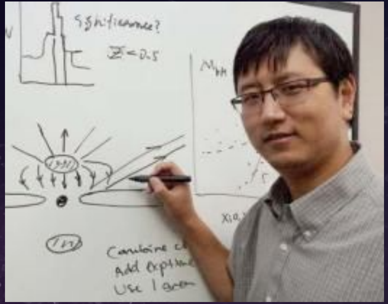
OU Astrophysics

Nikki Nielsen

Faculty

Xinyu Dai
Gravitational lenses, clusters, AGN



Mukremin Kilic
White dwarfs & their planets

Nikki Nielsen
CGM
Galaxy evolution

Michael Hayden
Galactic archaeology
Stellar abundances

Saloni Bhatiani
Instructor
Gravitational lensing

New Instructor
Fall 2026
(search this Summer 2026!)

Karen Leighly (retired)
AGN outflows

Sean Matt
Stellar theory
Rotation, winds, magnetism, accretion

Sergio Martin-Alvarez
Galaxy evolution theory
Magnetic fields, cosmic rays
Arriving Fall 2026

Postdocs

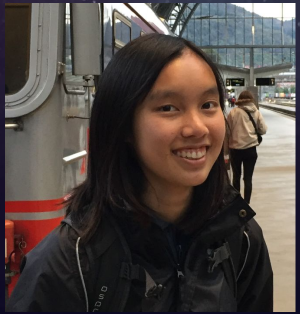
Dai Group

Marko Mi ćić
Dodge Fellow
Gal–AGN interactions

Heechan Yuk
AGN

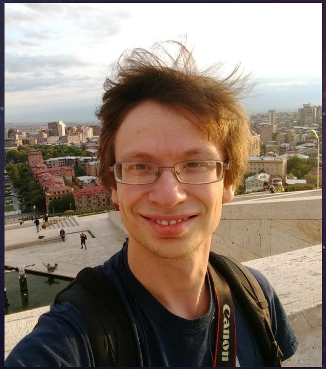
Matt Group

Javier Serna
Stellar activity



Jess Birky
Computational
Stellar

Kilic Group



Matthew Green
Binary stellar systems

Nielsen Group

Grecco Oyarzún
CGM/Galaxies

Sameer
CGM

Hayden Group

Carlos López-Cobá
Galaxy kinematics

Nagaraj Vernekar
Galactic archaeology

Research Facilities

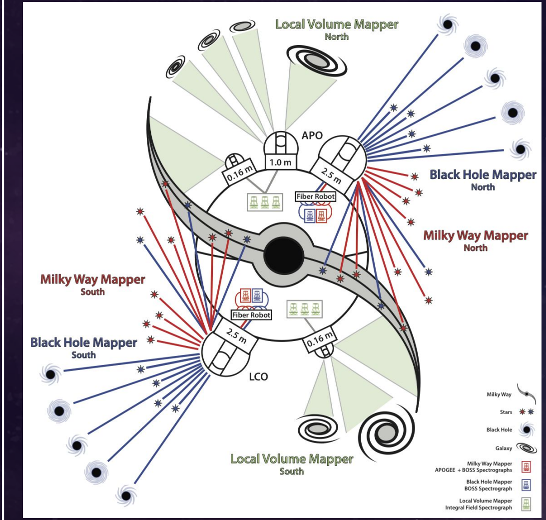
Apache Point Observatory 3.5m Telescope

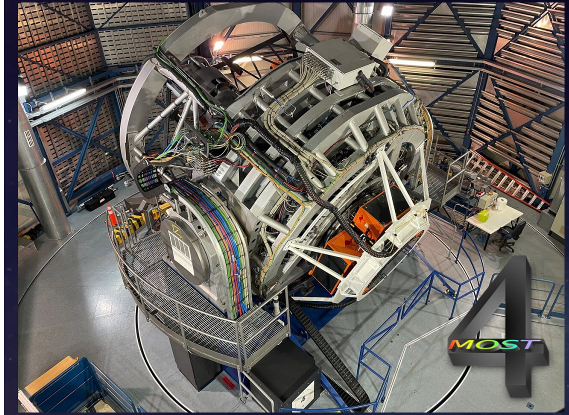
HST, *JWST*, Keck Observatory, Gemini Observatory,
Very Large Telescope, *Chandra X-ray Observatory*

70 half nights, remotely operated
Students can be PI

Research Facilities

Surveys: SDSS V, ASASSN, 4MOST, ULTRASAT, Galah, Geckos, DUVET, etc





Research Facilities

OU Supercomputing Center for Education and Research
→ OSCER

High performance computing
- Over 10,000 CPU cores, 23TB of RAM and 450TB of usable hard disk space

Free use for OU community
- Students can have accounts under advisor projects

Some faculty have dedicated nodes, storage space, etc

Henry Neeman, OSCER Director

Astrophysics at OU

New Astrophysics PhD program

First incoming class was 2024/2025

Third incoming class starting this fall

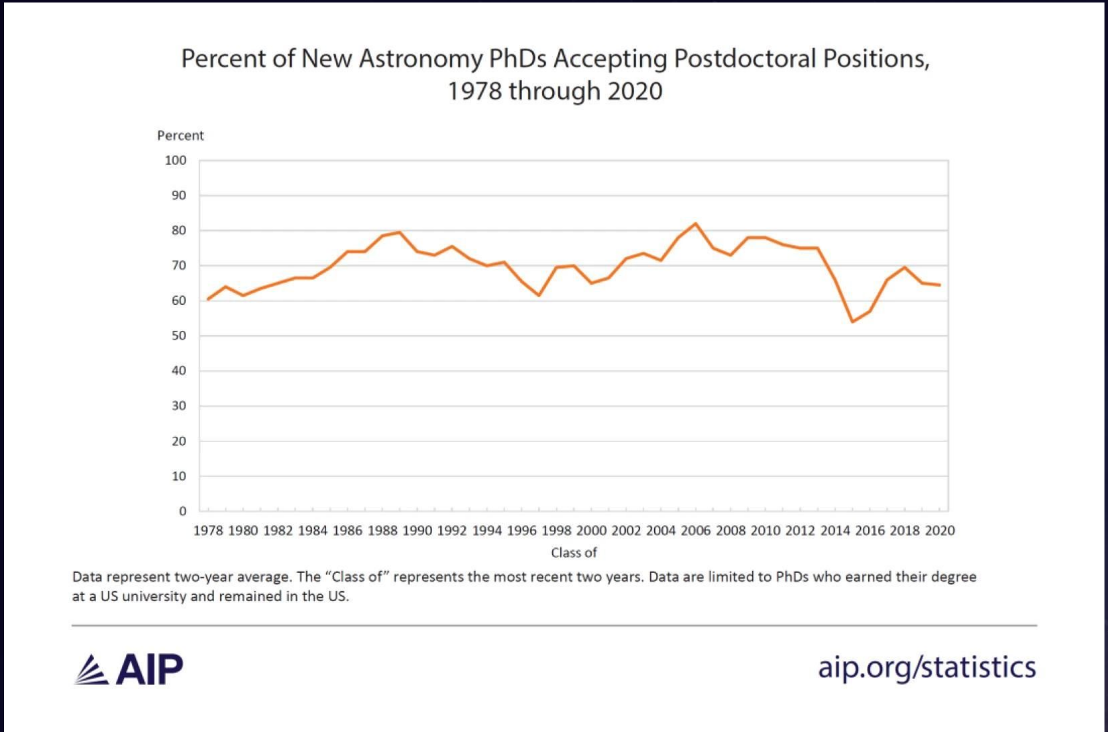
28 students total

Consider applying!

