# Welcome! We are glad you are here

# Wifi

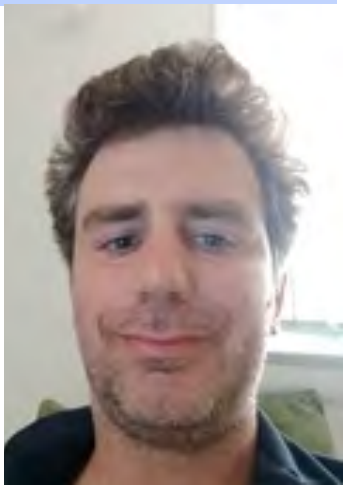
- **eduroam – preferred**
- **UK-guest network**

- **Your must allow network to set your DNS for this to work**

# Helpful locals

Gary

Maryam



Fran

Priyanka

Marios

Arnab

# Group projects

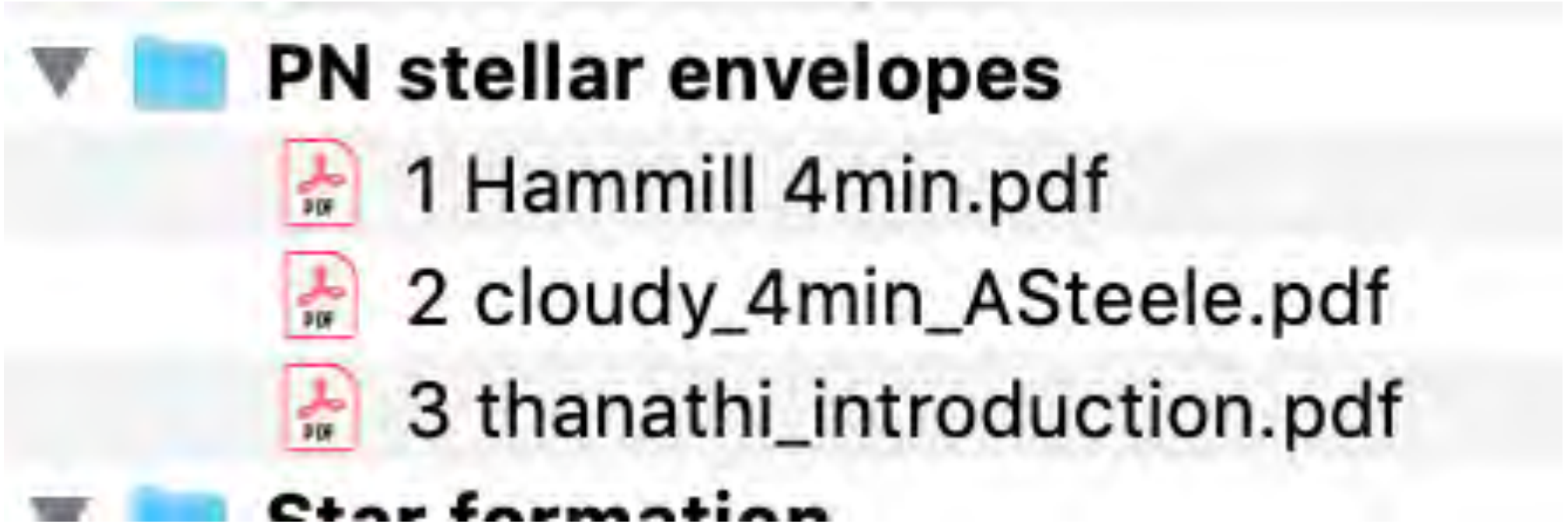
- Break up into small groups of like-minded participants
- Define a research problem you will do using Cloudy
- The project/group must have a memorable name (needed to get grants or telescope time)
- Give brief presentations of the projects at the end of each day
- (See projects from old workshops)

# Some rules

- **Rule 1: There are no rules**
- **Rule 2: Research is what you are doing when you don’t know what you are doing**
- **Rule 3: You can switch groups if you like, or form a new group with other participants**
- **Rule 4: We end each day for a summary of the group’s progress and problems**

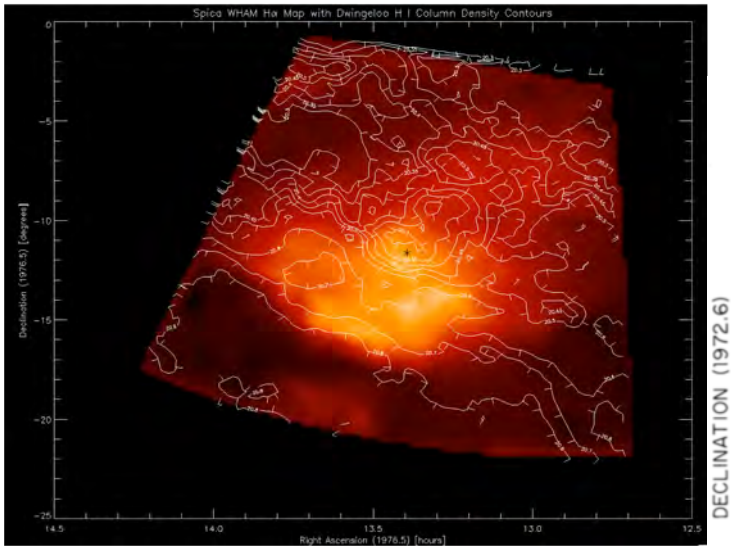
# Talks by topics (more or less)

- PN stellar envelopes
- Star formation
- Starburst
- Cluster Physics
- AGN


PN stellar envelopes
1 Hammill 4min.pdf
2 cloudy_4min_ASteele.pdf
3 thanathi_introduction.pdf

Joey Hammill

# Modelling the α Virginis (Spica) HII Region to Constrain Model Atmospheres

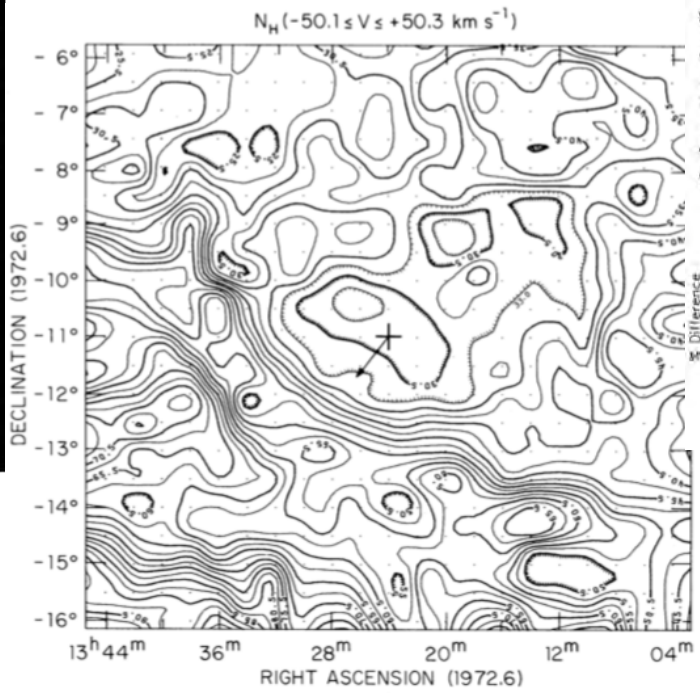


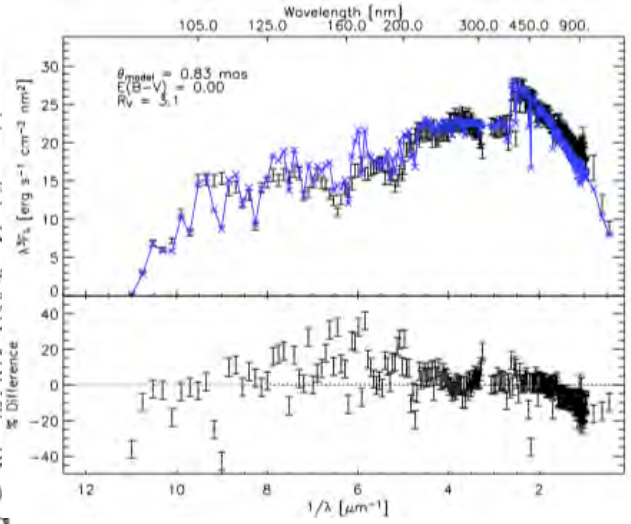

*Left*: Hα emission around Spica, at star, from WHAM data (Haffner et al., 2003) with updated Dwingeloo neutral hydrogen density map

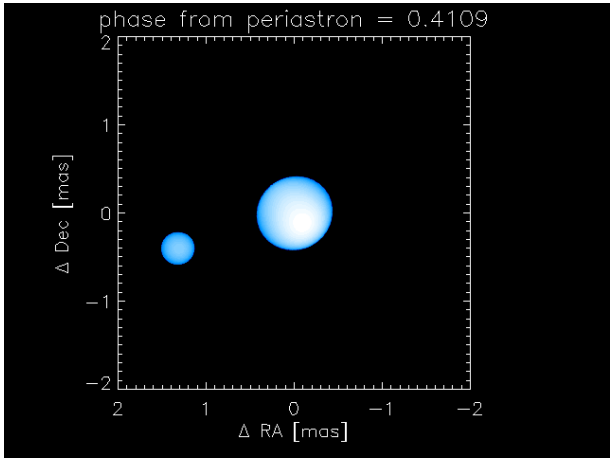
*Center*: Neutral hydrogen column density around Spica, at cross (Fejes, 1973)

*Top Right*: Spica UV spectrum (Aufdenberg et al., 2006)

*Lower Right*: Simulation of Spica system (Aufdenberg)



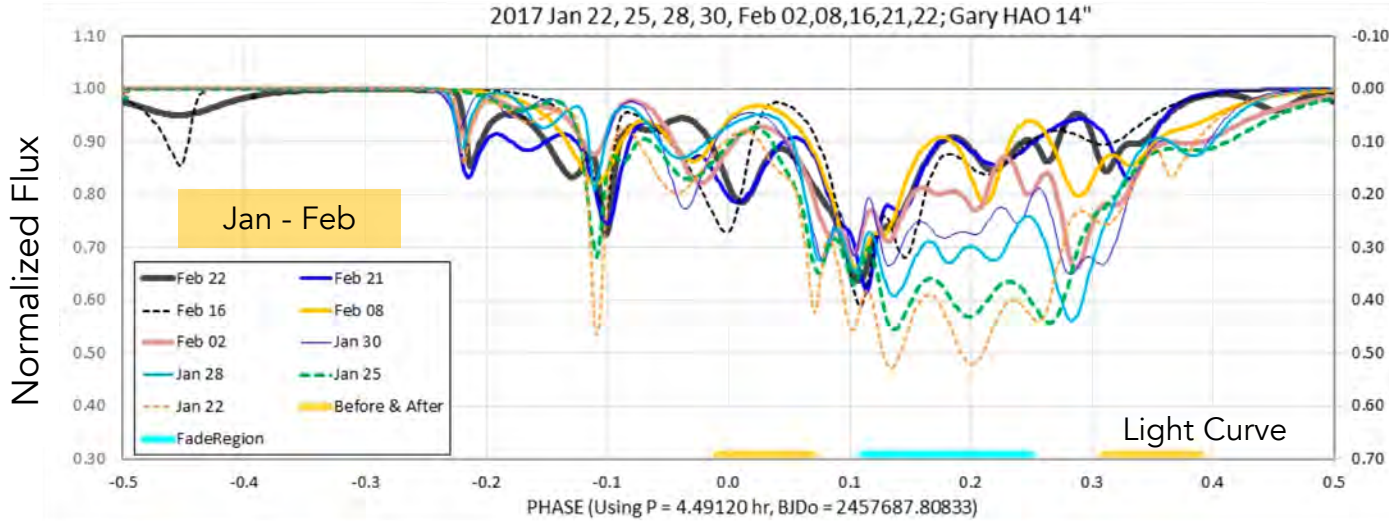




- Models of α Virginis A and B
- Access to WHαM data
- Older contour maps of 21cm and Hα for HI and HII densities in the Spica region

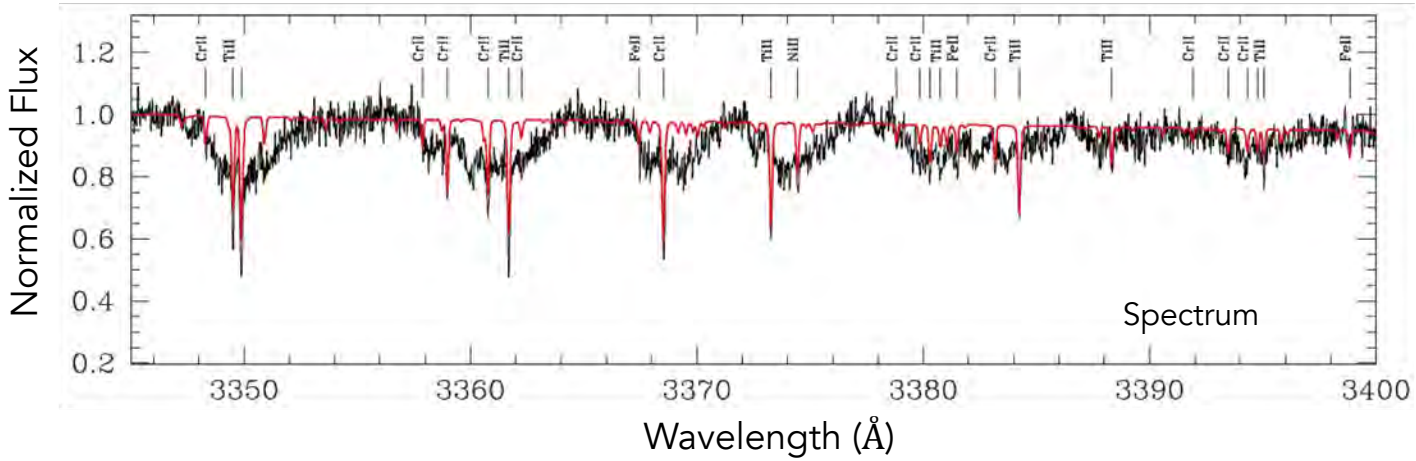
Cloudy application: Use Cloudy and model Spica atmospheres to define structure of HII region and further constrain model atmospheres

