OSTERBROCK SIERRA CONFERENCE 2021

Los Padres National Forest
Campo Alto Campground

OCTOBER 23-24, 2021

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.

Sierra 2021 Organizing Team

- Head Organizer:
  - Minghan Chen (UCSB) - minghan@physics.ucsb.edu

- Campus Liaisons:
  - Felipe Ardila (UCSC) - fardila@ucsc.edu
  - Patty Bolan (UCD) - pmbolan@ucdavis.edu
  - Steven Giacalone (UCB) - steven_giacalone@berkeley.edu
  - Ming-Feng Ho (UCR) - mho026@ucr.edu
  - Courtney Klein (UCI)- kleinca@uci.edu
  - Jack Lubin (UCI) - jlubin@uci.edu
  - Micah Oeur (UCM) - moeur@ucmerced.edu
  - Anthony Pahl (UCLA) - pahl@astro.ucla.edu
  - Mahdi Qezlou (UCR) - mqezl001@ucr.edu
  - Bryan Scott (UCR) - bscot002@ucr.edu
  - Sarah Steiger (UCSB) - steiger@physics.ucsb.edu
  - Stella Zhang (UCSD) - yiz020@ucsd.edu

Schedule

	10/22 FRIDAY	10/23 SATURDAY	10/24 SUNDAY	10/25 MONDAY
7:00 AM		BREAKFAST	BREAKFAST	
8:00 AM		BREAKFAST	BREAKFAST	Departure
9:00 AM	A	MORNING SCIENCE	MORNING SCIENCE	D
10:00 AM	R	MORNING SCIENCE	MORNING SCIENCE	E
11:00 AM	R	FREE / REC TIME	FREE / REC TIME	P
12:00 PM	I	FREE / REC TIME	FREE / REC TIME	A
1:00 PM	V	FREE / REC TIME	FREE / REC TIME	R
2:00 PM	A	FREE / REC TIME	FREE / REC TIME	T
3:00 PM	L	FREE / REC TIME	FREE / REC TIME	U
4:00 PM	CHECK IN	FREE / REC TIME	FREE / REC TIME	R
5:00 PM	DINNER	DINNER	DINNER	E
6:00 PM	DINNER	DINNER	DINNER	
7:00 PM	ICEBREAKERS & INTRODUCTIONS	DINNER	DINNER	
8:00 PM	Stargazing	EVENING DISCUSSION	EVENING DISCUSSION	
9:00 PM	Stargazing	EVENING DISCUSSION	EVENING DISCUSSION	
Sunrise:		7:10 AM	7:11 AM	7:12 AM
Sunset:	6:15 PM	6:14 PM	6:13 PM	

Morning Science Format:

All attendees will submit a one page summary of their scientific work/interests, which we will bind together into a booklet and distribute to everyone.

In the mornings we will gather together and each participant will give a short synopsis of their work (à la poster presentation) and people can follow along in the booklet.

Evening Discussion Topics:

Night 1 (Saturday): What do we (dis)like about our departments? What can be done to improve grad student work environments?

Night 2 (Sunday): 1. When science advancement meets cultural preservation: the case of TMT and Starlink. 2. How to maintain this UC astro grad community and the future of the Sierra Conference.

Aliza Beverage, Berkeley, she/her

Bio

Hi! I'm a rising third year graduate student at UCB. I work on the chemical enrichment and star-formation histories of quiescent galaxies at $z > 0.5$ with Prof. Mariska Kriek (who just moved to Leiden this year 🙃). Outside of astronomy, I compete in Strongman, eat lots of Thai food, and enjoy backpacking/hiking!

Subfield

Galaxy formation and evolution.

Contac info

- Web: abeverage.github.io
- Twitter: @SPACEbeverage

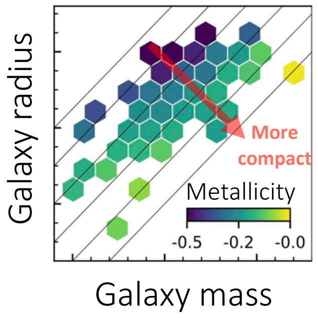
Abstract

One of the most remarkable discoveries from the past two decades in extra-galactic astronomy is the finding of a large population of high-redshift galaxies with very low star formation rates. To this day, we still do not understand how these galaxies fit into the wider picture of galaxy evolution, and what exactly shut off their star-formation so early. Part of the reason we haven't solved the puzzle is that obtaining high-quality spectra of these galaxies is really hard. For my thesis, I will be the first to measure the chemical enrichment and star-formation histories of 20 massive quiescent galaxies at $z = 1.4 - 2.1$ using ultra-deep spectra from Keck MOSFIRE+LRIS ("The Heavy Metal Survey"). Before getting to that, I have completed a parallel project with a lower redshift comparison sample ($0.5 < z < 0.7$) in which we find (1) compact quiescent galaxies are more metal rich, and (b) the metallicity of the quiescent galaxy population evolves significantly between $z \sim 0.7$ and z0.

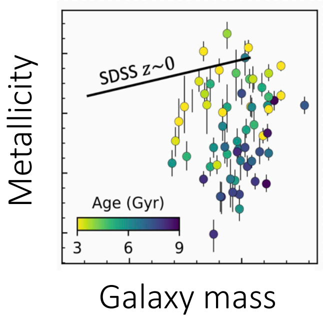
abeverage@berkeley.edu
UC Berkeley

The Mass-Metallicity Relation (MZR) of Quiescent Galaxies Over Cosmic Time

Compact quiescent galaxies are more metal rich

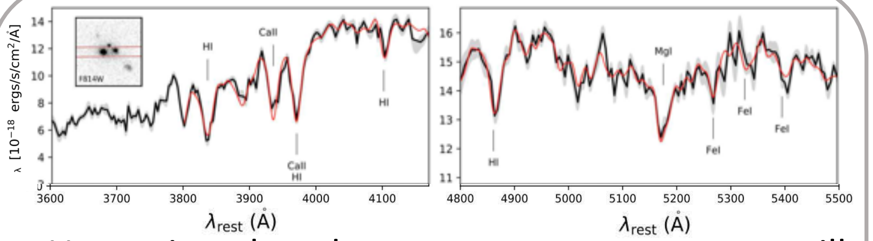


The MZR evolves from $z{\sim}0$ to $z{\sim}0.7$ (implications for quenching)

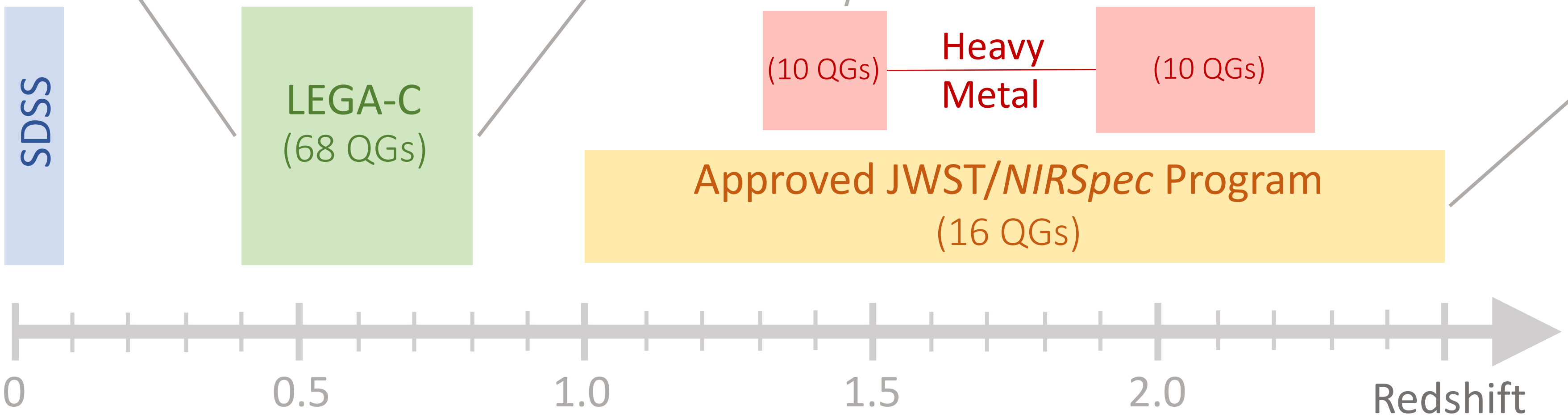


http://arxiv.org/abs/2105.12750

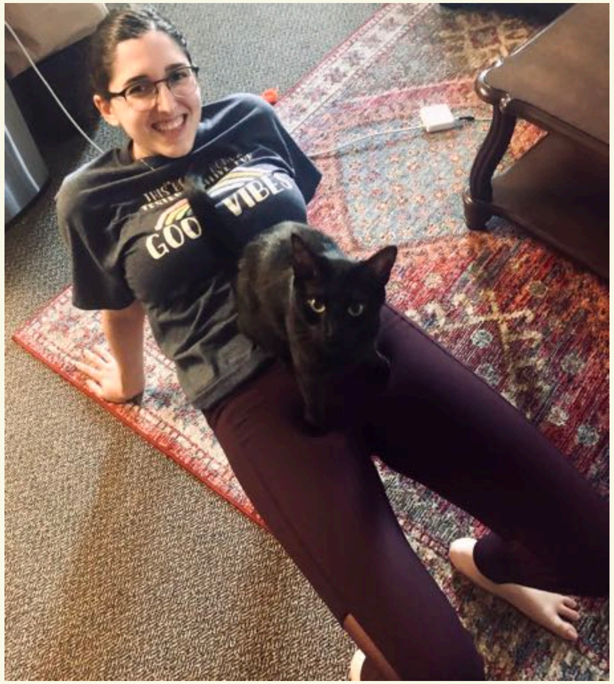
Abstract. The mass-metallicity relation and its evolution can tell us about the formation and enrichment histories of galaxies. The relation has been extensively studied for star-forming galaxies out to $z \sim 3.5$, but the MZR of quiescent galaxies (QGs) has only been measured out to $z \sim 0.5$. This is because measuring their metallicities is extremely difficult. Here I present the results from a study of $z \sim 0.7$ QGs and present two exciting upcoming surveys targeting QGs at even higher redshifts ($1.0 < z < 2.5$).



Upcoming ultra-deep spectroscopic surveys will provide robust elemental abundances and ages for the $z > 1$ quiescent population



Amy S. Ralston, Irvine, she/her



Bio

Hi everyone! I'm a rising 3rd year graduate student in astrophysics at UCI working with Prof. Asantha Cooray on observational studies of star-forming galaxies in proto-galaxy clusters around Cosmic Noon ($z \sim 2$).

————————————————————————–

I am the Director of the Women in Physics/Astro (WiPA) Mentoring Program. I'd love to collaborate with other institutions to expand our mentoring program - so definitely reach out to me!

————————————————————————–

I like to unwind with some piano, yoga, and playing fetch with my cat, Rowena (interrupting said yoga on the left). HP fans will know who she's named after :)

Subfield

Dusty star-forming galaxies (high-z), galaxy clusters, sub-mm.

Contact info

- linkedin.com/in/amy-ralston/
- Social media: Facebook

Abstract

I study the progenitors of galaxy clusters, "protoclusters", at high redshifts (z = 1-3) around Cosmic Noon. These protoclusters are thought to be comprised of powerful, dusty star-forming galaxies (DSFGs). This research is interested in determining the DSFG properties and what role they play in large-structure formation as well as cluster evolution.

`ralstona@uci.edu`
UC Irvine

Fantastic Protoclusters and Where to Find Them

What are "protoclusters"?

- A protocluster is a galaxy cluster (GC) pre-virialization, with no primary dark matter halo having been formed yet.
- ... so then ...
- How do we find evidence of a galaxy cluster before it exists?

Using DSFGs to Find Protoclusters

- DSFGs = Dusty Star-Forming Galaxies ($10^2 - 10^3$ $M_\odot$ yr^{-1}, $L_{IR} \sim 10^{13} L_\odot$)
- Locally, GC cores are dominated by massive ellipticals
- Merger scenario points to DSFGs being excellent candidate progenitors of these ellipticals in GC cores
- By identifying DSFGs at Cosmic Noon, we can trace protoclusters!

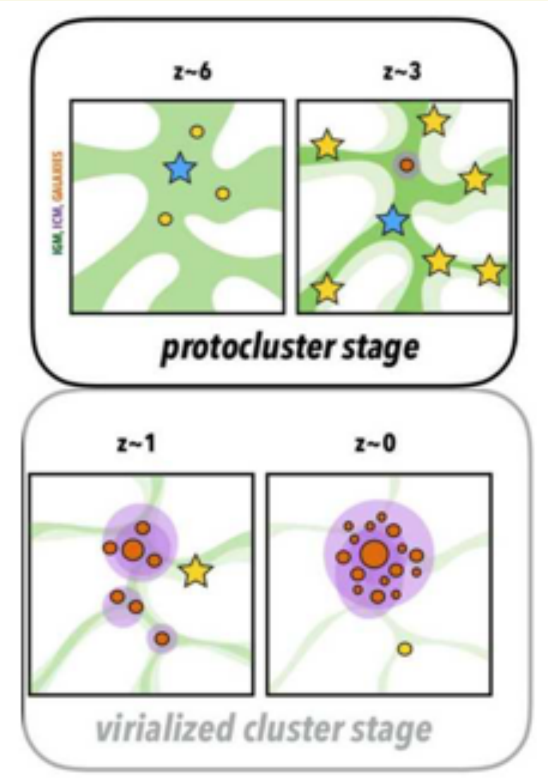


Figure 1. Diagram of galaxy cluster evolution from early (z = 6) to present times (z = 0). In the protocluster stage, it is actively collapsing and accumulating more material, and therefore, cannot be described by the viral theorem. *Image Credit: Prof. Caitlin Casey*

Observations

For each DSFG in a cluster, we are performing broadband photometry and SED-fitting with:

1. Spitzer/IRAC (3.6 & 4.5 μm)
2. Herschel/SPIRE (250, 350, & 500 μm)
3. JCMT/SCUBA-2 (850 μm)

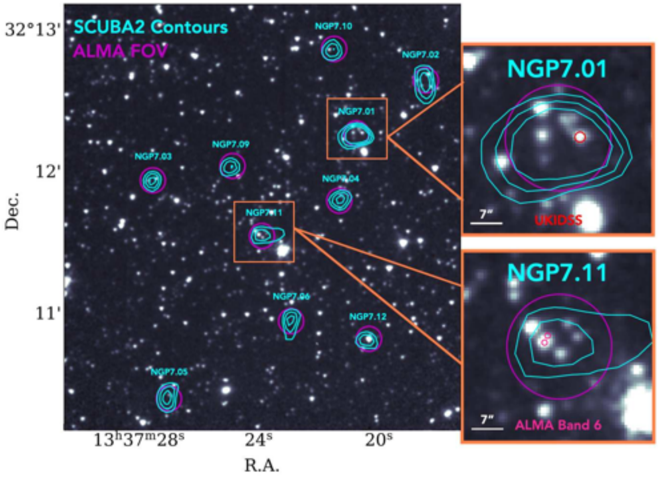
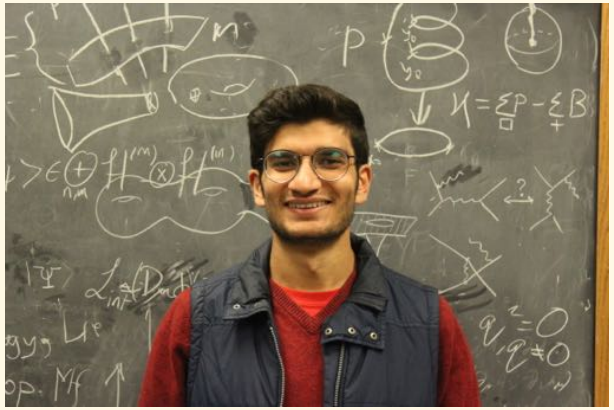


Figure 2. DSFG-rich protocluster candidate NGP7, comprised of 12 blended sub-mm objects (teal contours) and many IRAC counterparts (background).

ralstona@uci.edu
UC Irvine

Arsalan Adil, Davis, he/him



Bio

Hi fellow nerds! I love physics, chai, and mountains (in that order). I grew up in Karachi, Pakistan and am currently studying theoretical cosmology but also take a keen interest in quantum information science. Outside of physics, I really enjoy being outdoors, camping, and climbing and feel very fortunate to be a part of this conference that combines these interests.

☑ I'm not a robot

reCAPTCHA

Subfield

Cosmology theory, Early universe cosmology, CMB, Bayesian statistics, Quantum information

Contact info

- email: aadil@ucdavis.edu
- Twitter: @CosmicCharsi

Abstract

Cosmologists are in a quandary due to various cosmological tensions that have emerged in recent years. The most notable of this is a $\approx 4.5\sigma$ tension in the expansion rate of the Universe as inferred from the cosmic microwave background versus measurements of supernovae brightness. Here, we explore a particular scalar field model of dark energy (dubbed "quintessence") which is able to ameliorate some of these tensions.

aadil@ucdavis.edu
UC Davis

Quintessential H_0 Tension

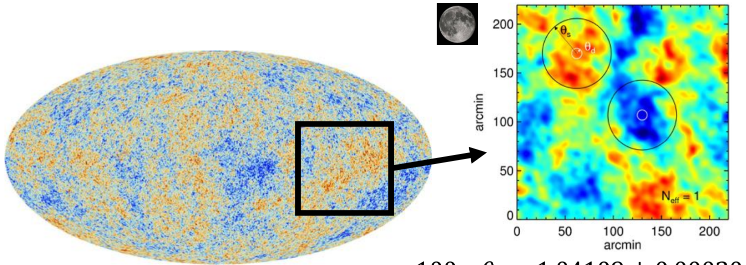
Arsalan Adil
Department of Physics & Astronomy
UC Davis

The Problem

Cosmologists are in a quandary: the value of the cosmic expansion rate today, H_0, as measured by late-universe probes (notably via the "cepheid calibrated supernovae" method of the SH0ES team) differs from the value *inferred* by early-universe probes (notably by the Planck measurement of the Cosmic Microwave Background [CMB] assuming ΛCDM) by $\approx 4.5\sigma$.

Since the CMB probes requires us to assume a cosmological model in order to infer H_0, a likely source for this discrepancy is that the current standard cosmological model is incomplete. Here, we propose a model for dark energy, dubbed "quintessence", which can help alleviate this so-called "H_0-tension".

The Constraints



$$100 * \theta_s = 1.04109 \pm 0.00030$$

The CMB map very precisely measures the angular size of the sound horizon at recombination, θ_s^*. From this, one can infer H_0 since $\theta_s^* = r_s^*/D_M^*$, where

$$r_s^* = \int_{z_*}^{\infty} \frac{dz}{H(z)} c_s(z) \qquad D_M^* = \int_0^{z_*} \frac{dz}{H(z)}$$

$$H(z)^2 = \frac{8\pi G}{3c^2}\,[\rho_r(z) + \rho_m(z) + \rho_{DE}(z)]$$

A Solution?

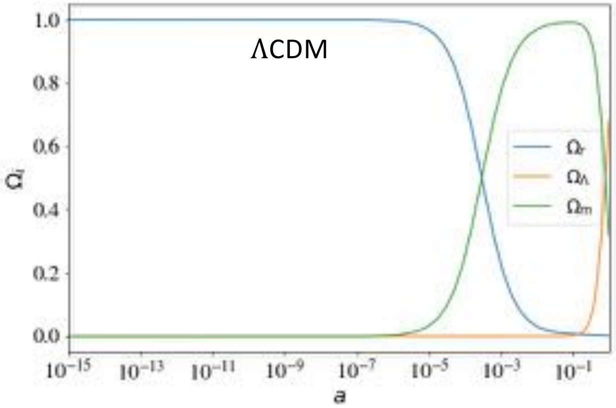


Fig.1: Various components in the Universe in a ΛCDM cosmology from your favorite cosmology textbook. Notice that the cosmological constant is negligible for most of cosmic history.

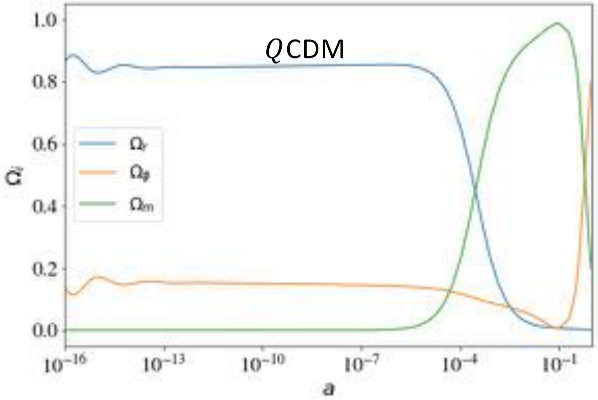


Fig. 2: The same components, but now the quintessence field plays the role of dark energy today while contributing non-negligibly early on.

$$V(\phi) = ((\phi - B)^2 + A)\, e^{-\lambda\phi}$$

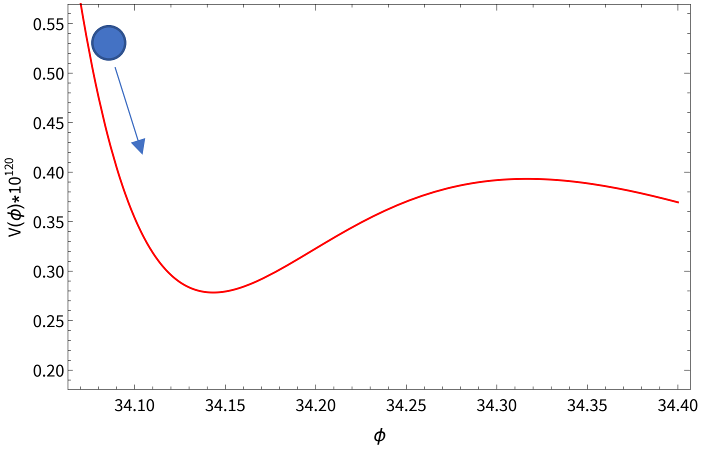


Fig. 3: Scalar field "quintessence" dark energy rolling down the potential (think: inflation). The dynamics of the field (i.e. the energy density and pressure) are determined entirely by the shape of the potential.

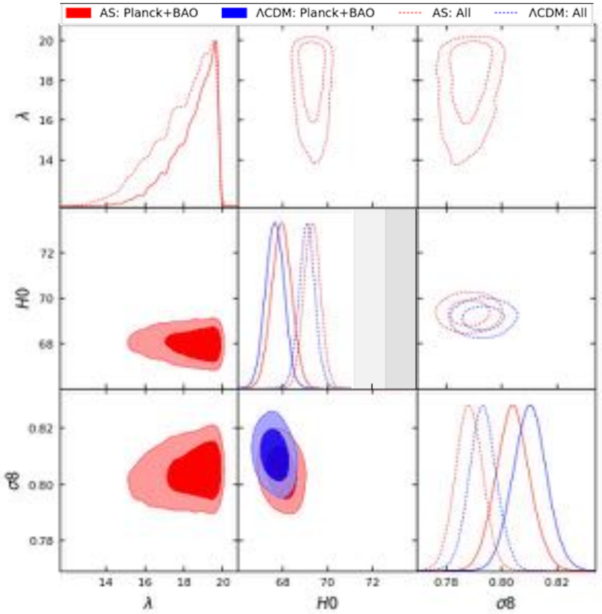


Fig. 4: Parameter estimates for two combinations of data sets. The results for the QCDM (ΛCDM) are in red (blue). Notice the $\approx 1\sigma$ increase in H_0 in QCDM compared to the ΛCDM case.

Bryan Scott, Riverside, he/him

Bio

I am a 6th year PhD Candidate in Physics & Astronomy. My research is mainly in large scale structure, and how we can use our understanding of it to learn about both the physics of galaxies and the origin and history of the universe. I am also an advocate for equity in science and for improving access to and the quality of post-secondary scientific education. In my free time, I enjoy hiking in the Southern California foothills and I'm learning to sketch.

Subfield

Astrophysics of Galaxies, Cosmology, and Astrostatistics

Contact info

- Web: bscot.github.io/
- Social media: LinkedIn: bit.ly/2W9P21P

Abstract

Photometric and spectroscopic intensity mapping are novel techniques for measuring large scale structure to constrain astrophysics and cosmology. By measuring a continuous function of brightness on the sky rather than detecting discrete sources, these techniques promise to answer questions like, "how bright is the universe as a whole?" and "Is Einstein's Theory of General Relativity a correct description of the universe on the largest scales"? We apply an inference technique called clustering redshift estimation to intensity mapping and forecast the performance of two future survey and intensity mapping experiments. Further, a new cosmological probe - millimeter-wave line intensity mapping - can constrain models of deviations from General Relativity through their effect on the formation and distribution of galaxies.

