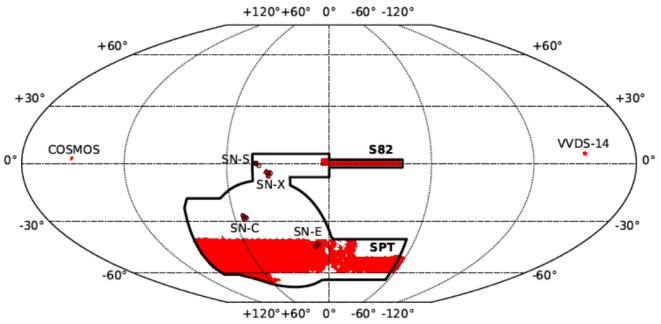
Carnegie Mellon University

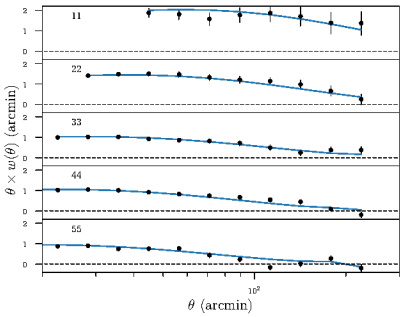
McWilliams Center for Cosmology

2017 Jamboree

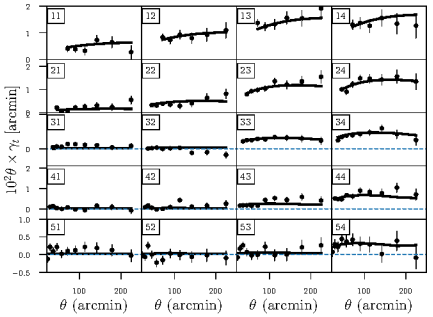
Scott Dodelson: Learn about Beyond the Standard Model Physics from Surveys



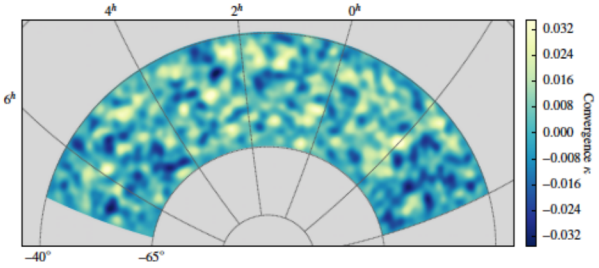
Dark Energy Survey: Year 3



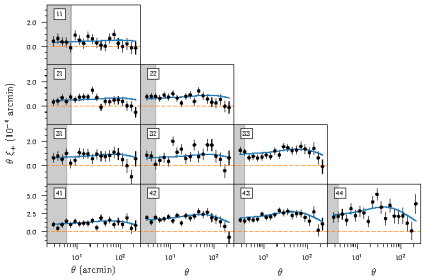
Galaxy correlation function



Galaxy-galaxy lensing



South Pole Telescope



Cosmic Shear

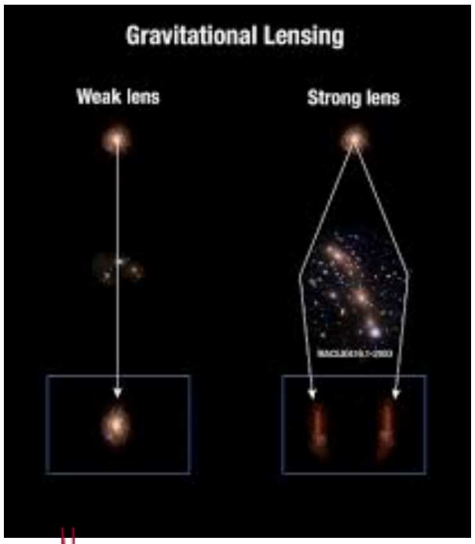
- <g-kappa>, <shear-kappa>, increase power of 3x2
- <cluster-y> (helps calibrate cluster masses: lensing, CMB lensing, y, X-Ray, richness)
- Y3: redux, theory, cosmosis, pipeline (within LSST DESC), add clusters
- New ideas: shrinkage, cluster correlation lensing, neutrino priors, Balrog for randoms, integrated photo-z clustering

Rachel Mandelbaum

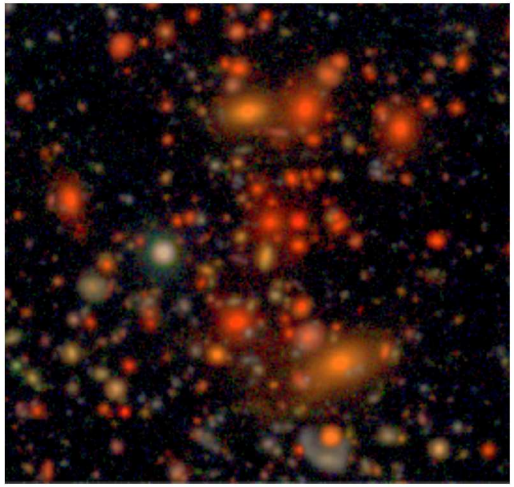
Observational cosmology:

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

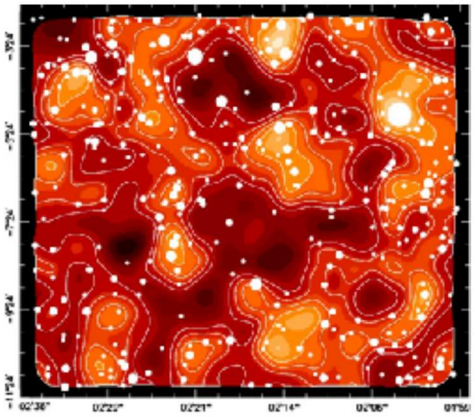
I measure this:



for tens of millions of galaxies



to (statistically) map dark matter and answer these questions



My current playground:

(Check out HSC DR1!!)

LSST DESC Dark Energy Science Collaboration

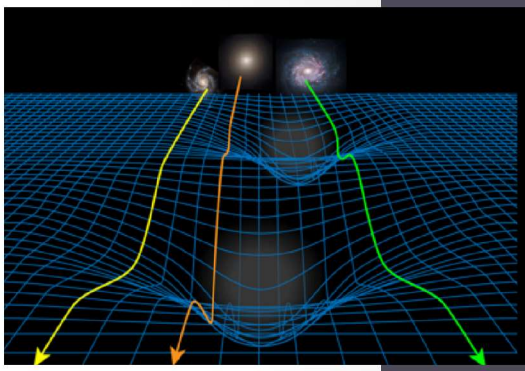
Future surveys I'm involved in:

LSST

euclid

Simon Samuroff

Postdoctoral Research Associate
for Rachel Mandelbaum



Observational cosmologist, worked on the lensing analysis for Year 1 of the Dark Energy Survey

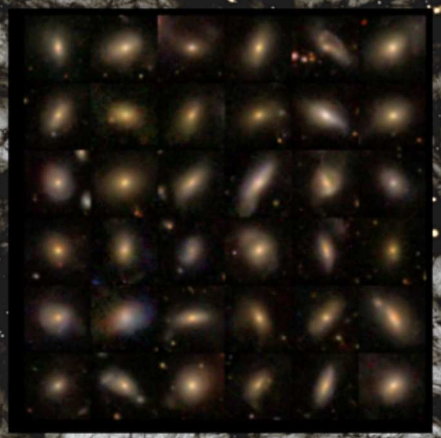
Research interests:

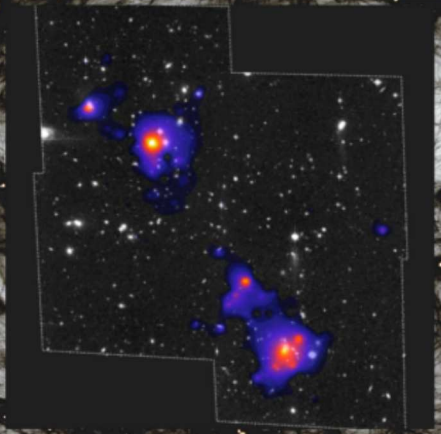
- Galaxy Shear Estimation: Recovering unbiased lensing measurements from crowded photometric survey images
- Intrinsic Alignment of Galaxy Shapes: Morphology dependence and cosmological implications
- Joint-Probe Cosmology: How additional late-time data can help control lensing systematics

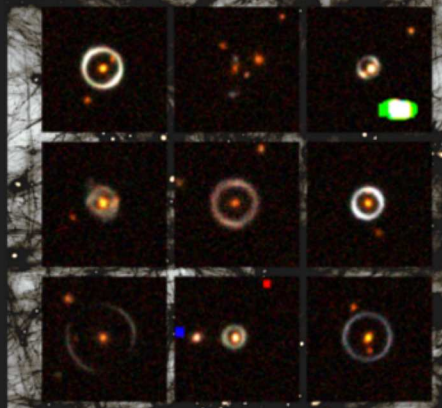
Francois Lanusse

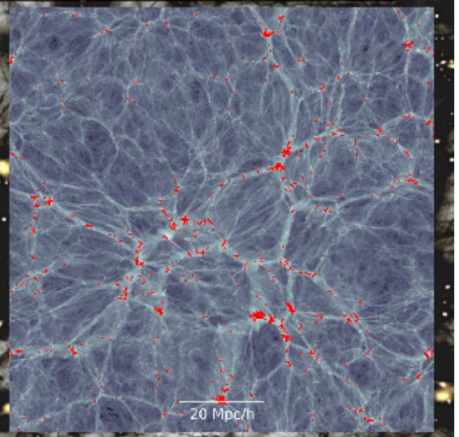
Postdoc with Rachel Mandelbaum

- Observational Cosmology
  - Weak Lensing
- Astrostatistics
  - Machine Learning
  - Statistical Signal Processing









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McWilliams Center for Cosmology

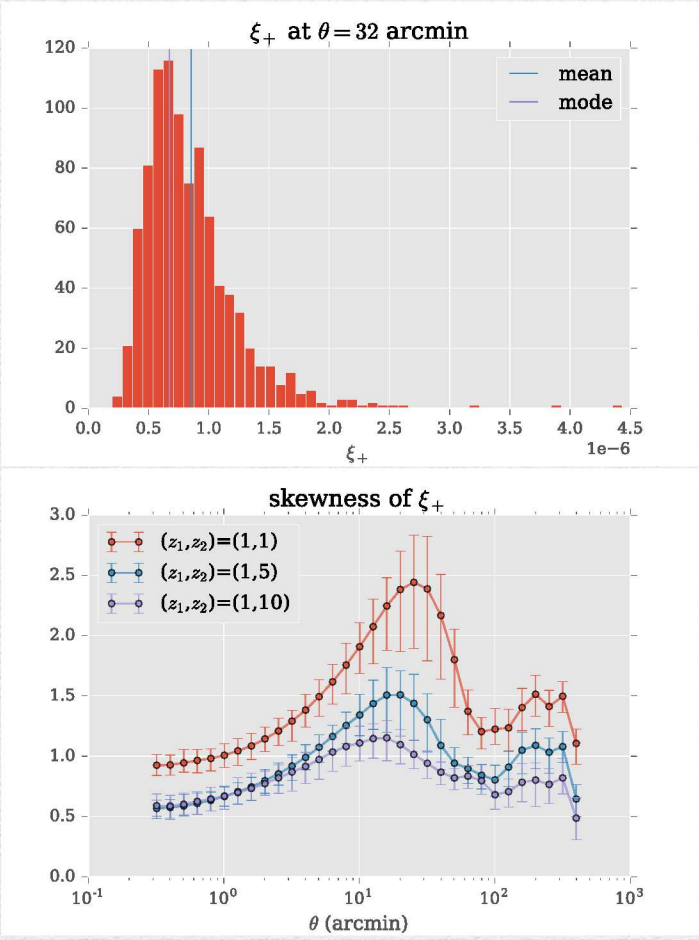
LSST DESC Dark Energy Science Collaboration

HSC

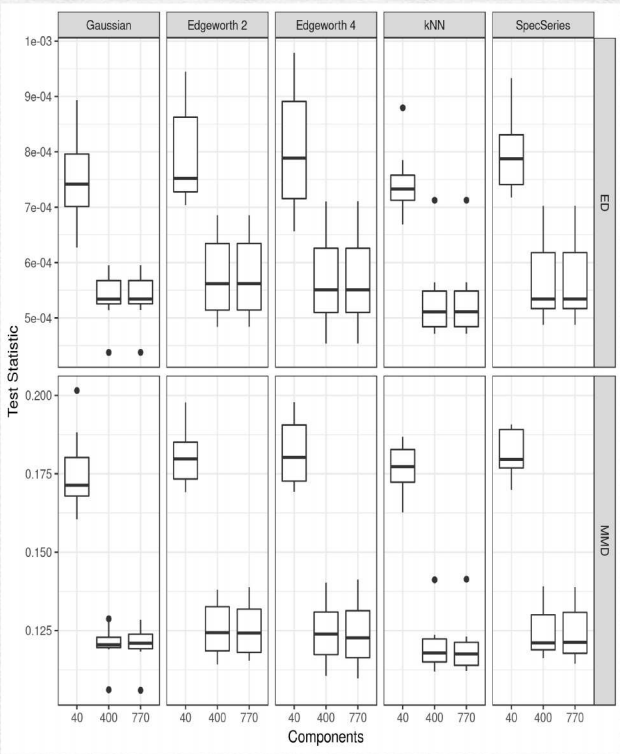
The Non-Gaussian Likelihood Function of Weak Lensing Correlation Functions and Cosmological Parameter Biases

