National AI Institute for the Sky | SkAI Institute

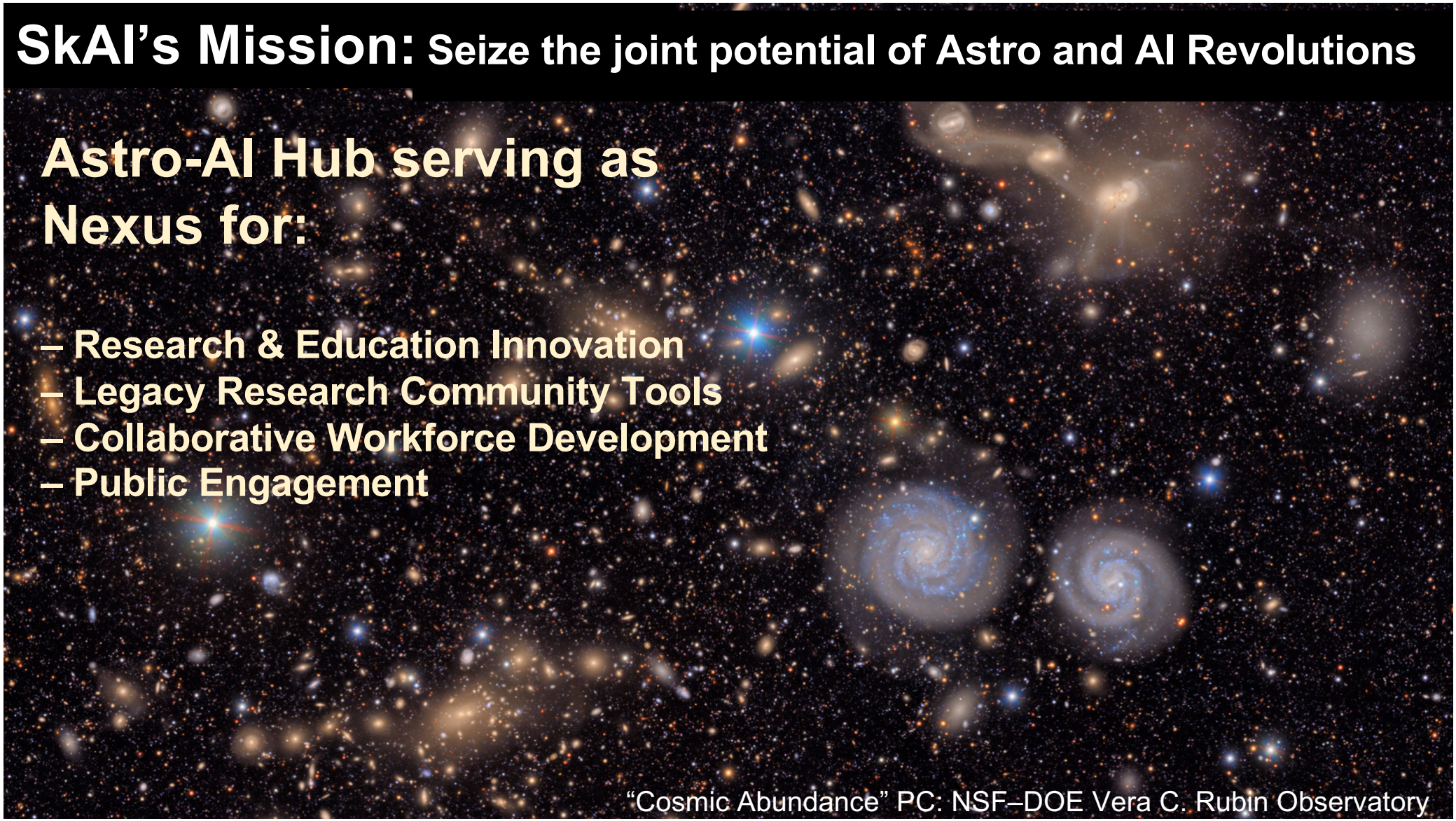
CAA Fall 2025 Meeting

October 7, 2025

Funded by the U.S. National Science Foundation and the Simons Foundation

Convergence Time in Astronomy and AI

SkAI's Mission: Seize the joint potential of Astro and AI Revolutions

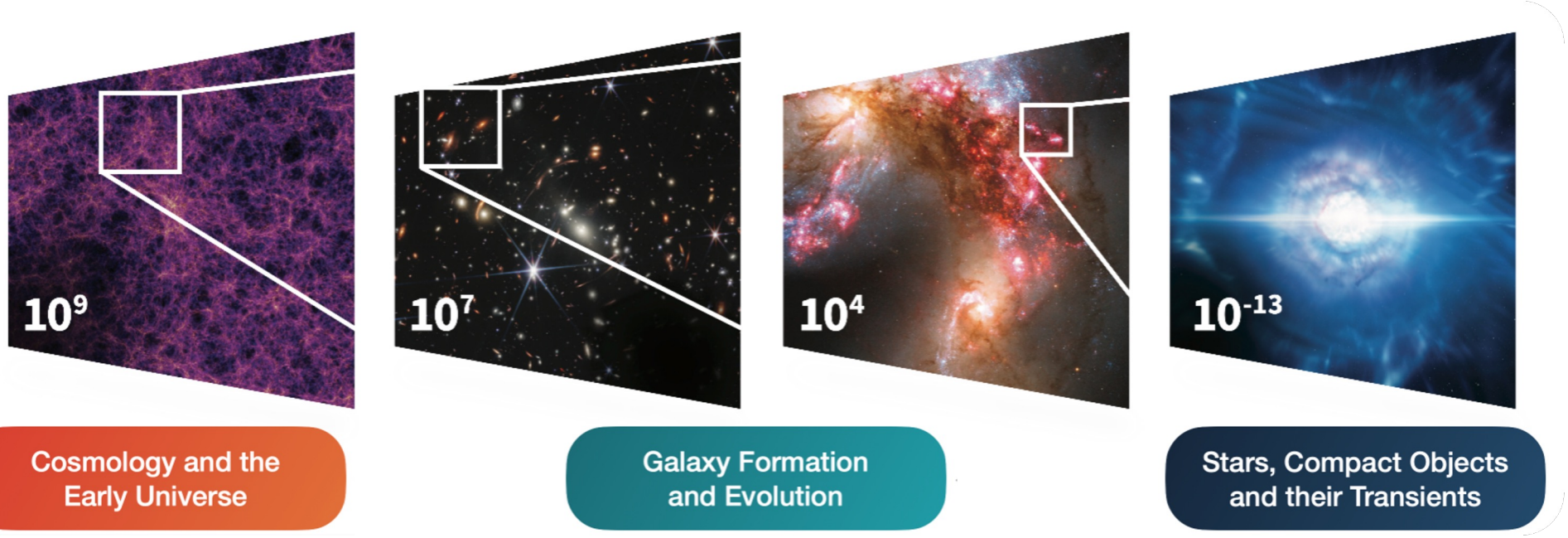


Astro-AI Hub serving as Nexus for:

- Research & Education Innovation
- Legacy Research Community Tools
- Collaborative Workforce Development
- Public Engagement

"Cosmic Abundance" PC: NSF–DOE Vera C. Rubin Observatory

SkAI Institute: Bridging Scales Across Astrophysics



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Bridging Scales Across Astrophysics & AI

