



DISCOVERING INTRAGALACTIC SPECTRA WITH COSMIC ORIGINS

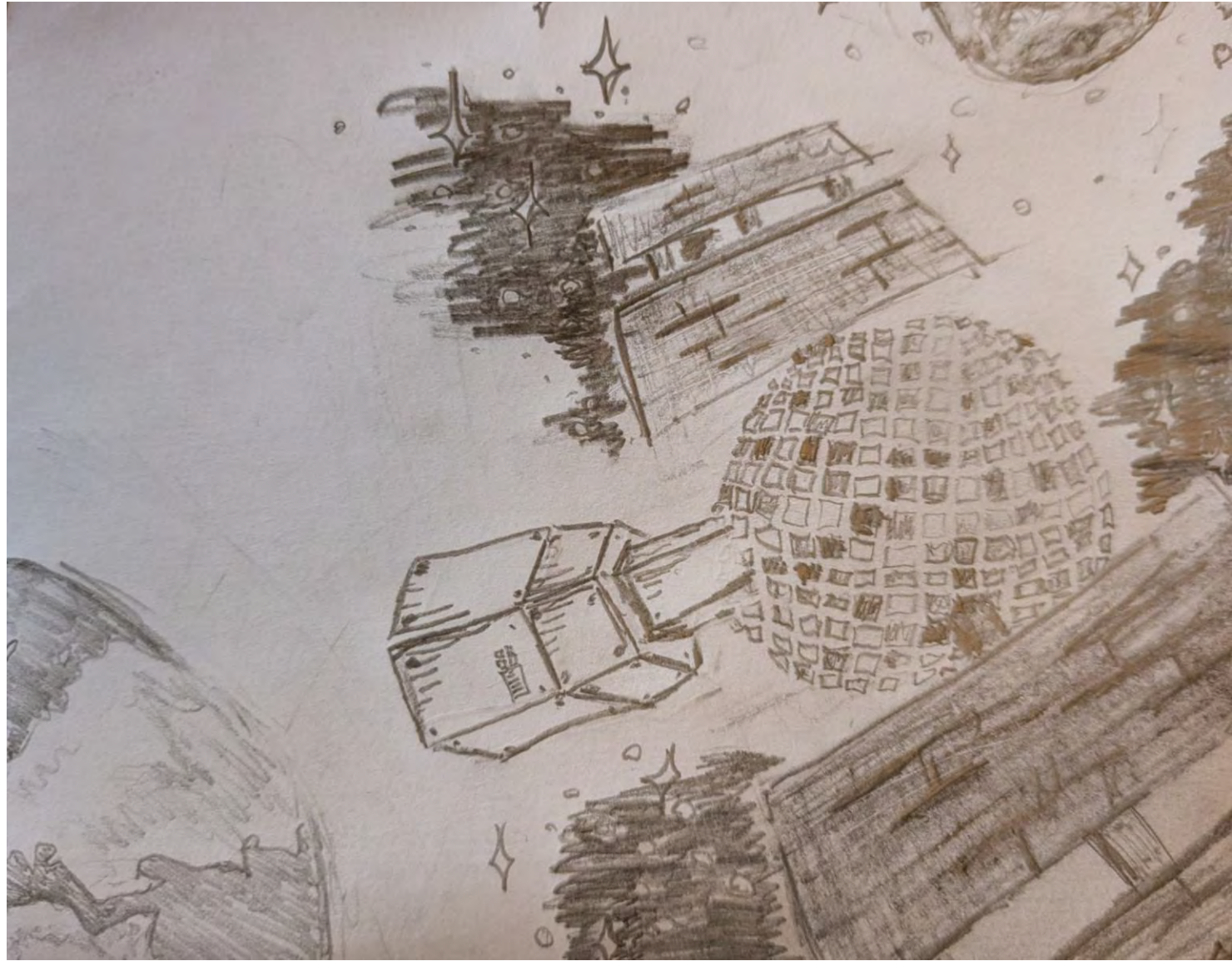
S. Tuttle, PI

May 2026



Deputy PI: Jess Werk (UW)
Project Scientist: Sanch Borthakur (ASU)
Instrument Scientist: Mike Davis (SWRI)
Deputy PS: Frances Cashman (PC)
Deputy IS: Emily Witt (JHU)

Project Manager: Gabe Loftus (SDL)
Systems Engineer: Sara Susca (SDL)
Spacecraft Lead: Randy Rose (SWRI)



**NASA Solicitation NNH26ZDA0110
Astrophysics Explorers Program
2026 Small Explorer (SMEX)**



DETERMINING INTRAGALACTIC STRUCTURE WITH COSMIC ORIGINS

*Creating the first maps of our cosmic
ecosystem of nearby galaxies, connecting
galactic properties and processes to the
infrastructure of the universe*