# Circumstellar (CS) Gas around Polluted White Dwarfs

Amy Steele – University of Maryland




Keck, HIRES, best fit model




Typical elements: C, N, O, Mg, Si, S, Ca, Fe, and Ni

**Example: WD 1145+017**

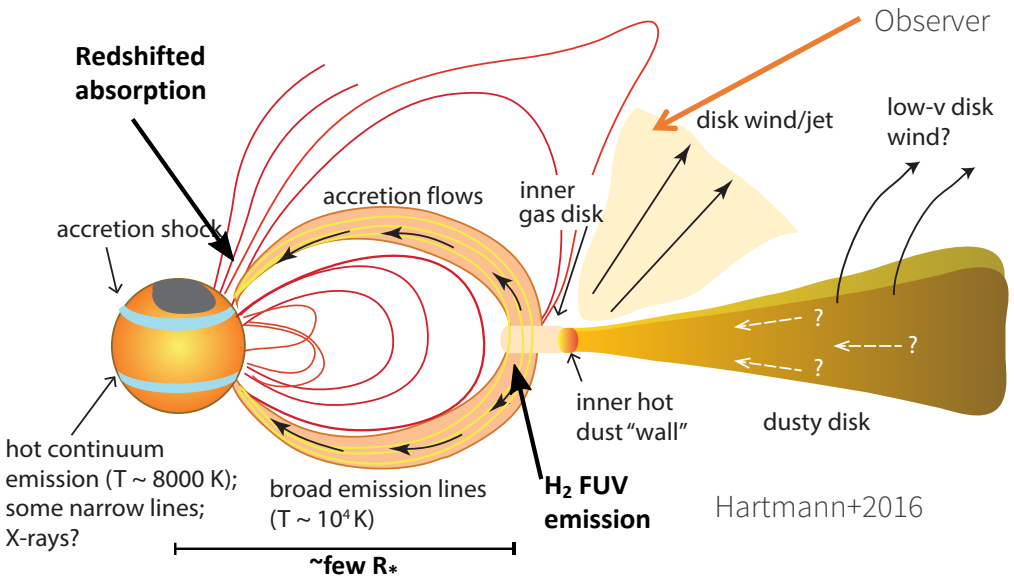
- Transiting planetesimal
- Rapid changes of circumstellar gas
- Accretion from differentiated rocky material

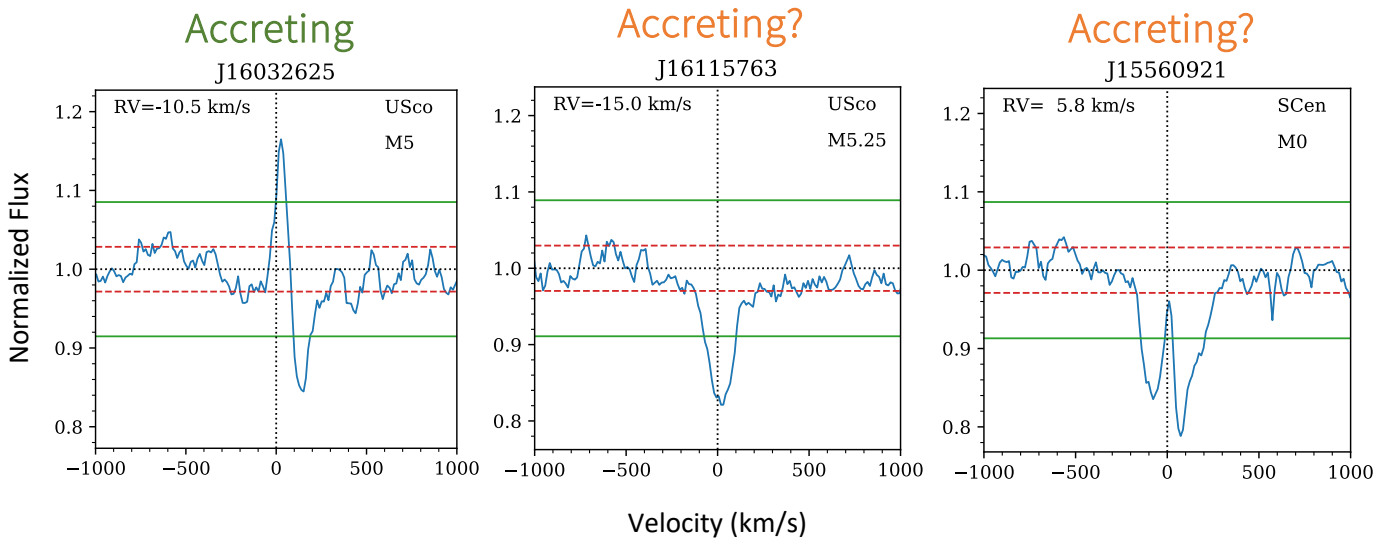
**Rock sublimates and accretes onto the WD surface**

- Models (to date) have not yet been able to link the CS species to the total atomic abundance in gas.
- We plan to use Cloudy to determine the CS gas abundance.

# Characterize He I 10830 as a (Low) Accretion Indicator in T Tauri Stars

Atom Thanathibodee




## Survey of T Tauri Stars in Nearby Young Stellar Populations

- How does accretion proceed at very low rate?
- Does magnetospheric accretion still hold?
- What cause accretion to stop?

## Using He I 10830 to search for Low Accretors

Four Categories of Observed Profiles
- Clearly Non-accretors
- Clearly Accretors
- Central Absorption (Coronal vs. Magnetospheric)
- Peculiar

Cloudy will help understand the formation of the line in coronal regime and magnetospheric regime


Star formation
1 Carr Active G...Time 4min.pdf
2 garg.pdf
3 Holguin_intro_talk_2019.pdf
4 Krishnarao.pdf
5 Tarantino_4mintalk.pdf

# The SFACT Survey – Metallicities with Cloudy

by David Carr

## The SFACT Survey

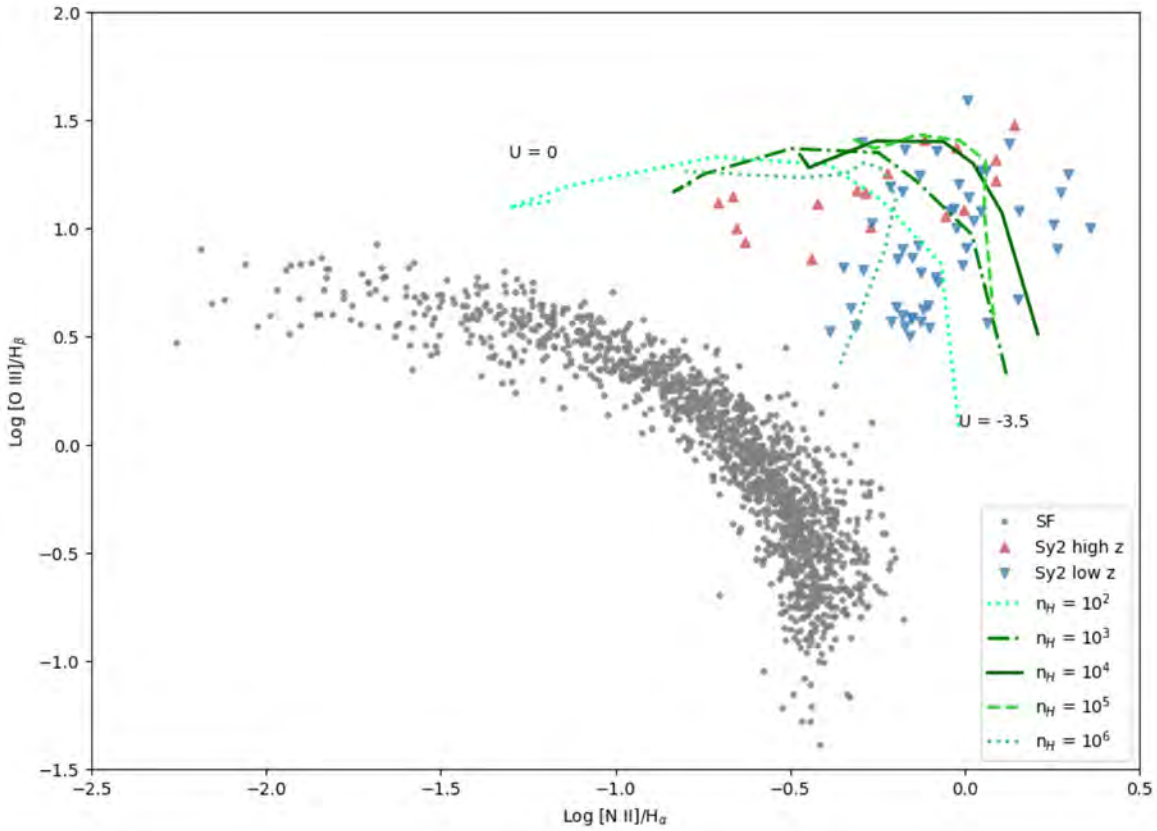
- Designed to find emission line galaxies across a wide redshift range

## How is Cloudy involved

- Construct a grid of AGN models that match the KISS sample
- Vary that grid with metallicity

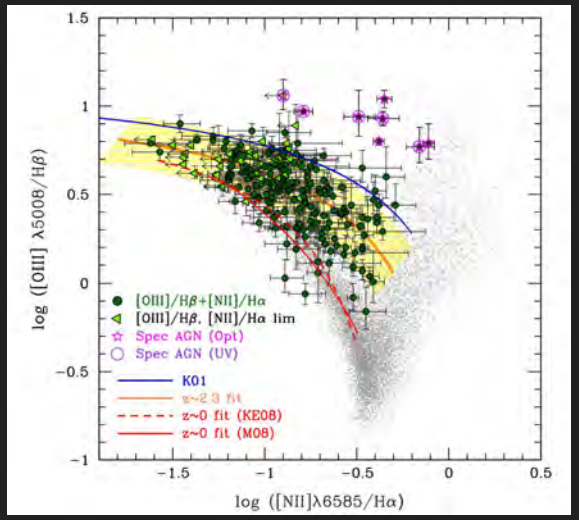
## What I need to do

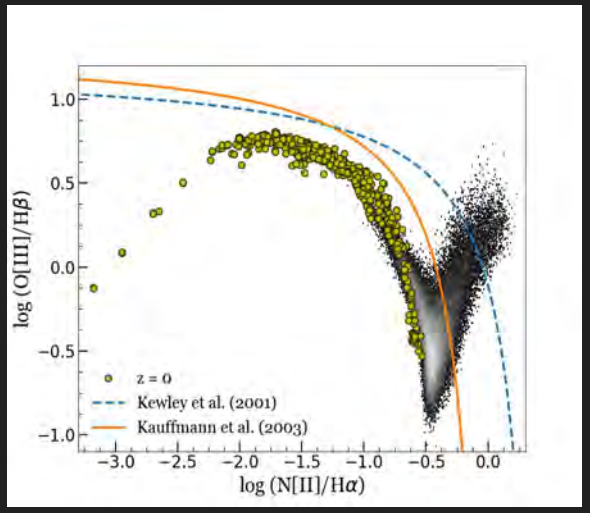
- I must figure out how to accurately model an AGN to fit the upper right part of the sample
- I need to vary the final grid's metallicity and see how it affects its position on the graph

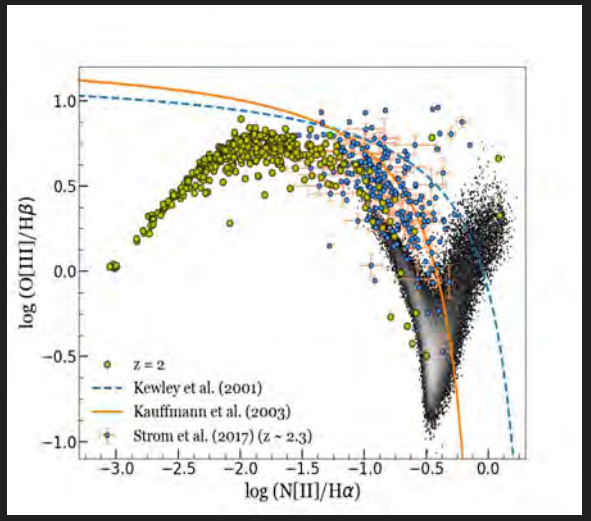


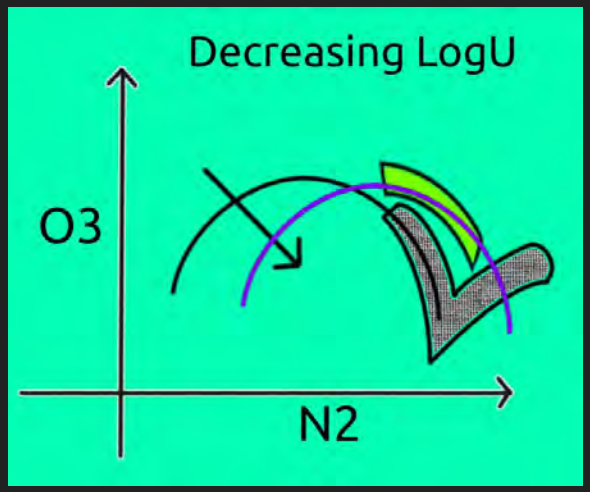
# Understanding the BPT diagram offset at high Z