Observational class trip to APO

Lunar Sooners solar eclipse event

Grad School Outcomes



Most other grads go into tech-skill jobs such as:

- data science
- finance
- software
- policy
- research support

Telescope support (Keck, APO, STScI)

Science writing (Physics Today)

Science editor (Nature)

National Science Foundation

Satellite companies

Grad School Outcomes

Prof Hayden

Boquan Chen (2022) - Postdoc at Australian National University, then Ohio State University

Purmortal Wang (2023) - Postdoc at University of Utah

Prof Nielsen

Hasti Nateghi (2024) - Geospatial analyst at Australian Communications and Media Authority

Daniel McPherson (2024) - Bureau of Meteorology, Australia

Antonia Fernandez-Figueroa (2026) - Postdoc, CASSACA (Chile)

Prof Matt

Adam Finley (2020) - Postdoc at CEA Saclay (France), then ESTEC (Netherlands)

Angela Breimann (2021) - Data scientist at Ofcom (Scotland)

Tom Wilson (2022) - Data scientist at Smith Institute (Scotland)

Prof Kilic

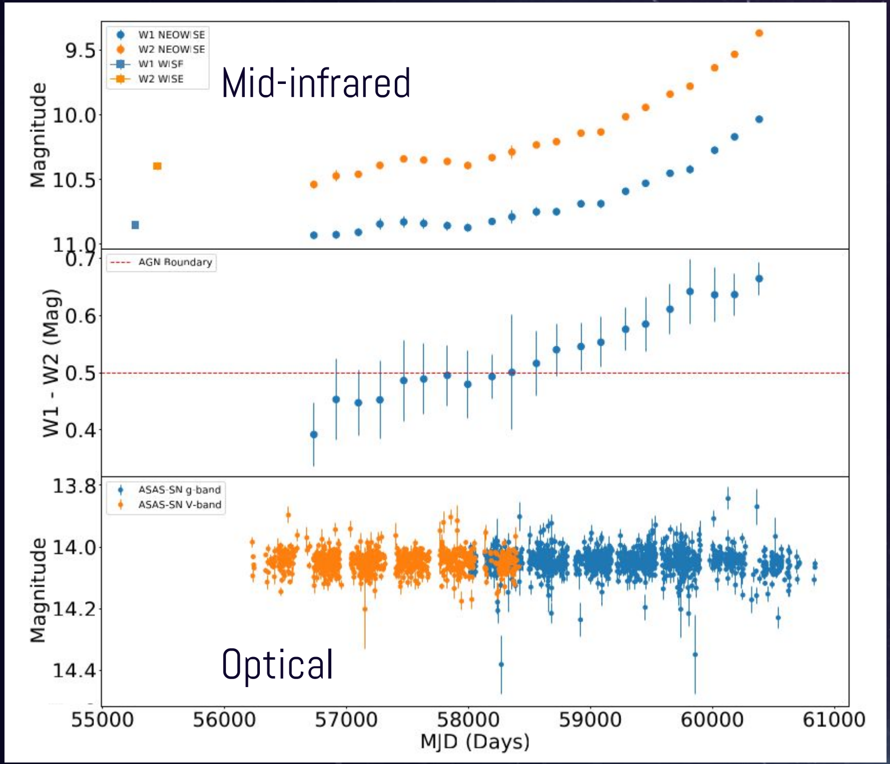
Alek Kosakowski (2021) - Postdoc at Texas Tech, then UNC Chapel Hill

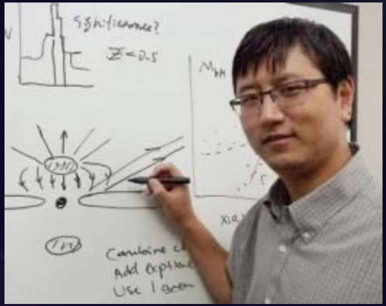
Onder Catmabacak (MS 2023) - Industry

Adam Moss (2025) - Postdoc at U Florida

Xinyu Dai

Gravitational lenses, galaxy clusters, active galactic nuclei, and gamma-ray bursts





Dai et al. 2026: A Decade-Long Increasing Mid-Infrared Luminosity in Galaxy NGC6447: a Turning-On Candidate of Active Galactic Nucleus

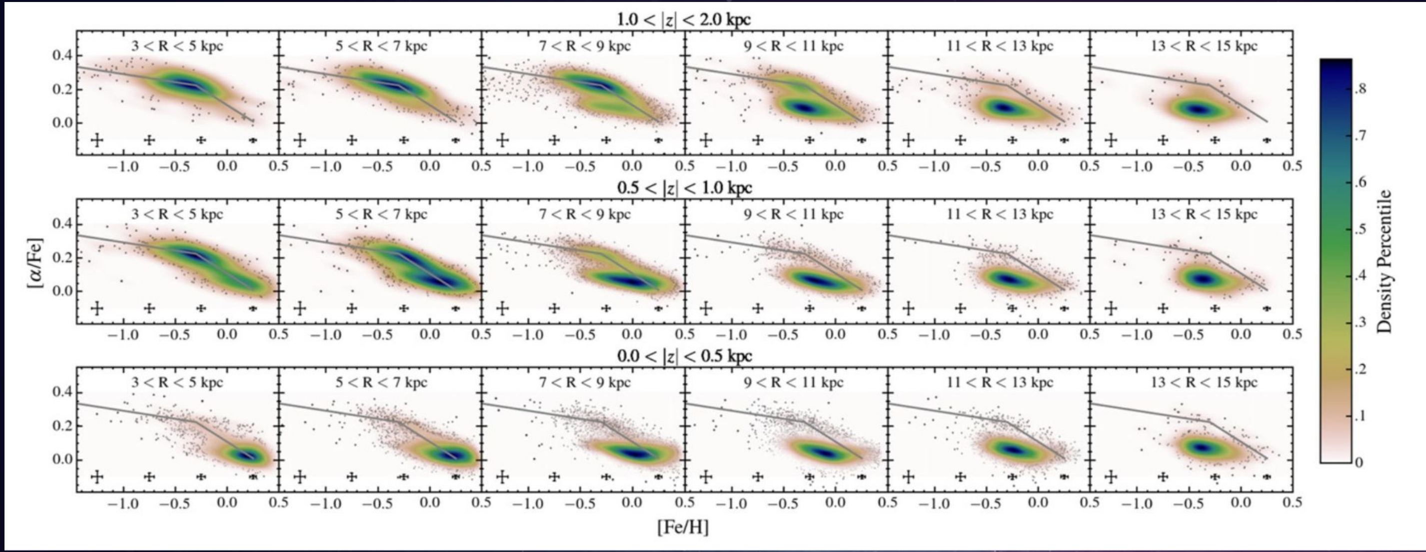
The gas surrounding the AGN in a nearby galaxy has dispersed recently, making the central engine visible

Michael Hayden

Galactic archaeology and galactic evolution

Hayden et al. 2015: Chemical Cartography with APOGEE: Metallicity Distribution Functions and the Chemical Structure of the Milky Way Disk

Spectra for 70,000 red giants. Elemental abundances vary with position in our Galaxy.

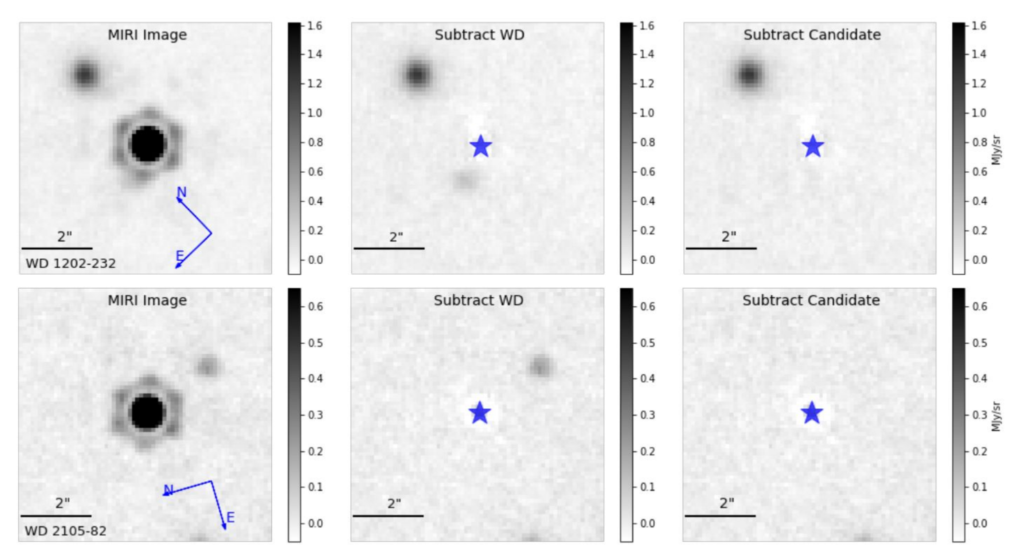


Mukremin Kilic

White dwarfs, planets and debris around white dwarfs

Mullally et al. 2024 (incl Kilic): JWST Directly Images Giant Planet Candidates Around Two Metal-Polluted White Dwarf Stars

