

Jamboree 2021

The McWilliams Center of Cosmology

Poojan Agrawal

Postdoctoral researcher with Carl Rodriguez

Role of massive stars in stellar population studies

Massive stars contribute to

Transient
phenomena

Chemical
enrichment

Compact
remnants

Ionizing
radiation

Uncertainties in their evolution

Mass loss
rates

Nuclear reaction
networks

Rotation

Mixing
processes

How these uncertainties affect the
properties of their populations

Stellar binaries

Globular
clusters

Nuclear star
clusters

Galactic nuclei

Potential explanation for

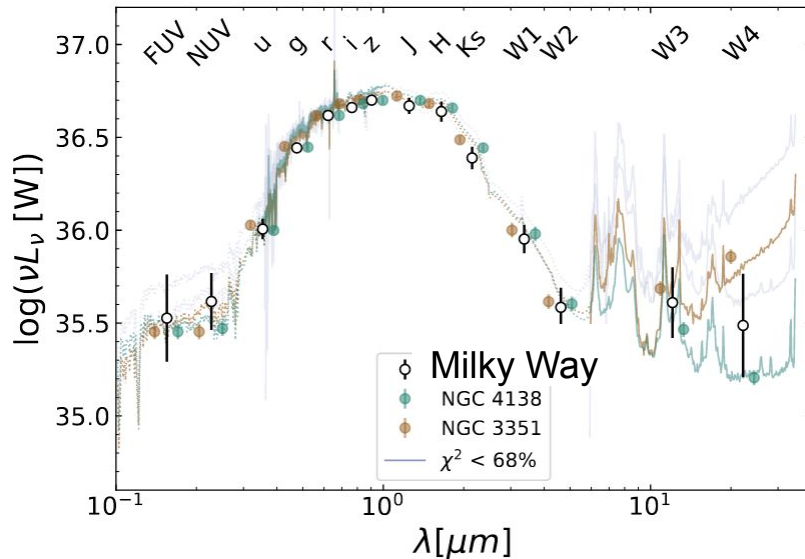
Binary
properties

Dynamical
properties of
clusters

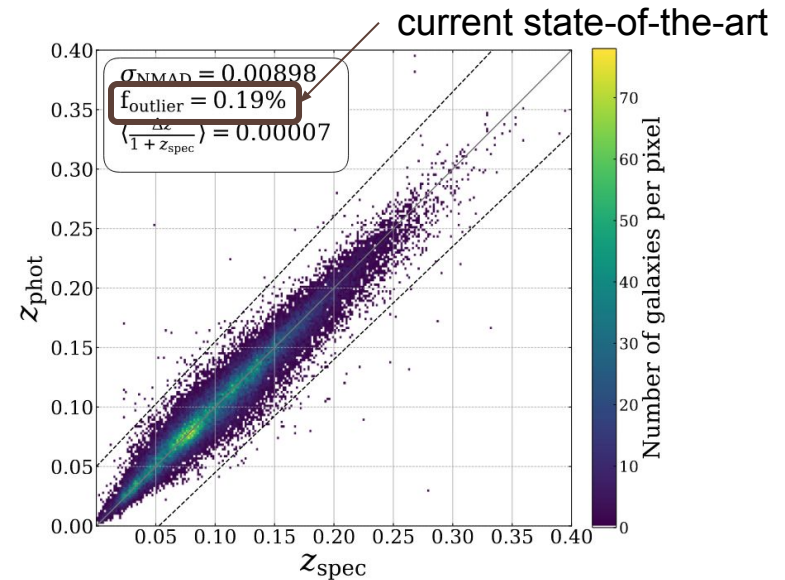
Gravitational
wave
observations

Multiple stellar
populations

Brett Andrews (Pitt Research Faculty)



Cat Fielder: Milky Way SED with Gaussian Process Regression (arXiv: 2106.14900)



Biprateep Dey: Photometric Redshifts with a Deep Capsule Network

Local Calibration of Photo-z PDFs (arXiv: 2110.15209)

Federico Berlfein

1st Year Physics Graduate
Student

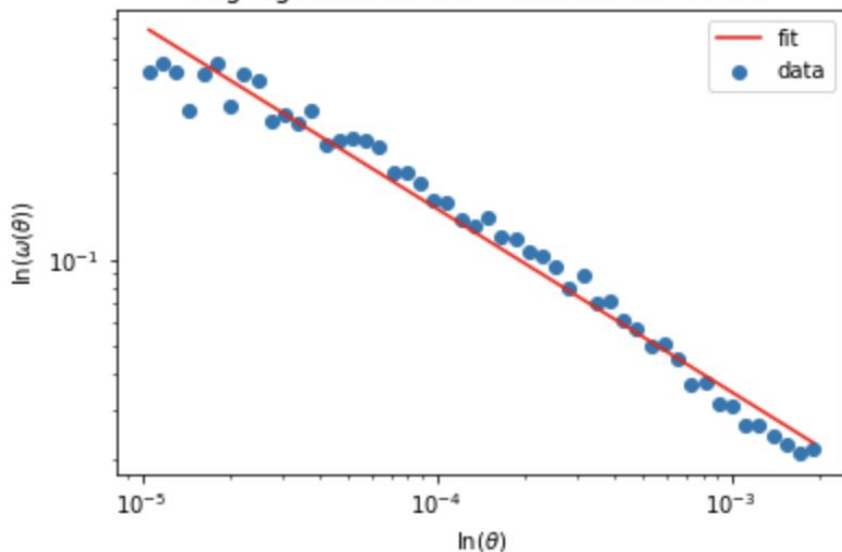
Advisor: Rachel Mandelbaum



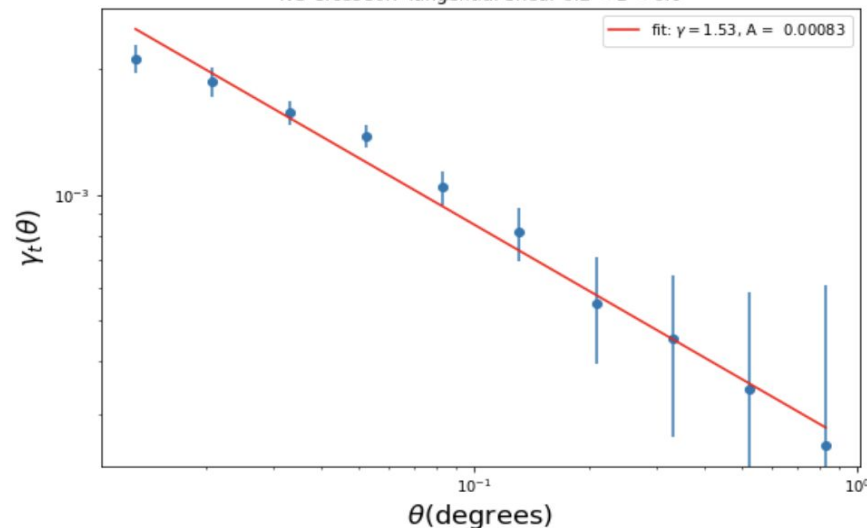
Research:

- Weak lensing and clustering analysis of HSC (Hyper Supreme-Cam) data
- Simple models using auto-correlations and cross-correlations
- 1st semester → Neural Network → How to be a grad student

Log-log Autocorrelation Redshift Bin 0.7-0.8



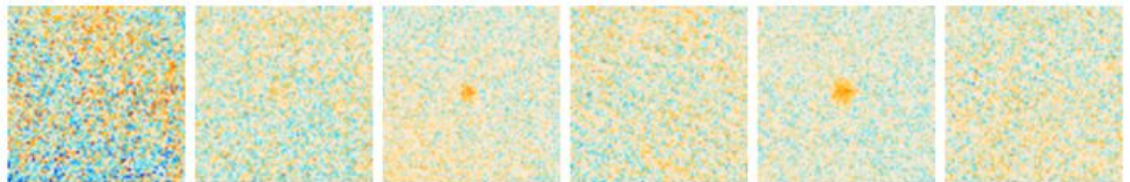
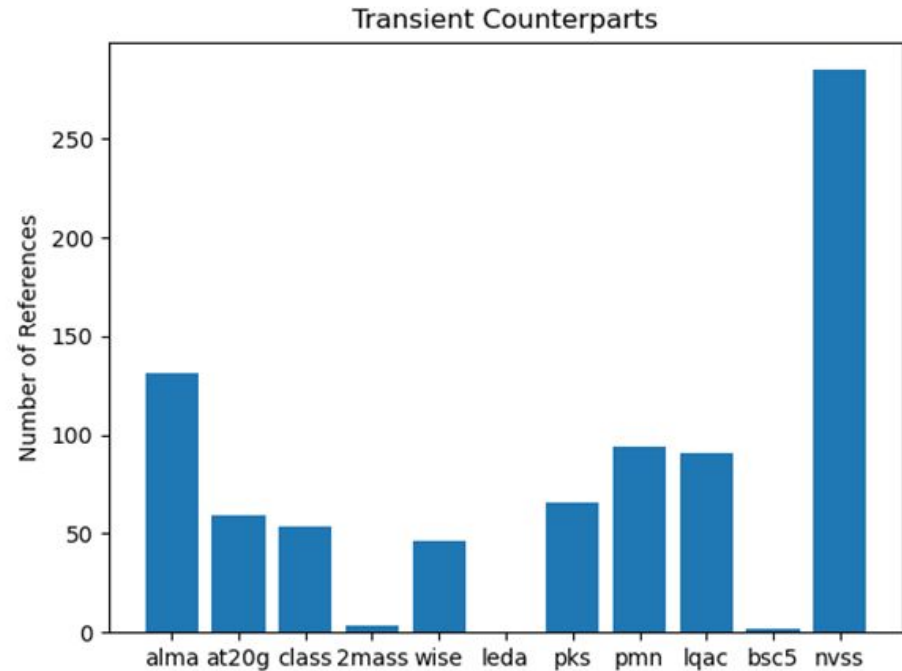
NG CrossCorr Tangential Shear $0.2 < z < 0.6$

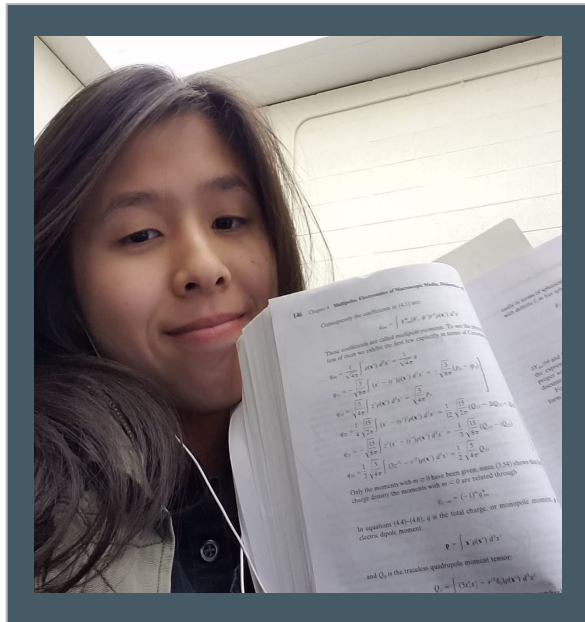


Emily Biermann
University of Pittsburgh
Advised by Arthur Kosowsky



- Search for transient events using ACT data
- Found 524 candidate events, many repeat several times
- Currently working on finding counterparts. We expect to mostly find flaring stars
- Results shown are preliminary

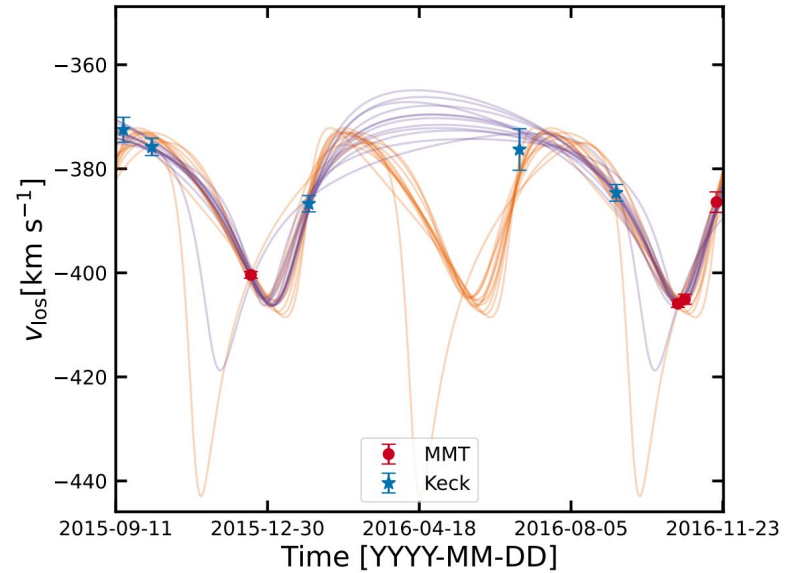




Rachel Buttry (3rd Year Grad Student)
Advisor: Matt Walker

What I study:

- Dwarf Galaxies
- Binary star populations
- Spectroscopic binaries



Sculptor



Fornax



Tomás Cabrera

2nd Year Physics Graduate Student

Advisor: Carl Rodriguez

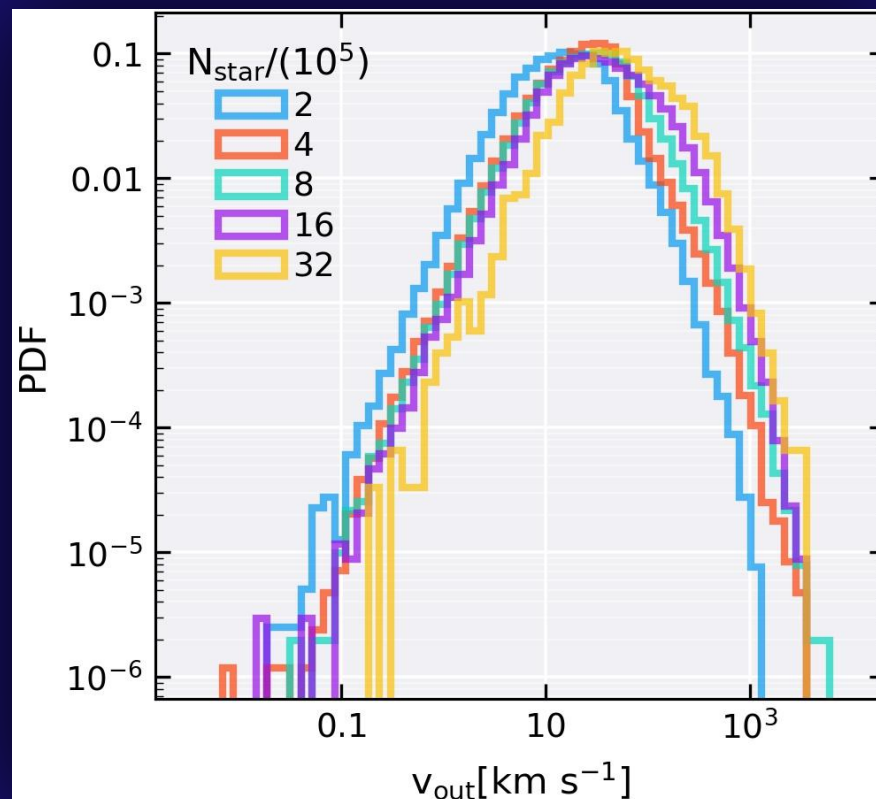
Star Cluster Dynamics via. Monte-Carlo Simulations