TEAM & INSTITUTIONS

UNIVERSITY of
WASHINGTON



PennState



SOUTHWEST RESEARCH INSTITUTE

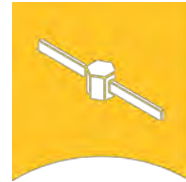


BERKELEY LAB



SPACE DYNAMICS
LABORATORY

HORIBA

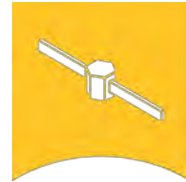


SSL

KSAT
KONGSBERG
KONGSBERG SATELLITE SERVICES



TRUSTED
SPACE



SSL

KSAT
KONGSBERG
KONGSBERG SATELLITE SERVICES



JOHNS HOPKINS
UNIVERSITY

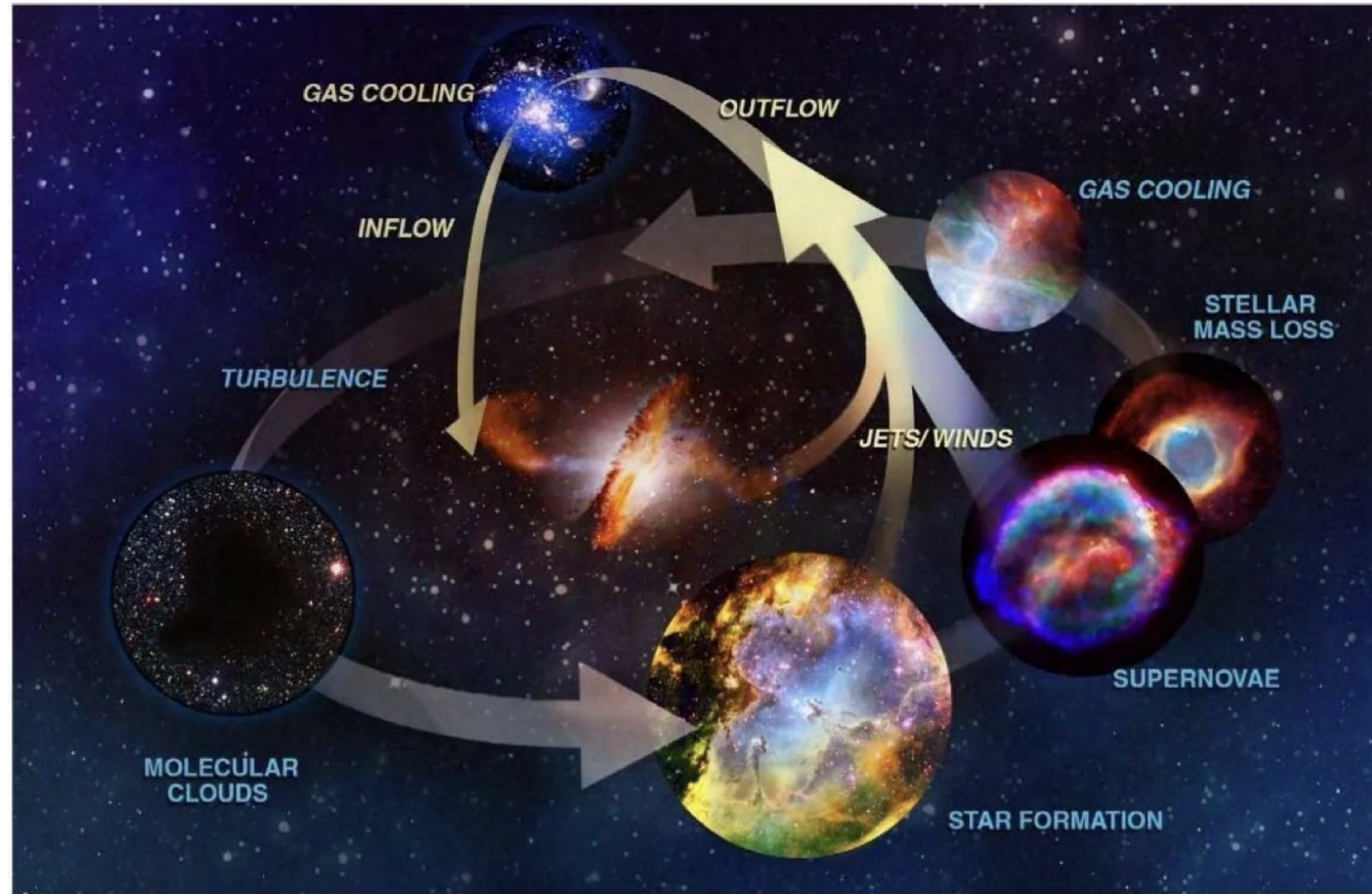
ASU Arizona State
University



ASTRO2020

KEY QUESTION

D-Q2: How do gas, metals, and dust flow into, through, and out of galaxies?