`bscot002@ucr.edu`
UC Riverside

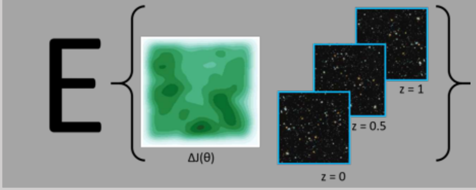
Astrophysics and Cosmology with Photometric and Spectroscopic Intensity Mapping

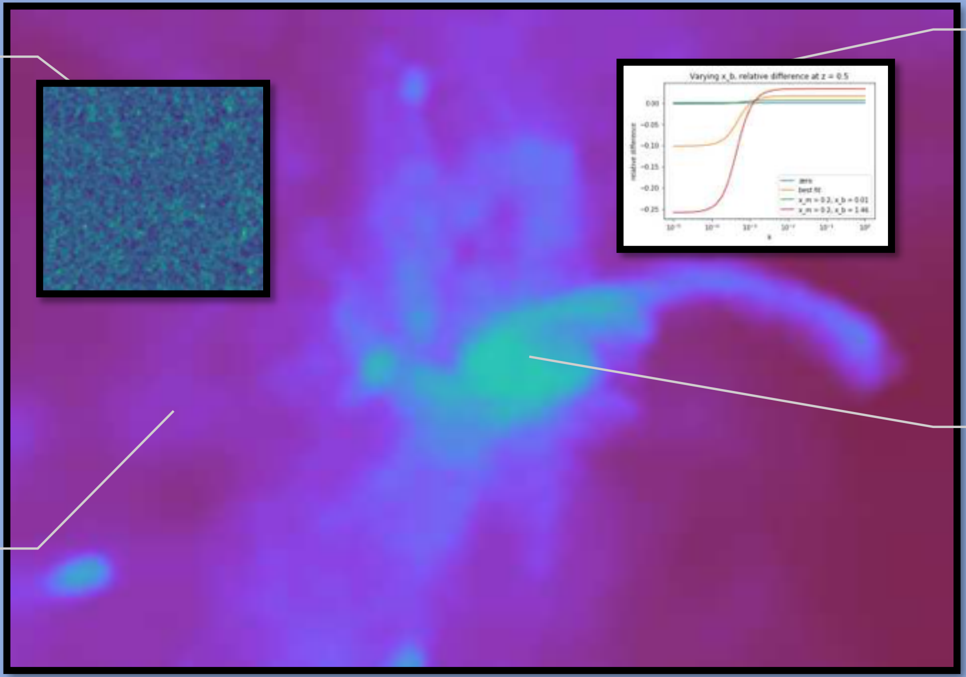
Bryan Scott
University of California, Riverside

Intensity mapping measures a continuous function of brightness on the sky. Rather that catalogs of sources with discrete properties, the data product are maps of emission. IM experiments intrinsically measure a simultaneous product of astrophysics and cosmology, which we can decompose in cross correlation or through forward modeling.

Broadband Tomography with CASTOR and SPHEREx

Cross correlations between a photometric intensity map and a large scale structure catalog can be used to extract the distribution of emission contained in diffuse ultraviolet backgrounds.





Simulated galaxy in z=9 SIMBA snapshot.

Large volume probes as a function of redshift.

LIM and Modified Gravity. Generic families of modified gravity models, called Horndeski theories, predict deviations from the LCDM power spectra. With their large cosmological volumes, LIM experiments can deliver competitive constraints on cosmology beyond GR.

Cross correlations of line emission at z = 9.

Bright local foregrounds and line confusion make accurate determination of emission redshift, and hence measurements of structure formation, challenging. Cross correlations between emission lines or with galaxy catalogs can mitigate these problems and allow reliable inference from z=0-9. Estimates of the cross correlation signal therefore require reliable simulations of both line emission and structure formation over a large range in redshift. We combine large hydrodynamic simulations (SIMBA, Asterix) and a line emission code (SIGAME) to accomplish this.

Caleb Choban, San Diego, he/him

Bio

My research focuses on modelling dust, its life cycle, and its effects on and interactions with the ISM. I am currently investigating how dust effects galaxy evolution and observations in cosmological zoom-in simulations. I am also interested in how we model ISM physics, particularly chemical networks and radiative transfer in the ISM. When my mind isn't dusty I enjoy hiking, biking, and a good board game.

Subfield

Interstellar medium, dust, cosmological simulations.

Contact info

- Web: caleb-choban.github.io/
- Social media: 🐦@cchoban

Abstract

Dust is integral to the physics within the ISM, providing a surface for complex astrochemistry, reducing the abundance of gas phase coolants, affects ISM radiation pressure, and redistributes galactic SEDs. Observations find diverse dust scaling relations which suggest a complex dust system depending heavily on local gas properties, but many galaxy formation models do not capture this, treating dust in post-processing or assume a constant dust-to-metals ratio (D/Z=0.4). Recent strides have been made developing dust evolution models for galaxy formation simulations but these approaches vary in their assumptions and degree of complexity. Based on these approaches I developed two separate dust evolution models which track dust by 'Element' and dust by 'Species'. I integrated both models into the magneto-hydrodynamics code GIZMO coupled to the FIRE-2 model for stellar feedback and ISM physics, and compared them in idealized MW-like galaxy simulations. Here, I demonstrate that while both models can produce reasonable galaxy-integrated results, the dust by 'Species' approach reproduces the diverse dust scaling relations observed in the MW.

cchoban@ucsd.edu
UC San Diego

The Galactic Dust-Up: Modeling Dust Evolution in FIRE

Caleb Choban and Dušan Kereš

The Galactic Model

Resolves multiphase ISM and includes a comprehensive set of stellar feedback processes

Tracks individual SNe events – important for dust destruction

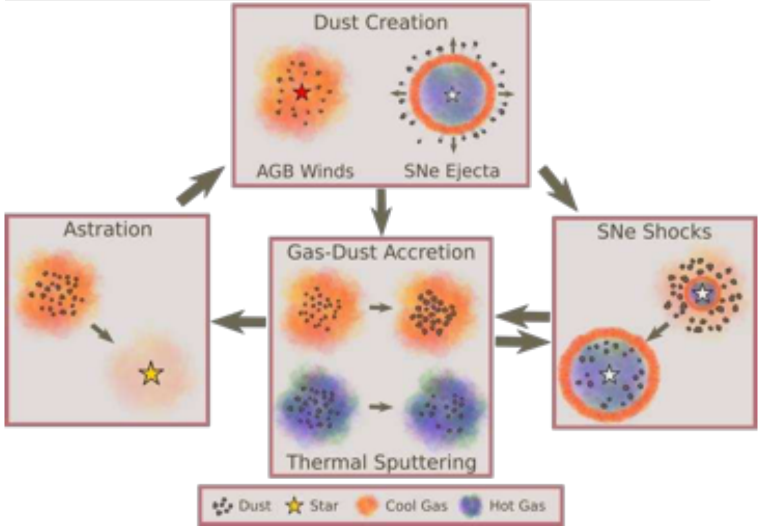
FIRE
Feedback In Realistic Environments

Tracks principle heavy elements which make up major dust species

Matches a wide range of galactic observations

- Evolution of galactic mass-metallicity relation
- Kennicutt–Schmidt star formation law

The Dust Lifecycle



The Dust Models

Dust by ‘Element’

Follows the dust yields for individual elements C, O, Si, Mg, and Fe, tracking only carbonaceous dust and generalized silicate dust.

Most routines are quite simple, being based off a few large assumptions and treating each element near identically for all physical processes

Easy to implement and main model used in recent cosmological simulations

Dust by ‘Species’

Tracks the yields of the most abundant directly observed dust species and theoretical dust species necessitated by other observations

Observed: silicates, carbon, and SiC
Theoretical: metallic iron and O-bearing dust

Routines are complex, being based off simulated yields or well-established observations and follow strict chemical composition of dust

Hard to implement and only used in some idealized simulations and analytical models

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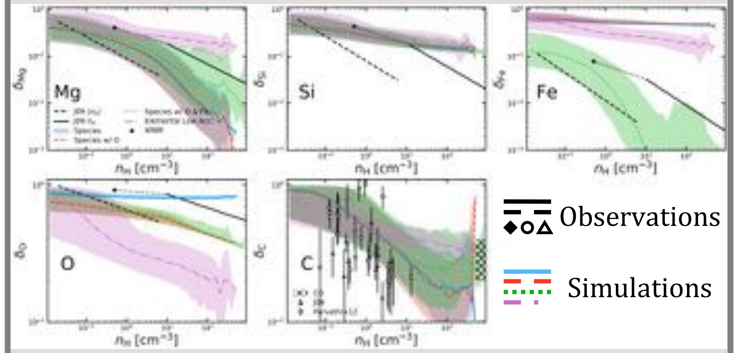
A foundation dedicated to science since 1912.

Comparing to Observations

MW Observations: Element Depletions

Observe gas-phase abundances compared to an assumed reference abundance

Any elements missing are assumed to be in dust

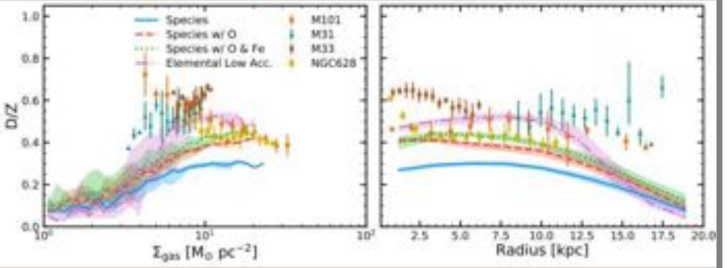


Extragalactic Observations: Dust Emissions

Requires multi-wavelength observations of dust mass, gas mass, and metallicity

$$I_{\rm CO} \xrightarrow{\text{with } \alpha_{\rm CO}} \Sigma_{\rm H_2} \xrightarrow{\text{with } \Sigma_{\rm H_I}} \Sigma_{\rm gas} \xrightarrow{\text{with Z}} \Sigma_{\rm metals} \xrightarrow{\text{with } \Sigma_{\rm dust}} D/Z$$

There are numerous galaxy-integrated observations but only a few nearby galaxies are spatially-resolved



Camille M. Bernal (she/her)

Bio

My work combines inelastic neutron scattering and anharmonic first-principles phonon simulations to study high-temperature materials thermodynamics. I am actively designing experiments and models for investigating materials under extreme conditions, including high temperature and pressure phase transitions and their local dynamics or short-range excitations. When atomic motion isn't on my mind, I can be found hiking or curled up listening to a true crime podcast.

Subfield

Condensed matter, thermodynamics.

Contact info

Abstract

It is well established that atomic vibrations dominate the entropy in solid and liquid phases. The challenge remains in determining if the difference in vibrational entropy through the melting transition is larger than the change in entropy from other sources (configurational, electronic). We performed inelastic neutron scattering (INS) measurements on powder samples of germanium (Ge) from 298-1500K, 200 degrees above T_{melt}, to directly assess contributions from atomic motion. Our experimental vibrational spectra were processed using customized multiphonon and multiple scattering corrections. Subsequent analysis, informed by vibrational-transit theory, was used to calculate the vibrational density of states (DOS) for each phase. Preliminary results for Ge show that the difference between the solid and liquid DOS accounts for over 50 % of the entropy of fusion.

`cbernal@caltech.edu`
Caltech

through the melt: can atomic vibrations explain entropy of fusion?

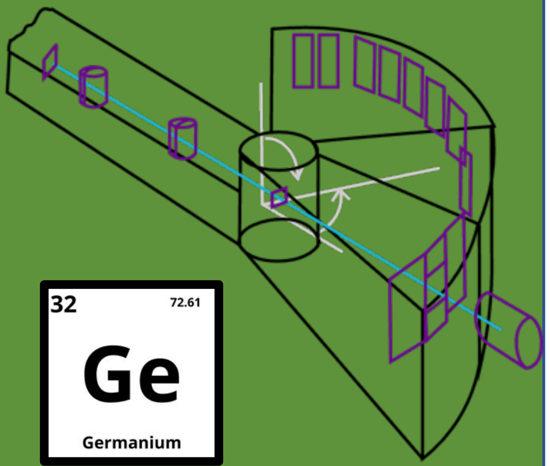
INS → SQE → DOS → ΔS_{vib}

Camille M. Bernal, Claire N. Saunders, Stefan Lohaus, Doug Abernathy, Brent Fultz; Caltech & Oak Ridge National Laboratory

Method

Inelastic neutron scattering (INS) is an experimental method used to directly measure quantized vibrations, called phonons.

Incident neutrons hit the sample and scatter. We are interested in inelastic events, i.e. neutrons that scatter with energy between E and E+dE into a section of solid angle, dΩ.

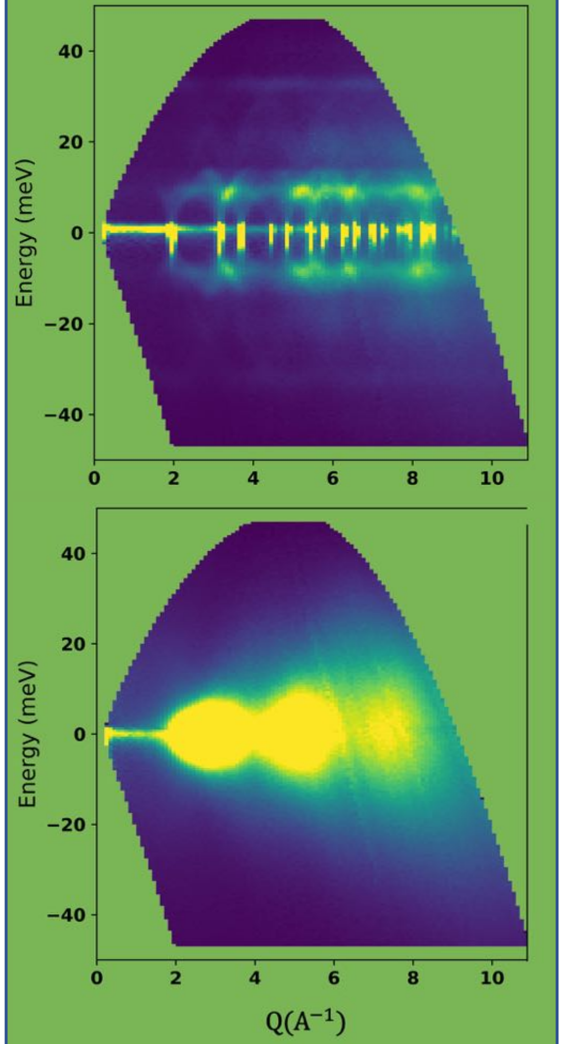


32 72.61
Ge
Germanium

System

Ge granules were sealed in evacuated quartz tubes and placed into ARCS, a chopper spectrometer.

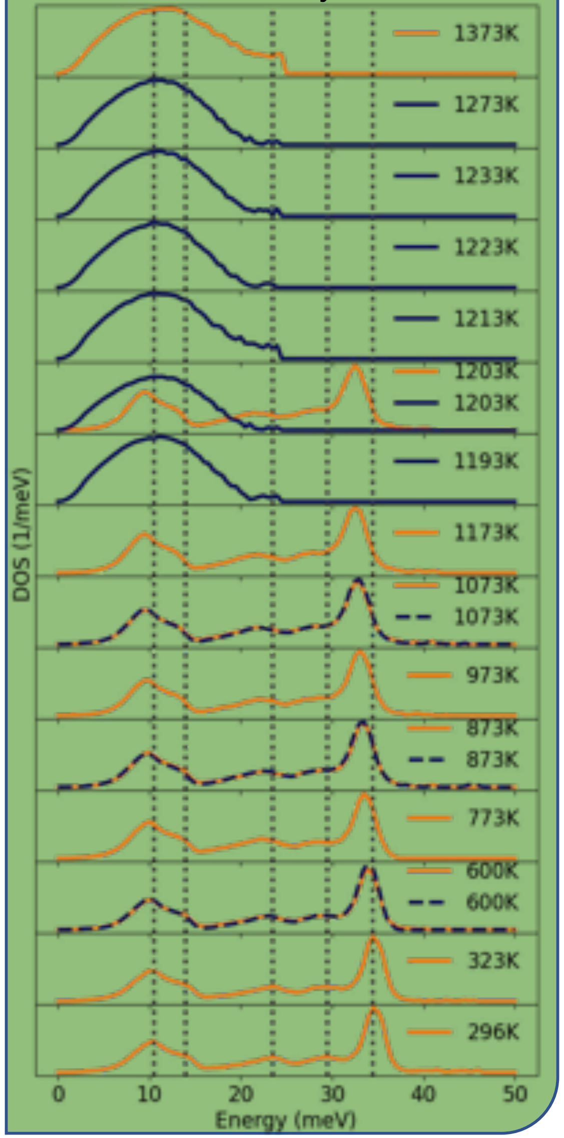
Data



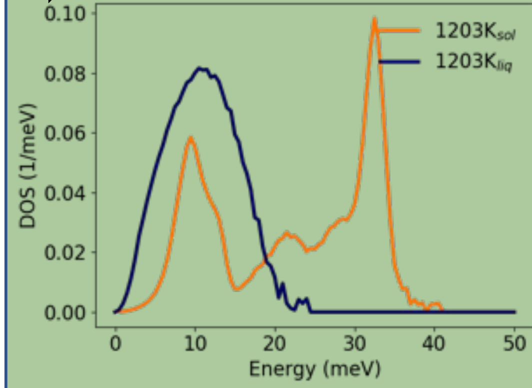
Scattering intensites, S(Q,E), of solid (top) and liquid (bottom) Ge at 1203K.

Analysis

$$S(Q,E) \propto \int e^{i\omega t}\left(1 + b\int \frac{g(E)n(E)}{E} + \cdots\right)$$



Results



⬇

$$S_{vib} = 3k_B \int_0^\infty g(E)\big[(n(E)+1)\ln(n(E) + 1) - n(E)\ln\big(n(E)\big)\big]dE$$

✚

$$\Delta S = S_{solid,1203K} - S_{liquid,1203K}$$

⬇

$$\Delta S_{fus} = 3.85$$

$$\Delta S_{vib,fus} = 2.01$$

$$\boxed{\Delta S_{vib,fus} = 0.52 \times \Delta S_{fus}}$$

Christopher Snapp-Kolas, Riverside, he/him

Phone: (951)675-3371

Bio

I am a fifth year graduate student who has completed his candidacy exam for the Physics Ph.D. program. I'm primarily interested in galaxy evolution in the high redshift universe ($z\sim2$) currently, but find all aspects of astronomy intriguing. In my personal time I play guitar (somewhere between novice and intermediate skill level), I play RPG video games such as the Legend of Zelda and Kindom Hearts, and I'm also attempting to develop my own video games. Ideologically, I am a Christian.

Subfield

Galaxies: evolution, galaxies: high redshift, ultraviolet: galaxies

Contact info

- github.com/csnap001
- facebook: christopher.snappkolas

Abstract

Our research project is focused on the properties of dwarf galaxies ($\log(M^*) < 9.5$) at "cosmic high noon" where star formation density peaks (Hopkins&Beacom 2006). Our sample includes Rest-UV and rest-Optical spectra allowing for robust determinations of redshift and thereby allowing for determination of velocity offsets and optical depths of low and high ionization UV absorption lines. These features, along with high ionization emission lines, can be used to constrain the shape of the ionization spectrum. Understanding these low mass systems will better constrain the ionizing output of galaxies in this regime.

`csnap001@ucr.edu`
UC Riverside

LYα ESCAPE FRACTION AS A FUNCTION OF MASS OF Z$\sim$2 DWARF GALAXIES

{ CHRISTOPHER SNAPP-KOLAS BRIAN SIANA}   UNIVERSITY OF CALIFORNIA, RIVERSIDE:DEPARTMENT OF PHYSICS AND ASTRONOMY

ABSTRACT

We present a sample of rest-UV and rest-optical spectra of low-mass, star-forming galaxies at "cosmic high noon." We are able to observe these galaxies by use of gravitational lensing by the clusters Abell1689, MACSJ0717, and MACSJ1149. The rest-UV spectra shows a Lyman alpha emitter fraction of $\sim$32%, significantly higher than larger mass samples at similar redshifts. The rest-optical spectra allow for systemic redshift determination and Hα measurements allow us to determine the intrinsic recombination line luminosities, from which escape fractions can be determined. We measure a Lyα escape fraction of 10% for low luminosity galaxies during this epoch.

SAMPLE

We collected 170 spectra over the course of 7 years with the LRIS spectrograph on Keck-I. Sample characteristics are given in Table 1, information on the observing conditions is given in Table 2, and some example spectra are given in Figure 2. The raw files were reduced using the LRIS data reduction pipeline in the PypeIt suite of reduction pipelines[1][2][3]. The raw files were bias subtracted and flat fielded, wavelength calibrated and cleaned of cosmic rays to produce the final 2D spectra from which 1D spectra were optimally extracted. We have two samples we use in our analysis. 1) The "LRIS sample" takes the above spectra and limits to those with confirmed redshifts above z$\sim$1.6 so that Lyα has coverage in all the spectra. We also account for multiple images since we are observing in gravitationally lensed fields. This sample consists of 94 galaxies. 2) The "LRIS+MOSFIRE sample" is further restricted to redshifts for which Hα is detected and results in a sample of 38 galaxies.

M$_{UV}$	log(M*)	z
(-19.5)-(-17)	8-9.5	1.6-3.2

Table 1: Sample

DATA

	N$_{Nights}$	N$_{spec}$	Exp (s)	Seeing
Count	5	204		
A1689_1	1	21	18000	0.9
A1689_3	1.5	22	12286	0.9
M1149_1	1	22	5400	1.1
M0717_2_new		16	9000	0.7
M0717_1		14	9000	0.9
A1689_4		11	9000	1.4
M1149_1_day2	0.5	21	5400	0.8
A1689_z1_1		19	12000	0.8
M1149_2	0.5	9	4500	1
M0717_3		21	6720	0.7
M1149_3	0.5	11	4860	1.5
A1689_6		17	9600	1

Table 2: Observations

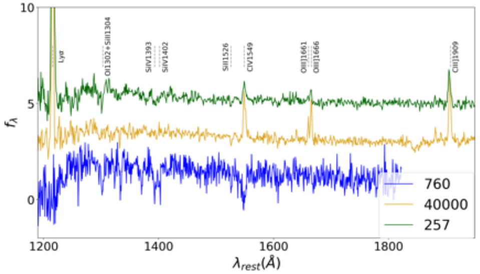


Figure 2: Sample Spectra
These spectra are in arbitrary flux density units and offset by 2 for visualization purposes.

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[9] J. Xavier Prochaska et al. Pypeit: The python spectroscopic data reduction pipeline. *Journal of Open Source Software*, 5(56):2308, 2020.

[10] J. Xavier Prochaska et al. pypeit/PypeIt: Release 1.0.0, April 2020.

INTRODUCTION

The Lyα emission line has been used as a tracer of high redshift galaxies and can be used to infer the star formation rate of galaxies. Lyα has also been used to study the cosmic phase transition of reionization by way of the Lyα emitter fraction. Lyα is prevalent in star forming galaxies and, as such, has been studied extensively at high redshift and high luminosity ($L > 0.5L_*$). However, galaxies at lower luminosity have not been studied well. We use long integrations and gravitational lensing to probe the Lyα properties of lower luminosity galaxies at $z \sim 2$.

RESULTS 1

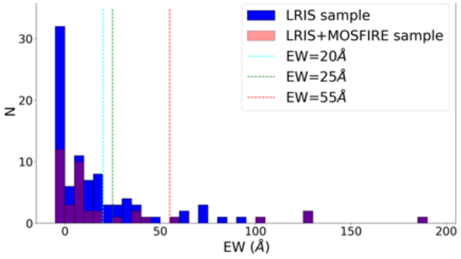


Figure 1: Lyα EW Distribution

Our galaxies exhibit four distinct catagories of Lyα emission, for which we use the naming conventions of [3] 1) "emission" 2) "absorption" 3) "combination" and 4) "noise". The emission spectra are modelled as a continuum with a Gaussian profile fit using an MCMC routine from PyMC3. The equivalent width (EW) is determined by extrapolating the continuum to 1215.67Å. similarly, the combination spectra are modelled as a continuum and a Lyα profile modelled as a first order approximation to the absorption plus a Gaussian. Again, the continuum is extrapolated to 1215.67Å to determine the EW. Figure 1 shows the Lyα EW distribution for both samples of galaxies. In order to compare with the literature we define Lyα emitters (LAEs) as those galaxies with EW≥20Å through which we can determine the Lyα emitter fraction (LAF). Our sample has a mean absolute rest-UV magnitude of M$_{UV}$ $\sim$-18.5 and has a LAF of 31.9%. We can compare this with other samples at the same redshift but higher absolute rest-UV magnitudes. The samples of Reddy et al. 2008 and Hathi et al. 2016 have absolute rest-UV magnitudes M$_{UV}$ $\lesssim$-19.5. Therefore, the faint end of these samples is $\sim$4-5 times brighter than our typical galaxy. The LAFs of these samples are 12%, 11.1%, and 10.7% respectively. This suggests that LAEs are more prevelant at lower luminosites and suggests higher Lyα escape fractions.

RESULTS 2

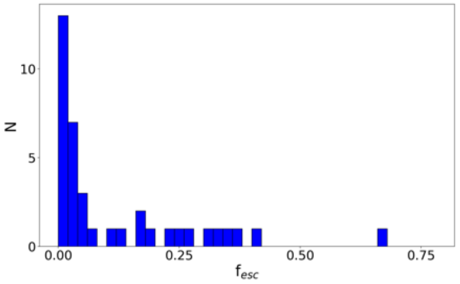


Figure 3: Lyα EW Distribution

In order to study the Lyα escape fraction we must measure the intrinsic Lyα luminosities of our galaxies. Our LRIS+MOSFIRE sample of 38 galaxies is perfect for this as we can estimate the intrinsic Lyα luminosity by measurement of the Hα luminosity and the assumption of CaseB recombination, such that L$_{Ly\alpha}$ = 8.7L$_{H\alpha}$. However, the Hα line is typically attenuated by dust, so we correct the Hα fluxes using a Cardelli et al. 1989 curve with R_V=3.1. In our sample, 12 of the galaxies do not show Lyα in emission and so we set f_{esc}=0 for these galaxies as a worst case scenario. Figure 3 shows the escape fraction distribution. Additionally, we sum the total observed Lyα flux and compare this with the total intrinsic flux to get a total escape fraction. The mean escape fraction of our sample is $\sim$11.6% and the volumetric escape fraction is $\sim$10.1%. It should be stressed that non-detections were given escape fractions of 0 and therefore these escape fraction measurements serve as lower limits. Hayes et al. 2010, Ciardull0 et al. 2014, and Weiss et al. 2021 have larger absolute UV magnitude samples with escape fractions of 5.3%, 4.4%, and 6% respectively. These preliminary findings suggest that lower mass/luminosity galaxies have larger Lyα escape fractions.