Astrophysics

Stars, Compact Objects, and their Transients

Galaxy Formation and Evolution

Cosmology and the Early Universe

Foundational AI

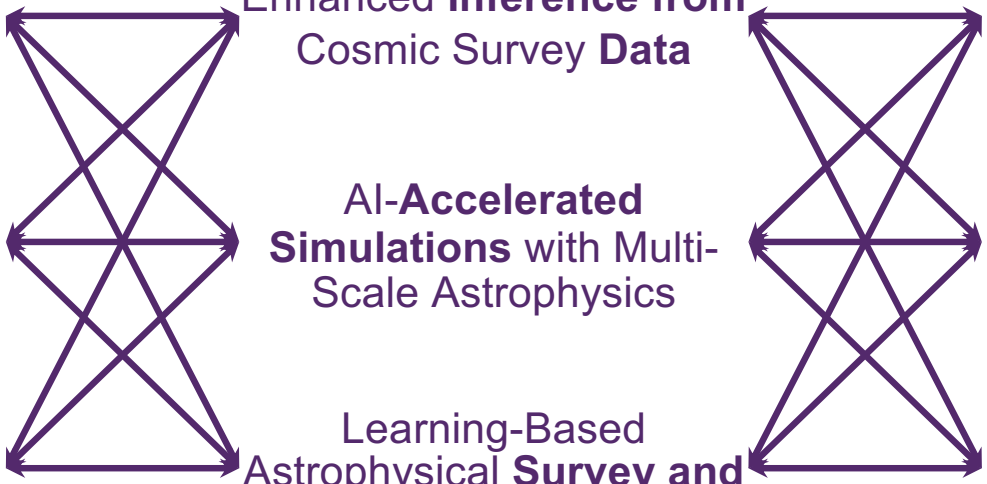
Generative Models

Astrophysics-Informed and Interpretable Architectures

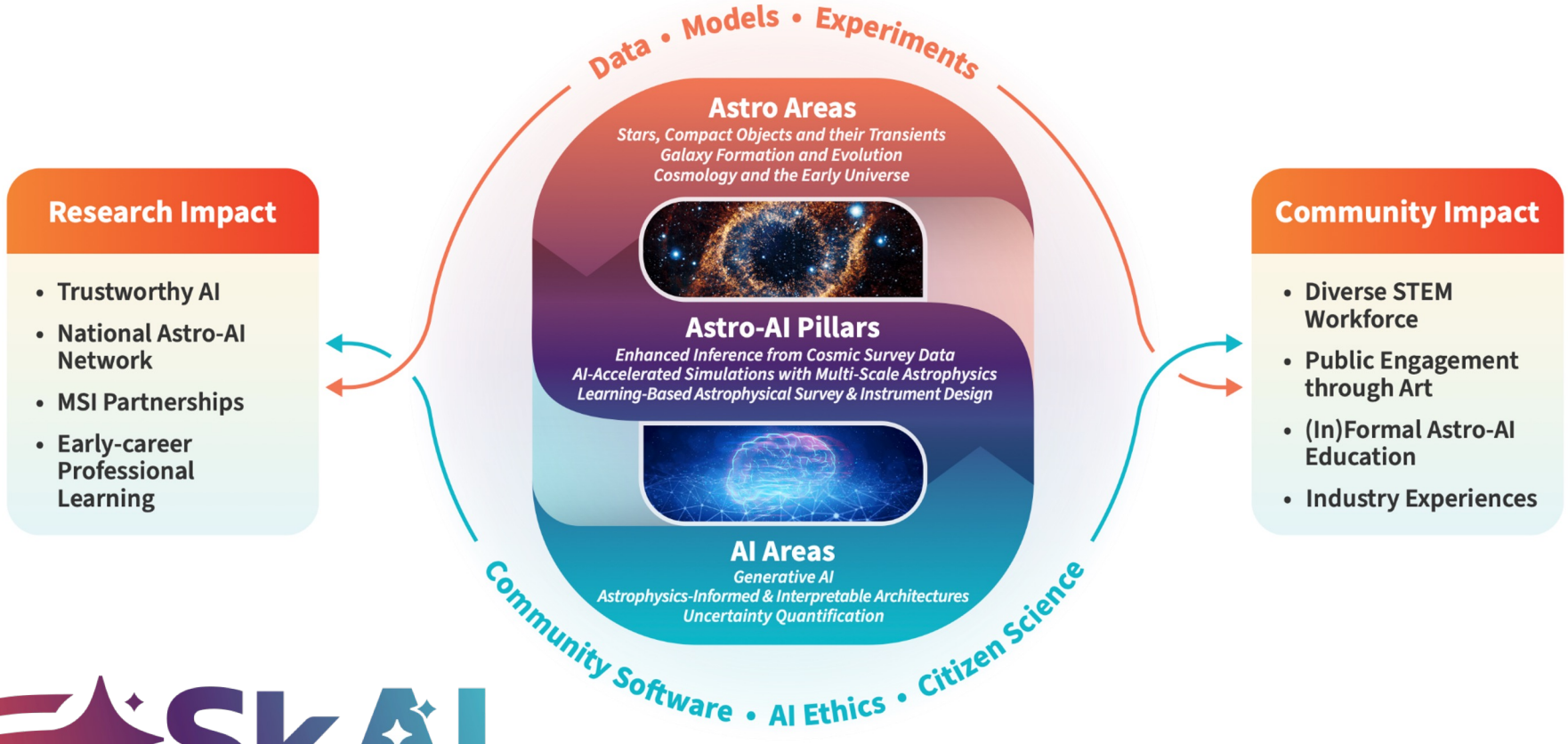
Uncertainty Quantification

Bridging Scales Across Astrophysics & AI

Astrophysics	Research Pillars	Foundational AI
Stars, Compact Objects, and their Transients	Enhanced **Inference from** Cosmic Survey **Data**	Generative Models
Galaxy Formation and Evolution	AI-**Accelerated Simulations** with Multi-Scale Astrophysics	Astrophysics-Informed and Interpretable Architectures
Cosmology and the Early Universe	Learning-Based Astrophysical **Survey and Instrument Design**	Uncertainty Quantification