Astrophysical products of clusters

- Hypervelocity stars
- Compact object binaries
- Tidal disruption events

Model development

- $10^7 M_{\odot}$ clusters (NSCs)
- SMBH physics



Nianyi Chen (4rd year grad)

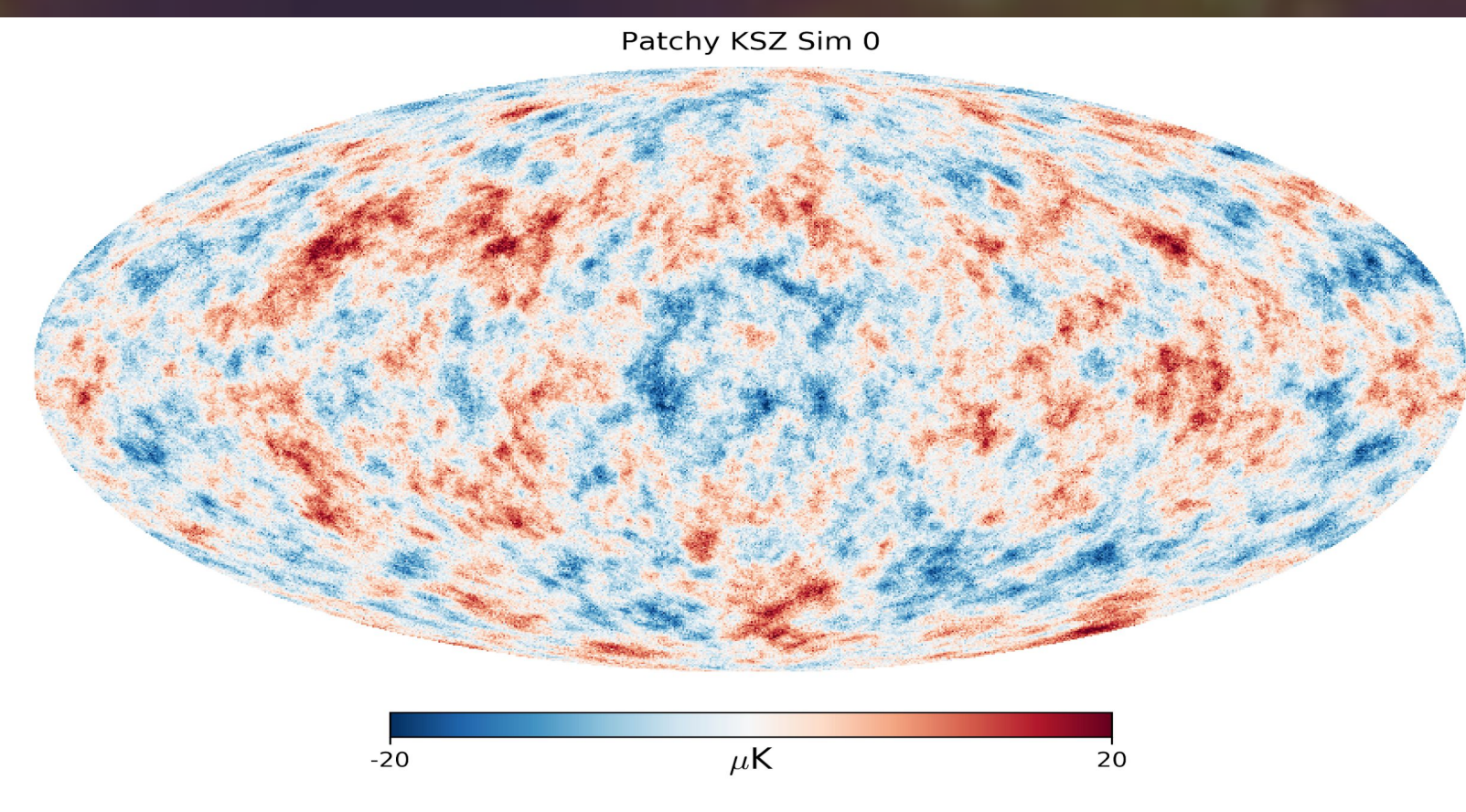
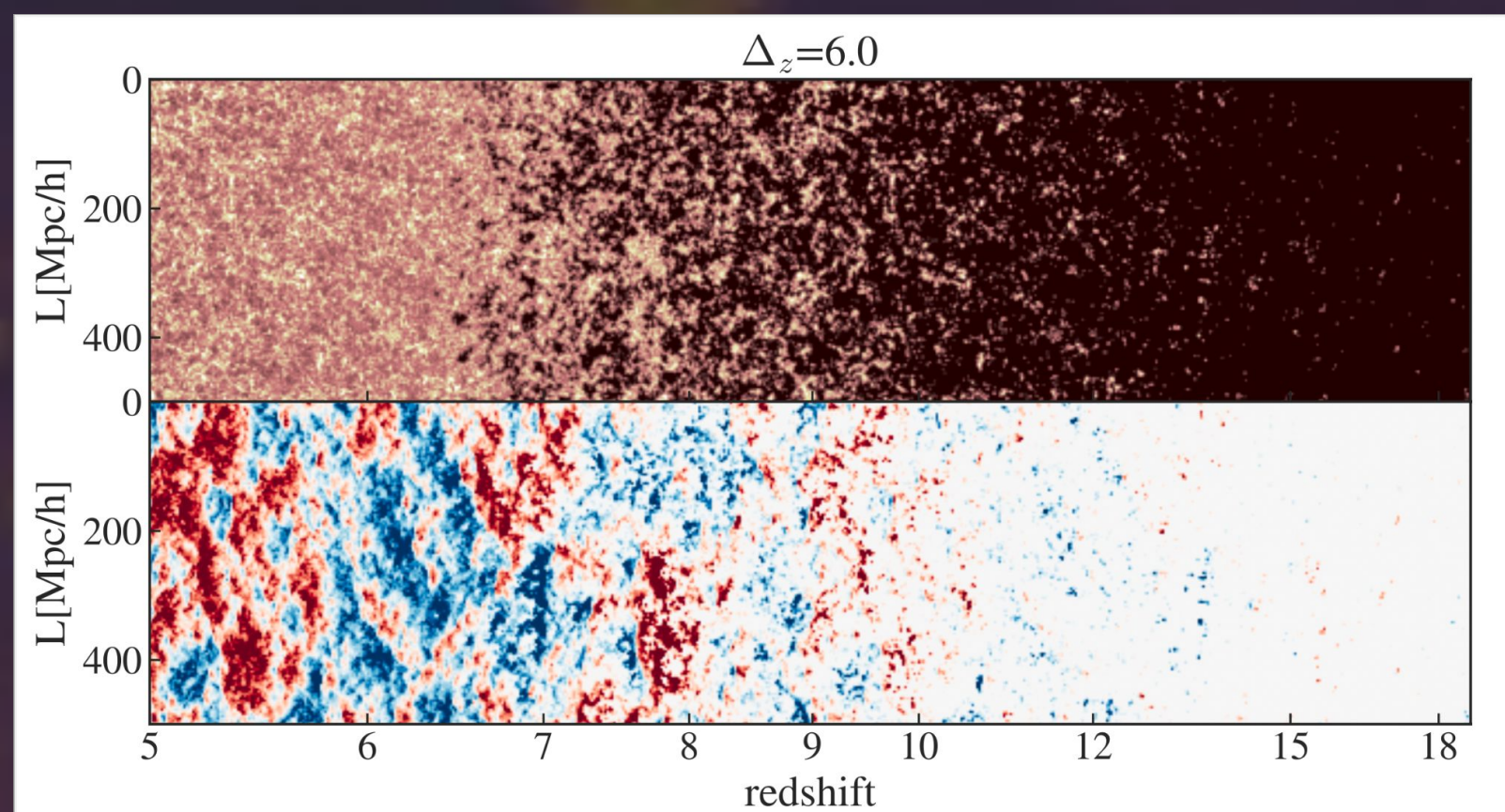
Work with: Hy Trac & Tiziana Di Matteo



**Reionization, Simulations,
kSZ, SMBH mergers**

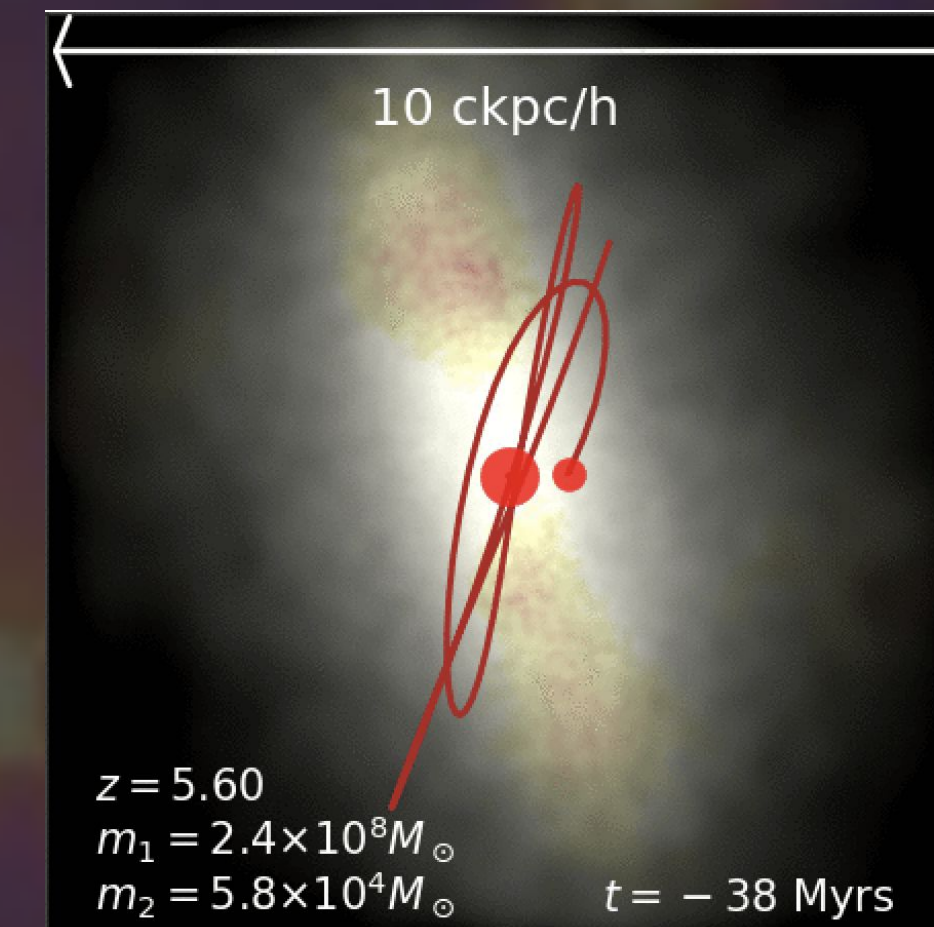
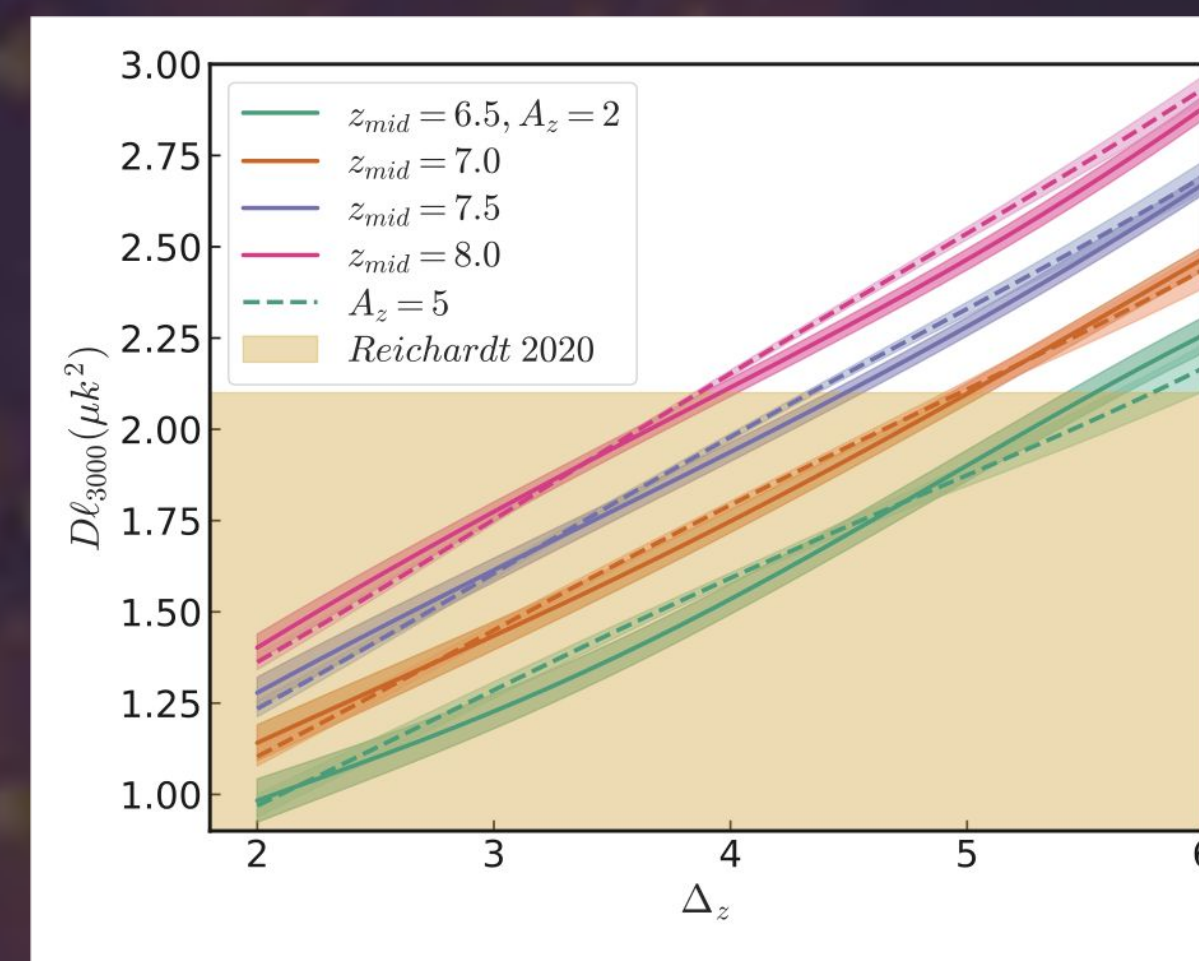
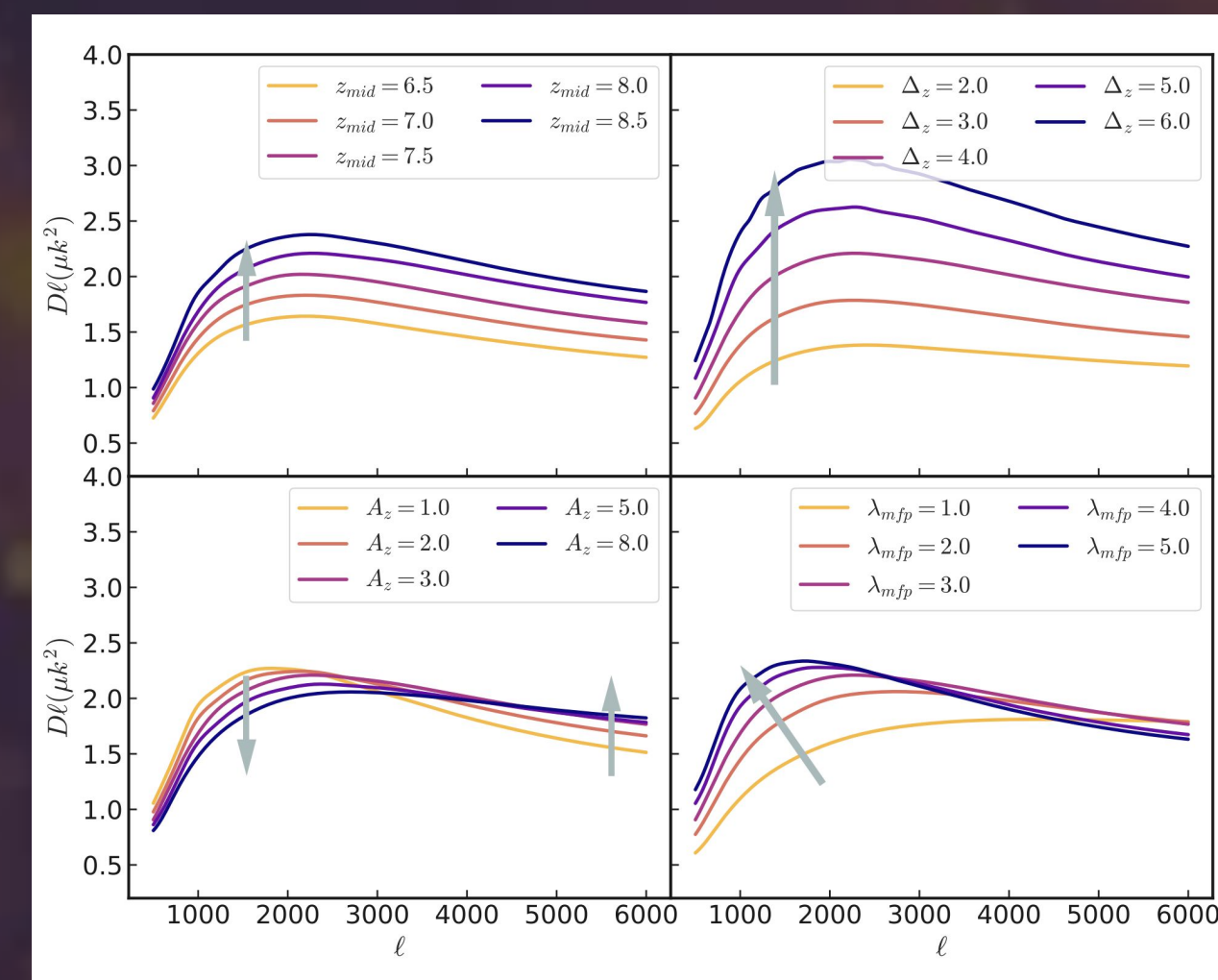
Semi-numerical Reionization + kSZ Effect

