
Image: Robert Kawika Sheer

# Welcome!

According to UC Astronomy lore, many years ago there existed an inter-campus gathering of graduate students known as the SIERRA Conference. This was a meeting organized by graduate students for graduate students, to encourage collaboration and networking within the astronomy community in California. Originally more true to its label of a scientific conference, it involved numerous talks on topics of interest solicited from the astronomy community at large. It eventually evolved into more of a camping retreat inviting grad students from different schools around California, still allowing for the mission of encouraging collaboration and networking across institutions. Unfortunately, this meeting has not taken place since 2014, and few of the current UC graduate students seem to know anything about it, suggesting that many schools have not participated in an even longer time. In general, there exist few opportunities for interaction between students of different UC campuses, despite all belonging to the same University of California, and having access to many of the same resources. The main exception is the Observational Astronomy Workshop at Lick Observatory, which allows for some networking across UC campuses, but is mostly limited to first- and second-year students interested in observations. It was at this event that most of the organizers learned about the SIERRA Conference, and discussed the idea of bringing it back. Thanks to the generous support of the Osterbrock Leadership Program, we have reincarnated the meeting as the Osterbrock Sierra Conference, an inter-campus meeting for all UC graduate students in astronomy, to help build a network and community of UC astronomers while enjoying the beauty of our state.

# Code of Conduct

We are dedicated to providing a harassment-free Sierra Conference experience for everyone. Harassment includes offensive verbal comments related to gender, gender identity and expression, age, sexual orientation, disability, physical appearance, body size, race, ethnicity, religion, technology choices, sexual images in public spaces, deliberate intimidation, stalking, harassing photography or recording, sustained disruption of talks or other events, inappropriate physical contact, and unwelcome sexual attention.

We do not tolerate harassment of conference participants in any form. If a participant engages in harassing behavior, the conference organizers may take any action they deem appropriate, including warning the offender, or expulsion from the conference. Participants asked to stop any harassing behavior are expected to comply immediately.

If you are being harassed, notice that someone else is being harassed, or have any other concerns, please contact one of the conference organizers immediately.

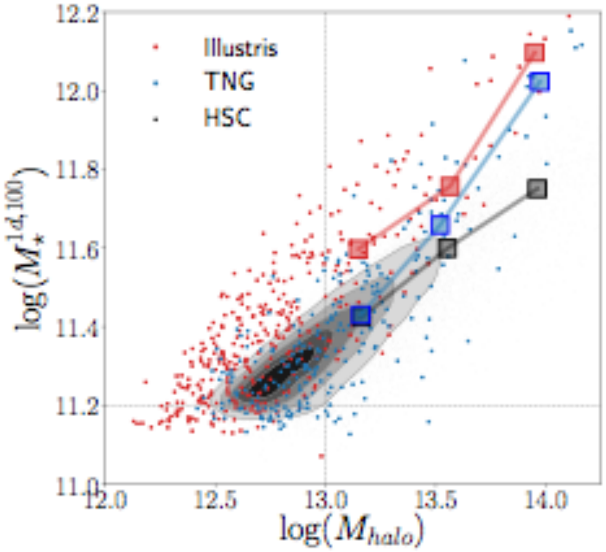
We expect participants to follow these rules during presentations, discussions, all leisure and recreational activities throughout the duration of the conference, and in any social media posts relating to the conference.

# Felipe Ardila
He/him/his
UC Santa Cruz
Galaxy Evolution- Cosmology

I am rising third year grad student at UC Santa Cruz. I am originally from Colombia, but grew up in Miami, Florida. I finished my undergrad at the University of Florida and then spent 2 years as post-baccalaureate at Princeton University. When I am not thinking about galaxies, I like to go outside to enjoy nature, and sometimes organize camping trips. I like the idea of purposeful gatherings and meeting new people. I am also into bird watching, rock climbing, and data visualization.

Email: fardila@ucsc.edu
Github: @f-ardila
Instagram: @_felife_
Snapchat: @felife

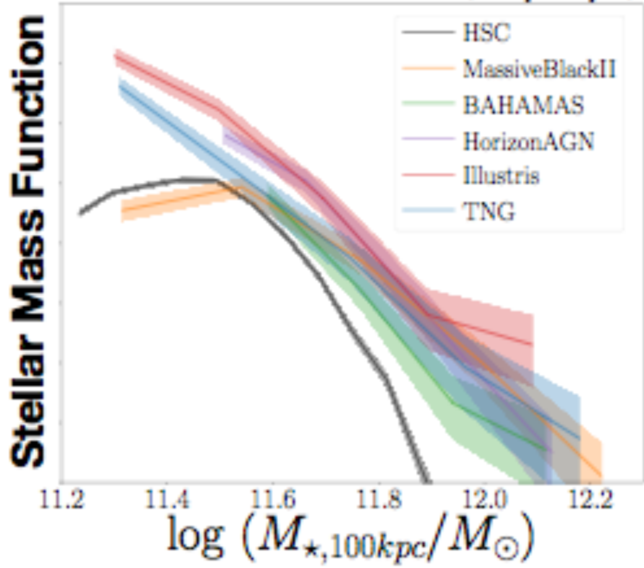
The dominant driver of large scale structure formation in the universe is dark matter. Baryons, despite being subdominant, also produce important effects in the distribution of matter at various scales. One way to study these baryonic effects is with cosmological hydrodynamic simulations. These are commonly tuned to match the stellar mass functions (SMFs) of observed galaxies, but there are often important differences in the way masses are measured in simulations and in data. I performed a detailed comparison of the stellar mass profiles of massive galaxies in several hydrodynamic simulations (focusing on IllustrisTNG) with new high-quality data from the Hyper Suprime-Cam (HSC) Survey. We focus on low redshift, high mass galaxies with log(M*)>11.6 for which HSC can trace the light profiles of individual galaxies out to 100 kpc. We and that simulations tend to produce galaxies with too much stellar mass in their outer envelopes. Our next steps will focus on understanding these differences and specially the role that baryonic effects may play in the general distribution of matter in these galaxies. We aim to expand an existing baryon correction model (Schneider & Teyssier 2015) by exploring which observables most highly constrain the effects and including them in the model.



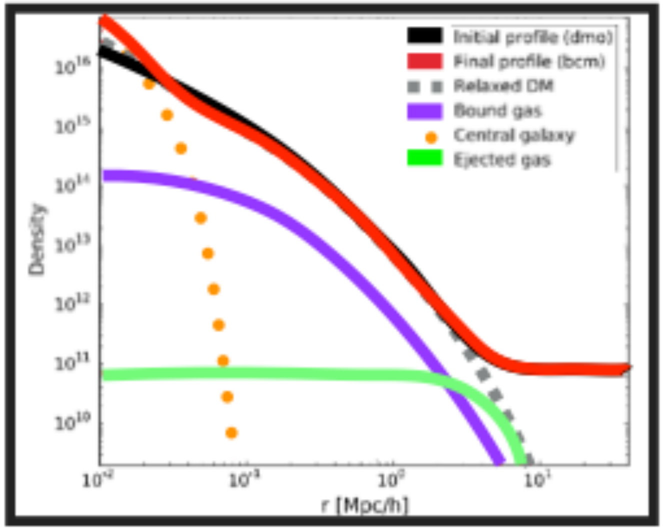

Cosmological hydrodynamic simulations produce massive elliptical galaxies that contain too much stellar mass.

*Feedback calibration?*

*Ardila+2019 (in prep.)*




# BARYONIC EFFECTS IN MASSIVE GALAXIES

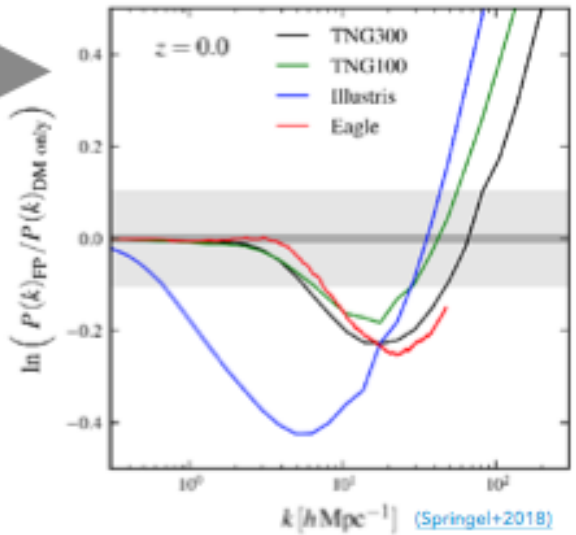



*Baryonic correction model* (Schneider & Teyssier 2015)

Baryons affect the distribution of matter even at large scales.

*Constrain using empirical model from data:*

- *stars*
- *DM halo*
- *gas*




# Rory Bentley

he/him/his

UCLA

Galactic Center- Stellar Populations

I grew up in south Louisiana and eastern Canada, and got my BS at Louisiana State University in 2018. I've been interested in astronomy (professional and amateur) since I was little. I also enjoy hiking and visiting national parks, food, dogs, geography and geology.

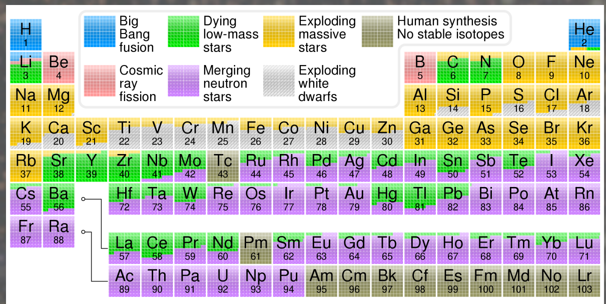
Email: rbentley@astro.ucla.edu
Instagram: @rorywearsshades
Twitter: @rorywearsshades

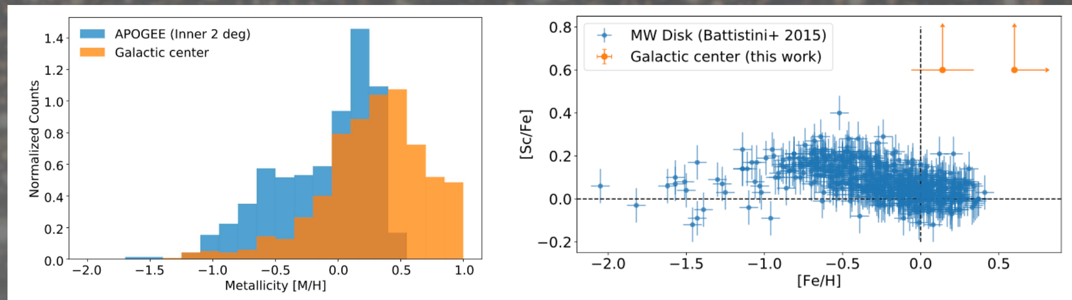
The metallicity of stars and stellar populations is an important property that allows us to understand their formation and subsequent evolution. Metallicity can also serve as a signature for separating multiple populations of stars formed at different times. The Milky Way's Nuclear Star Cluster (NSC) has been found to contain both metal-poor and extremely metal-rich stars, suggesting a complicated formation history. My project involves using high-resolution spectroscopic observations from NIRSPEC of NSC stars to better determine the metallicities and formation history of the NSC. Additional astronomy topics that interest me are high-mass stars, star clusters and stellar populations, and Milky Way structure.

# Determining the origins of the Milky Way's nuclear star cluster

Rory Bentley, University of California: Los Angeles     Email: rbentley@astro.ucla.edu

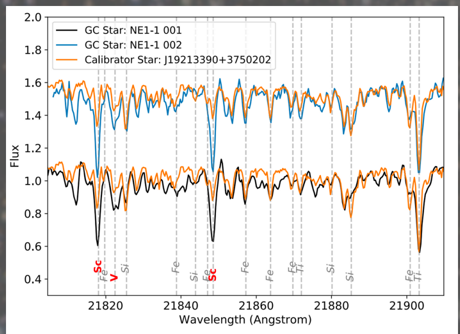
## Background:




Different processes in stellar evolution produce different elements. Using high-resolution spectroscopy, we can determine elemental abundances in stars, which can tell us about the environment they formed in.