Chien-Hao Lin *Group: Rachel Mandelbaum*

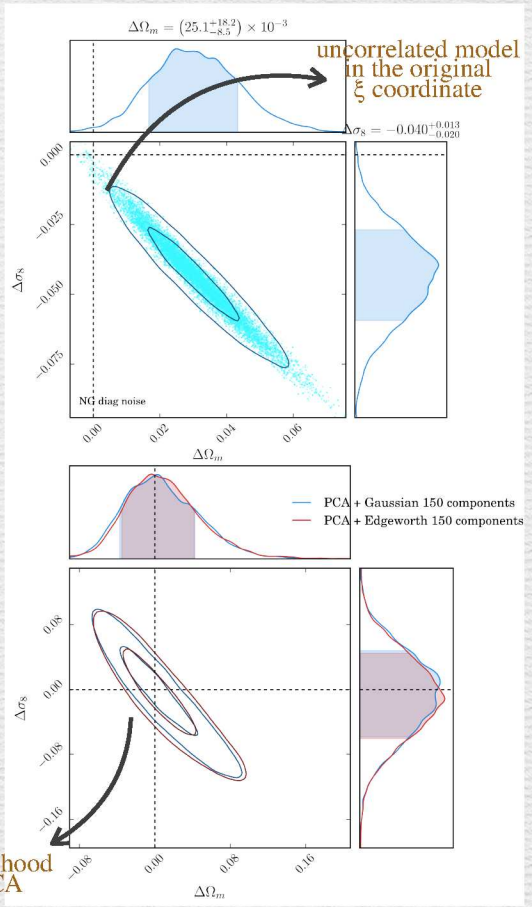
Non-Gaussian distribution of ξ



PCA analysis
on high-dimensional data



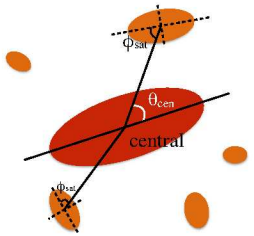
Bias due to non-Gaussian
likelihood function



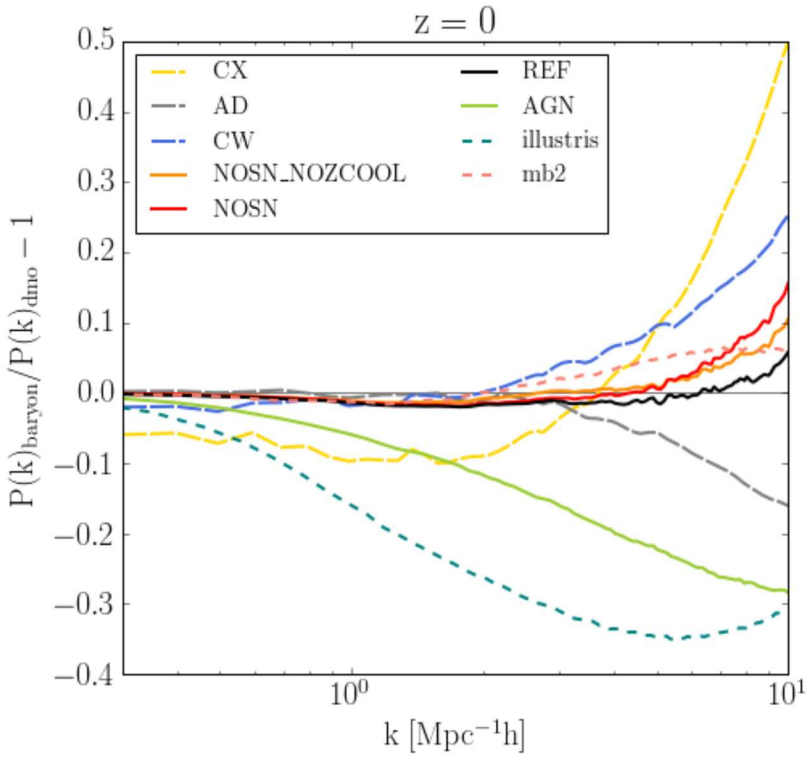
Hung-Jin Huang

- 4th year graduate student
- Advisor : Rachel Mandelbaum

Research



- Intrinsic Alignment in redMaPPer clusters
- Baryon's effect on weak lensing observables



Carnegie Mellon University

HUSNI ALMOUBAYYED

GROUP: RACHEL MANDELBAUM

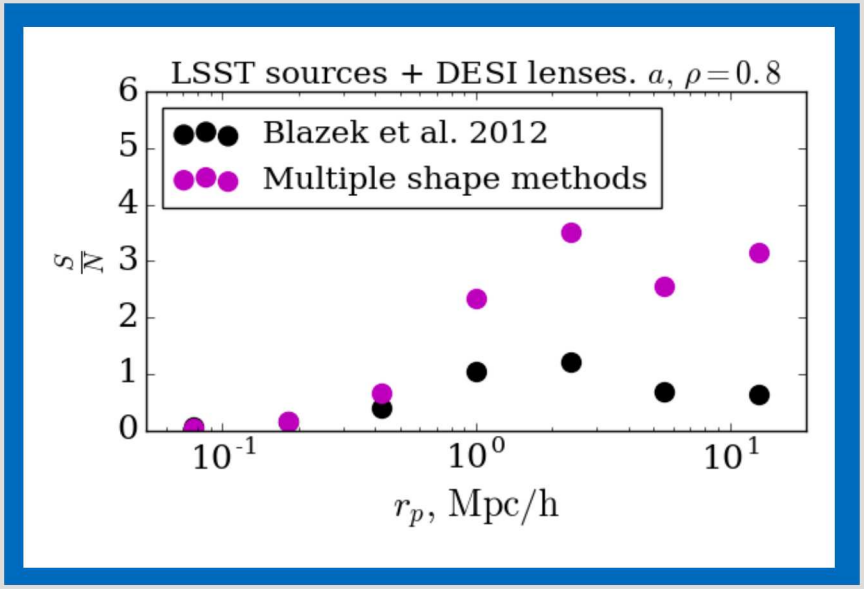
THE MCWILLIAMS
Center for Cosmology

2nd year PhD student working on:

- LSST PSF modelling errors (weak lensing systematic to precisely measure shear signal)
- DESC CCL
- www.husni.space

Danielle Leonard

McWilliams Postdoctoral Fellow



Projects and interests:

Measuring intrinsic alignments using multiple shape-measurement methods (w/ Rachel Mandelbaum)

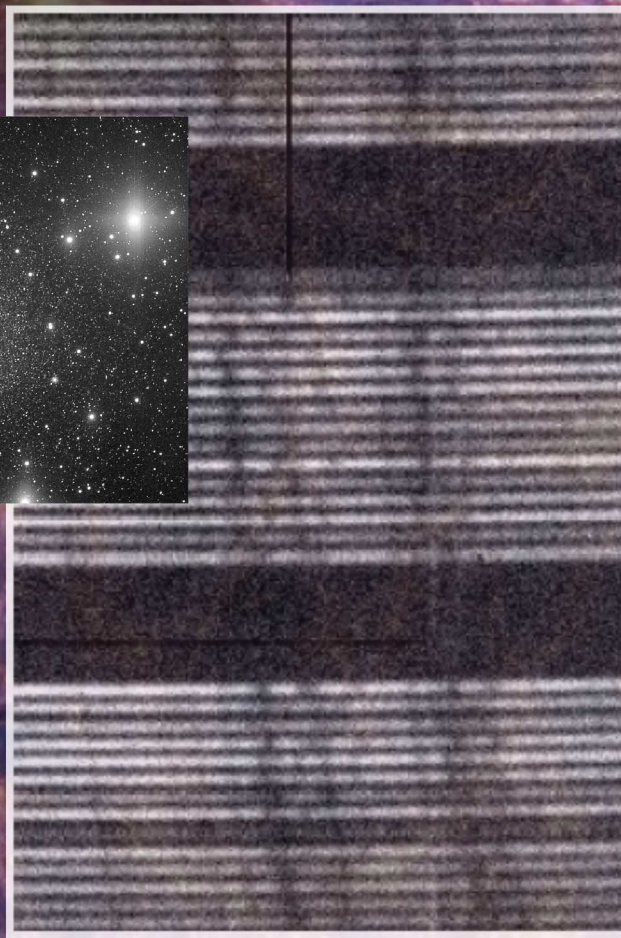
Core Cosmology Library development (LSST DESC)

Testing gravity using weak lensing, large-scale structure, and the CMB

Member of: LSST DESC Dark Energy Science Collaboration

SIMONSOBSERVATORY

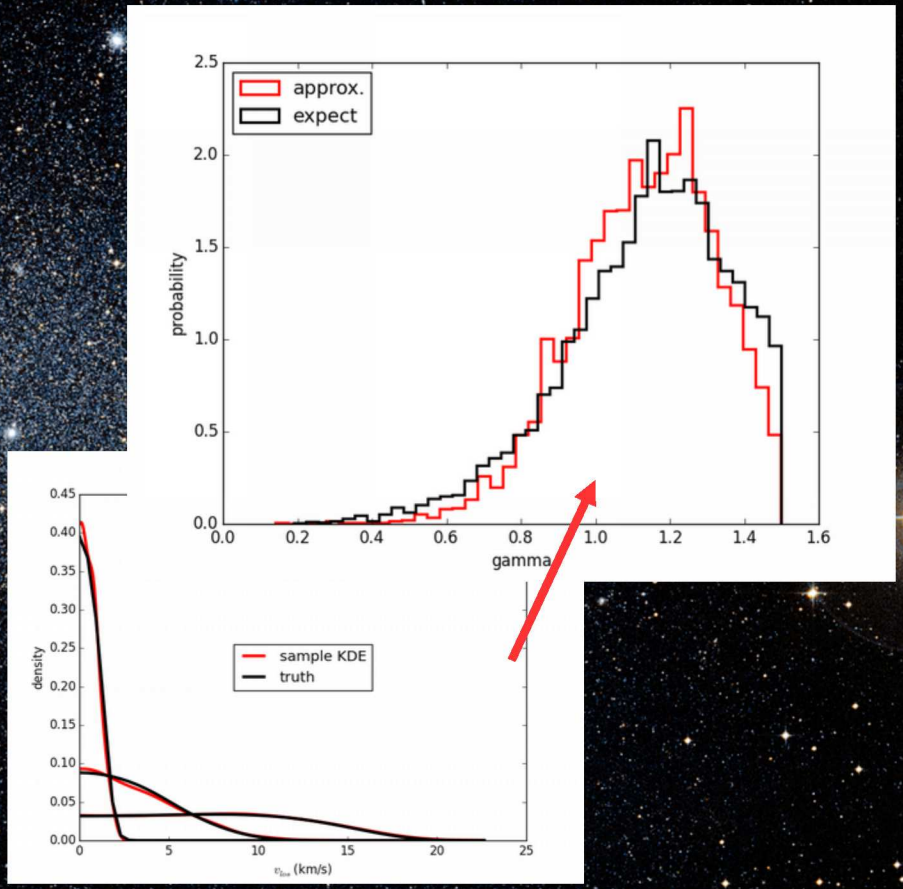
Matthew Walker - CMU



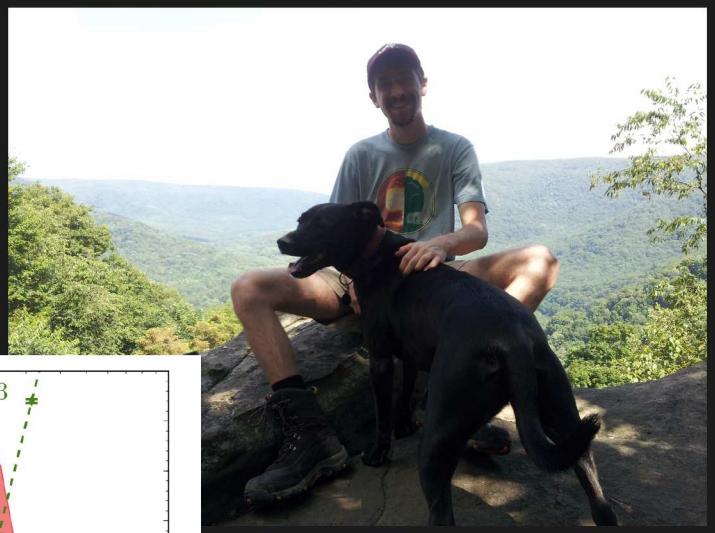
Mao-Sheng Liu (Terrence)
Advisor: Matthew Walker

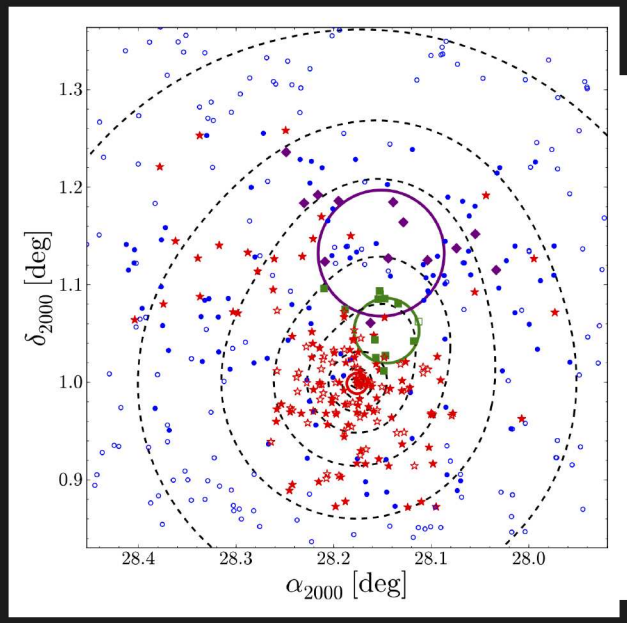
Study the distribution of dark matter at small scale through sampling-based inference techniques.