Candidate planet separations of 11 AU and 35 AU, masses 1-7 M_{Jup}. JWST program to confirm the candidates



Sergio Martin-Alvarez

Galaxy evolution in simulations, magnetic fields, cosmic rays, SN feedback

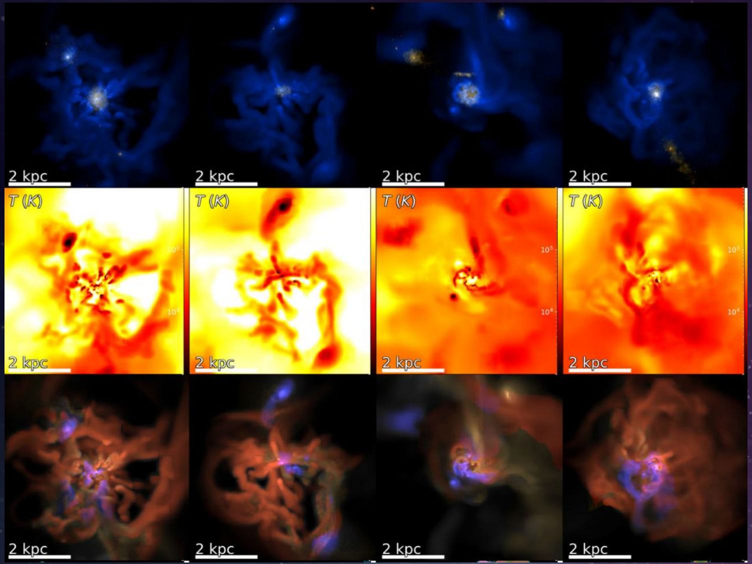
Martin-Alvarez et al. (2026): The Pandora project - II. How non-thermal physics drives bursty star formation and temperate mass-loaded outflows in dwarf galaxies

Standard simulations create outflows that are too energetic

Including radiation and cosmic rays produces outflows in better agreement with observations

Standard

Full physics



Densities

Gas temperatures

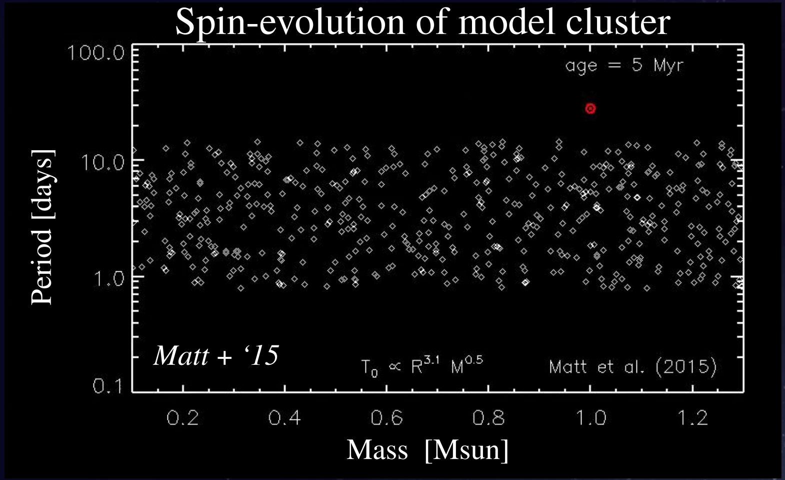
Gas velocities (blue in, red out)

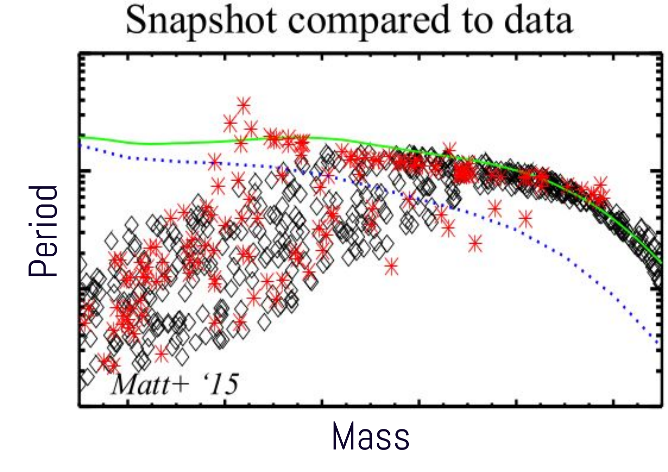
Sean Matt

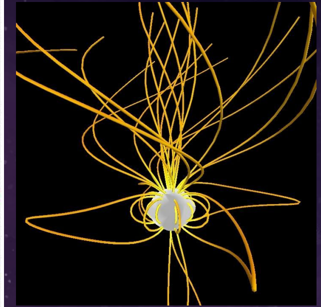
Theory of Stellar Rotation, Magnetism, Winds, Accretion

Matt et al. 2015: The Mass Dependence of Angular Momentum Evolution in Sun-Like Stars

Models of magnetic stellar wind torques and evolution of stellar rotation of Sun-like and low-mass stars

