Climate & weather



Google (Neural GCM 2023)

Cosmology



Hahn et al (SimBIG; PNAS 2023)

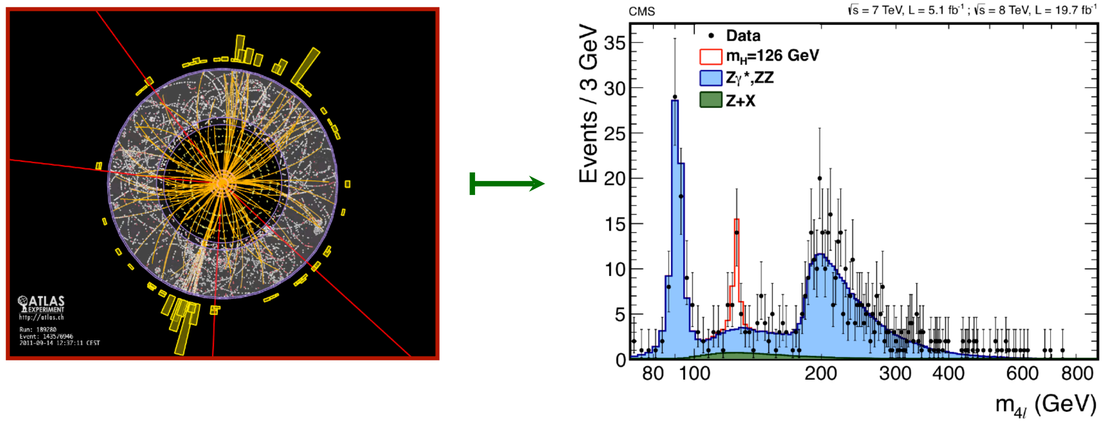
Proof of concept ⟶ Adoption ⟶ *Progress!*

AI + Physics: *A new frontier?*

Framing: Kyle Cranmer

Many fields within AI4Science are pushing the frontiers of AI… what about physics?

Reliable inference with complex forward models



Extremely fast real-time inference

High Energy Physics

Build tools to process LHC collisions occurring 40 million times per second data in real-time using AI.

Read More >

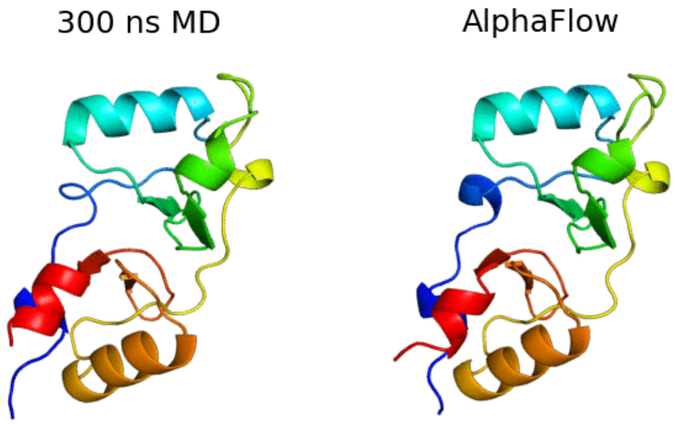
(From A3D3 website)

- Sampling under complex symmetries and exactness guarantees (e.g., in lattice QFT)
- Statistical anomaly detection
- Highly structured models/data-generating processes
- …

Physics can be a frontier for AI!

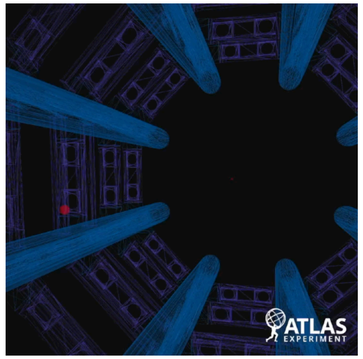
Generative AI / foundation models: *More of the same? A paradigm shift?*

Augmenting existing capabilities?