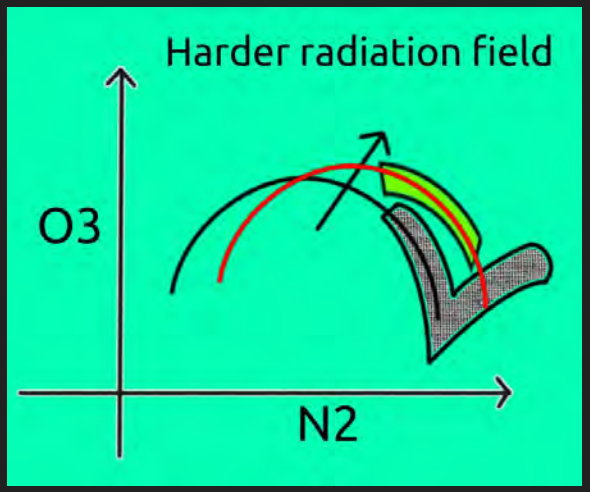
Prerak Garg



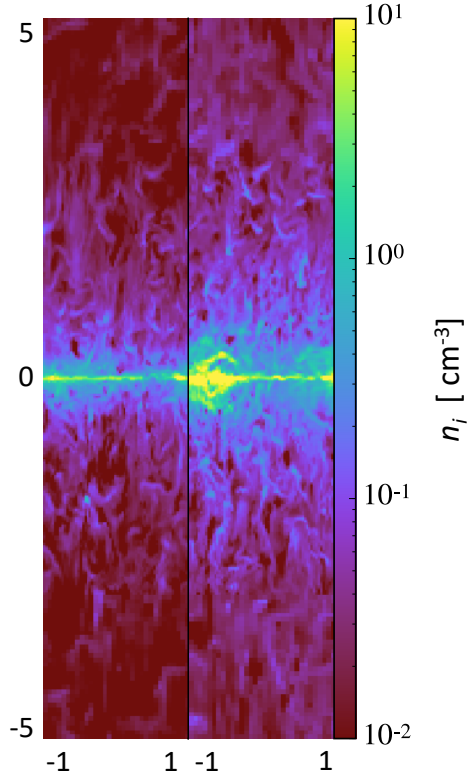



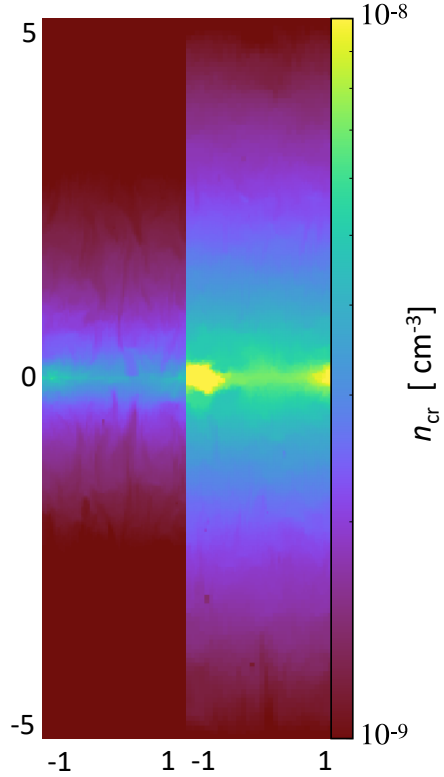



# Effect of cosmic rays on dynamical and thermal state of galaxy

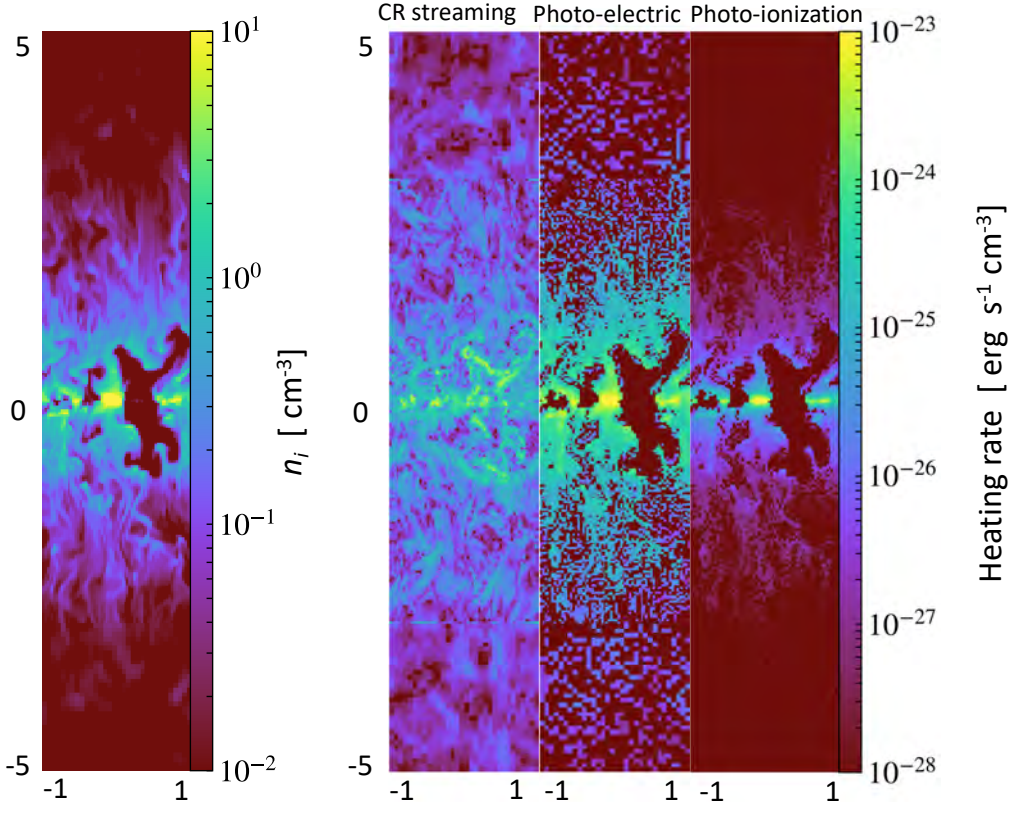
Paco Holguin

Turbulence → Faster CR transport → Enhanced stellar feedback

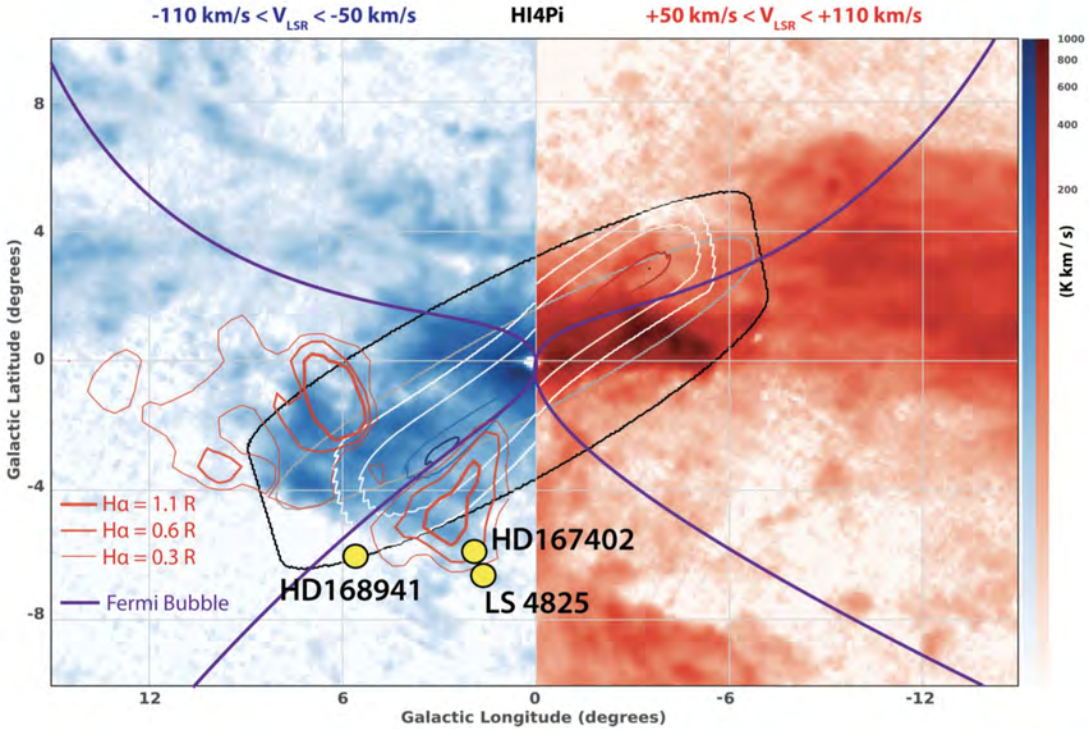



CR and radiation heating of the circumgalactic medium



# LI(N)ERs Close to Home: Ionized Gas in the Milky Way



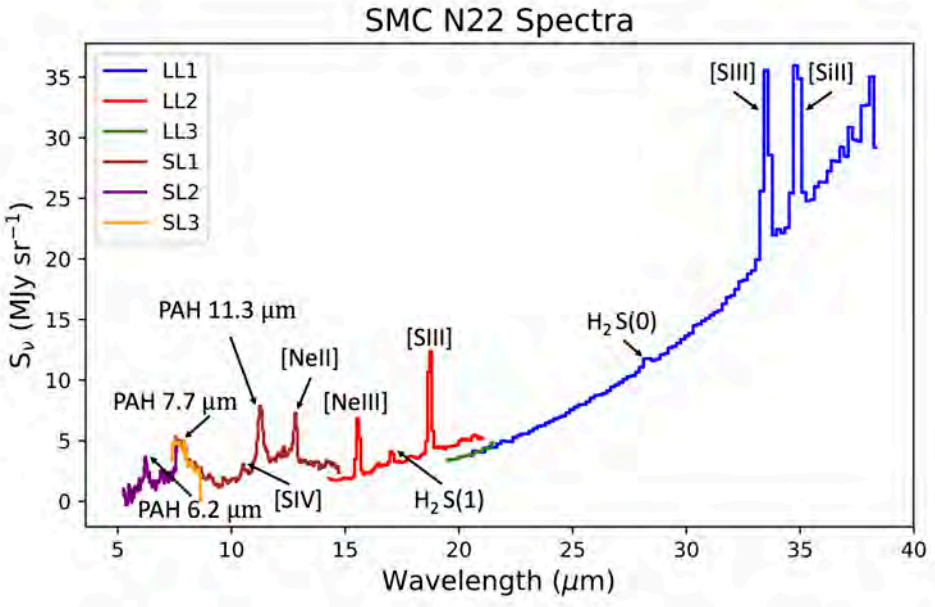

**Milky Way allows us to resolve ionizing sources and study LI(N)ER gas with absorption lines for the first time!**

## DK (Dhanesh Krishnarao)

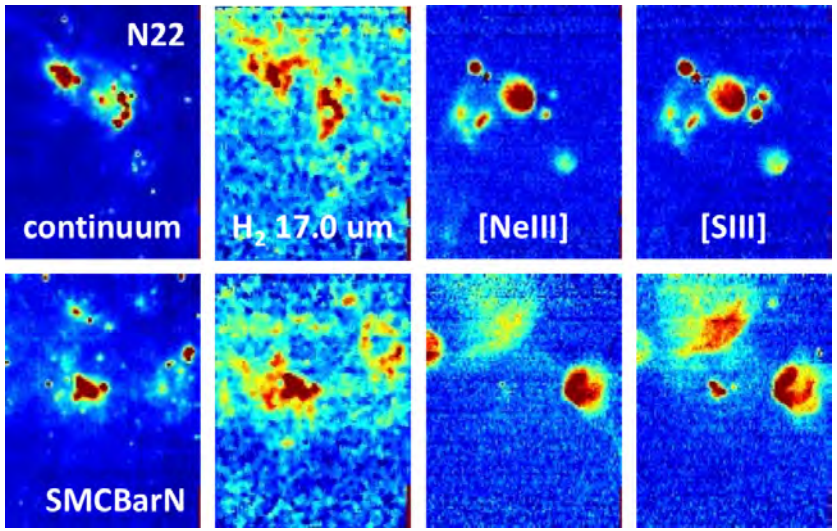
- A “convenient” gas distribution lets us put the Inner Milky Way on a BPT Diagram - Largely LI(N)ER like
- HST, FUSE, and IUE sightlines identified; Optical Emission observed with WHAM
- Requires 5-10% of ionizing photons from CMZ
- Or 10x the local ionizing flux

# The Physical Conditions in the Star-Forming Low Metallicity Interstellar Medium

Elizabeth Tarantino, University of Maryland

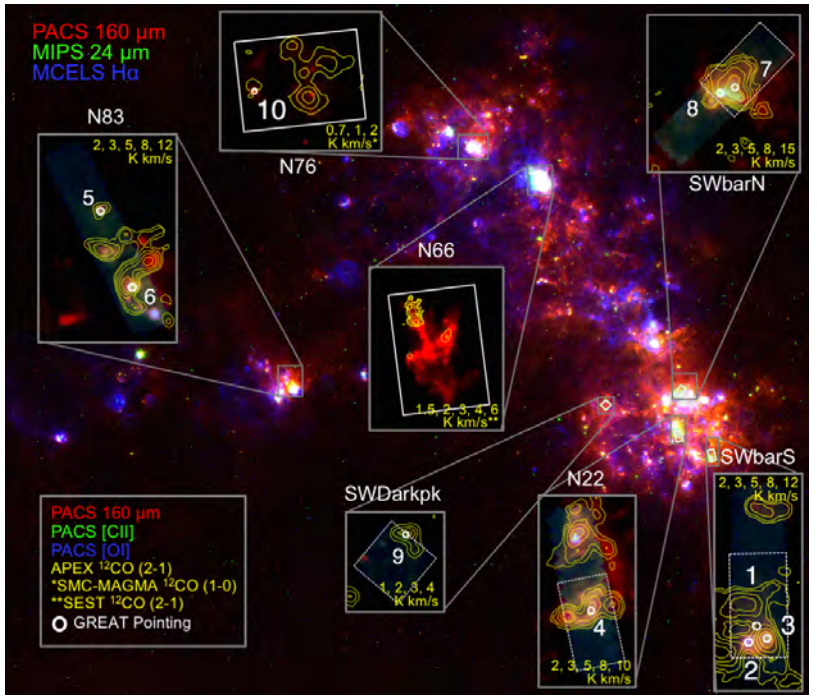



- What are the conditions of the HII regions in the SMC?
- What is the interplay between the interstellar radiation field and the cooling in the atomic and molecular media at low metallicities? ($Z_{SMC} \sim Z_{\odot}/5$)
- What are the characteristics of the interface between the HII region and the molecular reservoir in metal-poor star forming systems?




