Connecting Winds and CGM Through Observations

Is feedback driving galaxy evolution, not just winds?
Distinguishing SF-, SNe-, AGN-driven outflows
Positive vs. negative feedback
Ejective vs. preventative mode feedback
Detecting low-, high-z outflows into CGM

Role of CRs?
Linking AGN accretion to feedback, jets
Ionized vs. neutral gas outflows
Bulk motions vs. escaping gas
High-z analogs or precursors to low-z outflows?

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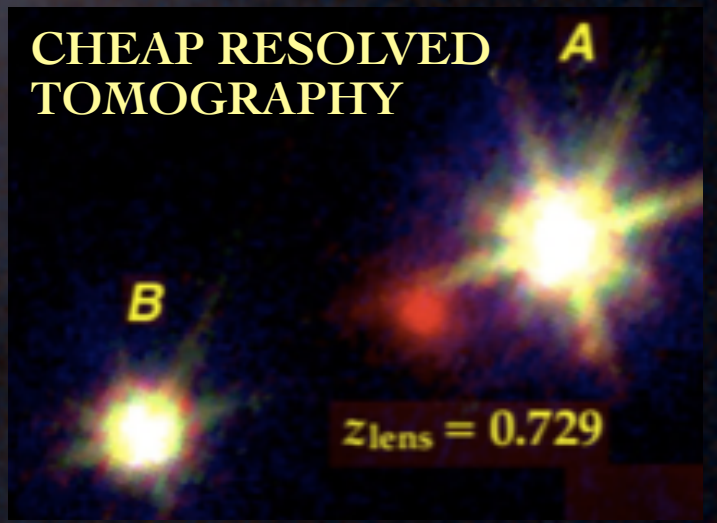
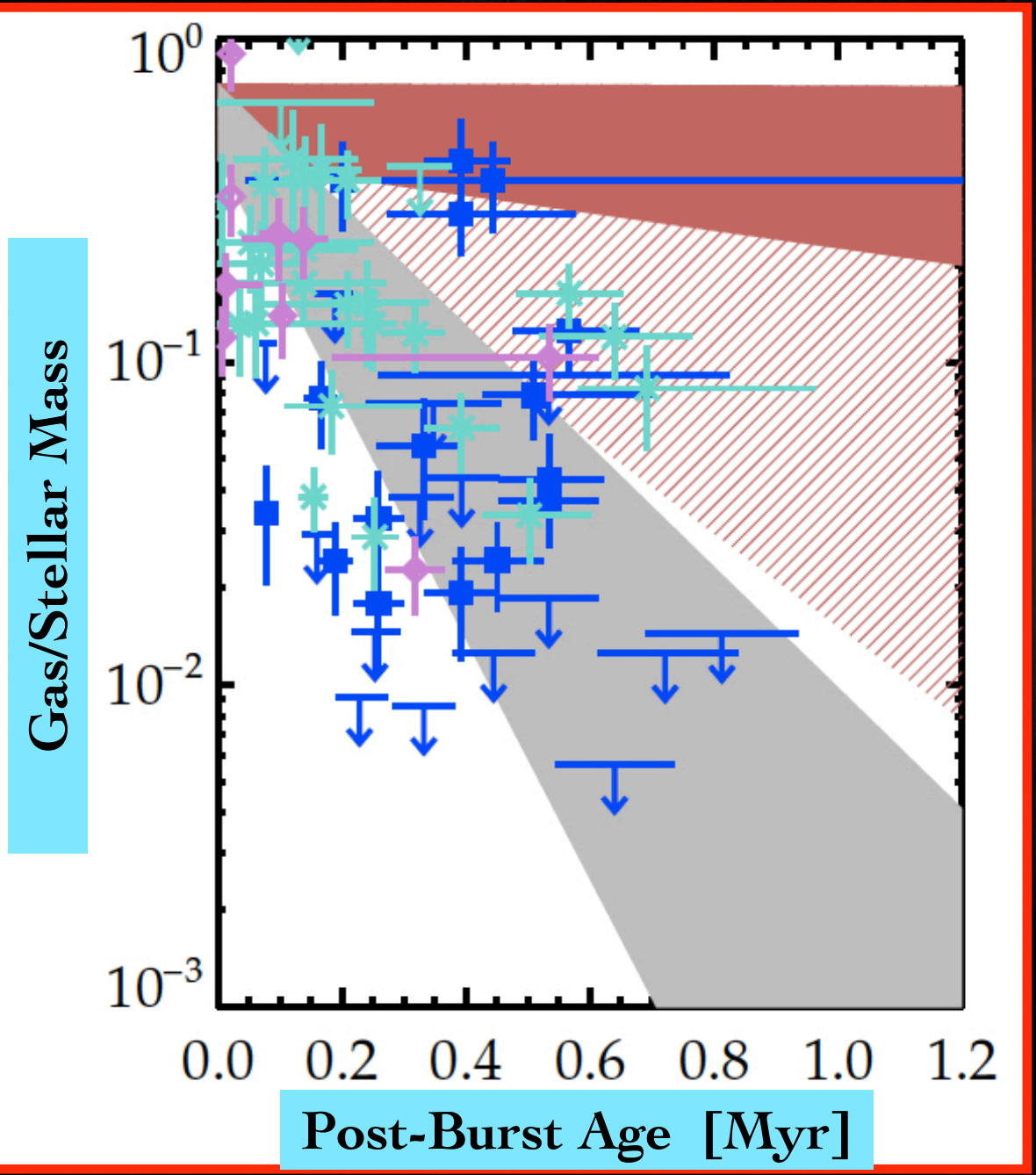
DIRECT CGM IMAGING