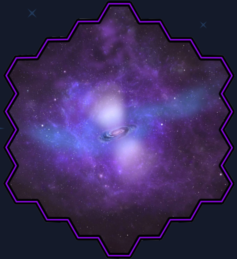






Nikki Nielsen

OU CGM Group



Postdocs

Sameer

Grecco Oyarzun

Graduate Students

Kaitlyn Linder

Amisha Rane

Haikun Xue

Jacob Callebs

Undergraduate Students

Jaden Cooper

Isabella Hildinger

Emily Thrun

Ethan Dyer

Yesenia Sanchez

Observing with the biggest telescopes

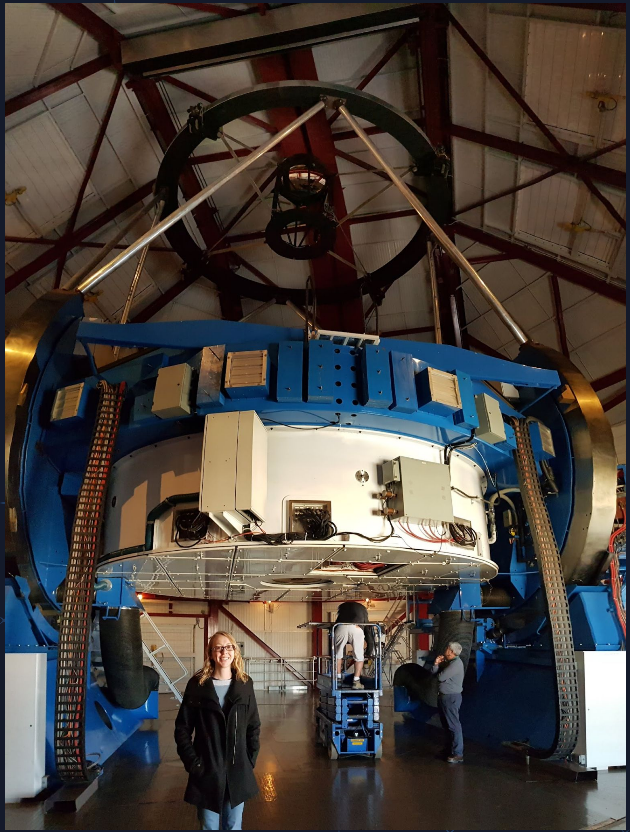
Apache Point Observatory, Sunspot NM

Sloan Digital Sky Survey Telescope 2.5 meters

APO 3.5 meter telescope

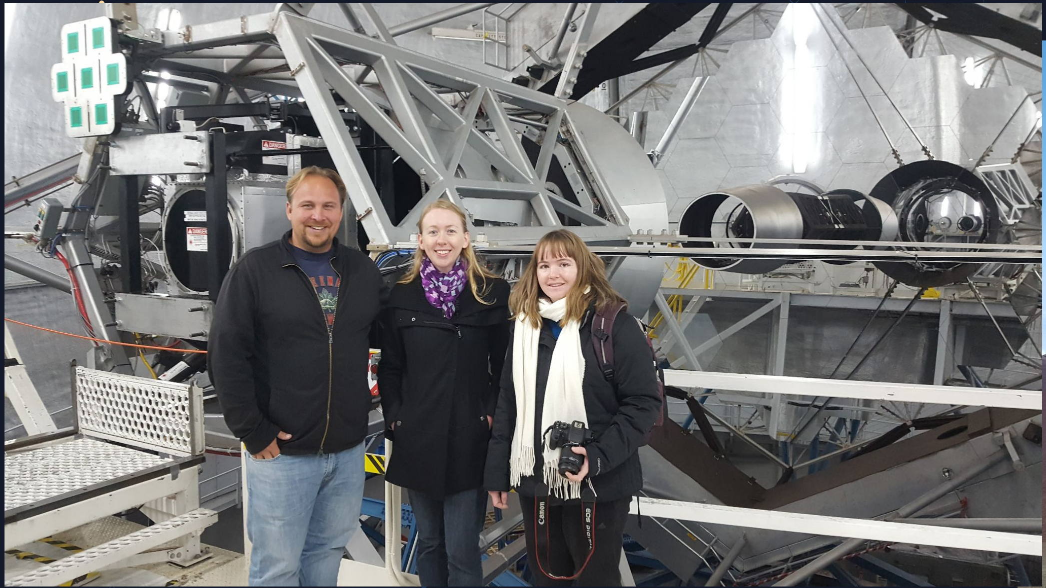
Observing with the biggest telescopes

Magellan Telescopes, 6.5 meters



Observing with the biggest telescopes

WM Keck Observatory Telescopes, 10 meters



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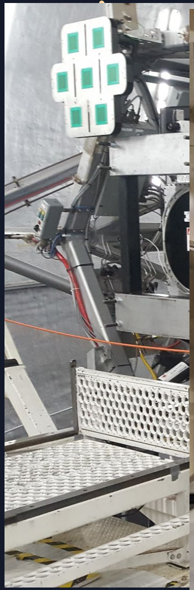
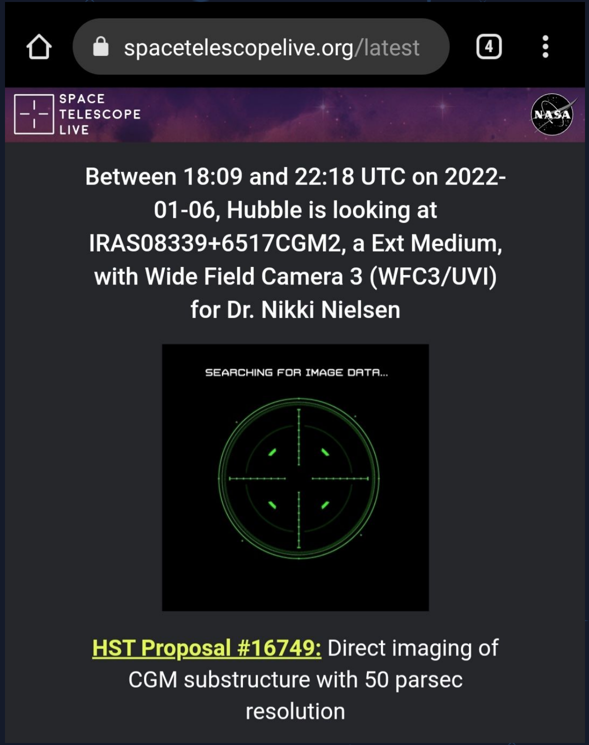
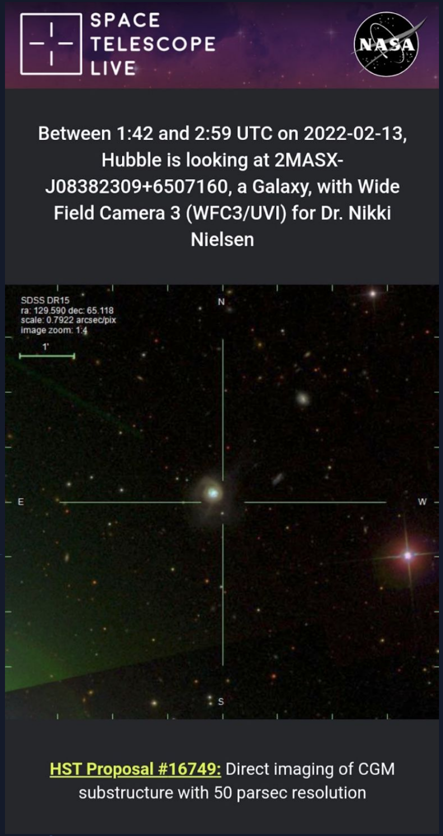


Observing with the biggest telescopes

Hubble Space Telescope, 2.4 meters

Kennedy Space Center



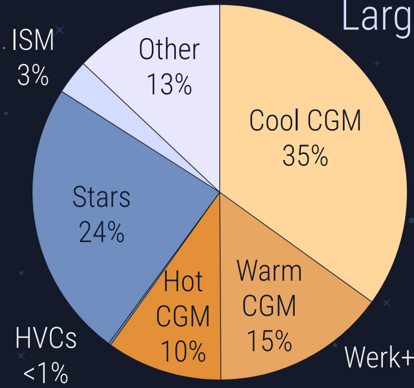


Defining the Circumgalactic Medium

Interface between the interstellar medium and intergalactic medium

Generally gravitationally bound material out to ~200 kpc (R_{vir})

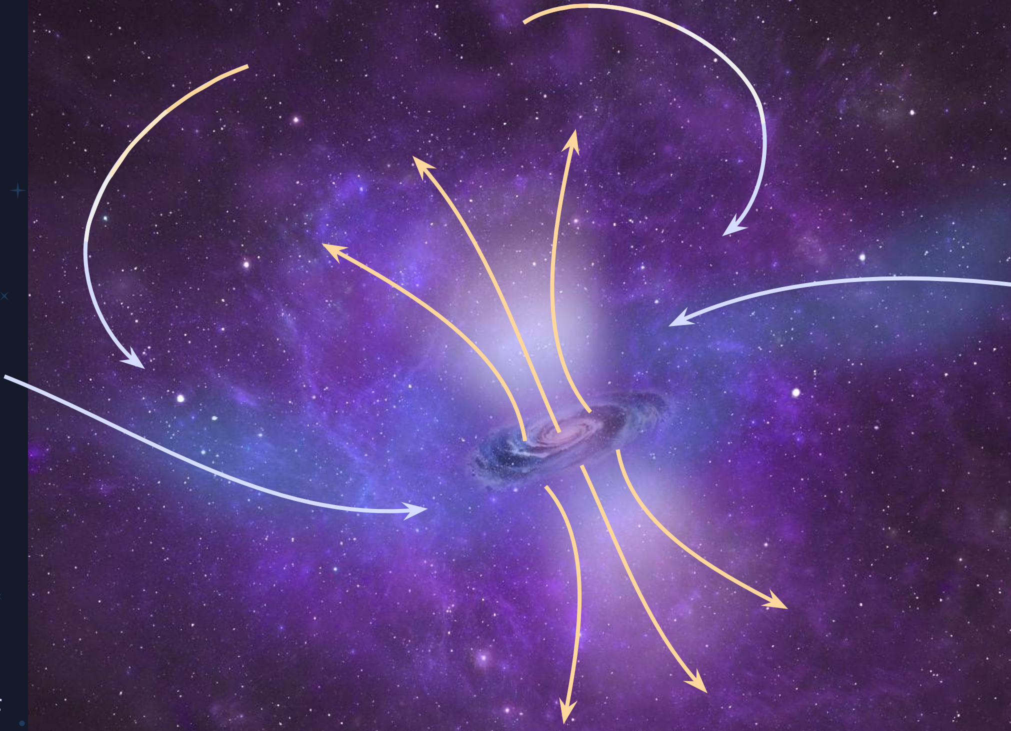
Diffuse ($n \sim 10^{-3}$ cm^{-3})
Multiphase ($T \sim 10^{4-7}$ K)



Werk+ (2014)