- New semi-numerical code for patchy reionization
- Study the patchy kSZ effect with various reionization scenarios



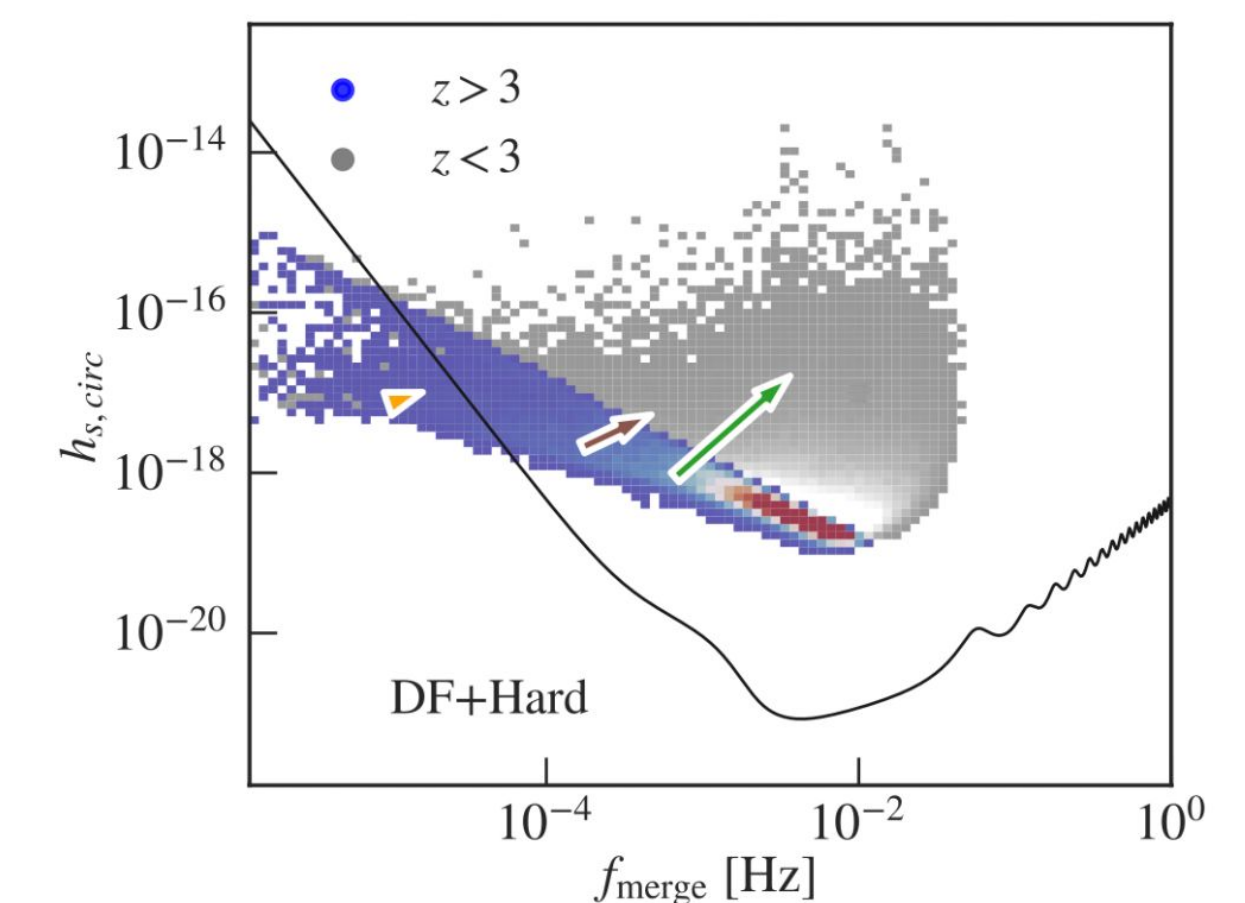
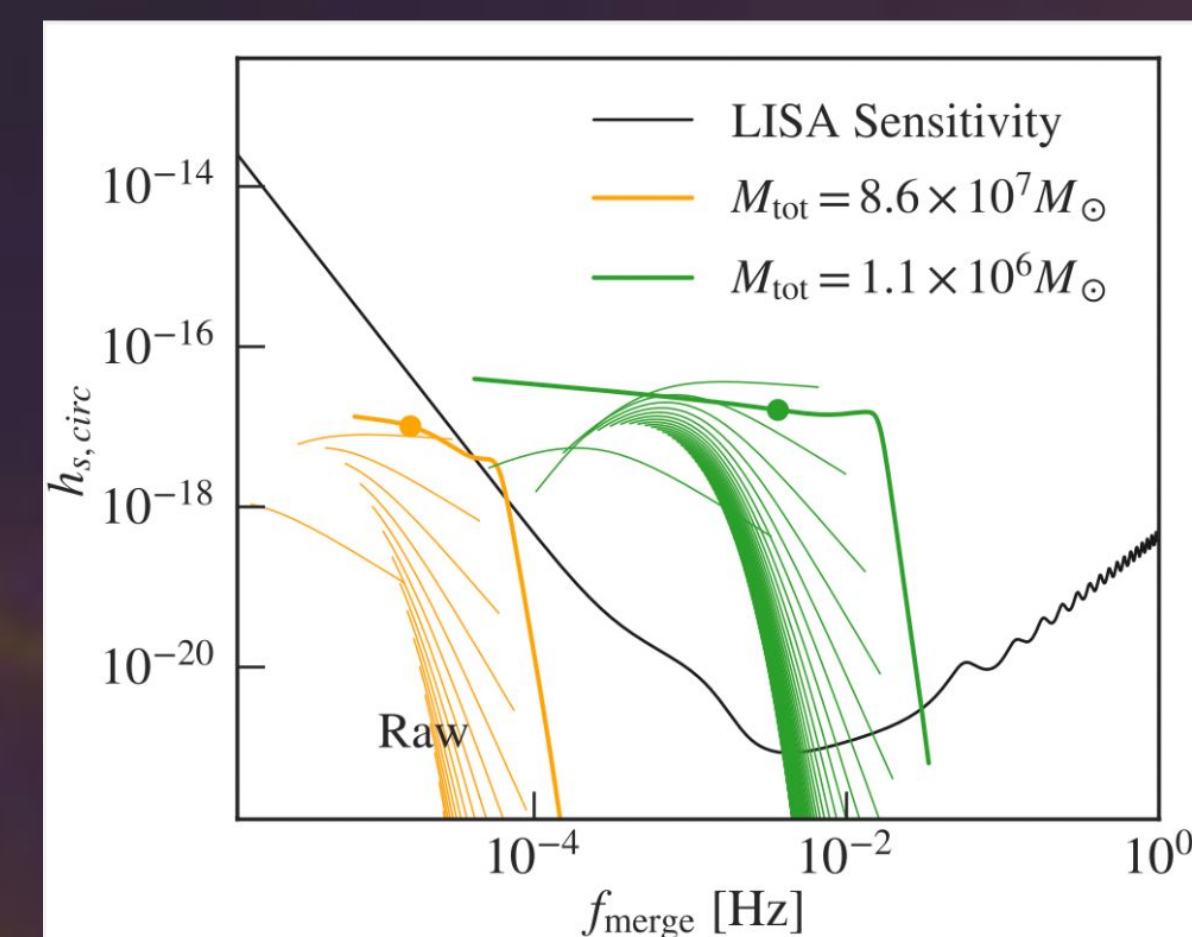
Spectra with Gaussian Process Emulation

- Combine semi-numerical simulation with ML
- Fast emulations or constraining EoR parameters



Hydro Simulation + BH Mergers

- More physical BH dynamics in large cosmological simulations
- BH merger rate/signal-to-noise predictions for future experiments (e.g. LISA)



Emma Clarke



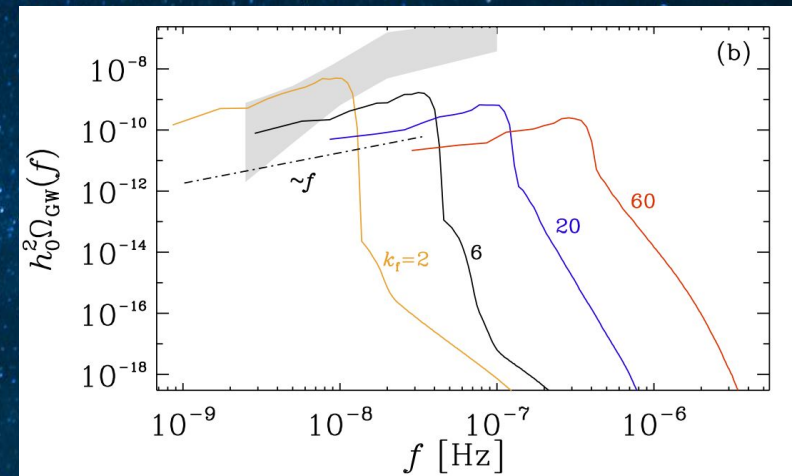
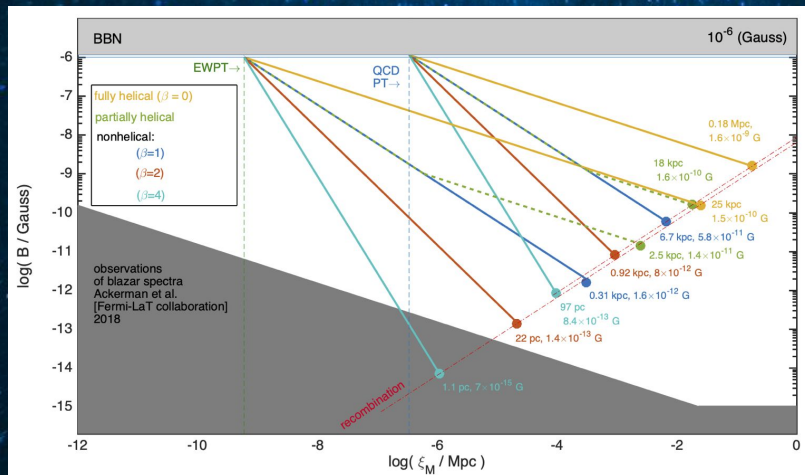
3rd Year Physics Graduate Student
Advisor: Tina Kahniashvili

Research: Primordial Magnetic Fields & Early-Universe Turbulence

turbulent evolution of
magnetic fields

observable signatures

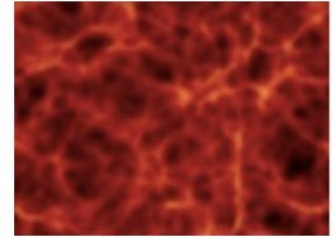
- CMB & LSS
- gravitational waves



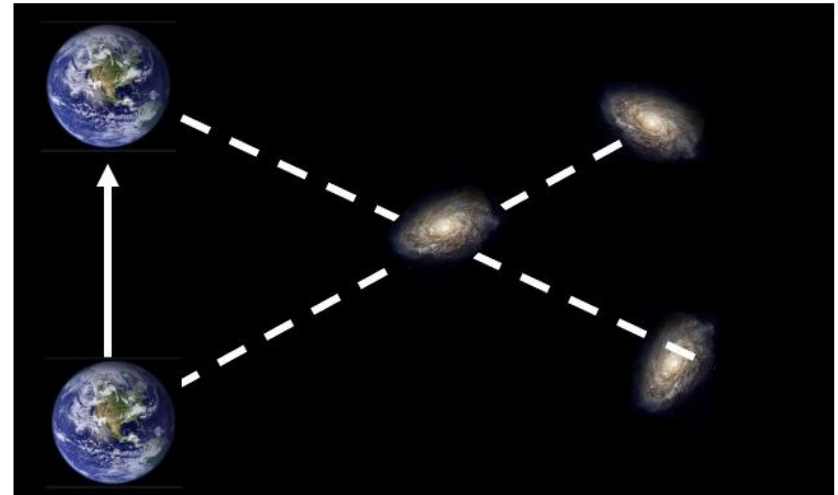


Rupert Croft

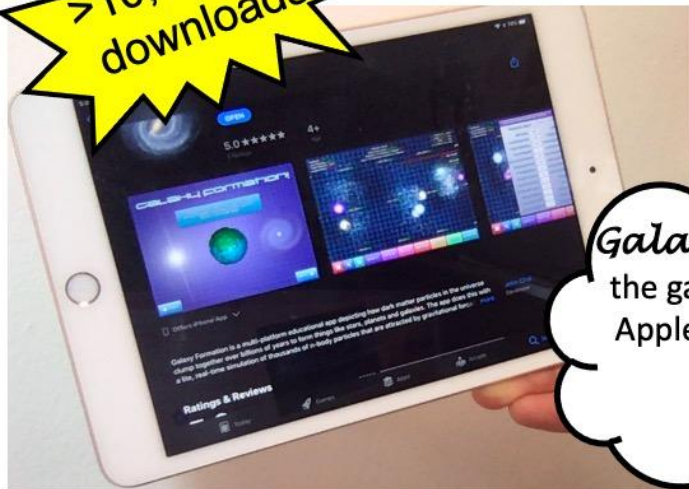
Intensity mapping
(mapping large-scale structure
with spectral lines)
in simulations and observations



Measuring H_0 with galaxy parallax



>10,000
downloads!