FUTURE RESEARCH

The shape of the ionizing spectrum for low mass galaxies at this epoch is not well understood and because of their low dust and metallicity we expect the ionizing spectrum to be harder. The sample shows high ionization emission lines which will facilitate the analysis of the ionizing spectrum in these galaxies and allow us to constrain its shape.

Daniel Polim, Davis, Any Pronouns

Bio

I am a fifth year graduate student focusing on astro instrumentation and searches for dark matter.
I've lived in central Pennsylvania, New York City, and Davis.
I enjoy woodworking, photography, rock climbing, bird watching, writing, skiing, hiking, and occasionally having time for research. Ask me about any of those or the LSST and I'll talk your ear off.

Subfield

Astro-Instrumentation, LEO Satellite Mitigation and Dark Matter

Contact info

- Web: `www.danielpolin.com`
- Twitter: @D_Polinova
- Instgrams:
  @polinova_photography
  @polinova_woodworking

Abstract

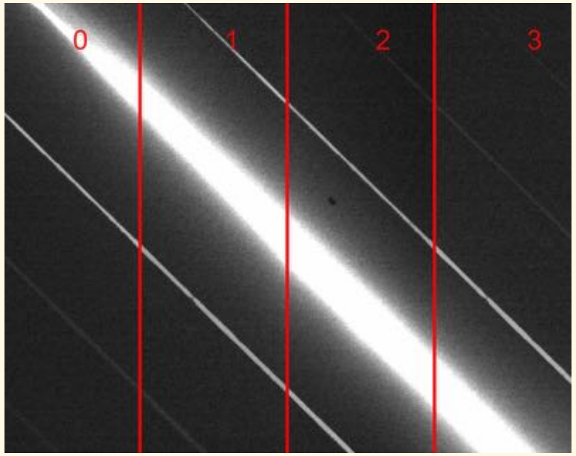
My research focuses on the Rubin Observatory LSST Camera, which I helped construct. I work on studying and mitigating the effects of Low Earth Orbit Satellites on survey astronomy and the LSST in particular. I study photometric and astrometric distortions of CCD detectors. I hope my work can help ensure a future of ground based astronomy brighter than satellite constellations.

`dapolin@ucdavis.edu`
UC Davis

LSST Survey Astronomy in the Era of LEO Satellites

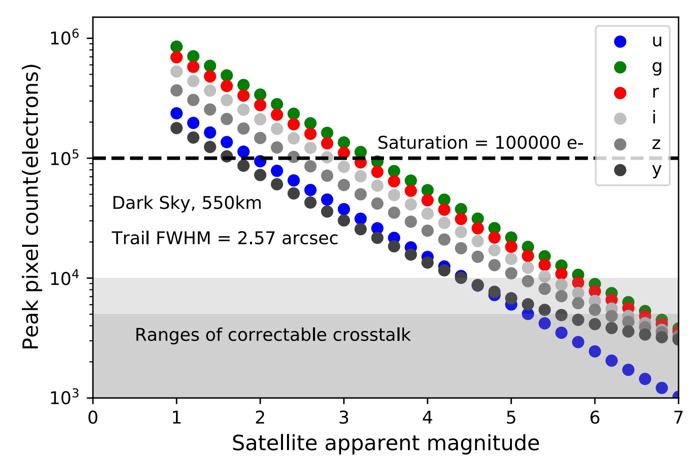
Low earth orbit satellites present a novel obstacle for ground based astronomy, and survey astronomy in particular. We examine how new satellite constellations will impact the Rubin Obsevatory LSST and possible paths forward.

Satellite Image and Crosstalk



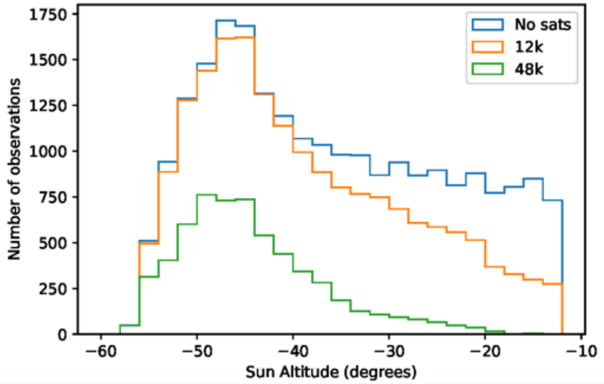
An image of a simulated satellite streak using the LSST Beam simulator and science grade CCD. Visual crosstalk streaks are visible on neighboring amplifiers.

Potential for Correction



The peak trail brightness in e^{-} per pixel for a Starlink satellite at 550 km as a function of apparent AB mag as seen by Rubin Observatory. Colors correspond to the six different LSSTCam filter bands.

Satellite Avoidance



Number of successful observations as a function of the Sun's altitude for 30 days. Attempts to avoid LEOsats rapidly become counterproductive as the number of LEOsats rises.

arXiv:2006.12417
Funded by DOE Grant

dapolin@ucdavis.edu
UC Davis

Dylan Green, Irvine, He/Him

Bio

According to my bio for my podcast, I'm a world renowned gardener who uses a spaceship to grow rare oaktrees. In real life I like to do physics in my free time, when I'm not podcasting, taking film photos, or baking delicious pies and pastries that my roommate and friends eat before I do. Occasionally I even write.

I am entering my third year at UCI, and currently work with Professor David Kirkby. As part of my work I am a member of two collaborations, DESI and LSST.

Subfield

Cosmology, deep learning, Lyman-α analysis

Contact info

- Web: dylana-green.github.io/
- LinkedIn: /spacemandylan/
- Twitter: @spacemandylan

Abstract

In spectroscopic surveys it's important to accurately and automatically identify quasars (QSOs) to re-observe them with a later observation pass. Our work employs a convolutional neural network (CNN) to identify QSOs from their raw but rebinned spectra. By training on SDSS calibrated spectra, previous models have achieved an approximately 90% true positive rate when testing visually inspected Dark Energy Spectroscopic Instrument (DESI) spectra but often suffer from overfitting issues. In our work we achieve similar or better results without overfitting by reducing the number of trainable parameters in the model.

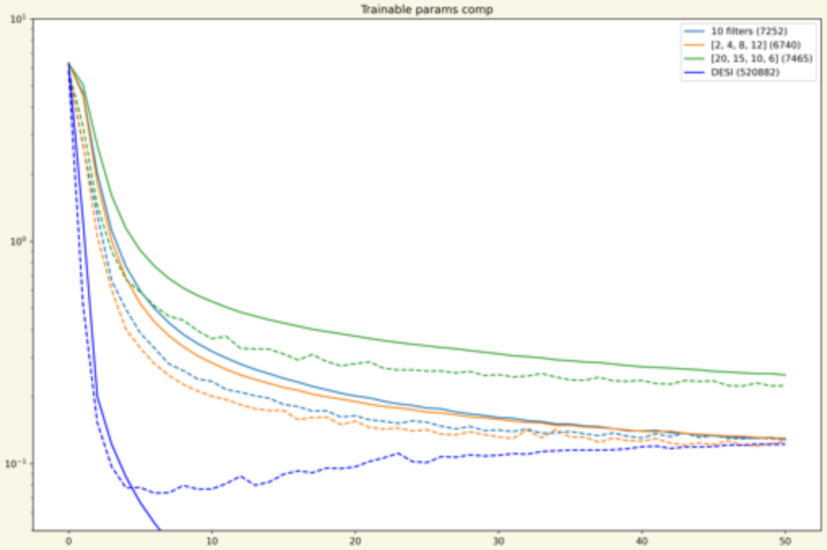
`dylanag@uci.edu`
UC Irvine

1868

Using Deep Learning to Identify Quasars from Spectra

Abstract

In spectroscopic surveys it's important to accurately and automatically identify quasars (QSOs) to re-observe them with a later observation pass. Our work employs a convolutional neural network (CNN) to identify QSOs from their raw but rebinned spectra. By training on SDSS calibrated spectra, previous models have achieved an approximately 90% true positive rate when testing visually inspected Dark Energy Spectroscopic Instrument (DESI) spectra but often suffer from overfitting issues. In our work we achieve similar or better results without overfitting by reducing the number of trainable parameters in the model.



Plot of training and validation loss curves for different model structures. Solid curves represent training loss, while dashed curves are validation loss.

Experiment Design

CNN models with 100 filters per convolutional layer and 4 convolutional blocks have achieved 90% True Positive Rate and <5% False Positive Rate when looking at DESI data. These models produce 520,882 trainable parameters. However, when inspecting the loss curve we find clear signs of overfitting on the validation dataset. In order to combat this we experiment with different convolution sizes, eventually finding that with just 6,740 trainable parameters (only 1.3% the original!) we can achieve similar validation performance without overfitting.

`dylanag@uci.edu`
UC Irvine

Garett Lopez, Riverside, he/him

Bio

I was born and Raised in Los Angeles. I went to El Camino college and eventually received my B.S. in Applied Math from UCLA. After graduating, I worked in industry for a couple of years. I rediscovered my interest in astronomy and decided to come back to research and am now a rising 3rd year at UCR. Hobbies include running, cooking and video games.

Subfield

Intergalactic Medium, Reionization, Cosmology, Dark Matter

Contact info

- Email: glope119@ucr.edu

Abstract

The particle nature of dark matter is still undetermined. Many models, including the WIMP, predict that dark matter could annihilate with itself or possibly decay into standard model particles. These events can generate a cascade of high energy electrons and photons and leave imprints in the thermal history of the universe. These imprints can be seen in the Lyman-α forest. Previous work has explored how different kinds of dark matter can impact a perfectly uniform universe. Appropriately modeling the inhomogenous nature of the Epoch of Reionization, will allow for a more realistic picture of how much the thermal history of the universe can constrain the contribution from dark matter annihilation / decays.

Constraining Dark Matter with the Lyman α Forest

Abstract

The particle nature of dark matter is still undetermined. Many models, including the WIMP, predict that dark matter could annihilate with itself or possibly decay into standard model particles. These events can generate a cascade of high energy electrons and photons and leave imprints in the thermal history of the universe. These imprints can be seen in the Lyman-α forest. Previous work has explored how different kinds of dark matter can impact a perfectly uniform universe. Appropriately modeling the inhomogenous nature of the Epoch of Reionization, will allow for a more realistic picture of how much the thermal history of the universe can constrain the contribution from dark matter annihilation / decays.

Structure Boost the Annihilation Rate

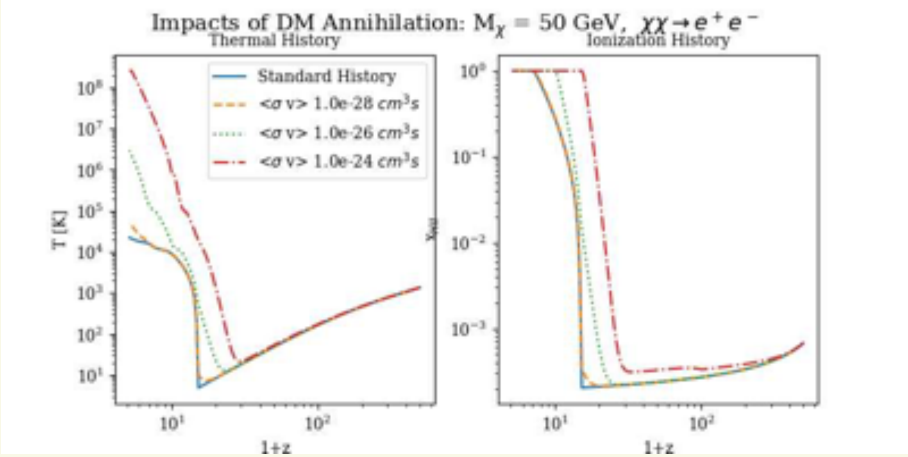
Structure Collapse accelerates the annihilation rate. We calculate the annihilation rate for an individual halo of mass M_H then integrate across the HMF.

$$\Upsilon(z) = \int_{M_{min}}^{M_{max}} N_{ann}(M_H, z) \frac{dN}{dM_H}(z)\, dM_H$$

Reionization is Patchy

During Reionization, the universe is divided into highly neutral and highly ionized regions. This changes how energy from dark matter annihilation or decays deposit into the IGM relative to the homogeneous picture

Impacts on Cosmic History



Significant deviations from the measurements of the thermal and ionization history can rule out part of the DM parameter space

glope119@ucr.edu
UC Riverside

Isabella Trierweiler, Los Angeles, she/her

Bio

I'm a 4th year working on planetary science at UCLA. I grew up in Alabama and Minnesota. My work focuses on polluted white dwarf systems, using the observed excess metal pollution to learn about exoplanetary bodies. Around the department, I'm an outreach coordinator and help manage our Marginalized Identities in Physics and Astronomy group. Outside of science, I like knitting, meeting neighborhood cats, and attempting to grow fruit trees.

Subfield

Planetary Science, Polluted White Dwarfs, Dynamics, Geochemistry

Contac info

- Twitter: @ITrierweiler

Abstract

Polluted white dwarf stars offer a unique way to study the bulk compositions of exoplanetary material. These stars show signs of recent accretion of rocky bodies, and analyzing the excess metal lines in their spectra tells us about the relative elemental abundances of accreting material. One of the challenges of this method is to determine what types of parent bodies, such as asteroids, comets, or moons, are responsible for the observed pollution.

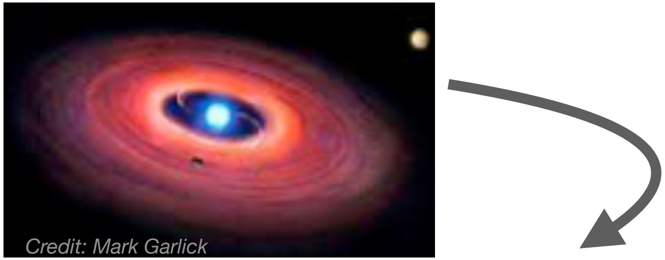
I work with a mixture of analytical models and n-body simulations to learn more about white dwarf accretion events, and determine how probable it is to accrete moons versus asteroids.

`isabella.trierweiler@ucla.edu`
UC Los Angeles

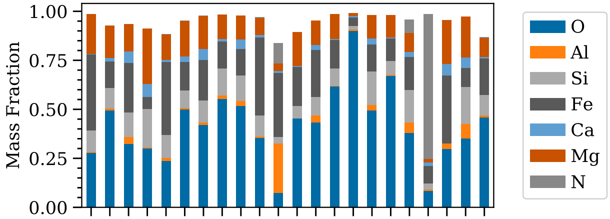
Using Polluted White Dwarfs to Study Extrasolar Bodies

What is a Polluted White Dwarf?

White dwarfs are the remnants of medium-mass stars. When a solar system turns into a white dwarf system at the end of the host star's life, instabilities can cause objects like moons and asteroids to fall onto the white dwarf.



Credit: Mark Garlick

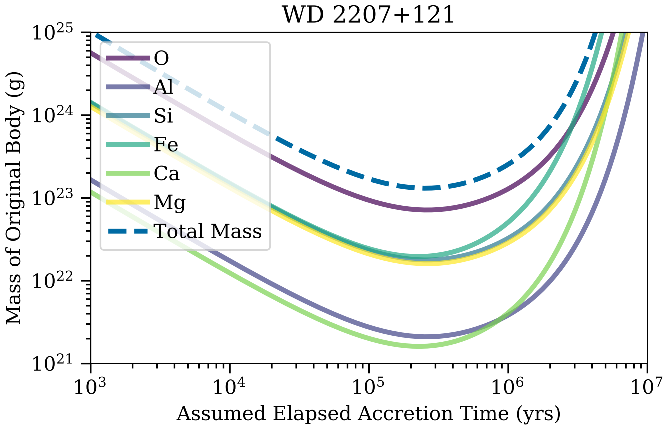


A cartoon plot representing the different kinds of compositions we might extract from a polluted white dwarf spectrum.

This pollution is observed as excess metal lines in the white dwarf spectrum. Observing the lines tells us about the composition of the objects that were accreted by the white dwarf, which can inform us of the object's former geochemical properties.

Modeling Accretion

To learn about what the observed polluters looked like before they were accreted by the white dwarf, we use a model to turn back the clock on accretion events. The model gives an a range of estimates for the mass and composition of the original body, which depend on how long one assumes the accretion has been ongoing.



An example of the accretion model. Each line shows the what the mass of a given element in the original body would be, if we assume a particular accretion time. This shows that the original body needs to be at lest about 10^{23} g total to provide the pollution levels we observe on the white dwarf WD 2207+121.

We find that most accreted objects needed to be quite large, at least 10^{23} g. This is about the mass of Enceladus or Vesta, one of the largest bodies in our asteroid belt.

isabella.trierweiler@astro.ucla.edu
UC Los Angeles

Isabella Trierweiler, she/her

Jackie Blaum, Berkeley, she/her

Bio

Hi everyone! I'm a second year interested in computational astrophysics and all things machine learning. Before moving to the Bay Area, I spent most of my life in Iowa - yay corn. My hobbies include hiking/backpacking, ballet, lyra, yoga, and cooking. Hmu if you want to swap vegan recipes! On the weekends you can find me at the farmer's market, a local coffee shop, wine bar, brewery, or the dog park. I have a Basset Hound/Pitbull mix named Koda who is the love of my life. I also let >500 vermicomposting worms live in my apartment so I can feed my plant babies. Someone please teach me how to fold in the cheese (iykyk).

Subfield

Computational astrophysics, data science

Contact info

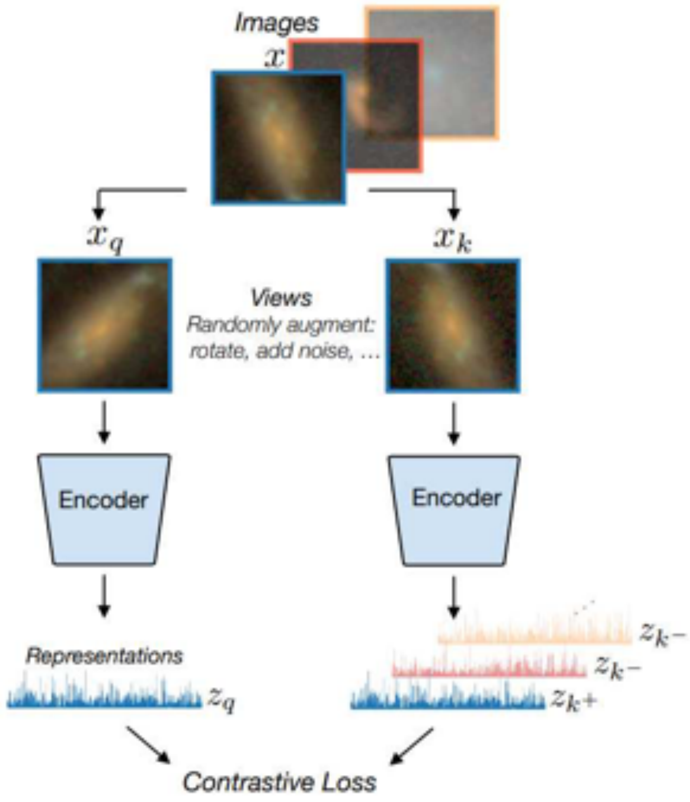
- Facebook: Jackie Blaum
- Instagram: @jackieblaum
- Snapchat: jackie572

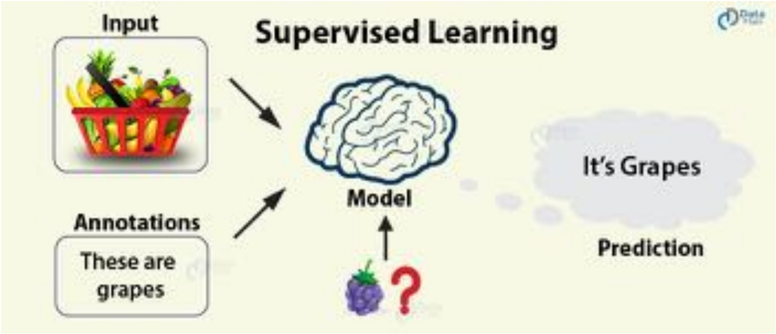
Abstract

Strong gravitational lenses help us constrain the expansion of the universe, study dark matter, and examine features of high redshift galaxies. However, only about one in every 10,000 galaxies is strongly lensed. We can use supervised machine learning to find these rare objects, but lensed training samples are lacking and therefore limit the accuracy of predictions. An emerging method for tackling large unlabeled datasets is through self-supervised learning, which first builds meaningful representations of images without the use of labels before performing standard supervised learning. We are applying this method to search for strong lenses in Dark Energy Camera Legacy Survey data.

jrblaum@berkeley.edu
UC Berkeley

Finding Strong Lenses with Self-Supervised Learning





Abstract

In the search for rare objects such as strong gravitational lenses, we can benefit from the use of supervised machine learning. However, we lack a significant number of strong lens training samples, which limits the accuracy of predictions. An emerging method for tackling large unlabeled datasets is through self-supervised learning (SSL). We are applying this method to search for strong lenses in Dark Energy Camera Legacy Survey (DECaLS) data.

SSL Method

- Build representations of images without using labels (upper left)
- Perform supervised learning using labeled representations as input (lower left)
- Predict on DECaLS images and find new lenses (below)

jrblaum@berkeley.edu
UC Berkeley

James Wiley, San Diego, he/him

Bio

James is a 4th year physics graduate student at the University of California San Diego. His love for astrophysics began when he worked at the Laboratory for Atmospheric and Space Physics in Boulder, CO building sounding rockets carrying prototype astronomical payloads. He now works on ground-based observatories in the optical and infrared and studies a wide range of science cases from galaxy evolution to the origin of cosmic rays.

Subfield

Instrumentation, Galaxy Evolution, Astroparticle physics, Time-domain Astronomy.

Contact info

- ▸ SERF 319
- ▸ 770-689-7530

Abstract

James is currently working on the mechanical design for Liger, a next generation adaptive optics fed integral field spectrograph (IFS) and imager for the Keck I Observatory. Liger will provide higher spectral resolving power, wider wavelength coverage, and a larger field of view than any current IFS. James is also working on the mechanical design for the Panoramic All-sky Near-infrared and Optical Search for Extraterrestrial Intelligence (PANOSETI). This all-sky all-the-time observatory can detect extraterrestrial laser pulses down to nanosecond resolution. James will use these instruments and currently uses others for a myriad of science cases including detecting the circumgalactic medium (CGM) around high-redshift quasi-stellar object (QSO) host galaxies and trying to observe the optical counterpart to fast radio bursts (FRB) and gamma ray bursts (GRB).

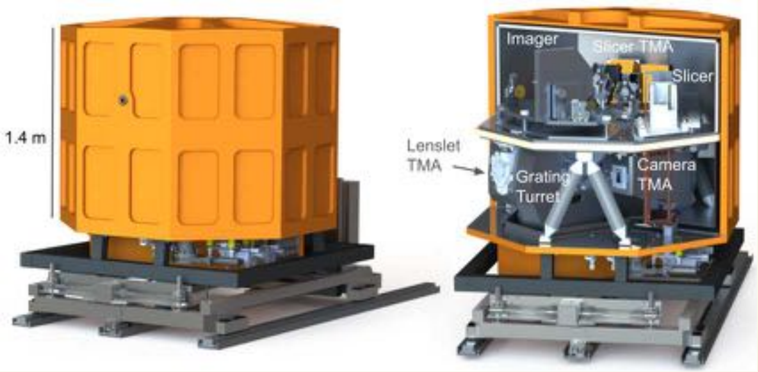
jhwiley@ucsd.edu
UC San Diego

Liger, a Next Generation Imager and Integral Field Spectrograph for the Keck I Observatory

Abstract

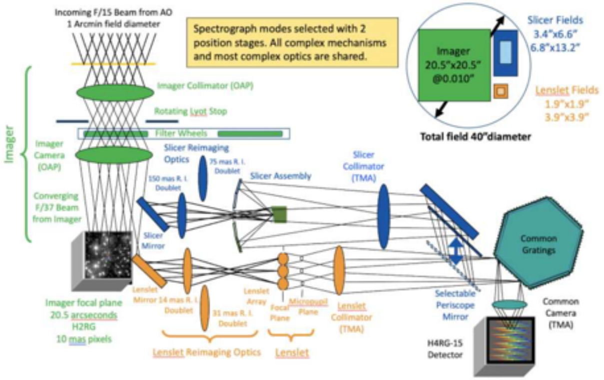
I present the overall design of the optical and mechanical systems for Liger - a next generation adaptive optics (AO) fed imager and integral field spectrograph (IFS) for the W. M. Keck Observatory. Liger is designed to take advantage of the Keck All-sky Precision Adaptive Optics (KAPA) upgrade and will provide parallel imaging, higher spectral resolving power (R~4,000-10,000), wider wavelength coverage (~0.8-2.4 μm), and larger fields of view (up to 13.2") than any current IFS.

Mechanical Design



(left) Exterior of the Liger cryostat mounted on the AO enclosure cart that moves the instrument to active and stored positions. (right) Cross section of the Liger dewar showing the optical subsystems and support structure.

Optical Design



Cartoon diagram illustrating the light path and opto-mechanical layout of the Liger imaging camera (green), the lenslet re-imaging optics (orange), and the slicer re-imaging optics (blue).

jhwiley@ucsd.edu
UC San Diego

Jamie Burke, Santa Barbara, he/they

Bio

I'm an n^{th} year grad student at UCSB.
Science interests: observations of supernovae and other explosive extragalactic transients.
Personal interests: traveling to semi-arbitrarily significant places (all 58 CA counties, etc.), hiking, cycling, reading, Super Smash Bros.