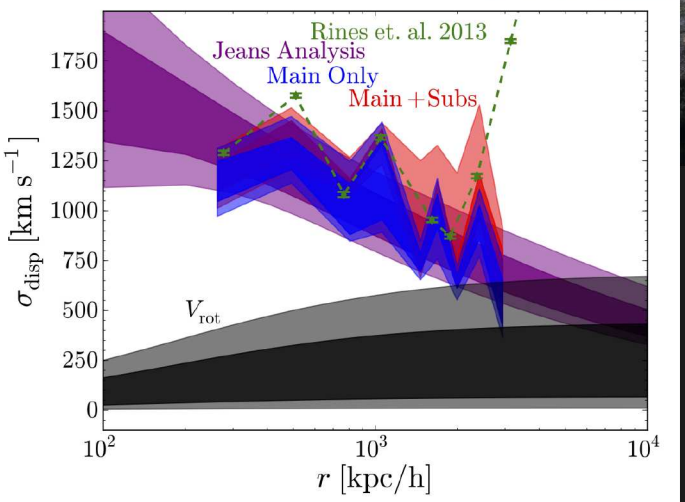
- Density and Likelihood Approximation
- Neural Network Variational Inference



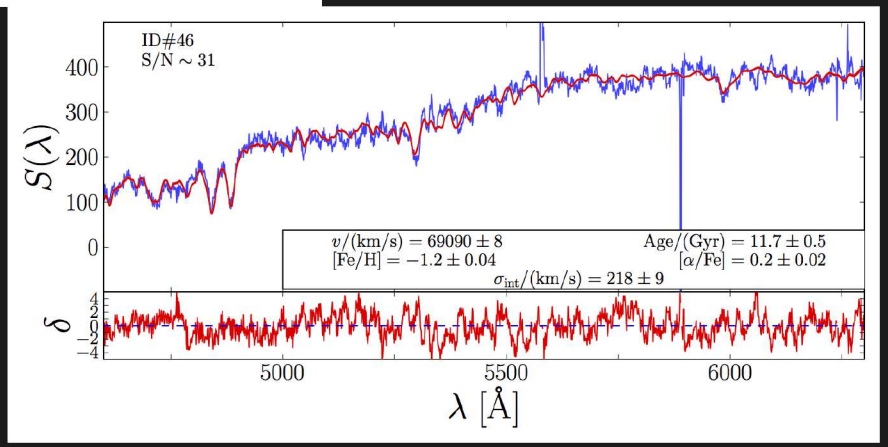
Evan Tucker - 5th Year Grad Student





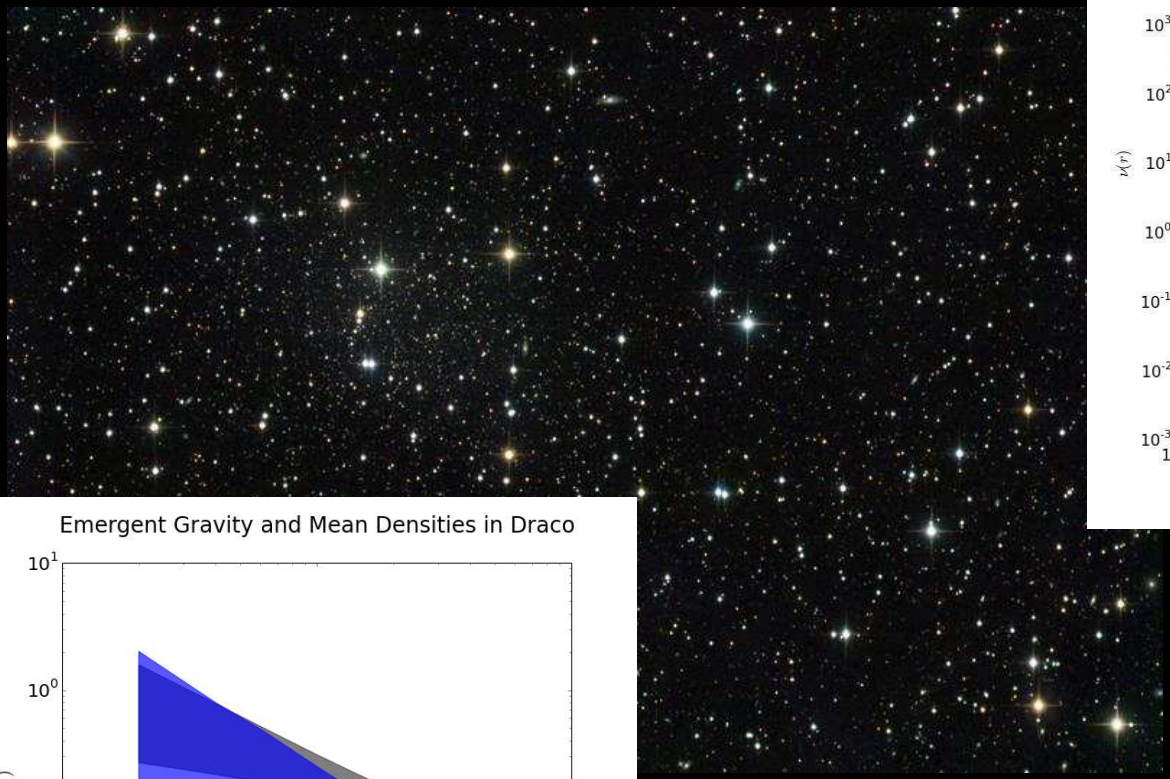


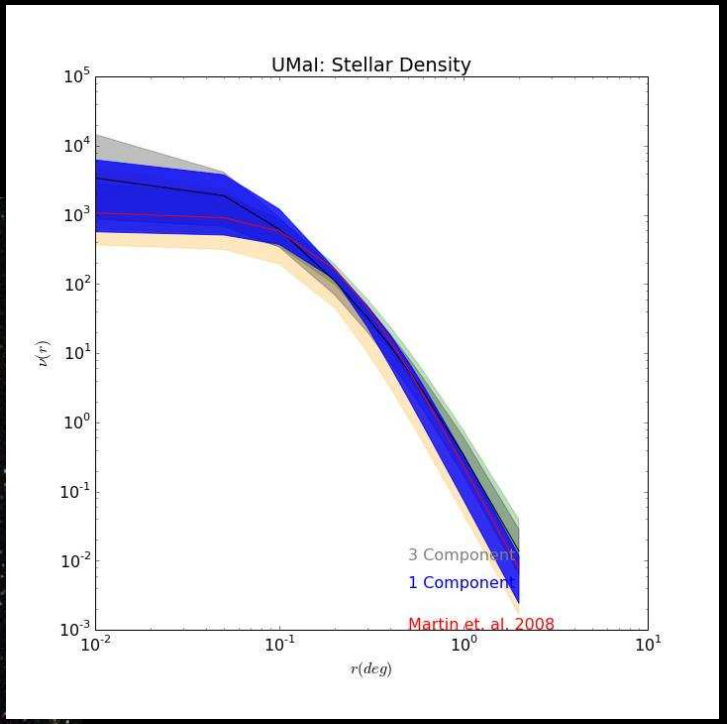
- Working with Matt Walker
- Fitting Galaxy Spectra:
  Mean redshift, ages, [Fe/H], [α/Fe], and σ_{int}
- Multi-population Dynamical Modeling of Galaxy Clusters

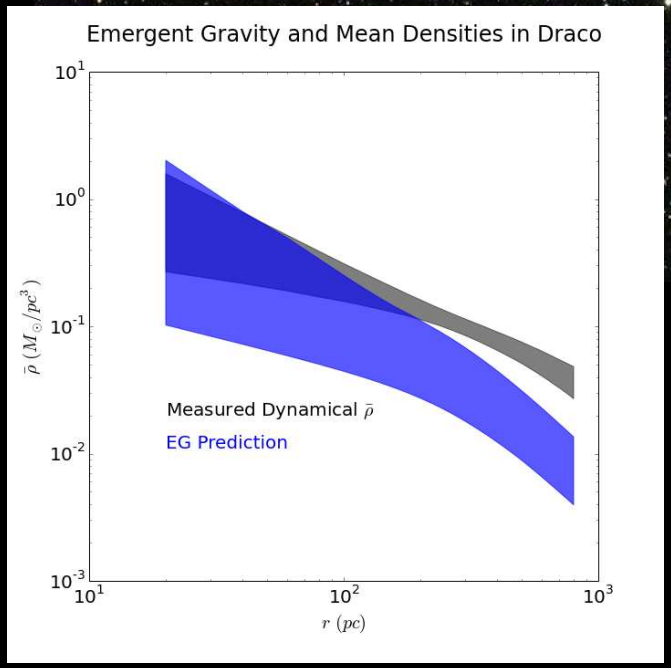


Alex Moskowitz

Advisor: Matt Walker







Research Interests

Dwarf Galaxies:

Stellar Distributions

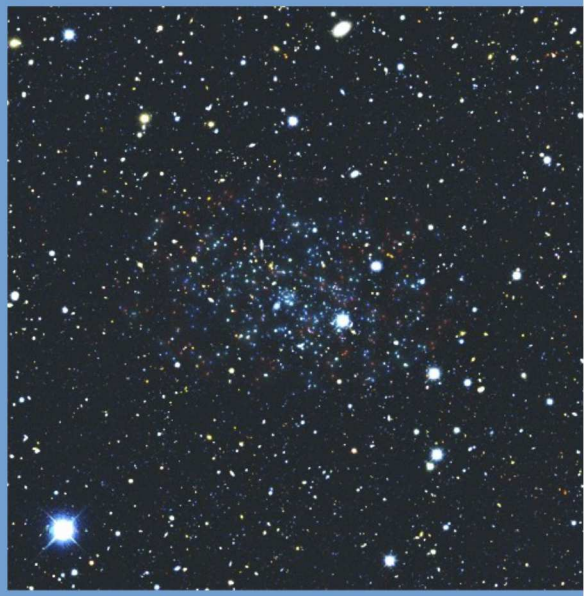
Alternative Gravity Theories

Image via http://spider.seds.org/spider/LG/dra_dw.html

Sergey Koposov

Scientific Interests:

- Milky Way structure
- Dwarf galaxies
- Stellar Streams
- Dark Matter
- Large surveys



Projects

- Gaia
- DESI
- WEAVE
- LSST

Techniques:

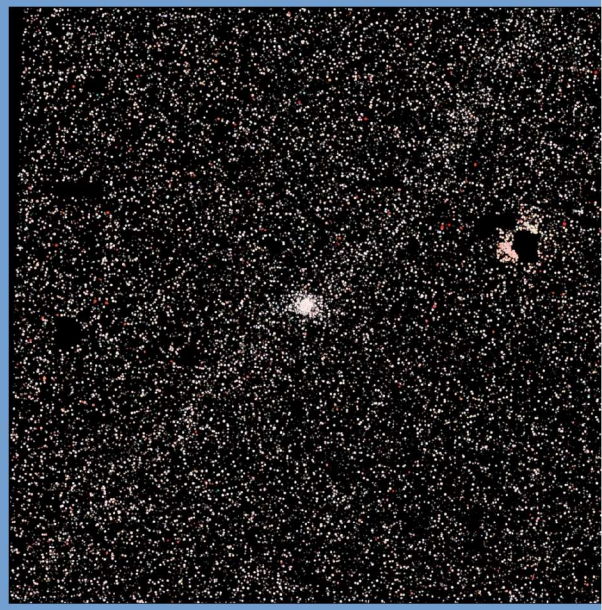
- Data mining
- Statistics/ Bayesian Inference
- Machine Learning

Technical expertise:

- Python
- C/C++
- SQL/Databases
- STAN
- Imaging/Spectro-scopic data processing
- Big data

Office: Wean 8313
Email: skoposov@cmu.edu

Resources @CMU: WSDB – Whole Sky DataBase -- SQL database with catalogs from all major large surveys (SDSS/ PS1/ Gaia etc)



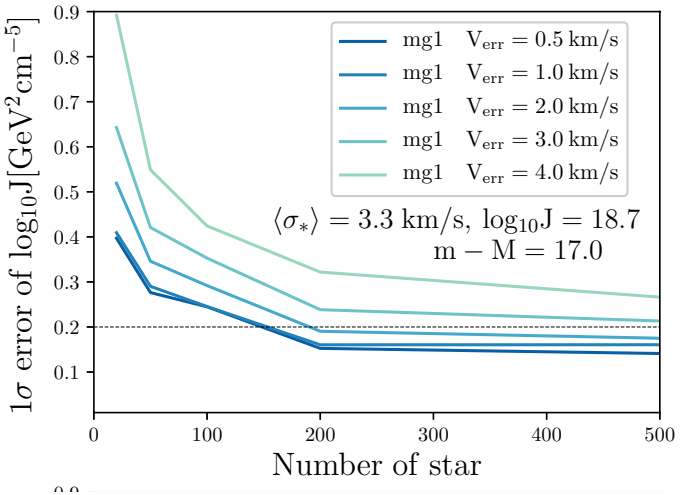
Mei-Yu Wang

McWilliams Postdoctoral Fellow

Research interests:

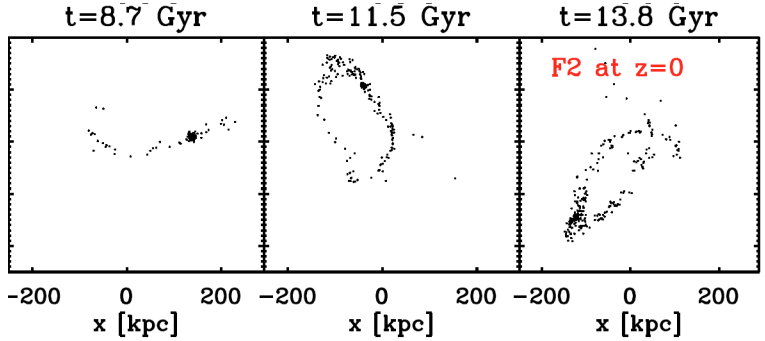
Astrophysical probes of dark matter, the Milky Way and the Local Group, N-body numerical simulation

Uncertainties of indirect detection "J-factor" as a function of stellar kinematic data properties

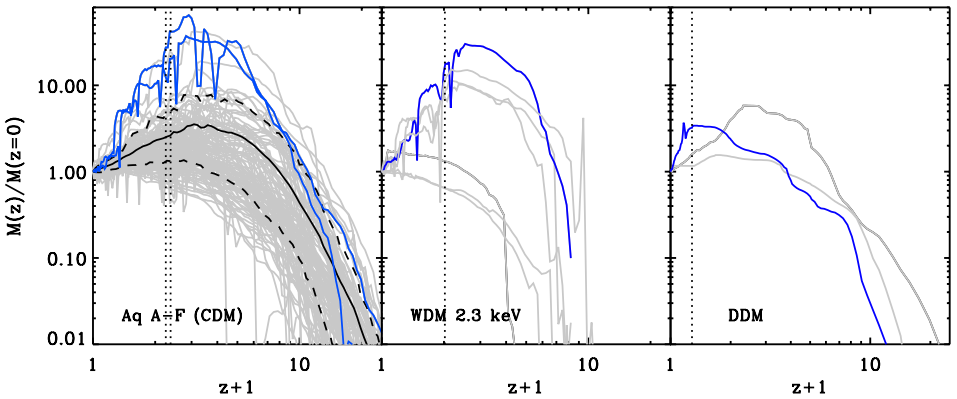


MW, Drlica-Wagner, Li, Strigari, in preparation

Milky Way dwarf satellite galaxy evolution in N-body simulations



MW, Fattahi, Cooper, Strigari, Frenk, et al. (2017)



MW, Strigari, Lovell, Frenk, Zentner (2015)

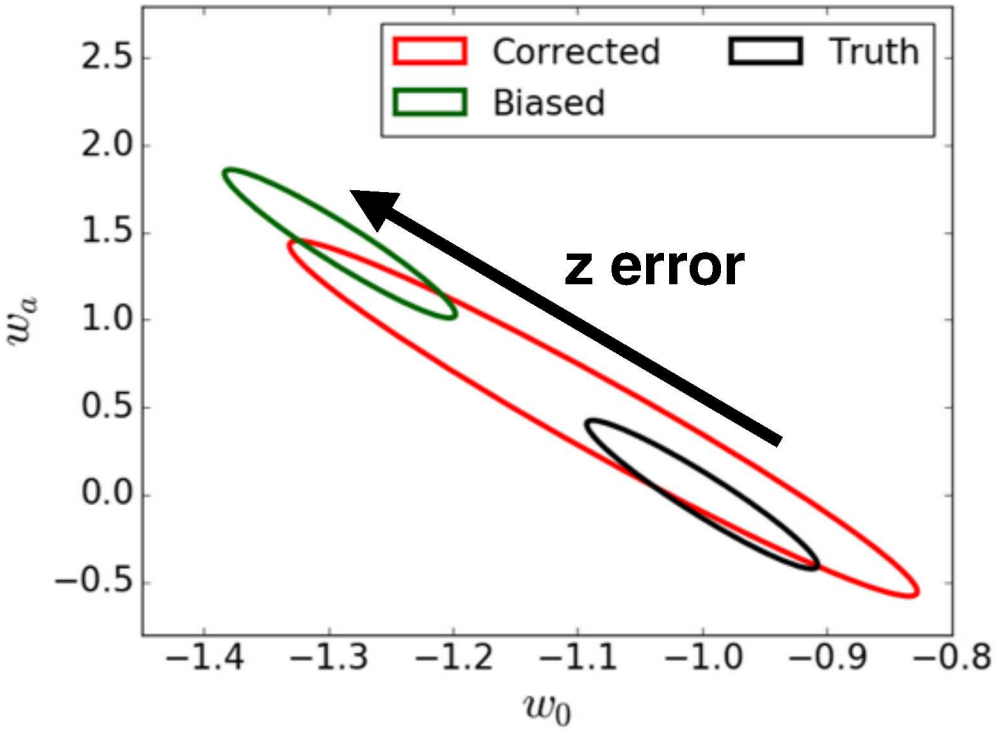
Markus Michael Rau

Research Group:
Rachel Mandelbaum
Hy Trac

arXiv:1607.00383

Machine Learning
Astrostatistics
WL/LSS
Cosmological Simulations

We developed a method to **correct** photometric redshift induced **errors** in cosmological **parameter constraints**



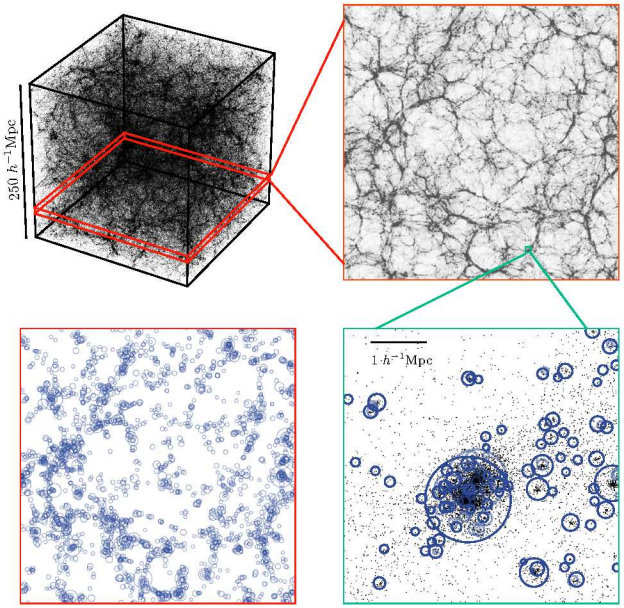
Galaxy clustering forecast

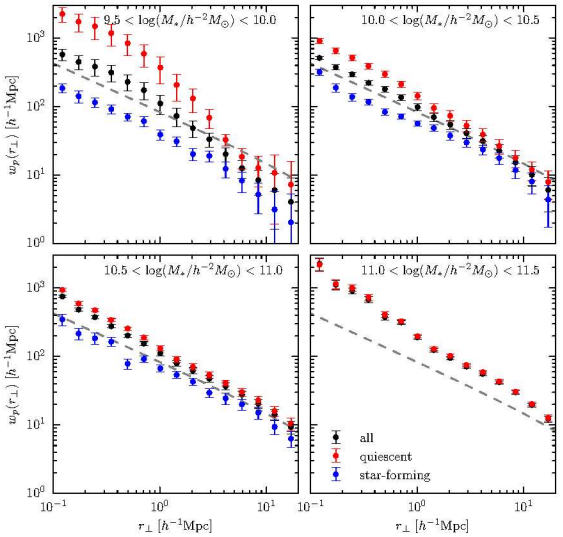
Duncan Campbell

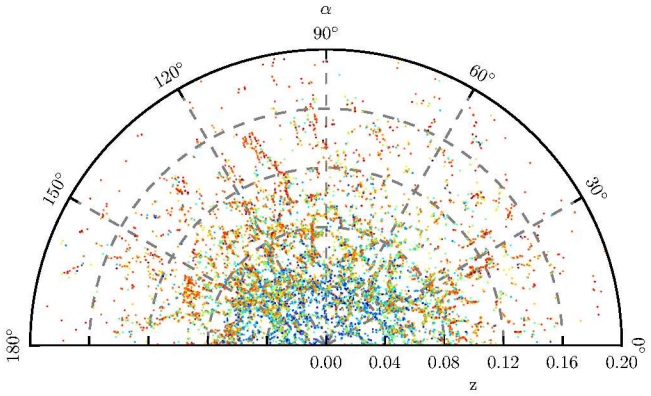
McWilliams Postdoctoral Fellow

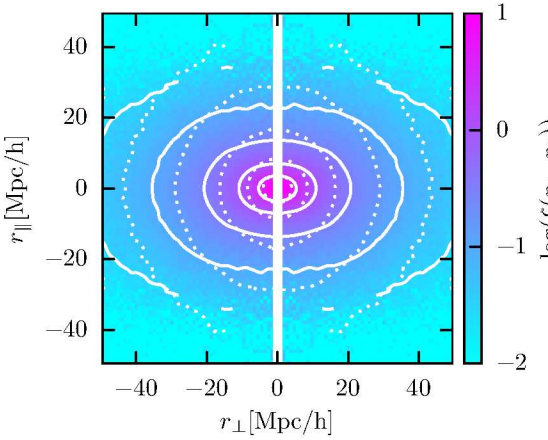
Research Interests

- Galaxy-Dark Matter Halo Connection
- Galaxy Star-formation Histories
- Galaxy Environment
- Assembly History of Dark Matter Haloes
- Dark Matter Substructure
- Forward Modeling Techniques
- Galaxy Clustering
- Weak Lensing
- Galaxy Groups
- Redshift Space Distortions





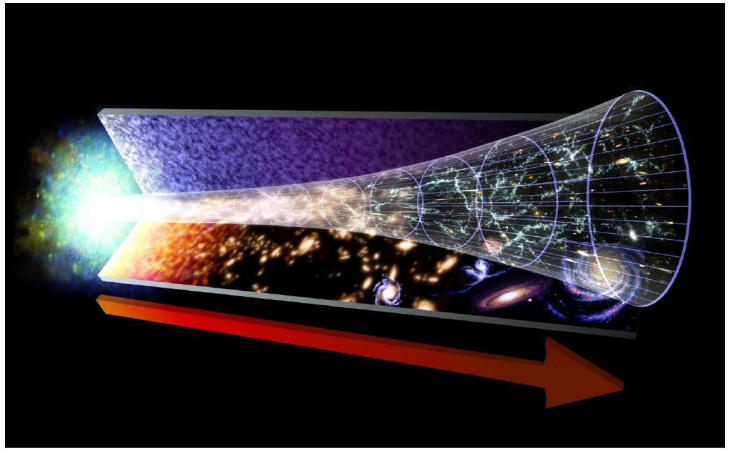


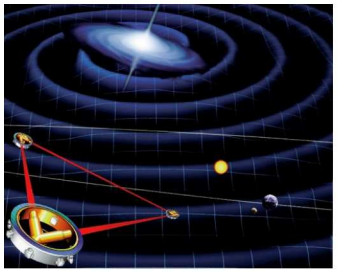


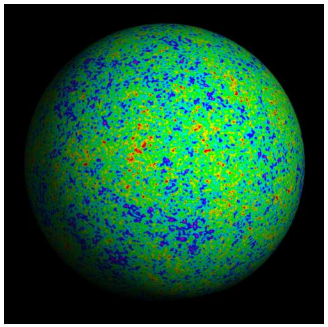
Tina Kahniashvili

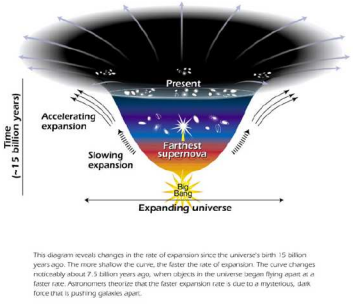
The McWilliams Center For Cosmology

Physics
Carnegie Mellon

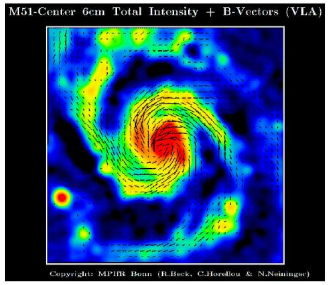








This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The more shallow the curve, the faster the rate of expansion. The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart at a faster rate. Astronomers 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
  - Accelerated expansion
    - Dark energy
    - Massive gravity
  - Astro-particle physics
    - Neutrinos mass origin
- Astrophysics
  - Cosmic magnetic fields
  - Cosmic turbulence

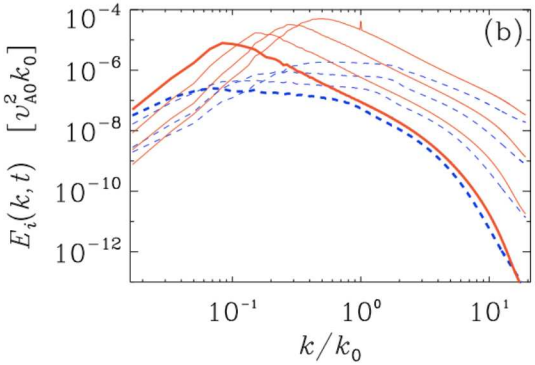
Sayan Mandal

Physics
Carnegie Mellon University

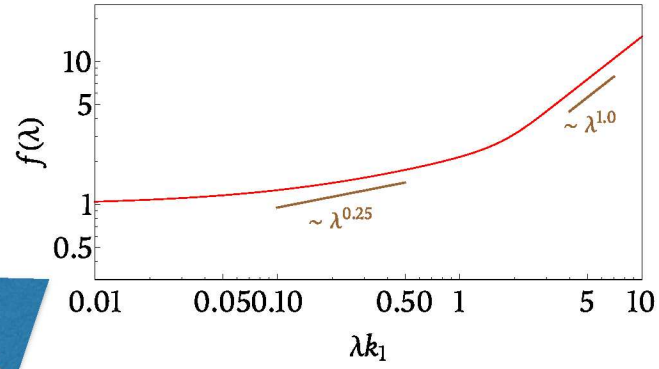
THE MCWILLIAMS
Center for Cosmology

2nd Year Student, working with Tina Kahniashvili.