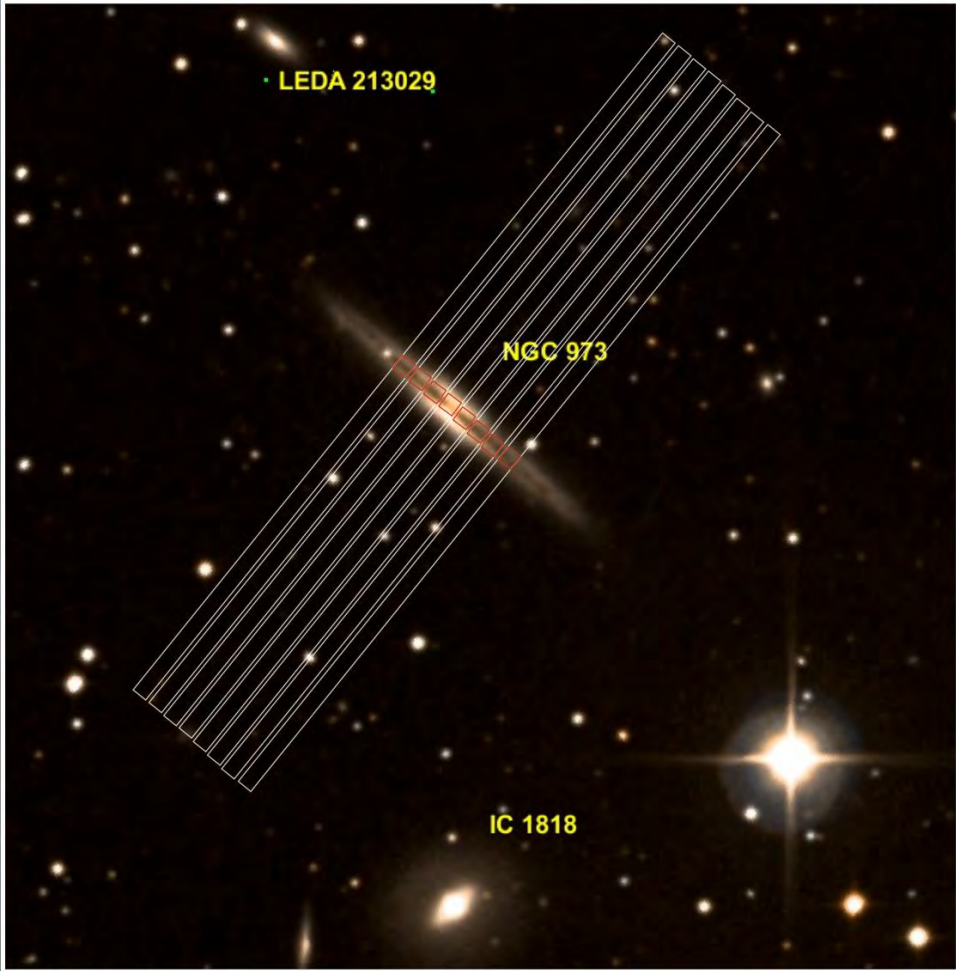
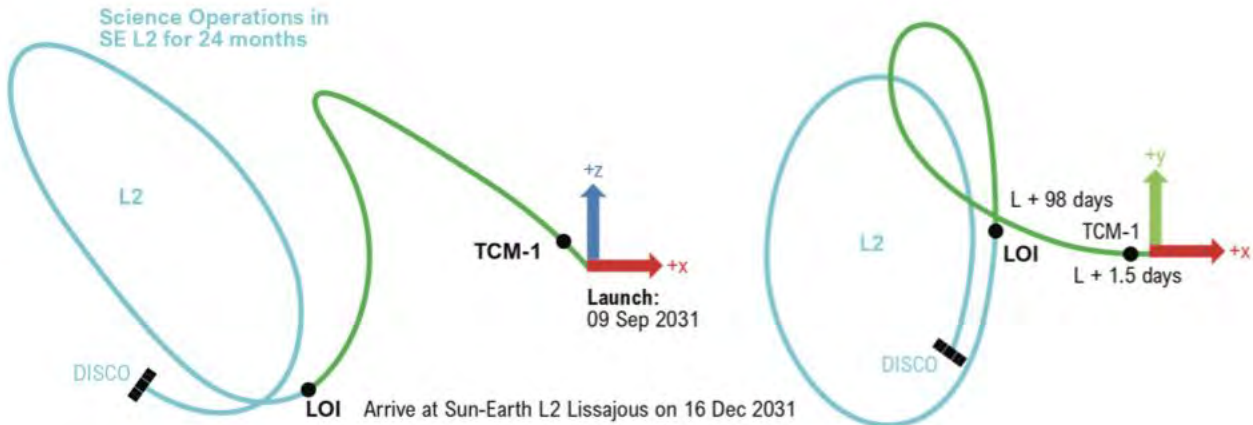
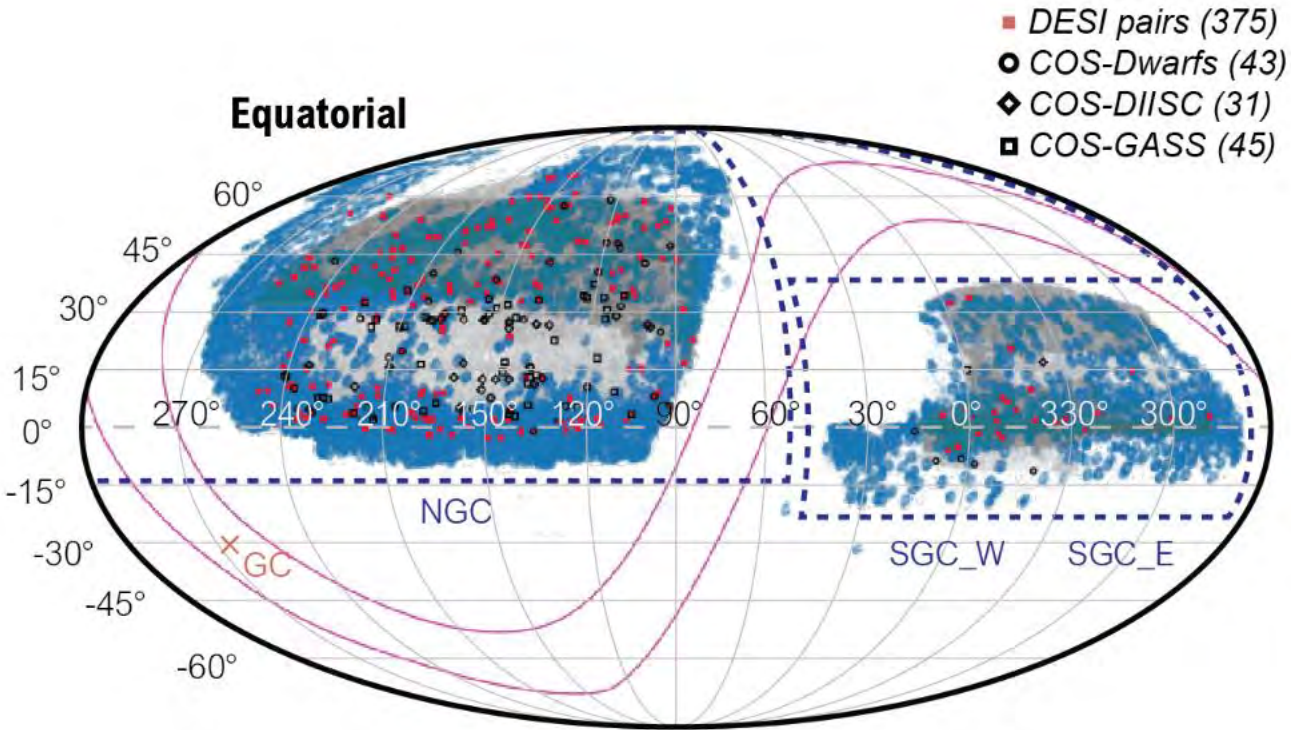


DISCO SCIENCE GOALS

- **Characterize the diffuse circumgalactic medium:** Trace diffuse CGM at $10^5 \text{ K} < T < 10^6 \text{ K}$ in a statistical sample of galaxies. Characterize the physical structure of the CGM across galaxy properties using cool gas tracers (CII, SII), Intermediate temp gas tracers (CIII and SIII), and warm gas traces (OVI and NV). Confirm or rule out OVI relationship to star formation rate.
- **Connect galactic feedback to the CGM:** Measure combined OVI emission and absorption spectra of star-forming galaxies to create spatial and kinematic maps of the warm/hot CGM to constrain the relationship between gas transport and gas regulation in galaxies.
- **Trace Milky Way gas flows:** Within our Milky Way Galaxy, measure column densities of multiphase gas species to determine metallicities, dust depletion, molecular fractions and kinematics, quantifying signatures of inflow and outflow that sustain the Galactic ecosystem.