Large fraction of baryons (>50%)
CGM mass > **ISM** mass

Contains record of past gas flows

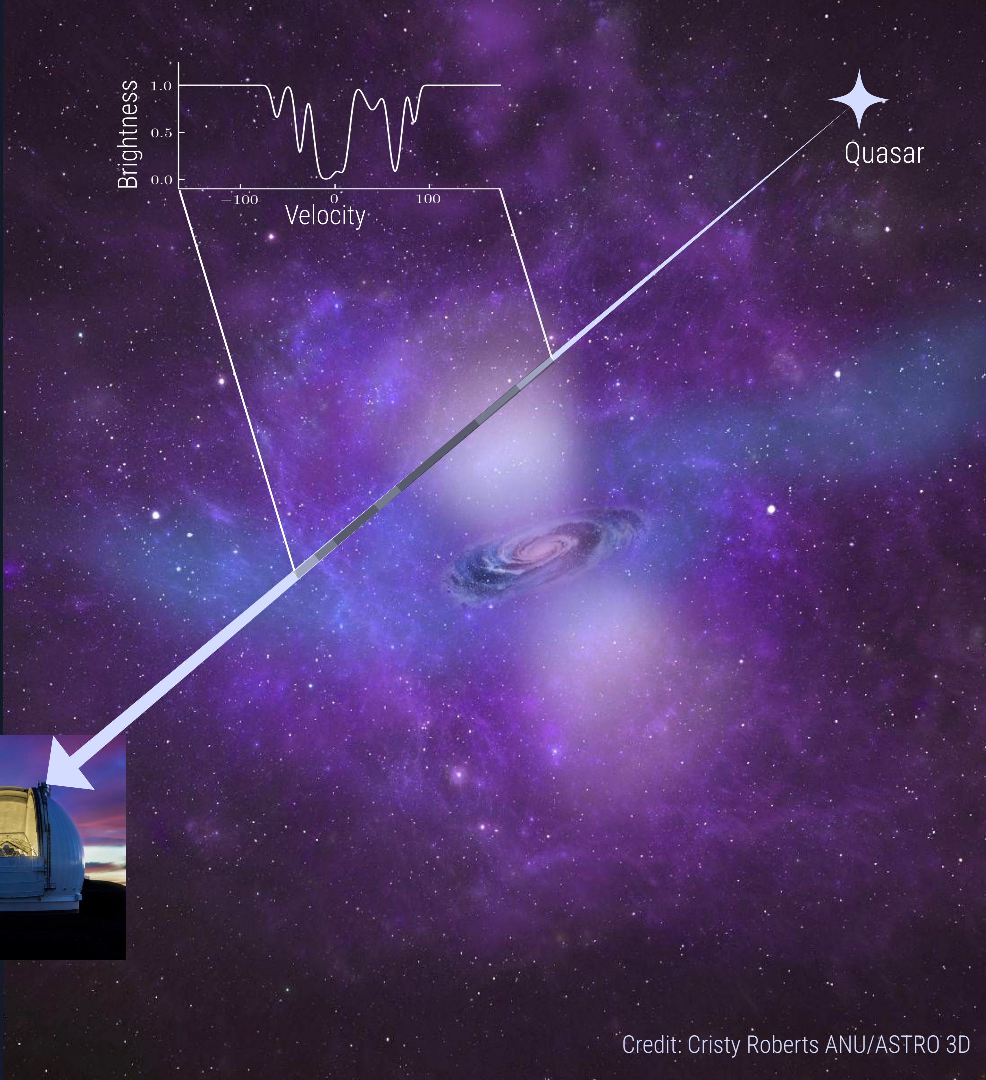


Credit: Cristy Roberts ANU/ASTRO 3D

Observing the **Circumgalactic Medium**

Typically done indirectly in absorption with pencil-beam probes

One of the motivations to build the Hubble Space Telescope!



How do galaxies transition from **star-forming** to **quiescent**?

- Where are the gas flows?
- What are their geometries, velocities, and metal content?
- How much mass is being moved around?
- How do these properties compare to the galaxy's star formation activity?

The **circumgalactic medium** (**CGM**) hosts and influences these gas flows

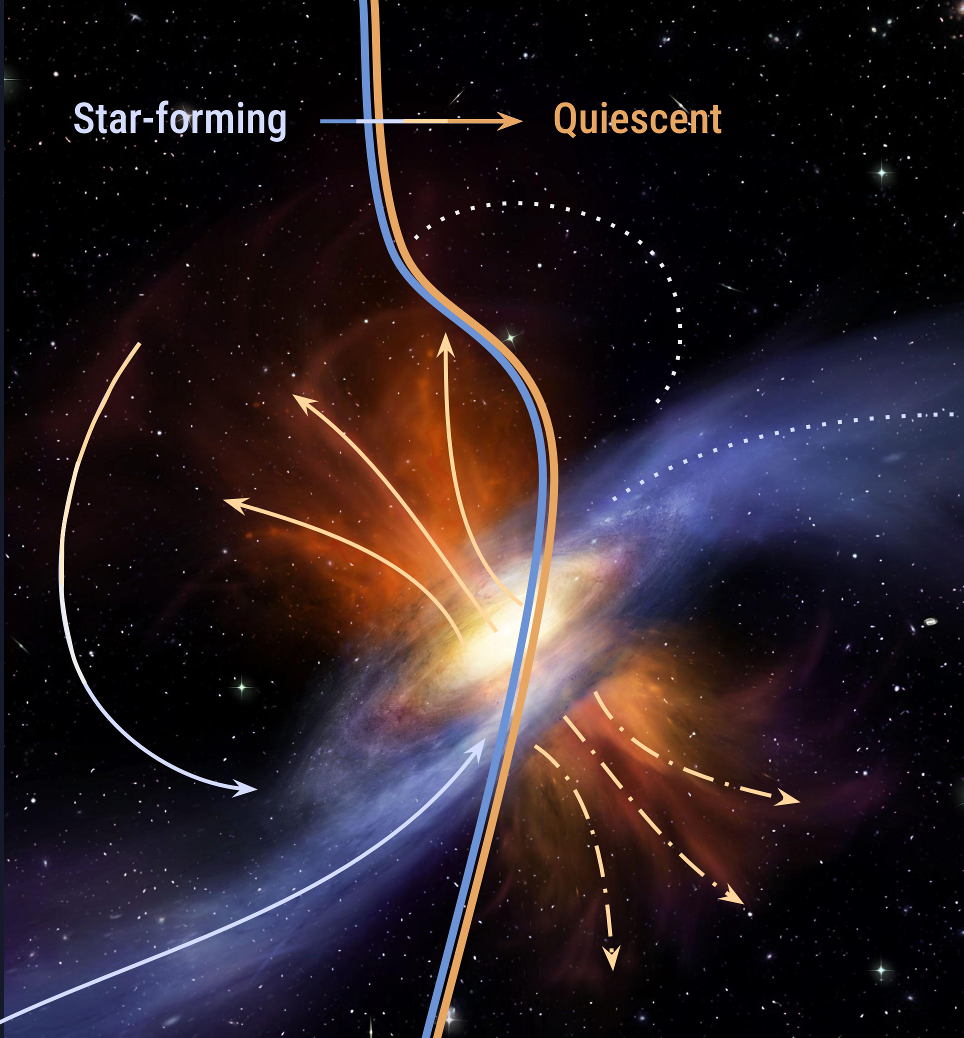
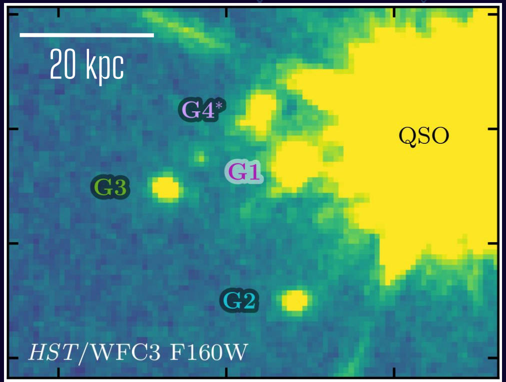


Illustration: James Josephides

The IntraGroup Medium of a Compact Group at z=2.43:
Outflows, Accretion, and Tidal Streams



Galaxies G1, G2, and G3 identified by **Lyα** emission in **KCWI/Keck**

G4* has no emission but is similar size and colour

Tidal streams may be present between galaxies

Nielsen+ (2022); also see Fernandez Figueroa, GGK, NMN+ (2024)