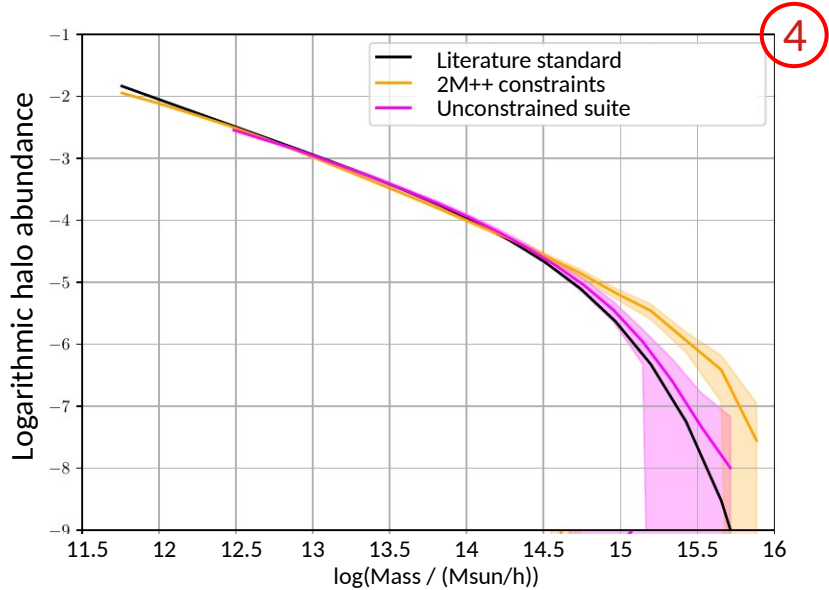
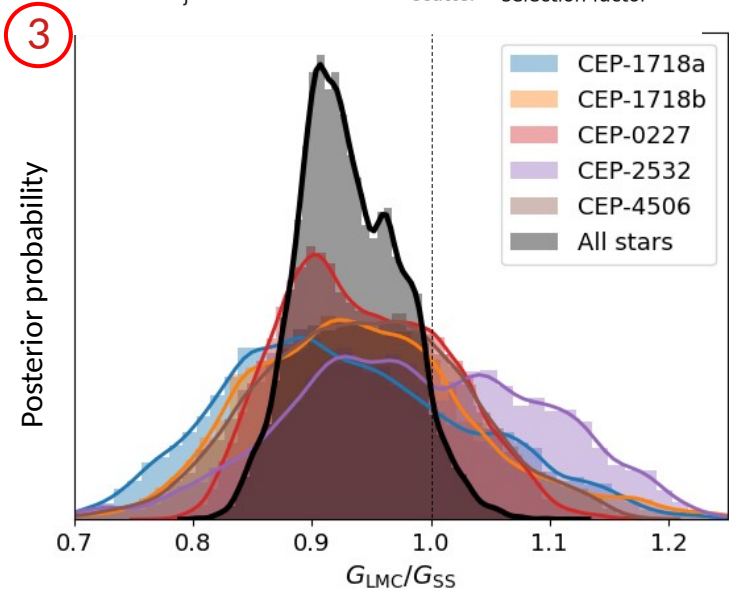
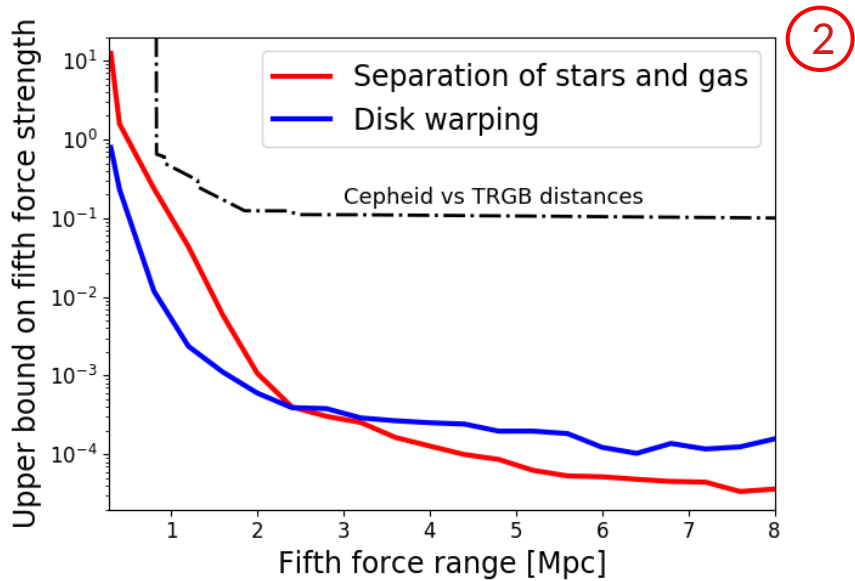
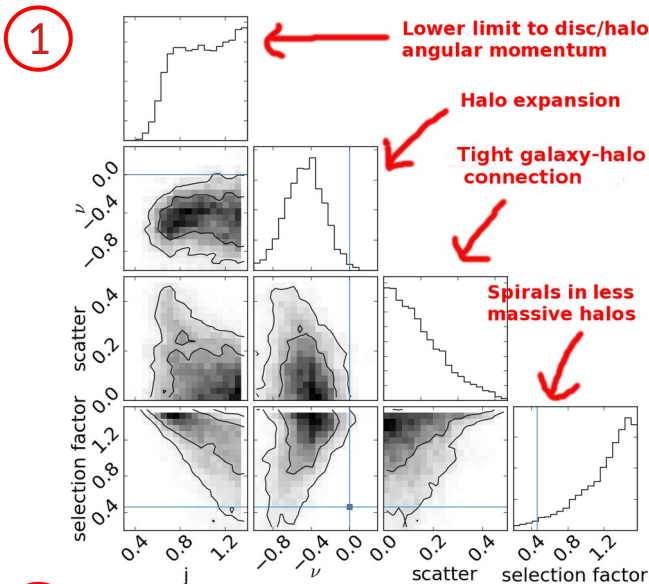
Galaxy Formation
the game: available on
Apple App and Google
Play stores

Also: weak gravitational lensing
galaxy formation simulations
deep learning and cosmology

Harry Desmond
McWilliams Fellow



- 1. Inferring galaxy formation from dynamical scaling relations
- 2. Probing new fundamental forces with galaxies
- 3. Testing gravity with variable stars
- 4. The structure of the local universe





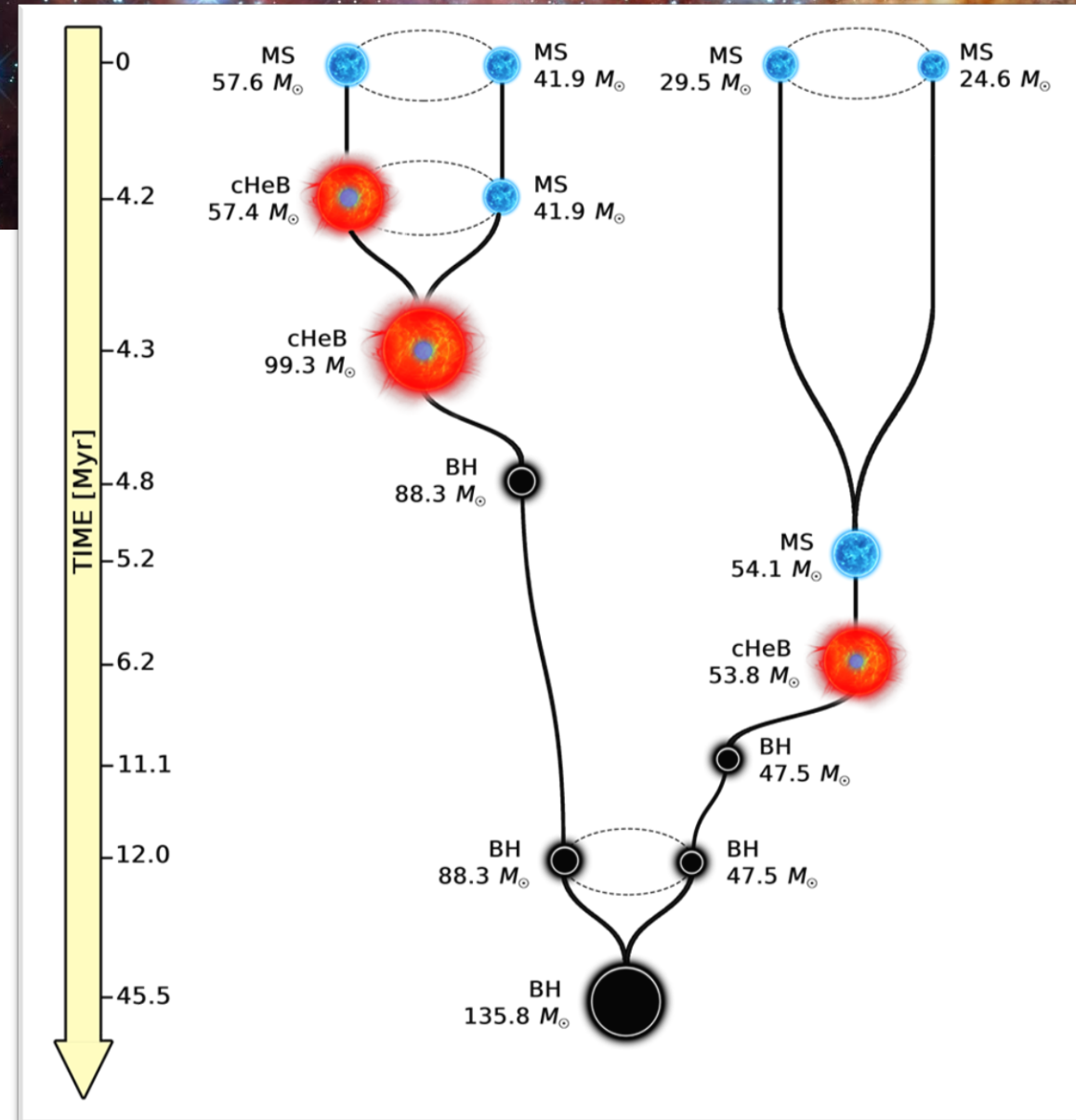
Ugo Niccolò Di Carlo (He/Him) - Postdoc

Main research interests:

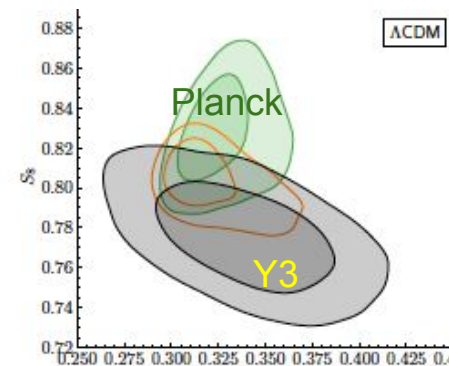
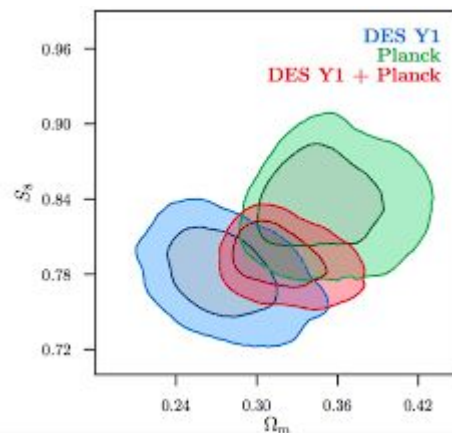
Dynamics of star clusters
Formation of gravitational wave sources
Formation of massive stellar BHs and IMBHs
Direct N-body simulations

Other interests:

Cooking & Baking
Music & Playing Drums
Videogames



Scott Dodelson



Interests (Ordered chronologically):

1. Theoretical Particle Physics and Cosmology (inflation, dark matter, neutrinos, dark energy/modified gravity)
2. Numerical Work ([hydro code!](#) [cosmosis](#))
3. Constraints on local density
4. Cosmological Analysis of Surveys (Dark Energy Survey, South Pole Telescope)
5. Anisotropic clustering (e.g., in lensing, also in clustering, Galactic dust/B-modes)
6. Machine Learning for Analysis
7. ???