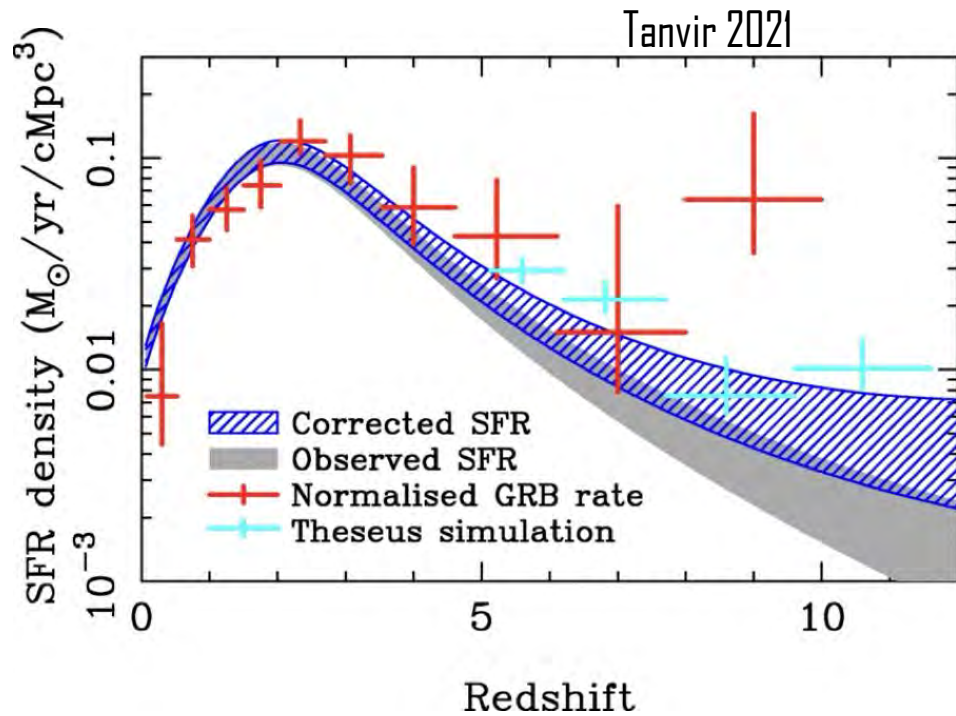
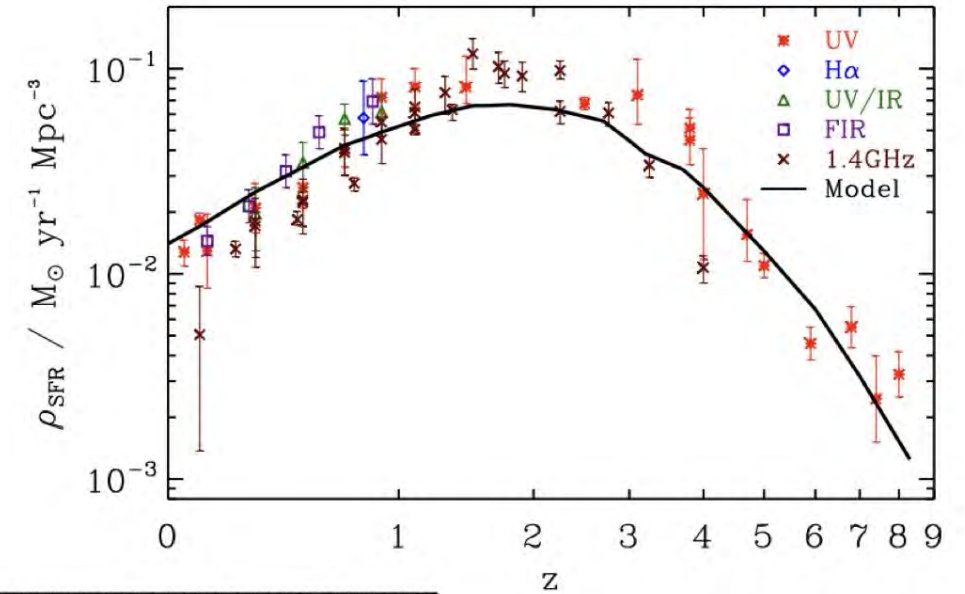
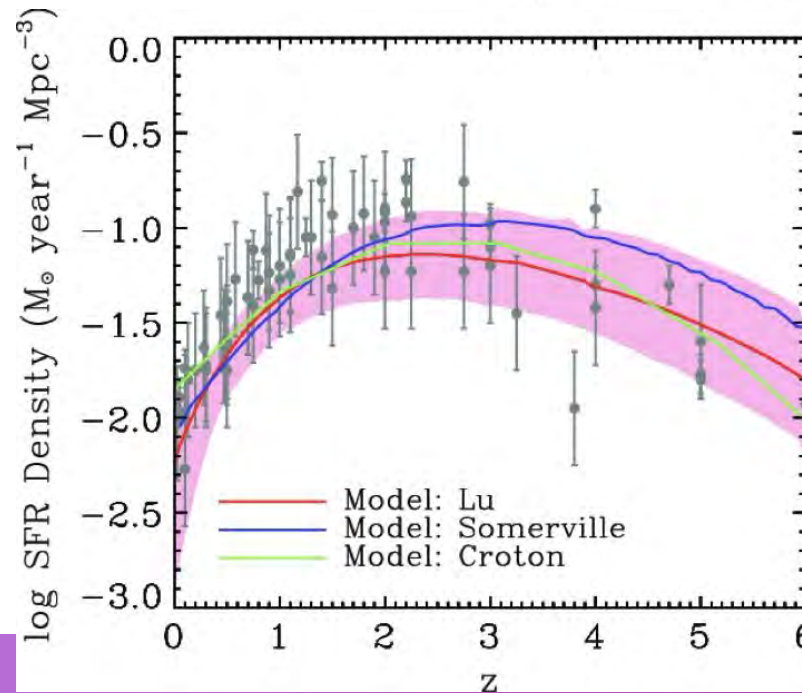


DISCO APPROACH



STAR FORMATION OVER TIME

Master 2012



Lu 2014

INTERNAL VS EXTERNAL EVOLUTIONARY EFFECTS

External

Prolonged infall of gas
Mergers and hierarchical clustering
Galaxy harassment
Gas stripping by collisions and ICM

Internal

Driven by:
Dark matter halo
Bars and distortion
Spiral structure
Galactic winds
Nuclear black holes



