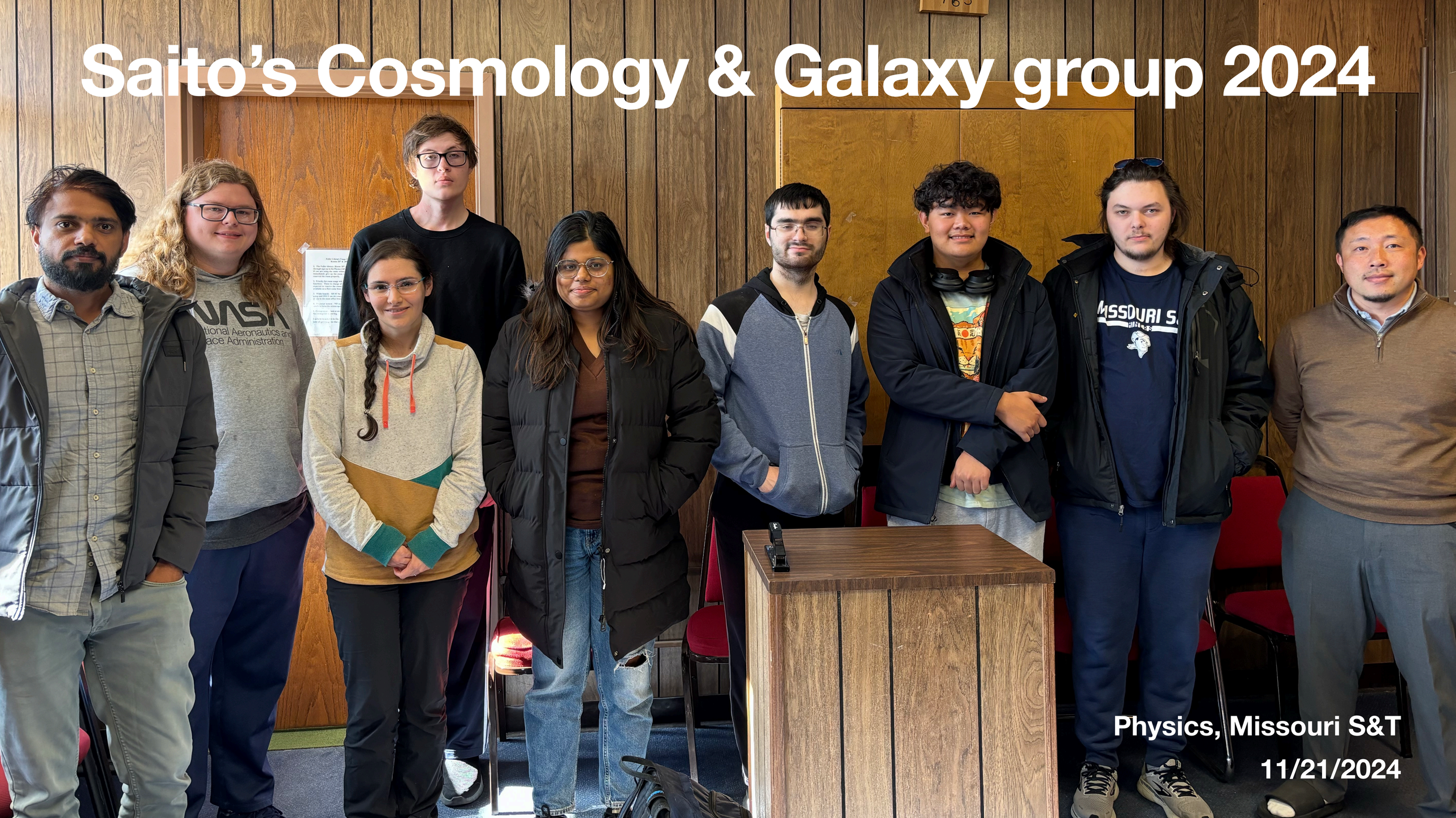
# Saito's Cosmology & Galaxy group 2024




Physics, Missouri S&T

11/21/2024

# Welcome to Cosmology & Galaxy group!

- **Current members (starting after Fall 2024)**
  - **Faculty: Shun Saito** 🇯🇵
  - **Postdoc: Hasti Khoraminezhad** 🇮🇷 **Amit Kumar** 🇮🇳
  - **PhD students: Cole Rischbieter** 🇺🇸 **Deeshani Mitra** 🇮🇳 **Steven Karst (CS)** 🇺🇸
  - **Undergraduates: Evan Blake** 🇺🇸 **Andrew Madsen** 🇺🇸 **Daniel Mackay** 🇺🇸 **Abie Luo** 🇺🇸