We hope to use Cloudy to:

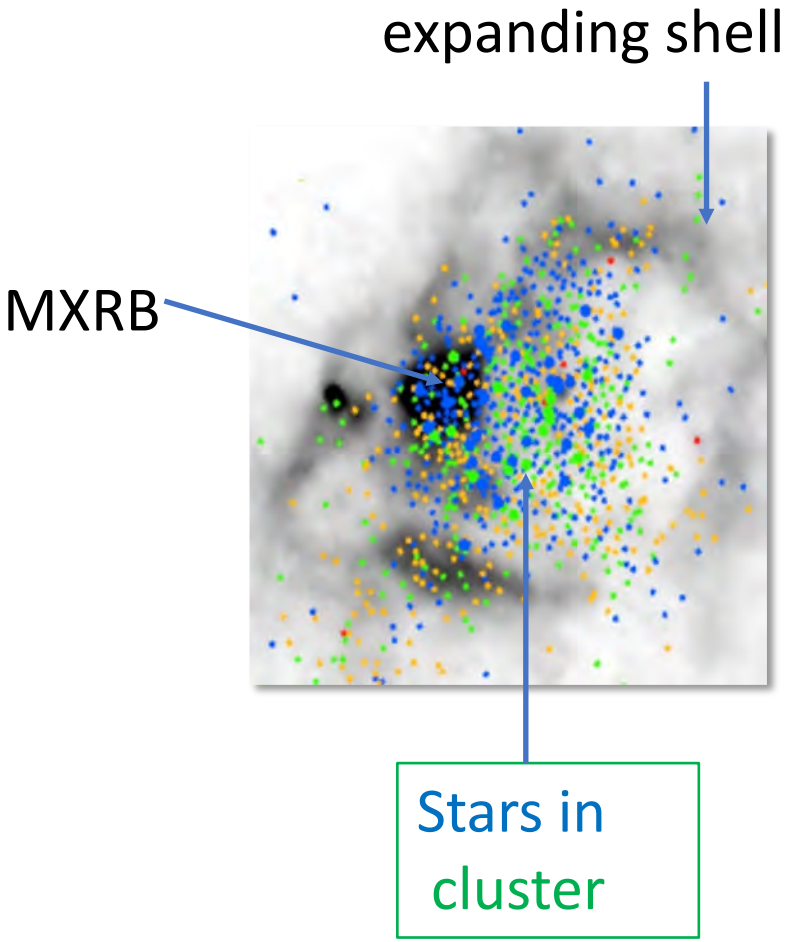
- Model the near and far infrared ionized lines
- Find the ionizing radiation field strength and hardness, ionization parameter, density of ionized gas, temperature, incident radiation field, and cooling efficiency in PDRs/neutral gas

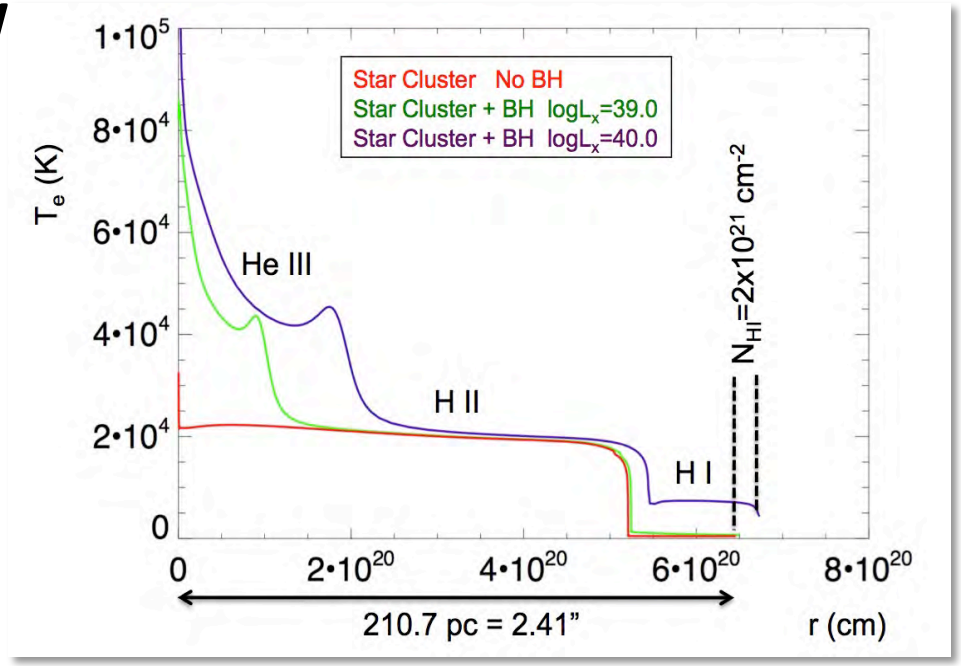


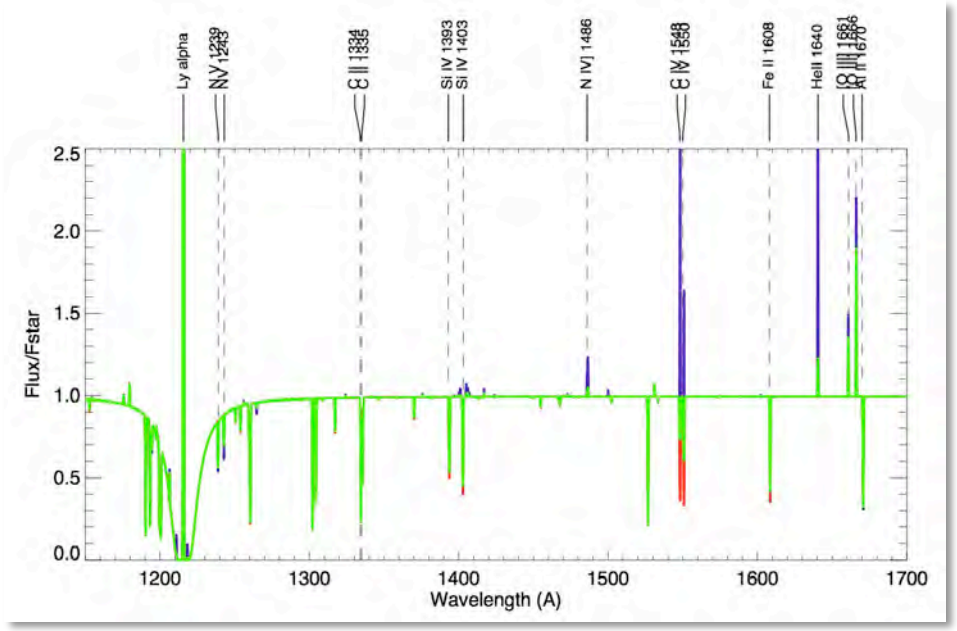

starburst
1 Heap_IZw18_Cloudspec.pdf
2 litke.pdf
3 Olivier_intro.pdf
4 Arnab Sarkar 4 min talk.pdf
5 Sun_CII.pdf
6 SuzukiNao_4min_Slide.pdf

# An Ultra-Luminous X-ray Source (ULX) in I Zw 18-NW

Sally Heap



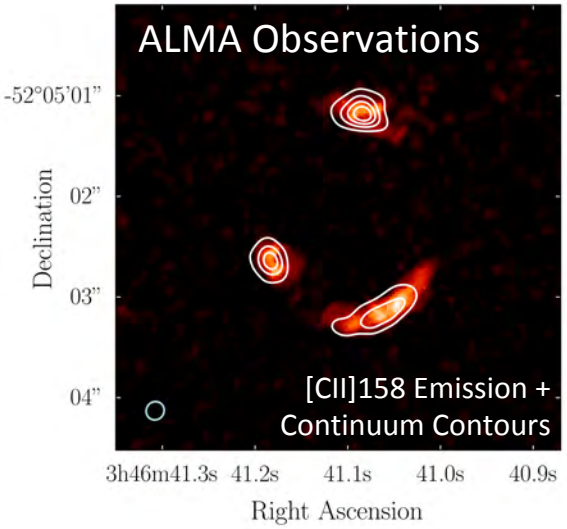



# SPT0346-52: a z=5.7 Hyper-Starburst Galaxy Merger

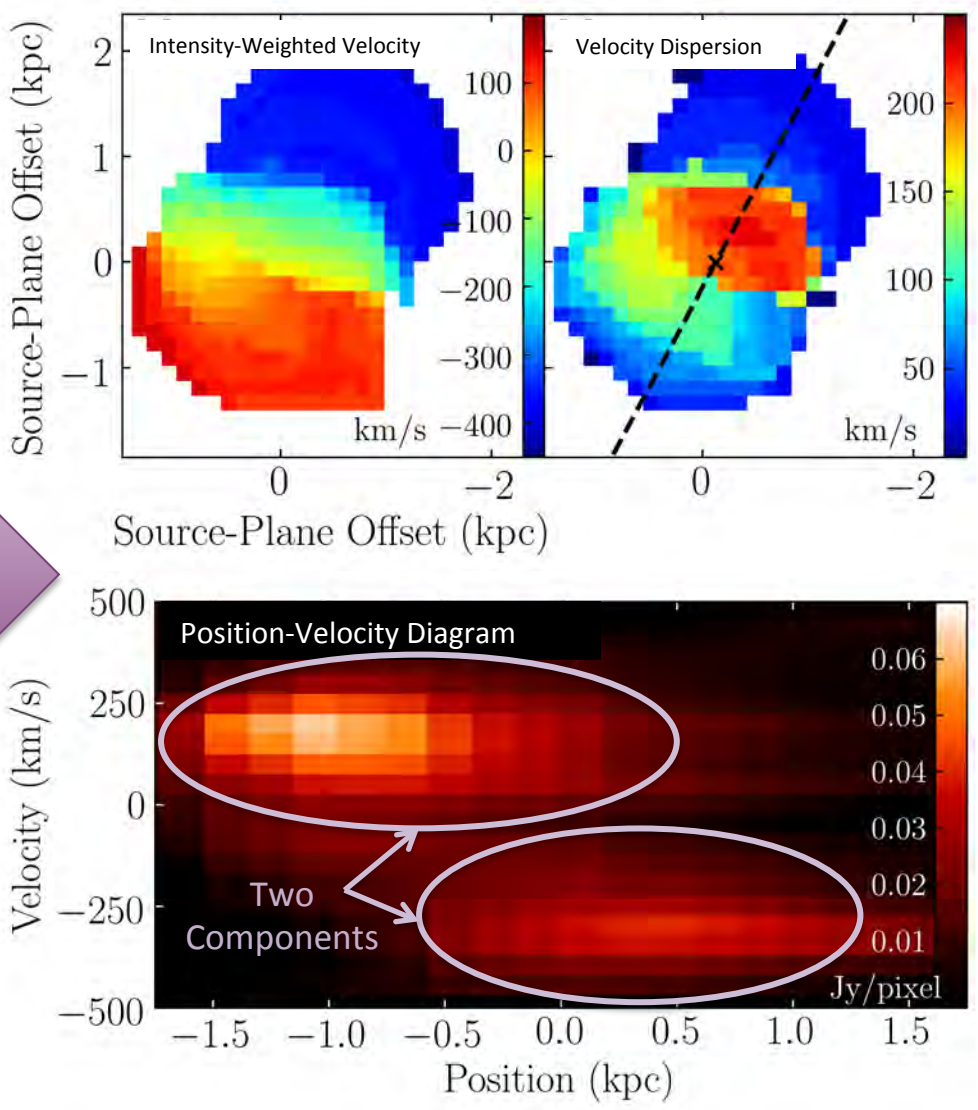
**Katrina Litke**, University of Arizona

- $L_{FIR}$ ~ 2x10^13 $L_{\odot}$ (intrinsic)
- $\Sigma_{SFR}$ ~ 4200 $M_{\odot}$/yr/kpc$^2$
- No AGN
- Merger-driven star formation




Pixelated, Interferometric Lens Modeling

"De-lensed" [CII]158 emission

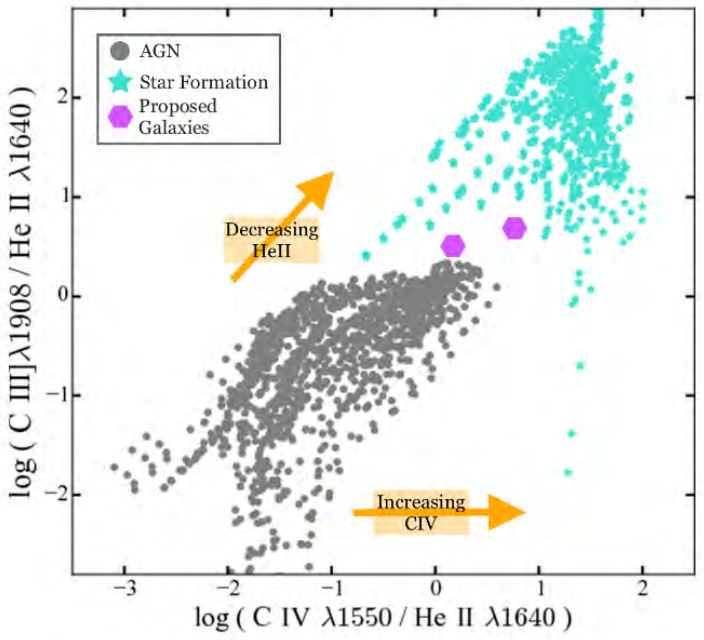


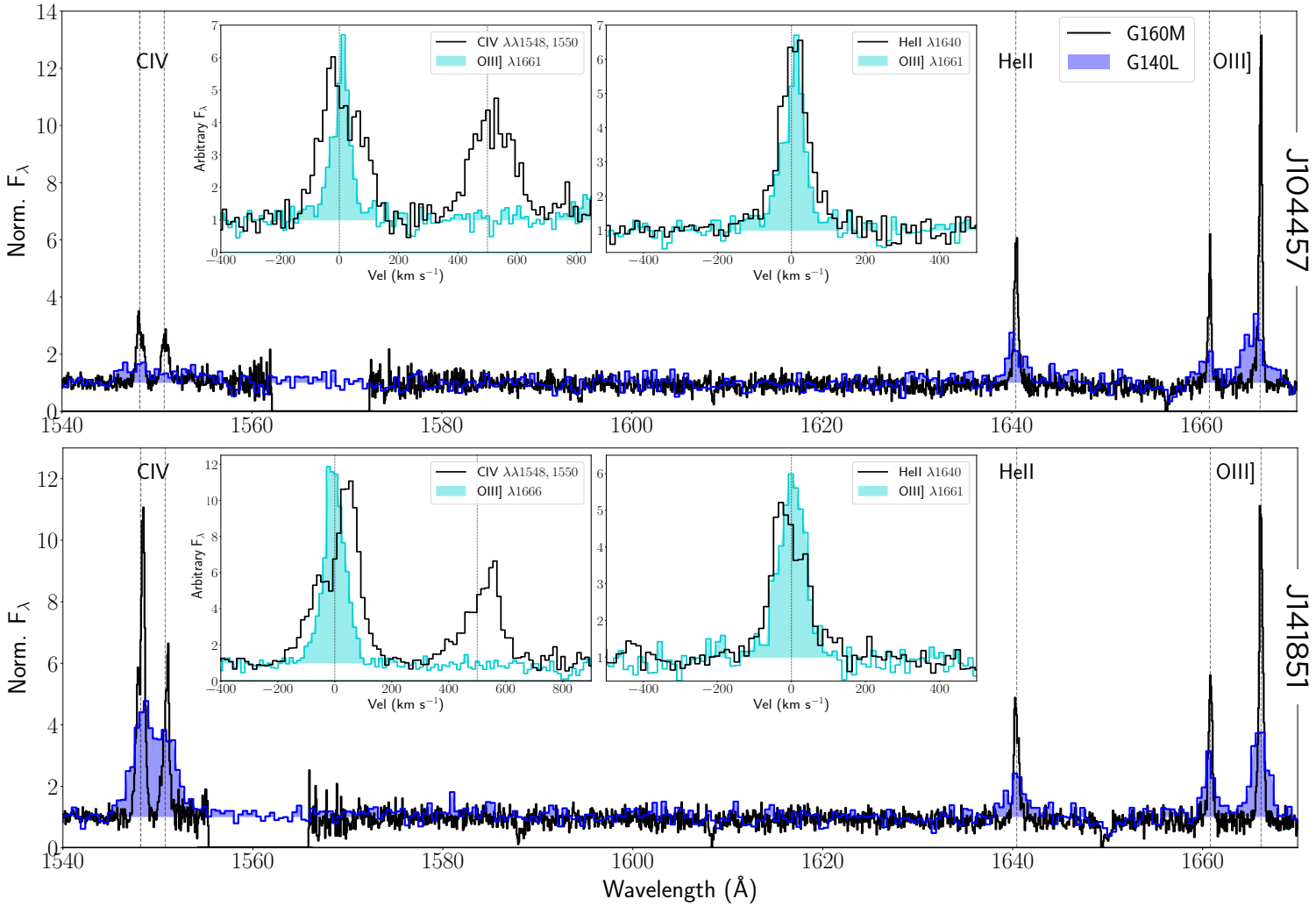

Next Steps:
[NII]205, [NII]122,
[OI]145, [OI]63

# Extreme UV Emission in Local Analogues of Reionization-Era Galaxies

Grace M. Olivier

- Two $z \sim 0.1$ galaxies
- Intense nebular He II emission
- Double-peaked C IV emission
- Suggests significant number of $E >$ 47.89 eV photons produced in and possibly escaping from these galaxies