SkAI Institute: Overview



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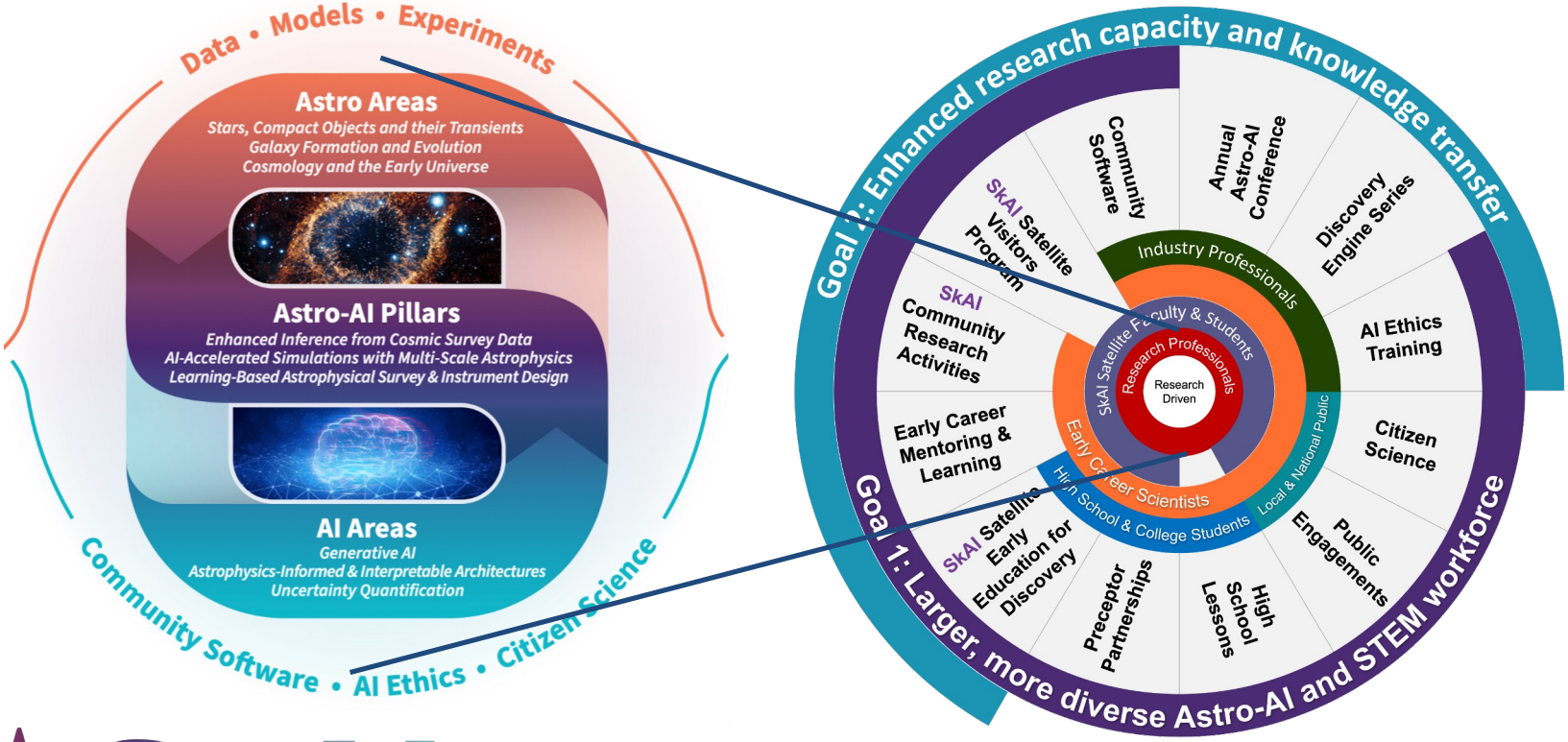
SkAI Institute: Overview