1. *Primordial Magnetogenesis:*
   A. *Generation due to Inflation:* $\mathcal{L} \supset f(\phi)F_{\mu\nu}F^{\mu\nu}$, *etc.*
   B. *Generation due to Phase Transitions (EW and QCD)*
   C. *Connection with Baryogenesis*
2. *Evolution of Magnetic Fields due to turbulent processes.*



(arXiv: 1607.01360)



3. *Studying the "Realizability Conditions" for these fields,* $|\mathcal{H}_M| \leq 2L_M\bar{\rho}_M$.

Model of the Spectrum: $$\frac{\mathcal{F}_{ij}^{(B)}(\mathbf{k})}{(2\pi)^3} = P_{ij}(\mathbf{k})\frac{E_M(k)}{4\pi k^2} + i\varepsilon_{ijl}k_l\frac{H_M(k)}{8\pi k^2}$$

THE MCWILLIAMS
Center for Cosmology

Physics
Carnegie Mellon University

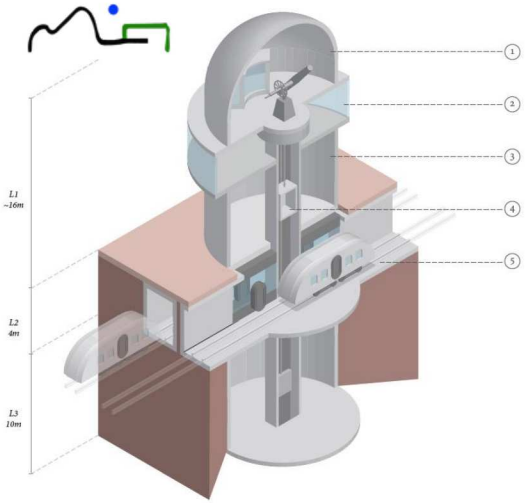
PAUL ROGOZENSKI

- Senior CMU Physics with Track in Astrophysics
  - Minors in Computer Science and German Studies
- Advisor: Tina Kahniashvili
- Research in Massive Gravity

Physics

Diane Turnshek, special faculty, astronomy instructor

HP & Intel® Design Challenge: make life better for astronauts, "Life In Space" winning design



Chromatopolis
THE COLOR WHEEL CITY

2017 Finalist,
MARS CITY DESIGN: the innovative platform for creating cities on Mars

THE
Pgh Chapter of IDA
International Dark-Sky Association

It's as clear as night and day. Together we can reclaim our night sky.

Light pollution disrupts ecosystems, human health and safety.

Pittsburgh
idapgh.org

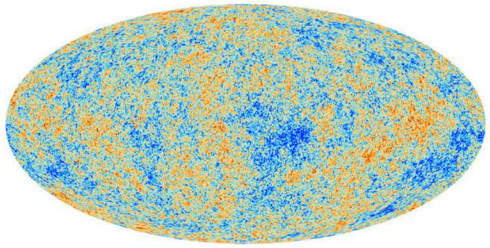
Light pollution is getting worse. If you love a dark night sky full of stars, join us and local students to protect our nighttime environment. You do not have to be a member of IDA to attend meetings. Free. Open to the public.

Student Leadership Positions Available

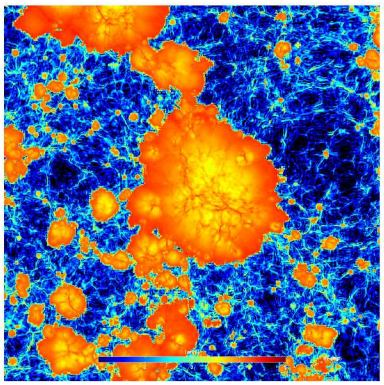
Free Parking in the East Campus Garage Next Door

Hy Trac
Assoc Prof
8307 Wean Hall
hytrac@cmu.edu

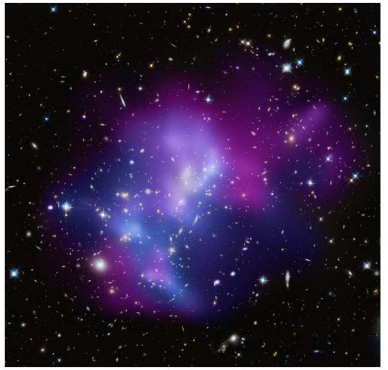
CMB



First Stars & Galaxies



Galaxy Clusters



Group

Minghan Chen, Aristide Doussot, Yizhou He,
Matt Ho, Ian Holst, Michelle Ntampaka

Interests

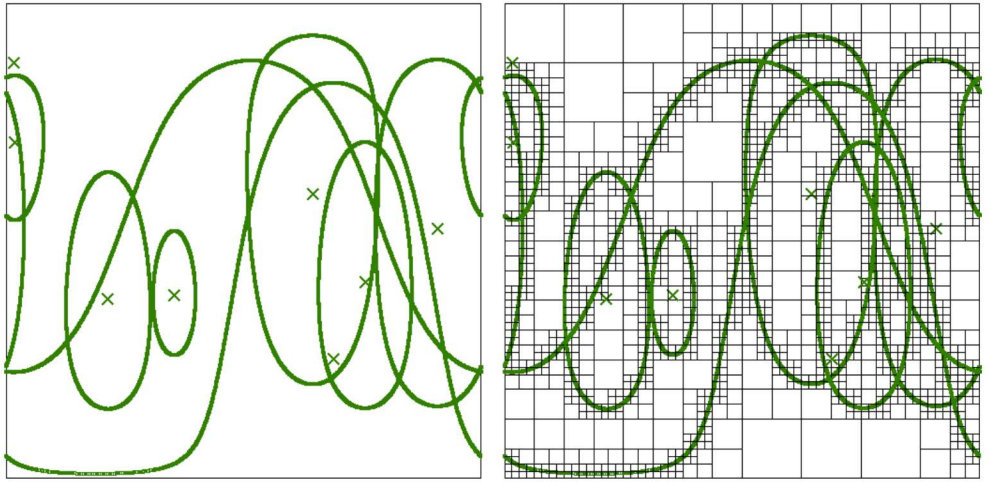
Structure formation & evolution,
large-scale structure, dark matter halos,
galaxies, clusters, cosmic reionization

Tools

Cosmological simulations,
N-body, hydro, radiative transfer

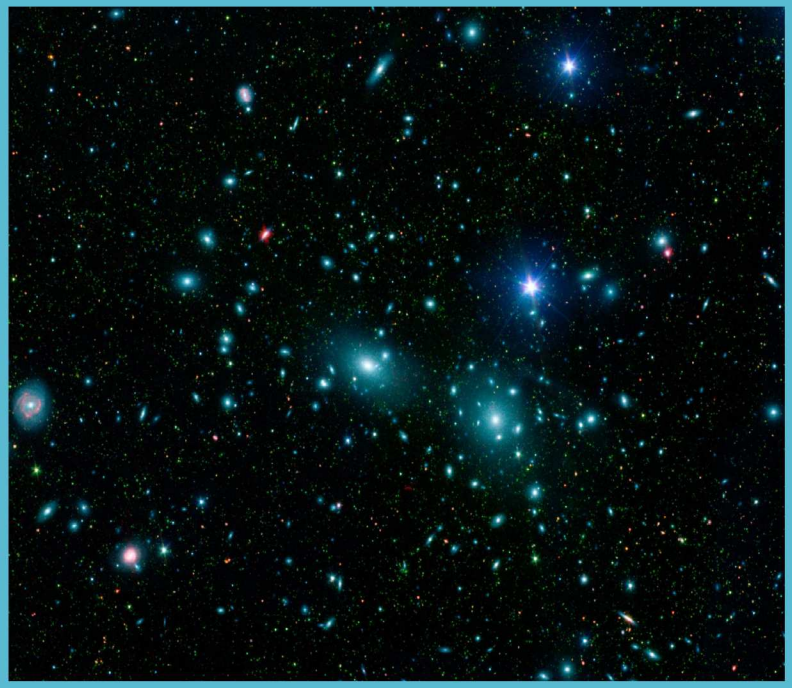
Ether: finite-volume particle method
Hyper: fast hydro-particle-mesh
RadHydro: radiation-hydrodynamics

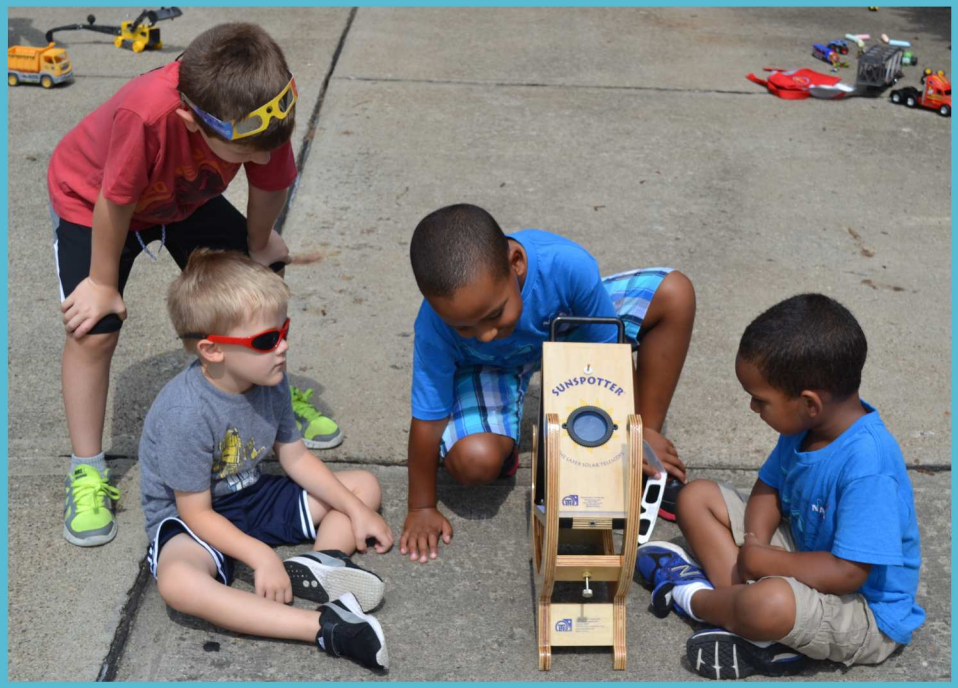
Heart of Ether: a given sphere is interested by many spheres



Michelle Ntampaka

- Graduate student working in Hy Trac's group
- Research: Galaxy Cluster Dynamics with ML and Stats
- Early Childhood Astronomy Outreach