Subfield

Extragalactic optical observations, astrophysical data management systems

Contact info

- Web: I should probably make a professional website, shouldn't I
- IG: jamison.frost

Abstract

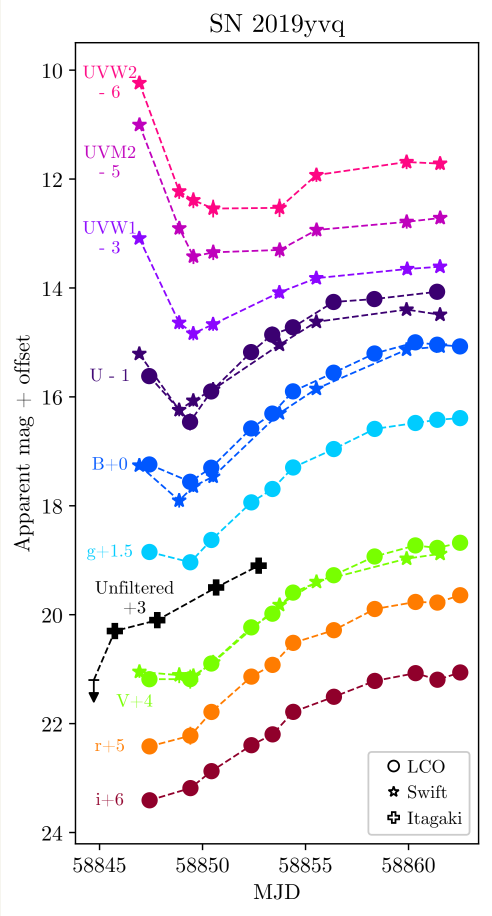
I use the robotic telescopes of Las Cumbres Observatory to study supernovae. I assist with observations of ~all supernova types, but I'm mostly interested in the photometry of type Ia supernovae in the first few days after their explosion, and what these early data can reveal about the progenitor systems of these events.

`jburke@ucsb.edu`
UC Santa Barbara

Early Observations of Type Ia Supernovae

Abstract

I use the robotic telescopes of Las Cumbres Observatory to study supernovae. I assist with observations of ~all supernova types, but I'm mostly interested in the photometry of type Ia supernovae in the first few days after their explosion, and what these early data can reveal about the progenitor systems of these events.



Science

Despite their use as cosmological standard candles, there are many open questions about the progenitor systems of type Ia supernovae.
To the left is the lightcurve of a supernova which displayed an early UV excess (arxiv #2101.06345).
This UV excess arises from the supernova ejecta getting shock-heated after running into a stellar companion to the exploding white dwarf.
Such excesses are difficult to observe but provide clues to the progenitor systems of type Ia supernovae.

Software

My advisor (Andy Howell) is the PI of a large collaboration (the Global Supernova Project, ~150 scientists). At any given time we are following ~50 different supernovae.
We have some specialized software (the Supernova Exchange) to manage our targets and observations. A large project over my PhD has been writing a version 2 of this software to extend its functionality (e.g. requesting observations on Gemini).
I also assist with maintaining and updating our data reduction pipelines.

jburke@ucsb.edu
UC Santa Barbara

Jenny Calahan, University of Michigan, she/her

Bio

Hello! My name is Jenny Calahan and I am a fourth year astro grad at the University of Michigan. I am originally from the Chicago-land area, and did my undergraduate work at the University of Arizona. Outside of work, I love to sing (showtunes, especially), traveling, and exploring new places. I'm an Astrobites writer and love science communication in all its forms. I am coming to this conference as an intruder/plus-one, thanks for letting me attend!

Subfield

Protoplanetary Disks, Planet Formation, Astrochemistry.

Contact info

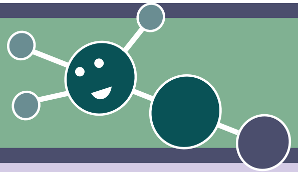
- Web: tinyurl.com /jcalahan
- Social media: Twitter - @jkcalahan

Abstract

I am very interested in the chemistry and planet forming capabilities of protoplanetary disks. One of my current projects focuses on how we can form the molecule methyl cyanide (CH3CN) in the gas of the protoplanetary disk. CH3CN has been seen to be an important molecular stepping stone to more complex molecules that necessary for life. We have observed some CH3CN in disks, and its chemical origin is unclear. Previous thought has leaned towards the need for dust to act as a facilitator for CH3CN formation. My updated thermo-chemical models show a different picture. I have created highly tuned models for the TW Hya and HD 163296 disks and can reproduce CH3CN observations by using only gas-phase chemistry. I am currently pushing these models to the limit to explore what exact conditions are necessary for CH3CN and semi-complex molecules to form.

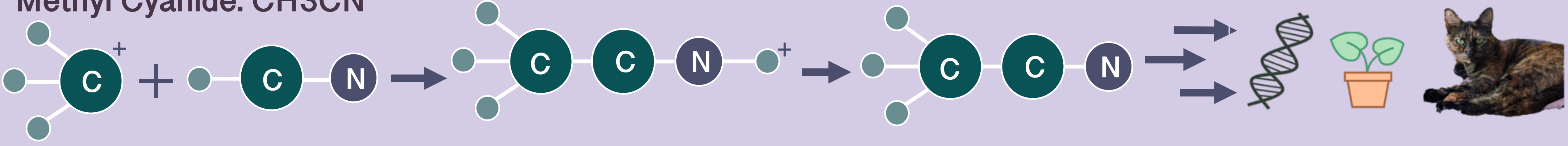
`jcalahan@umich.edu`
Univeristy of Michigan

Forming CH3CN in Protoplanetary Disks

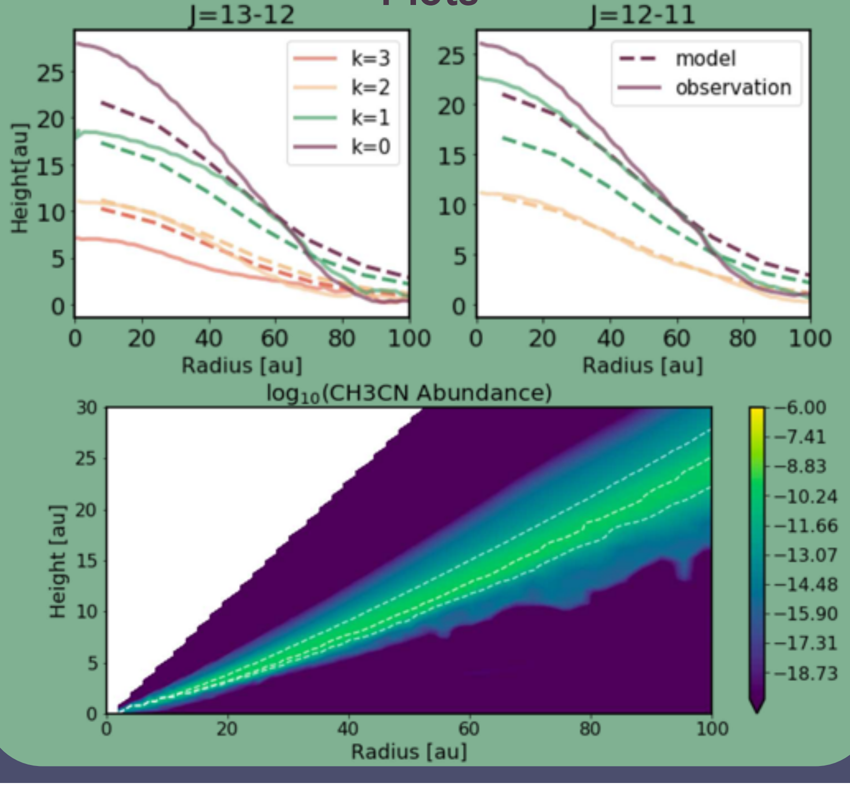


Contact:
jcalahan@umich.edu

Methyl Cyanide: CH3CN



Plots



Past modeling work found it difficult to form CH3CN and other complex molecules in the gas phase within protoplanetary disks. This lead the field to believe that the bulk of CH3CN formation occurs on the surface of dust grains. In Calahan et al. 2021, I present a model of the disk around TW Hydra that reproduces multiple observations of CO, HD, and dust from ALMA and Herschel. That same model, under certain conditions is able to produce CH3CN in the gas. The three components that are driving factors:

- UV field/tau=1 surface location
- Initial C/O ratio, which consists of free carbon in the form of C or CH4 and free oxygen in atomic form or in frozen water on grains

What's next?

- HD 163296 model and CH3CN replication – much more massive disk, different UV field, different dust distribution
- Other complex molecules reproduced? HC3N, CH3OH, CH2CN have been observed. Are there other wack molecules out there to observe?
- Look out for our paper in ApJ letters 🤞

Jenny Quinn, Merced, they/them

Bio

I'm Jenny Quinn, a first year graduate student at UC Merced. I received my undergraduate degrees in Physics and Computer Science at Texas AM University and am originally from Houston, Texas. My hobbies include drinking and learning about tea, and collecting mechanical keyboards and fountain pens. This is my first time camping, and I am looking forward to the experience!

Subfield

Galaxy Evolution, Stellar Migration, Simulations

Contact info

- Email: jquinn4@ucm.edu

Abstract

My current work with Sarah Loebman aims to investigate the structure and kinematics of spiral galaxies and star clusters across time by simulating Milky Way-like galaxies. We will be applying a Windowed Fast Fourier Transform method on Latte simulations to investigate the nature and structure of spiral arms.

`jquinn4@ucmerced.edu`
UC Merced

Examining the Structure of Spiral Galaxies

Abstract
We will explore the nature and evolution of spiral galaxies by identifying characteristics of spiral arms across time through the use applying a Windowed Fast Fourier Transform on high resolution Latte Simulations. This will be conducted on the 15 currently simulated Milky Way-like galaxies and the results will be compiled in a table to be used for future research.

Latte Simulations (run by Dr. Andrew Wetzel at UC Davis)
These simulations are a suite within FIRE-2 that focuses on simulating Milky Way-like galaxies. The ultra-high resolutions and dynamic range used by these simulations make it possible to model everything from large structures, such as spiral arms, to small scale stellar populations

Figure 1: An illustrative sample of *Latte* disks showing a variety of spiral structure, star formation, and cosmological environments.

jquinn4@ucmerced.edu
UC Merced

1868

Karthik Prabhu, Davis, he/him

Bio

I'm a 4th year PhD candidate, working with Prof Lloyd Knox. I am interested in developing statistical models to detect primordial B-modes in CMB using the South Pole Telescope + Bicep/Keck data(South Pole Observatory). Besides doing science, I enjoy running, hiking, volleyball and video games.

Subfield

Intergalactic medium, cosmology, Bayesian machine learning.

Contact info

- Twitter: karthikprabhu22

Abstract

I am currently working on the Pipeline B2 of the South Pole Observatory that is focused on detecting the inflationary B-mode signals in the CMB among its other science goals. Pipeline-B2 is a map-based likelihood approach that takes multi-frequency data from the SPO telescopes and outputs a posterior for the parameters that control the CMB signal, lensing template and the galactic foregrounds.

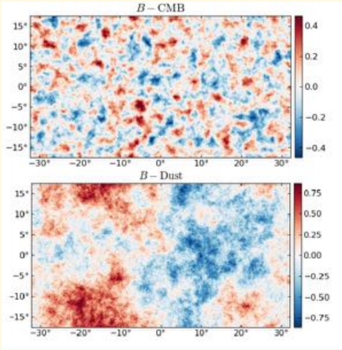
kprabhu@ucdavis.edu
UC Davis

A map-based likelihood approach for detecting primordial B-modes

Abstract

One of the primary predictions of inflation is the existence of a nearly scale-invariant spectrum of primordial gravitational waves(PGW). These PGWs imprint a unique divergence-free pattern on the polarization maps of the Cosmic Microwave Background, known as B-modes. The attempts to detect these B-mode signals have been hindered by the presence of polarized galactic foregrounds. My research is focused on modeling these foregrounds in order to facilitate inferences of the primordial signal specifically focussing on spatially varying spectral indices and non-gaussianities.

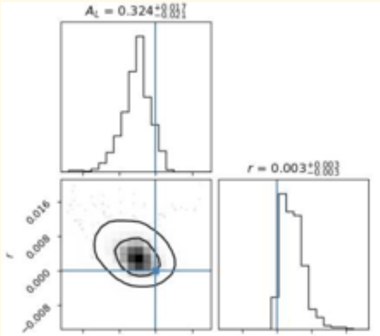
CMB B-modes



Pipeline-B2

Forward model of data: A sum of CMB signal, foregrounds and noise.

$$d = \mathbb{F}_{\mathrm{CMB}}\mathbb{L}(\phi)f + \mathbb{F}_{\mathrm{d}}\left(\beta_{\mathrm{d}}, T_{\mathrm{d}}\right) g_{\mathrm{d},\nu_0} + n$$



Modelling challenges

Currently working on two extensions to the dust foreground model:

- Spatially varying spectral indices using the moment expansion formalism: Promote β_d to be a function of spatial position in the sky

$$\mathscr{D}_\ell^{\nu\nu'} = A_{\mathrm{d}}\left(\frac{\ell}{80}\right)^{2+\alpha}\left[\left(\frac{\nu}{353\mathrm{GHz}}\right)^{\beta_d}\frac{B_\nu\left(T_{\mathrm{d}}\right)}{B_{353}\left(T_{\mathrm{d}}\right)}\right]\left[\left(\frac{\nu'}{353\mathrm{GHz}}\right)^{\beta_d}\frac{B_{\nu'}\left(T_{\mathrm{d}}\right)}{B_{353}\left(T_{\mathrm{d}}\right)}\right]$$

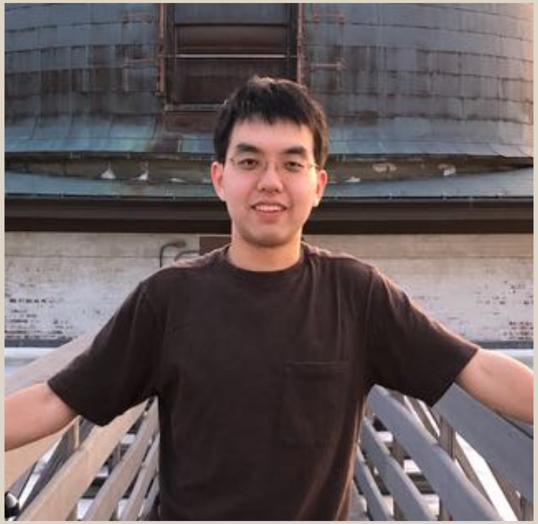
- Non-gaussianities in the dust emission using Frolov models: Transform polarization tensor (I,Q,U) into “polarization fraction” tensor (i,q,u)

$$i = \tfrac{1}{2}\ln\left(I^2 - P^2\right) \qquad q = \tfrac{1}{2}\tfrac{Q}{P}\ln\tfrac{I+P}{I-P} \qquad u = \tfrac{1}{2}\tfrac{U}{P}\ln\tfrac{I+P}{I-P}$$

$$I = e^i\cosh p \qquad Q = \tfrac{q}{p}e^i\sinh p \qquad U = \tfrac{u}{p}e^i\sinh p$$

kprabhu@ucdavis.edu
UC Davis

Kenneth Lin, Berkeley, he/him



Bio

I am currently a second-year graduate student at UC Berkeley involved in characterizing detectors for the upcoming La Silla Schmidt Southern Survey, working with Dr. Peter Nugent at LBNL. I received my B.S. in physics and astronomy in 2020 from the University of Massachusetts Amherst and grew up in the small town of Harvard, Mass. I love playing the cello, going to orchestral concerts, hiking, and learning to speak languages (5 currently).

Subfield

CCD detectors, instrumentation, transients, cosmology.

Contac info

- Web: kwlin0.github.io

Abstract

The La Silla Schmidt Southern Survey (LS4) is a 5-year public, wide-field, optical survey which intends to complement the *Legacy Survey of Space and Time* (LSST) carried out on the Rubin Observatory in searches for transients and gravitational wave standard sirens. Using an upgraded 20-square degree QUEST camera on the ESO Schmidt Telescope with LBNL fully-depleted CCDs, LS4 will have a higher cadence over LSST, covering 2k-4k square degrees per night which enables characterization of fast-evolving transients to 21^{st} magnitude. LS4 will also open a new phase-space of discovery between 12^{th} and 16^{th} magnitude, where Rubin is expected to saturate. We expect to achieve first light by late 2022 and we report on current progress in characterizing the CCDs that will be optimized for our survey.

kwlin@berkeley.edu
UC Berkeley

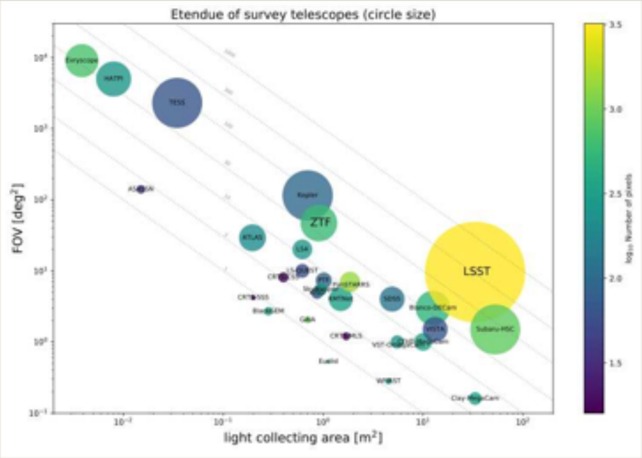
CCD Testing for the La Silla Schmidt Southern Survey

Abstract

The LS4 Survey uses 32 LBNL CCDs repurposed from DES to cover the focal plane of the QUEST camera, which sits at the prime focus of the ESO 1-m Schmidt Telescope. Each CCD has 2k × 4k pixels, with about a 1" resolution. We present the types of tests that we are undertaking to characterize and select science grade CCDs. Specifically, we describe the routines we developed to measure the gain, read noise, linearity, and photon transfer curves (PTC) using Fermilab low-threshold acquisition (LTA) readout electronics.

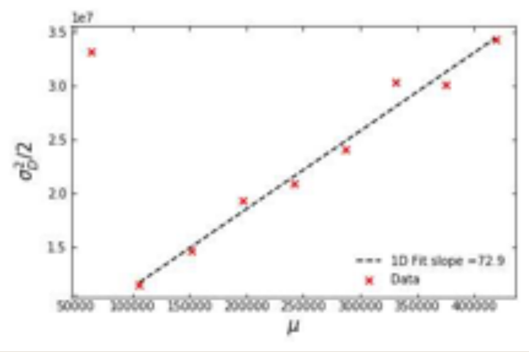
Role of LS4

- ► 45s exposure + 15s readout/slew, cadence no longer than 3 days.
- ► Identify events early to trigger spectroscopy within 24h.



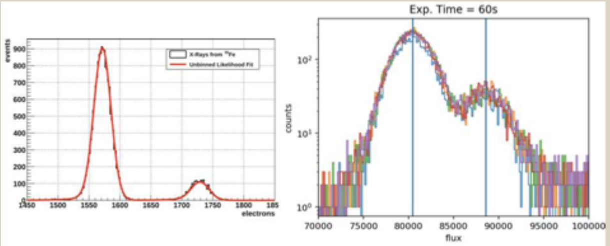
Photon Transfer Curves

PTCs enable us to measure gain and the linearity when the detector is evenly illuminated.



We also use ^{55}Fe X-ray source as another method to measure gain and read noise as we accelerate the readout time (6 μs/px).

Gain & Read Noise



Synergy beyond LSST

- ► 10% ToO, with 90% of survey streamed to 3 brokers.
- ► Follow-up with SoXS for flash spectroscopy during the night.
- ► Host galaxy z measurements with DESI, 4MOST/TiDES.

kwlin@berkeley.edu
UC Berkeley

Lizvette Villafaña (she/her)

ABOUT ME

Hi everyone! I am an incoming second year at UCLA and a California native. Originally from a small agriculture-based town located in northern Central California, I moved to Los Angeles in 2013 to start my undergrad at UCLA. I fell in love with the city and now consider it home after living in the area for 8 years. <3

I graduated from undergrad in 2018 and immediately started my master’s program in aerospace engineering at USC, where I focused on nanosatellite control systems. Although cool, I realized I missed astronomy way too much, so I started my Ph.D. program the Fall after obtaining my M.S. degree. On my free time I love to hike, bike ride by the beach, “surf ” (still learning), take zumba classes, jump rope, or stay in and watch chick-flicks with my cat.

FOLLOW ME ON twitter

@villafal_

RESEARCH

My primary research interest involves understanding the origin of the empirical black hole (BH) scaling relations (i.e. the tight correlations observed between BH mass and host galaxy properties). In particular, I am interested in probing these relations at higher redshifts to help constrain theoretical interpretations. Improving the virial mass estimators used to estimate BH masses across cosmic time, will directly help aforementioned studies by reducing uncertainties.

I am currently working with Tommaso Treu to do so by: (1) modelling the Broad Line Region of AGNs to search for correlations between the scale factor (used in reverberation mapping) and other AGN parameters and (2) re-calibrating the R-L relation used for the single epoch method by accounting for selection effects.

`lvillafana@astro.ucla.edu`
UCLA

Improving Virial Black Hole Mass Estimators:
The search for a new scale factor for reverberation mapping campaigns

REVERBERATION MAPPING

In our local universe, the gravitational sphere of influence of a super massive black hole (BH) can be spatially resolved, and stellar/gas kinematics can be modeled in order to constrain the BH's mass. Beyond $\sim$ 120 Mpc, however, our current technology can no longer resolve the gravitational sphere of influence. Instead a method called reverberation mapping can be used, but only for type 1 (Broad Line) AGNs. Reverberation (echo) mapping resolves the gravitational sphere of influence in "time" by observing fluctuations in the optical continuum that are later echoed in the broad emission lines.

With a few assumptions:

- the Broad Line Region (BLR) is virialized
- the motion of the BLR clouds are dominated by gravity
- the broad line is broadened by the virial motion of the emitting gas
- the observed time delay, τ, is due solely to light travel time ($\tau = R_{\rm BLR}/c$)

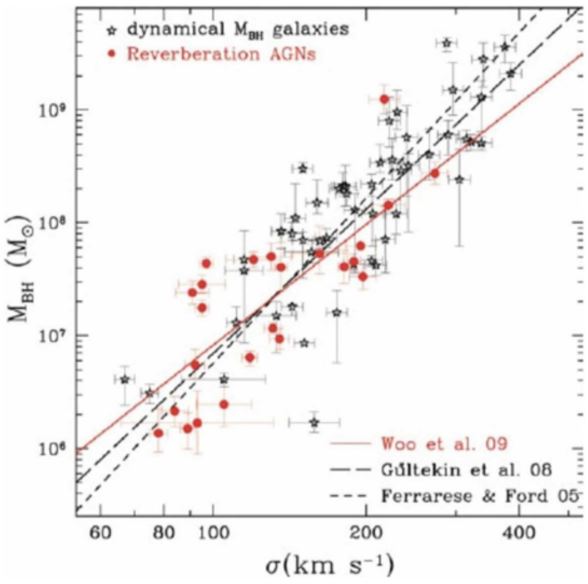
The black hole mass can be approximated as:

$$M_{\rm BH} = f\frac{c\tau v^2}{G} \qquad (1)$$

where f represents a dimensionless scaling factor meant to account for BLR geometry and kinematics.

THE SCALE FACTOR

Typically an empirically calibrated average f is used by forcing AGN host galaxies to obey the local M-sigma relation.



Woo et al. (2013)

Although the intrinsic scatter of the local M-sigma relation remains controversial, most studies agree it is $\sim$ 0.3 dex. The associated uncertainty of the average scale factor determined using this technique, is therefore the greatest source of error in reverberation mapped BH mass estimates.

MODELING THE BLR

Our team uses CARAMEL (Code for AGN Reverberation and Modeling of Emission Lines) to model the BLR using reverberation mapping data. The observed continuum, integrated Hβ emission, and Hβ line profiles are fed into CARAMEL and the BLR is modeled as point particles that instantaneously reflect light towards an observer. Then, using Bayesian inference, the model explores a 27 parameter space that best fits the data and constrains the black hole mass without using the scale factor.

Combining the black hole mass estimate produced by our model with the observed time lags and emission line widths retrieved using cross-correlation methods, we invert eqn. 1 to determine individual scale factors:

$$f = \frac{GM_{\rm BH}}{c\tau v^2} \qquad (2)$$

Our group has modeled the BLR for 17 AGNs and I am currently working to add another 8-10 AGNs to the sample using Lick AGN Monitoring Project (LAMP) 2016 data. Our goal is to search for correlations between the scale factor and other AGN parameters. If such a correlation is found, it can be used to calibrate individual scale factors for future reverberation mapping campaigns, rather than using the current average value.

Lizvette Villafaña
`lvillafana@astro.ucla.edu`
UCLA

Mahdi Qezlou, Riverside, He/him

Bio

Hey. I'm a rising 4th year UCR-Carnegie graduate fellow. Currently, working on Lyman Alpha Tomography IMACS Survey (LATIS). Interested in both theoretical and observational Astrophysics/Cosmology.
I have a cute dog, her name is Hazel! In my free time, I eat, hike and run!