Previous, lower resolution studies of stars in the Milky Way's Nuclear Star Cluster (NSC) found stars with both low ([M/H] ~ 1.0) and extremely high metallicities ([M/H] > ~0.7). However, abundances of individual elements have only been measured on two stars.




## Project plans and goals:

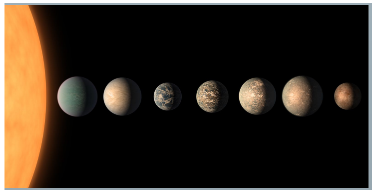
- Observe select sample of NSC stars and calibrator stars with independently determined metallicities with NIRSPEC in K-band
- Use calibrator stars to test abundance determination methods, and develop a set of high [M/H] spectral standards in K-band
- Use new abundance determination routine on the NSC stars, and obtain accurate metallicity and abundance measurements
- Use metallicity and abundance measurements to help determine the formation history of the NSC

Minghan Chen
he/him/his
UC Santa Barbara
Exoplanet

I am an upcoming second year at UCSB working for Tim Brandt on high contrast imaging of exoplanets. I grew up in China and did my undergrad in physics at Carnegie Mellon. I love soccer, movies, outdoor activities, rock music and video games. And I brag about this everywhere I go: I can parallel park by drifting.

Email: minghan@ucsb.edu
Instagram: @clcmhl

The field of exoplanets has been rapidly developing over the past decades and has seen more than 4000 exoplanets discovered, mainly through indirect methods like transit and radial velocity. Direct imaging offers complementary observations of planets with face-on orbits, allowing further understanding of planet formation and evolution. However, direct imaging also faces 3 main challenges: high contrast between host star and planets, close proximity of the planets to the host star and image degradation. These have limited the number of planets imaged so far to only a few dozen. New instruments and techniques like adaptive optics, coronagraphs and differential imaging are being developed to address these issues. I am working on developing a post-processing package for a new instrument called Coronagraphic High Angular Resolution Imaging Spectrograph (CHARIS) on the Subaru Telescope. The goal is to subtract off the point-spread function of the host star, maximize any potential planet's signal and extract planet astrometry and spectrum.



# High Contrast Imaging of Exoplanets

Minghan Chen, UCSB

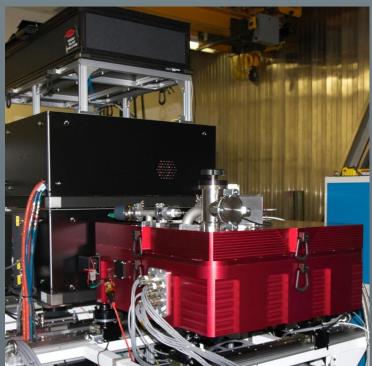
## Introduction

Ways to detect/observe exoplanets:
1. Transit
2. Radial Velocity
3. Direct Imaging

Challenges for direct imaging:
1. High contrast between host star and planet
2. Spatial Resolution
3. quasi-static speckle noise

Why we need direct imaging:
Only way to observe planet surface properties

## Instrument



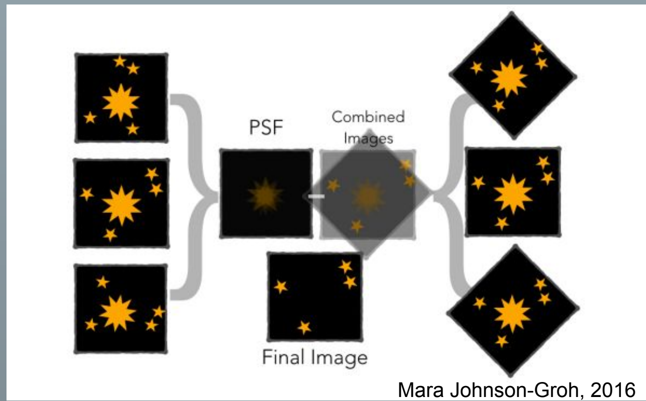
SCExAO

CHARIS

Tyler Groff et al. 2017

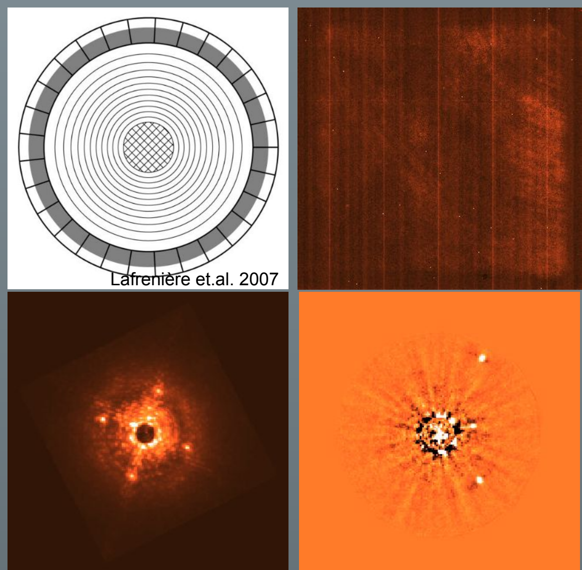
## Method

Angular Differential Imaging (ADI)




Mara Johnson-Groh, 2016

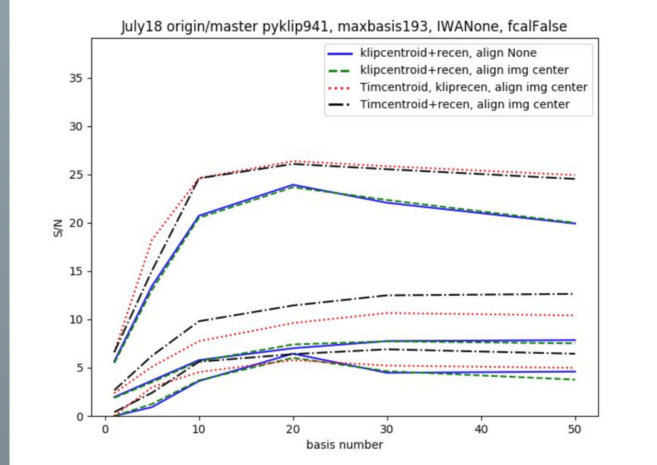
TLOCI + ADI + SDI + NMF

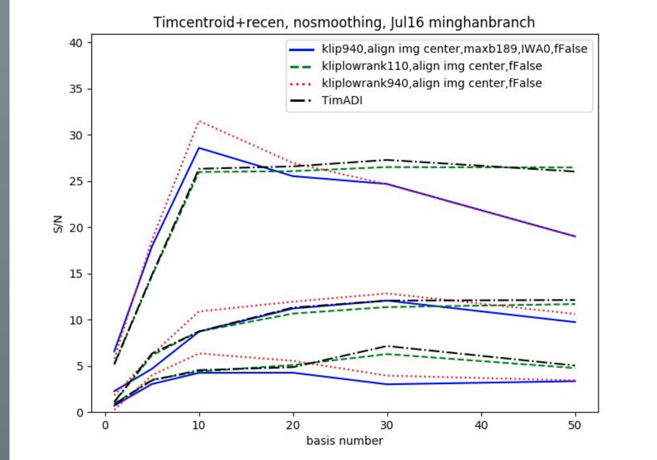


Lafrenière et.al. 2007

pipeline → post processing → science

## Progress




1. New centroid performs better

2. NMF also has slight advantage


# Sara Crandall

she/her/hers

UC Santa Cruz


Stellar Evolution

I am a 4th year graduate student the UC Santa Cruz. Kansas born and raised, I received my B.S. in physics from Kansas State University in 2012 and my M.S. in physics from Kansas State University in 2016. I'm a single mom and in my free time I advocate for affordable and appropriate housing and child care for students with families on the UCSC campus. Recently I had the pleasure of serving as a 2019 Christine Mirzayan Science & Technology Policy Fellow at the National Academies of Sciences where my project was to promote diversity and inclusion in the Astro2020 decadal survey.


Email: sacranda@ucsc.edu

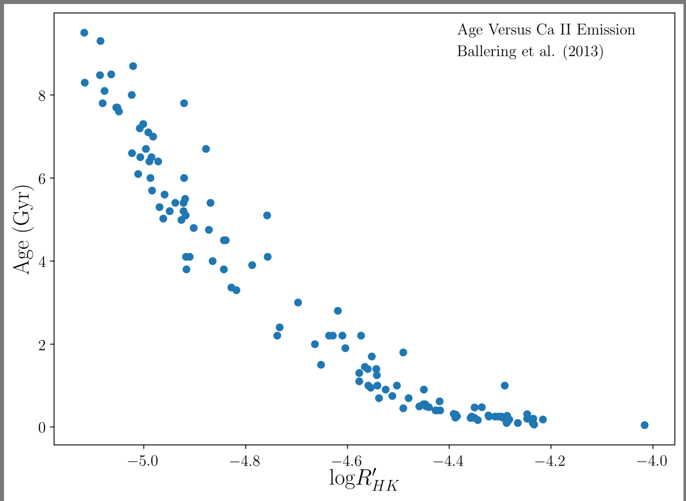
Twitter: @SaraRCran

Website:https://sites.google.com/ucsc.edu/saracrandall/home?authuser=0


Stellar age cannot be directly measured, yet age determinations are fundamental to understanding the evolution of stars, planets, and galaxies. Previous works indicate that as a dwarf star ages and spins down, its activity declines. Thus stellar age relates directly to chromospheric activity. I utilize far-ultraviolet photometry gathered by The Galaxy Evolution Explorer (GALEX) space telescope as an indicator of stellar activity to consequently infer ages of late-F, G, and K type dwarf stars.

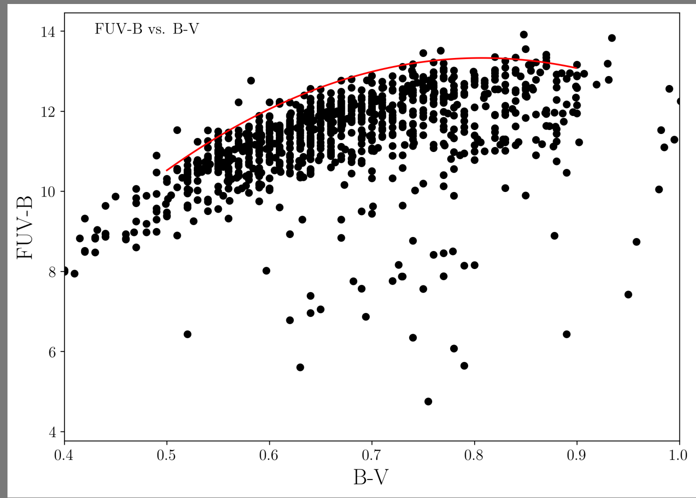
# Estimating Ages of Solar-type Dwarf Stars with GALEX FUV Photometry

Sara Crandall, G. Smith, A. Subramonian, K. Ho, and K. Cochrane




Stars spin down as they age, which leads to decreased chromospheric activity.