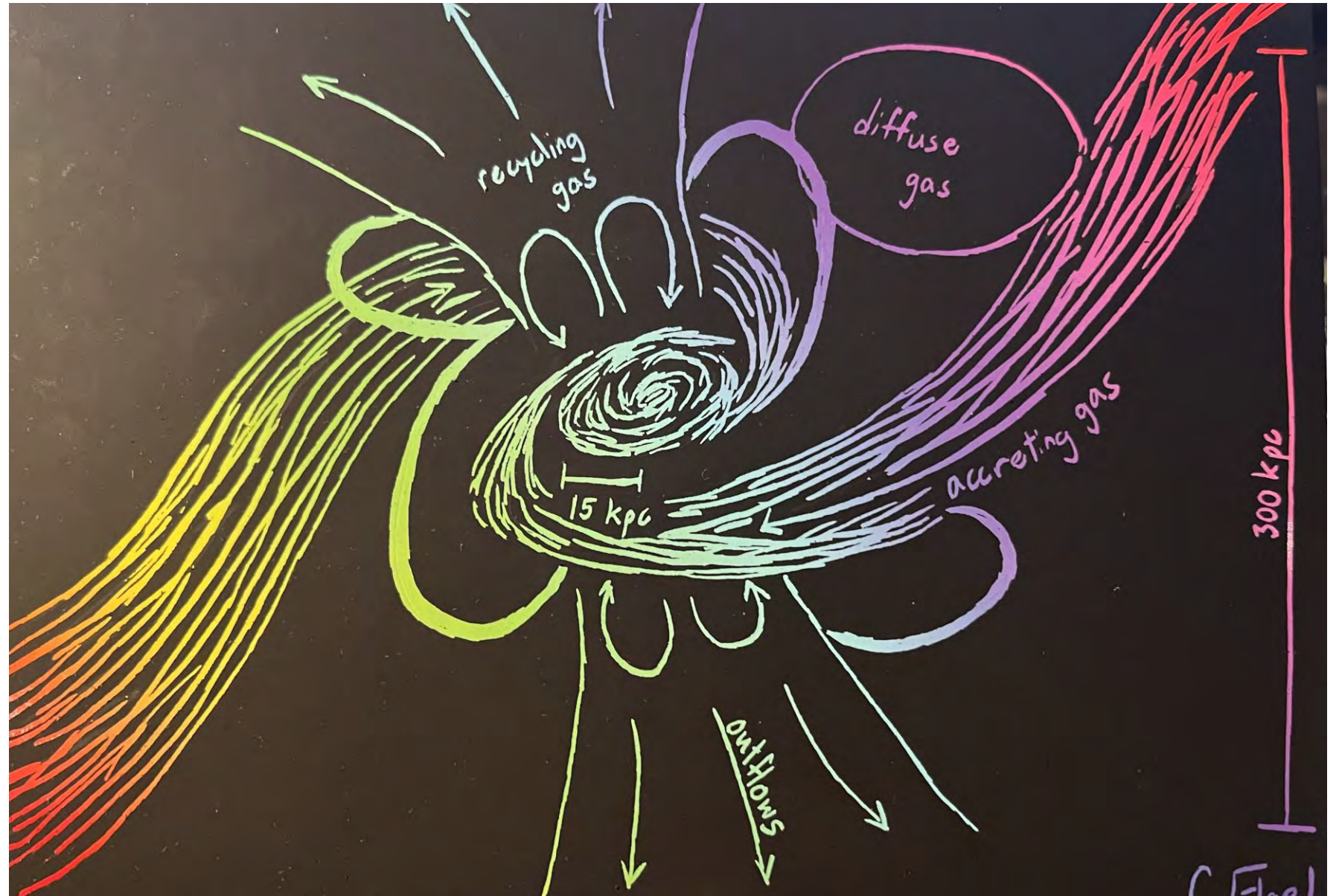
EXTENDED GALAXY GAS



Extended Disk of Galaxy M83



THE CIRCUMGALACTIC MEDIUM



From Tumlinson, Peebles and Werk 2017

C. Igel for ASTR 323

THE CIRCUMGALACTIC MEDIUM

The circumgalactic medium (CGM) is a collection of multi-phase gas between a galaxy and the intergalactic medium in which the galaxy is embedded.

This gas is warm/hot (10^4 - 10^6 K) and diffuse. This has historically made it difficult to detect.

High energy -> UV and X-ray Diffuse -> Low surface brightness



B - Instrument Performance

Characteristic	Requirement	Capability
Wavelength range	100-140 nm	97-144 nm
Field of View	8 x 360 arcsec (LSS); 8 x 8 arcsec (ES)	8 x 360 arcsec (LSS); 8 x 8 arcsec (ES)
Spectral Resolution @ 100 nm	3,300 (LS); 33,000 (ES)	3,440 (LS); 35,000 (ES)
Effective Area @ 103 nm	58 cm ² (LS); 25 cm ² (ES)	82 cm ² (LS); 30.3 cm ² (ES)

DISCO will provide:

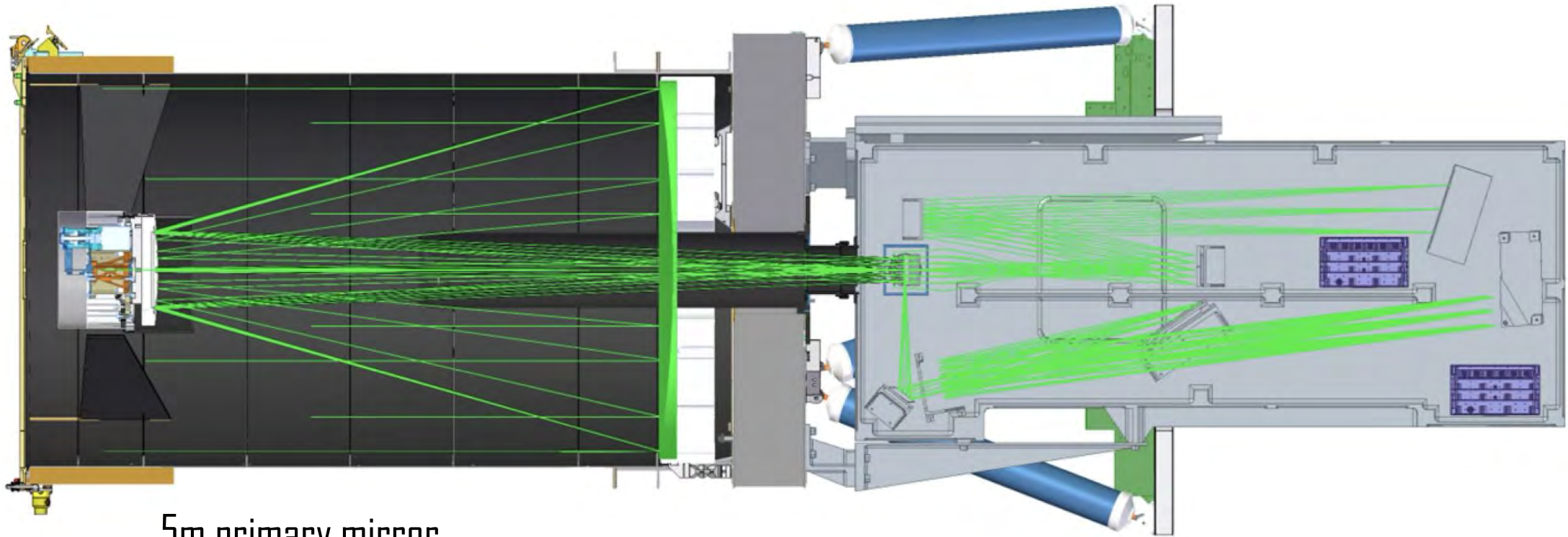
1. Access to a wide range of lines tracing orders-of-magnitude in temperature, density, and ionization states covering ionization potential of a few to 100+ eV.
2. Primary features include
 - a. Neutral gas tracers: O I and H I as robust metallicity indicators.
 - b. Ionized gas tracers: O VI, Si IV, and N V to identify hot outflows.
 - c. Molecular tracers: H₂ and CO for probing cold, star-forming gas.

A combination of these features is critical for modeling the mass and metal content of the galactic ecosystem that ultimately connect CGM physics to feedback physics.



OPTICAL DESIGN

Lo-FEVER: $R > 3,300$, Long slit, 6' x 8"