Subfield

Intergalactic medium, cosmology, Galaxy Evolution

Contac info

- Web: mahdiqezlou.github.io
- Social media: Twitter: MQezlou Instagram : mahdiqezlou

Abstract

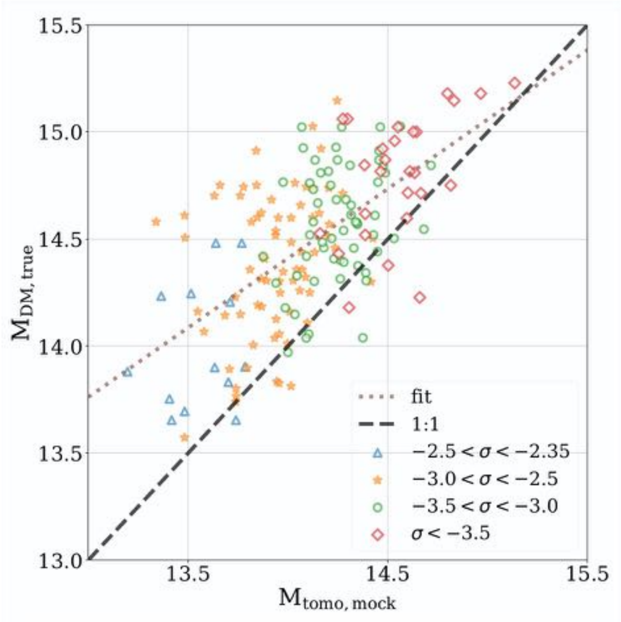
Lyman Alpha Tomography IMACS Survey (LATIS): A survey conducted with Magellan Telescope aims to create a large 3D structure of Intergalactic Medium. It does so by observing the Lyman-alpha forest within the spectra of 3800 background LBGs and QSOs over 1.7 deg^2. On this poster, I explain how we build our models to detect many protoclusters and protogroups within this 3D map.

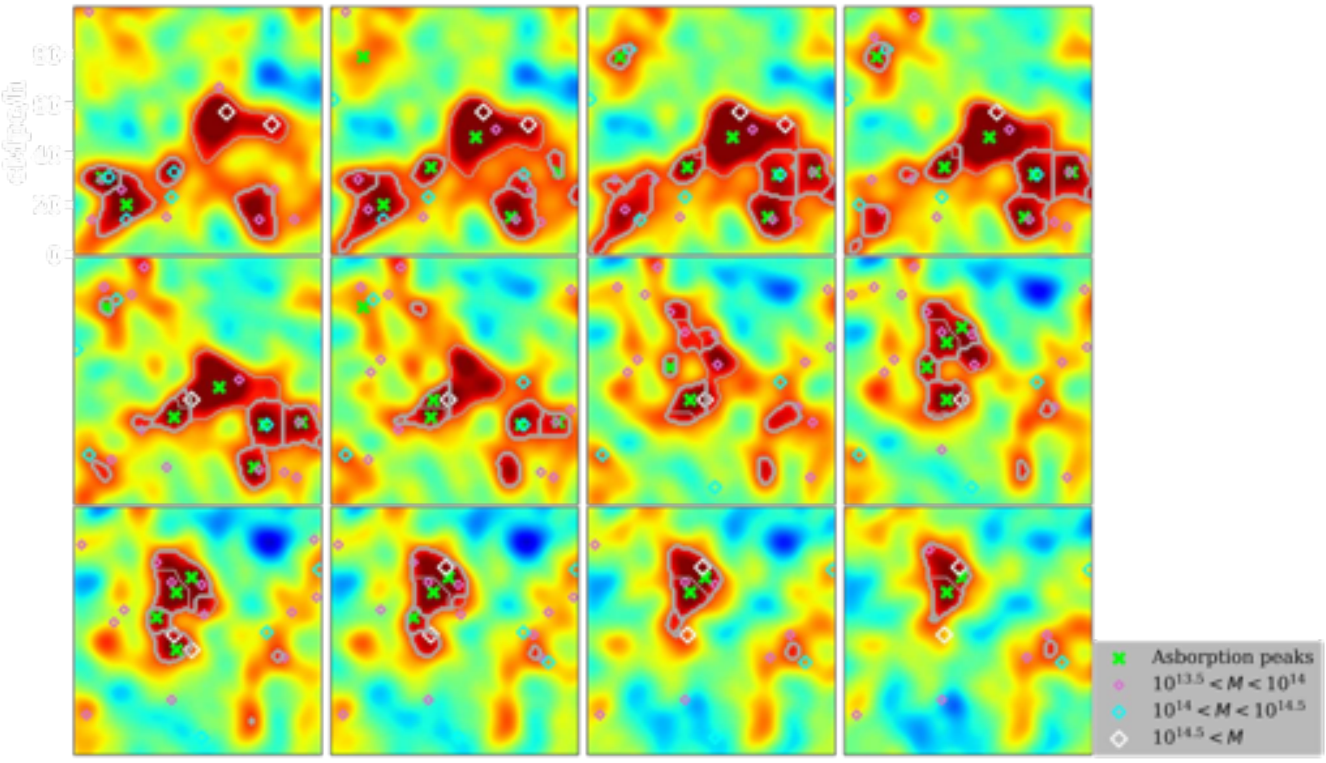
`mahdi.qezlou@email.ucr.edu`
UC Riverside

Lyman Alpha Tomography and Protocluster/groups

Mahdi Qezlou, UCR-Carnegie observatories

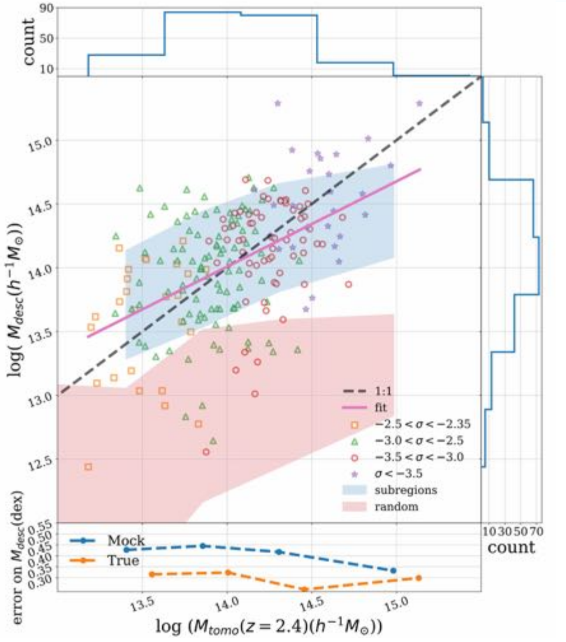
Z ~ 2.5





Mock-Observed LATIS

Z = 0



Micah Oeur, Merced, (she/her)

Biography

I am a friendly 2nd year grad student at UC Merced working with Dr. Sarah Loebman using simulations to investigate the evolution of stars in the galactic disk.
I graduated last year from Cal State Long Beach, which is where I am from!
I currently live in Merced spend a lot of my days horseback riding, picnicking at Lake Yosemite, and playing Tetris on my switch!

Subfield

Cosmological simulations, data-analysis methods, chemo-dynamical tools.

Contact info

- Website: oeur.github.io/
- Twitter: @MicahOeur

Abstract

Context. We compare data-analysis methods used to constrain the galactic gravitational potential. Each of these makes different (but always strong) assumptions and each is differently sensitive to violations of the assumptions.
Methods. We build toy dynamical models of toy dynamical systems as data for use in the comparisons, "observe" them and compare the outcomes of measurements made by different methods.
Results. We demonstrate that orbital torus imaging recovers the true potential for an isothermal distribution embedded in a simple harmonic oscillator by two methods: a classical-statistics approach a Bayesian approach. These results are promising and will allow us to do further comparisons of these different data-analysis methods in the future.

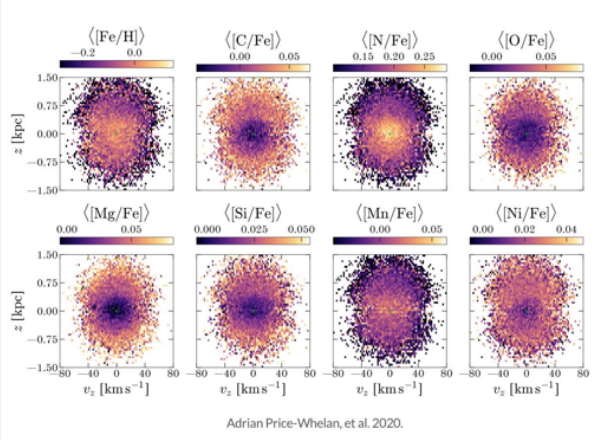
`moeur@ucmerced.edu`
UC Merced

Comparisons of Dynamics Data-Analysis Methods

Abstract

Context. We compare data-analysis methods used to constrain the galactic gravitational potential. Each of these makes different (but always strong) assumptions and each is differently sensitive to violations of the assumptions.
Methods. We build toy dynamical models of toy dynamical systems as data for use in the comparisons, "observe" them and compare the outcomes of measurements made by different methods.
Results. We demonstrate that orbital torus imaging recovers the true potential for an isothermal distribution embedded in a simple harmonic oscillator by two methods: a classical-statistics approach a Bayesian approach. These results are promising and will allow us to do further comparisons of these different data-analysis methods in the future.

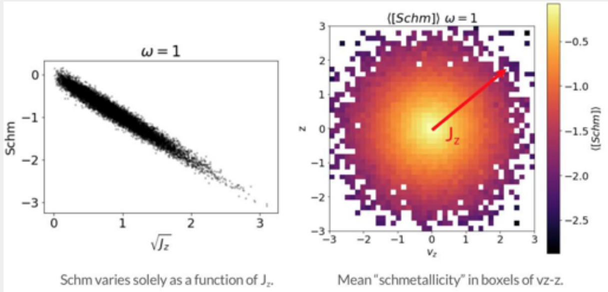
Motivation for OTI: Real Data



Adrian Price-Whelan, et al. 2020.

Chemical abundance gradients for 56,000 stars from APOGEE & Gaia.

Toy Data



Schm varies solely as a function of J_z.

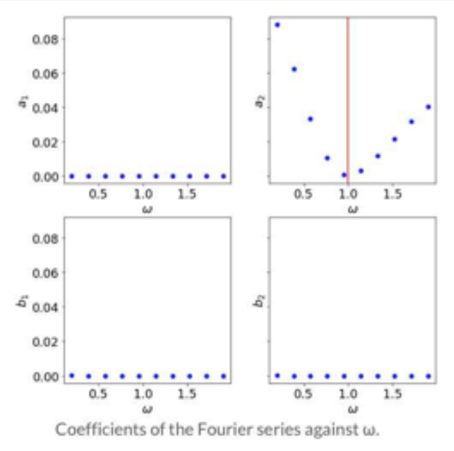
Mean "schmetallicity" in boxels of vz-z.

10,000 tracers in a SHO potential.

Smooth Model Fit to Data

$$\Delta(\theta_z) = c_0 + a_1 cos(\theta_z) + b_1 sin(\theta_z) + a_2 cos(2\theta_z) + b_2 sin(2\theta_z)$$

0 Angle Dependence



Coefficients of the Fourier series against ω.

Coefficient minimized at $\omega = 1$.

moeur@ucmerced.edu
UC Merced

Ming-Feng Ho, Riverside, he/him

Bio

Originally from Taiwan, I am going to be a 4th year PhD candidate, working with Simeon Bird on simulation-based inference and machine learning in quasar spectroscopic observations. I am currently a NASA future investigator through the FINESST award.

My research motivation comes from my enthusiasm for helping relieve people from labour-intensive works in academia. I also spend lots of time on public issues related to international grad students.

When I am not working, I play cello and text mining.

Subfield

Intergalactic medium, cosmology, Bayesian machine learning.

Contac info

- Web: jibancat.github.io
- FB: airofthehouse
- Snap: @fho812

Abstract

An emulator enables the estimation of simulation output by interpolating across the parameter space. All current emulators are single-fidelity emulators, training only expensive high-fidelity simulations. Training an emulator requires tons of expensive simulations, making the emulation approach less practical. We present the first implementation of multi-fidelity emulation in cosmology, where many low-resolution simulations are combined with a few high-resolution simulations to produce an improved emulation accuracy. Our multi-fidelity emulator can achieve percent-level accuracy on average with only 3 high-fidelity simulations and outperform a single-fidelity emulator using 11 simulations. Our proposed emulator shows a new way to predict non-linear scales by fusing simulations from different fidelities, making the emulation development substantially more practical.

`mho026@ucr.edu`
UC Riverside

A Multi-Fidelity Emulator for Cosmology

Abstract

We present the first implementation of multi-fidelity emulator in cosmological inference, where many low-resolution simulations are fused with a few high-resolution simulations to achieve an increased emulation accuracy. We demonstrate that our multi-fidelity emulator can achieve percent-level accuracy with only 3 high-fidelity simulations and outperforms a high-fidelity only emulator that uses 11 simulations. Our multi-fidelity emulator is fast to train, using only a simple modification to standard Gaussian Processes.

Single-Fidelity Emulator

A single-fidelity is modelled as a Gaussian process:

$$p(f) = \mathcal{GP}(f; \mu, K(x, x'; \boldsymbol{\theta})), \tag{1}$$

with μ to be GP mean prior function, and K is the kernel function specified by hyperparameters, $\boldsymbol{\theta}$.

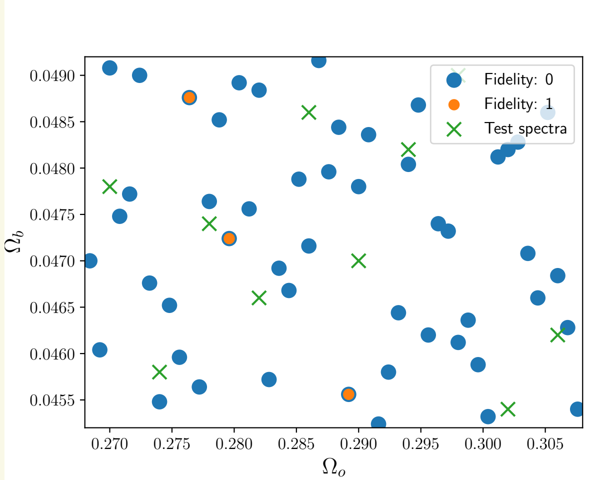
Multi-fidelity emulator (NARGP)

Consider we have observed data, $\mathcal{D}_t = \{x_{i,t}, y_{i,t}\}$ for fidelity $t = 1, \ldots, s$ and simulation $i = 1, \ldots, n_t$. We model a multi-fidelity emulator as:

$$f_t(x) = \rho_t(x, f_{t-1}(x) - \mu_{t-1}) + \delta_t(x), \tag{2}$$

where $\rho_t(\cdot)$ is a function of both input parameters x and previous fidelity's output. $\rho_t(\cdot)$ is modelled as a GP.

Nested Sampling Design



The nested sampling design, $\mathcal{D}_1 \subseteq \mathcal{D}_2$. **(Blue):** $\mathcal{D}_2$ with 50 sampling points in low-fidelity simulations. **(Green):** 10 points from the testing high-resolution simulations set. **(Orange):** $\mathcal{D}_1$ with 3 points in high-resolution simulations.

mho026@ucr.edu
UC Riverside

Minghan Chen, Santa Barbara, he/him/his

Bio

I'm a fourth year graduate student at UCSB studying exoplanets and brown dwarfs. I grew up in China and have been studying in the US since undergraduate. I drink a metric ton of milk tea everyday to keep me going. Outside of work, I enjoy playing soccer, video games, skiing, movies, anime, fantasy/mystery novels, and outdoor stuff in general.

Subfield

Exoplanets, Direct Imaging, Statistical Analysis.

Contac info

- Email: minghan@ucsb.edu/

Abstract

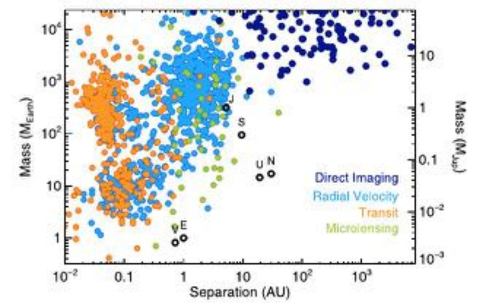
Coronagraphic High Angular Resolution Imaging Spectrograph (CHARIS) is a high contrast imaging instrument paired with SCExAO–an extreme adaptive optics system–on the Subaru Telescope. We are putting together an open source python reduction pipeline that takes advantage of recent advancements in post-processing techniques such as KLIP and forward modeling. This will enable easy, streamlined data reduction that allows us to characterize giant planets and brown dwarfs. Equipped with SCExAO's beam steering mode which allows a pointing offset to the guide star, and the capability to perform spectral-polarimetry imaging unique to CHARIS, we are able to make observations of very widely separated companions (such as late-T dwarf Gl 504b) and obtain spectra of bright disks (such as HD 34700). These will enable us to carry out precision tests for brown dwarf atmospheric models and characterize disk properties.

`minghan@ucsb.edu`
UC Santa Barbara

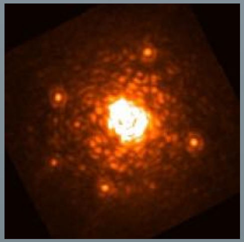
Characterizing Giant Planets and Brown Dwarfs with CHARIS

Minghan Chen, Tim Brandt (advisor)
University of California, Santa Barbara, CA, USA

Introduction



Direct imaging is one of the methods to detect and characterize exoplanetary systems. It is most sensitive to young, giant planets / brown dwarfs at wide orbits.



Challenges for direct imaging:

1. High contrast between host star and planet
2. Spatial Resolution
3. Quasi-static speckle noise

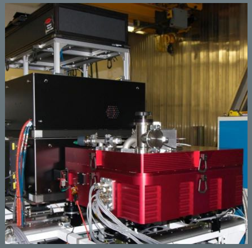
Why direct imaging:

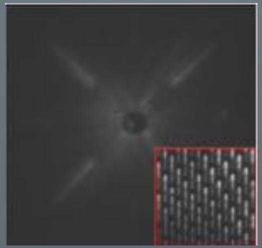
- Characterize exoplanet surface properties
- Dynamical masses
- Test evolutionary models and atmospheric models

Instrumentation

SCExAO: Subaru coronagraphic extreme adaptive optics, corrects for distorted wavefronts to achieve the diffraction limit.

CHARIS: Coronagraphic high angular resolution imaging spectrograph, capable of taking high contrast, high resolution images and low resolution spectra at the same time.





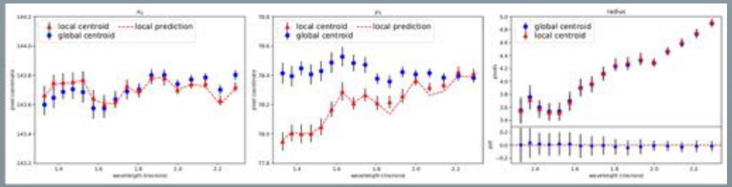
Post Processing Pipeline

pyKLIP for CHARIS

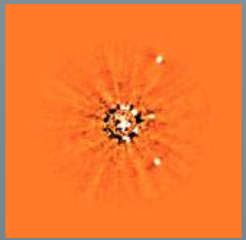
pyKLIP is an open source python library put together by Wang et al. (2015). It has all the major components necessary for processing CHARIS data.

Step 1: Centroiding and image registration

Use satellite spots to locate the centroid of each image, and align all images before PSF modeling.



Step2: PSF modeling and subtraction



Observing techniques: ADI, SSDI

KLIP: $\chi^2 = \sum_{ij} (D_{ij} - D'_{ij})^2$

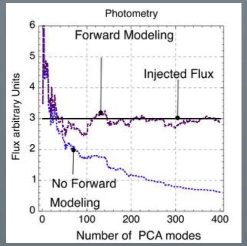
PCA based algorithm with local optimization

Weighted low-rank approximation:

$$\chi^2 = \sum_{ij} w_{ij} (D_{ij} - D'_{ij})^2$$

Alternative to KLIP that allows pixel weighting

Step3: Forward modeling

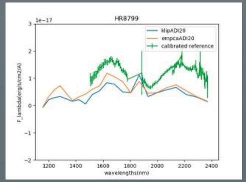


Corruptions to the physical signal:

- Over-subtraction
- Self-subtraction

Forward modeling:
Models the effect of propagating a signal through the PSF subtraction process and corrects for it

Astrometric, spectrophotometric calibrations



- Instrument plate scales
- Position angles
- Fluxes in physical units

Dynamical Masses

Relative astrometry from long term relative orbit monitoring → system mass

Relative astrometry + RV + absolute astrometry (Gaia) → companion mass individual masses

$$\frac{a^3}{P^2} = \frac{G(M+m)}{4\pi^2}$$

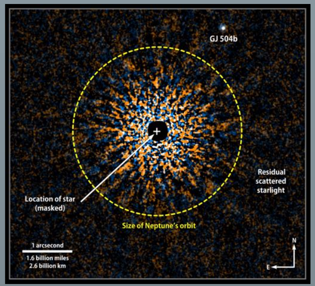
$$a_{astrometric} = \frac{Gm}{r^2} \cos\varphi$$

$$a_{RV} = \frac{Gm}{r^2} \sin\varphi$$

$$\rho_{DM} = r \cos\varphi$$

Dynamical masses: Robust, model independent

Evolutionary and Atmospheric Models



Gl 758 B (benchmark late-T dwarf):
Teff ~ 600 K
Mass: 38.1 +- 2 Mjup
Luminosity (Log L/Lsun): -6.07 +- 0.03
Age: >~ 5 Gyr

Gl 504 b:
Teff ~ 600 K and similar host star activity as Gl 758 B
Other parameters uncertain

CHARIS observations:
NIR spectra using the beam steering mode

What we can do:

- Precision tests of evolutionary models and atmospheric models for ultra-cool T dwarfs at this temperature
- Interpret Gl 504 b spectrum using Gl 758 B as an anchor and infer its properties

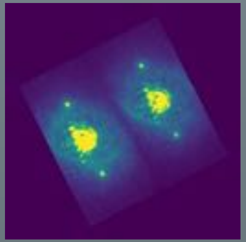
Spectral Polarimetry

Spectrum + polarimetry Imaging of two disks

HD 15115: circumstellar disk

HD 34700: protoplanetary disk

What we can do:
Detailed characterization of disk properties at different wavelengths



References

Brendan P. Bowler 2016 *PASP* **128** 102001
Groff, T., Chilcote, J., Brandt, T., et al. 2017, in Techniques and Instrumentation for Detection of Exoplanets VIII, ed. S. Shaklan, Vol. 10400 (SPIE), 315
Pueyo, L. 2016, ApJ, 824, 117
Wang, J. J., Ruffio, J.-B., De Rosa, R. J., et al. 2015, pyKLIP:PSF Subtraction for Exoplanets and Disks
Kuzuhara, M., Tamura, M., Kudo, T., et al. 2013, ApJ, 774, 11

Molly Wolfson, Santa Barbara, she/her

Bio

I am a fourth year student working with Professor Joseph Hennawi at UCSB. My research focuses on the high-redshift ($z > 5$) intergalactic medium (IGM). I combine observations and simulations to study the universe. I am interested in answering questions about the epoch of reionization and the nature of dark matter. I also help organize UCSB's Astro Lunch (when we are not in a pandemic) and our Women in Physics group. My dog's name is Pippin and he studies the best sticks to chew.

Subfield

Intergalactic medium, cosmology, statistical methods, observations

Contact info

- Web: mollywolfson.github.io/
- Instagram: molly.wolfson

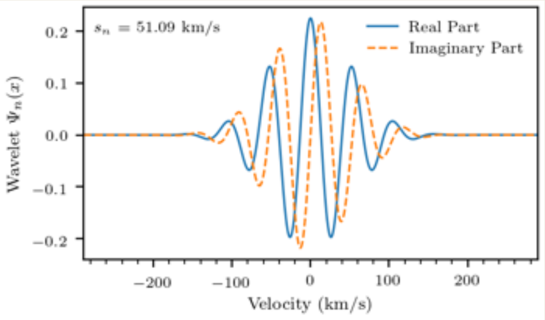
Abstract

The thermal state of the IGM is encoded in the small-scale structure of Lyman-α (Lyα) absorption in quasar spectra. Typically, the 1D flux power spectrum is used to measure the average small-scale structure along quasar sightlines. At high redshifts where the opacity is large, this averaging mixes transmission spikes with absorption troughs. Wavelet amplitudes are an alternate statistic that maintains spatial information while quantifying fluctuations at the same spatial frequencies as the power spectrum, giving them the potential to more sensitively measure the small-scale structure. Previous Lyα forest studies using wavelet amplitude probability density functions (PDFs) neglected strong correlations between PDF bins and across wavelets scales. I present these previously ignored correlations for wavelet amplitude PDFs.

`mawolfson@ucsb.edu`
UC Santa Barbara

Correlations Between Wavelet PDF Statistics

Morlet Wavelet



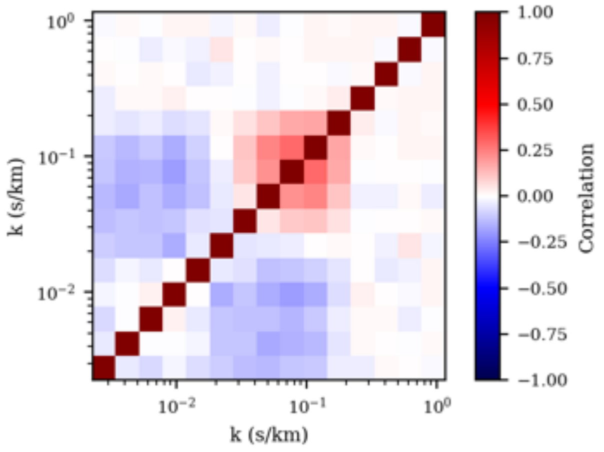
This is localized in both real and frequency space.

Summary

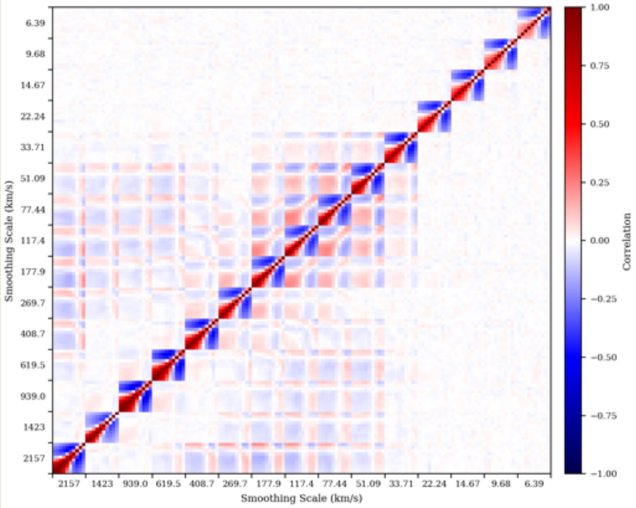
Wavelet amplitude PDFs are a useful statistic for studying small-scales in the IGM. Previously, off-diagonal correlations have typically been ignored in analyses. We calculated these correlations from simulations and found features similar to those in the power spectrum.