CONTROLLED EXPERIMENT

CHEAP RESOLVED TOMOGRAPHY



Post-Starbursts: Molecular Gas Evolution

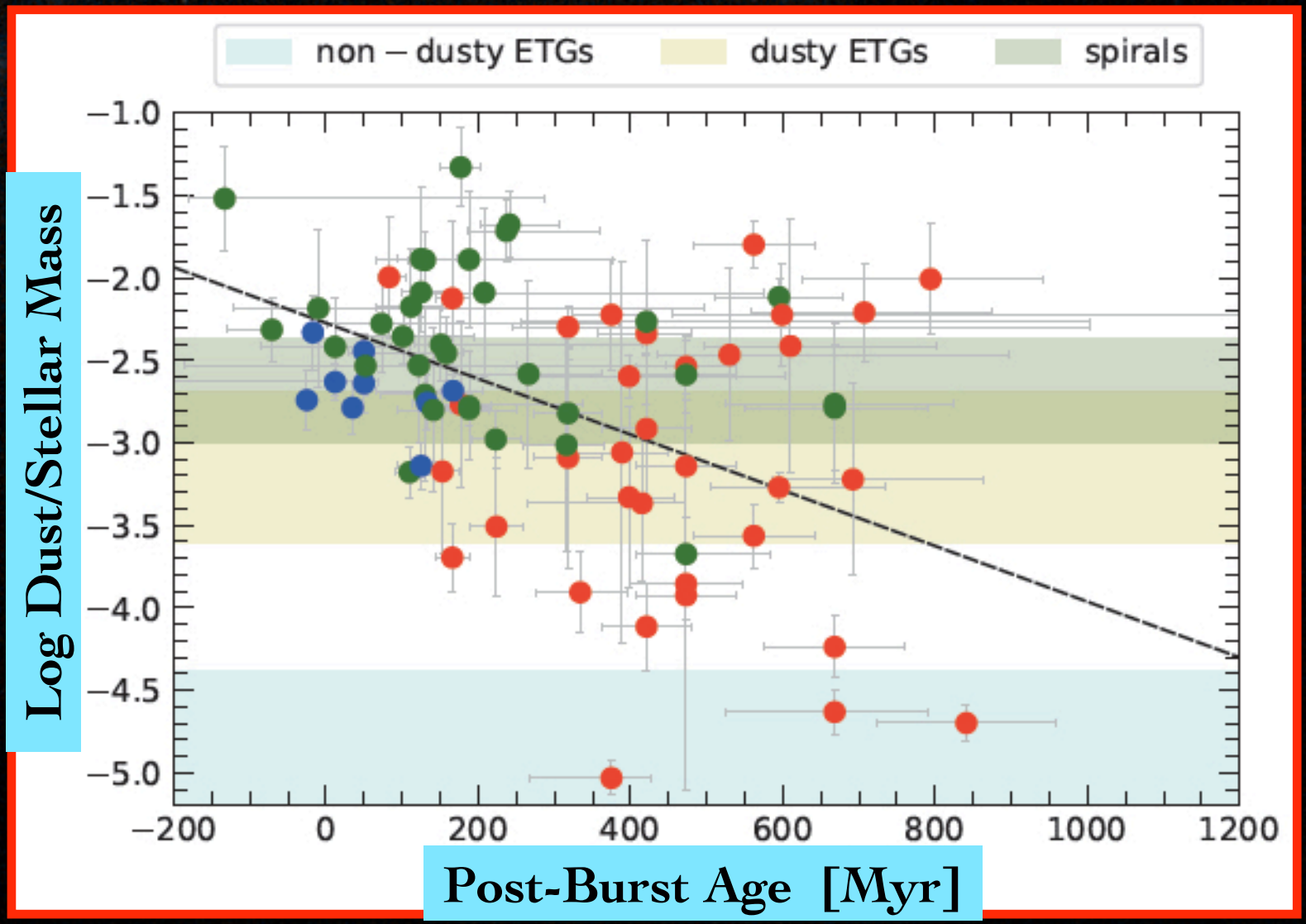


depletion from star formation not enough

rapid, 100-200 Myr → AGN/LINER feedback