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SkAI Institutional Hub

Lead Institutions

Partner Institutions

Satellite Network

Art Partners

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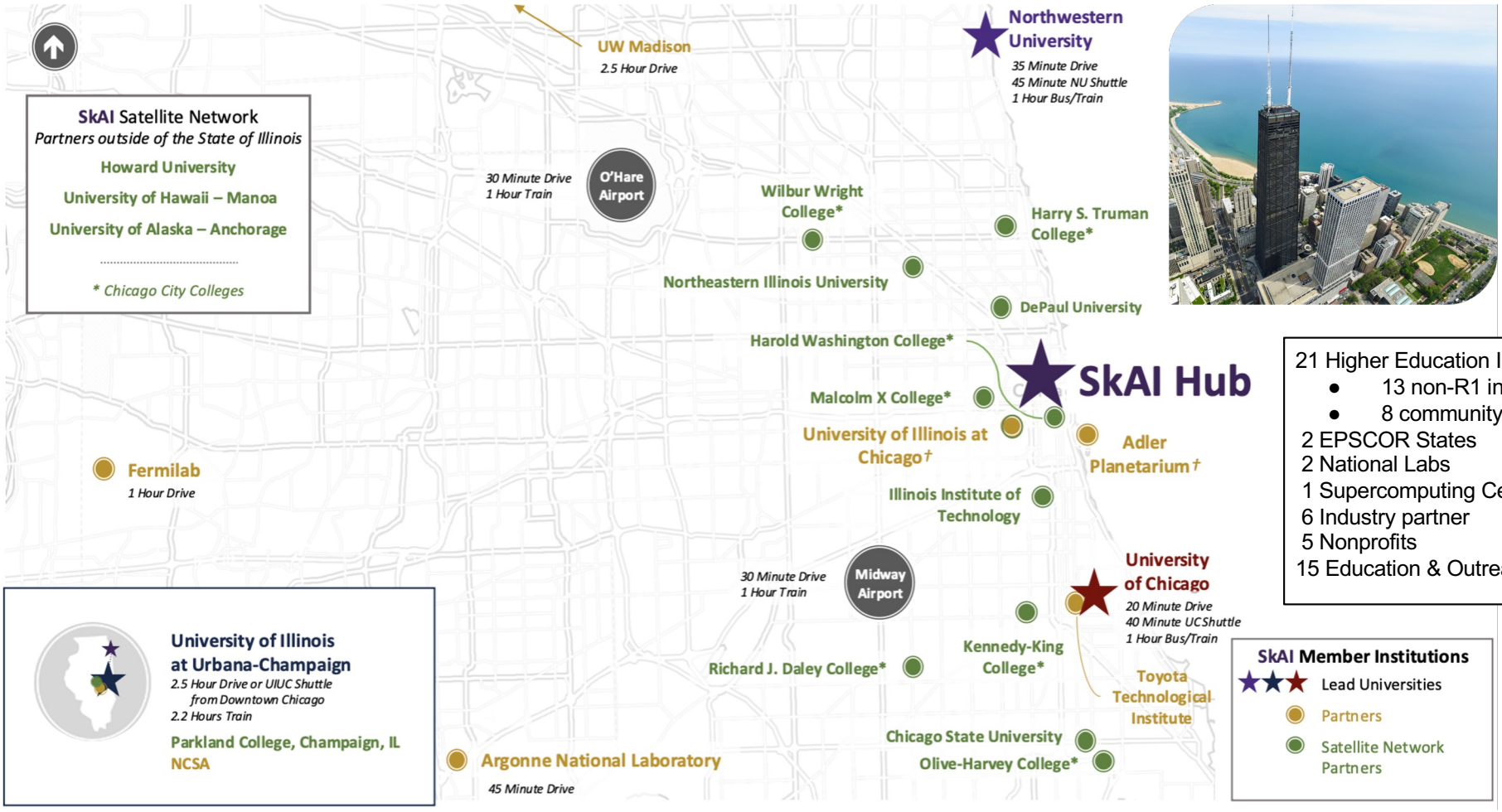
SkAI as a Geographic Hub



21 Higher Education Institutions
- 13 non-R1 institutions
- 8 community colleges

2 EPSCOR States
2 National Labs
1 Supercomputing Center
6 Industry partner
5 Nonprofits
15 Education & Outreach partners

SkAI Institute: Executive Board

Astro
AI
Ops

Vicky Kalogera
NU

Elise Ahn
SkAI

Chihway Chang
UC

Aggelos Katsaggelos
NU

Gautham Narayan
UIUC

Tjitske Starkenburg
NU

Rebecca Willett
UC

Adam Miller
NU

Aleksandra Ćiprijanović
FNAL

Michael Zevin
Adler

Michael Maire
UC

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External Advisory Board

Federica Bianco
Physics & Astronomy,
University of Delaware
Associate Professor

Andy Connolly
Astronomy,
University of Washington
Professor

Angus Forbes
Engagement Team,
NVIDIA
Strategic Researcher

Dan Foreman-Mackey
JAX, Google Deepmind
Research Engineer

Tara Javidi
Electrical & Computer Eng.,
UC San Diego
Professor

J. Nathan Kutz
Applied Mathematics,
University of Washington
Professor

Year 1 External Advisory Board Meeting

September 8–9, 2025
SkAI Hub

Chris Lintott
Department of Physics,
Oxford University
Professor

Roummel Marcia
Applied Mathematics,
UC Merced
Professor

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Inaugural SkAI Conference

Open SkAI 2025

- **Plenary speakers:** Federica Bianco (Delaware), George Karniadakis (Brown)
- **Invited speakers:** Rachel Mandelbaum (CMU), Matteo Sesia (USC), Fei Sha (Google), Chenhao Tan (UC)

- 70+ contributed presentations
- 50-50 talks/posters (70% non-SkAI)

- **Interactive community engagement**: Tutorials, Mentoring Lunch, Glossary, SEER

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SkAI Research Events

- **Works-in-Progress Wednesdays** (project updates)
- **Journal Club** (early-career Co-leads)
- **Colloquia** (invited external speakers)
- **Research Pillar Events** (tutorials, hackathons)
- **Topical Workshops** (coming)

Aim: To enable collaboration, networking, mentoring, and cross-pollination between computer science and astronomy and across career stages.