Correlations

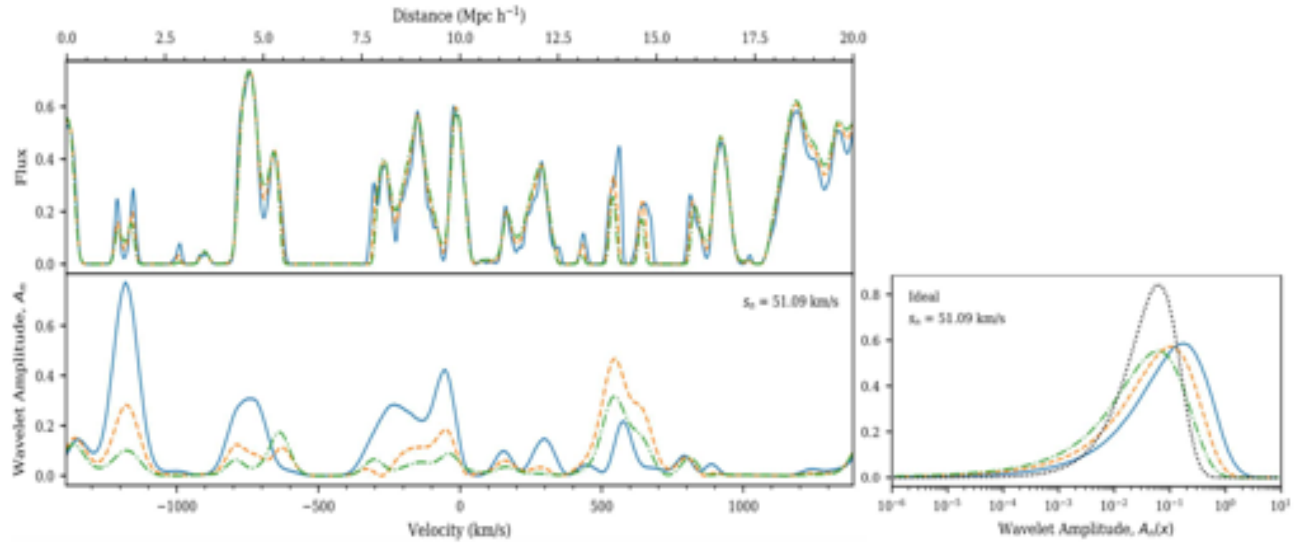
Power



Wavelet Amplitude PDFs



What is a Wavelet Amplitude PDF?



mawolfson@ucsb.edu
UC Santa Barbara

Nicholas Duong, Irvine, He/Him

Bio

Hi everyone - you can call me Nick and I was born and raised in Louisville, Kentucky. I am entering my third year as a graduate student at UCI, working with Dr. Aomawa Shields' SCECIE group on exploring the climate and potential habitability of exoplanets with 1-D and 3-D climate modeling. I also find great joy in mentoring others and wish to develop my own astronomy outreach program in Irvine.

Outside of academics, I love playing video games, anime/manga, swimming, boxing, and I am currently learning to play the piano. I am a huge geek, especially about Disney, Star Wars, and Marvel/DC, and love to geek out with others so feel free to come talk with me!

Subfields

Exoclimatology, 1-D EBM & 3-D GCM Climate Modeling, Biosignatures, and M-dwarf Habitability

Social Media

- LinkedIn: /in/astronamese/
- Facebook: /astronamese/
- Instagram: @astronamese

Abstract (Currently between projects so I will talk about my previous work at UCI!)

A possible material that may form on the cold surfaces of extrasolar planets is cryoconite – a dark, powdery, windblown dust that accumulates on snow, glaciers, and ice caps. Because of its low albedo, the presence of cryoconite may have altered Earth's energy budget and deglaciation threshold during globally ice-covered, "snowball" episodes. Using a one-dimensional energy balance climate model, we simulated the equilibrium climate response of an airless planet with varying surface percentages of cryoconite to a range of instellations from F-, G-, K-, and M-dwarf stars. Assuming an Earth-like land/ocean distribution, we find that the effect of cryoconite is greatest for planets orbiting stars with more visible and near-UV output. This is because cryoconite has a much lower albedo at these shorter wavelengths, compared with pure water ice and snow. For an F-dwarf planet with the land surface covered with a 75%/25% water ice/cryoconite mixture, full deglaciation occurs with about 33% less instellation than a similar planet with no cryoconite on its surface. For planets orbiting M-dwarf stars, whose spectral output peaks at infrared wavelengths, the albedos of ice and snow at these longer wavelengths are comparable to those of cryoconite, resulting in relatively small differences in the deglaciation thresholds between cryoconite concentrations on these planets. These results have implications for the climate stability of planets with substantial land fractions, for which cryoconite would be a significant contributor to the overall planetary albedo.

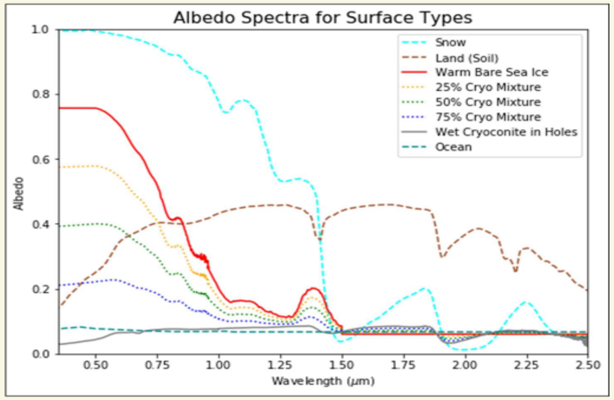
nichod1@uci.edu
UC Irvine

The Effect of Cryoconite on the Deglaciation Thresholds of Snowball Planets

What is Cryoconite?

Cryoconite is a dark, powdery, windblown dust that accumulates on snow, glaciers, and ice caps on Earth. It can sometimes be found in holes on the frozen surface.

Cryoconite's Low Albedo...



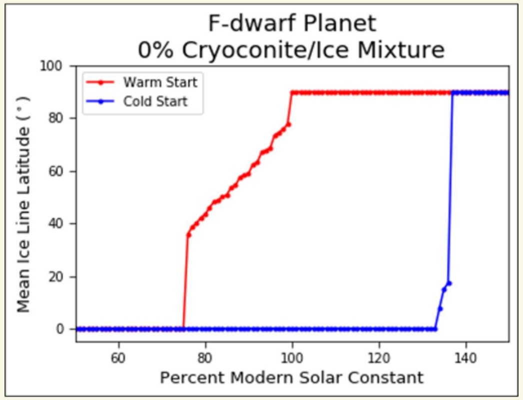
...And Its Potentially Powerful Effect

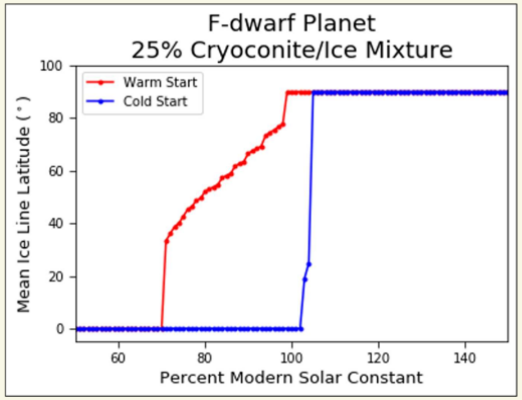
Stars of different spectral type emit their peak flux at varying wavelengths. Cryoconite's wide-ranging low albedo could thus have a significant effect on deglaciation thresholds for exoplanets in "snowball" states orbiting different types of stars.

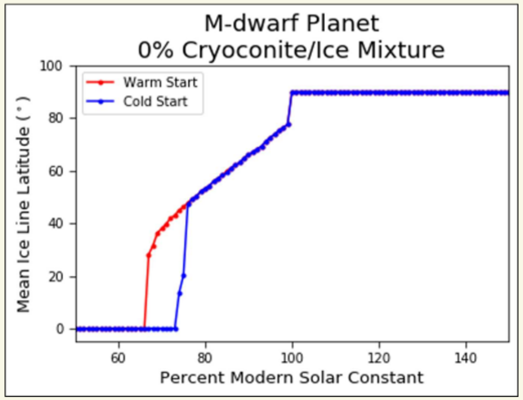
Broadband surface albedos for different cryoconite mixtures were calculated for airless planets (assuming an Earth-like land/ocean distribution) orbiting F-, G-, K-, and M-dwarf stars and we also use previously calculated albedos for the other surface types (Shields et al. 2013). Our parameterization is then incorporated into a modified 1-D energy balance model (EBM) (North & Coakley 1979). We then identified the level of instellation required to fully thaw out of globally ice-covered conditions.

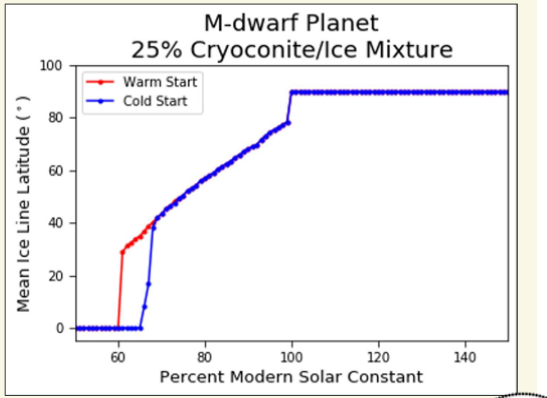
A Stronger Impact for Planets Orbiting Hotter Stars

F-dwarf planets with just a 25% cryoconite mixture deglaciate fully at about 33% lower instellation than a similar planet with no cryoconite on its surface. In contrast, M-dwarf planets are able to deglaciate fully at similar instellations for surface mixtures containing 0% and 25% cryoconite.









nichod1@uci.edu
UC Irvine

1868

Nicholas Ferraro, Los Angeles, he/him

Nick (and Jansky)

Bio

Hi folks! My name is Nick, and I am a rising second year graduate student at UCLA. At UCLA, I work with Jean Turner on the identification of super star clusters (SSCs), but I spent two years between undergrad and grad school working as a data analyst on the Very Large Array (VLA) in Socorro, New Mexico. Outside of the classroom, I'm a big fan of running, playing piano, having board game/D&D nights with friends, and hiking with my dog/best friend/platonic soulmate Jansky.

Subfield

Radio astronomy, interferometry, extragalactic astronomy, HII regions

Contact info

- Email: nferraro@ucla.edu
- Instagram: @ngsferraro

Abstract

My current research project is a VLA survey of Wolf-Rayet galaxies with the goal of identifying young, local, super star cluster (SSC) candidates. I will create a publicly available atlas and catalog of the SSC candidates, from which I can plan follow-up observations by ALMA or Keck to confirm potential SSC status as part of my eventual PhD work.

My love for teaching astronomy, especially to non-science students, was a driving factor in my decision to pursue a higher degree in Astrophysics. During my time at UCLA, I intend to participate in the Scholars of Teaching as Research (STAR) program offered by CIRTL@UCLA, and expand the radio astronomy education opportunities available to undergraduates.

A Local Wolf-Rayet Galaxy Survey

Abstract

We propose a survey of local galaxies showing spectral features of Wolf-Rayet stars. These spectral features are present in galaxies with young super star clusters (SSCs), and are an indicator of large concentrations of massive stars. The goal is to make a census of giant HII regions associated with young super star clusters in the local universe. The free-free fluxes from these maps will allow extinction-free estimates of their Lyman continuum rates and luminosities of the clusters. The resulting catalog will provide sources for future molecular line and infrared studies into the properties of super star cluster formation.

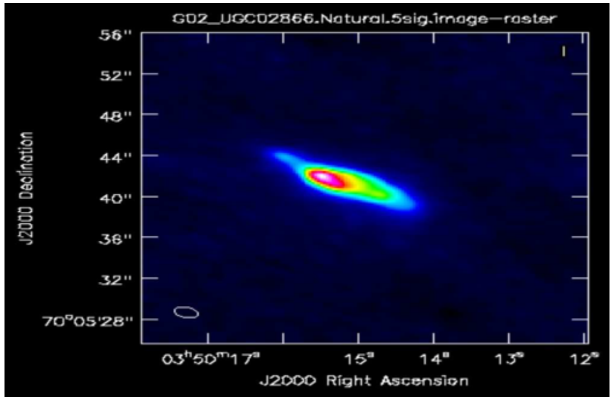
Super Star Clusters (SSCs)

- Thousands of O Stars
- Young ($\lesssim$ 100 Myr)
- Massive ($\gtrsim 10^{5.5}\ M_\odot$)
- Diameters $\sim$ 5 pc
- High star formation rates
- Potential precursors to globular clusters?

Survey Details

- VLA C Configuration (Longest baseline: 2.1 miles)
- K Band (18 $\sim$ 26.5 GHz) Continuum observations
- 30 targets, follow-up observations possible with ALMA and Keck

Survey Targets



An early draft radio interferometric image of target source UGC 02866 produced using the NRAO's (National Radio Astronomy Observatory) CASA (Common Astronomy Software Applications) package.

`nferraro@ucla.edu`
UC Los Angeles

Patty Bolan, Davis, she/her

Bio

Hi! I'm Patty, a rising fourth year Ph.D. student at UC Davis working with Maruša Bradač on the first galaxies formed. I use data from large telescopes to analyze properties of galaxies during the Epoch of Reionization (roughly $6 < z < 11$) to understand more about these first galaxies and the environment they live in. Aside from astro stuff, I love getting outside: rock climbing, trail running, and thru-hiking are my favorite things! I also grew up playing traditional Irish music, and it's a huge part of my life!

Subfield

Galaxies, reionization, galaxy evolution

Contact info

- Social media: Twitter @pattybolan, Instagram @p.bolan

Abstract

The Epoch of Reionzation (EoR), lasting from roughly $z \sim 15$ to $z \sim 6$ is a period of cosmic history with many open science questions. Of these, one of the most important relates to the determination of a detailed timeline on how the neutral hydrogen fraction, $\bar{x}_{HI}$, of the intergalactic medium (IGM) evolved during the EoR. In my most recent work, I use observations of Lyman Break Galaxies (LBGs) from the EoR to put constraints on $\bar{x}_{HI}$ at $z \sim 6$-8. By using a faint sample of galaxy candidates from the ionized universe ($z \sim 6$) whose luminosities match those at higher redshifts, we are able to isolate IGM effects on Lyman-alpha emission (Lyα, 1216Å) from those of the interstellar medium (ISM), allowing us to confidently infer the neutral fraction with small uncertainty.

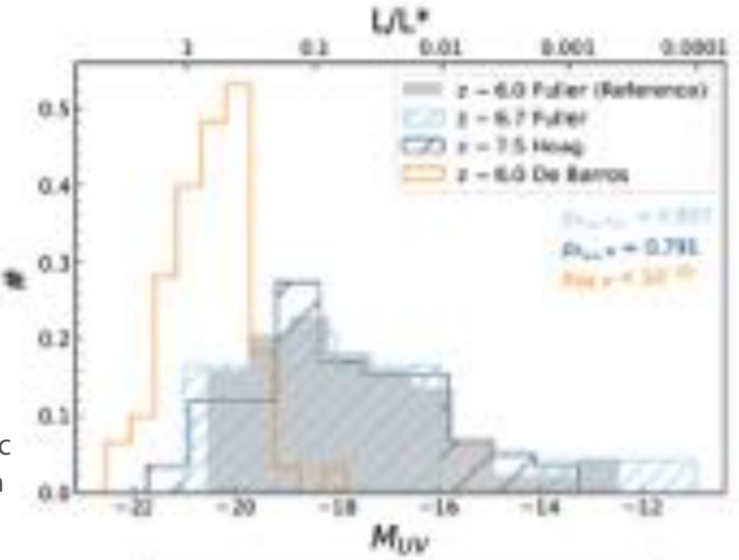
`pmbolan@ucdavis.edu`
UC Davis

INFERRING THE IGM NEUTRAL FRACTION AT *z* ~ 6-8

PATTY BOLAN, BRIAN LEMAUX, CHARLOTTE MASON, MARUSA BRADAC

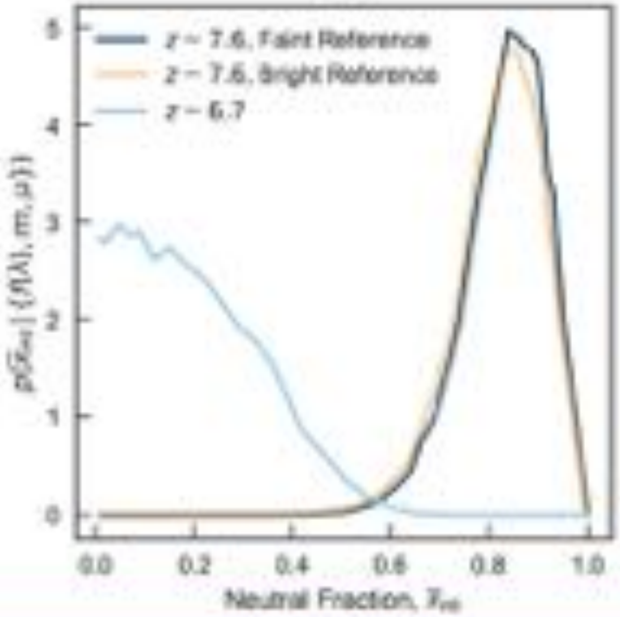
ABSTRACT

One of the most important science questions from the he Epoch of Reionzation (EoR) relates to the determination of a detailed timeline on how the neutral hydrogen fraction, x_{HI}, of the intergalactic medium (IGM) evolved during the EoR. In this work, we use observations of Lyman Break Galaxies (LBGs) from the EoR to put constraints on x_{HI} at z ~ 6.7 and z ~ 7.6. Our samples are comprised of almost 300 intrinsically faint LBG candidates from z ~ 5 - 8.2 with the average luminosity representing typical reionization era galaxies. With this faint sample, we are able to isolate IGM effects on Lya from those of the interstellar medium (ISM), allowing us to confidently infer the neutral fraction with small uncertainty.



METHODS

We use three samples of galaxies in this work: a reference sample from the ionized universe at z ~ 6.0, and two high-z samples at z ~ 6.7 and z ~ 7.6, used to infer x_{HI}. The reference sample of LBGs is used to model the intrinsic Lya equivalent width (EW) distribution without the effects of attenuation in the IGM due to neutral hydrogen. In previous work (Hoag), the neutral fraction at z ~ 7.6 was determined with a bright reference z ~ 6.0 sample (De Barros). In this work, we add a faint sample of reference galaxies (Fuller) to better characterize the Lya EW distribution of faint galaxies. We perform rigorous Monte Carlo tests on the UV beta slopes and aboslute magnitudes, M_{UV}'s, of the high-z samples against the reference one to increase our confidence that all samples are likely to come from the same parent distribution.



RESULTS

Using the faint reference sample, we infer an upper limtit on x_{HI} at z ~ 6.7 of 0.25 within 68% confidence, and a neutral fraction of $x_{HI} = 0.83^{+0.08}_{-0.11}$ at z ~ 7.6. In the previous analysis at z ~ 7.6, using the same sample of high-z candidates, but a brighter reference sample, we infer the same neutral fraction with larger 1 sigma errors. Using the faint z ~ 6.0 samples, we reduce the error by 14%, owing to tighter constraints on the Lya EW distrubtion which is used in the Bayesian inference. Our constraints on x_{HI} are consistent with a late and rapid reionziation scenario. Our values are coherent with other measurements of the neutral fraction within error. By using a faint reference sample to infer the neutral hydrogen fraction during reionization, we are probing typical ionizing galaxies as well as reducing the error in x_{HI} from previous analyses.

pmbolan@ucdavis.edu

Pratik Gandhi, Davis, he/him

Bio

I'm a rising 4th year astro grad at UCD, originally from Mumbai, India. I study galaxy formation and evolution, and am really interested in the use of both simulations and observations in the study of galaxies. Outside of research, I'm interested in science communication, teaching, and social issues in academia. I'm a member of the Astrobites collaboration (feel free to reach out if you wish to apply!). Also a huge fan of Star Trek, with my favourites being DS9 and TNG!

Subfield

Galaxy formation, Local Group, reionisation, near-far connection, FIRE simulations

Contact info

Email: pjgandhi@ucdavis.edu
Twitter: @astrogandhi

Abstract

A major open question in astronomy is: which types of galaxies contributed the most to cosmic reionisation? One way to address this is through direct observations of the first galaxies at early cosmic times ($z > 6$), but this is often challenging even with the best available telescopes. An alternative is the "near-far" approach, where the star formation histories of nearby satellite galaxies of the Milky Way and Andromeda can inform our knowledge of galaxy populations at $z \sim 6 - 10$ (during the Epoch of Reionisation). For my thesis, I aim to test, characterise, and validate/invalidate this method using the FIRE simulations of galaxy formation, and use them in conjunction with HST/JWST observations of Local Group dwarfs to infer the properties of galaxies more than 12 billion years ago.

Pratik Gandhi, Davis, he/him

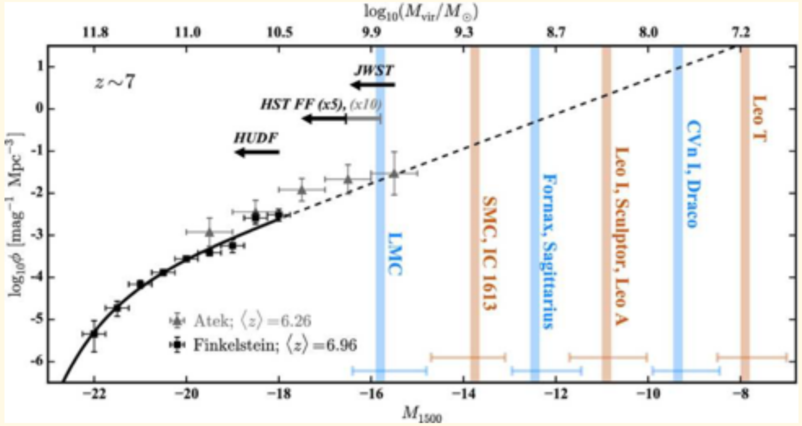
Background on High-Redshift UVLF

To understand whether faint (low-mass) galaxies were dominant in driving cosmic reionisation, we must understand the faint-end of the galaxy UV luminosity function (UVLF) at $z \gtrsim 6$, i.e., the number of galaxies at different luminosities. Although direct observations of high-z galaxies is a useful probe, even with HST/JWST we are likely unable to observe galaxies faint enough to characterise the very faint-end of the UVLF at $z \gtrsim 6$. The near-far technique provides an alternative by using star formation histories (SFHs) of Local Group dwarf galaxies to probe high-z faint galaxy populations.

Testing Near-Far Method with FIRE

For my thesis, I am using the FIRE simulations of galaxy formation (Hopkins+18) to test the validity of the near-far approach. Using high-resolution hydrodynamical sims of high-z galaxies as well as Local Group dwarfs, I seek to precisely constrain the mapping from dwarf SFHs to high-z galaxy properties. I will also test the accuracy of our methods for reconstructing dwarf SFHs by creating synthetic observations of the simulated dwarfs.

Near-Far Approach



$z \sim 7$ UVLF (Boylan-Kolchin+15), with scatter points showing current state-of-the-art observed samples. Arrows indicate magnitude limits for HST/JWST. Vertical bands show regimes probed by SFHs of various Local Group dwarfs, demonstrating how this approach allows us to probe the high-z UVLF much fainter than HST/JWST limits.

Write for Astrobites!

Astrobites is an astro-ph reader's digest run entirely by graduate students. We publish daily summaries of new astronomy papers in a manner accessible to undergrads and early grad students. Learn more at `astrobites.org`!

`pjgandhi@ucdavis.edu`
UC Davis

Roman Gerasimov, San Diego, he/his

Bio

Amateur astronomer most of his life, Roman's professional career began with Jupiter magnetosphere monitoring at *University College London Observatory*. Today he constructs computer models of stars for *Cool Star Lab* at UCSD. Roman's research interests also include population III stars, microwave mapping of interstellar dust, astrophysical searches for quantum gravity and history of astronomy.

Subfield

Stellar astrophysics, brown dwarfs, globular clusters, theory

Contac info

- SERF 319
- github.com/Roman-UCSD

Abstract

The coeval members of globular clusters serve as stellar astrophysics laboratories, as otherwise inaccessible parameters such as age and composition are often restricted within the cluster and may be inferred from its colour-magnitude diagrams. Until recently, the typically large distances to globular clusters confined such studies to their most massive members. Now, the promise of highly sensitive ground- and space-based facilities will extend the reach of these studies into the substellar regime. Roman uses state-of-the-art modelling framework `PHOENIX` to predict colours and magnitudes of brown dwarfs in nearby globular clusters ahead of their first anticipated detections with *JWST*, *TMT* and *GMT*.

romang@ucsd.edu
UC San Diego

Brown dwarfs in ω Centauri

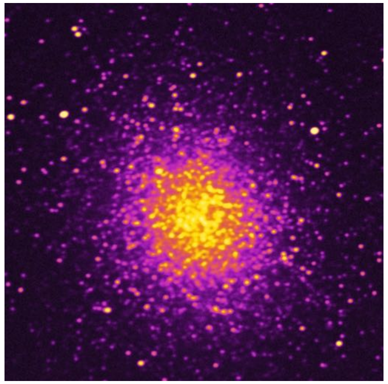


Figure 1: Globular cluster ω Centauri, photographed by J Wiley and R Gerasimov on 04/10/2021 from *Rachel, NV*.