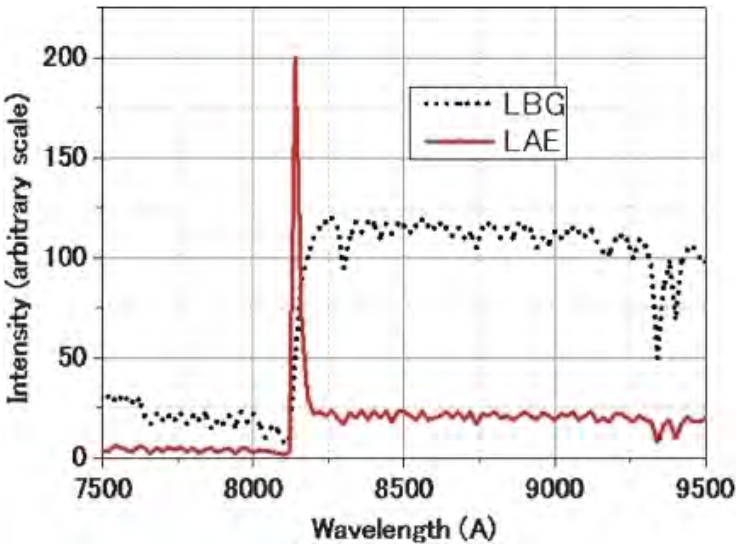


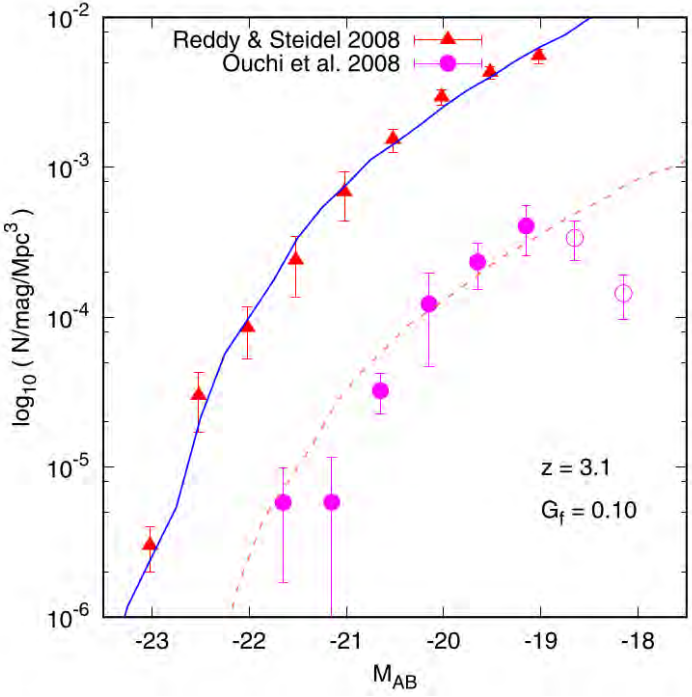



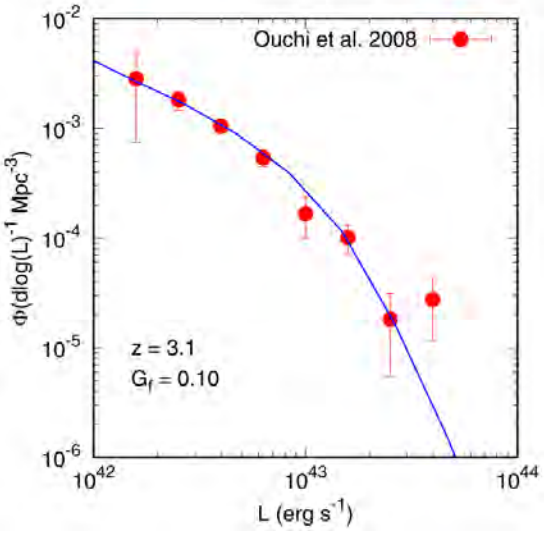

Berg et al. 2019, arXiv:1905.06434

*On Lyman-α Emitting galaxies*

*- Arnab Sarkar (UK)*



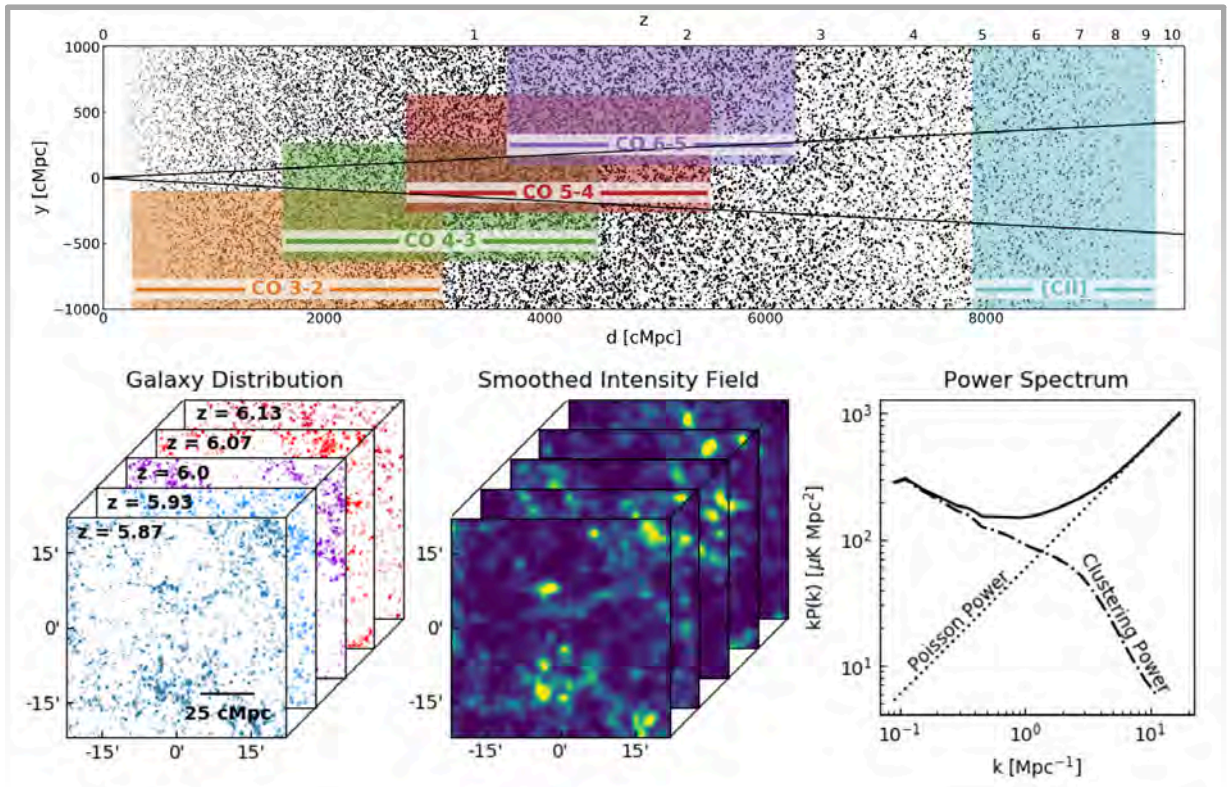

$f_{esc}$=*Escape fraction of ionizing photons*

*f* = Star formation efficiency*

$f_{esc}^{Ly\alpha}$*= Lyman-alpha escape fraction*

# Line Intensity Mapping of [CII] Emission in the Early Universe

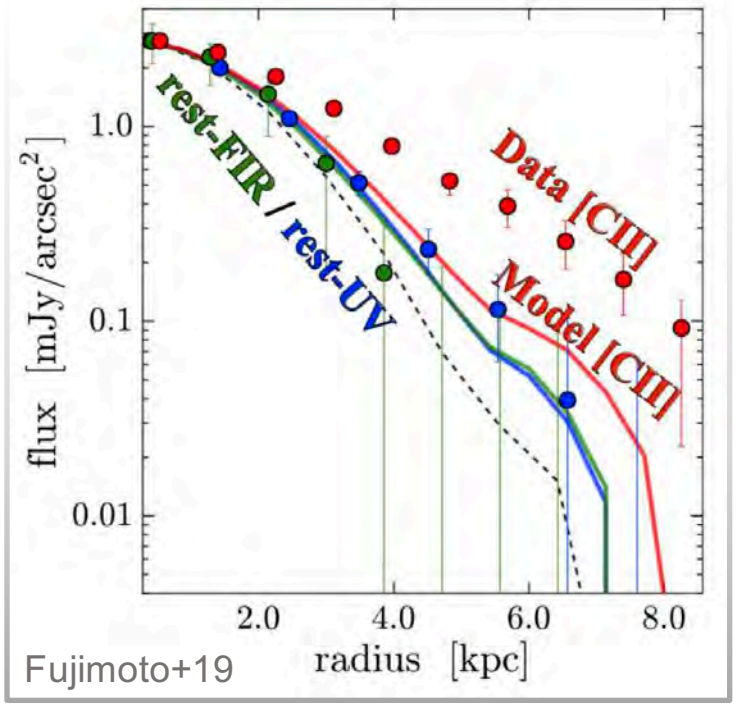
*Guochao (Jason) Sun*




- LIM: **3D analogy** of CMB measurements, but with redshift information!
- A method to probe large-scale structure **complementary** to galaxy surveys
- Study **multi-phase ISM** with **multi-tracer LIM**

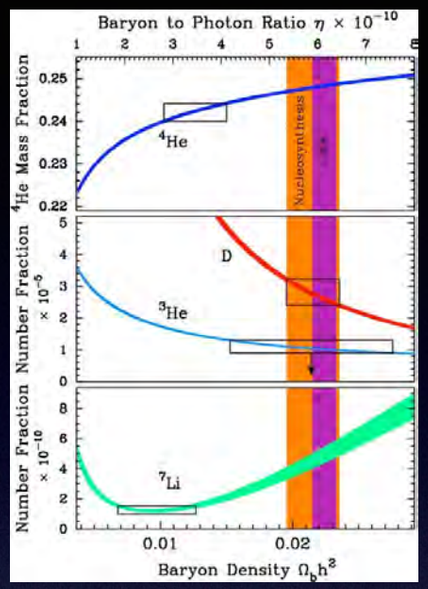
**Mysterious [CII] halos at $z \sim 6$**

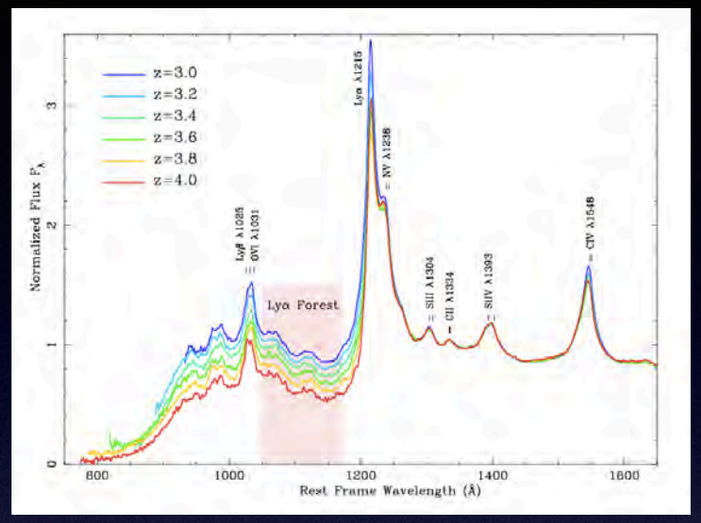
- How to better model them? (CLOUDY)
- Insights intensity mapping can offer?
  - Small-scale physics