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SkAI as a Community Hub: Digital

Learn about how to join SkAI's different communities (newsletters, Slack, etc.)

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Three Research Pillars

- **Enhanced Inference from Cosmic Survey Data:** time-series forecasting, uncertainty quantification, and multiwavelength data correlation, leveraging data from the Rubin Observatory and other datasets, emphasizing real-world application and scalability
- **AI-Accelerated Simulations with Multi-Scale Astrophysics:** physics-informed AI architectures, generative models, and uncertainty quantification to enhance the realism and efficiency of simulations
- **Learning-Based Astrophysical Survey and Instrument Design:** spectrometer design, intelligent scheduling, and rapid transient follow-up

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SkAI Research Connections

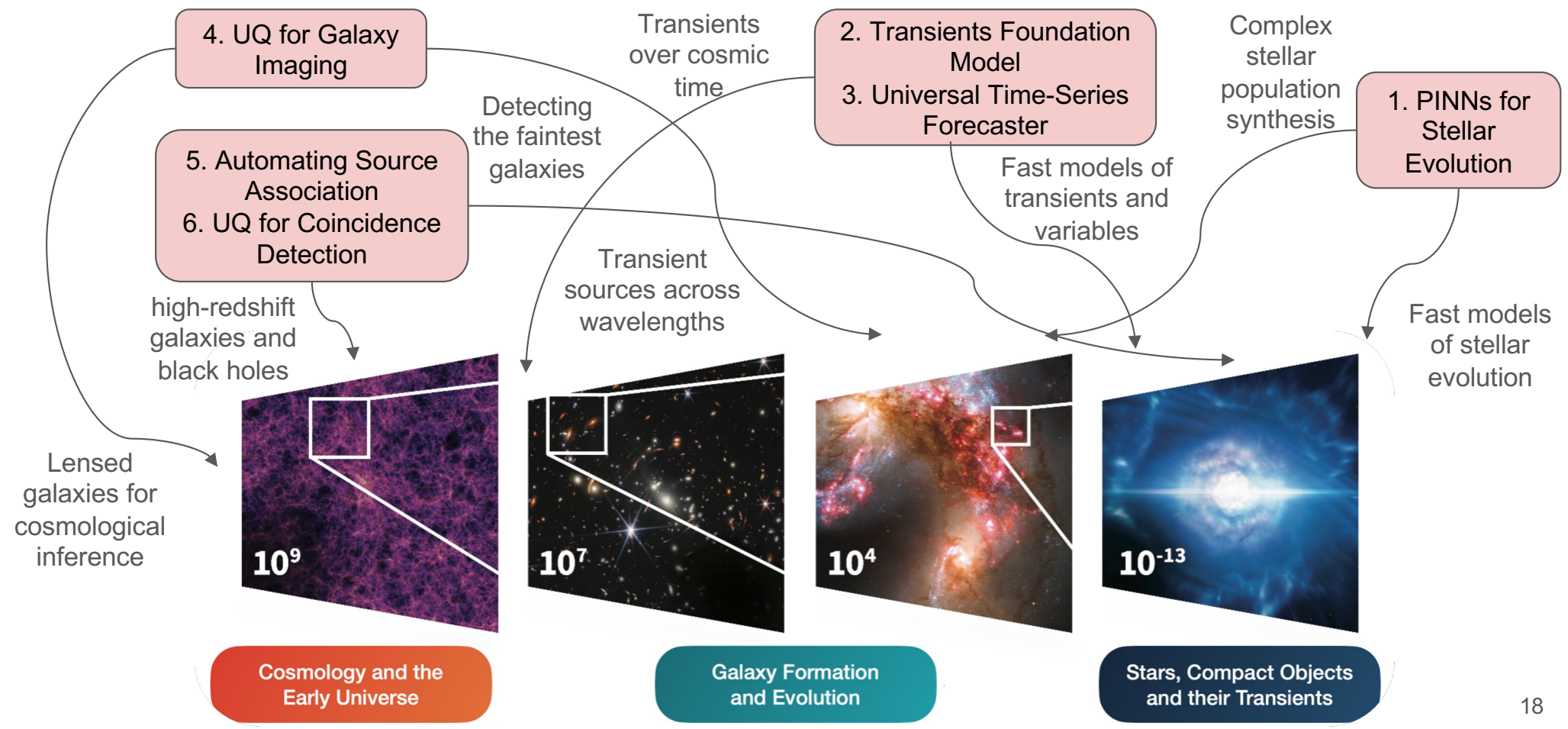
10 funded projects, the Astro-AI pillars, and the astrophysics and fAI areas