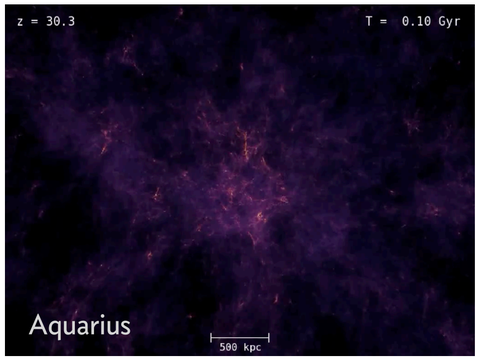


Jing et al, *AlphaFlow*

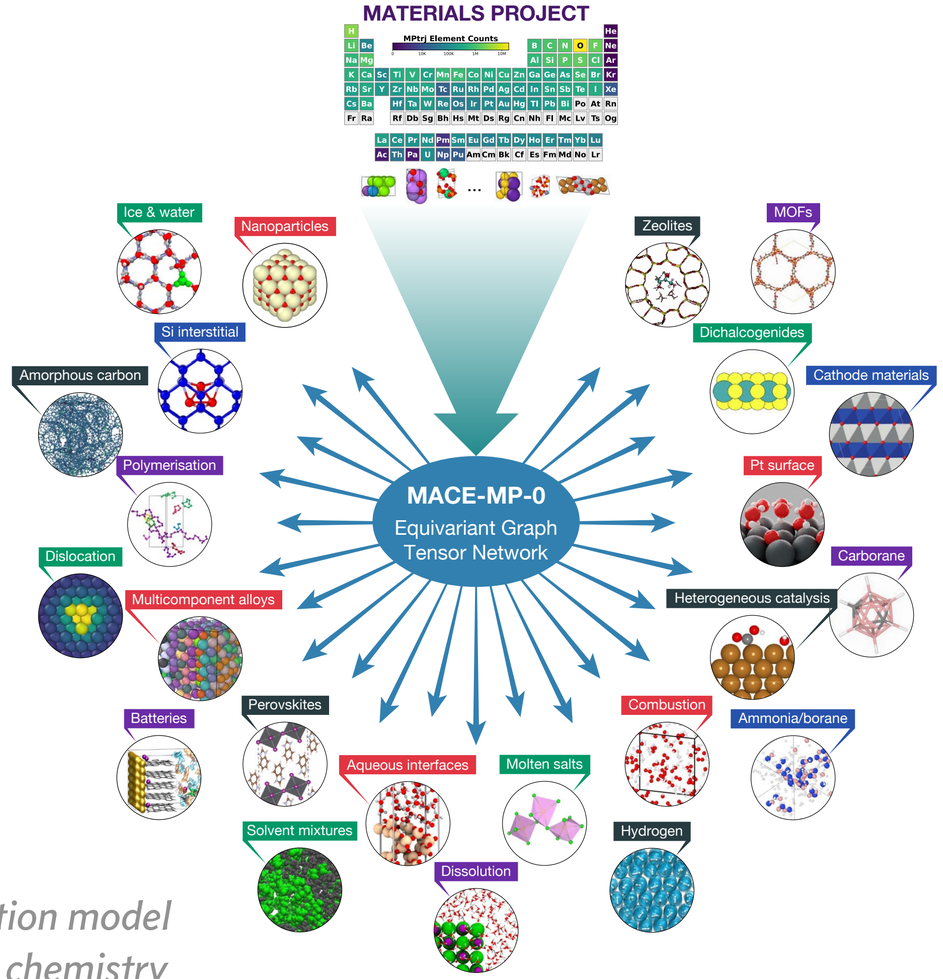
Collider physics



Cosmology



New ways of doing things?