- **Research activities**
  - **Midwest Cosmology Network discussion (at 2-3:30pm on Monday)**
  - **Joint seminar with University of Western Cape (occasionally)**
  - **Regular one-to-one meeting (on Friday)**
  - **Telecons if you join HETDEX/DESI/PFS/Roman**

# Ongoing and Forthcoming Galaxy Redshift Surveys

2020 — 2024 — 2025 — 2030 — 2035 — Year



**Spec-S5**




eBOSS

# Ongoing and Forthcoming Galaxy Redshift Surveys

2020 — 2024 — 2025 — 2030 — 2035 — Year

HETDEX
Hobby-Eberly Telescope Dark Energy Experiment
Illuminating the Darkness

Dark Energy Spectroscopic Instrument II

Spec-S5

LyA

Dark Energy Spectroscopic Instrument

Introducing the Nancy Grace Roman Space Telescope

SuMIRe
Prime Focus Spectrograph

eBOSS

euclid consortium

# Ongoing and Forthcoming Galaxy Redshift Surveys

2020 | 2024 | 2025 | 2030 | 2035 — Year

HETDEX — Hobby-Eberly Telescope Dark Energy Experiment — Illuminating the Darkness

Dark Energy Spectroscopic Instrument II

Spec-S5

LyA

Dark Energy Spectroscopic Instrument

Introducing the Nancy Grace Roman Space Telescope

Prime Focus Spectrograph — SuMIRe

[OII]
[OIII]
HA

eBOSS

Euclid consortium

# Ongoing and Forthcoming Galaxy Redshift Surveys

2020 | 2024 | 2025 | 2030 | 2035 — Year

HETDEX — Hobby-Eberly Telescope Dark Energy Experiment — Illuminating the Darkness

Dark Energy Spectroscopic Instrument II

Spec-S5

LyA

Dark Energy Spectroscopic Instrument

Introducing the Nancy Grace Roman Space Telescope

[OII]

[OIII]

Hα

SuMIRe Prime Focus Spectrograph

eBOSS

Euclid consortium

**SS's group officially joins:**

- **HETDEX: Cosmology SWG chair**
- **DESI: HOD TG lead**
- **(PFS: leading target selection)**
- **Roman: Galaxy/Astrophysics modeling lead**

# Tips for success in your research

- **Research = Ask + Solve + Communicate.**
  - **Ask questions at any time.** A great researcher asks a great question.
  - **Share your project idea.** It is the most difficult to come up with a project.

    When you read a paper, criticize it, and think of what you can do next.
  - **Solve and debug quickly.** Don’t be afraid of your mistakes, but do know how to check.
  - **Make a publication quality plot, always.** An excellent plot quickly conveys the point.

- Your goal is to make me write the best possible recommendation letter. I will do so if:
  - You showed me something beyond my expectation.
  - You shared with me an idea or method I could not think of.
  - You lead an effort rather than being just a player. This includes not just research but also seminar/conference organization & outreach activities etc.

- Hey 👋, welcome to our group! 🙂
- I'm Hasti and I work with Shun on the following ideas.
- We work on ***Lyman-Alpha Emitting galaxies (LAEs)*** : Modeling them in simulations as well as studying them in HETDEX data.
- ***The goals:***
  - 1. Empirically simulating a realistic mock catalog for LAEs at ($z \sim 2-3$)
  - 2. Understanding the LAE-halo connection in the context of Large-Scale Structures
- ***Why it is interesting?***
  - High-redshift Universe has less explored in precision cosmology era, and high-z LAEs are the target of on-going/upcoming surveys like HETDEX/DESI-II, ..., so there is a high demand for careful modeling/understanding of LAEs at high-z
  - LAEs are known as young star forming galaxies, they radiate Ly$\alpha$ emission corresponds to $\lambda_{\rm rest} = 1215.67\text{Å}$ in UV, so they can be probe in optical/NIR telescopes at $z > 2$ and they are prominent than the continuum.
  - They will contribute in understanding the main science goals like Dark Energy, Galaxy Evolution, ...
  - It is fun to learn about them but of course challenging 🙂