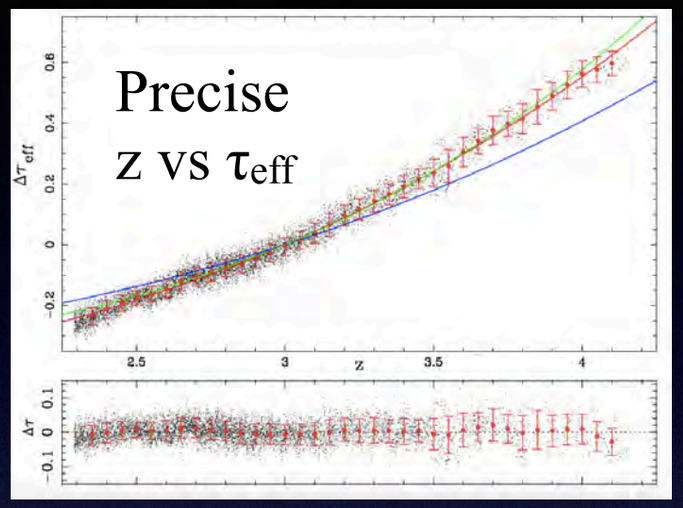


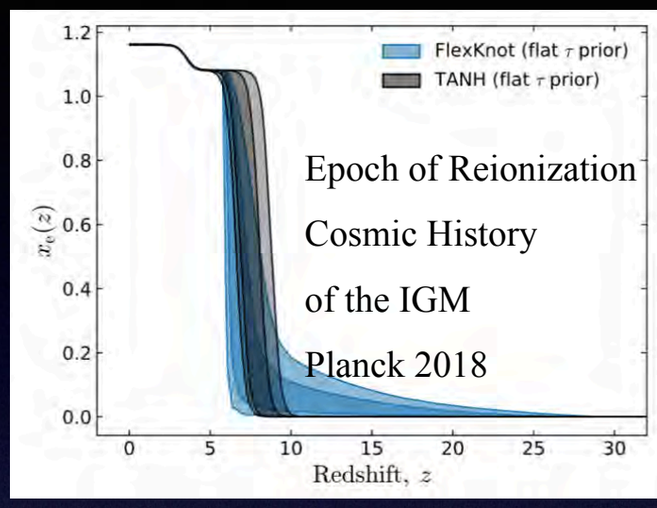
# Precision Cosmology through the Intergalactic Clouds (IGM)

Nao Suzuki (Kavli IPMU, Univ of Tokyo) : $\Omega_b$ $\tau$ $\sigma_8$ $\Lambda$

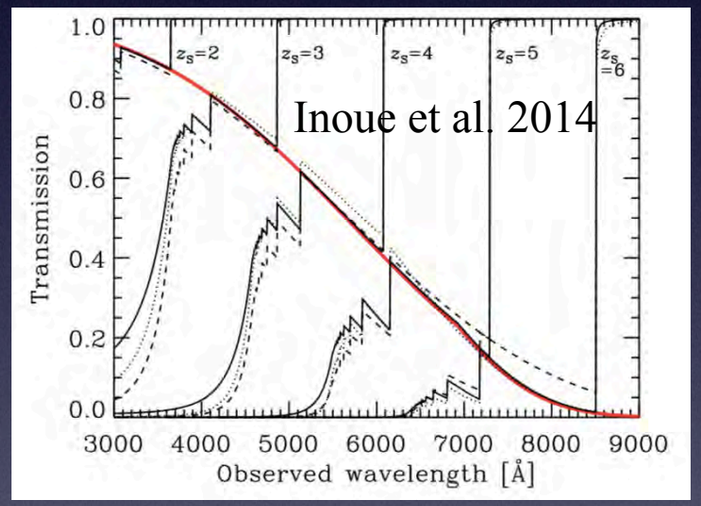


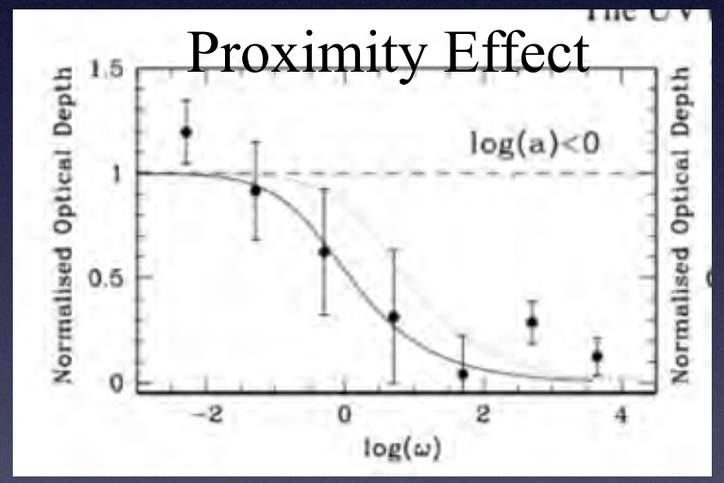



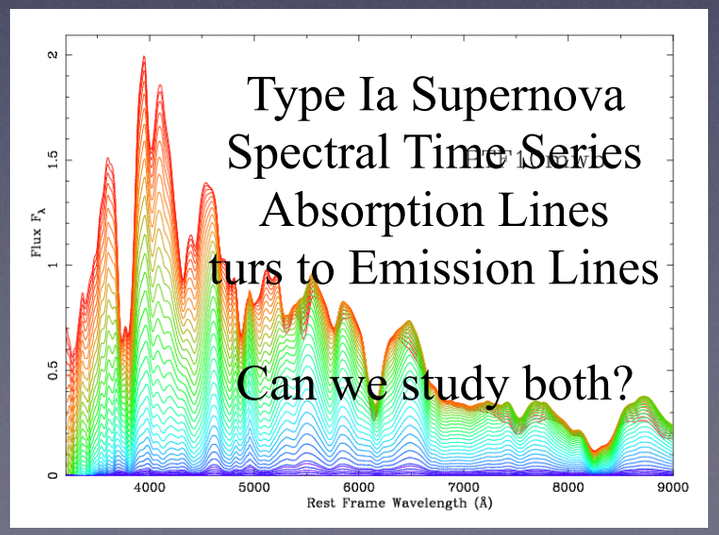



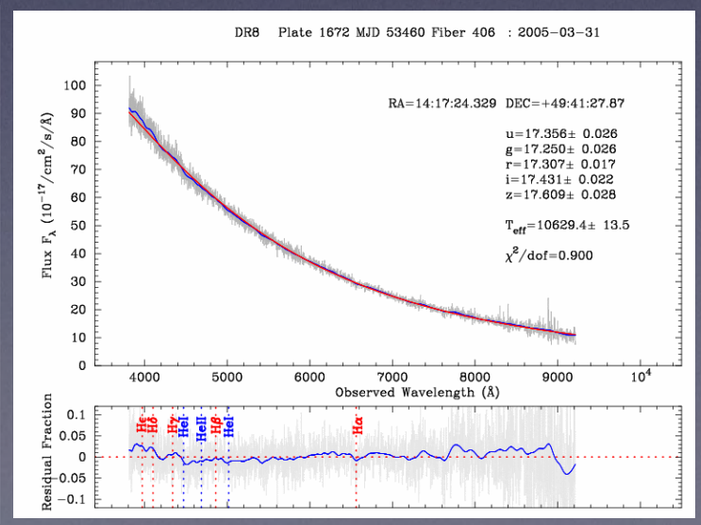




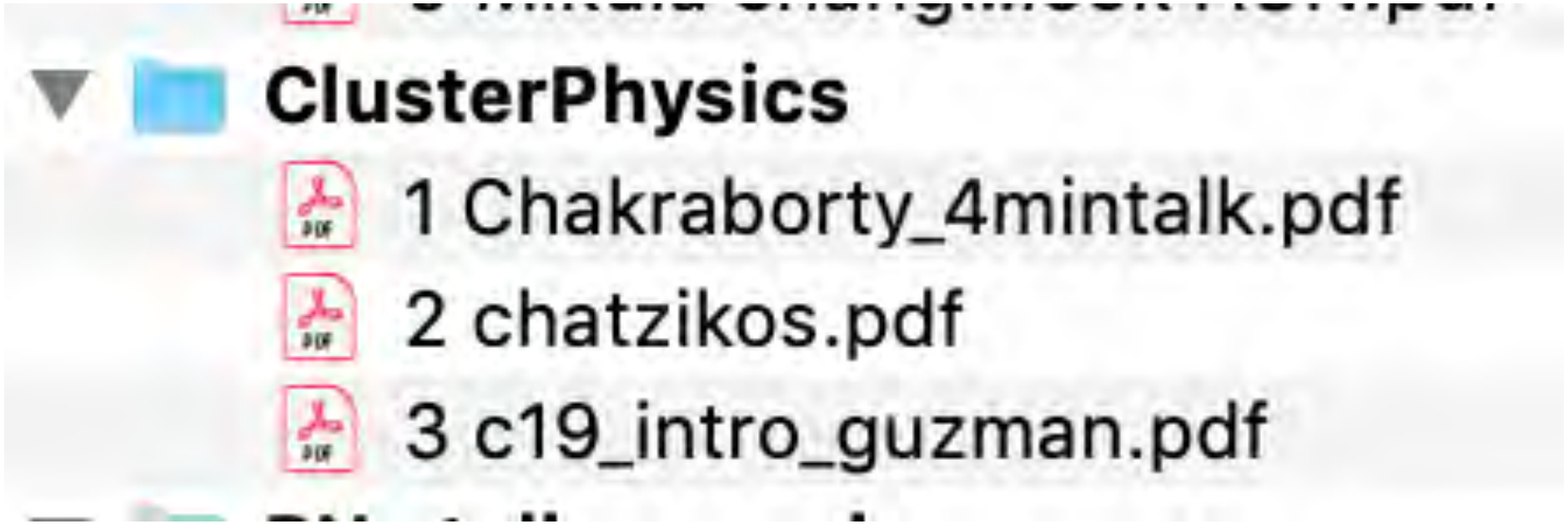




Wish to probe the Ionization history of the universe using Quasar Spectra and Lyman Series

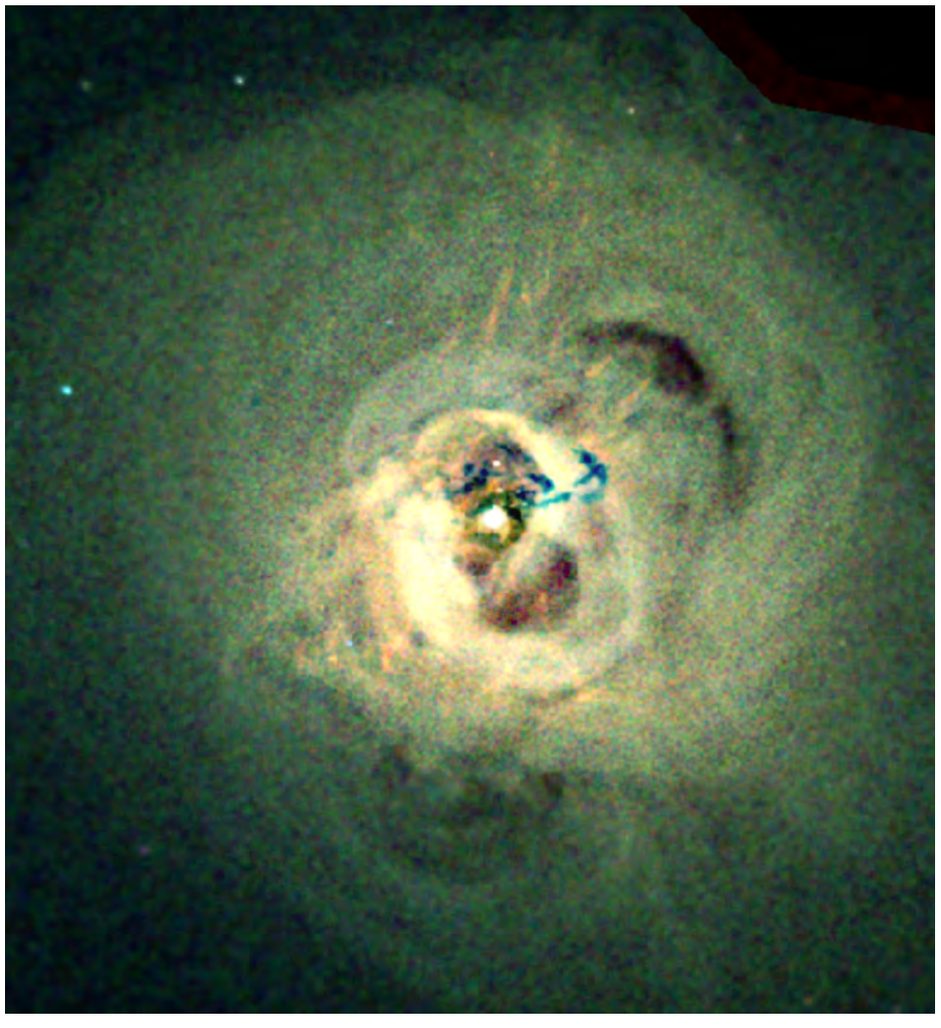

Mysterious Blackbody Stars are identified (Suzuki & Fukugita 2018) We can use it as a calibrator but what is the physics behind this?!