Batatia et al, *A foundation model for atomistic materials chemistry*

Broad themes and questions

- What is the potential impact of generative AI in the physical sciences?
  - **David Hogg** (NYU/Flatiron): *Physics-Motivated Approaches to Model Design: Observations and Data Analysis*
  - **Anna Scaiffe** (Manchester): *Foundation Models in Physics: Successes in Astrophysics*
  - **Thea Aarrestad** (ETH Zurich): *Physics-Motivated Approaches to Hardware Design*
  - **David Hogg** (NYU/Flatiron), **Pavel Izmailov** (OpenAI), **Matt Schwartz** (Harvard): *Panel: Potential impacts of generative AI in physics*
- What are the synergies and differences from other fields?
  - **Kevin Yang** (Microsoft Research): *Foundation Models beyond Physics: Successes in Molecular Biology*
  - **Simon Batzner** (Google): *Physics-Motivated Approaches to Model Design: Deep Learning*
  - **Song Han** (MIT EECS): *Big vs. Small Generative Models (Song Han)*
- What are pathways for contributions from the physical sciences to influence generative AI?
  - **Hidenori Tanaka** (Harvard): *Physics-Motivated Approaches to Model Design: Natural Science of AI*
- What is needed from a community perspective to achieve these impacts
  - **Dan Huttenlocher** (MIT), **Vijay Reddi** (Harvard), **Jesse Thaler** (MIT/IAIFI): *Panel: Community Perspectives on what is needed for gen AI to fulfill its promise in physics*

NSF AI Institute for Artificial Intelligence and Fundamental Interactions

One of the inaugural NSF AI Institutes

(IAIFI, 🗣️: eye-ϕ)

Harvard

Northeastern

= AI + Physics*

*Not just “fundamental interactions”!

Connect with IAIFI

Socials

Join our Mailing List
http://mailman.mit.edu/mailman/listinfo/iaifi-news

Follow on X (Twitter)
@iaifi_news

Follow on LinkedIn
https://www.linkedin.com/company/iaifi/

Watch on YouTube
https://www.youtube.com/IAIFIInstituteforAIFundamentalInteractions

Public Colloquia

In-person at MIT + Zoom. Next up:

- March 22: Soledad Villar (JHU)
- April 12: Jennifer Ngadiuba (Fermilab)

Summer Workshop

IAIFI
Summer Workshop
August 12–August 16
2024

Pre-registration now open
https://iaifi.org/summer-workshop.html

IAIFI Organizers

Phil Harris
Associate Professor, MIT/IAIFI/A3D3

Phiala Shanahan
Associate Professor, MIT/IAIFI

Marisa Lafleur
Project Manager, IAIFI

Siddharth Mishra-Sharma
IAIFI Fellow, MIT/Harvard/IAIFI

Gaia Grosso
IAIFI Fellow, MIT/Harvard/IAIFI

Schedule: *Day 1*

	Speaker	Title	Time
Talks	Anna Scaife	Foundation Models in Physics: Successes in Astrophysics	9:30–10:30 am
		Coffee Break	10:30–11:00 am
	Simon Batzner	Physics-Motivated Approaches to Model Design: Deep Learning	11:00 am–12:00 pm
		Lunch Break	12:00–1:30 pm
	Kevin Yang	Foundation Models beyond Physics: Successes in Molecular Biology	1:30–2:30 pm
		Coffee Break	2:30–3:00 pm
	David Hogg	Physics-Motivated Approaches to Model Design: Observations and Data Analysis	3:00–4:00 pm
Panel	Dan Huttenlocher, Vijay Reddi, Jesse Thaler	Panel: Community Perspectives on what is needed for gen AI to fulfill its promise in physics	4:00–5:30 pm

Schedule: *Day 2*

	Speaker	Title	Time
Panel	Pavel Izmailov, Matt Schwartz, David Hogg	Panel: Potential impacts of generative AI in physics	9:00–10:30 am
	Coffee Break		10:30–11:00 am
Talks	Song Han	Big vs. Small Generative Models	11:00am–12:00 pm
	Lunch Break		12:00–1:30 pm
	Thea Aarrestad	Physics-Motivated Approaches to Hardware Design	1:30–2:30 pm
	Coffee Break		2:30–3:00 pm
	Hidenori Tanaka	Physics-Motivated Approaches to Model Design: Natural Science of Artificial Intelligence	3:00–4:00 pm
Fireside chat	Jared Kaplan	Fireside Chat: Jared Kaplan, Anthropic (Virtual) Moderated by Jesse Thaler	4:00–5:15 pm