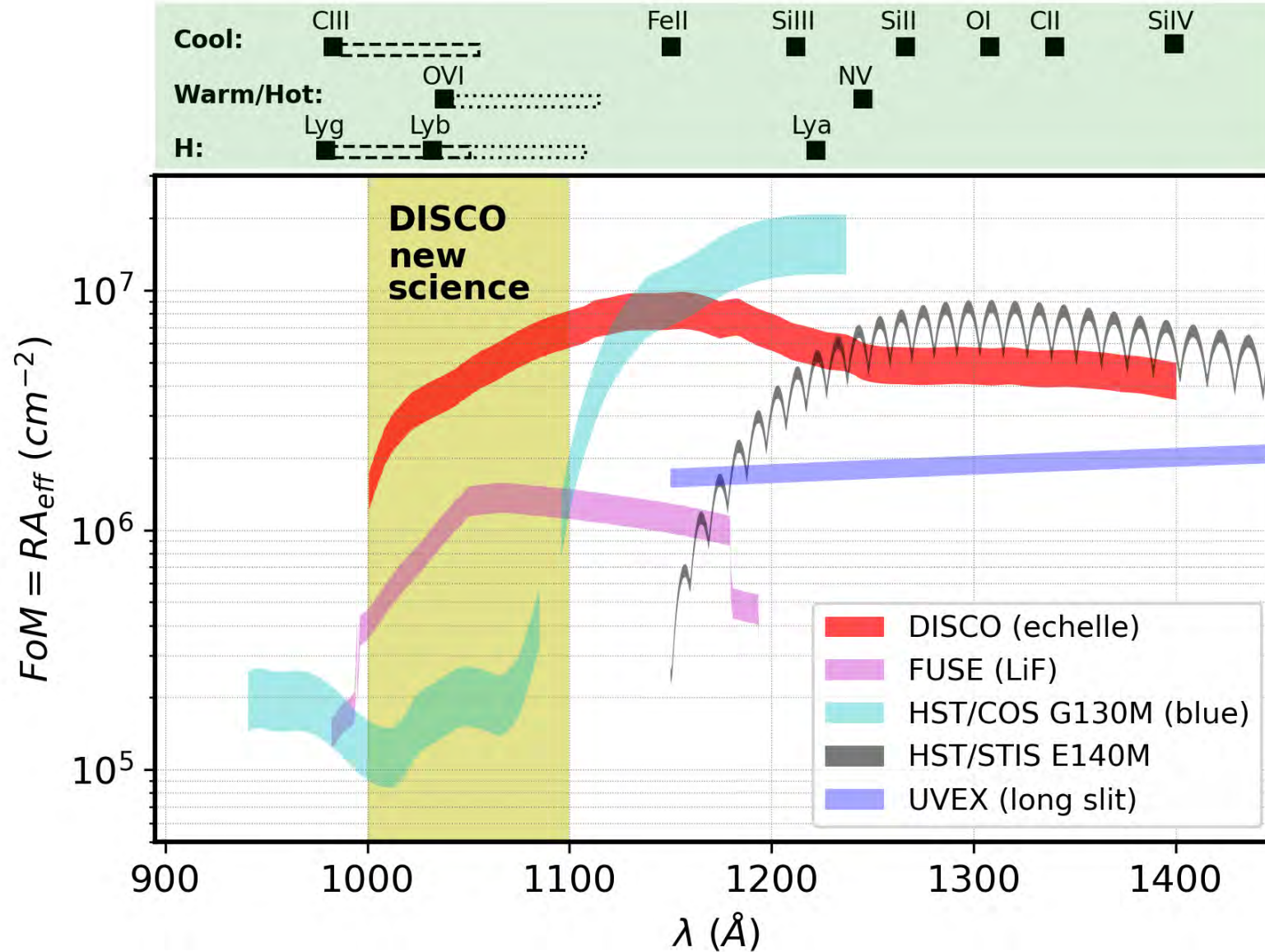


.5m primary mirror

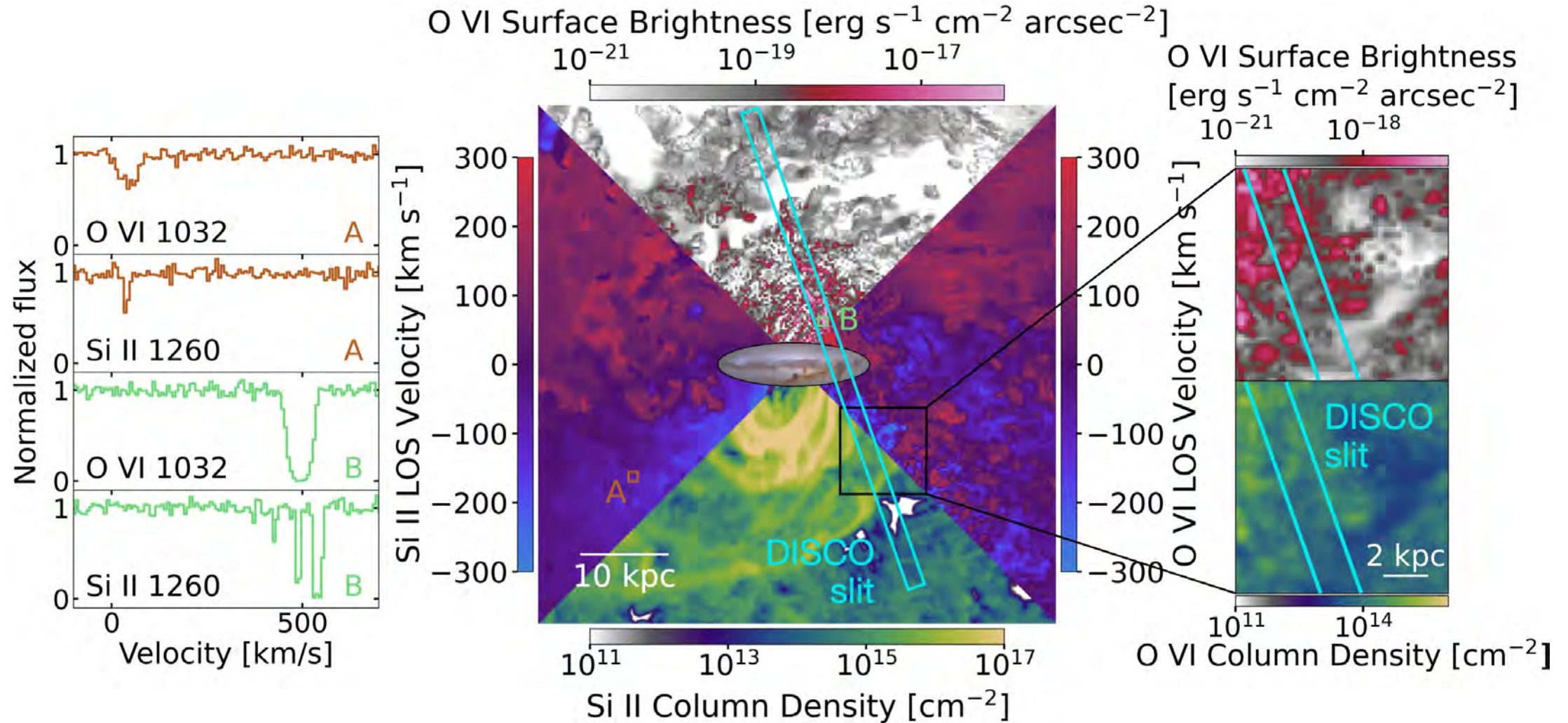
Hi-FEVER: $R > 33,000$, Echelle, 8"x8"