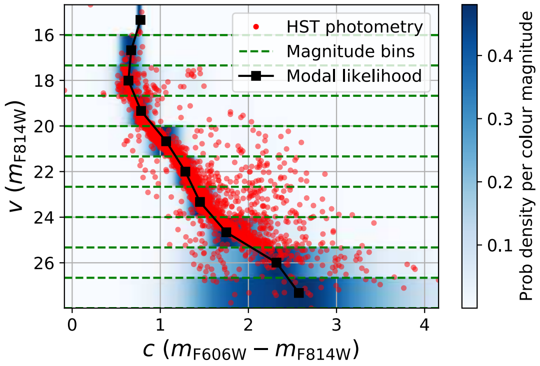


Figure 2: Optical photometry of ω Centauri with *HST/ACS/WFC*. The magnitude space is divided into ten bins with the modal point and inferred scatter in data within each bin shown.

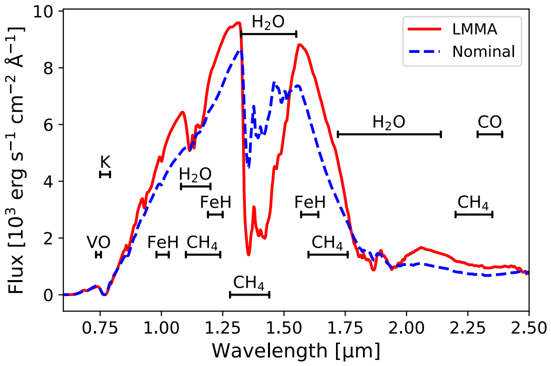


Figure 3: Synthetic spectra of selected model atmospheres. Shown here are the $T_{\mathrm{eff}} = 1200$, $\log(g) = 5.0$ atmospheres for the nominal and α-enhanced abundances of ω Centauri (LMMA).

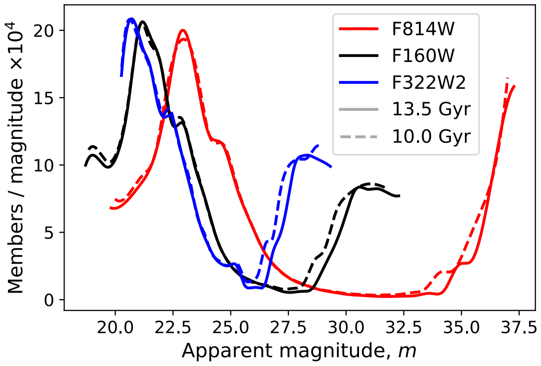


Figure 4: Predicted luminosity function for *HST* F814W and F160W bands and *JWST* F322W2 band. The two peaks correspond to the Main Sequence and brown dwarfs in the cluster.

Introduction

Ω Centauri is the largest ($4 \times 10^6\ \mathrm{M}_\odot$, 10^7 stars) known globular cluster. Variation in abundances among its members is restricted due to the coeval nature of the population, allowing inference of characteristics for the faintest members based on their bright counterparts with high-quality measurements. As opposed to stars, brown dwarfs (BDs) never achieve energy equilibrium, remaining on the cooling curve their entire lifespans. As such, the placement of BDs in the colour-magnitude space is highly dependent on the age of the cluster. In this study, we use *HST* photometry of bright ω Centauri members to determine the chemical composition of BDs in the cluster and predict their colour-magnitude diagram to inform future observations with *JWST*.

Method

We use the state-of-the-art modelling framework `PHOENIX` to calculate new model atmospheres for BDs that include critical low-temperature effects such as precipitation of clouds, molecular absorption and non-Local Thermodynamic Equilibrium (Fig. 3). The evolutionary code `MESA` is coupled with those models to produce synthetic isochrones and luminosity functions (LFs) for bright ω Centauri members as functions of chemical composition and age. Those are in turn fit onto the available *HST* photometry (Fig. 2). The best-fit isochrone and LF are extended into the substellar regime to predict expected brown dwarf counts in the cluster that may be observed with future photometric surveys such as *JWST* (Fig. 4).

romang@ucsd.edu
UC San Diego

Rezaee, Saeed

Bio

My name is Saeed! I am a PhD candidate at UCR/Astronomy department. I work in the Prof. Reddy group.

Subfield

Galaxy evolution, ISM: Dust extinction. Star-formation at high-redshift galaxies.

Contac info

- Linkedin Profile
- Google Scholar

Abstract

Finding a probe to trace stochastic star-formation history at high redshift galaxies is the subject of my most recent research. I am going to present about this topic at the upcoming conference. I also research on quantifying the effect of ISM dust extinction/attenuation. I am also interested in Deepsky and Landscape Astro-photography and I plan to take photos at Quaking Aspen Campground.

Contact:

`sreza003@ucr.edu`
UC Riverside

CAN Hα TO UV LUMINOSITY RATIO PROBE BURSTINESS OF HIGH REDSHIFT GLAXIES?

Saeed Rezaee, UCR
sreza003@ucr.edu

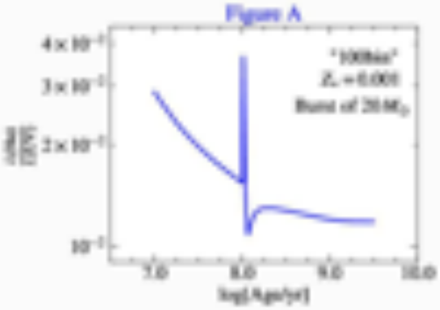
Abstract

We use the MOSDEF survey to probe the utility of the globally measured dust-corrected Hα to UV luminosity ratio ($L(H\alpha)/L(UV)$) in tracing stochastic star-formation history (SFH) and/or variation in the high-end mass of the IMF. Firstly, by employing 3D/HST photometry of 310 galaxies, we analyze the distribution of star-formation rate surface density (Σ_{SFR}) versus $L(H\alpha)/L(UV)$ ratio by using a morphology metric called Patchiness. we also use far-ultraviolet LRIS spectra of 160 galaxies to construct composite spectra in bins of $L(H\alpha)/L(UV)$. We use the composites to measure the strength of the stellar features associated with young massive stars ([CIV] $\lambda\lambda$1548, 1550, [SiIV] $\lambda\lambda$1393, 1403 and [He II] λ1640) and study their correlations with the average $L(H\alpha)/L(UV)$ of galaxies contributing to each composite. Despite the fact that several studies have shown that $L(H\alpha)/L(UV)$ may be a strong indicator of stochastic SFH for local galaxies, our results do not support this assumption for high-redshift galaxies. We believe that the utility of $L(H\alpha)/L(UV)$ in high-redshift is restricted due to considerable uncertainty caused by dust extinction and aperture mismatch. (We did not include the second part of this analysis in this poster due to limited time available for the presentation.)

Effect of a burst on $L(H\alpha)/L(UV)$ Values

We use the Binary Population and Spectra Synthesis (BPASS) version2.2.1 models (Eldridge et al. 2017, Stanway E. R. et al. 2018) to predict the effect of a burst of star-formation on a galaxy with constant SFR. These models include the effect of binary stellar evolution. A Chabier (2003) IMF with an upper mass-cutoff of $100M_\odot$, and a stellar metallicity of $Z_* = 0.001$ are assumed for this model.

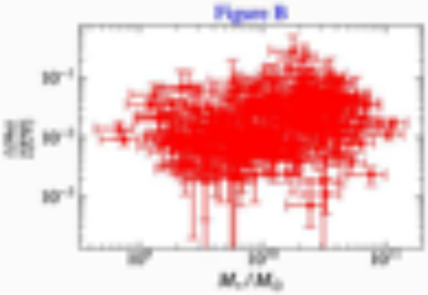
Figure A



Why is $L(H\alpha)/L(UV)$ being used to probe burstiness?

Hα nebular recombination line and UV continuum trace star-formation activities within different time scales. The former arises in the ionized gas around massive stars with short main-sequence lifetimes of ~ 10 Myr, while the latter originates by O and B-type stars with lifetimes of ~ 100 Myr. Therefore, variation in the observed $L(H\alpha)/L(UV)$ of a galaxy may be an indication of star-formation activities within the ranges mentioned above. To illustrate the effect of a burst of star-formation on $L(H\alpha)/L(UV)$ ratio, as shown by Figure A, we use a SED model of a single galaxy with constant SFR of $1M_\odot$ and add a burst with the strength of $20M_\odot$. At the time when burst occurs $L(H\alpha)$ increase and cause an overall increase of $L(H\alpha)/L(UV)$, while immediately after the burst, $L(H\alpha)/L(UV)$ decreases due to $L(H\alpha)$ falling much faster than the UV continuum luminosity. The distribution of $L(H\alpha)/L(UV)$ of galaxies in our sample (Figure B), there are galaxies with very low $L(H\alpha)/L(UV)$. We study if those galaxies are undergoing post-burst phase to exhibit such low values of Hα to UV ratio.

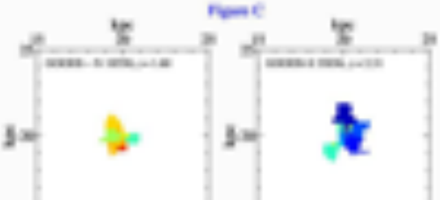
Figure B



Resolved Photometry

Using Voronoi binning technique by Fetherolf et al. 2020, and Cappellari & Copin (2003), we group the pixels to build sub-images within the individual images of galaxies. We calculate Σ_{SFR} for each Voronoi bin using resolved SED modeling. Figure C shows two examples of Σ_{SFR} maps constructed for two galaxies in 3D/HST survey. Distinct parts of a galaxy display different Σ_{SFR}, as seen in the diagram below.

Figure C



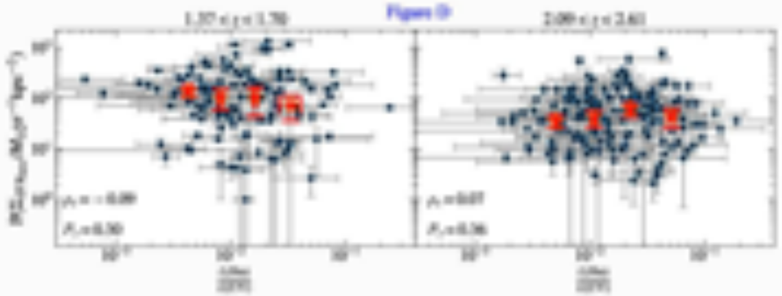
Patchiness

Patchiness is a morphology metric newly defined by Fetherolf et al. 2021b, in prep. Patchiness measures the Gaussian probability that each independent component of a distribution be equal to the weighted average of the distribution and is defined as:

$$P(X) = -\ln\left\{\left[\prod_{i=1}^{N}\frac{1}{\sqrt{2\pi}\sigma_i}\exp\left[-\frac{(X_i-\langle X\rangle)^2}{2\sigma_i^2}\right]\right]\right\}, \tag{1}$$

Where X_i are the values of the parameter X measured for individual Voronoi bins along with their uncertainties shown as σ_i. $\langle X\rangle$ is the weighted average of the same measured values. Figure D shows Patchiness of star-formation rate surface density vs. $L(H\alpha)/L(UV)$. We found no-correlation between the above-mentioned parameters.

Figure D



Sarah Steiger, Santa Barbara, she/her

Bio

I am a fifth year graduate student at UCSB working with Ben Mazin on instrumentation for exoplanet direct imaging. Outside of lab I love dancing, hiking, lounging with my cats, and, more recently, running a role playing game I recently started with a group of my friends!

Subfield

Exoplanets (High-Contrast Imaging)

Contact info

- Twitter: @SarahSteigs

Abstract

The main challenge of high contrast imaging from the ground is removing diffracted light from a host star to image close-by planetary companions that can easily be a millions to billions of times fainter than the host star itself. This diffracted light can have many causes, but light caused by instrument imperfections is particularly challenging to remove and can manifest as point spread function sized spots in an image. These spots can easily masquerade as planetary companions and present a the limit for current achievable contrasts. In my group, we work on a novel type of detector technology called Microwave Kinetic Inductance Detectors (MKIDs) which are superconducting, photon counting detectors that have the ability to measure the arrival time (to within a microsecond) and energy (R~5) of every photon incident on the array with no read noise or dark current. The timing and energy information we get from these detectors allows us to perform real-time and post processing techniques to correct for these instrumental effects and lower achievable contrasts. My research in particular focuses on the development of the MKID Data Reduction and Analysis Pipeline to generate science quality images from MKID camera data. I also perform observations/analysis with our instrument behind SCExAO at the Subaru Telescope, the MKID Exoplanet Camera (MEC).

`steiger@physics.ucsb.edu`

UC Santa Barbara

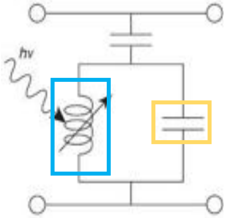
High Contrast Imaging with SCExAO and MEC

S. Steiger, A. B. Walter, N. Fruitwala, J. I. Bailey, III, N. Zobrist, N. Swimmer, I. Lipartito, J. P. Smith, O. Guyon, J. Lozi, C. Bockstiegel, S. R. Meeker, G. Coiffard, R. Dodkins, P. Szypryt, K. K. Davis, M. Daal, B. Bumble, S. Vievard, A. Sahoo, V. Deo, N. Jovanovic, F. Martinache, T. Currie, T. D. Brandt, and B. A. Mazin

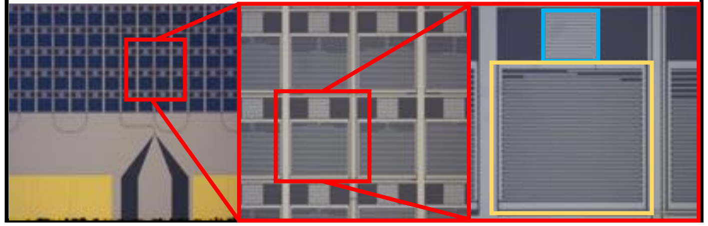
Mazin Lab
All of the wavelengths
All of the times
mazinlab.org

MKIDs

Each Microwave Kinetic Inductance Detector (MKID) pixel is a superconducting LC resonant circuit. When a photon hits the superconducting inductor, Cooper pairs are broken in the material, changing the inductance. This causes an analogous change in the resonant frequency of the circuit that we can measure to determine the arrival time and energy of each incident photon with no read noise or dark current.

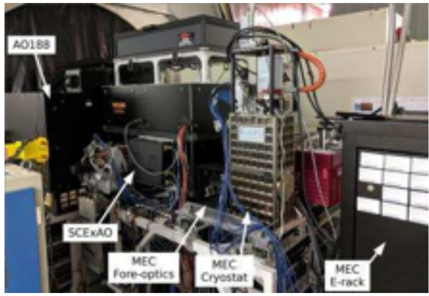


Below: Zoom out of an MKID array. Right: MKID equivalent circuit with the inductor labeled in blue and the capacitor labeled in yellow – colors show the equivalent parts on the actual MKID pixel



SCExAO/MEC

The MKID Exoplanet Camera (MEC) [1] is a Y-J band IFU located behind SCExAO (right). The key features of MEC, enabled by its Microwave Kinetic Inductance Detector array, include:



- Inherent energy resolution without the use of filters or gratings (R ~ 5)
- Microsecond timing resolution

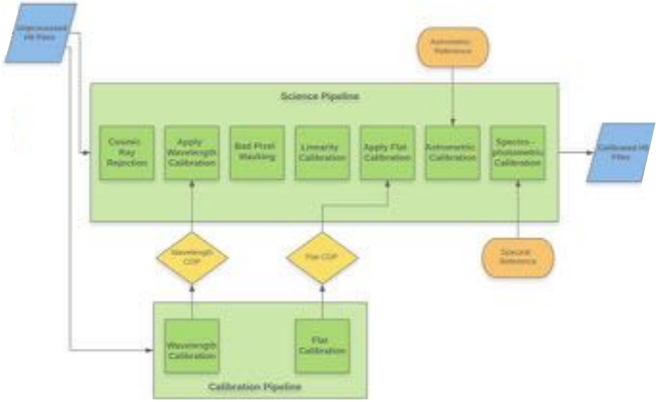
The MKID Pipeline[1]

Going from raw MKID binary files to calibrated science images requires a dedicated custom calibration and analysis pipeline.

The MKID Pipeline is open source and designed with an easy-to-use command line interface and yaml configuration system. Once MEC is commissioned, the goal of the pipeline is for other users to be able to apply for, and easily analyze, MKID data for their own science!

Notable steps include:

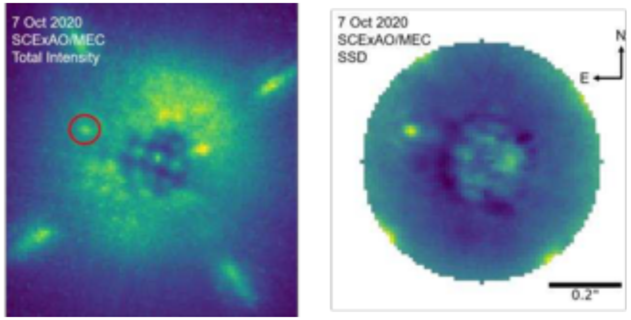
- Wavelength Calibration (to convert Δ f -> energy)
- Flat-fielding
- Hot Pixel Masking
- Flux Calibration



References

1. Walter, A. B., Fruitwala, N., Steiger, S., et al. 2020, PASP, 132, 125005, doi: 10.1088/1538-3873/abc60f
2. Steiger et. al. 2021, The Astronomical Journal, Volume 162, Issue 2, id.44, 11 pp, doi: 10.3847/1538-3881/ac02cc

Stochastic Speckle Discrimination with MEC[2]



Stochastic Speckle Discrimination (SSD) is a post processing technique that uses photon arrival time statistics to distinguish companions from a comparably bright speckle field (above). It is implemented in the following way:

1.) The total observation is broken up into a series of short (20ms) exposure images

2.) A modified Rician (Equation 1) is fit for each pixel and Ic and Is are determined

3.) The ratio of Ic/Is is used as a diagnostic tool to distinguish between speckles and companions

$$\rho_{MR}(I) = \frac{1}{I_S} exp\left(-\frac{I+I_C}{I_S}\right) I_0\left(\frac{2\sqrt{II_C}}{I_S}\right) \quad (1)$$

SSD, using no PSF subtraction techniques and relying solely on photon arrival time statistics, achieves a comparable SNR to the IFU CHARIS which utilized Reference Differential Imaging

Shawn Knabel, Los Angeles, he/him

Bio

I am 29 years old and from Louisville, KY, where I began my career with a Bachelor of Music from the University of Louisville specializing in jazz guitar performance. I worked as a musician for several years and spent some time living in Brasilia, Brazil, before deciding to return to school for physics. I received my BS from U. Louisville and came to UCLA this summer to begin grad school. I play soccer, play video and board games, and am learning to surf. Loving California so far!

Subfield

Gravitational lensing, cosmology, extragalactic astronomy, galaxy evolution.

Contac info

- Phone: 502-407-9364
- Instagram: Shawn Knabel

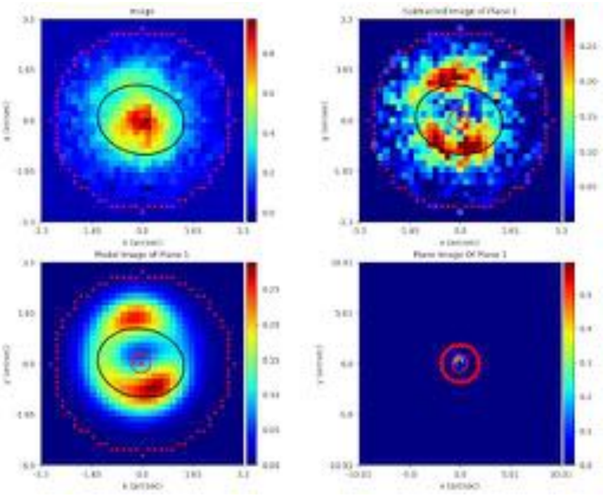
Abstract

Strong gravitational lensing reveals total mass content in the inner regions of large galaxies that includes both the stellar and dark components. I have taken lens candidates identified by other teams via machine learning in the Kilo Degree Survey (KiDS) and selected those with high-probability second-redshift solutions in the spectroscopic Galaxy and Mass Assembly (GAMA) survey. These are likely the redshifts of the lensed source, which is an essential ingredient for constraining models of the lensing system. I construct lens models using a python suite called PyAutolens that conducts non-linear searches of parameter space to maximize Bayesian evidence of the model's fit to the KiDS observed image. GAMA's high completeness (~98%) and detailed environment measures allow us to view these measurements of the stellar and dark matter components of each lens galaxy in the context of its position relative to other galaxies.

shawnknabel@astro.ucla.edu
UC Los Angeles

KiDS Strong Lenses - Mass Content and Environment

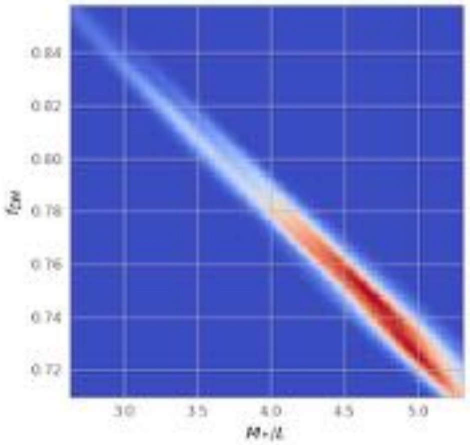
Lens Model Fit



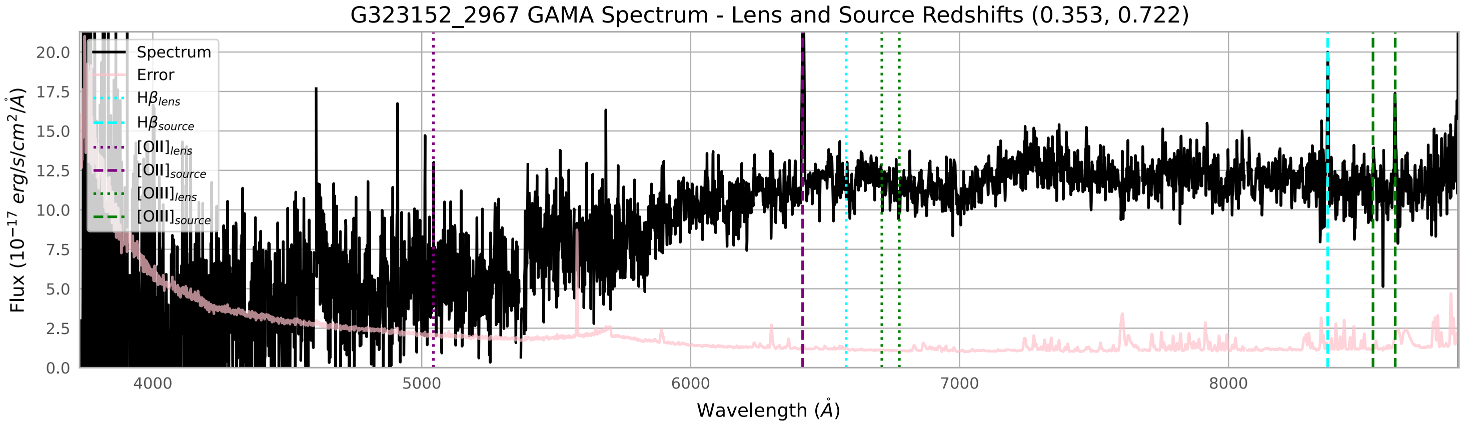
G323152-2967

Results from one example model. The left figure shows the KiDS image, the image with lens light subtracted, the model source-light image, and the source position. Right shows the degeneracy between dark matter fraction and M_*/L by Bayesian probability. Below is the GAMA spectrum, showing strong emission lines at higher redshift than the primary continuum/emission line fit.

Dark Matter Fraction & M_*/L



Spectrum



shawnknabel@astro.ucla.edu
UC Los Angeles

Vidya Venkatesan, Irvine, she/her

Bio

Hey! I am Vidya Venkatesan, a second-year graduate student, working with Professor Aomawa L. Shields at the University of California, Irvine. In my research, I explore the effect of the interaction between the host star spectrum and planetary surface composition on the climate stability of exoplanets using climate models. Besides research, I also love outreach, basketball, scuba diving, traveling, and reading.

Subfield

Exoplanets, Climate modeling, M-dwarf habitability.

Contac info

- Social media: twitter- astrovidee

Abstract

A planet's frozen surface can have a dramatic effect on its climatic evolution. On eccentric planets, which spend a significant portion of their orbits at large distances from their host stars, temperatures may reach levels low enough for the condensation of atmospheric species, leading to a variety of possible frozen surface compositions, many of which exist on planetary bodies within our own Solar System. Given the wavelength-dependent albedos of these exotic ices, their radiative effects on the climatic evolution of planets orbiting stars with different spectral energy distributions (SEDs) may vary widely. Here we quantify the effects of surface carbon dioxide ice on the climate hysteresis of planets orbiting stars of different spectral types, using a 1-D energy balance climate model. Assuming fixed (Earth-like) atmospheric gas concentrations, a 1-bar surface pressure, and CO_2 ice grain sizes of 2-2000 μm, we quantify the range of instellations over which atmospheric CO_2 might be expected to condense on planets with thin atmospheres orbiting stars of different spectral types. We find marked differences in the instellation values required to reach CO_2 condensation temperatures and to thaw out of global ice cover on planets orbiting stars of different spectral types. The trend of a smaller climate hysteresis on M-dwarf planets compared to planets orbiting stars with more visible and near-UV output holds when an albedo parameterization for CO_2 surface ice is incorporated into our model. This work is the first of its kind to incorporate the wavelength-dependent albedo effects of atmospheric CO_2 condensation onto the surfaces of cold planets orbiting stars with different SEDs.