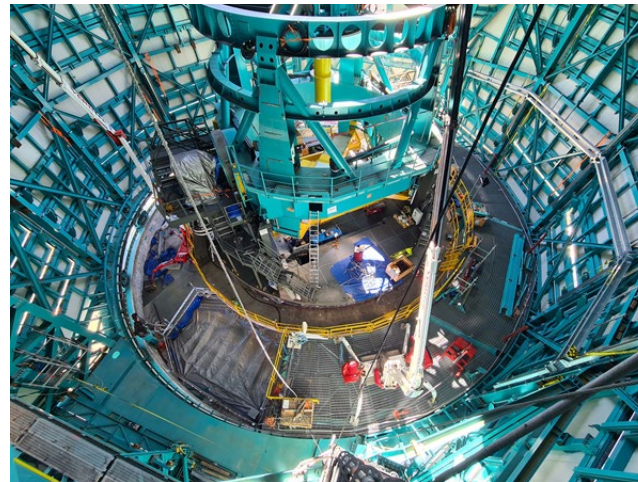
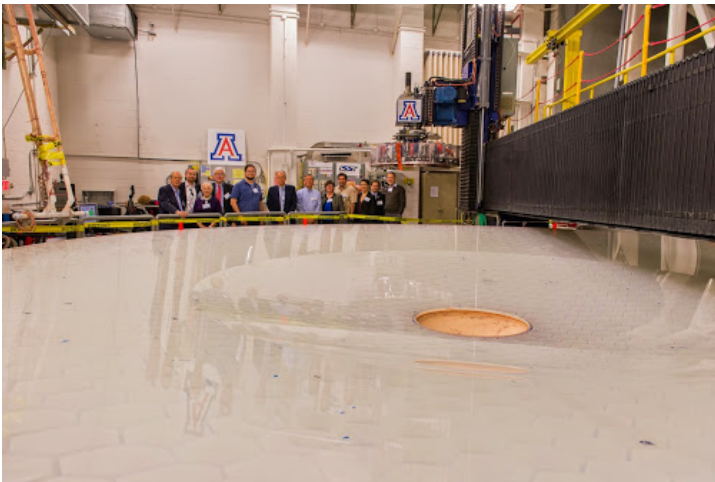
Fred Gilman

McWilliams Center Jamboree 2021

I have been involved in the LSST project, now the Vera Rubin Observatory, since CMU joined the LSST Corporation in 2008.

- After chairing the oversight committee for construction of the Observatory, I became a member of the Management Board for Operations of the Vera Rubin Observatory.
- Considerations: Impacts of delays induced by the Covid epidemic, ramping up operations with NSF/DOE + AURA/SLAC + hundreds of other stakeholders; appointments; data rights, in-kind contributions to operations from international institutions; interim data facility; personnel, etc.

The Management Board will meet again at the end of November with more interesting issues to consider.





Matthew Ho

5th Year PhD Student @ CMU
Hy Trac group

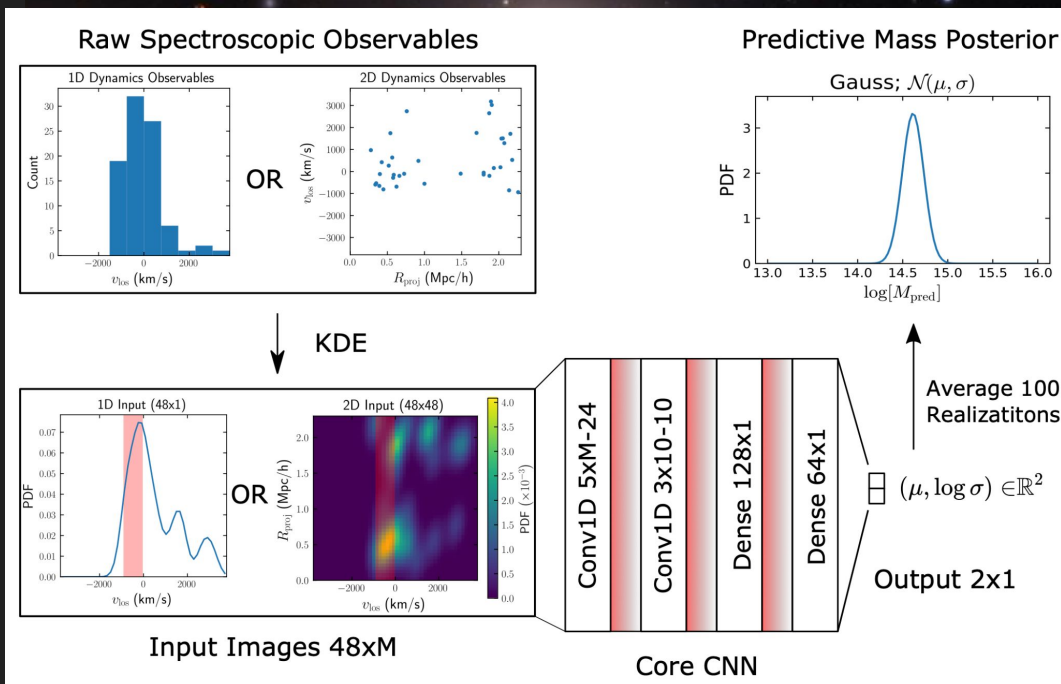
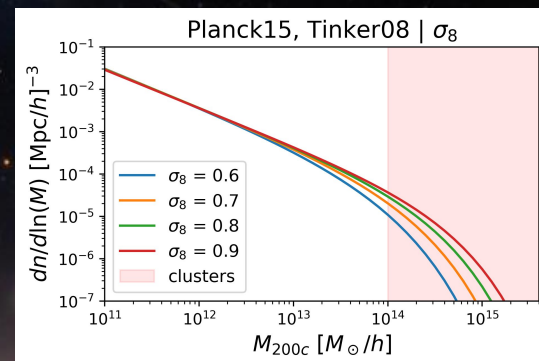
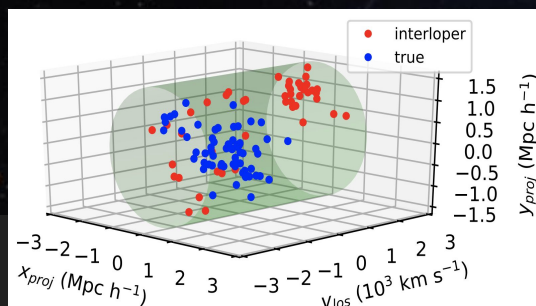
Clusters + Machine Learning

Cluster Cosmology

- Inference from observations (spec-z's, lensing, X-ray, ...)
- Cluster finding, member selection
- Mock observations from N-body + hydro simulations
- Survey analysis (DESC)

Data Science

- Deep Learning
- Generative Models
- Bayesian Modeling, Approximate Inference, Nonparametric Statistics



Technical Expertise: Python, Jupyter, Keras/TF, Git, HPC, SLURM

Yesukhei - Weak lensing: Intrinsic alignment of galaxies

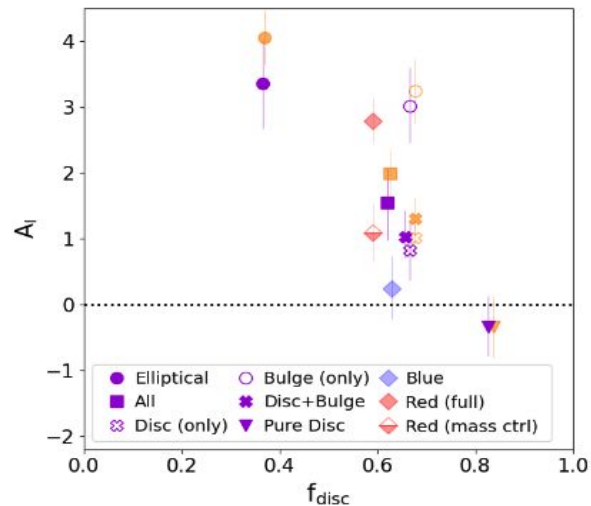
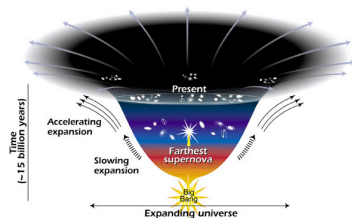
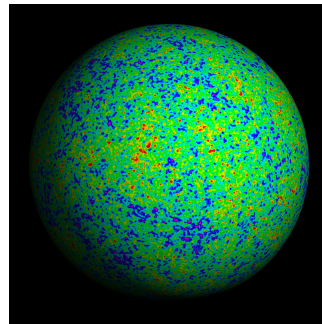
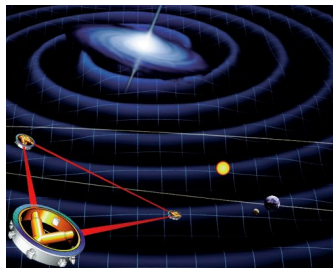
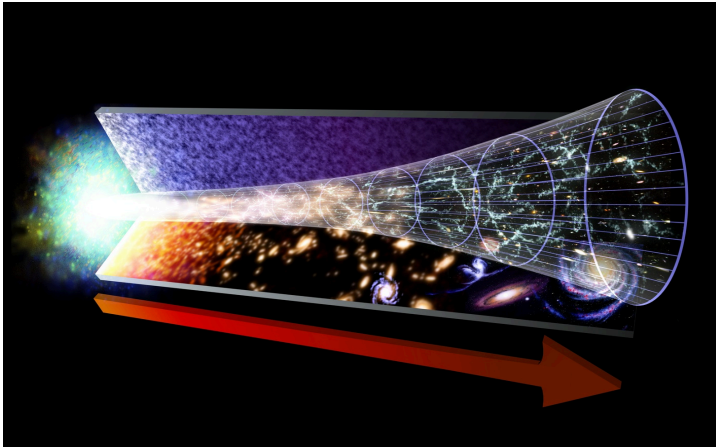


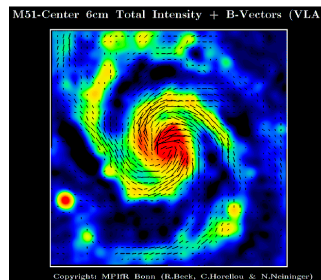
Figure 7. Dependence of the alignment strength parameter A_I on f_{disc} . The purple points are the main mass controlled samples presented in Table 1. Orange points are the non-mass controlled (i.e full samples from the simulation). In both cases there is a clear decreasing trend with f_{disc} in the strength of the alignments. The purple points are slightly below the orange points indicating that there is some little dependence on mass, however the overall trend is the same. Additionally we have also plotted the color split samples indicated by the diamond shape, for the red sample half filled diamond represents the mass-controlled sample and the full diamond - full sample.

Tina Kahniashvili

The McWilliams Center For Cosmology



This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The more shallow the curve, the faster the rate of expansion. The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart at a faster rate. Astronomers theorize that the faster expansion rate is due to a mysterious, dark force that is pushing galaxies apart.



- Cosmology

- Very early universe

- Gravitational waves
 - Cosmic microwave background
 - Fundamental symmetries

- Late-time cosmology

- Dark energy
 - Massive gravity

- Astro-particle physics

- Neutrinos mass origin

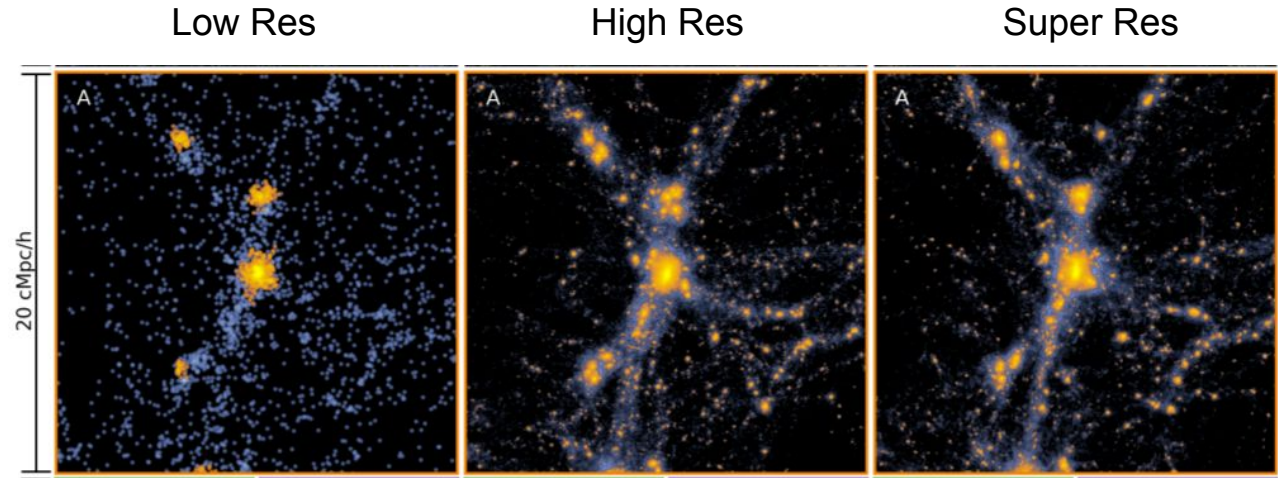
- Astrophysics

- Cosmic magnetic fields

- Cosmic turbulence

Patrick LaChance

3rd Year Graduate Student
Advisor: Rupert Croft

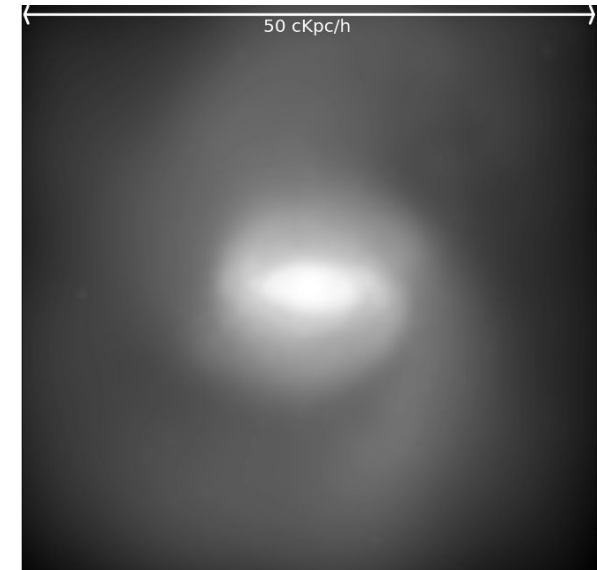
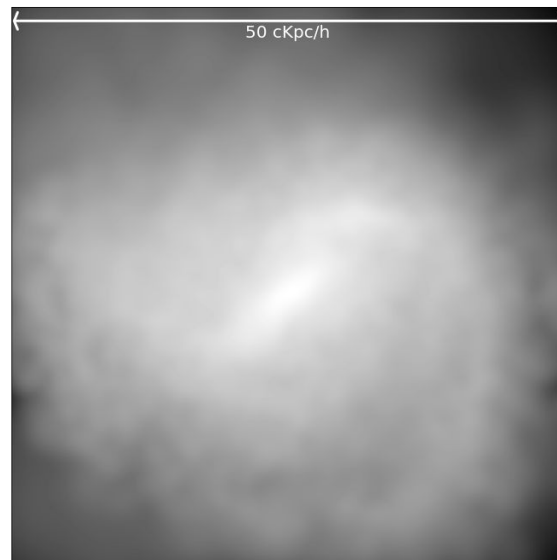


Dark Matter Density Fields

Li et. al. 2021

FUV images of Redshift 4 Astrid Subhalos

- Interests / Area of Research:
 - Applications of machine learning to cosmological simulations.
 - Galaxy structure and populations
- Current Projects:
 - Using GANs to increase the fidelity of low resolution simulations
 - Investigating density-morphology relation in the Astrid simulation



Xiangchong Li (Postdoc)

UTokyo/IPMU (PhD) -> CMU (working with Rachel Mandelbaum)