		ASTRO AREAS			ASTRO-AI PILLARS			AI AREAS		
	PROJECTS	AP1: Stars Compact Objects, Transients	AP2: Galaxy Formation and Evolution	AP3: Cosmology and Early Universe	Pillar 1: Enhanced Inference from Cosmic Survey Data	Pillar 2: AI-Accelerated Simulations with Multi-Scale AP	Pillar 3: Learning-Based Survey and Instrument Design	fAI1: Generative AI	fAI2: Astrophysics-Informed and Interpretable Architectures	fAI3: Uncertainty Quantification
Started YR1	1: PINNs for Stellar Evolution									
	2: Transients Foundation Model									
	3: Universal Time-series Forecaster									
	4: Uncertainties for Galaxy Imaging									
	5: Automating Source Association									
	6: UQ for coincidence detection									
Start YR2	7: Cosmology Inverse Problems									
	8: AI-Enabled Spectrometer Design									
	9: Intelligent Survey Scheduling									
	10: Interpretable Latent Spaces									
Unfunded	B3H: Black Box for Black Hole									
	The Data Concierge									

Data Models Experiments

Almost every project involves investigators from multiple institutions.

Examples of SkAI Research Bridging Astrophysical Scales



Research Output and Impact

SkAI Research is taking off!

In first six months project members have had:

- multiple—submitted and in-preparation—publications and proposals (17)
- work presented their YR1 work at conferences and related venues (9)
- releases - actual and in-preparation - of public dataset and community software (6)

Across SkAI, members:

- were invited to high-impact astro and AI events (4)
- were awarded grants related to SkAI goals (3)
- published many publications with SkAI affiliation & aligned with SkAI mission (49)

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Computing and Data Storage Infrastructure

By now we have:

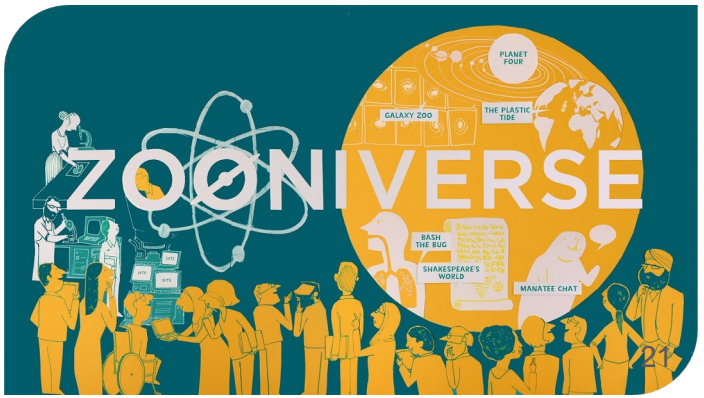
- Assessed SkAI-wide needs (responses from about ~25 projects)
- Tested pilot allocations and runs for system “debugging”
- Established protocols for access to NCSA (application/allocation/access)
- Developed protocols for access to ANL
- Streamlined dashboard monitoring, ticket system, and RSE support
- Developed connection systems to receive live Rubin alerts (LBNL/NERSC)

NVIDIA

Zooniverse: Citizen Science Projects

SkAI projects with Zooniverse components

- *DELVE Dwarf Search*: Identifying ultra-faint dwarf galaxies (beta testing)
- *Cosmic Trails and Tails*: characterize streams and shells around galaxies (conception phase)
- *Automating Bayesian inference of millimeter source association*: check multi-wavelength source associations (conception phase)
- SkAI-affiliated Zooniverse projects: *Gravity Spy, Dark Energy Explorers, SpaceWarps, Baby Star Search*



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Nurturing Next-Generation Talent

Building a *multitiered* framework

- Early-Career Workforce Development
- Higher Education: University, College, and Community Colleges
- High School Education
- Informal Learning and Education

Year 1 focus: Foundational planning, recruitment, and outreach, with full programming set to launch in Year 2

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Higher Ed: University, College, and Community Colleges

- The **Preceptor Program**: Focuses on teaching, research, and mentoring to prepare postdocs to be high-impact educators at different types of higher education institutions.
- The **Satellite Early Education for Discovery (SEED)**: SkAI's undergraduate summer research experience

Satellite Network students listen to SkAI researchers present their work during the July 18 Open House.