`vidyav1@uci.edu`
UC Irvine

The Radiative Effects of Carbon dioxide Ice on the Climate Stability of Extrasolar Planets

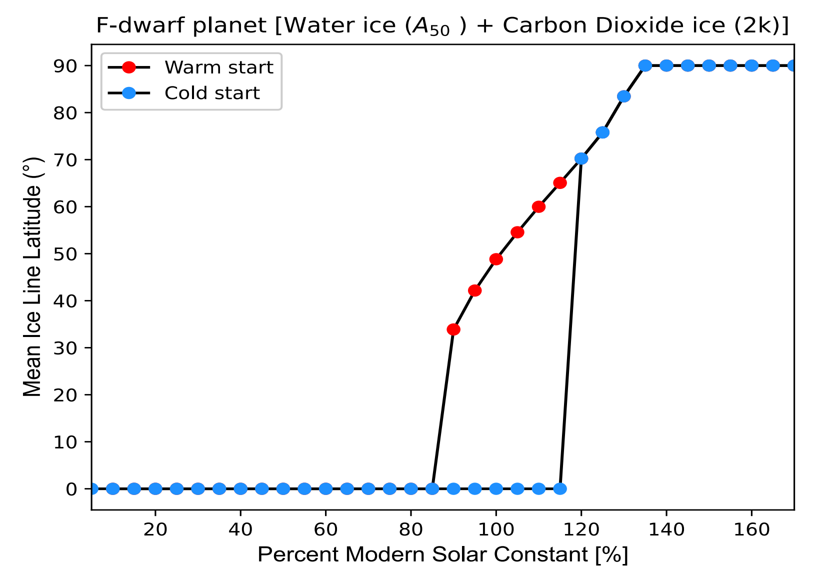
Eccentric planets may harbor surface ices

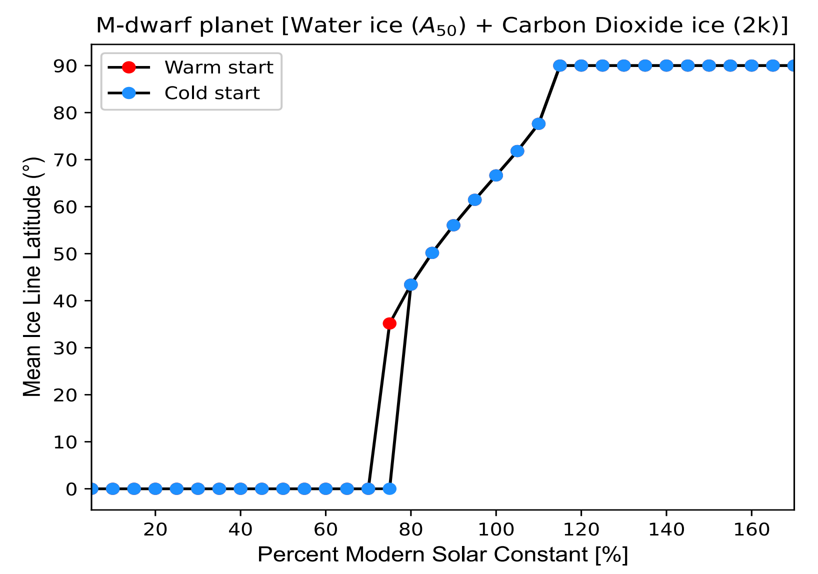
Many eccentric planets spend a significant amount of their orbits at vast distances from their host stars, where they are susceptible to the condensation of atmospheric species out onto the surface. Such species may include carbon dioxide ice as well as water ice. M-dwarf stars emit their peak radiation at longer wavelengths, and carbon dioxide ice is very reflective at these wavelengths. The interaction between the spectral energy distribution of M-dwarf stars and CO_2 ice on the surfaces of orbiting planets may therefore be significant.

Our approach

We modified a 1-D energy balance climate model (EBM) (North and Coakley 1979), with previously calculated broadband planetary albedos assuming ocean and water ice surfaces (Shields et al. 2013) to incorporate an albedo parameterization for the formation of CO_2 ice on the surfaces of planets receiving low amounts of instellation from F-, G-, K-, and M-dwarf stars. We then identified the level of instellation required for entrance into and exit out of globally ice-covered conditions as a function of host star spectral type.

F-dwarf planets require 35% more flux to thaw out of global ice cover than M-dwarf planets





vidyav1@uci.edu
UC Irvine

Wei-Xiang Feng, Riverside, he/him

Bio

I am interested in all topics related to gravity and cosmology, including dark matter halos, theory beyond general relativity, and applications to high energy astrophysical phenomena, etc. Recently, I am working on the origin of high redshift quasars or supermassive black holes.

Subfield

Supermassive black holes, gravity, dark matter, cosmology.

Contac info

- Research Gate: Wei-Xiang-Feng
- Linkein: wxfeng

Abstract

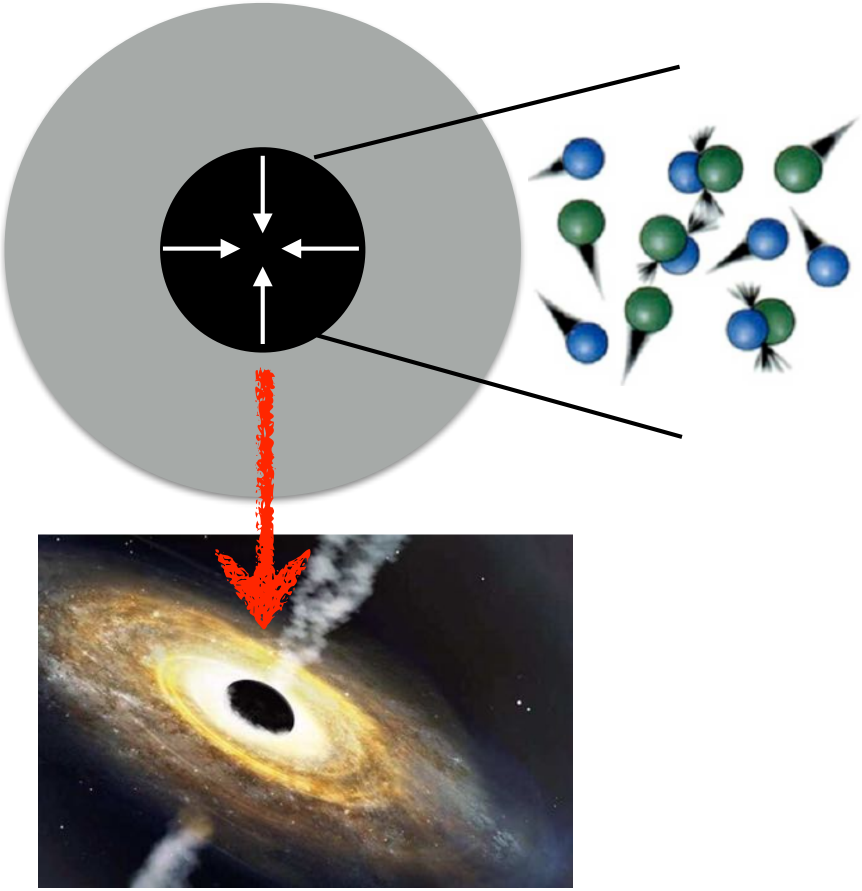
Observations show that supermassive black holes (SMBHs) with a mass of $\sim 10^9 M_\odot$ exist when the Universe is just 6% of its current age. We propose a scenario where a self-interacting dark matter halo experiences gravothermal instability and its central region collapses into a seed black hole. The presence of baryons in protogalaxies could significantly accelerate the gravothermal evolution of the halo and shorten collapse timescales. The central halo could dissipate its angular momentum remnant via viscosity induced by the self-interactions. The host halo must be on high tails of density fluctuations, implying that high-z SMBHs are expected to be rare in this scenario. We further derive conditions for triggering general relativistic instability of the collapsed region. Our results indicate that self-interacting dark matter can provide a unified explanation for diverse dark matter distributions in galaxies today and the origin of SMBHs at redshifts $z \sim 6$–7.

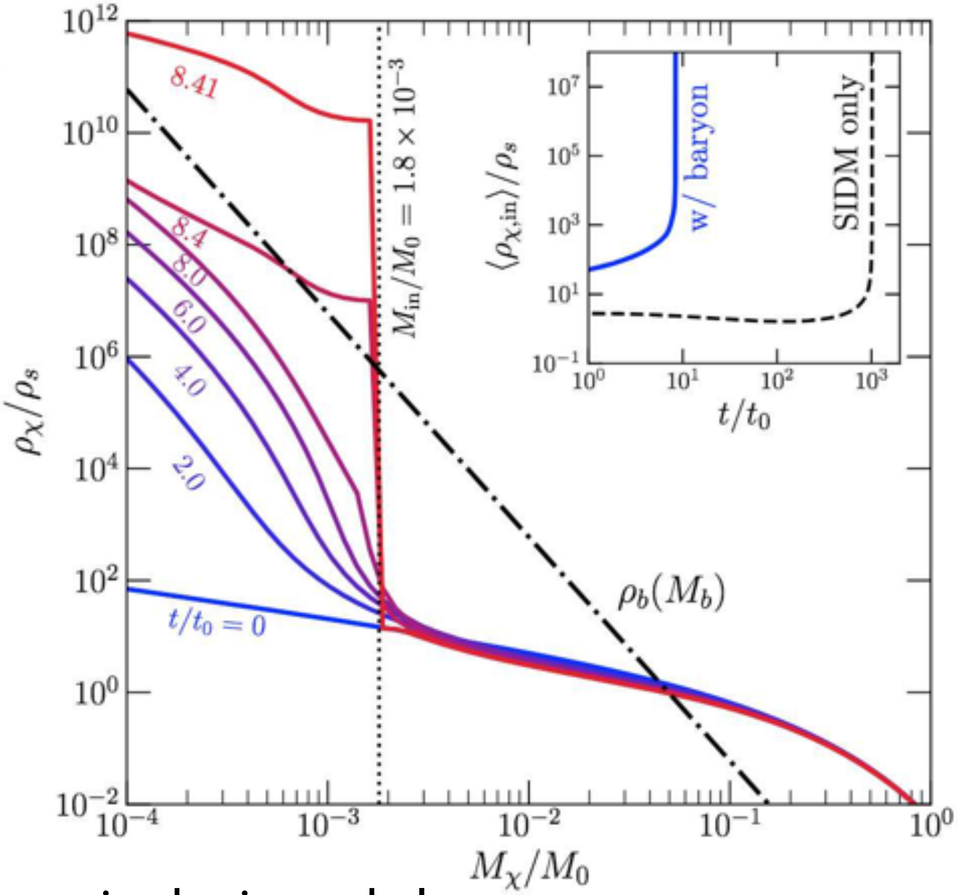
`wfeng016@ucr.edu`
UC Riverside

Seeding SMBHs with Self-Interacting Dark Matter

Wei-Xiang Feng, University of California, Riverside

Reference: Feng, Yu, Zhong (2010.15132)
Astrophys. J. Lett. **914** (2) L26





- Dark matter self-interactions transport heat in the inner halo
- The central halo can experience gravothermal collapse, resulting in a massive seed black hole
- The self-interactions lead to viscosity that dissipates the angular momentum remnant
- The presence of baryons in protogalaxies can significantly speed up the onset of the collapse
- It may explain ~10^9 $M_\odot$ SMBHs at redshift z~7 with a low accretion efficiency of f~0.1

William (Will) Schultz, Santa Barbara, he/him

Bio

I am entering my 5th year as a graduate student at UCSB studying stellar astrophysics. In particular, I am interested in the envelopes of massive stars ($M \gtrsim 20\, M_\odot$) across the main sequence and Hertzsprung Gap where turbulence can dominate the dynamics. I am also interested in applying machine learning algorithms/neural networks to solve astrophysical problems.

When I'm not in the office, you can find me hiking or trail running, backpacking, cycling, cooking, baking bread, or brewing beer.

Subfield

Stellar astrophysics, Massive star evolution and structure, 3D hydrodynamic simulations, machine learning/neural networks

Contact Info

- ▶ Web: (Under development)

Abstract

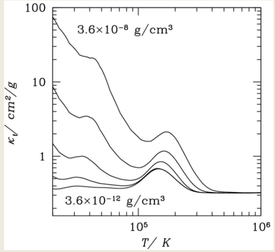
The advent of recent 3D radiation hydrodynamic (RHD) simulations have revolutionized our ability to model and understand massive stars and particularly their envelopes. They shed new light on convective, turbulent dynamics in near-Eddington limited regimes and could significantly improve 1D stellar evolution models, which currently utilize clever workarounds that lack physical backing in these regions. Additionally, recent models reveal surface turbulence, excited by opacity peaks, produce Stochastic Low-Frequency Variability (SLFV), matching TESS observations. Novel red supergiant models simulate the non-spherical geometry of the surface plumes and reveal novel correlations within the large convective envelopes.

wcschultz@ucsb.edu
UC Santa Barbara

Turbulent Convection in 3D RHD Simulations of Massive Star Envelopes

Opacity Peaks

- As T decrease near the surface, ions (particularly Fe, He, and H) become partially ionized increasing κ significantly.
- Increases in κ cause the local Eddington ratio to approach unity leading to turbulent convection



(Jiang et al. 2015)

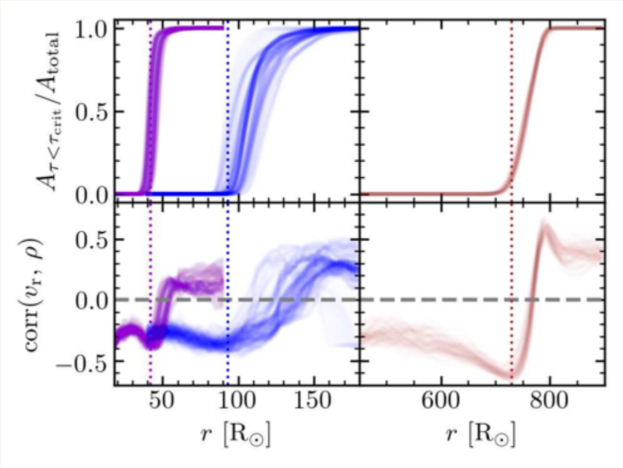
“Inefficient” Convection

- Convective efficiency parameter $\gamma \sim F_c/F_r \sim (P_{gas} + P_r)v_c\tau/P_r c$
- $\gamma < 1$, radiation can leak from plumes, defining a critical optical depth

$$\boxed{\tau_{crit} \sim \frac{c\,P_r}{v_c\,(P_{gas} + P_r)}}$$

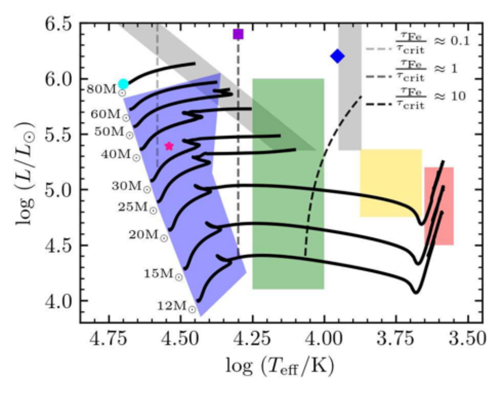
- In stars with $P_{gas} \gg P_r$, $\tau_{crit} \lesssim 10$
- In more massive and redder stars, $\tau_{crit} \gtrsim 1000$

Velocity Correlations



Purple, blue, and red correspond to an 80 $M_\odot$ model near the S-Dor instability strip, a 56 $M_\odot$ model near LBV outburst, and a 16 $M_\odot$ red supergiant respectively. (colors match HR diagram)

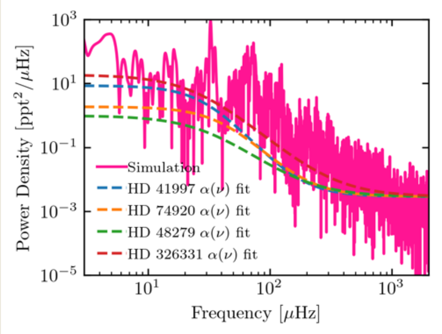
HR Diagram



Some 3D Insight to Improve 1D Models

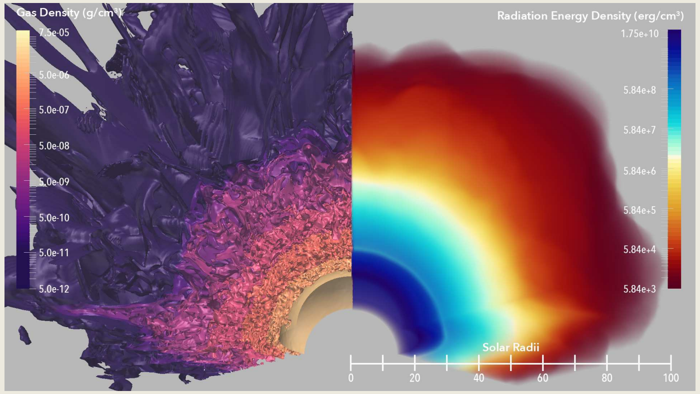
- The strong negative correlation between F_r and ρ leads to less radiation pressure support in optically thick regions as $\nabla P_r = \frac{-1}{c} F_r \kappa \rho$ (see Schultz, Bildsten, Jiang 2020)
- Turbulent pressure, $P_{turb} \approx \frac{1}{2}\rho v_c^2$, dominates support near the surface of most massive stars, inflating them and counteracting the decrease of ∇P_r

Stochastic Low-Frequency Variability



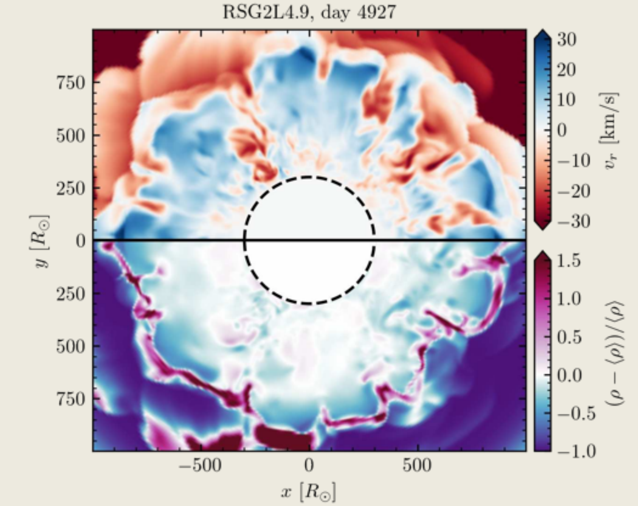
Excess low-frequency power in the temporal power spectra of the light curve from a 35 $M_\odot$ main sequence star model agrees with those from similar stars observed with TESS. Previously, internal gravity waves or wind effects were the only accepted origin.

3D Blue Supergiant Model



ρ and T structure of an 80 $M_\odot$ star between the S-Dor instability strip and the LBV outburst phase. The density is structured with large contrasts, while the temperature is smooth as the radiation pressure dominantes the pressure support, fixing T.
(fig from Jiang et al 2018)

3D RHD Red Supergiant Model



Overdensity and v_r structure of a 16 $M_\odot$ red supergiant. Only several plumes cover the surface compared to bluer models with hundreds of plumes, however the change in correlation is still present. Figure courtesy of Jared Goldberg.

Will Schultz (in collaboration with Prof. Lars Bildsten, Dr. Yan-Fei Jiang, and Jared Goldberg
`wcschultz@ucsb.com`
UC Santa Barbara

Alexandra Mannings, Santa Cruz, she/her

Bio

Hi! My name is Alexandra, and I'm a 3rd year grad at Santa Cruz. I am originally from Georgia, but I have family all over the place these days. This is my first time camping, so I'm very excited to attend the conference this year. I currently am exploring two fields: spectroscopic instrumentation (exo-planet science) and FRB science and follow-up.

Subfield

Transients, High-energy, Fast Radio Bursts, HST

Contact info

- email: almannin@ucsc.edu

Abstract

Fast Radio Bursts are quick pulses of radio emission, first detected in high time resolution pulsar data. The high dispersion measure of the bursts implied that they were coming from outside of the Milky Way. The first FRB to be precisely localized (sub-arcsecond precision) confirmed the extra-galactic origin of these luminous events. To this day 10s of FRBs have high-precision localizations, allowing for studies of host galaxies and local environments of the bursts. The recent work I led presented the first HST survey of FRB host galaxies, where we were able to take a closer look at the FRB local environments and host characteristics.

Courtney Klein, Irvine, she/her

Bio

I am currently an incoming 3rd year physics grad student focusing on galaxy evolution in cosmological simulations. I am from the Seattle area, so living in Irvine is like being on vacation, and I have gladly embraced the daily sunshine and beach. Outside of research and school things, I try to always find myself outside doing something active. For leisure I hike, surf, climb, and play volleyball, and for a more competitive side I do triathlon which takes a bit of swimming, biking, and running.

Subfield

Galaxy Evolution, Galaxy Interactions, Mock Observations.

Contact info

- Website: courtk32.github.io
- Twitter: @astro_klein

Abstract

The ability to connect simulations and observation enables us to better utilize the information learned from each individually. I am currently making mock observations of galaxies from FIRE Cosmological simulations which we are comparing to observed surface brightness profiles of galaxies. The goal is identify why some observed galaxies appear to be under represented in simulations. As we grow larger volume simulations we have been able to detect some of these more scarce galaxies.

Dylan Benton, UC Merced (he/him)

Biography

I am a 2^{nd} year graduate student at UC Merced working with Dr. Sarah Loebman using cosmological simulations to explore the warping of gases and stars in the disk of milky way-like galaxies.

I grew up in Sacramento, CA, did my undergrad at Cal Poly SLO, and I went on to earn a teaching credential and teach high school Calculus and Physics for a few years before returning to continue my studies at UC Merced.

I currently live in Merced outside of my studies you can find me playing games, working out, or just investigating whatever I find interesting.

Subfield

-Cosmological simulations
-Warp analysis of galactic disk stars and gas

Contact info

- ► Website: dbenton0423.github.io/
- ► Email: dbenton@ucmerced.edu

dbenton@ucmerced.edu
UC Merced

Felipe Ardila, Santa Cruz, he/him

Bio

I am a former grad student at UC Santa Cruz. I recently left astronomy with plans to transition into data science. Previously, my research focused on studying very massive galaxies in clusters to learn about cosmology and galaxy evolution.

I am originally from Colombia, and grew up in Miami. I finished my undergrad at the University of Florida and then spent 2 years as post-baccalaureate at Princeton University. I like to spend time outside to enjoy nature, and sometimes plan camping trips. I have been helping to organize the Sierra Conference since 2018. I like the idea of purposeful gatherings and meeting new people. I am also into bird watching, rock climbing, and data visualization.

Subfield

Data Science, Data Visualization, Extragalactic, Cosmology, Galaxy Evolution

Contact info

- ▶ f-ardila.github.io
- ▶ LinkedIn: felipe-ardila

`fardila@ucsc.edu`
UC Santa Cruz

Jack Lubin, Irvine, he/him

Bio

Beginning my 4th year at UCI, I originally come from the east coast but have been loving the California living! When I'm not searching for exoplanets, I'm watching NY Yankee baseball, playing golf, reading sci-fi, or biking to the beach. As for research, I participate in the TESS-Keck Survey (TKS), which is a collaboration across the UCs, Caltech, and UHawaii to measure the masses of 100 planets first discovered to be transiting by the currently ongoing TESS mission. I am also interested in coming up with new strategies to identify and characterize stellar activity signals in RV time series.

Subfield

Exoplanet discovery and characterization

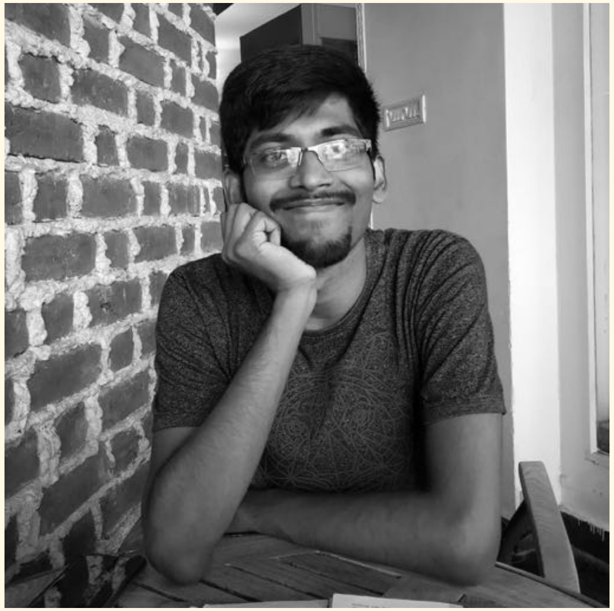
Contact info

- Web: jluby127.github.io/
- Social media: @LubysLemmas

Abstract

We're entering new era in exoplanet discovery: a new generation of extreme precision spectrographs have just been coming online with more on the way. Now we can probe signals on the order of what we expect to get from an earth-twin, that is an earth mass planet orbiting a sun-like star in at 1 AU. But stellar activity is now the biggest hindrance to finding these planets. These stellar activity signals can mask true planet signals or masquerade as planets themselves. We need new tools and techniques to better distinguish between persistent planetary signals and quasi-periodic, varying amplitude stellar activity signals.

Prayaag R. Katta, Davis, he/him



Bio

I'm a second year student, and have just started getting into the research game (so any tips are appreciated xD)
I like anime, gaming and am excited to hear about all the new physics here!

Subfield

Cosmology, Dark Matter

Contact info

- Twitter: @kattastrophyz

Abstract

Currently working on reducing OSIRIS data and getting pretty pictures from it. I'm also working on getting an accurate noise map of the data

`prkatta@ucdavis.edu`
UC Davis