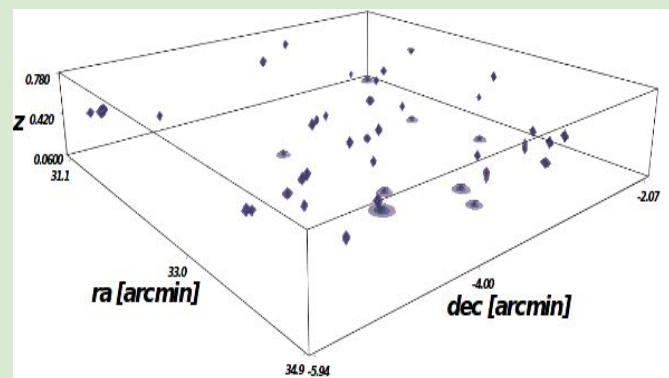
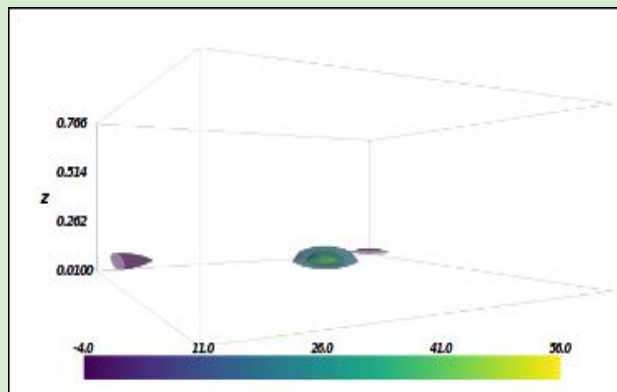
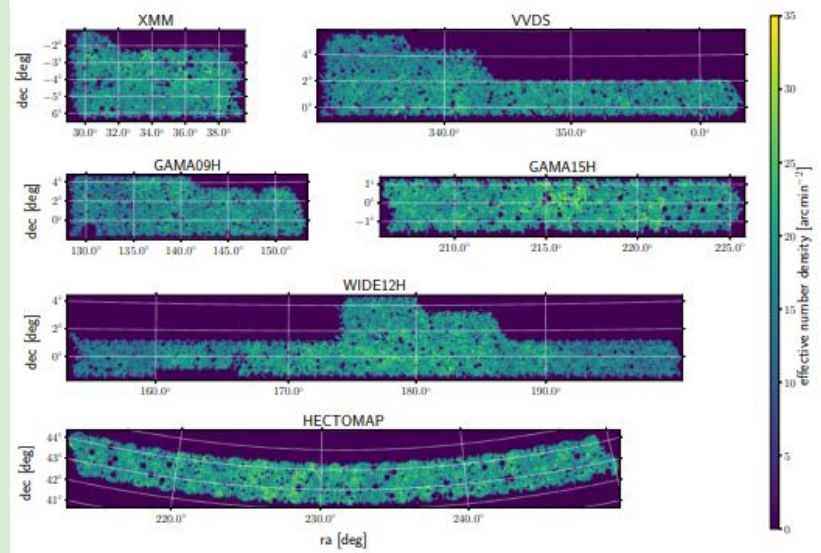
Dotfiles: <https://github.com/mr-superonion/dotfiles>

From image to shear catalog

- Galaxy Image simulation;
- Shear estimator:
 - ❖ Analytical shear estimator controlling bias to subpercent level for isolated galaxies ([FPFS](#));
 - ❖ Bias related to blending.

From shear catalog to 3D mass map

- Sparsity;
- Oracle property;
- Adaptive lasso.



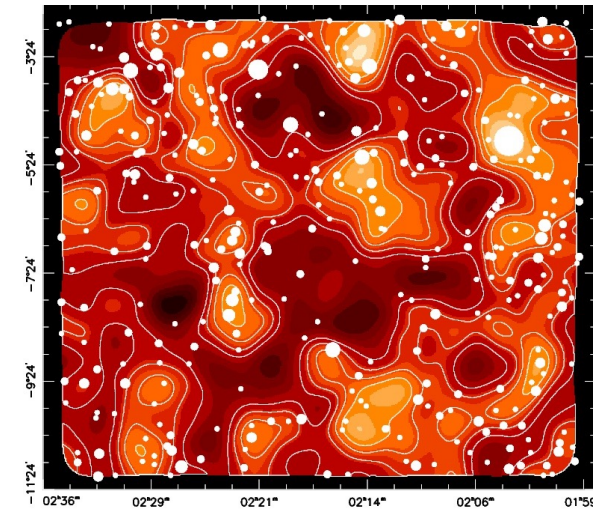
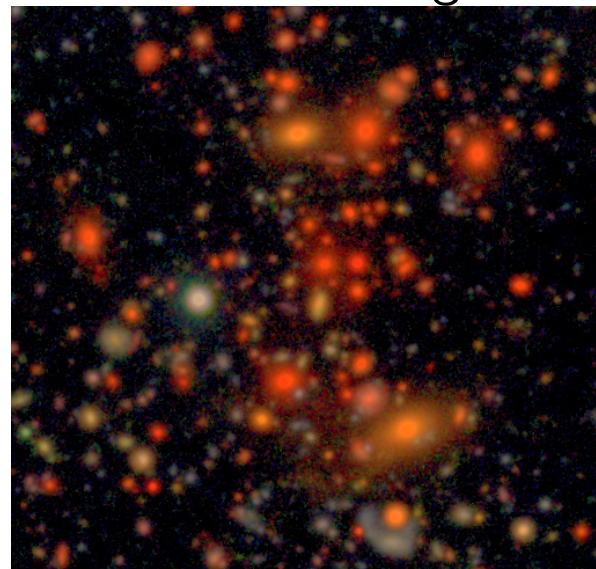
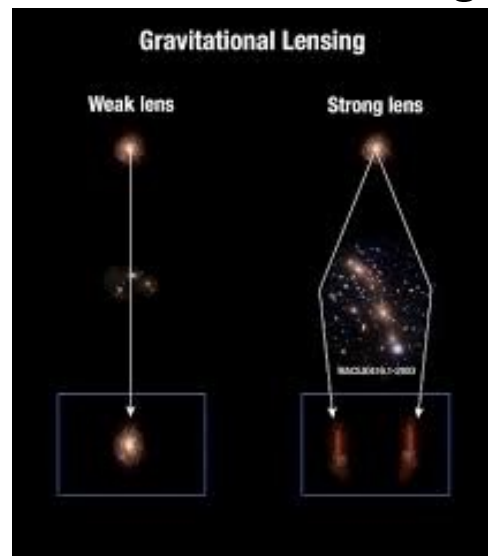
Rachel Mandelbaum



Observational cosmology:

- how can we make the best use of large datasets? (+stats, ML method)
- cosmology: dark energy, modified gravity
- the galaxy-dark matter connection

I measure weak lensing for tens of millions of galaxies to (statistically) map dark matter and answer these questions



Currently
working on:

While preparing for...

Rubin Observatory



Including a *new* effort funded by the Schmidt Futures Foundation, to build scalable science analysis frameworks for LSST – collaborators welcome!

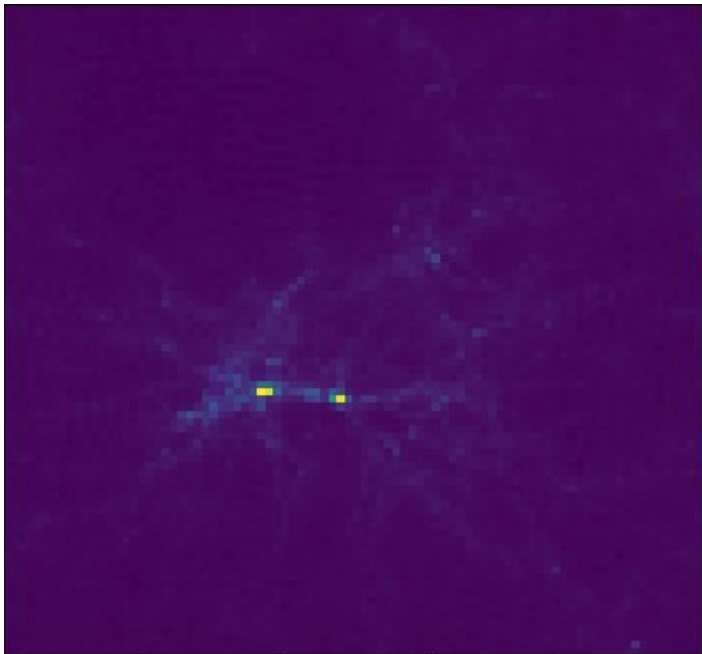
HYPER SUPRIME-CAM

Carleen Markey

1st year grad student

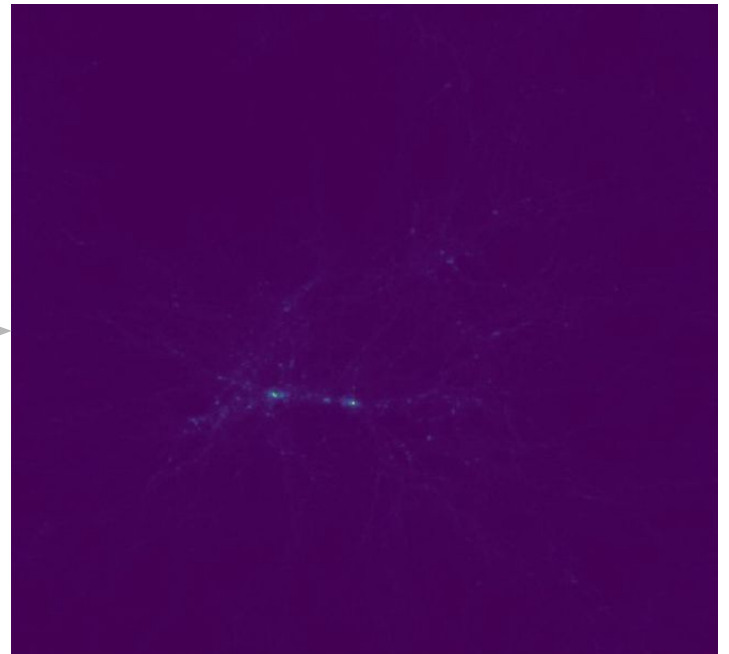
Advisors: Tiziana Di Matteo and Rupert Croft

Low Resolution



Neural
Network

Super Resolution



Super-resolution of black hole merger simulations

- New McWilliams Fellow
- From Scotland
(PhD at Edinburgh / ROE)
- Previous MSc in AI
(Also at Edinburgh)



Ben Moews

(aka "that person with the weird beard")

Research:

- Bayesian nonparametrics and HPC for cosmological Inference
- Machine learning for hybrid analytical models of galaxy evolution
- Density ridge estimation and cosmic voids for alternative cosmologies
- Impact work in finance and criminology, for reasons, surely

Hobbies:

- Books (the happy kind)
- Music (the unhappy kind)
- Tinkering with vintage watches while swearing in German or Scottish English

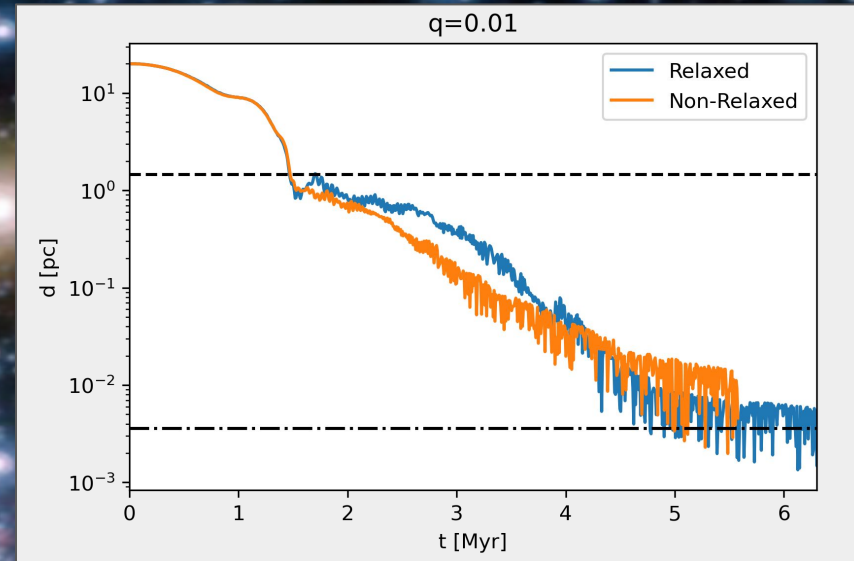


Midgardsblot Music Festival 2018, Norway, on a way-too-big chair

Dipto Mukherjee

3rd year graduate student

Advisor: Hy Trac



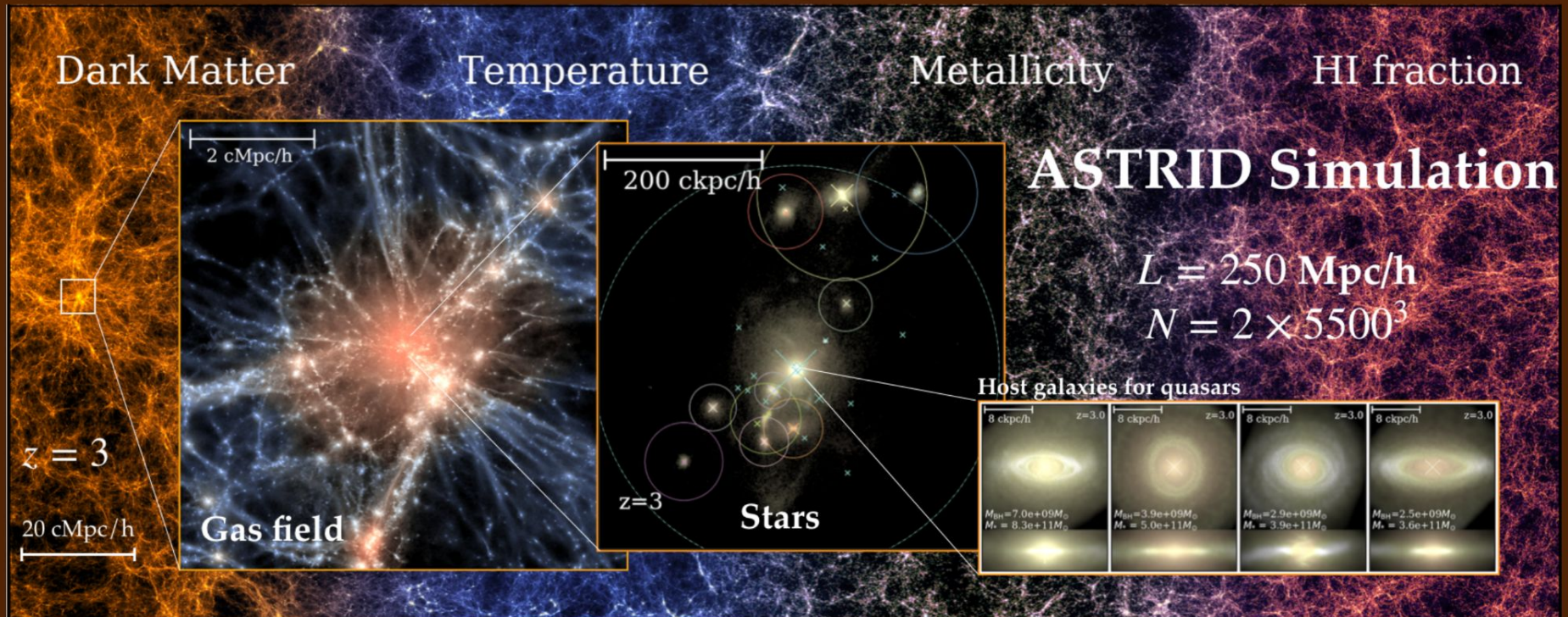
Research Interests:

- Supermassive Black Hole mergers in Nuclear Star Clusters
- Sources of millihertz gravitational waves for LISA
- Fast N-body techniques using Fast Multipole Methods for collisional dynamics

Yueying Ni (<https://yueyingn.github.io>)

5th year PhD candidate, Advisor: Tiziana Di Matteo

- Growth and evolution of high- z galaxies and quasars with Large cosmological hydrodynamic simulations & Constrained Gaussian Realizations
- ML in simulation / Super-resolution simulations
- Astrophysical probes of alternative dark matter models

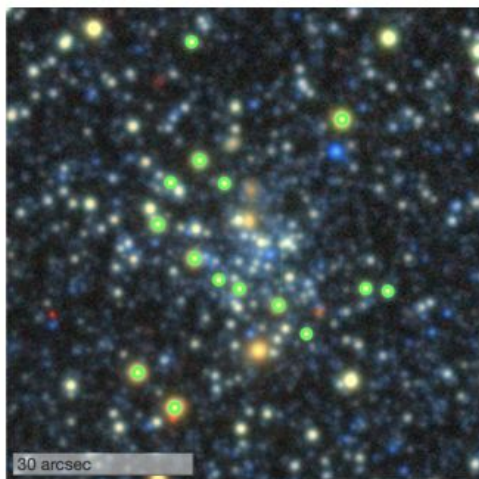
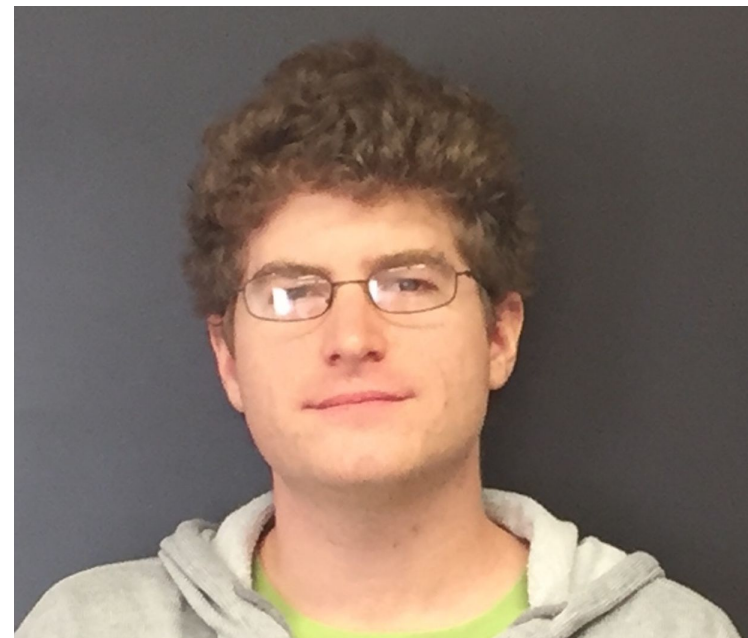


Andrew Pace

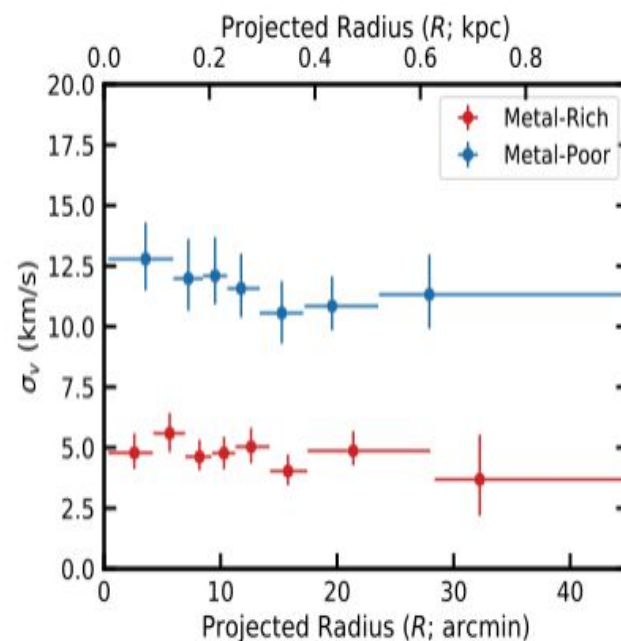
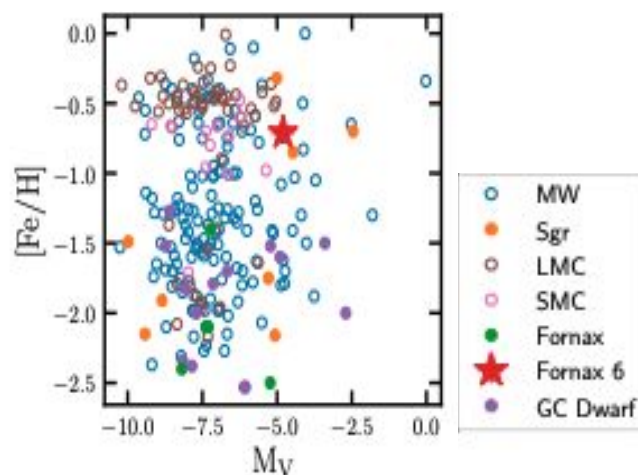
Postdoc, Milky Way Group

Research Interests:

- Dark Matter
- Dwarf Galaxies
- Stellar Streams



Spectroscopy of Fornax 6 Cluster



Dynamics of Multiple Populations

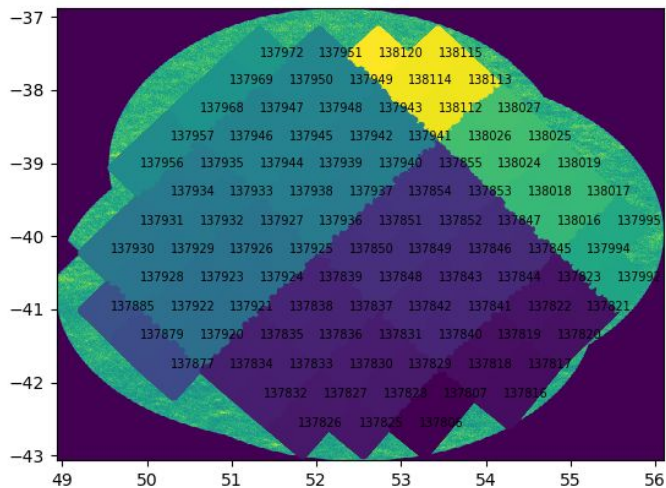
Andy Park 1st year graduate student
Advisor: Rachel Mandelbaum

Research

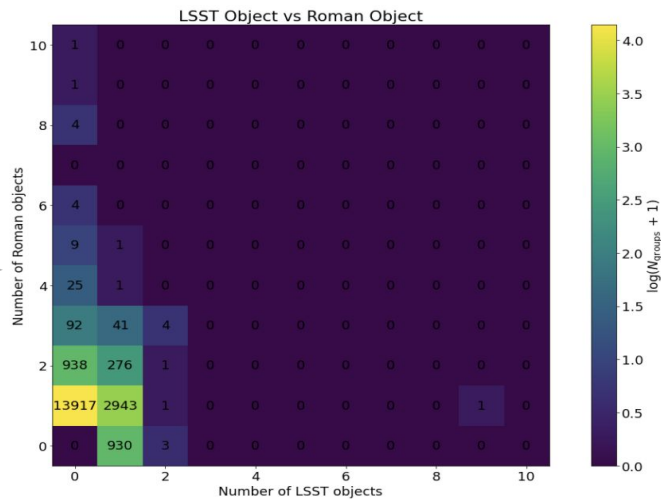
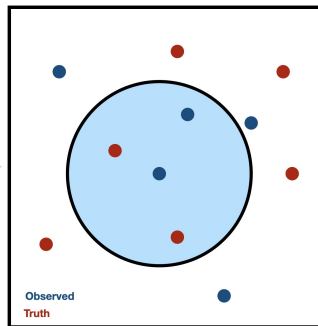
Joint Rubin observatory and Roman Space Telescope pixel-level simulations.

How many separate Roman objects can be identified among blends in the LSST images?

- Study blending properties by cross matching catalogs



20 sq. deg overlapping area



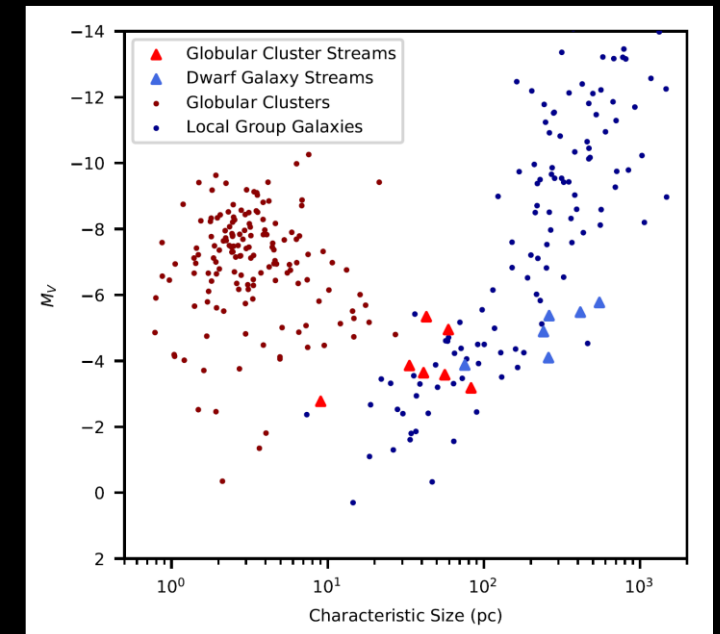
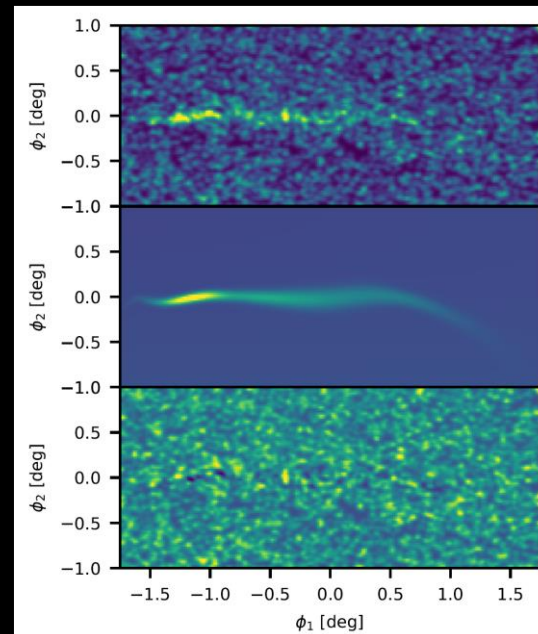
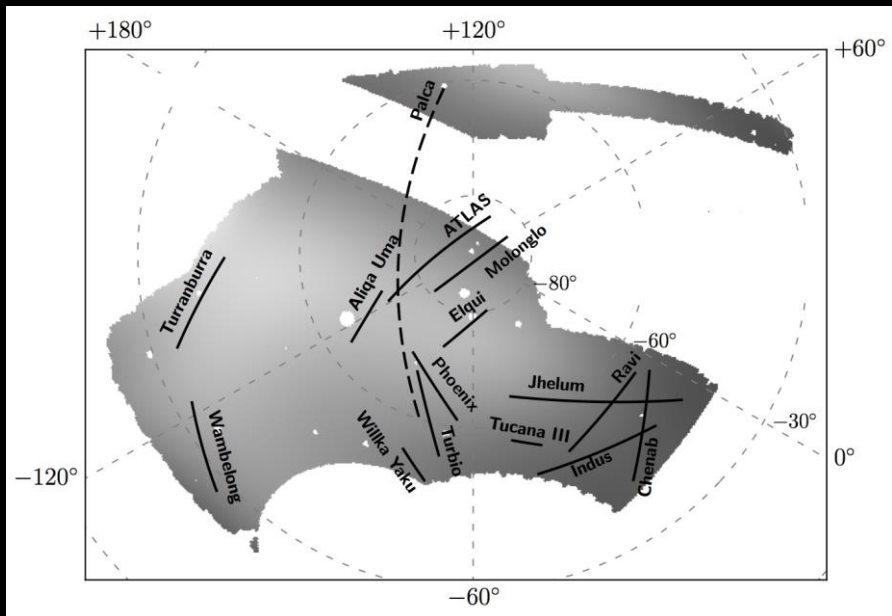
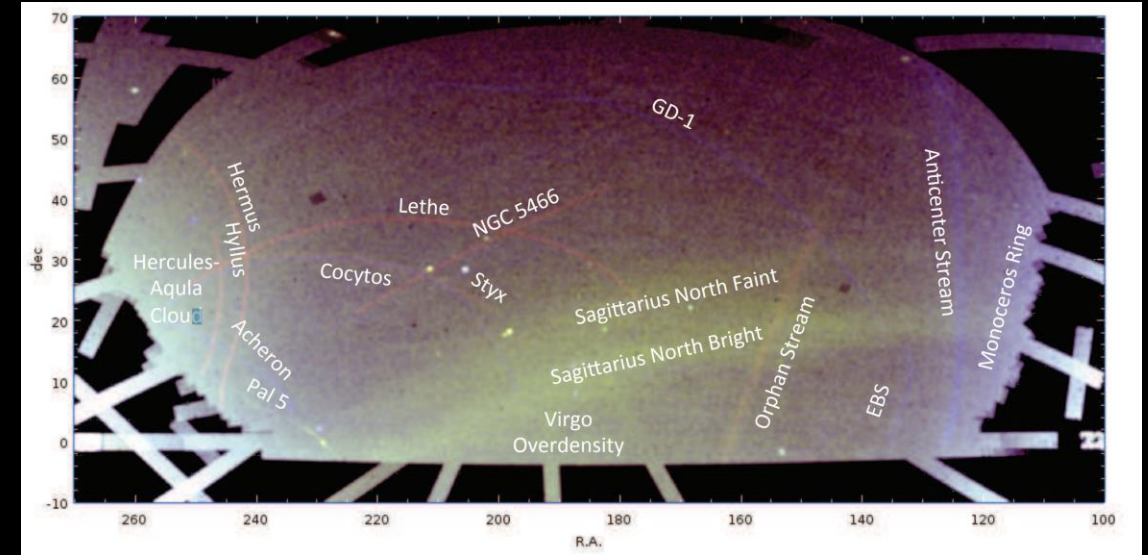
Jeff Patrick