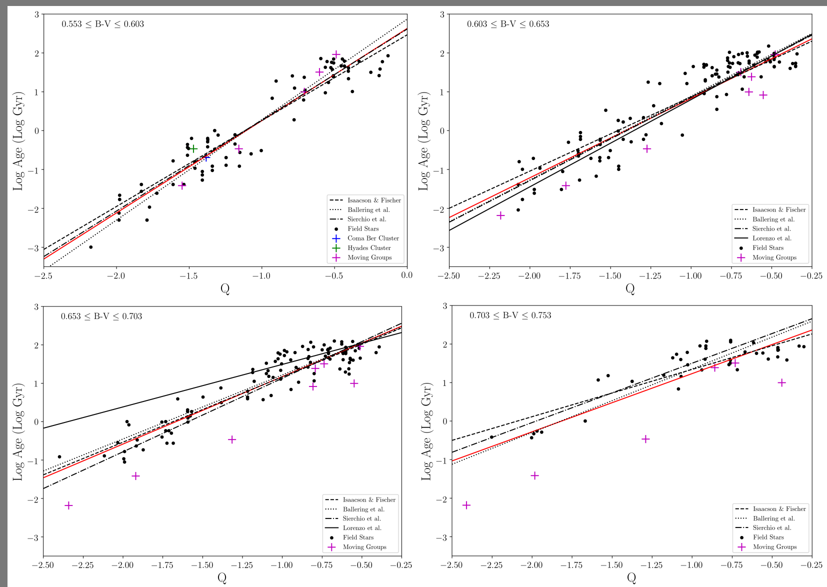
Chromospheric and coronal spectral emission lines, such as Ca II H & K and soft X-ray emissions are often used as stellar activity indicators, and hence age. However, this often requires high resolution spectroscopy.




Ca II H & K and soft X-ray emission lines from late-F, G, & K type stars have been shown to be tracers of FUV luminosity.

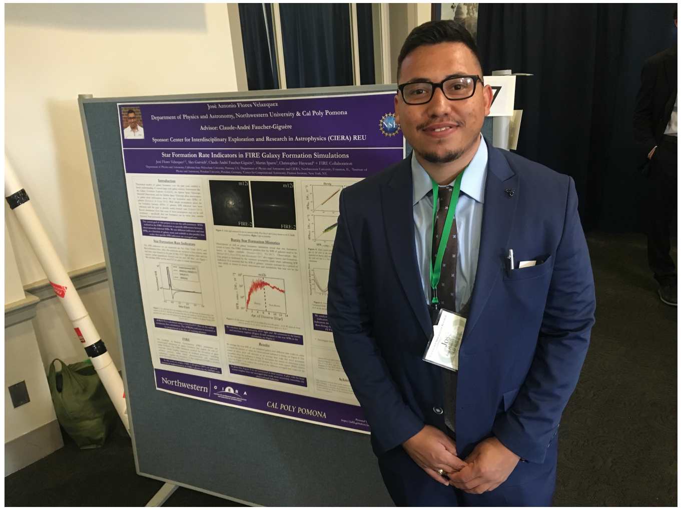
This work characterizes the relationship between FUV magnitudes and stellar age through simple linear functions.

FUV-age fits of field stars and representative moving group & cluster stars are described by the function
$log_e(\tau) = log_e(a) + bQ$
where
$Q(FUV-B) = (FUV-B) - u_{FUV}(B-V)$
is an FUV-excess parameter in which
$u_{FUV} = -29.701(B-V)^2 + 47.959(B-V) - 6.031$
represents a minimum chromospheric activity for a given color. Overall fits are shown (left) in red for four color ranges.




## Conclusions

Purely empirical age calibrations for late-type dwarf stars have been demonstrated by utilizing only Johnson B & V and GALEX FUV magnitudes. In addition, we have shown strong correlations between FUV flux and stellar age for FGK dwarf stars. The FUV-excess parameter, Q, shows promise as an age indicator similar to Ca II H & K and soft X-ray emission lines for late-F, G, & K type dwarf stars independent of stellar modeling. This paper formulated a calibration such that with only photometric magnitudes, GALEX FUV photometry can be added to the toolbox of stellar age-dating techniques.




# José Flores Velázquez

he/him/his

UC Irvine

Galaxy Formation

Email: floresv@uci.edu

Twitter: astro___jose

Website: https://jaf12.github.io/joseflores.github.io/


Hello, my name is José Flores Velázquez. I received my B.S. in Physics from Cal Poly Pomona. Using galaxy formation simulations from the Feedback In Realistic Environments (FIRE) project, I have investigated the kinematics of galaxy mergers under the guidance of Prof. Jorge Moreno (Pomona College) as well as analyzed the timescales probed by H-alpha and far ultraviolet (FUV) star formation rate indicators under the guidance of Prof. Claude- André Faucher-Gigurère (Northwestern). I am now an incoming 2nd year at UCI working with Prof. James Bullock. Ultimately, I hope to become a professor upon graduating from UCI.


Understanding the rate at which stars form is vital to understanding galaxy formation. Observationally, the star formation rates (SFRs) of galaxies are typically measured using light in different bands under the assumption of a time-steady SFR. We use the self consistent SFHs realized in the Feedback In Realistic Environments (FIRE) project to quantify differences between observationally-inferred SFRs. We use different indicators and true SFRs, as a function of galaxy mass and redshift to predict the time scales that H$\alpha$and far ultraviolet (FUV) SFR indicators are averaged over. SFHs in FIRE are realistic in the sense that when averaged over longer timescales, the SFR either increases or decreases, resulting in time variable (bursty) SFRs. We also quantify the possible dependence of SFR indicators on SFR variability. Our results indicate that the effective timescales probaly these indicators do not depend significantly on galaxy mass as well as different redshift intervals with effective timescales of~4-5 Myr for H-alpha and~10-15 Myr for UV in both the time-steady and bursty regimes.

# Star Formation Rate Indicators in FIRE Galaxy Formation Simulations

José Flores Velázquez[1,2], Alex Gurvich[2], Claude-André Faucher-Giguère[2], Martin Sparre[3], Christopher Hayward[4], James Bullock[1] + FIRE Collaboration

[1]Department of Physics and Astronomy, University of California Irvine, CA, [2]Department of Physics and Astronomy and CIERA, Northwestern University, Evanston, IL, [3]Institute of Physics and Astronomy, Potsdam University, Potsdam, Germany, [4]Center for Computational Astronomy, Flatiron Institute, New York, NY,

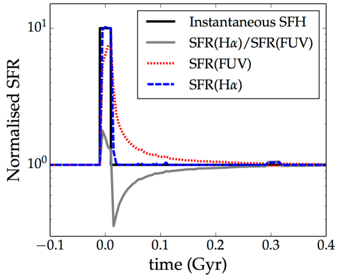
## Introduction

Theoretical models of galaxy formation over the past years enabled a better understanding of current large scale galaxy surveys. Instruments like the Galaxy Evolution Explorer (GALEX), the Spitzer Space Telescope, Herschel Observatory, and the Hubble Space Telescope allow astronomers to gather more information about the star formation rates (SFRs) of galaxies (Kennicutt & Evans 2012). With simple assumptions about the star formation histories (SFHs) of galaxies, SFR indicators have been calibrated with the goal to identify newly formed stars (Calzetti+2013). Recent simulations show that some of these assumptions may not be well motivated -- specifically that star formation can be more time variable (burstier) than previously thought.

**The central goal of this project is to use the self-consistent SFHs realized in the FIRE simulation to quantify differences between observationally-inferred SFRs. We use different indicators and true SFRs, as a function of galaxy mass and redshift to also predict time scales that specific SFR indicators are averaged over .**

## Star Formation Rate Indicators

The SFR indicators we are interested are Far Ultra Violet (FUV) and Recombination lines, (Hα). Hα emissions are exclusive to hot massive stars and trace stars formed in the past 10 Myr. FUV light probes older and less massive stellar populations formed over the past 100 Myr , see Figure 1. We calculate SFRs via Hα and FUV in order to mimic observations.




***SFR(FUV)* is calculated using a GALEX-FUV filter on the stellar continuum flux calculations. The *SFR(Hα)* indicator is assumed to be proportional to the flux of ionizing photons.**

**Figure 1**. *The solid black line is the normalized SFH of a 20 Myr burst, the dotted red line is the response of the FUV indicator and the dotted blue line is the response of the Hα indicator. The solid grey line is the ratio of the SFR derived by the indicators which is sensitive to the galaxy's bursty SFH (Sparre+2017).*

## FIRE

The Feedback In Realistic Environments (FIRE) simulations are cosmological simulations of galaxy formation that explore the role of stellar feedback. The FIRE simulation resolved the formation of giant molecular clouds. Explicit treatment of feedback processes – including radiation pressure, stellar winds, photoionization and supernovae explosions – regulate star formation. It also employed GIZMO, a modern mesh-free hydro solver (Hopkins+2014).

**In this work we employ FIRE-2 (Hopkins+2017), an updated numerical implementation of FIRE-1 physics for the GIZMO code.**

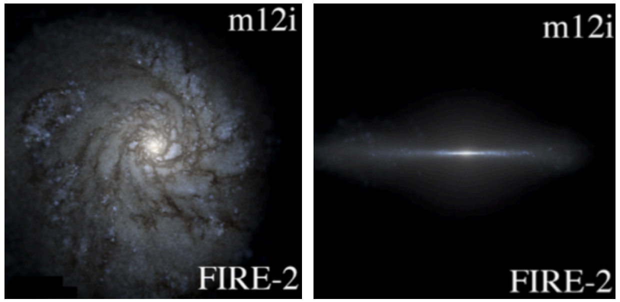



**Figure 2**. *Stellar light attenuated by dust in simulated Milky Way Mass-Like Galaxy known as m12i.* ***Left:*** *Face-on projection,* ***Right:*** *Edge-on projection.*

## Bursty Star Formation Histories

Observations as well as galaxy formation simulation reveal that star formation occurs in burst. The FIRE simulations predicts that the SFR of galaxies tend to be bursty at higher redshifts (Muratov+2015, FG-2017). Observations like: Shivaei+2015, Guo+2016, and Shimakawa+2017 also suggest bursty star formation. Our project is motivated by the common assumption made when calibrating SFR indicators. It is assumed that the SFR of galaxies remains constant for a period of time which as shown in recent observations and simulations that may not be the case.

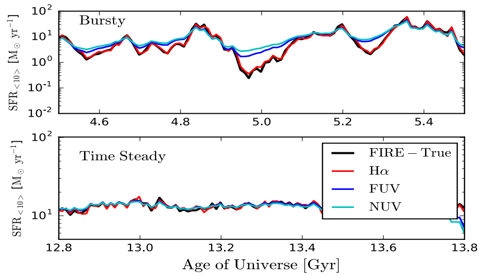



**Figure 3**. *10 Myr boxcar average SFH of the Milky Way mass-like galaxy -- m12i. Top panel shows instances of "bursty" SFRs and bottom panel shows instances of a "time-steady" SFRs.*

**We calculate the SFRs derived by *FUV* light *and Hα* emissions in the bursty and non-bursty regimes (Figure 3) and compare to the true SFRs in the simulation, see Figure 4.**

## Results

We average the true SFR of our simulated galaxy over different time scales in order to match the physics of what the observational indicator is doing, see Figure 4. The scatter in these plots will decrease at an average time scale that most accurately resembles what the indicator is doing. To determine the scatter we determine a best fit line through our SFR data set and calculate the root mean square (RMS) relative error. In Figure 5 we analyze the scatter at the different averaged time scales for the Hα and FUV indicators.