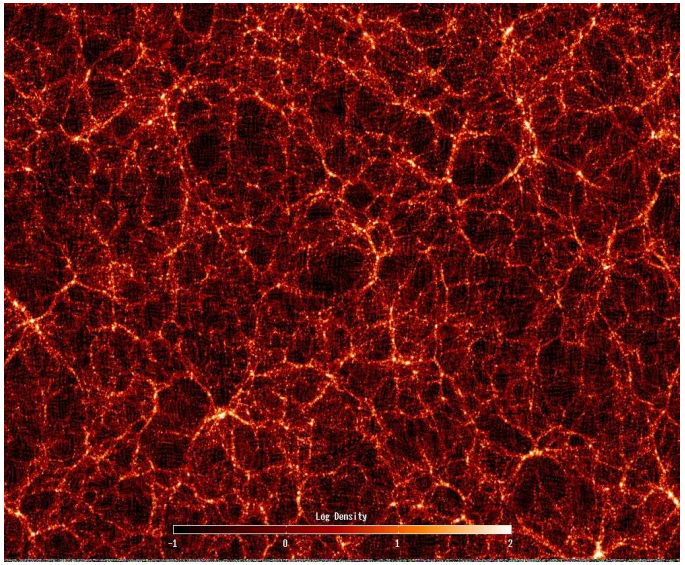
Physics

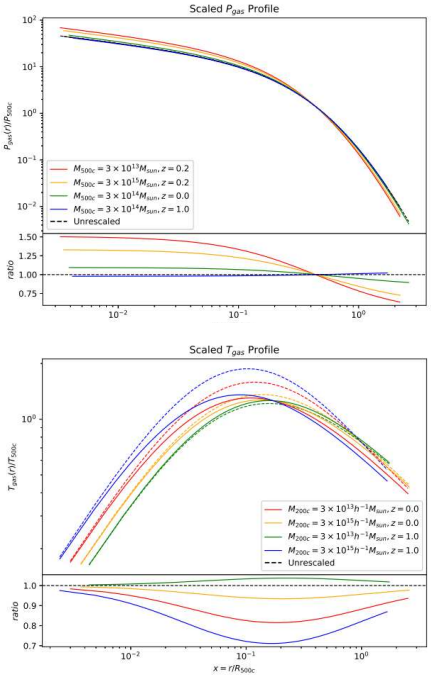
Carnegie Mellon University

McWilliams Center

for

Cosmology

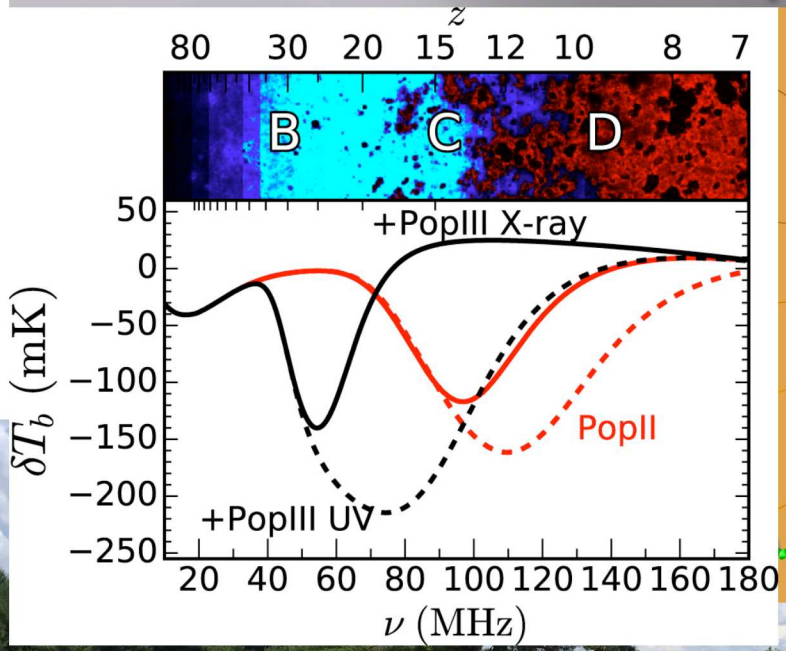




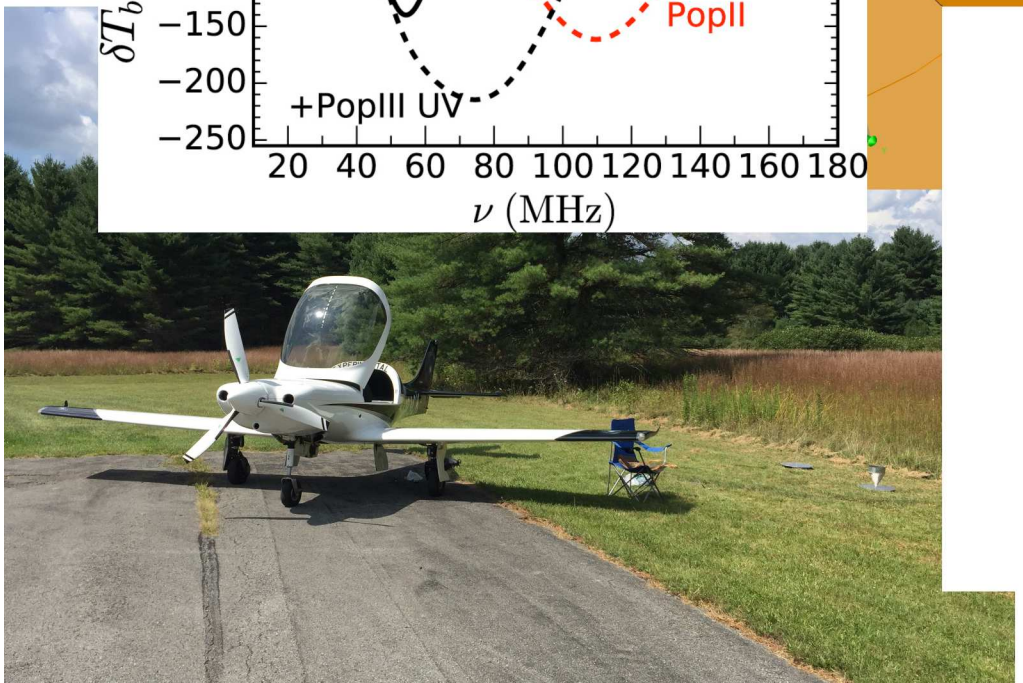
Yizhou He

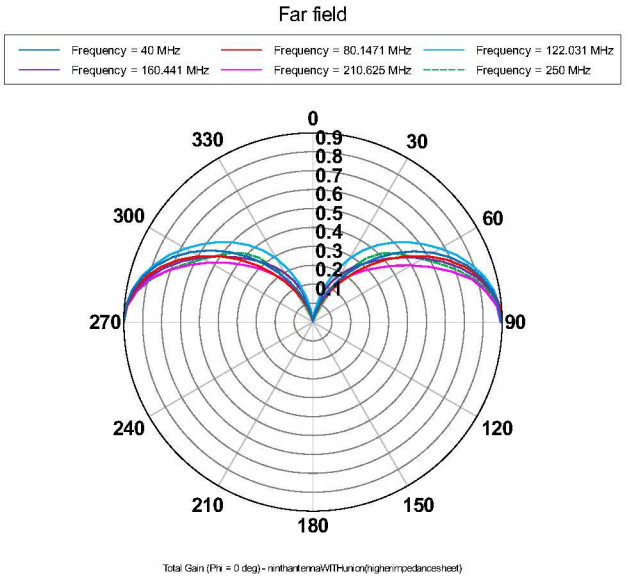
- 2nd year graduate student
- Advisor: Hy Trac
- Interest: numerical simulation & machine learning, dark matter halos, intracluster medium(ICM), intergalactic medium (IGM)

Jeff Peterson: Sensing the turn-on of the first stars at redshift 25 with a new type of 21-cm All-sky spectrum experiment



Antenna Sim: Olivia Kung
Hi-Z Amp: Jose-Miguel Garcia

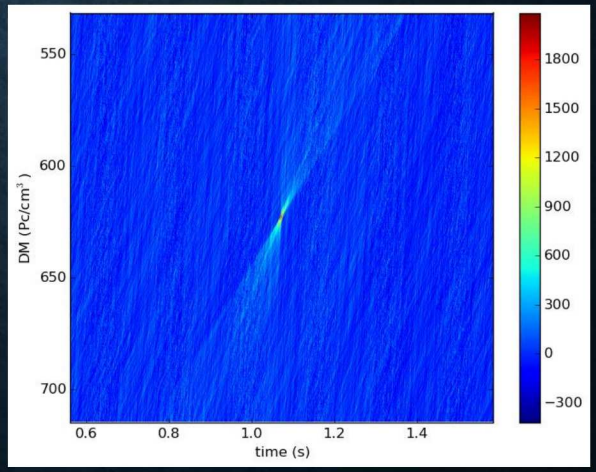




Hsiu-Hsien Lin

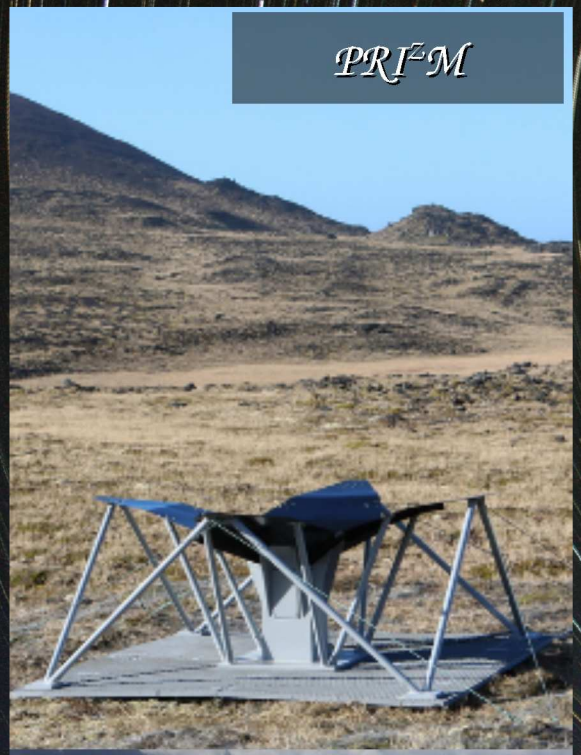
- 5th year physics graduate student
  - Advisor: Jeffrey Peterson
- Using the Green Bank Telescope
  - Search Fast Radio Bursts (FRBs) and pulsars
  - Pulsar timing algorithms
- Discover FRB110523

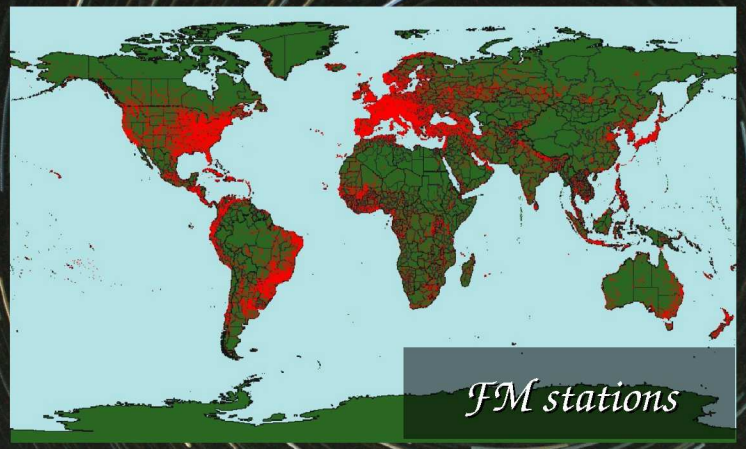
  Masui, K., Lin, H.-H., Sievers, J., et al. 2015, Nature, 528, 523

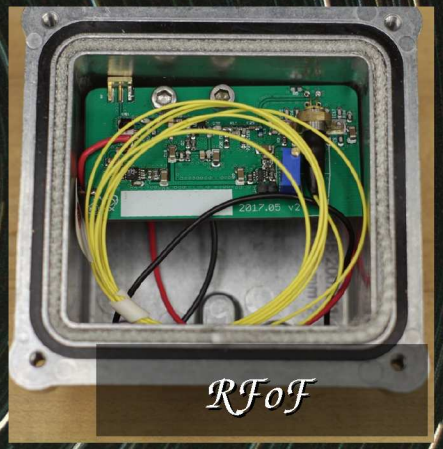


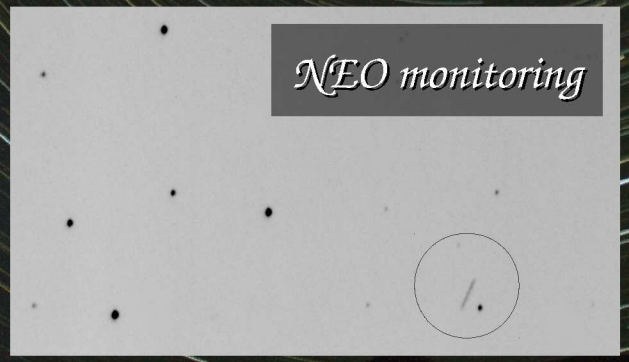
Astronomical instrumentation for PRIZM and HIRAX

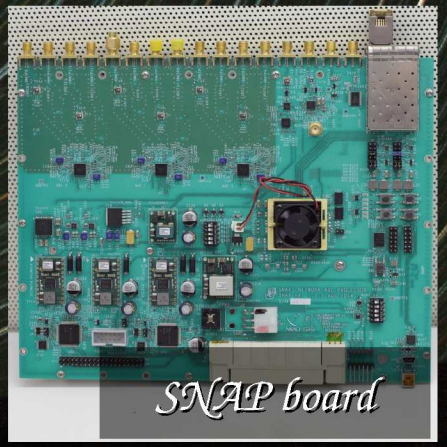
Antennas, low-freq amplifiers, RFoF links, FPGA acquisition systems and radio quiet site search.