# Modeling Lyman-alpha Intensity Mapping From a State-of-the-art Cosmological Hydrodynamical Simulation

## Who I Am

**Name:** Deeshani Mitra
**Position:** PhD Student in Physics , Missouri S&T

## What I Am Working On

•Developing **Lyman-alpha intensity mapping** models using **cosmological hydrodynamical simulations** (e.g., TNG50).
•Aiming to study large-scale structures of the universe by modeling diffuse Lyman-alpha emission.

## Goals of My Project

- **Advance Lyman-α Intensity Mapping**: Develop and use Lyman-α intensity mapping as a tool to study the large-scale structure of the universe, galaxy formation, and evolution.
- **Detect and Analyze Cosmological Signals**: Measure cross-correlation between Lyman-α intensity maps and galaxy distributions, aiming to detect Baryon Acoustic Oscillations (BAO) and Redshift Space Distortions (RSD).
- **Simulate and Validate Models**: Create realistic simulations of Lyman-α emissions using hydrodynamical and empirical models to support the calibration and interpretation of observational data.

## Why It Is Interesting

•Unveils the cosmic web structure.
•Offers insights into galaxy formation and the role of intergalactic hydrogen.
•Complements current and future surveys (e.g., HETDEX).

## Progress

•Generated **Lyman-alpha surface brightness maps** from TNG50 simulation data.

**References:**
•Byrohl, Chris, and Dylan Nelson. "The cosmic web in Lyman-alpha emission." *Monthly Notices of the Royal Astronomical Society* 523, no. 4 (2023): 5248-5273.
•Lin, Xiaojing, Zheng Zheng, and Zheng Cai. "Probing the Diffuse Lyα Emission on Cosmological Scales: Lyα Emission Intensity Mapping Using the Complete SDSS-IV eBOSS." *The Astrophysical Journal Supplement Series* 262, no. 2 (2022): 38.
•Heneka, Caroline, Asantha Cooray, and Chang Feng. "Probing the intergalactic medium with Lyα and 21 cm fluctuations." *The Astrophysical Journal* 848, no. 1 (2017): 52.

# Abie Luo

## Physics

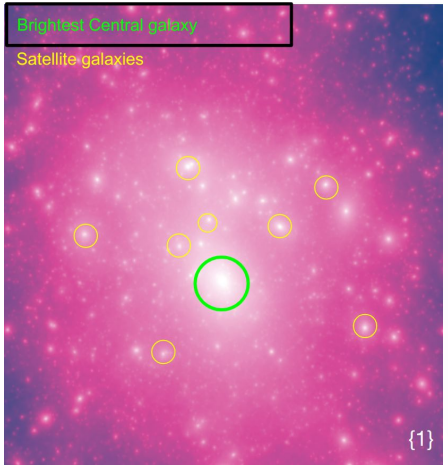
- I am currently working on Lyman-alpha emitters (LAEs) to quantify the impact of intrinsic line profiles on various measurements of the properties of LAEs.
- Goal: to quantify systematic bias of the measurement of LAE properties that include line width, luminosity, and equivalent width in narrow-band and spectroscopic LAE surveys.
- LAEs are fundamental and crucial to cosmology and galaxy evolution. As a result, it is vital to quantify the measurement bias for accurate modeling of LAEs.

MISSOURI S&T

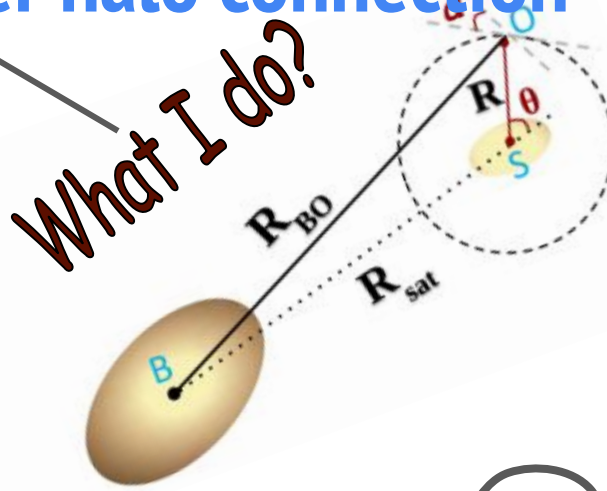
# Satellite galaxies and their dark matter halo connection

Hello!