ClusterPhysics
1 Chakraborty_4mintalk.pdf
2 chatzikos.pdf
3 c19_intro_guzman.pdf

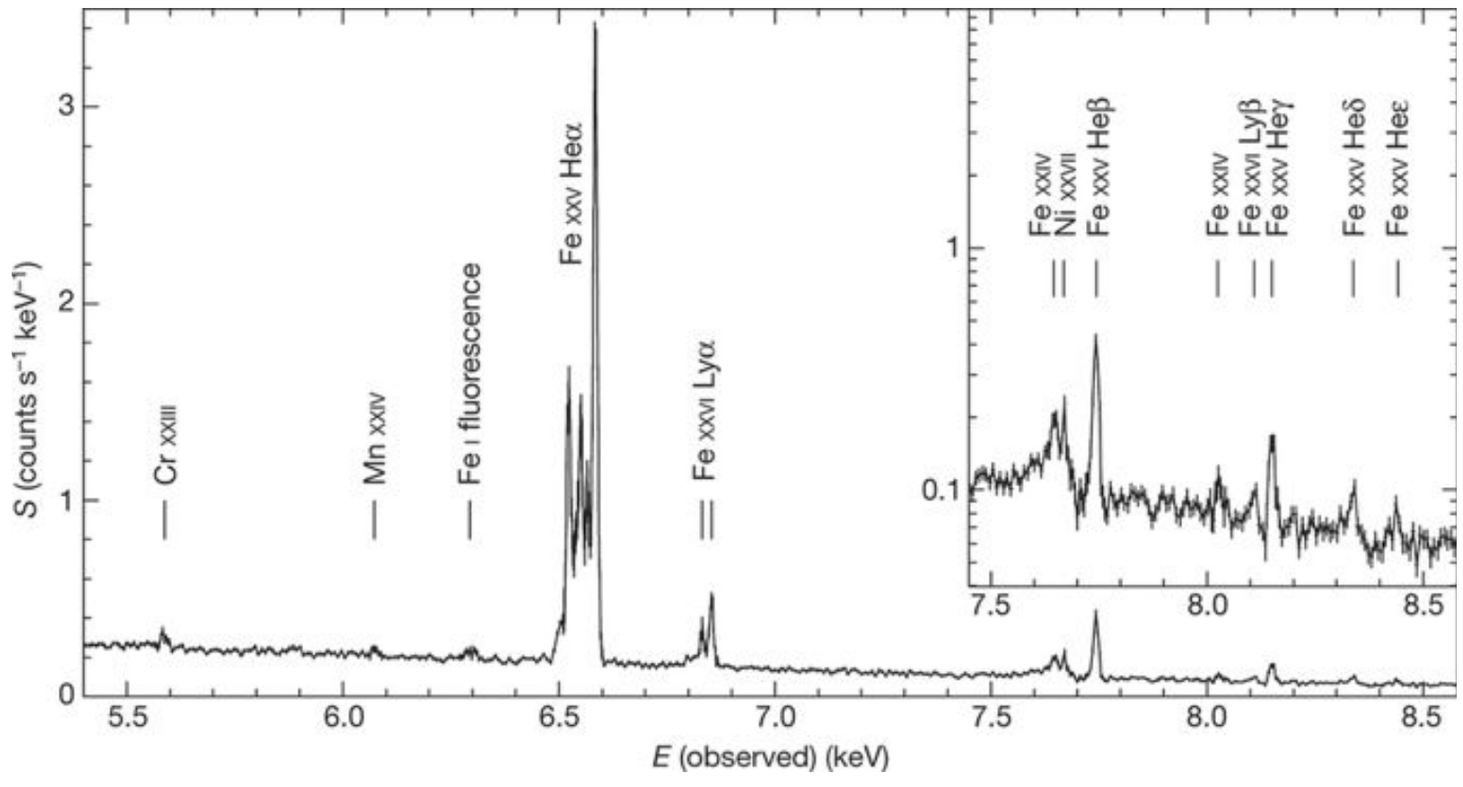
# X-ray observation of Perseus Cluster Core

Priyanka Chakraborty, University of Kentucky

**Questions:**
**What is cooling flow problem?**
**How to use CLOUDY to reproduce the spectra?**



**Chandra Image of Perseus core**

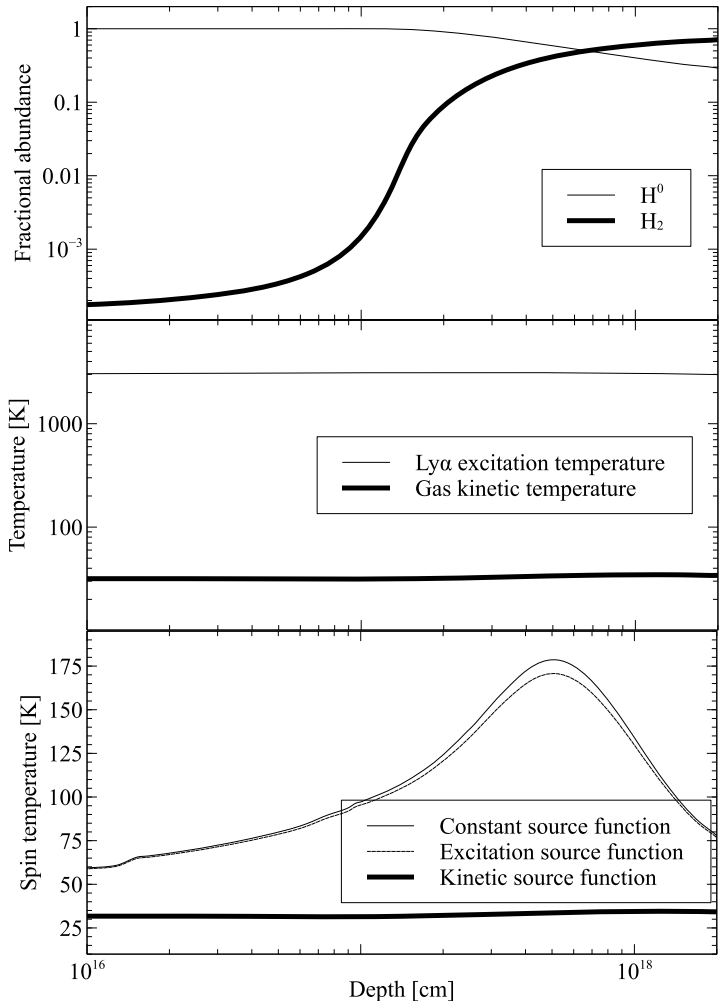



**X-ray spectrum of Perseus cluster core by Hitomi Observation**

Source: https://en.wikipedia.org/wiki/Perseus_Cluster
https://www.nature.com/articles/nature18627

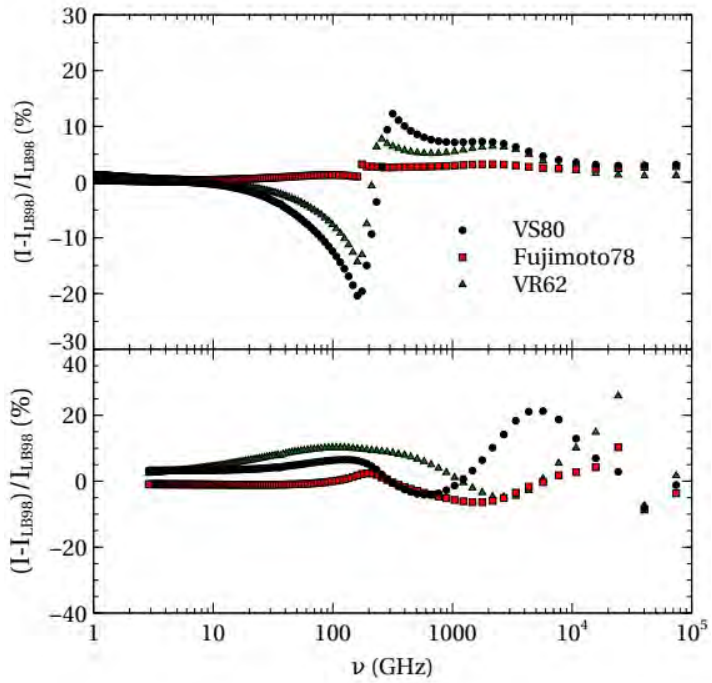
# Marios Chatzikos — University of Kentucky

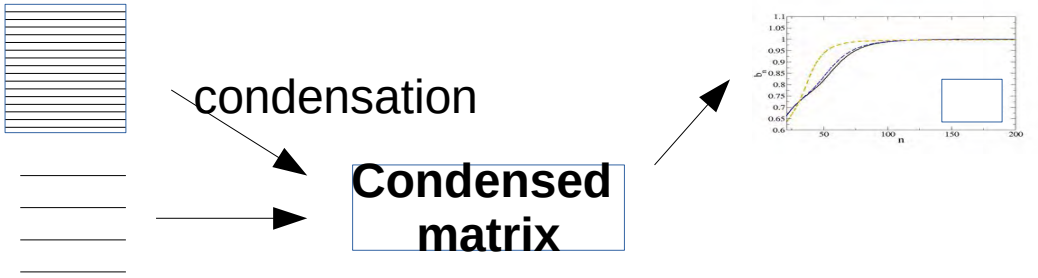
- Galaxy clusters
- Cloudy
- Atomic Physics:
  - Hyperfine Lines
  - Atomic models
- Shocks
- Exact Radiative Transfer



# Fran Guzmán - University of Kentucky

- Cloudy
- Atomic Physics
- Plasma Physics
- H-like & He-like iso sequences:
  - Primordial Abundances
  - Radio Recombination Lines
- Dielectronic Recombination impact.
- Heavy ions → Kilonova

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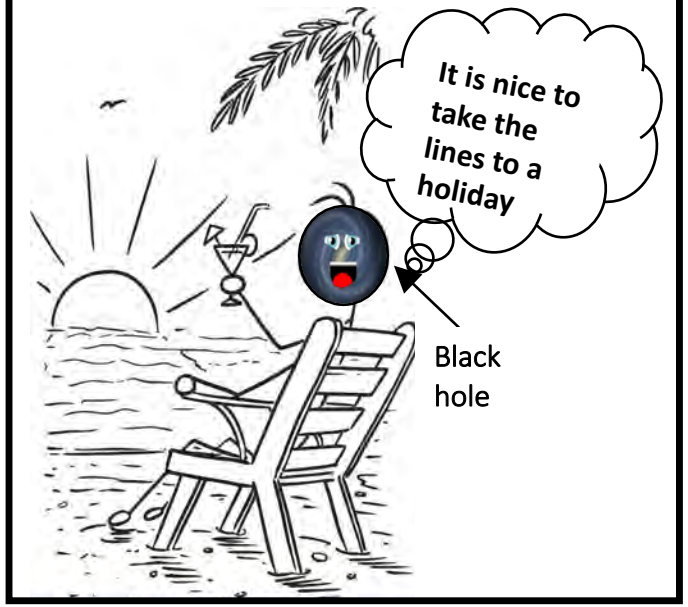
1 Maryam-4minTalk.pdf
2 grupe_cloudy_20190517.pdf
3 choi_4min_talk.pdf
4 Mariappan_4m_talk.pdf
5 Mikula chang...look AGN.pdf

University of Kentucky

# Paradox in pan-spectral observations of NGC5548

Maryam Dehghanian

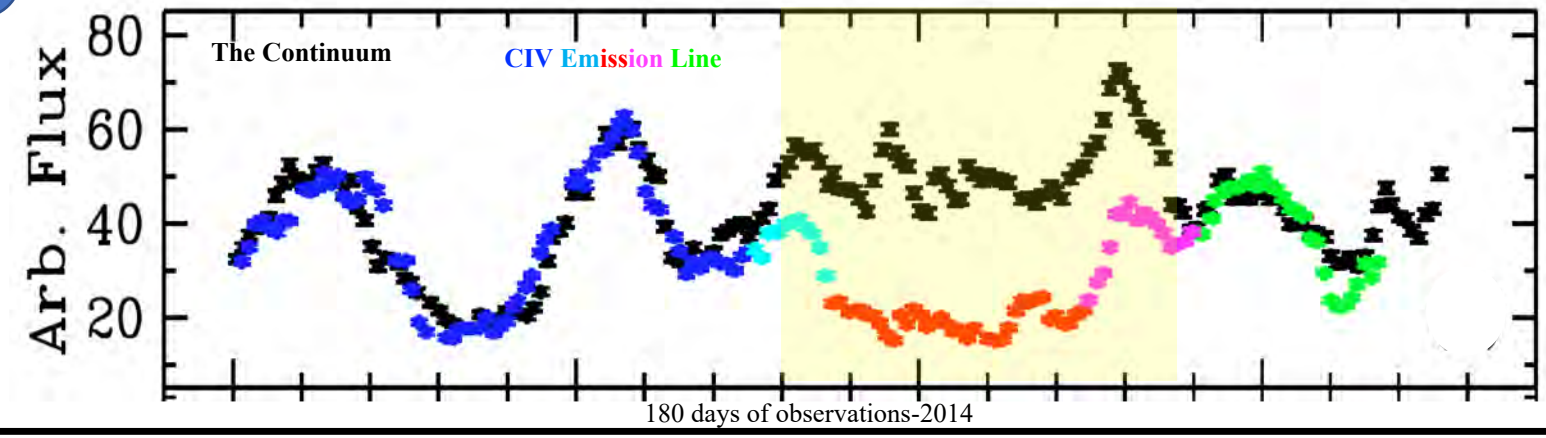
1




2

- A decorrelation between the emission/absorption lines and the continuum :The holiday
- Violates the basic assumption for BH mass estimations
- Why? How?

3



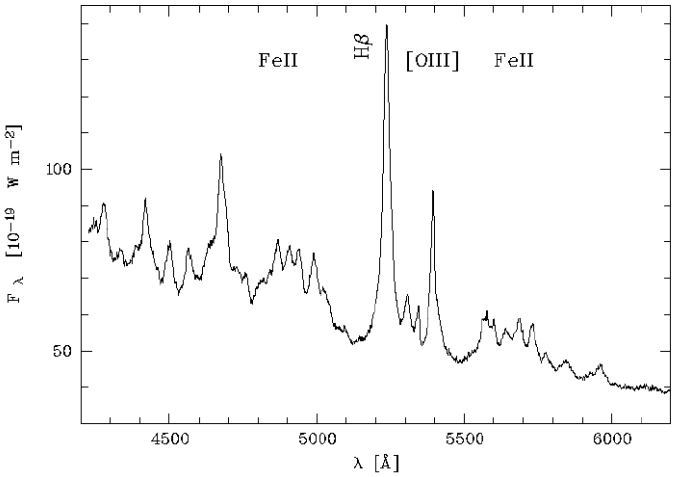

4

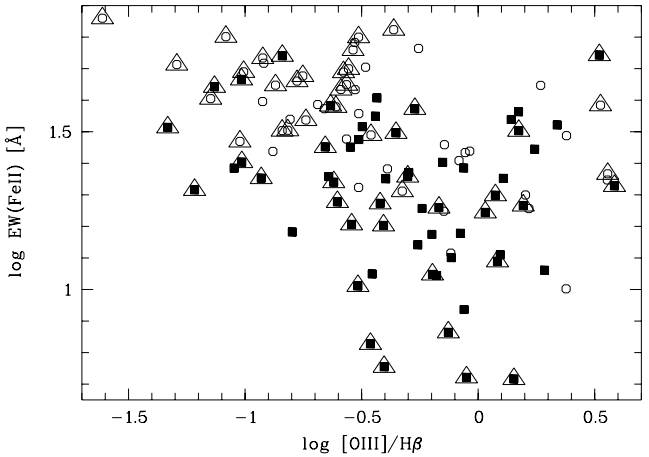
A disk-wind explains everything!