PRIZM


FM stations


RFoF


NEO monitoring


SNAP board


Marion Island

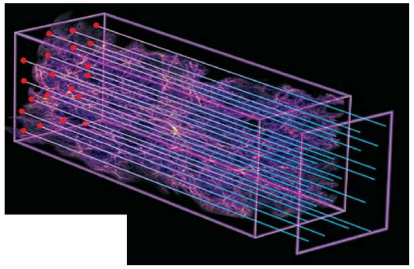
José Miguel Jáuregui-García

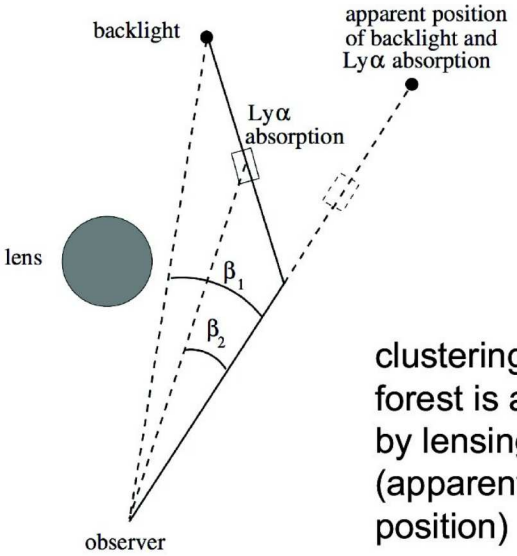
Postdoc with Prof. Jeff Peterson

CONACyT Research Fellowship

Rupert Croft

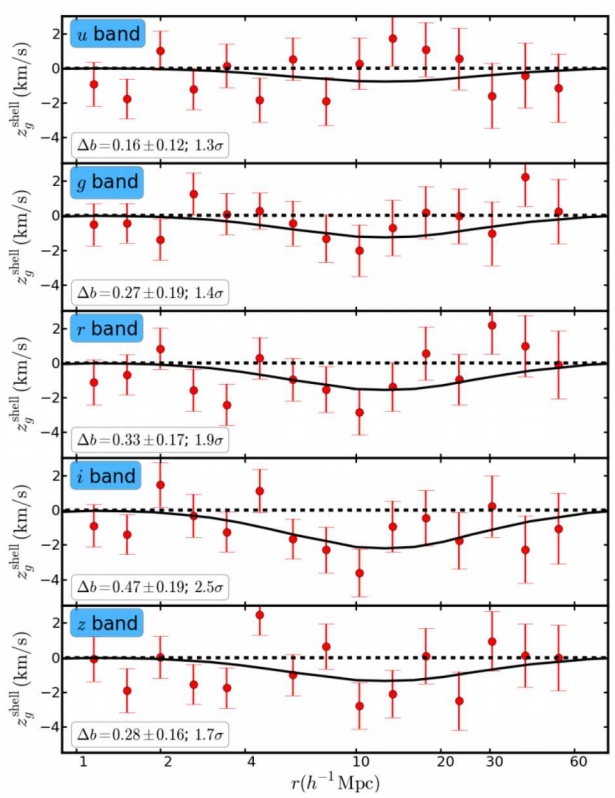
Weak gravitational lensing of the Lyman-alpha forest





clustering of the forest is affected by lensing (apparent vs actual position)

Relativistic distortions of galaxy clustering

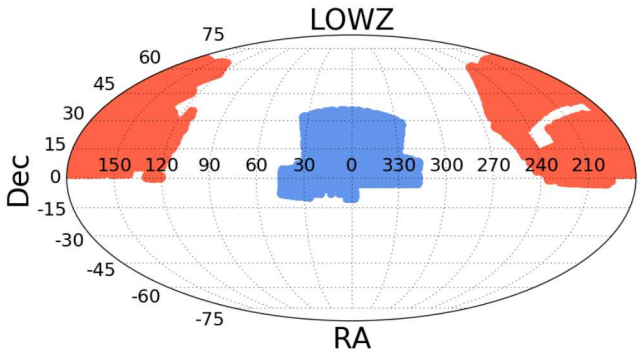


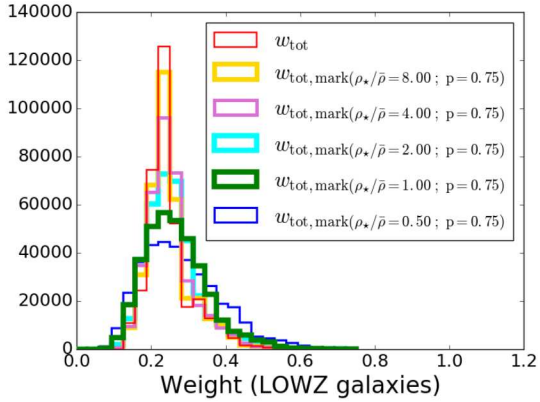
Cosmology video games

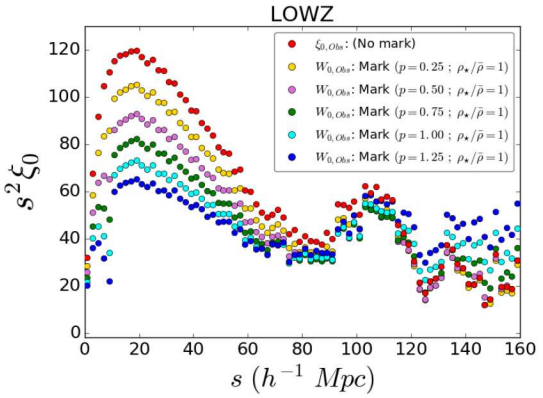
Using marked correlation functions to study galaxy formation

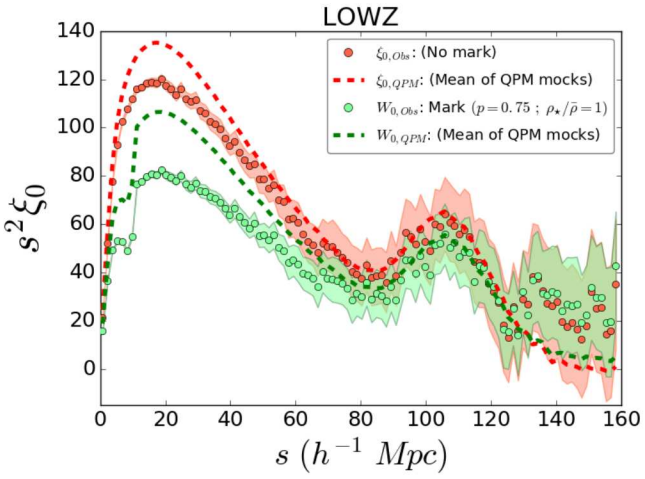
SIDDHARTH SATPATHY, PROF. RUPERT CROFT, PROF. SHIRLEY HO

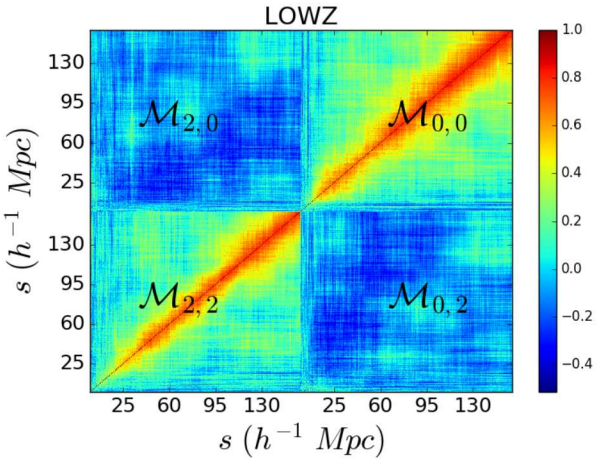
Carnegie Mellon University
McWilliams Center for Cosmology

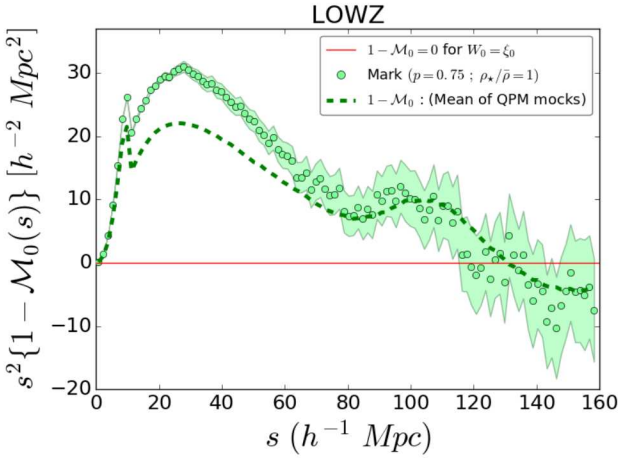








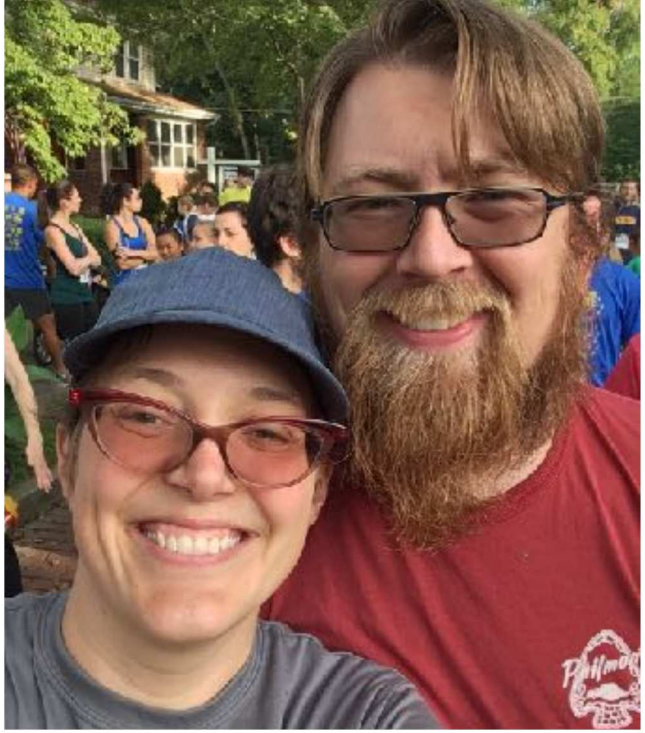


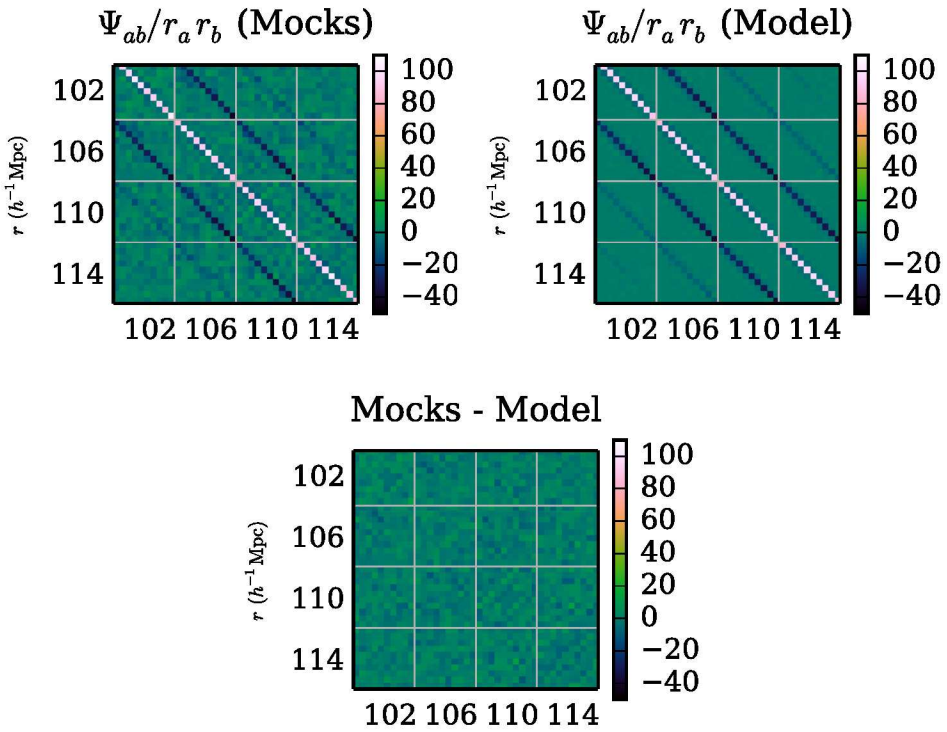


Ross O'Connell

McWilliams Center

LSS, BAO, etc.





Current interests:
Covariance matrix estimation
(now without mocks!)

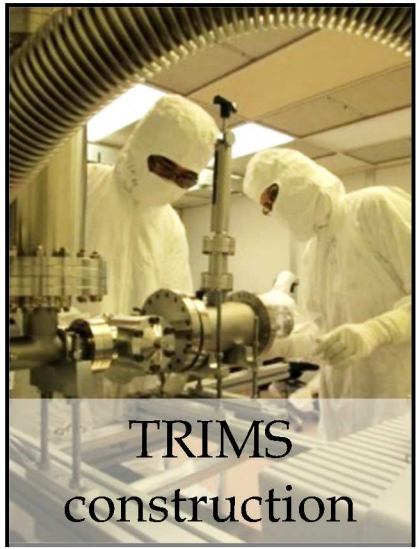
Tomographic analysis
(for eBOSS, DESI, etc.)

https://github.com/rcoconnell/Rascal

Diana Parno

Constraining neutrino properties on Earth

- Direct neutrino mass from T_2 β decay
  - KATRIN: analyzing commissioning data and gearing up for physics runs
  - TRIMS: studying source systematics
- COHERENT: coherent elastic neutrino-nucleus scattering for supernova cooling, dark-matter detection, Standard Model tests
  - Neutrino flux modeling



Recent AstroParticle Theory Projects Leonard Kisslinger and Collaborators:

1)Ψ AND Υ PRODUCTION VIA $\sqrt{s_{pp}}$=8 TeV p-Pb , Leonard S. Kisslinger, arXiv:1708.00439/hep-ph, submitted to Phys. Rev. D (2017)

The differential rapidity cross sections for Ψ and Υ production via p-Pb collisions at 8 TeV was estimated. This is an extension of previous work on heavy-quark state production via A-A collisions at RHIC, as LANL experimentalists will carry out experiments starting next year at the LHC, CERN, with the possible detection of the Quark-Gluon plasma.

2)B PRODUCTION IN p-p AND A-A COLLISIONS, Leonard S. Kisslinger and Bijit Singha (CMU student). Submitted to Int.J.Theor.Phys. (2017)

The production of $B^+(b\bar{d}), B^o(b\bar{u})$ via unpolarized p-p collisions at 200 GeV is an extension of our recent work on $D^+(c\bar{d}), D^o(c\bar{u})$ production. In addition to being an important study of QCD, the estimate of B production via A-A collisions could provide a test of the production of Quark Gluon Plasma (QGP) in relativistic heavy ion collisions (RHIC).