Is this me?

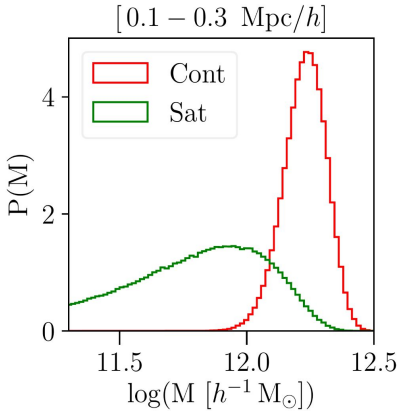


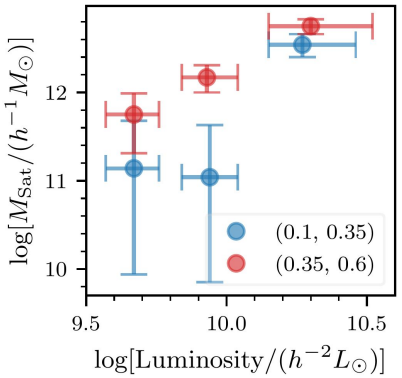

What I do?

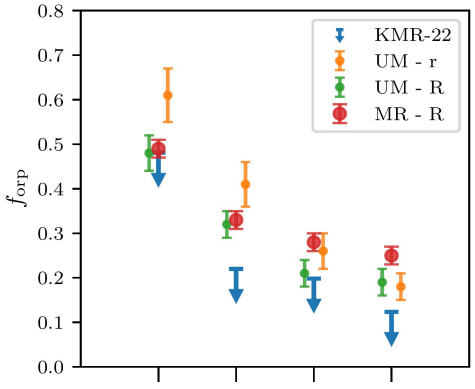



Why should we care?

- Satellite galaxies evolve differently compared to their counterpart field galaxies.
- To populate galaxies to their host dark matter halos, thereby modeling their distribution in the Universe.
- Connect observations with our theoretical understanding of the Universe.
- Study the nature of the dark matter.



# Cole Rischbieter

## Project:

Finding optimal weighting for a set of observables.

## Goal:

To determine the weighting function that optimizes the signal-to-noise ratio for galaxy detection and intensity mapping surveys, as well as for their cross-correlation.

## Why is it interesting?:

Finding direct evidence for inflation is one of the key goals of cosmology. However, doing so requires us to go to larger scales, of which is dominated by noise. By developing an optimal weighting function, we are able to more effectively probe larger scales without increasing survey volume.

# Steven Karst

- **Current Project**: Enhancing Galaxy Target Selection With Machine Learning

- **What it is:** Using reinforcement learning to isolate ancient galaxies with a particular emission line

- **Why it's interesting:**
  - Part of PFS Collaboration; results may be used with real-life telescope!
  - Has been my project since early 2021
  - Presented at Jefferson City Capitol Day and UGRC twice, once as an OURE Fellows project

# Evan Blake

Modeling galaxy emission lines using DSPS (Differentiable Stellar Population Synthesis)

- Goal: To model the galaxy spectrum for photometry including both continuum and emission line fluxes
- Utilizing JAX to run HMC enables us to significantly speed up the fitting for millions of galaxies.
- Why it is interesting: Should allow for more accurate and insightful fitting, such as giving more information about physical conditions in ISM and its connection with global galaxy properties

**Understanding dust attenuation and its effects on emission line galaxies**

**By Andrew Madsen**

- Main goal: Use the state-of-the-art Illustris TNG simulation and PEGASE dust modeling to measure the effects of dust attenuation on emissions lines from distant galaxies. This will allow us to develop a better understanding of the evolution of these galaxies, and the physical mechanisms that shape dust attenuation curves.

- Why it is interesting? Dust attenuation is interesting because it is something we have to consider when measuring light from any distant galaxy, as dust is present everywhere in the universe. The degree to which light is being attenuated from a galaxy can tell us a lot about the evolution of the galaxy, and provide insight on some of the fundamental questions of astrophysics and cosmology.