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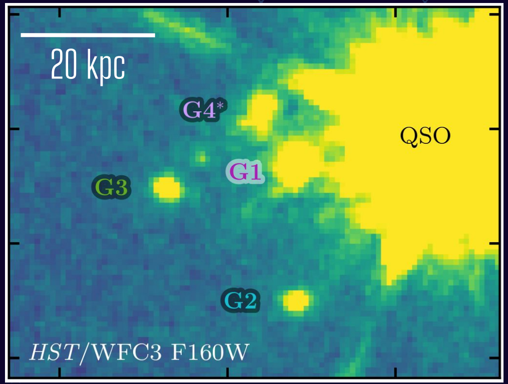

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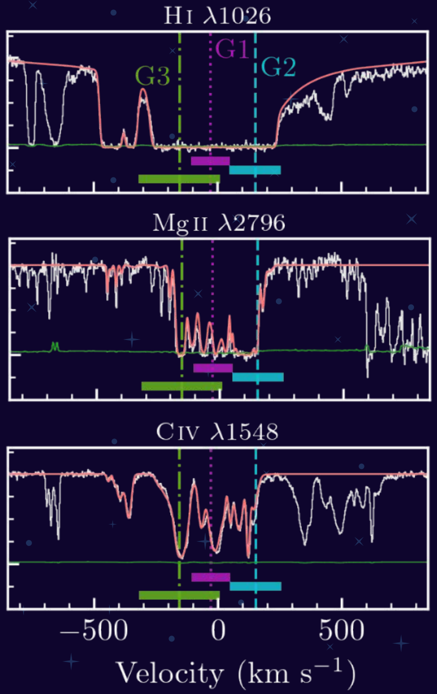
UVES/VLT Quasar Spectrum:
Features a **DLA** and *ultra-strong* **MgII** absorption



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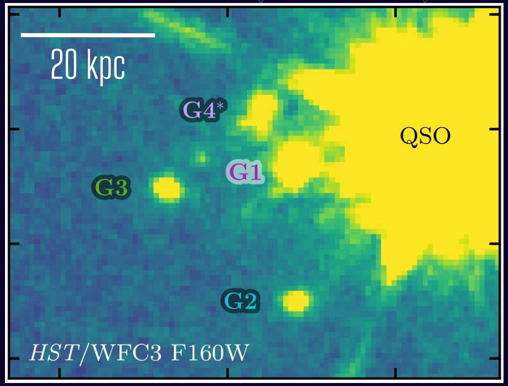

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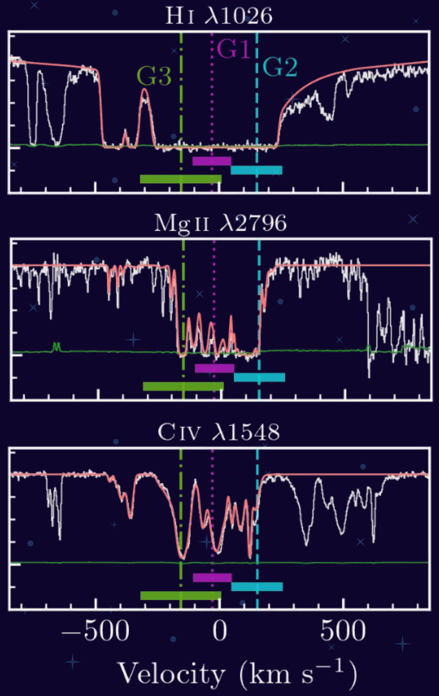
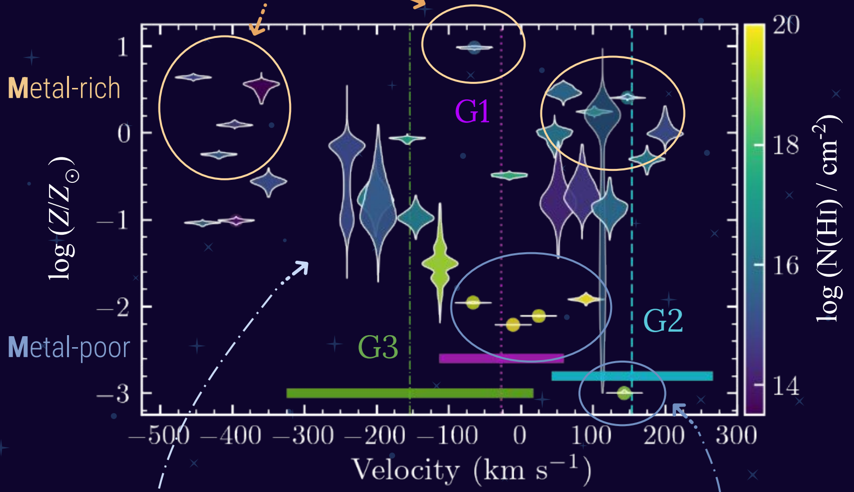


Cloud Metallicities:

Outflowing gas clouds
v_{out} ~ 400 km s^{-1}

G1 is driving outflows
SFR$_{G1}$=17 M$_\odot$ yr^{-1}



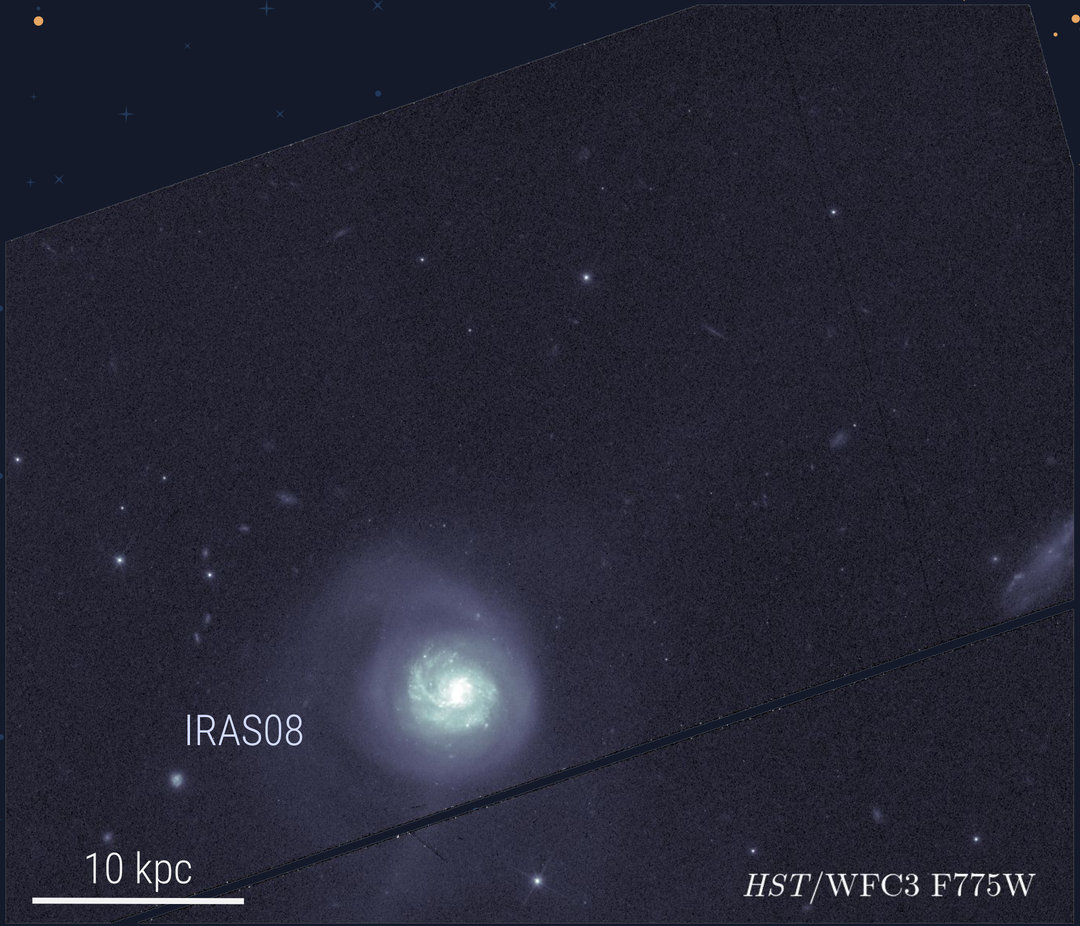
Rest of clouds are tidal and intragroup material

Accreting gas clouds falling onto the group

Nielsen+ (2022); also see Fernandez Figueroa, GGK, NMN+ (2024)

