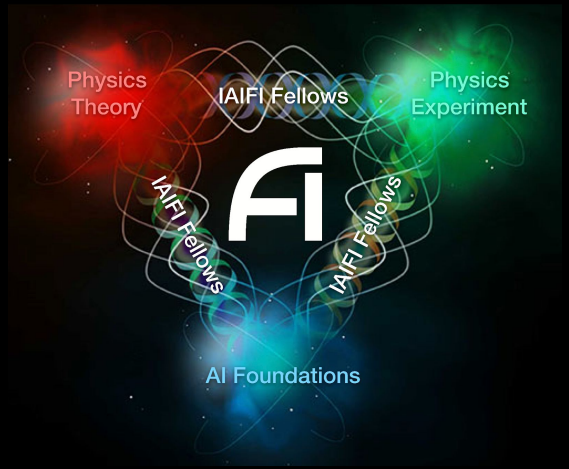
NSF AI Institute for Artificial Intelligence and Fundamental Interactions (IAIFI /aɪ-faɪ/)

Advance physics knowledge—from the smallest building blocks of nature to the largest structures in the universe—and galvanize AI research innovation



iaifi-management@mit.edu

https://iaifi.org

@iaifi-news

NSF AI Institute for Artificial Intelligence & Fundamental Interactions

Advance physics knowledge—from the smallest building blocks of nature to the largest structures in the universe—and galvanize AI research innovation

AI Foundations:

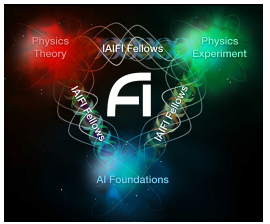
Power of machine learning to process large, rich data sets

Physics Theory & Experiment:

First principles and best practices from fundamental interactions

- 26 faculty + 100+(~20 FTEs supported) students and postdocs across MIT, Harvard, Northeastern, and Tufts
- Faculty by research home: 8 physics theory (2 particle, 2 lattice qcd, 1 astro/particle), 8 AI/EECS, 5 astro, and 5 experiment (2 LHC, 1 nu, 1 LIGO).
- Launched August 2020, started funding research January 2021, entering Year 3 of 5-year grant period ($4 million/year)

IAIFI Research



Theoretical Physics

- First principles theory calculations
- Surrogate models

Experimental Physics

- Data analysis and interpretation
- Embedding physical constraints to address symmetries and structures in the data

Foundational AI

- Point clouds/geometric regularization
- Theory of deep learning

Snapshot of IAIFI Activities

- IAIFI Fellowship Program
- Summer School & Workshop
- Public Colloquia
- Seminars & Journal Club
- Community Building
- Computing Resources
- Industry Partnerships

- Early Career and Equity Committee
- Interdisciplinary PhD Program at MIT
- MITx course
- IAIFI Penthouse
- IAIFI Affiliate Program
- Public Engagement

IAIFI and LHC Physics

In this domain, IAIFI is primarily focused on **knowledge/algorithm creation** with LHC motivations and applications—but also how solutions to LHC problems can be applied to other domains, both within and beyond the field of physics.

LHCb

- Strong connections to LHCb Real-Time Analysis (RTA, formerly Trigger) Project.
- IAIFI-developed *Robust and Provably Monotonic Networks* architecture adopted for all major selections in Run 3, and being considered for many more tasks (NeurIPS Phys Sci 2021); runs in LHCb trigger and offline.
- LHCb-motivated architecture shown to beat state-of-the-art in justice, medicine, etc (ICLR main conf 2022).
- Related project by LHCb team (+Tegmark's group) highlighted in NeurIPS main conf 2022.

CMS

- Strong connections to CMS Trigger Project, FastML, and A3D3.
- Strong connections between CMS and LIGO / Multi-Messenger Astrophysics.
- Example of intellectual development: *Quasi Anomalous Knowledge: Searching for new physics with embedded knowledge*, JHEP 2021.

Theory/Pheno

- Energy Mover's Distance — Jet physics (SHAPER, NEEMo, both at NeurIPS Phys Sci 2022; Thaler + LHCb)
- Physics-Motivated Latent Spaces (Schwartz + CMS)

Get involved with IAIFI

IAIFI Talks

Colloquia and Seminars on the **2nd** and **4th Friday** (with some exceptions) of every month **at 2:00 pm**

View schedule at https://iaifi.org/events

Watch on Zoom or come in person (Kolker Room)!

All previous colloquia also posted on YouTube: https://www.youtube.com/IAIFIInstituteforAIFundamentalInteractions

https://iaifi.org

Follow IAIFI

http://mailman.mit.edu/mailman/listinfo/iaifi-news → Join mailing list

@iaifi_news → Follow on Twitter

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

Connect

IAIFI Affiliates: Senior researchers/faculty in the Boston area interested in the IAIFI mission

- Apply at https://iaifi.org/affiliates

Friends of IAIFI: Junior researchers/students in the Boston area interested in the IAIFI mission

- Apply at https://iaifi.org/junior-interest