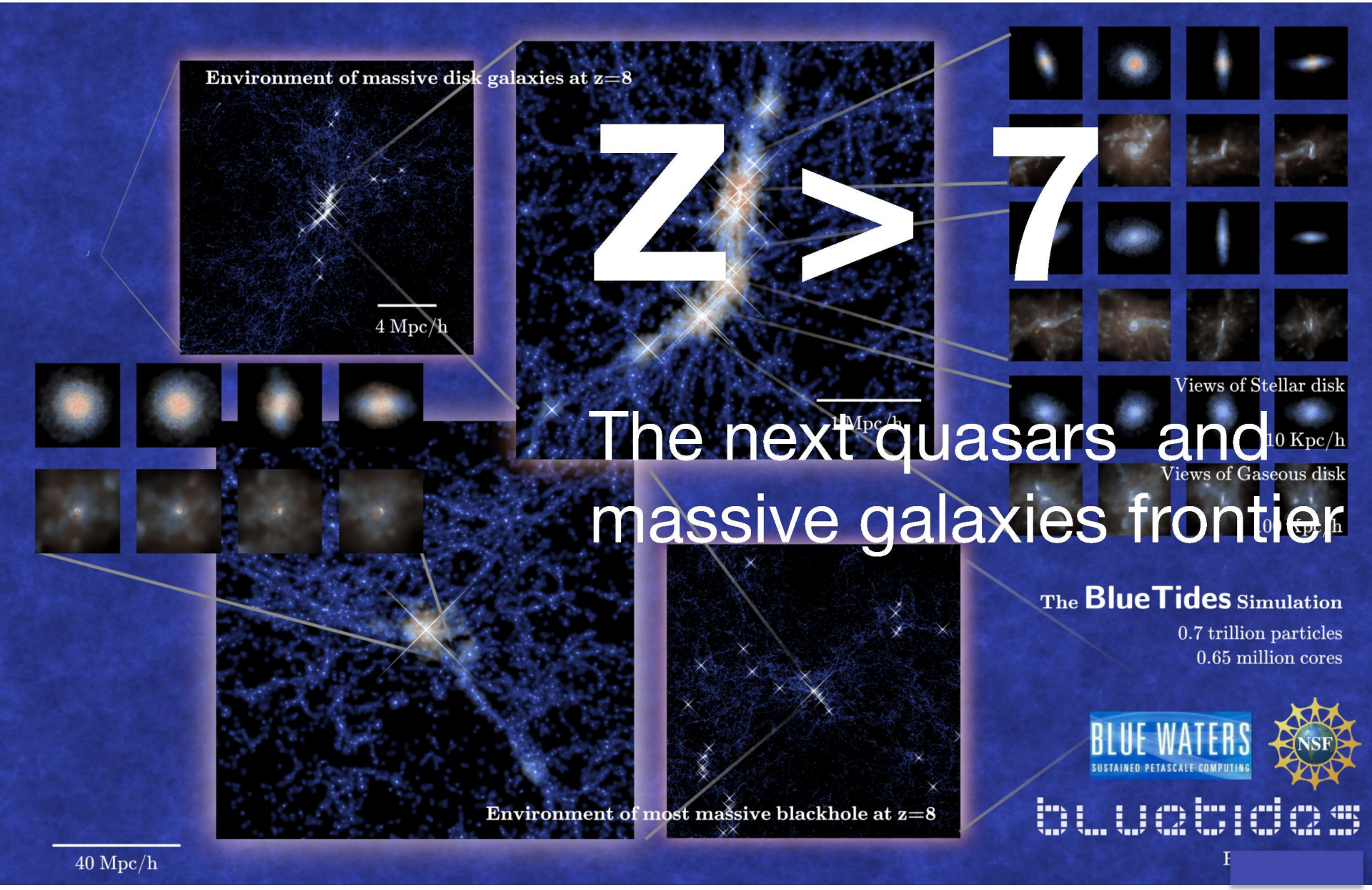
3) NEUTRINO TRANSITION PROBABILITY $\mathcal{P}(\nu_\mu \to \nu_e)$ WITH REVISED STERILE-ACTIVE NEUTRINO MIXING ANGLE, Leonard S. Kisslinger. Submitted to Int.J.Theor.Phys. (2017)

This brief report estimates the neutrino oscillation probability $\mathcal{P}(\nu_\mu \to \nu_e)$ with one sterile neutrino using the recently estimated sterile-active neutrino mixing angle α. This value of $\alpha \simeq 6.604$ used in the present work is more reliable than $\alpha = 9.24$ used previously. With these improved parameters the present results are very reliable for comparison with future neutrino oscillation experiments, inlcuding measurements of CP and T-reversal violations.

4) POLARIZED GRAVITATIONAL WAVES FROM COSMOLOGICAL PHASE TRANSITIONS, Leonard Kisslinger, Tina Kahniashvili, Phys. Rev. D 92, 043006 (2015)

The degree of circular polarization was estimated for the gravitational waves (QWs) generated during the electroweak (10^{-11} sec) and QCD phase transitions from the kinetic and magnetic helicity generated by bubble collisions during those cosmological phase transitions. Although the GWs polarization detection is beyond the currently available detectors, this study should help further developments.

Tiziana Di Matteo



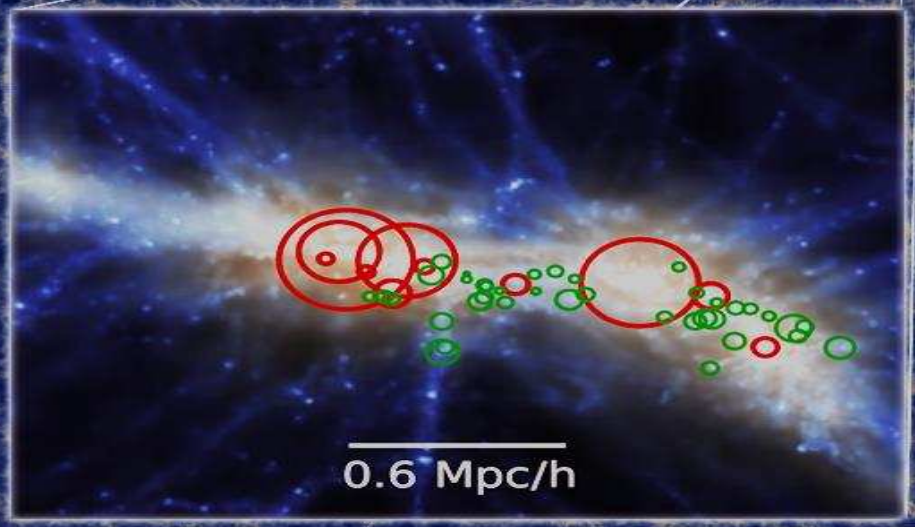
Aklant Kumar Bhowmick

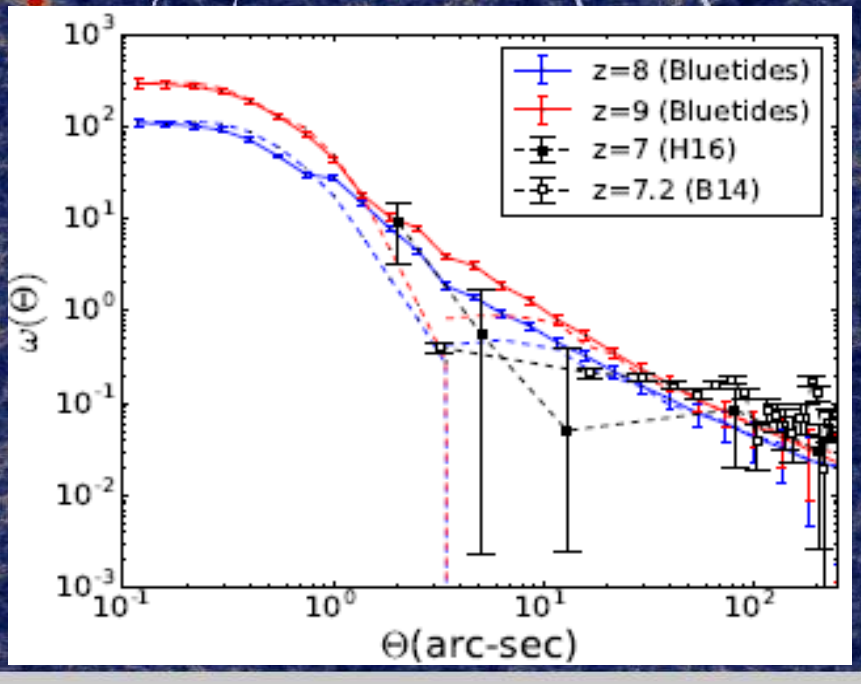
Research Focus:

Prediction of galaxy statistics using Cosmological Hydrodynamic Simulations

Advisor:

Tiziana Di Matteo





Kuan-Wei Huang

- 2nd year PhD student
- Advisor: Tiziana Di Matteo
- Working on analyzing scaling relations between black hole mass and galaxy properties in BlueTides simulation at high redshifts

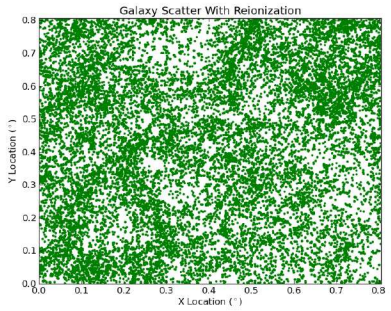
THE MCWILLIAMS Center for Cosmology

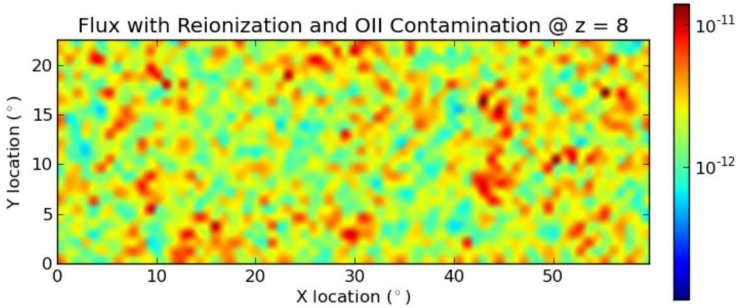
Physics
Carnegie Mellon University

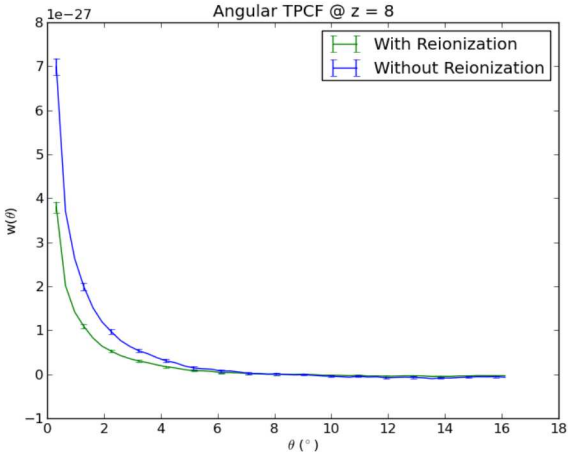
Jacob Cohen

Undergraduate Physics Major

Research Focus: Lyα Intensity Mapping w/ SPHEREx Satellite







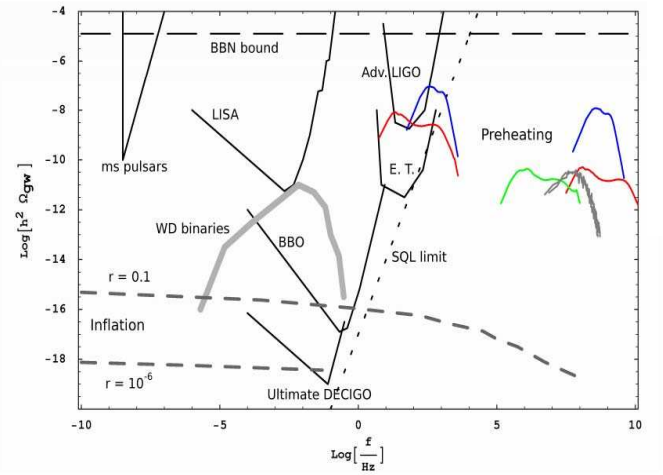
THE MCWILLIAMS
Center for Cosmology

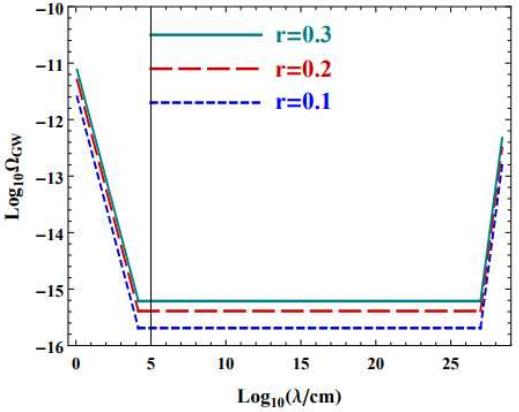
OLGA NAVROS
Advisor: *Tina Kahniashvili*

Physics
Carnegie Mellon University

Quintessential Inflation Models

- Unification of inflation and dark energy using a scalar field
- Gravitational Waves
- Constraints from BBN, CMB





Features:

- Slow-roll inflation, scaling regime, exit to dark energy
- Instant Preheating
- Exit to dark energy achieved by coupling to massive neutrinos