**In plots like Figure 4 we are interested in their scatter. A plot with the least scatter implies that our averaged time scale most accurately resembles the observational indicator.**

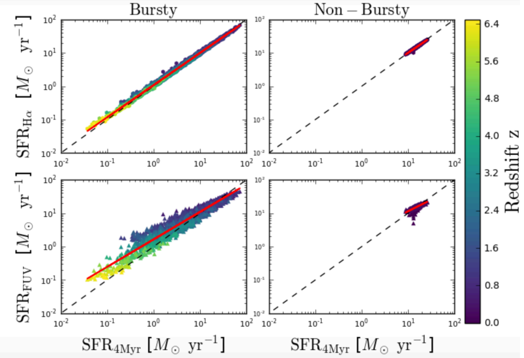



**Figure 4**. *These scatter plots are for the m12i simulation. Each point was generated by binning the ages of the stars in the simulation. SFR(Hα) (1st row), SFR(FUV) (2nd row) vs $SFR_{<4Myr>}$ are separated in Bursty (left) and Non-Bursty (right) regimes. The black dashed line is a one-to-one line and the solid red line is a best fit line between SFR derived by the indicators and the true SFR in our simulation.*

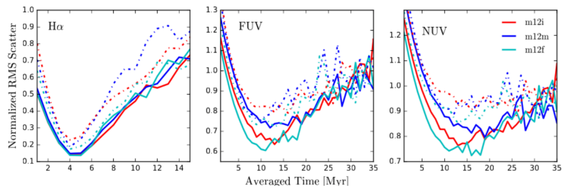



**Figure 5**. *Normalized RMS Relative Error (R.E.) vs Time Averaged: solid lines correspond to Normalized RMS R.E in the bursty regime and dotted color lines correspond to the Normalized RMS R.E. in the non-bursty regime. The different colors correspond to different simulated galaxies varying in mass.*

**We analyze the RMS relative errors of scatter for the *Hα* and *FUV* indicators and find that the best-fit timescales derived by these indicators do not depend significantly on whether the SFR is bursty. Best-fitting timescales of about 4-5 Myr for *Hα* and about 10-20 Myr for *UV* in both the time-steady and bursty regimes.**

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UCI Northwestern CIERA

Personal Website:
https://jafl2.github.io/joseflores.github.io/

# Jessie Hirtenstein
she/her/hers
UC Davis
Galaxy evolution

Hi everyone -- I'm a fifth year grad student at UC Davis, studying the effects of stellar feedback on galaxy evolution, particularly in low mass galaxies. When I'm not thinking about astronomy, I love baking, traveling and musical theater!

Email: jhirtenstein@ucdavis.edu
Twitter: @j_hirtenstein
Instagram: @canonlyodd

Are gaseous outflows from young, massive stars strong enough to alter the gravitational potentials of dwarf galaxies, resolving small scale tensions with LambdaCDM? If so, we would expect to observe this phenomenon at high redshifts where stellar feedback is most active. I will introduce the OSIRIS Lens-Amplified Survey (OLAS), a kinematic survey of gravitationally lensed low mass galaxies at z~2 taken with Keck adaptive optics, designed to study whether stellar feedback may resolve the cusp-core problem. OLAS probes the stellar mass and specific star formation rate range where simulations suggest that stellar feedback drives gas outflows, creating galaxy-wide potential fluctuations which can generate dark-matter cores. These observations are consistent with feedback-driven turbulence and outflows from the FIRE simulations, which predict core formation in dwarf galaxies.

# DYNAMICAL EFFECTS OF STELLAR FEEDBACK IN LOW MASS GALAXIES

**Jessie Hirtenstein, University of California, Davis**

## OSIRIS Lens-Amplified Survey (OLAS)

**Science Goals:** Test whether baryonic outflows resolve the cusp-core problem
**Needs:** Probe $M_*$ and z where stellar feedback is most dynamically affected, unique combination of lensing and Keck adaptive optics
**Instrument:** OSIRIS, Mauna Kea Integral Field Unit → spatially resolved kinematics
**Sample:** 17 star forming dwarfs galaxies, $8 < \log(M_*/M_\odot) < 9.8$, $1.2 < z < 2.3$

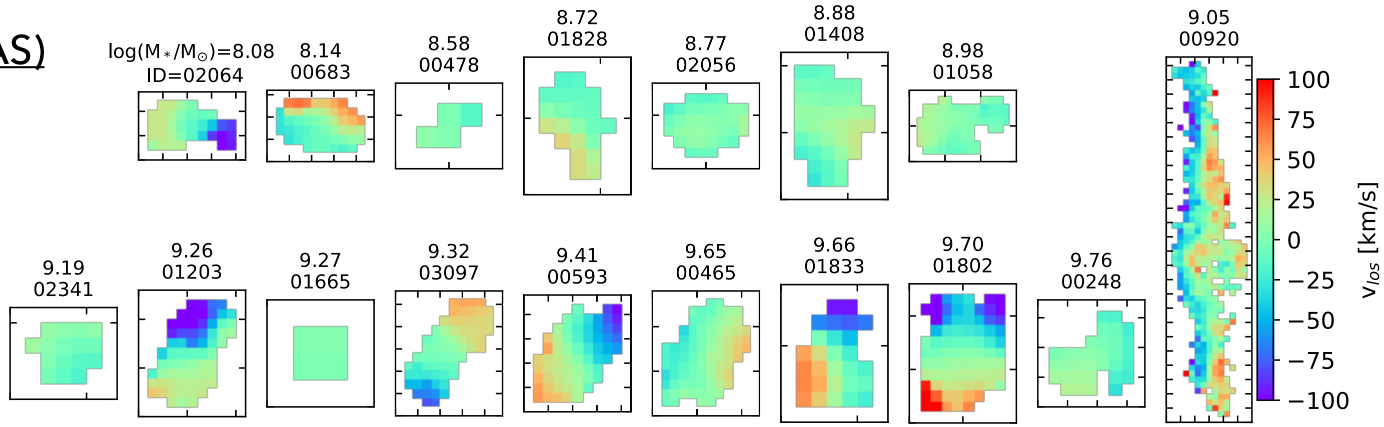



Figure 1. Hα velocity maps for 17 star forming galaxies in our sample. The galaxies are sorted by stellar mass ranging from log $(M_*/M_\odot)$ = 8.08-9.76, shown with a common velocity scale (right). Targets with log $(M_*/M_\odot)$ <9 (top row) typically have lower velocity shear and disordered kinematics (dispersion-dominated in most cases), whereas the more massive galaxies on the bottom row predominantly show ordered rotational motion.

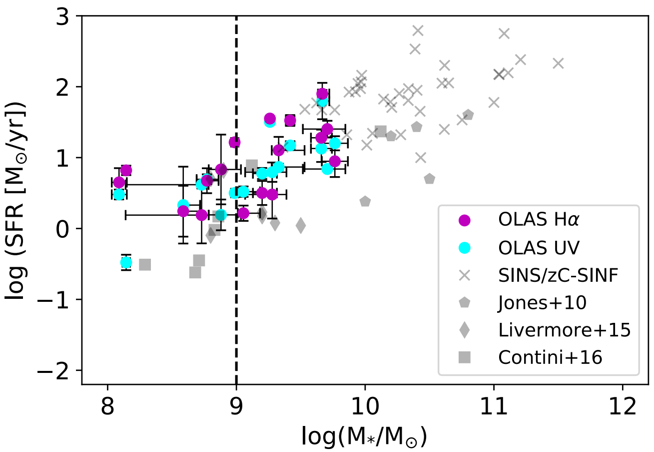



Figure 2. Comparison of OLAS sample to other kinematic surveys. This study pushes down roughly 1.5 orders of magnitude lower in stellar mass and SFR, as well as as one order of magnitude higher in spatial resolution than other kinematic surveys, due to the unique combination of adaptive optics and gravitational lensing.

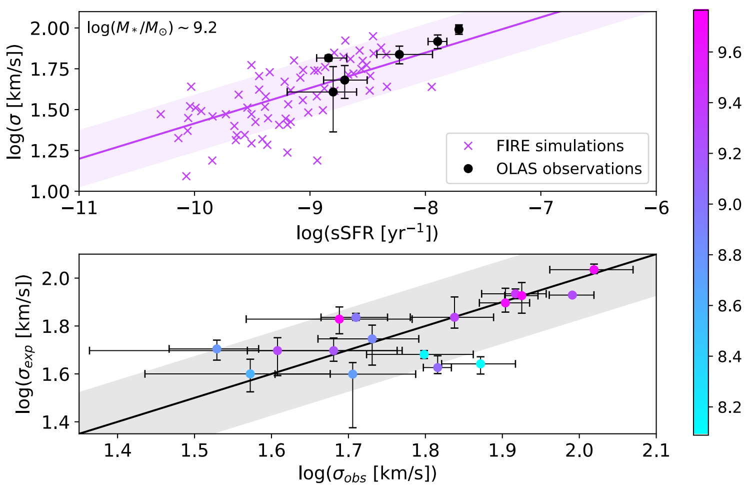



Figure 3. Top: Correlation of sSFR and σ in simulations (pink) compared to our OSIRIS data (black), at fixed mass log $M_* \simeq 9.2$. Bottom: Measured σ for each galaxy in our OSIRIS sample, compared to that predicted by simulations (e.g. based on their masses and sSFR).

## Take-aways:

- Sample probes masses and redshifts where simulations predict **feedback to be most effective**
- If stellar feedback resolves the core-cusp problem, it must be able to **alter the potential** of dwarf galaxies
- Simulations predict galaxies with a **higher sSFR** and hence more active feedback will have **higher intrinsic velocity dispersions**, resulting from the rapid change in their gravitational potentials (El-Badry et al. 2017)
- Observations in **1-sigma** agreement with simulations that resolve the cusp-core problem with stellar feedback


# Anthony Pahl

he/him/his

UCLA


Galaxy evolution

I'm a rising 3rd year astronomy graduate student at UCLA, originally from the jewel of the midwest (Minnesota). I'm a big fan of far away objects, high-powered computing, union organizing, and x-treme sports like rock climbing, surfing, and boogying down.


Email:pahl@astro.ucla.edu
SC: @tonyplus
Instagram: @tonyminus



The rest-UV spectrum of a star-forming galaxy is rich with information about massive stars and the interstellar medium. It reveals interstellar and circumgalactic gas properties such as covering fraction, kinematics, and chemical abundances, and offers probes of star formation and dust. We perform a comprehensive analysis of the redshift evolution of rest- UV spectral features of Lyα and low- and high-ionization interstellar metal absorption lines to z ~ 5 for the first time. We measure the equivalent widths of interstellar absorption features using stacked spectra in bins of Lyα equivalent width. We and a strong trend of decreasing low-ionization line strength with increasing Lyα emission strength, invariant over the redshift range z ~ 2 - 5, suggesting that both of these quantities are fundamentally linked to neutral gas covering fraction. We also and that the independence of Lyα equivalent width and high-ionization absorption line strength persists over the full redshift range studied here, demonstrating that high-ionization absorption lines are produced in a different phase of gas from that which attenuates Lyα photons. Applying a correction to the Lyα equivalent widths to remove attenuation by the intergalactic medium, we show that a z ~ 5.2 subsample tend to have stronger Lyα emission at axed low-ionization absorption strength than those at lower redshift, and are brighter, more massive, and more star-forming.