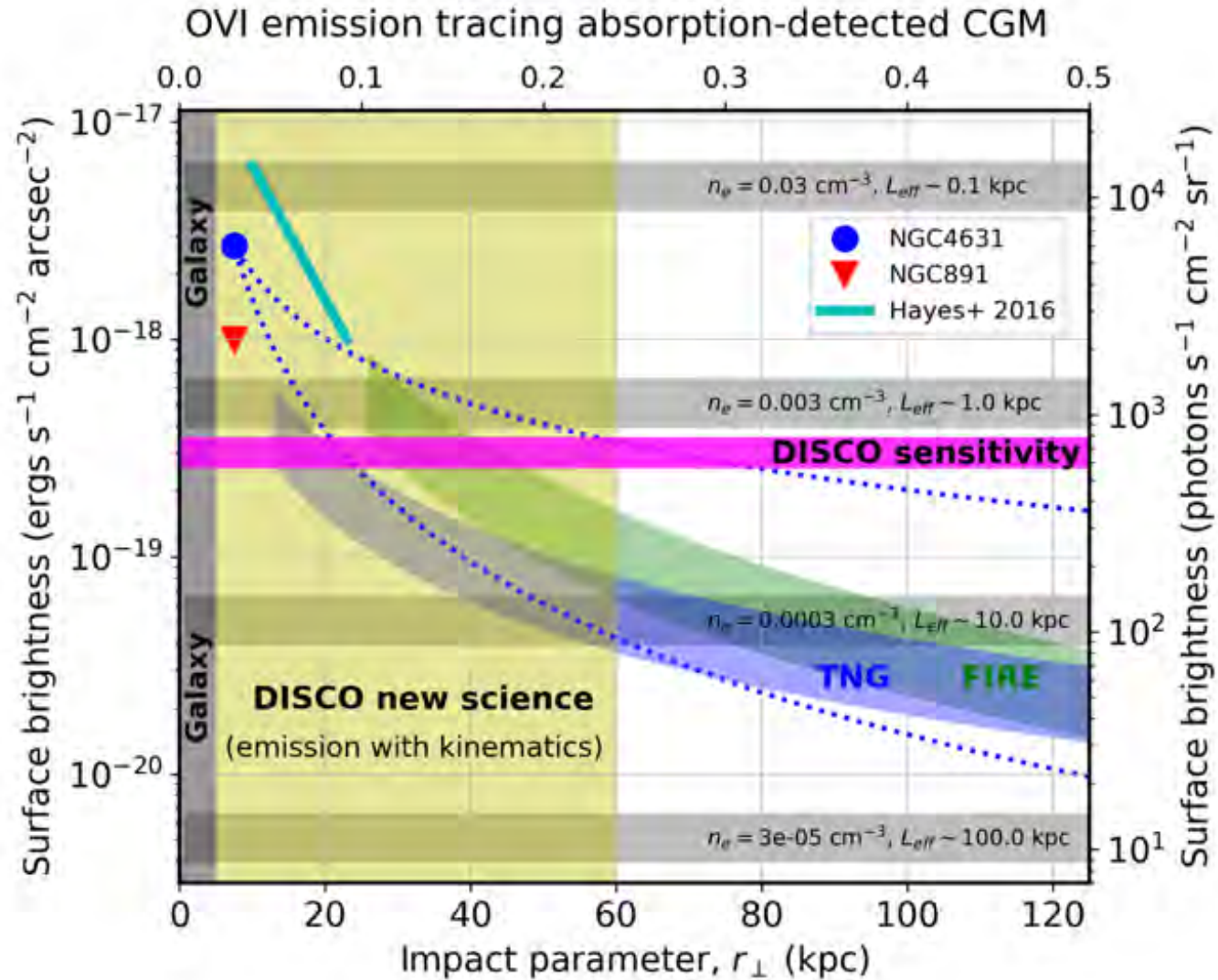
INSTRUMENT COMPARISONS



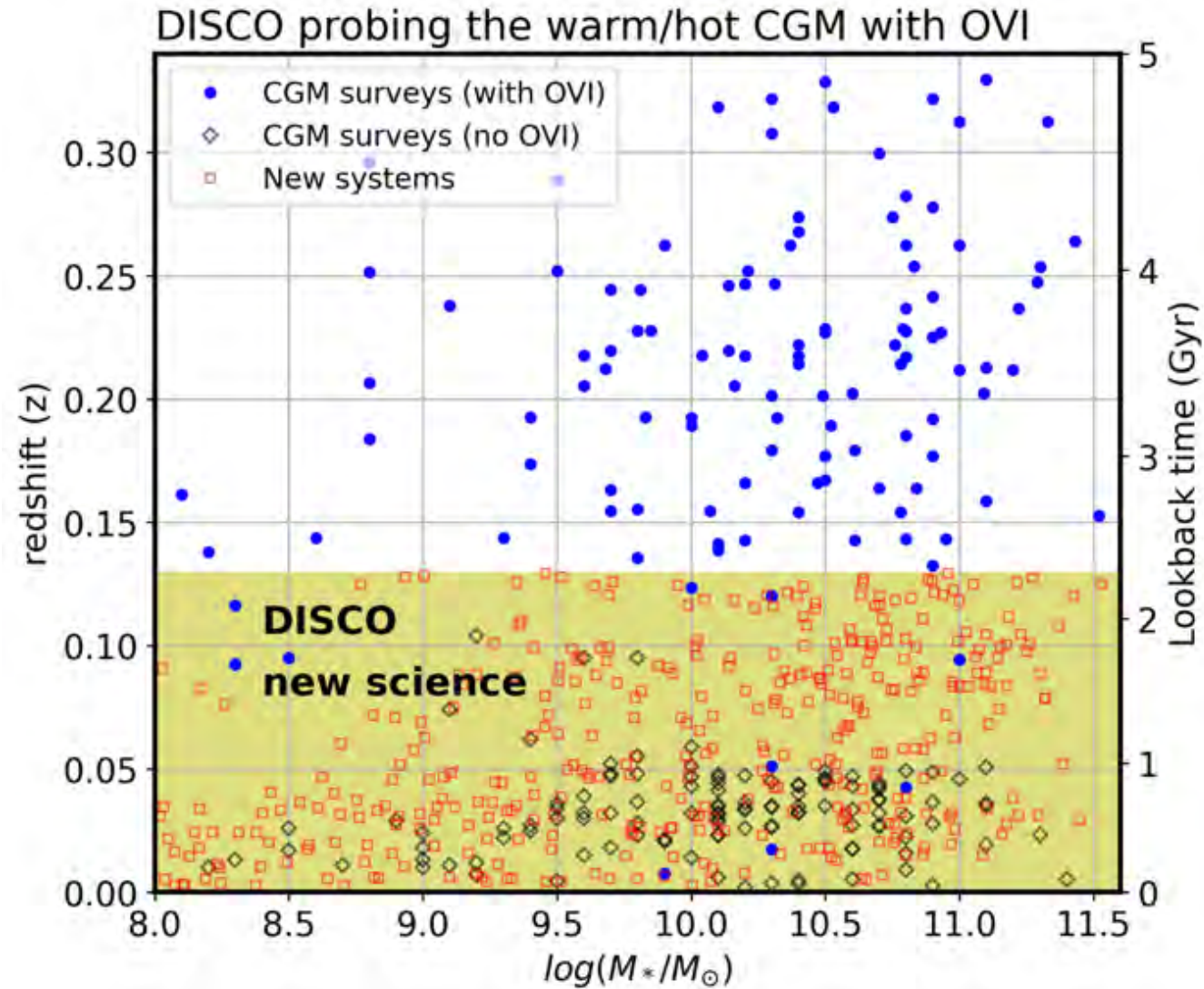
OBSERVATION DESIGN



COMPARISON WITH SIMULATIONS



LOW REDSHIFT POPULATION STUDY



SURVEYS

REMIX (Resolved Echelle Mapping of the Interstellar and eXtraplanar medium): $R > 3,300$ spectral mapping of line emission from CGM gas across ~ 100 kpc scales plus down-the-barrel spectroscopy tracing outflows in absorption and stellar population characteristics. This survey will provide these detailed maps for half a dozen nearby galaxies.

GROOVE (Galaxy–quasar Resolved Observations Of the Virialized Environment): $R > 33,000$ absorption measurement tracing diffuse gas at temperatures 10^4 - 10^6 K at sub-parsec scales in a statistical sample of galaxies. This will be combined with medium-resolution ($R > 3,300$) emission around QSO sightlines with absorption to estimate density of the CGM.

SPOTLIGHT (Stellar Probe Of the galacTic haLo and Interface Gas via High-resoluTion absorption): Mapping of the Milky Way disk-halo interface tracing structures like the Fermi Bubbles, high-velocity clouds (HVCs), and the disk-halo interface.



QUESTIONS?