IRAS08: A nearby starbursting galaxy

- z_{gal} = 0.019: 270 million ly away
- Average mass: $\log M_*/M_\odot = 10$
- "Face-on" disk: $i \sim 15°$
- Compact: 2.4 kpc = 8,000 ly
- HI plume contains 70% of neutral gas in system



Nielsen+ 2024

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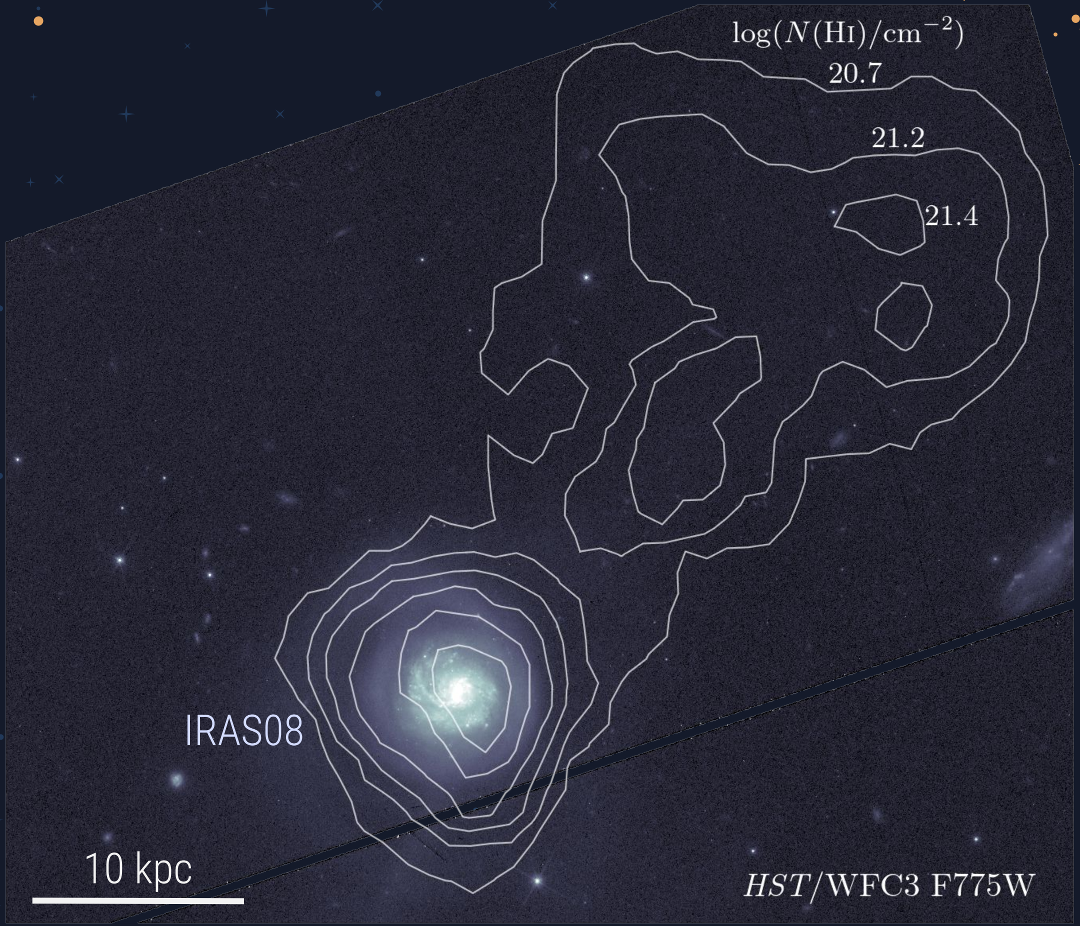

Nielsen+ 2024

CGM emission is everywhere!

- z_{gal} = 0.019: 270 million ly away
- Average mass: log $M_*/M_\odot$ = 10
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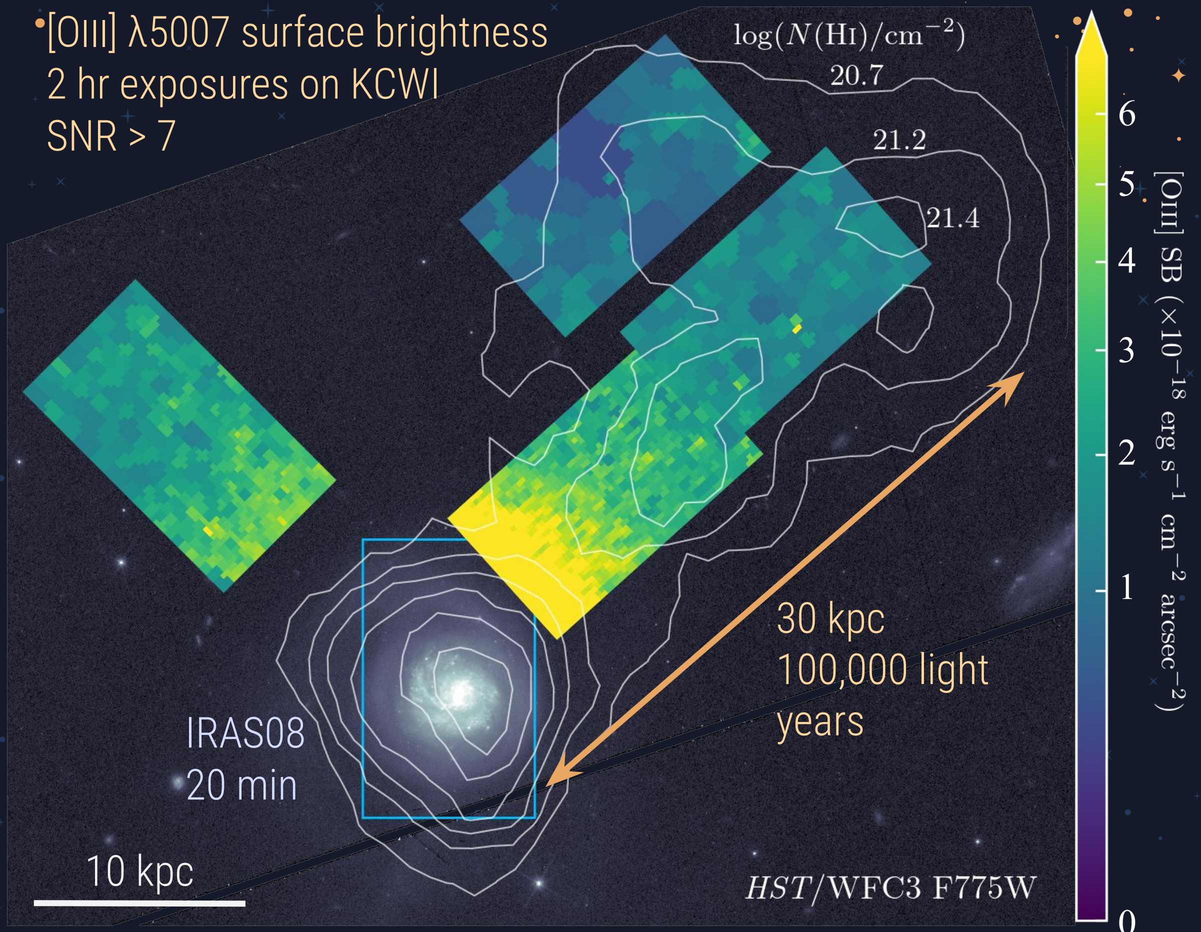
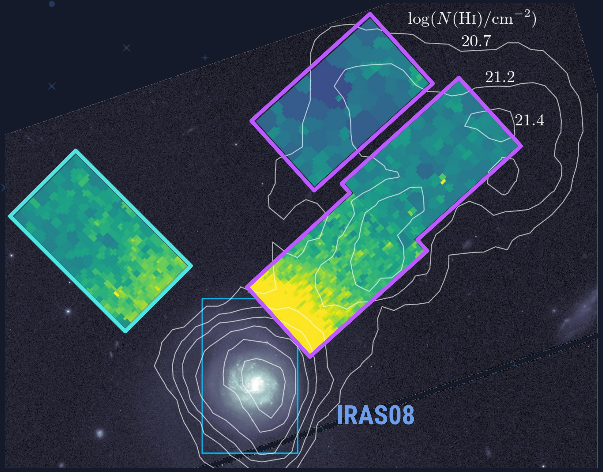
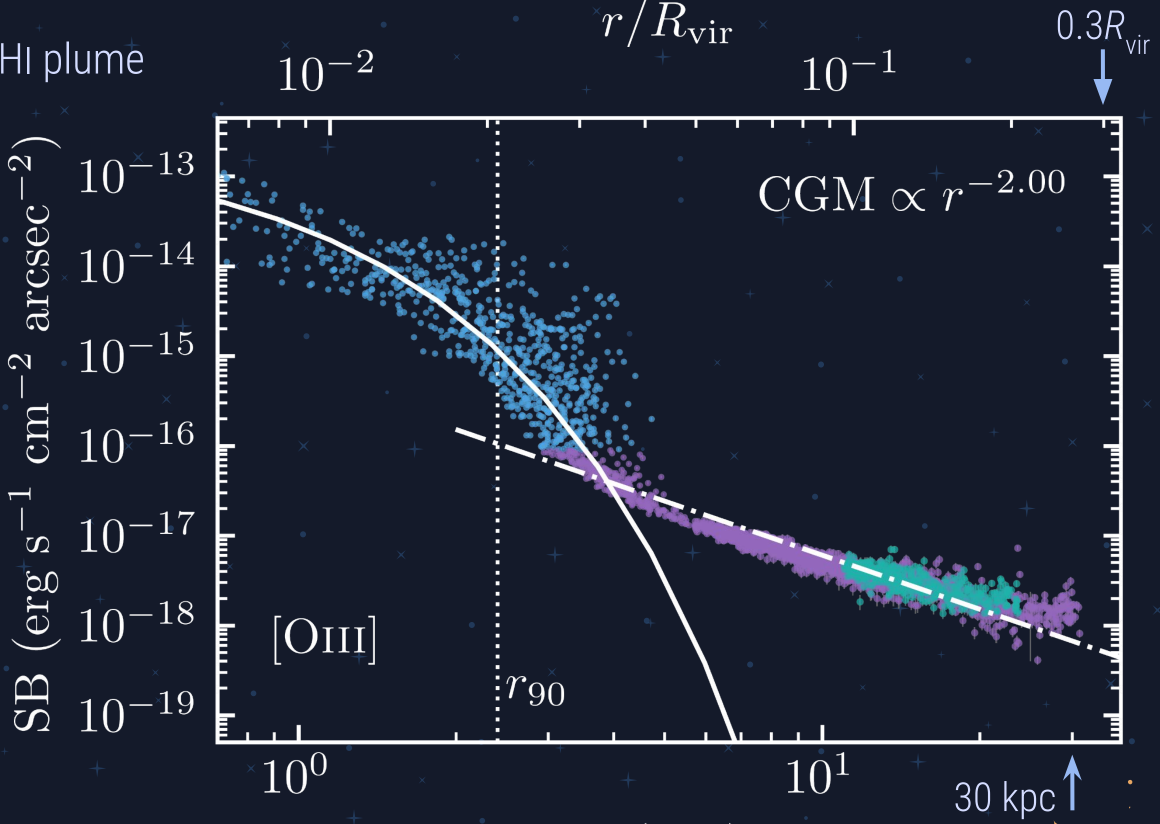