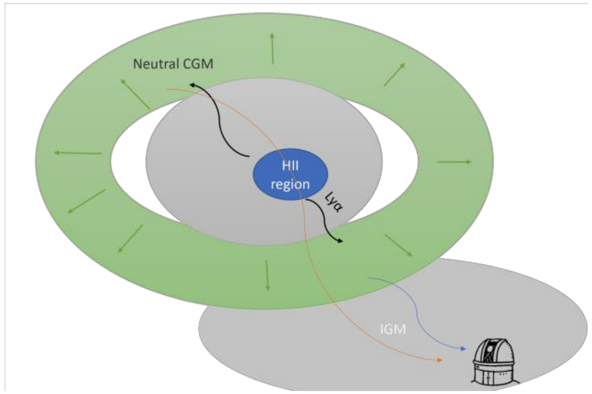
# Redshift Evolution of Rest-UV Spectrosc. Properties in Star-Forming Galaxies Beyond z~5

Anthony Pahl, University of California: Los Angeles
pahl@astro.ucla.edu

## Question

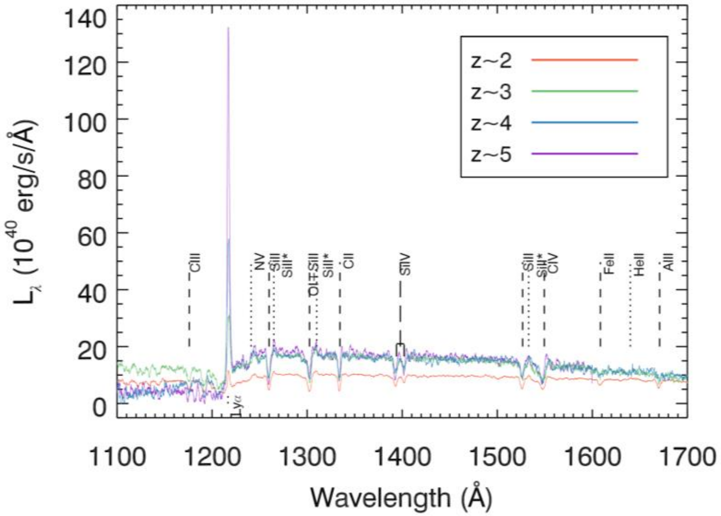
How do star-forming galaxies differ closer to Reionization? **Especially Lya production rate, escape fraction of UV photons??**

Our tool is the rest-UV spectrum: probes HII regions, ISM properties, gas inflow/outflow, dust content, neutral gas covering fraction, more!




## Data

Stacked DEIMOS spectra (w/ Lya, IS absorption)

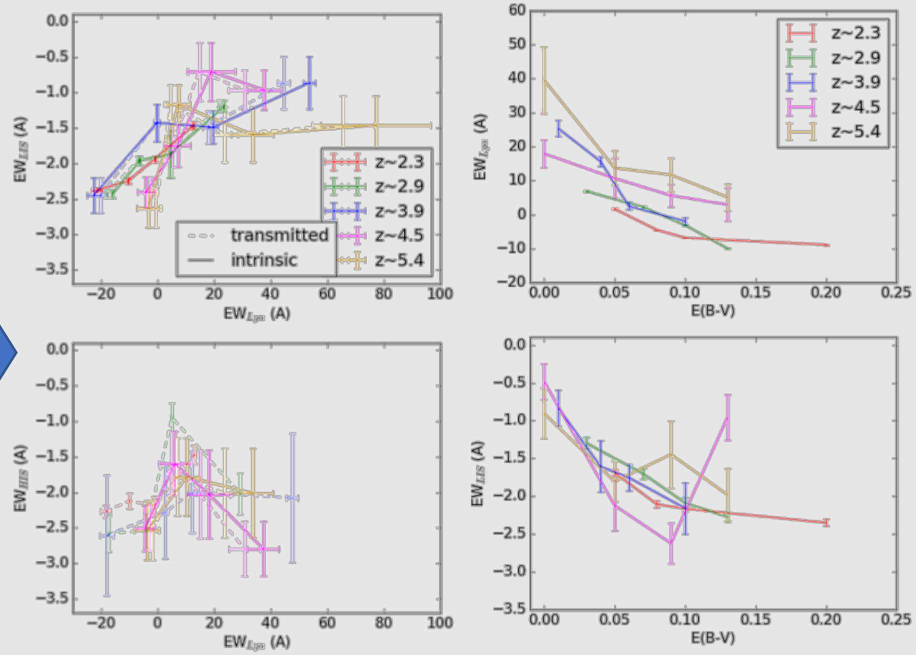



and COSMOS Photometry

## Measurements

- Equivalent width of lines as a function of Lya strength
- Correct for IGM attenuation

## Spectral Relationships




- Neutral gas covering fraction drives these relationships .. but z~5 galaxies may have stronger intrinsic Lya!

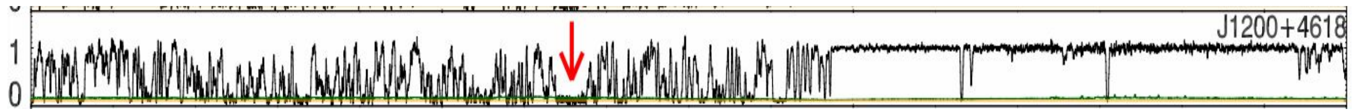
Mahdi Qezlou
he/him/his
UC Riverside
Intergalactic Media

I'm going to start my 2nd year as a grad student in UC Riverside. I work with Simeon Bird and about Intergalactic Media. Came from Iran and did my undergrad in physics back there. I like to have discussions about (Astro)physics, Data Science and computation, Education, Politics, History, and almost everything :)) The rest of the time, I prefer to spend my time in nature and get relaxed!

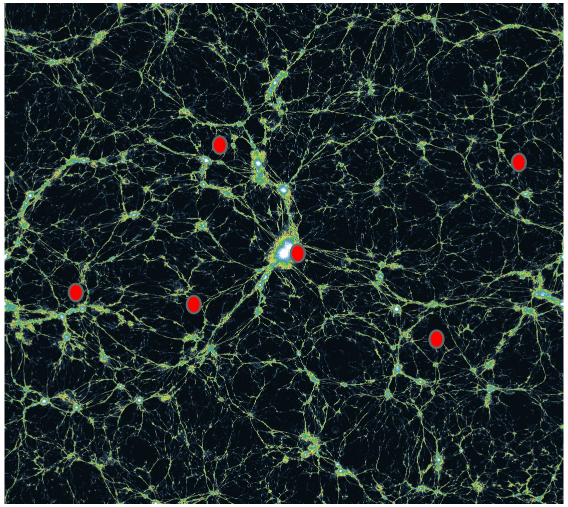
Email: mahdi.qezlou@email.ucr.edu
Github: github.com/mahdiqezlou
Instagram: @mahdiqezlou
Twitter: @mahdiqezlou

Intergalactic medium (IGM) is super important! Why!? Because it contains most of the Hydrogen in the universe. Hydrogen is also important ! Why!? Because it is too simple and therefore easy to be observed. So, my research is studying these mostly neutral Hydrogen clouds to understand the environmental effects on Galaxy Evolution. I compare observed absorption features caused by these clouds in quasar/galaxy spectrum with predictions from Hydro simulations. Too much words!!! Let's see some cool plots :)

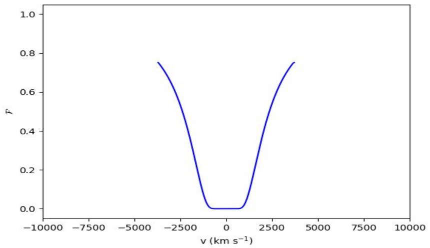
# Damped Lyman Alpha Systems (DLAs) :



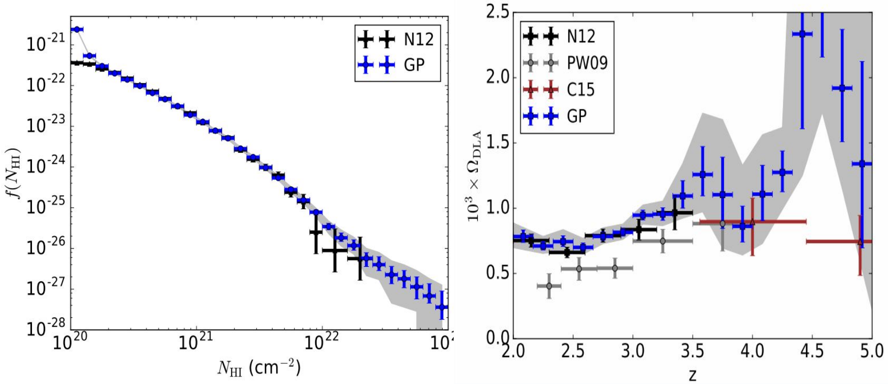

Sight-lines through Hydro simulation boxes



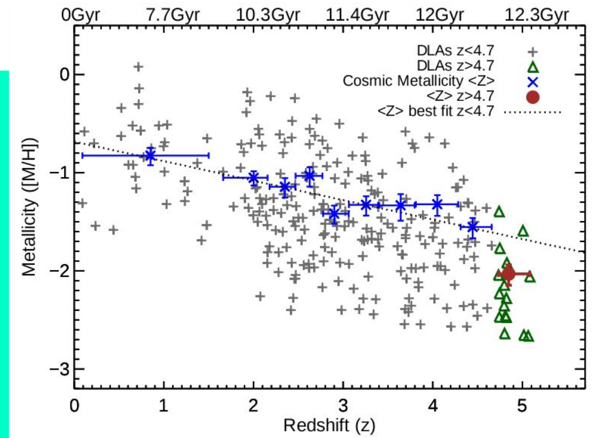
Simulating absorption features from Hydro simulations




Comparing to observation




Neutral Hydrogen Distribution in Universe
SDSS DR12, Bird et al. 2018




Metallicity of DLAs : A good indicator for feedbacks
Rafelski et al. 2013

## Goals:

. studying feedback models in cosmological Hydro Simulations
. Finding cosmological parameters on Non-Linear regimes ($\sigma$_8 )

# Jenna Samuel
she/her/hers
UC Davis
Cosmological simulations and satellite galaxies

I'm a rising 5th year grad student at UC Davis. I grew up in Miami, FL and I did my undergrad there too at Florida International University. I use simulations to understand how the distribution and dynamics of satellite dwarf galaxies impact their formation history. When I'm not working, I enjoy making silver jewelry, going to concerts, baking, working towards diversity and inclusion, hanging out with animals and friends, and playing board games!


Email: jsamuel@ucdavis.edu
Twitter: @astro_jenna
Website: jennasamuel.com



While many tensions between Local Group (LG) satellite galaxies and LCDM cosmology have been alleviated through recent cosmological simulations, the spatial distribution of satellites remains an important test of physical models and physical versus numerical disruption in simulations. Using the FIRE-2 cosmological zoom-in baryonic simulations, we examine the radial distributions of satellites with Mstar > 10^5 Msun around 8 isolated Milky Way- (MW) mass host galaxies and 4 hosts in LG-like pairs. We demonstrate that these simulations resolve the survival and physical destruction of satellites with Mstar >~ 10^5 Msun. The simulations broadly agree with LG observations, spanning the radial profiles around the MW and M31. This agreement does not depend strongly on satellite mass, even at distances <~ 100 kpc. Host-to-host variation dominates the scatter in satellite counts within 300 kpc of the hosts, while time variation dominates scatter within 50 kpc. More massive host galaxies within our sample have fewer satellites at small distances, because of enhanced tidal destruction of satellites via the baryonic disks of host galaxies. Furthermore, we quantify and provide fits to the tidal depletion of subhalos in baryonic relative to dark matter-only simulations as a function of distance. Our simulated profiles imply observational incompleteness in the LG even at Mstar >~ 10^5 Msun: we predict 2-10 such satellites to be discovered around the MW and possibly 6-9 around M31. To provide cosmological context, we compare our results with the radial profiles of satellites around MW analogs in the SAGA survey, finding that our simulations are broadly consistent with most SAGA systems.

# The spatial distribution of satellite galaxies around MW/M31-mass hosts in the FIRE simulations

Jenna Samuel, Andrew Wetzel, Erik Tollerud, Shea Garrison-Kimmel, et al.