French+ 2018a

Post-Starbursts: Dust Evolution

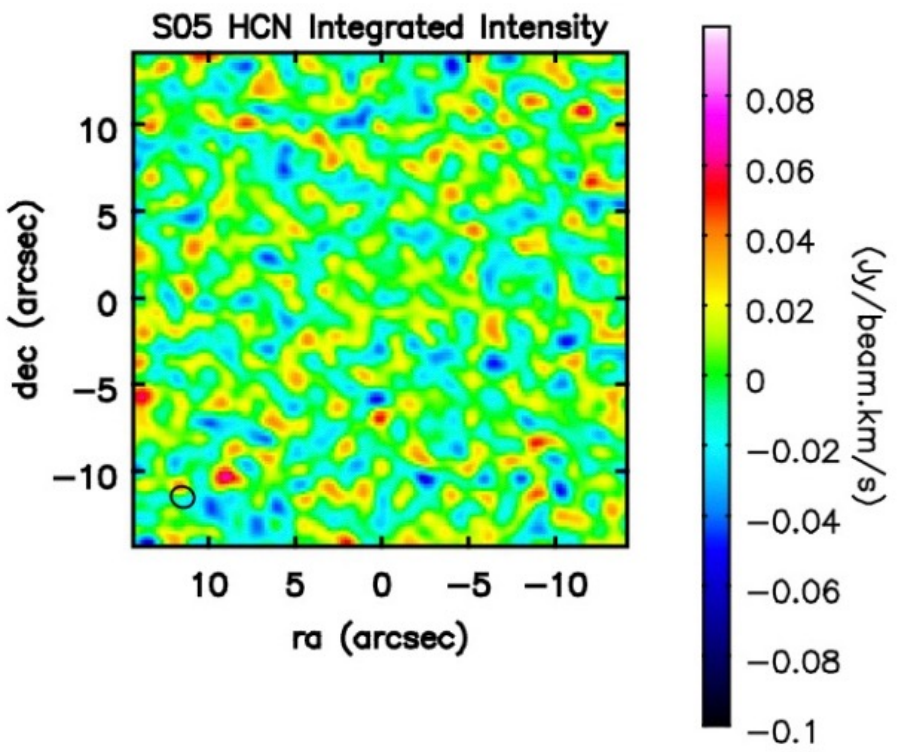


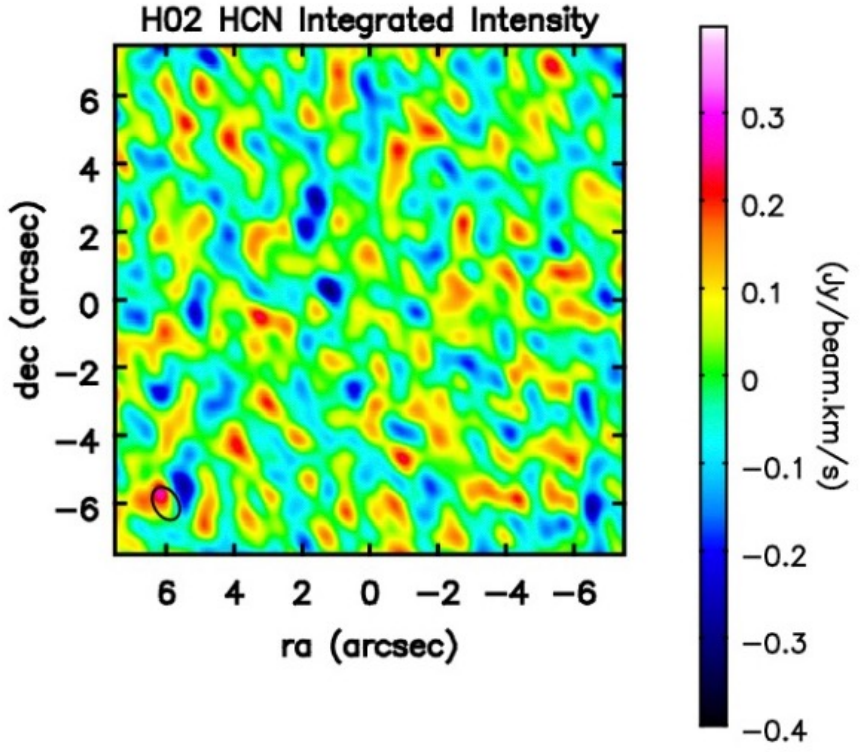
Li+ 2018 in prep

also 100-200 Myr decline → same mechanism