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Mentoring & Professional Development

Because Astro-AI is an emerging interdisciplinary field, ensuring that early-career researchers have mentoring and support from both Astro and AI experts is critical in helping lay a foundation for a **nexus of collaboration** at SkAI and beyond, where researchers can **adeptly navigate both disciplines**.

Mentoring Goal:

- Establish effective cross-disciplinary, cross-institutional, and multilevel mentoring.

Professional Development Goals:

- Promote professional learning for and among SkAI early-career scientists.
- Train the next generation of leading teaching scholars in the area of Astro and AI.

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Mentoring & Professional Development

SkAI's Mentoring and Professional Development Framework

- Individual mentorship for SkAI postdoc fellows
- Peer mentoring groups for early-career participants
- Events to facilitate interaction, knowledge transfer, and interdisciplinary connections

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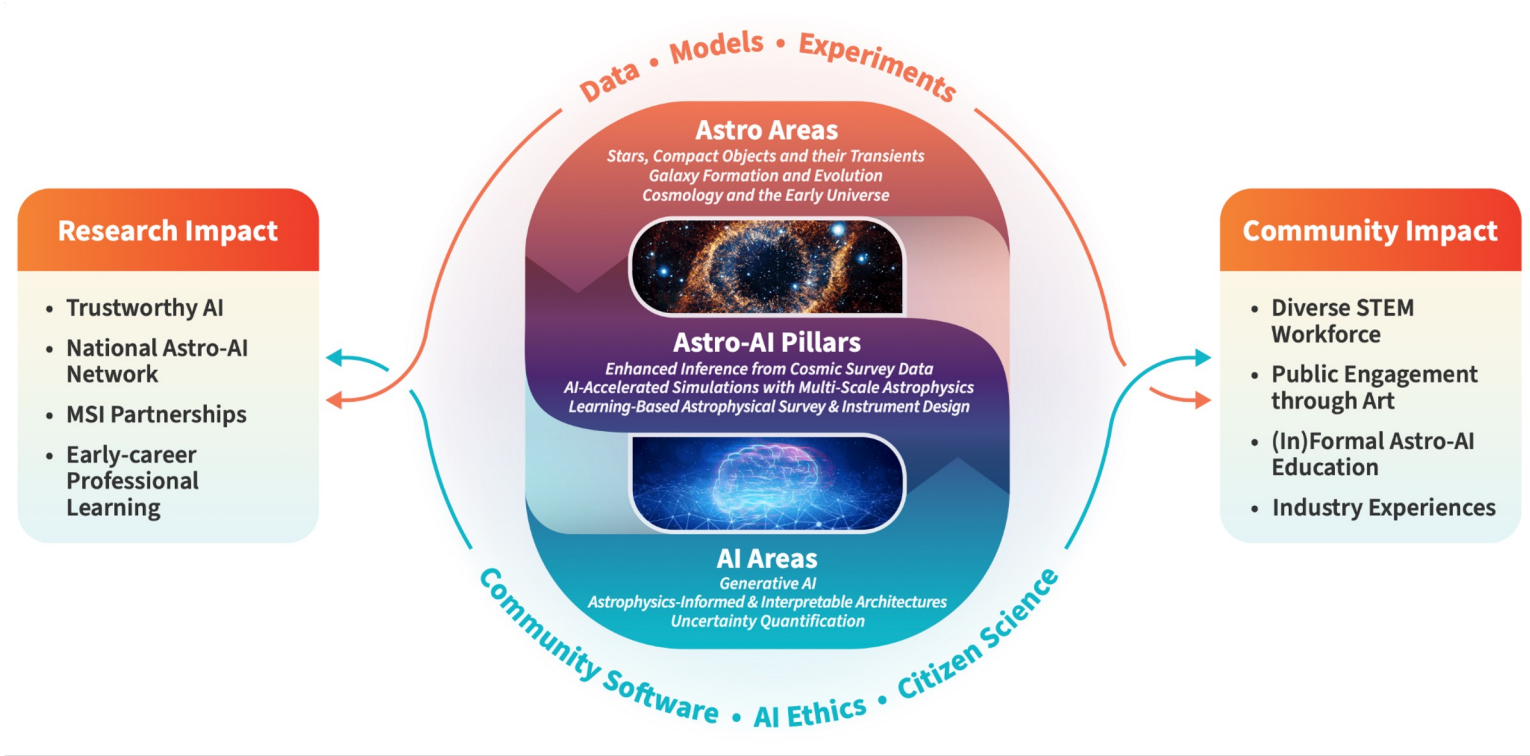
SkAI's Global Mission



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