UC DAVIS
UNIVERSITY OF CALIFORNIA

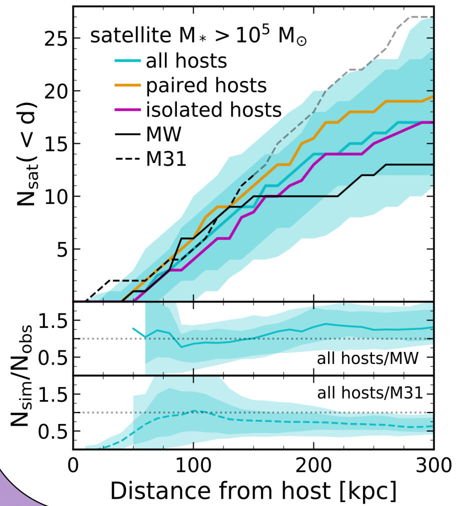
## Introduction

I. Using the FIRE-2 cosmological zoom simulations, we demonstrate that we reproduce the observed Local Group radial distributions of satellite galaxies as a function of distance from the host galaxy.
II. We also make predictions for the number of satellites remaining to be discovered around the Milky Way and M31.
III. See our paper for even more results! [1]

## Simulations

- 12 Milky Way/M31-mass hosts and their satellites [2, 3]
- Resolution: $m_{dm} = 3.5\times10^4\ M_\odot$, $m_{baryon} \approx 7.1\times10^3\ M_\odot$, $\epsilon_{gas} \approx 10$ pc
- Part of the FIRE simulations [4]

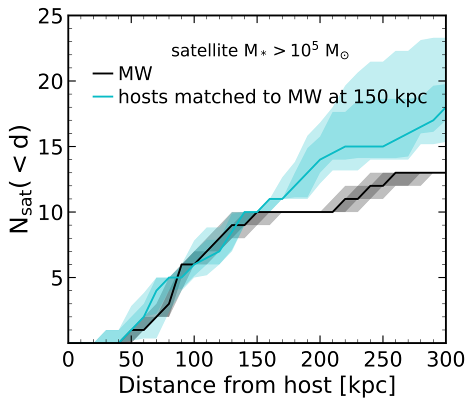
## Main result



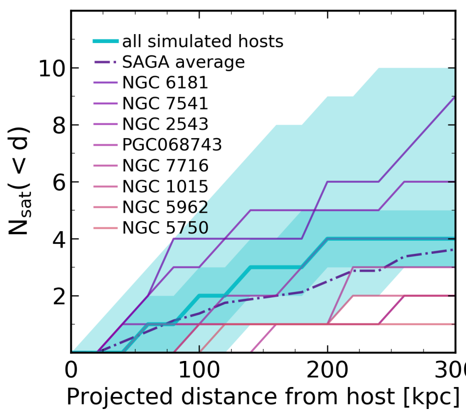

- The cumulative number of satellites as a function of distance from the host galaxy.
- The simulations (blue) are representative of Local Group observations (black).
- The MW's satellite profile lies completely within the simulation scatter at all distances, and M31's profile exceeds the scatter only slightly at low and high distances.
- There is not much difference between hosts in Local Group-like pairs (orange) versus isolated hosts (pink).

## Additional results

Selecting simulated radial profiles that match the Milky Way out to 150 kpc, we expect 2-10 (95%) more satellites to be discovered within 150 - 300 kpc.




We also compared 2D-projected radial profiles of our simulations to 8 Milky Way analogs from the SAGA survey, finding that they mostly lie within our scatter.




## Contact information

email: jsamuel@ucdavis.edu
website: jennasamuel.com
twitter: @astro_jenna

## References

[1] Samuel et al. 2019, MNRAS
[2] Wetzel et al. 2016, ApJ
[3] Garrison-Kimmel et al. 2019, MNRAS
[4] Hopkins 2018, MNRAS


# Bryan Scott
# he/him/his
# UC Riverside
# Observational Cosmology


I received my BS in Physics from Cal Poly, San Luis Obispo. From there, I went to the Jet Propulsion Laboratory where I worked on orbital dynamics in the context of outer solar system missions. After deciding to return to astrophysics, I am now a fourth year student in observational cosmology in Simeon Bird's group at UCR. I spend most of my time thinking about problems at the interface between data and theory. I am passionate about equity in science and higher education. I try not to forget what a privilege studying the night sky is  and travel as much as I can because there are wonders closer to home too!


Email:
bryan.scott@email.ucr.edu
bscot.github.io



The ionizing background effects structure in the universe on scales larger than any other non-gravitational process. Our understanding of the ionizing background is largely based on modeling of its sinks and sources. Models of sinks, for example, are used to understand the ionization state of the IGM and to set the cooling rate of gas in cosmological simulations. Because the sources of the ionizing background are the luminous structures in the universe, in principle, observations of the background carry information about star formation in galaxies and the accretion histories of supermassive blackholes. Despite its importance to diverse communities in astrophysics, the ionizing background is notoriously poorly constrained. In this work, we forecast constraints from a future space based all sky UV-optical survey on an SED model for the ionizing background and its sources. We do this with a data driven and scalable technique for redshift estimation based on spatial clustering.

# Revealing the Ionizing Background

A data driven technique for estimating the redshift distribution of sources in large surveys can be used to constrain the ionizing background and its sources.

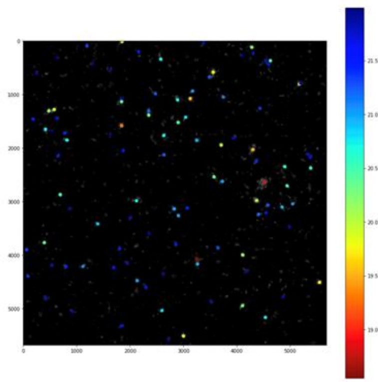
*Bryan Scott and Simeon Bird, University of California, Riverside*

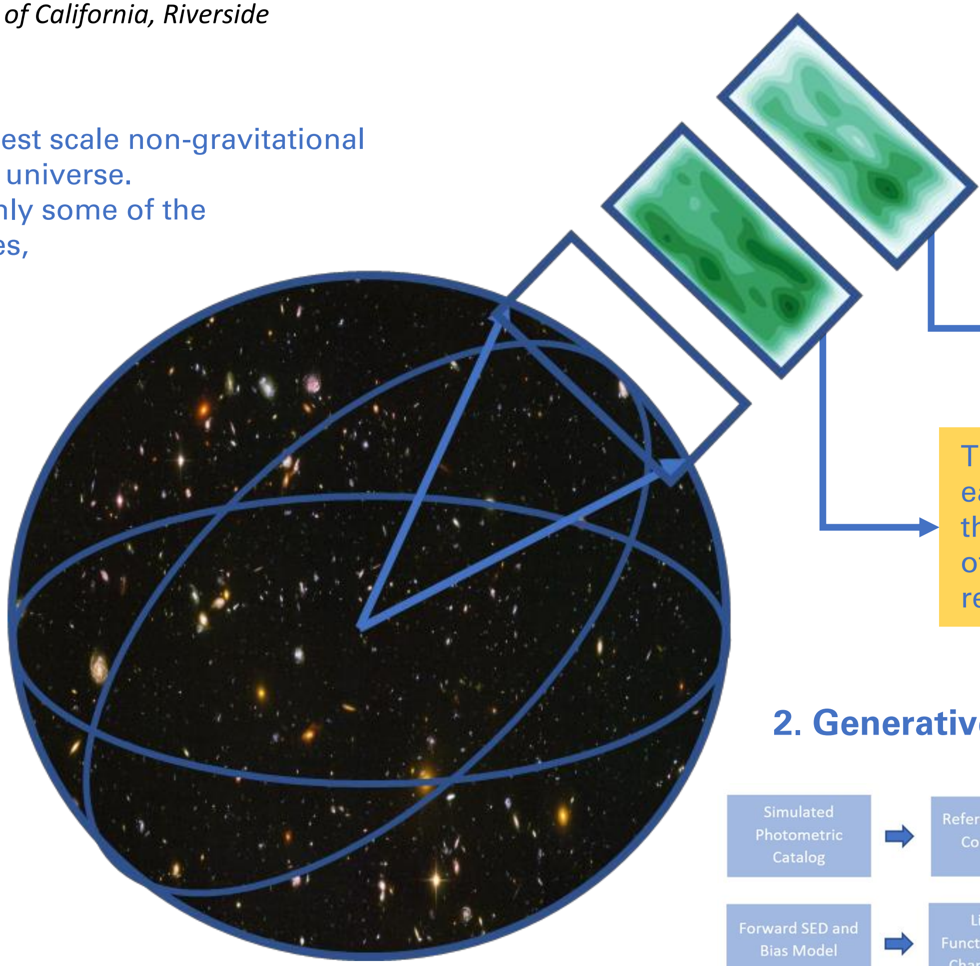
ASTRONOMY UCR

## The Theory

The **ionizing background** is the largest scale non-gravitational process that effects structure in the universe. It encodes information about not only some of the largest scale astrophysical processes, but also about smaller scales involved in star formation and the accretion of supermassive blackholes. An understanding of this background is key for studying the properties of the intergalactic medium and understanding the formation of structure in the universe.

## The Observations





In this work, we start with simulated images appropriate to a future all sky UV-optical survey mission.

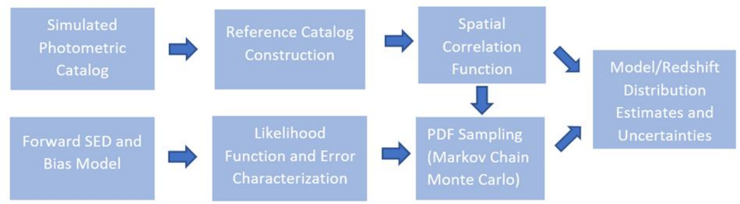
In large surveys, we directly observe a 2D projection of a 3D space. We can use **clustering redshift estimation** to infer the distribution of sources in this full space and in turn infer the parameters of an SED model.

## How it works:

### 1. Estimating the Redshift Distribution with Spatial Clustering

The intensity field is different in each redshift 2D slice. We correlate the projection of this with a catalog of spectroscopic redshifts to recover the 3D distribution.

### 2. Generative Modeling and Inference




Then we can forward model the observed intensity using an SED model and filter response. A Bayesian framework can recover the ionizing background model conditioned on the data, including parameterizations for its evolution with redshift. The parameters of this model encode information about the sources of the background.

Sunil Simha
he/his/him
UC Santa Cruz
Fast radio bursts

I'm a(n almost) second-year student at UCSC Astronomy. I've lived most of my life in India. I got my bachelor's and master's degrees in Physics from IIT Madras (Chennai, India). My really like sketching, painting and gaming on my computer. I also enjoy biking and I've recently gotten into calisthenics.

Email: shassans@ucsc.edu
facebook.com/HSSunilSimha

Since their discovery in 2007, Fast Radio Bursts (FRBs) have been an enigma. Although numerous FRBs have been discovered in the past, and that number has increased prolifically in the last few years thanks to CHIME, we don't really know how they are generated. Though there exist numerous theories, testing them has been difficult because FRBs weren't localized in the past. Recently we, the CRAFT collaboration, announced the first localized FRB: FRB180924. Since then we have localized a handful more and the numbers are only growing. We hope to be able to answer key questions about the origins and the environments of FRBs and also use them as tools to study the distribution of ionized matter in the foreground. I mainly work on studying the host galaxies of our localized FRBs and my first-year project will be on trying to understand what fraction of ionized matter exists in dark matter halos and how much lies outside.

**Sunil Simha**
*he/him/his*
Extragalactic studies using FRBs
**UC Santa Cruz**

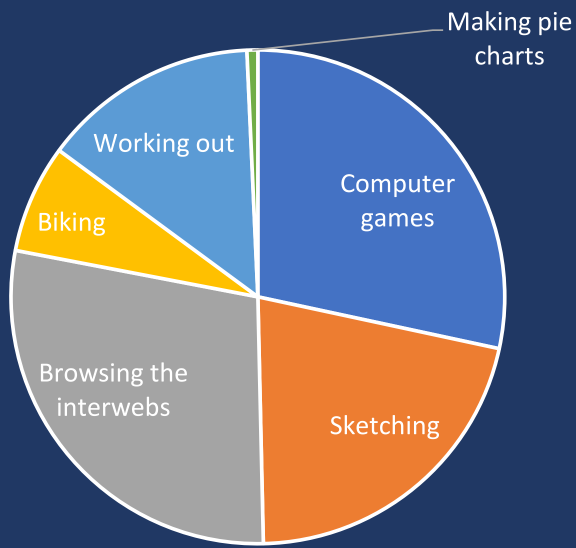
I'm a(n almost) second-year student at UCSC Astronomy. I've lived most of my life in India. I got my bachelor's and master's degrees in Physics from IIT Madras (Chennai, India).