Nielsen+ 2024

Surface Brightness profiles – [OIII] $\lambda 5007$

- No azimuthal variation **on** vs **off** the HI plume
- Transition between **ISM** and **CGM** at ~4 kpc! (~$2r_{90}$)





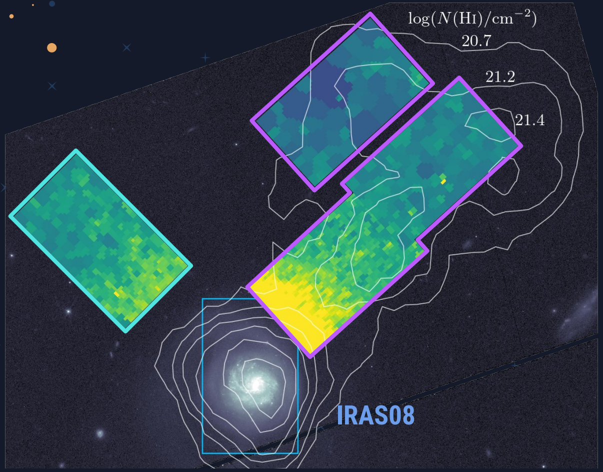
r_{90} = 90% radius of optical light

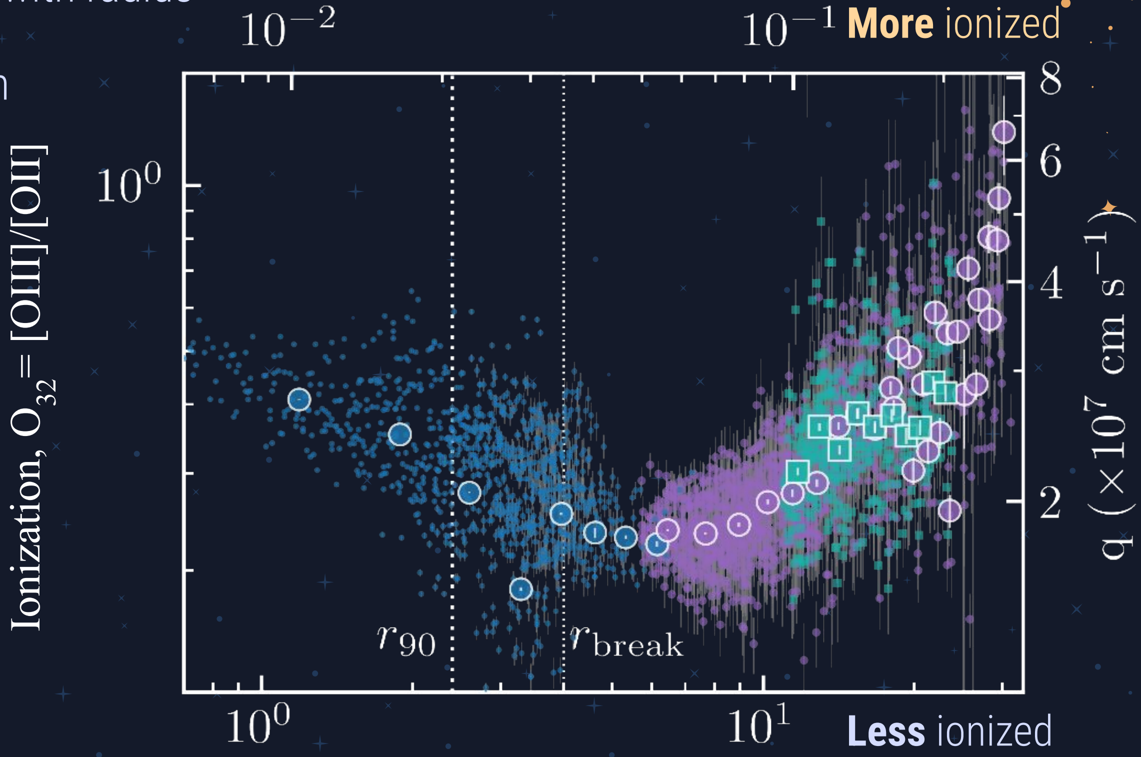
Nielsen+ 2024

The ionization mechanism changes in the CGM

ISM: ionization *decreases* with radius

CGM: *increasing* ionization with radius





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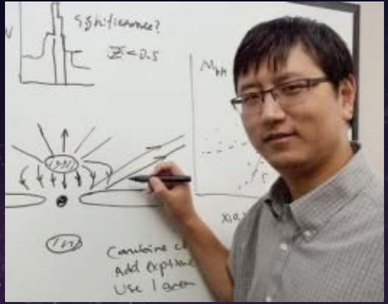
Nielsen+ 2024

Faculty

Xinyu Dai
Gravitational lenses, clusters, AGN



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AGN outflows

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White dwarfs & their planets

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Stellar theory
Rotation, winds, magnetism, accretion

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Galaxy evolution

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Galactic archaeology
Stellar abundances

Sergio Martin-Alvarez
Galaxy evolution theory
Magnetic fields, cosmic rays
Arriving Fall 2026

Saloni Bhatiani
Instructor
Gravitational lensing

New Instructor
Fall 2026

(search this Summer 2026!)