# Narrow Line Seyfert 1 Galaxies

## by Dirk Grupe

- NLS1s are AGN with low Black Hole masses and high $L/L_{edd}$
- Extreme X-ray variability and spectra
- Possibly AGN in an early stage
- On an extreme end of the Boroson & Green EV-1 relation (1992)
- Anti-correlation between optical FeII and [OIII] emission line strengths.
- Cloudy may help us to better understand the differences between NL and BL Seyfert 1s.
- For example: Starburst vs AGN component



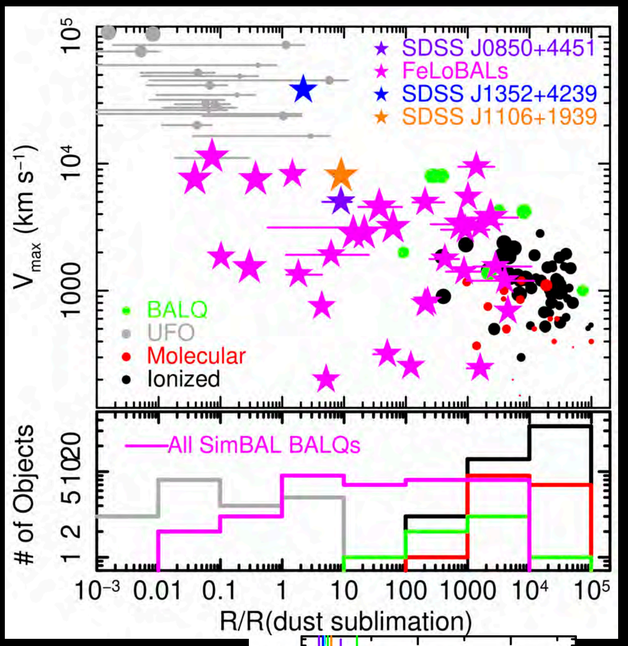



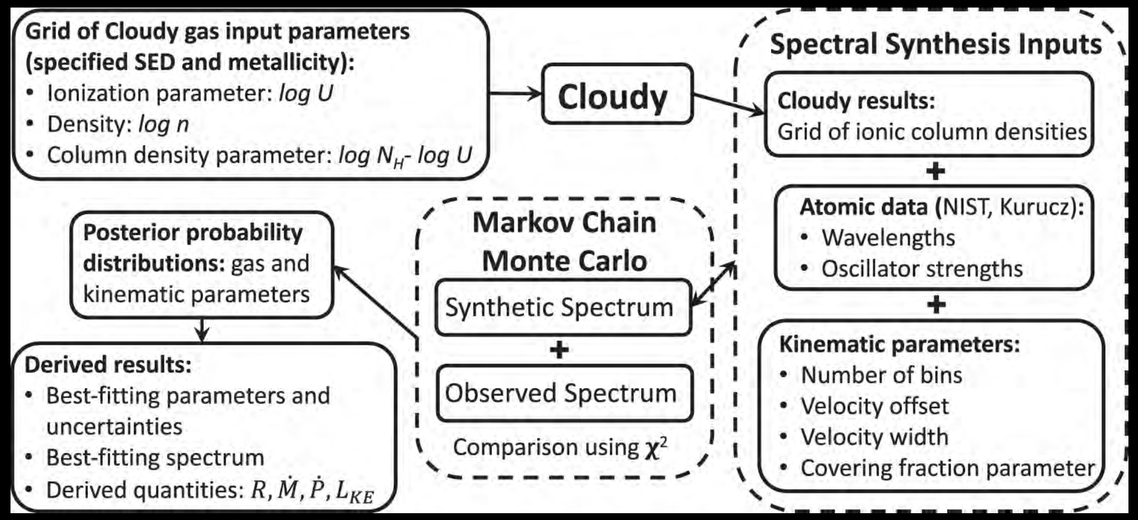

Grupe 2004, AJ

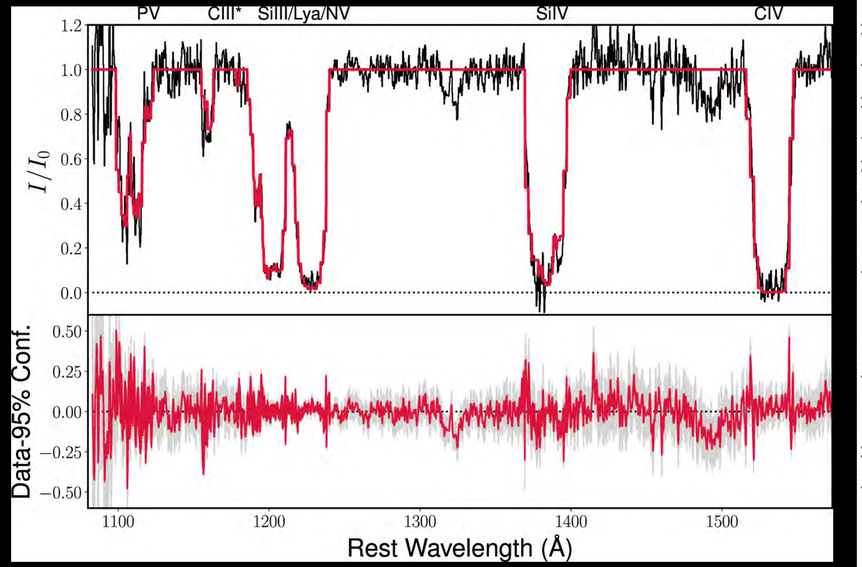
# *SimBAL*: Spectral-Synthesis for Broad Absorption Line (BAL) Quasars

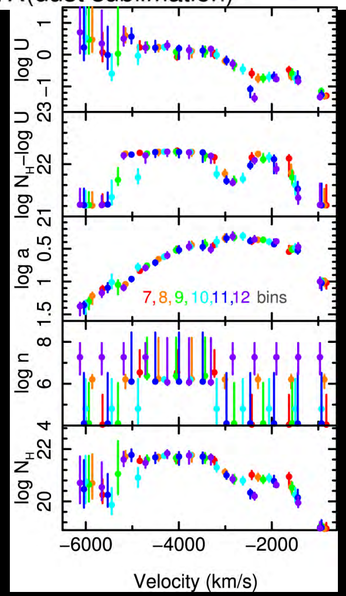
Joseph Hyunseop Choi, OU

- 20 ~ 40% of quasars show BAL features from quasar outflows.
- Strong quasar feedback candidate, but their physical properties are not well constrained.
- *SimBAL* models BAL quasar spectra and provides best fit parameters and the associated uncertainties.
- With *SimBAL* (and *Cloudy*), we can perform the first systematic study of BAL quasar outflows.



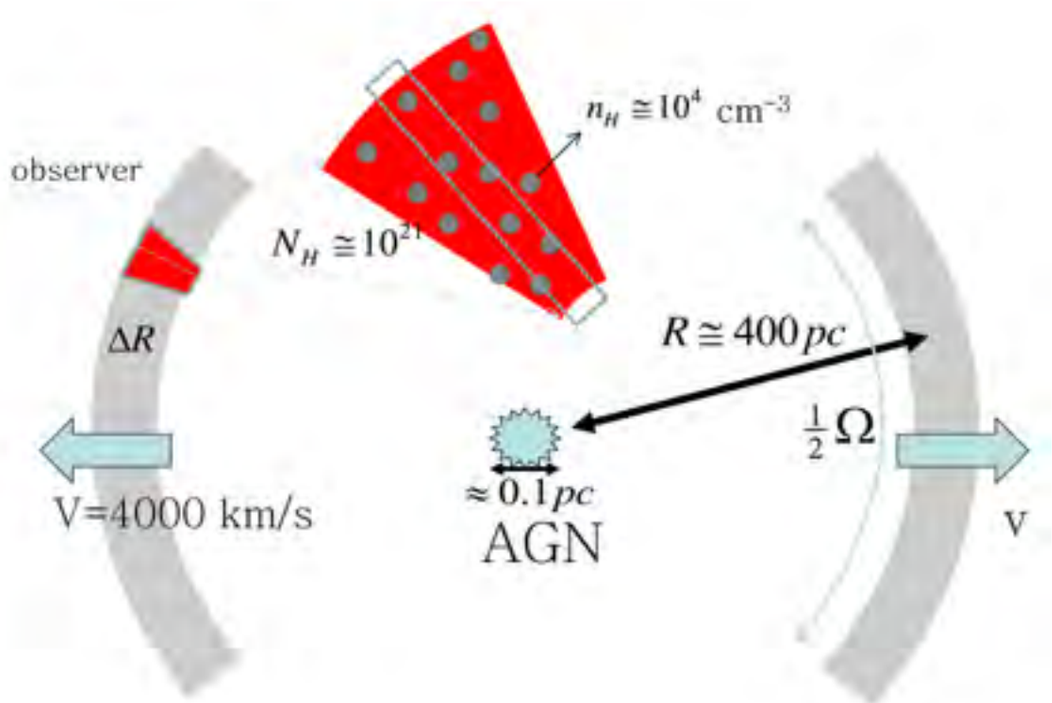



# AGN feedback from QSO absorption lines

Vivek Mariappan




Kinetic Luminosity : $\dot{E} = 4\pi\mu m_p \Omega R N_H v^3$, 1 % Lbol

Mass outflow rate: $\dot{M} = 8\pi\mu m_p \Omega R N_H v$, 100 Msun/yr

- Reliable measurements of Nion
- Photoionization modeling to convert Nion to NH and U
- Number Density via Troughs from metastable levels
- Distance of the Outflow from the Central Source:

$$U_H \equiv \frac{\Phi_H}{n_H c} = \frac{Q_H}{4\pi R^2 n_H c}$$

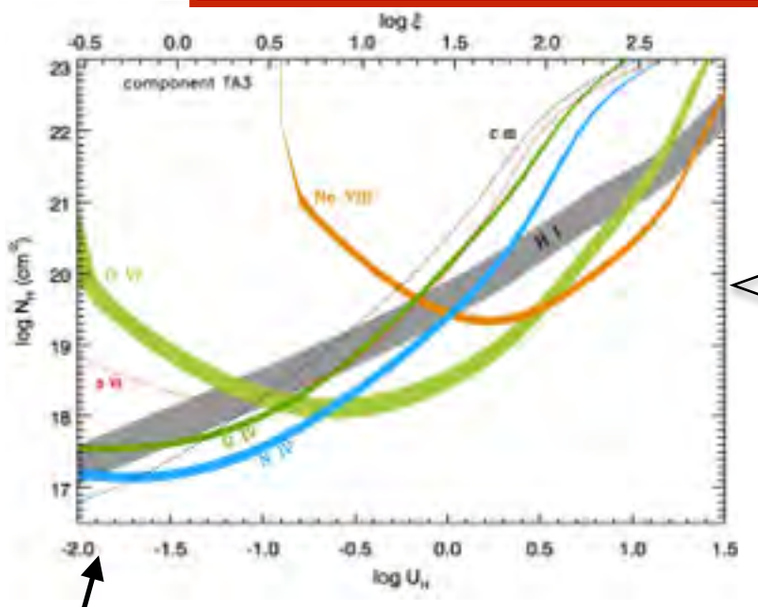
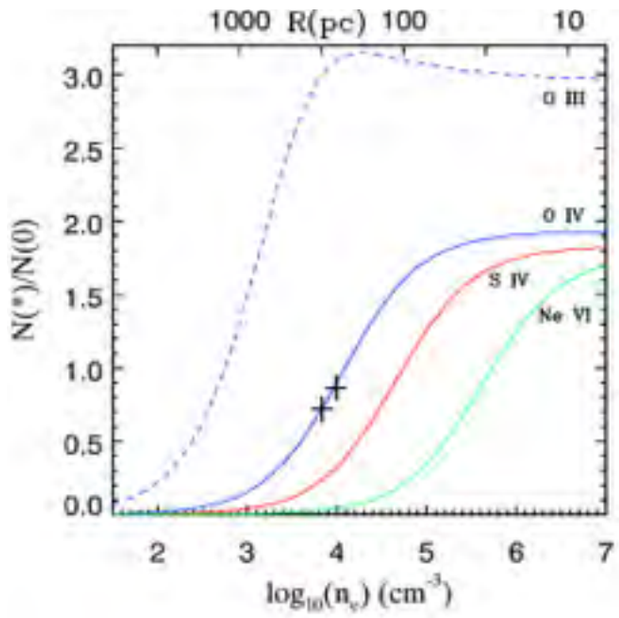



Photo ionization modeling to solve for NH and U

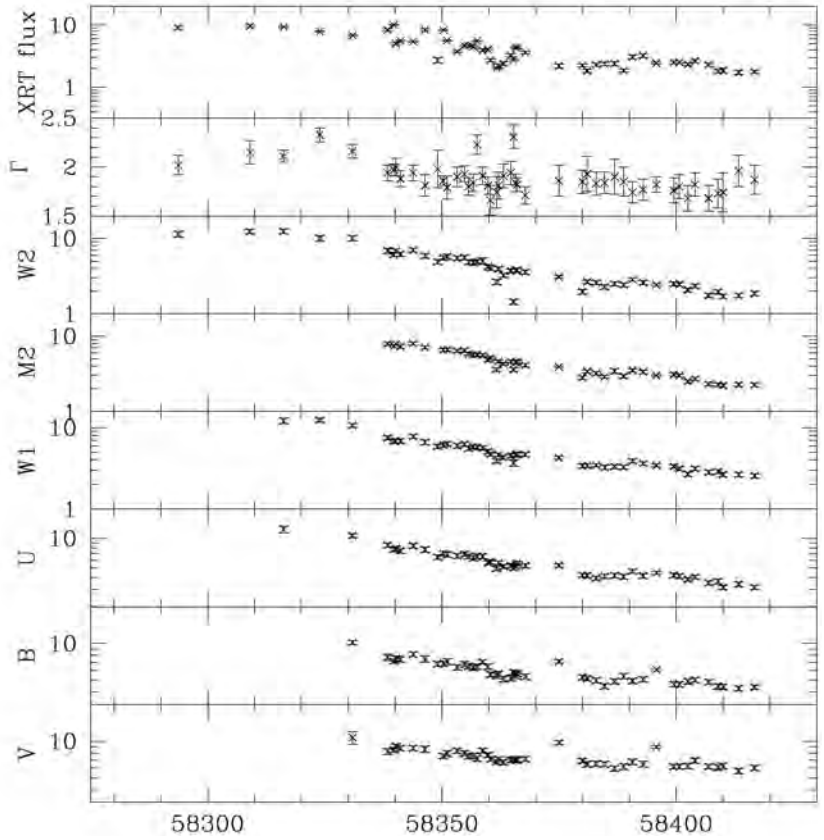



Fine structure lines to estimate electron density

**CLOUDY**

# NGC 1566: A Tempermental Changing Look AGN

Becca Mikula




- 40 Mpc, located in Dorado group
- Triggered INTEGRAL in June 2018 with Swift follow up
- Continued monitoring campaign sees changes in AGN classification- broadening and narrowing of Hα and Hβ lines
- Flare showed jump of around 3 mag in Swift W2 band and X-ray
- On steady decline currently