**Contact Info:**


shassans@ucsc.edu

facebook.com/HSSunilSimha


**Things I spend my free time on:**

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Sarah Steiger
she/her/hers
UC Santa Barbara
Instrumentation

Email:
steiger@physics.ucsb.edu

Hello! My name is Sarah Steiger and I am about to be a third(!) year graduate student at UCSB working with Ben Mazin on instrumentation for exoplanet direct imaging. Whenever possible, I like to swap out my JanSport for my hiking backpack, or do really anything that gets me outside including running, biking, hiking, and climbing. I also recently adopted two very adorable cats - I don't really have much else to say about that, I'm just very stoked.

Microwave Kinetic Inductance Detectors (MKIDs) are cryogenic superconducting UVOIR detectors that can determine the energy (R of 6 - 8 at 1 micron) and arrival time (to within a microsecond) of individual photons without read noise or dark current. This allows MKIDs to be able to interface with next generation adaptive optics systems, such as SCExAO at the Subaru Telescope on Mauna Kea, to reduce the effect of problematic atmospheric aberrations and achieve the contrasts needed to directly image exoplanets. Current best MKID devices, however, can only achieve an R~8 due to losses caused by amplifier noise and two level systems (TLS) noise. TLS noise is a function of how the superconducting film used to create the MKID resonator couples to the substrate it is deposited on. In my work, I have designed Hybrid Resonator devices where a part of the MKID pixel is made from a lower loss superconducting material. Through this, I hope to increase the energy resolution of the MKID detectors to get closer to their theoretical limit and image higher contrast targets.

All of the wavelengths
All of the times
mazinlab.org

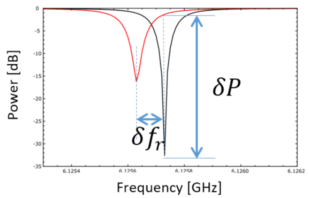
# Microwave Kinetic Inductance Detector (MKID) Improvements for Exoplanet Direct Imaging

**Sarah Steiger**, Clinton Bockstiegel, Neelay Fruitwala, Isabel Lipartito, Jenny Smith, Noah Swimmer, Alex B. Walter, Nicholas Zobrist, Gregoire Coiffard, Miguel Daal, Kristina Davis, Rupert Dodkins, Jeb Bailey, and Ben A. Mazin

## MKIDS

The **kinetic inductance effect** causes incident photons to change the surface impedance of a superconductor through the breaking of cooper pairs.

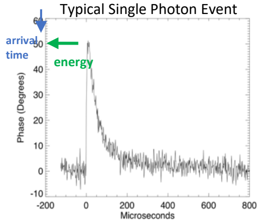
MKIDs are superconducting resonators where the photosensitive inductor is made out of a superconductor. An incident photon changes the inductance, and therefore the resonant frequency, of the MKID resonator (pixel). This change in resonant frequency can be measured by room temperature readout electronics to determine the arrival time and energy of the incident photon.

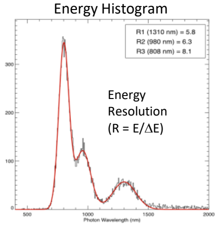

**Inductor** (high current density) is the sensitive element of the MKID pixel

Monitor the change of its resonant frequency in response to a photon event

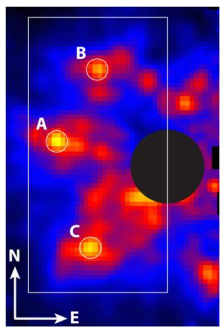
Typical Single Photon Event

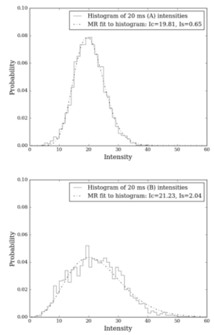



Energy Histogram




MKIDs are the perfect technology for pairing with next generation adaptive optics systems. One of the ways MKIDs can improve the effectiveness of existing direct imaging techniques is to take advantage of the fact that photons from planets obey different arrival time statistics than photons from atmospheric speckles. The noise-free, photon-counting abilities of MKIDs enable discrimination of speckles from substellar companions at small separations where differential imaging methods are ineffective[1]




## MOTIVATION FOR MY WORK

MKIDs have a theoretical energy resolution (R = E/ΔE) of 100 at one micron, but current best MKID detectors can only achieve an R ~ 8. This is likely caused by a combination of:

- **Amplifier Noise**
- **Two Level Systems (TLS) Noise**
- **Quasiparticle Leakage**

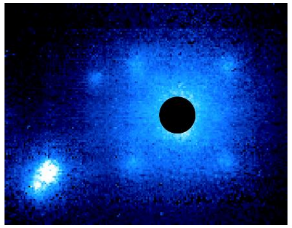
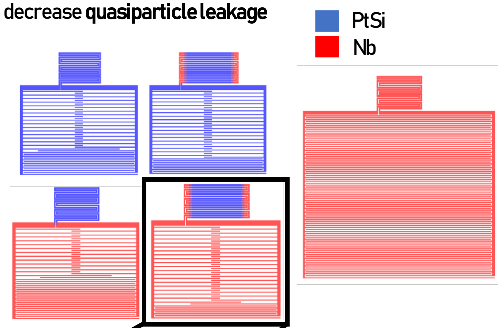


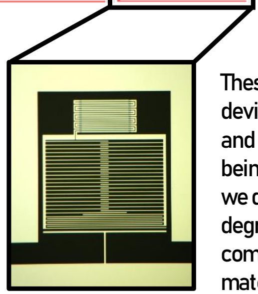
Image of the Trapezium system taken with the MKID Exoplanet Camera (MEC)

## HYBRID RESONATORS

It has been shown that **TLS noise** is capacitive in nature[2] so by creating the capacitor of an MKID pixel out of a lower loss material, we hope to decouple from these TLSs.

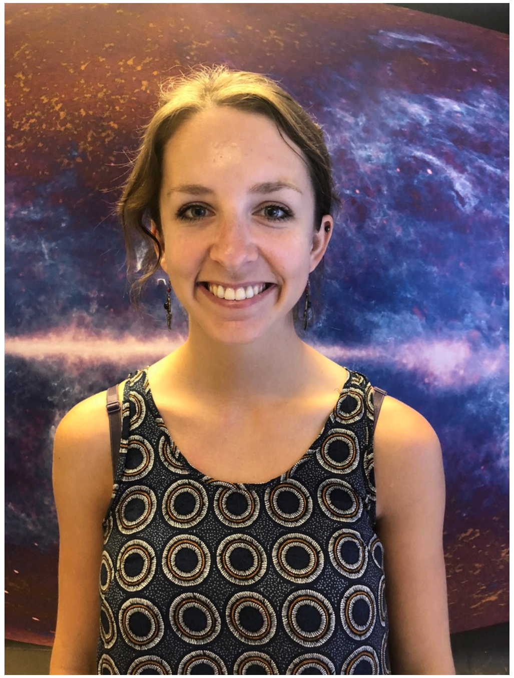
Additionally, by having a superconductor with a higher gap energy surrounding the photosensitive inductor, we can decrease **quasiparticle leakage**



These Hybrid Resonator devices have been fabricated and are in the process of being tested to determine if we do indeed see a degradation in noise compared to our single material MKID pixels.

1. Meeker et. al. 2018
2. Vissers et. al. 2012




Victoria Strait
she/her/hers
UC Davis


High redshift galaxies

I am going into my fifth year of grad school with Marusa Bradac studying galaxies in the first billion years after the Big Bang and enjoy rock climbing, trail running, and outreach.

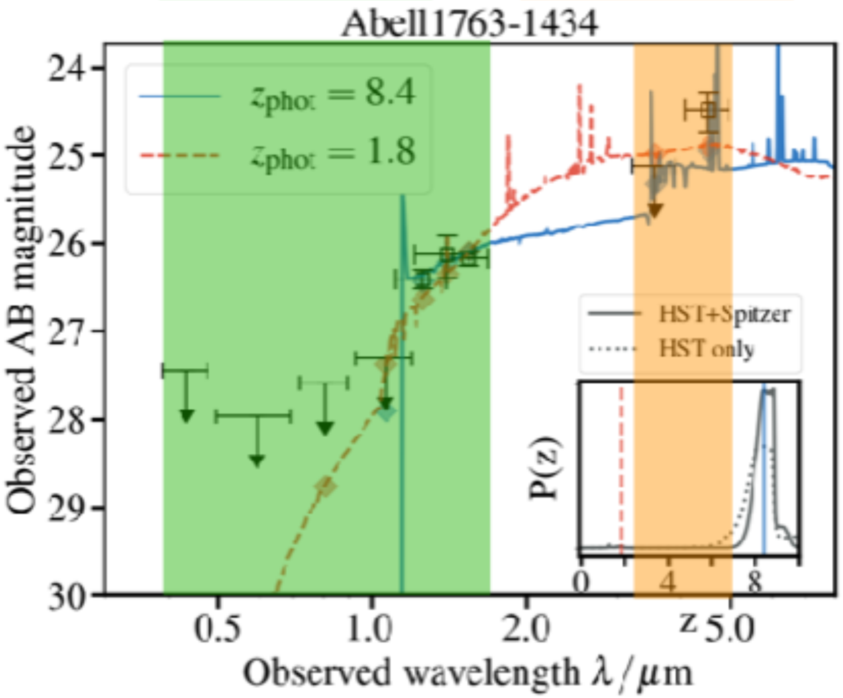

Email: vbstrait@ucdavis.edu

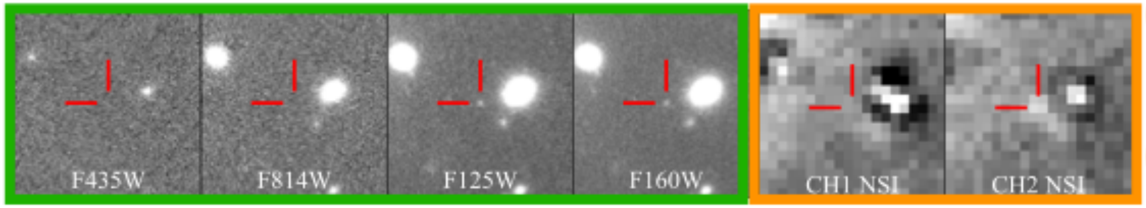
@vistrait



Stellar properties of galaxies in the redshift range z ~ 6-10 are key constraints for a full understanding of the process of reionization and the onset of star formation. As rest frame optical wavelengths fall into the near infrared, Spitzer/IRAC fluxes become essential to constrain these properties. I will present results on the star formation rates, stellar masses, and ages of a previously unknown z~8 multiply imaged system behind HFF cluster A370 and ~300 z ~ 6-10 galaxy candidates from the Reionization Lensing Cluster Survey (RELICS) and companion Spitzer-RELICS surveys using photometric redshift fitting using HST and Spitzer fluxes. These objects are perfect laboratories for JWST and TMT to study in great detail the stellar properties of galaxies in the early universe.