Working with Sergey Koposov and Matt Walker

6th year grad student

Worked on automated modelling of stellar streams

Currently studying their characteristics as a group





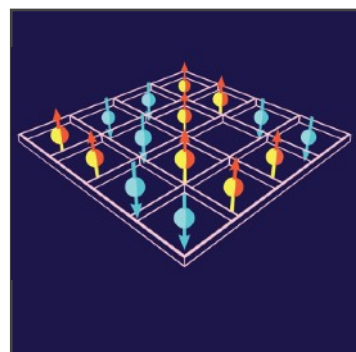
Riccardo Penco

Office: Wean 7408

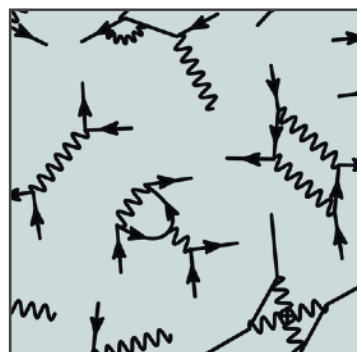
Email: rpenco@cmu.edu

Research Interests:

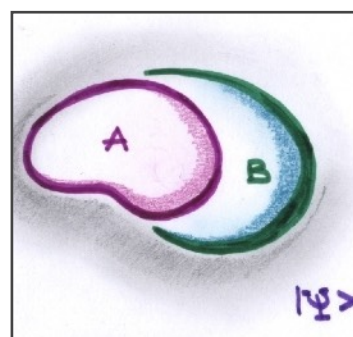
effective field theories for high energy, condensed matter,
and cosmology



EFTs for
magnetic systems



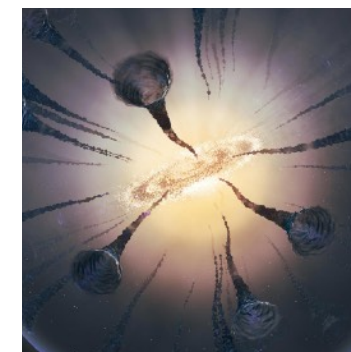
Scattering Amplitudes



EFTs for open systems



Black Holes



Gravitational waves

Patrick Shaw

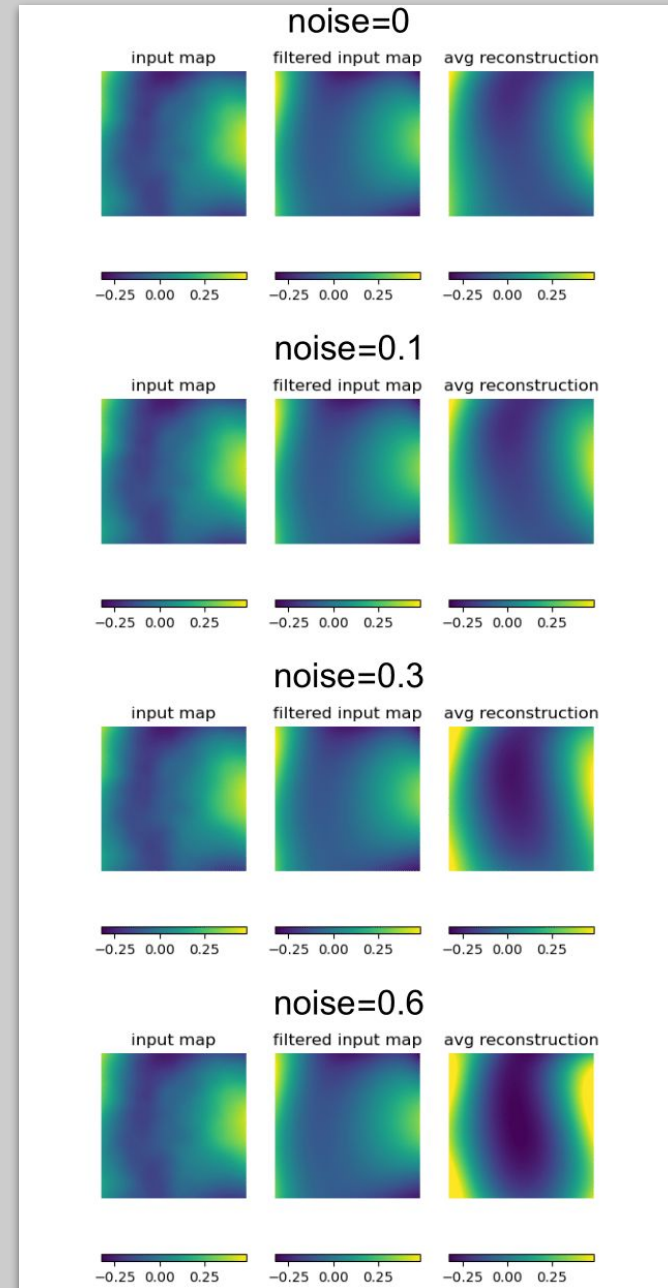


(If you confuse me and Patrick LaChance it's ok... we are identical to leading order)

(Although my hair has lifted one degeneracy)

Current Research:

- Weak lensing of the Lyman-alpha forest
- Use estimator developed by R. Benton Metalf, Nicolas Tessore, Rupert Croft to reconstruct the gravitational lensing potential from Lyman-alpha forest
- Apply to more realistic non-gaussian mock data



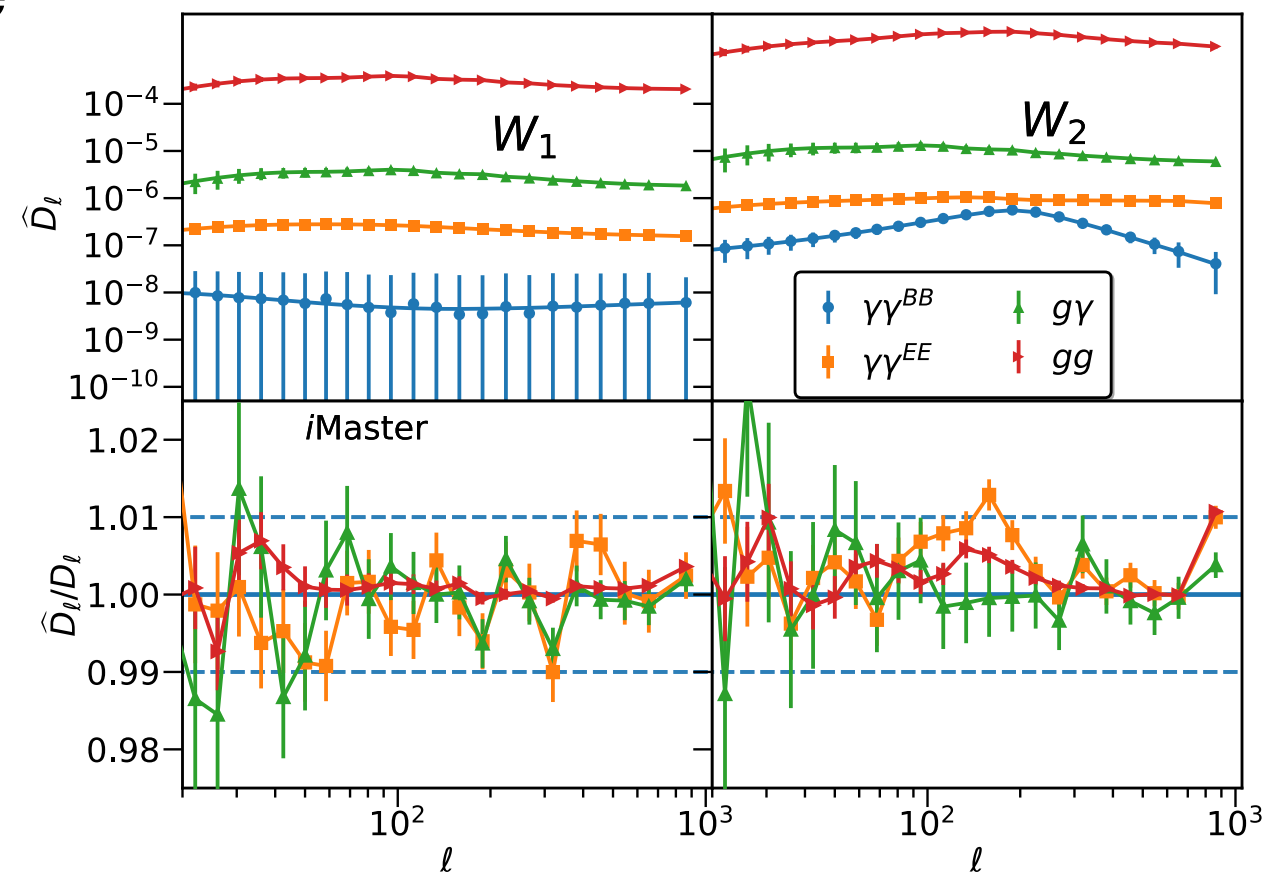
Sukhdeep Singh

McWilliams Postdoc fellow



Research interests

- Large Scale structure in the Universe
 - Weak Lensing measurements, systematics
 - Cross correlations, joint analysis, statistics.
- Intrinsic alignments of galaxies
- Fundamental plane / size relations of galaxies



Jonathan Stepp

Undergraduate

Research Advisor: Tina Kahniashvili



Research: Studying BBN limits on lepton asymmetry and a connection to primordial magnetic fields.

Diane Turnshek

Special Faculty

DH 2200



dianeturnshek.com/dark-skies/



PITTSBURGH SECTION of the PENNSYLVANIA CHAPTER

90.5 WESA
Heard on Morning Edition
Pittsburgh Wants You To See
Constellations When You
Look Up At The Night Sky

A Martinez, host
September 16, 2021



Diane Turnshek interviewed on NPR's Morning Edition.
Text and audio recording
Two minute listen.
[Continue reading](#)

Washington Examiner
Pittsburgh enacts measure
targeting light pollution to
become 'dark sky' city

by Jeremy Beaman, Energy and Environment Reporter
October 04, 2021



Pittsburgh decided it wants more darkness, but the city isn't
turning out the lights — it's just turning them down.
[Continue reading](#)

Trib Live
Peduto introduces 'Dark Sky'
legislation to reduce light
pollution in Pittsburgh.

by Paul Guggenheimer
August 25, 2021



Some Pittsburgh residents may have been wondering why some
stars in the night sky have been more difficult to see in recent
years. Or why evenings seem less tranquil than they used to?
[Continue reading](#)

CMU News
Dark Skies Ordinance To Dim
Pittsburgh's Light Pollution

by Emily Payne
September 27, 2021



CMU Special Faculty Diane Turnshek helps Pittsburgh bring
new regulation to light.
[Continue reading](#)

The Verge
Dark Skies Over Pittsburgh,
PA – Interview: "THERE
WERE NO MORE STARS . . ."

by Aria Alamhodadi
Jun 16, 2020



KDKA Live interview
Diane Turnshek – Carnegie
Mellon University
astronomer.

With Lynne Hayes-Freeland
August 25, 2021



[Continue reading](#)

IDA.org
September Monthly Star:
Q&A with Advocate Diane
Turnshek from Pittsburgh,
USA

International Dark Sky Association
September 24, 2021



Christian Science Monitor
Chasing darkness: One
reporter's journey into the
night

by Eva Botkin-Kowacki Staff writer
December 21, 2018



The Allegheny Front: A DARK
SKY ADVOCATE SAYS
LIGHT POLLUTION
SEPARATES US FROM THE
STARS

by Kara Holsopple
October 27, 2021



Pittsburgh is trying to dim light pollution. The city's Dark Sky
Lighting ordinance signed by Mayor Bill Peduto in September
calls for modifying lighting in newly constructed or renovated
city-owned facilities, city parks, and street lights.
[Read more](#)

Pittsburgh Post Gazette
Seeing the light: Peduto
administration aims to reduce
light pollution in proposed
ordinance

by Ashley Murray
August 24, 2021



An effort to see the Milky Way is underway with a potential
new city law that requires softer, subtler lighting in Pittsburgh
[Continue reading](#)

Metro21 Podcast: Diane
Turnshek Talks Light
Pollution and the Night Sky

November 14, 2018



Diane Turnshek
Talks Light
Pollution and
the Night Sky
Listen to the
podcast

Sky & Telescope
Pittsburgh Goes Dark: Could
this new Dark-Sky ordinance
begin a trend?

by Jamie Carter
October 12, 2021



Can you see the Milky Way from your home? Diane Turnshek
can, and she wants to Pittsburgh to see it, too.
[Continue reading](#)

CMU News
Artificial Light Survey of
Nighttime Pittsburgh

by Metro21: Smart Cities Institute
August 2021



Drones are camera enabled, with attached 500 lines per
millimeter diffraction gratings over the camera. Preliminary
flights identified different light sources, such as incandescent,
LED, high-pressure sodium vapor, and mercury.
This site is updated as the project progresses.
[Continue reading](#)

Carnegie Science Center
Podcast: Light Up the Sky
with Stars

December 5, 2016



How far do you
have to travel to
see the stars
clearly? Join
lecturer, author,
and astronomer
Diane Turnshek
as she discusses
how light
pollution not
only prevents us

DAILY KOS
The first major city in the
United States passes a dark-
sky ordinance.

by skralyx
October 07, 2021



Could the Milky Way be visible over a city like Pittsburgh once
again?
[Continue reading](#)

90.5 WESA
A Light Map Could Illuminate
How Street Lamps Are Part Of
Pittsburgh's Pollution
Problems

by Kiley Kosinski
July 6, 2020



Streetslights emitting artificial beams through neighborhoods
every night could be to blame for decreasing firefly
populations and a generation of young people with no concept
of what the Milky Way looks like in a starry night sky. A
Carnegie Mellon University professor and self-proclaimed dark-
sky defender, Diane Turnshek, is working with a small team to
study the problem of night time light pollution in the
Pittsburgh area.

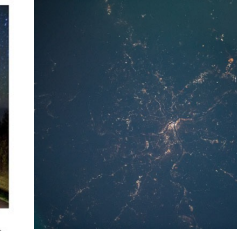
The Tartan
Physics professor receives
grant to study light pollution
with drones

by Owen Fox
Sep 30, 2018



Astronauts aboard
the ISS take
“before” images of
Pittsburgh at night

August 1, 2021



CMU News
Diane Turnshek to Pres
TEDx Pittsburgh

by Jocelyn Duffy
May 23, 2015



Physics faculty member Diane Turnshek will pres
at TEDxPittsburgh on the impact of light pollution
begins at noon on Saturday, May 23 [2015] at the B
Theater in downtown Pittsburgh.
[Continue reading](#)

The Tartan
Pittsburgh group fights for
dark skies

by Emma Flickinger
Oct 28, 2018



Roughly half of the stars visible in the 1990s can no longer be
seen in Pittsburgh's night sky. The stars aren't going anywhere

Tianqing Zhang

4th year grad student

Advisor: Rachel Mandelbaum

Weak lensing systematics by PSF

- Learn how HSC PSF higher-moments uncertainties cause systematics in weak lensing shear.
- Propagate these systematics to the cosmology analysis.
- Put requirements on LSST PSF higher moments.



Also interested in:

- Photo-z as a weak lensing systematics
- Galaxy blending
- Statistics and ML methodology in cosmology.