# Galaxies in Cosmic Dawn



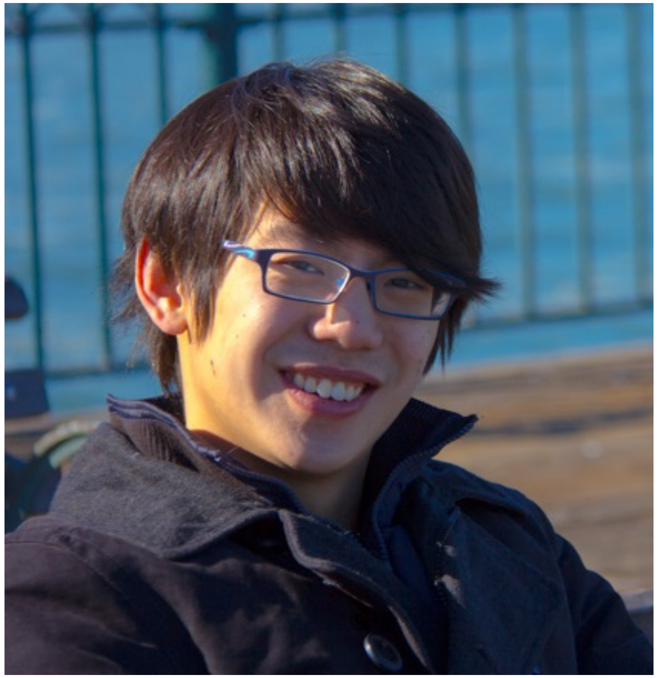

**Strong Balmer break = onset of star formation <100 Myr after Big Bang?**

## What does the z > 6 galaxy population look like?

- Average emission line strengths
- Average ages and formation times
- Average stellar masses & SFRs
- How do they contribute to reionization of the IGM?

## How do we observe them?

- Cluster lensing reveals “typical” galaxies
- HST for initial selection, Spitzer for rest-frame optical
- Ly-a, UV metal lines with ground-based spectroscopy
- Rest-frame optical lines with JWST



Brent Tan
He/Him/His
UC Santa Barbara
Cosmic Rays/CGM

Hi, I'm Brent and I'm a third year graduate student at UCSB where I work on Athena++ simulations involving cosmic rays in the CGM. I'm originally from Singapore, but I came to the US to do my undergrad in physics at Carnegie Mellon. In my free time I like puzzles, reading, gaming, watching shows, and in general missing food from back home.

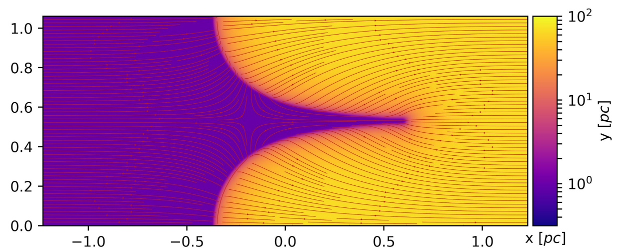
Email: zunyibrent@physics.ucsb.edu

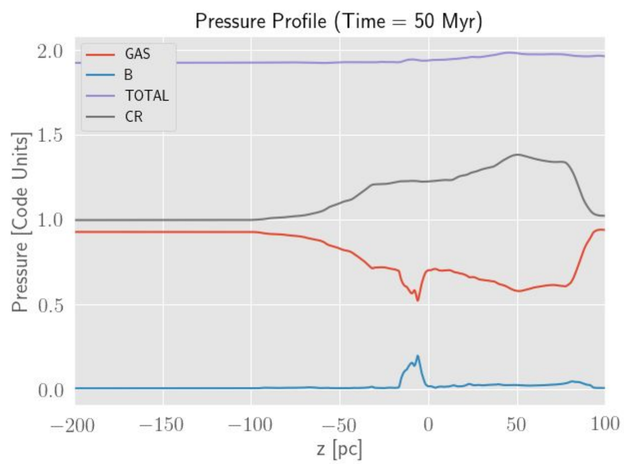
Cosmic rays account for a significant fraction of the energy budget in galaxies, and are roughly in equipartition with the thermal gas and magnetic fields. They should thus significantly impact the physics and evolution of multiphase gas in the CGM. I use simulations in Athena++ to study non-linear instabilities and behavior at the interfaces of this gas and the impact of cosmic rays in the fluid approximation.

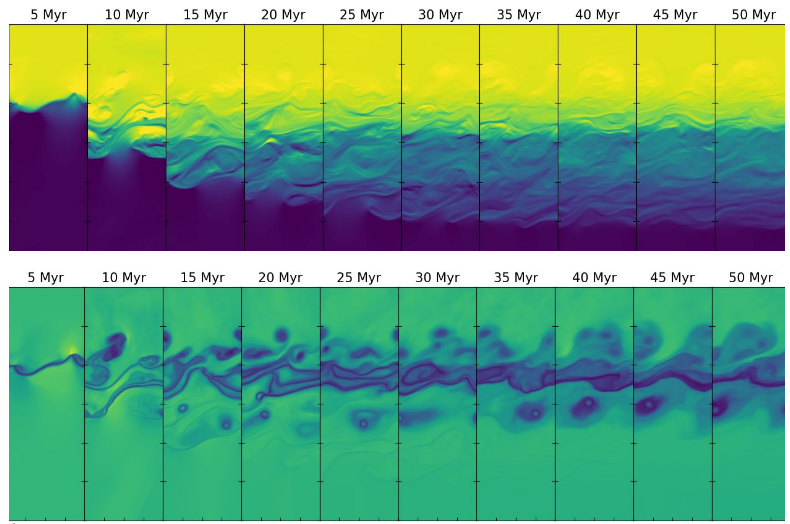
# Cosmic Ray MagnetoHydroDynamics

Athena++ with:
Cosmic Rays
Thermal Conduction
Radiative Cooling

Algorithms:
Two-Moment Approximation
Townsend Algorithm



Email: yiz020@ucsd.edu


# Stella(Yimiao) Zhang

She/her/hers

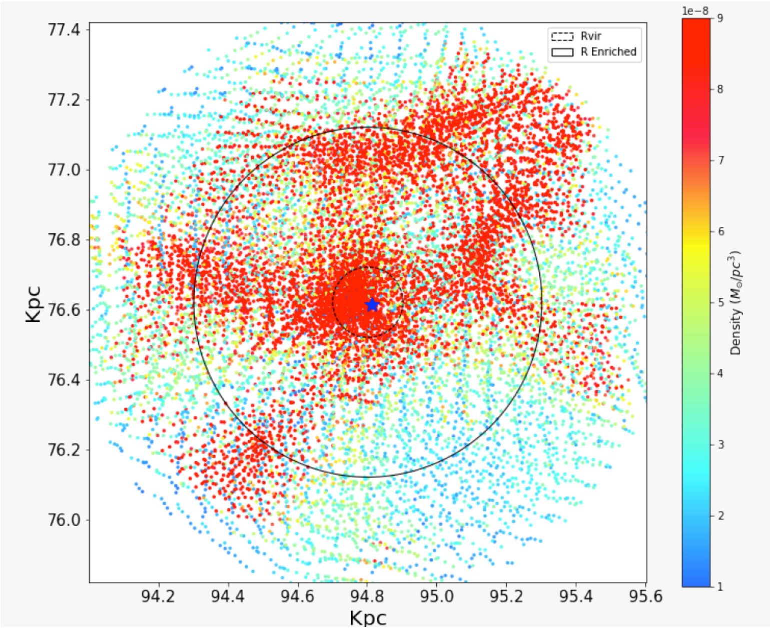
UC San Diego

Dwarf galaxies/Circumstellar disks

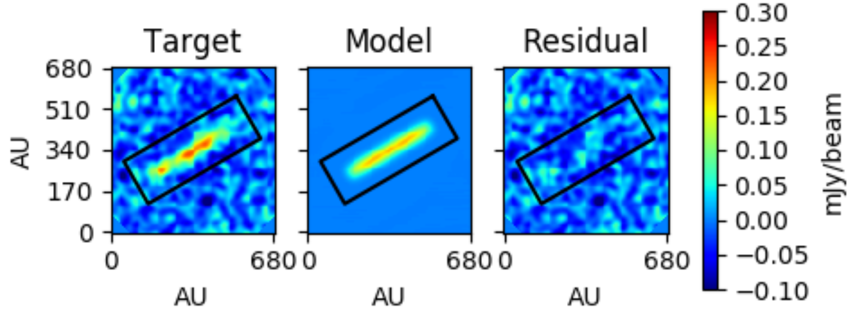

Hi! I am Stella, a rising 2nd year graduate student from UCSD. I finished my undergraduate at UCSD with a Math/Stats and Physics double major, and I'm now continuing my graduate study at UCSD as an NSF GRFP fellow. My interest is in high redshift Universe and computational Astrophysics but currently I'm working on the ALMA data of a debris disk 33 pc away from us. Outside of research, I've probably spent too much time on video games (favorite genre is horror), DnD/CoC, reading and going to classical concerts. If life could let me get double PhD in Astro and pure Math, I totally would.

In this presentation I would like to briefly touch on two projects that I am involved with. On the right we present our results on determining the properties of the debris disk surrounding star HR2562 based on the first ALMA detection of the system. HR2562 and its brown dwarf companion, HR2562B, were the first discovered system where a substellar companion resided in a cleared inner hole of a debris disk. The current best at model (top) and the fitted orbits of the BD (bottom) are shown. On the left I present the preliminary work for my NSF proposal: exploring the the effects of Population III (Pop III) supernovae on the formation and properties of Population II (Pop II) stars and the low mass dwarf galaxies where many of these Pop II stars could reside.

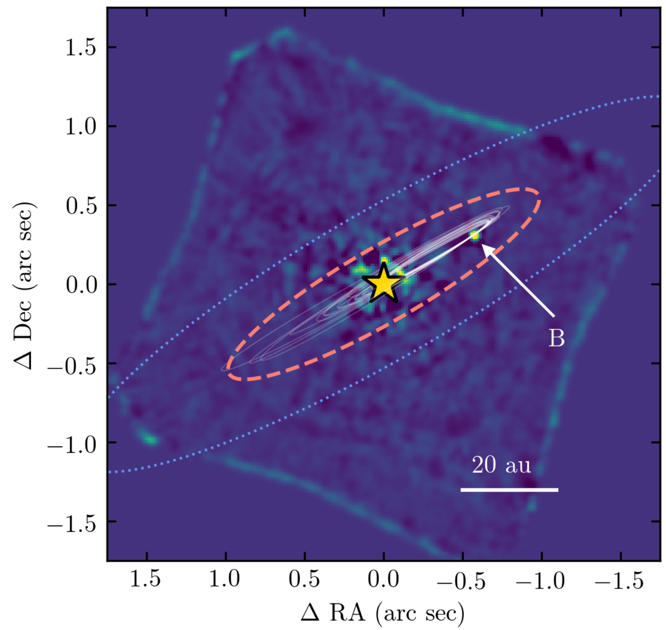
# Pop III stars vs circumstellar disks




Working on studying the effect of Pop III to Pop II transition on low mass dwarf galaxies in FIRE. Shown in figure is the density plot of gas particles in the largest halo in FIRE 1 run(m09) at z = 19. Black solid line marks the assumed radius of enrichment from Pop III supernovae (preliminary work for my NSF GRFP proposal)




Modeling the debris disk in HR2562: one of the few known debris disk to host a brown dwarf companion in its inner hole.



# Meet our Organizers!

**UCSC:** Felipe Ardila (fardila@ucsc.edu)

**UCB:** Steven Giacalone (steven_giacalone@berkeley.edu)

**UCD:** Jessie Hirtenstein (jhirtenstein@ucdavis.edu)

**UCI**: Devontae Baxter (dbaxter@uci.edu)

**UCLA:** Tony Pahl (pahl@astro.ucla.edu)

**UCR:** Marziye Jafariyazani (mjafa003@ucr.edu)

**UCSB:** Sarah Steiger (steiger@physics.ucsb.edu)

**UCSD:** Petia Yanchulova Merica-Jones (petiay@ucsd.edu)