Post-Starbursts: Why Quiescent?

ALMA: denser HCN, HCO+ gas not there!

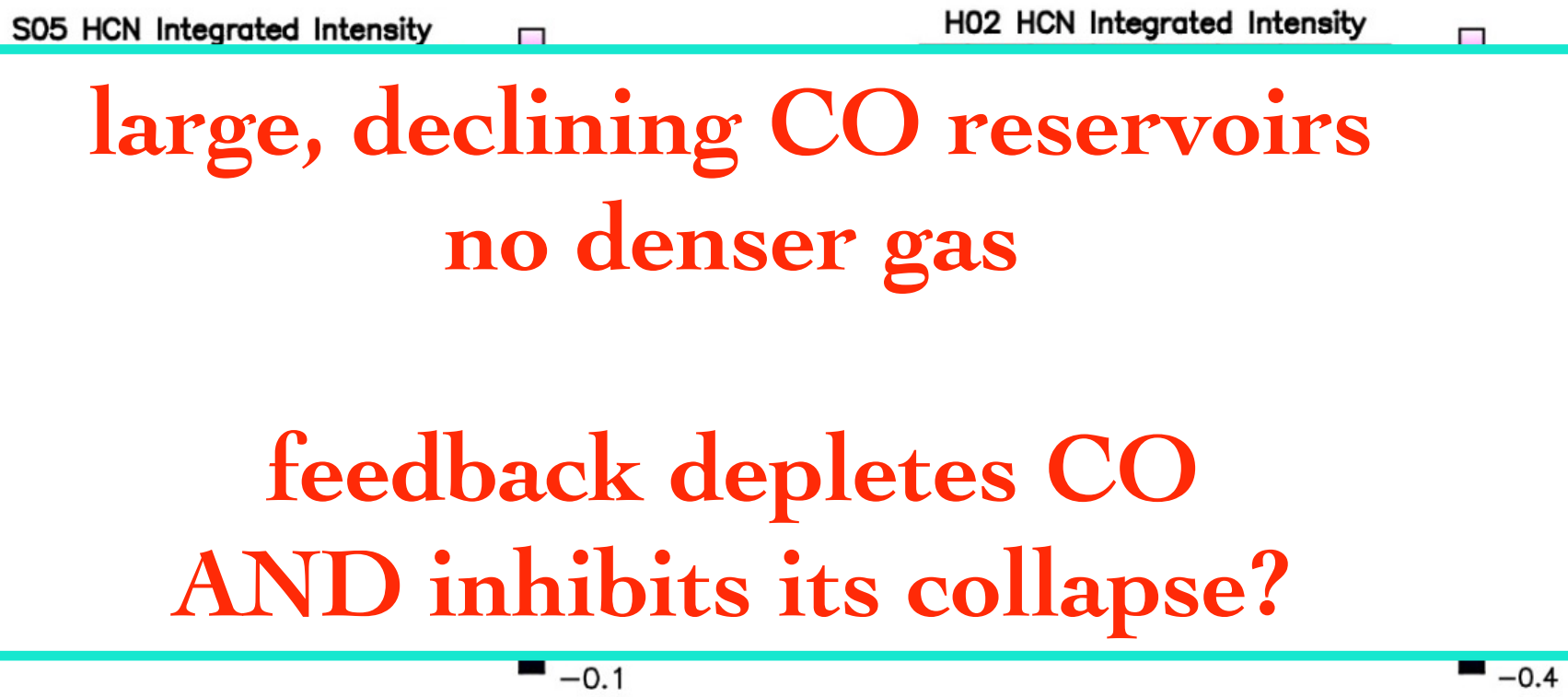




French+ 2018b

Post-Starbursts: Why Quiescent?

ALMA: denser HCN, HCO+ gas not there!

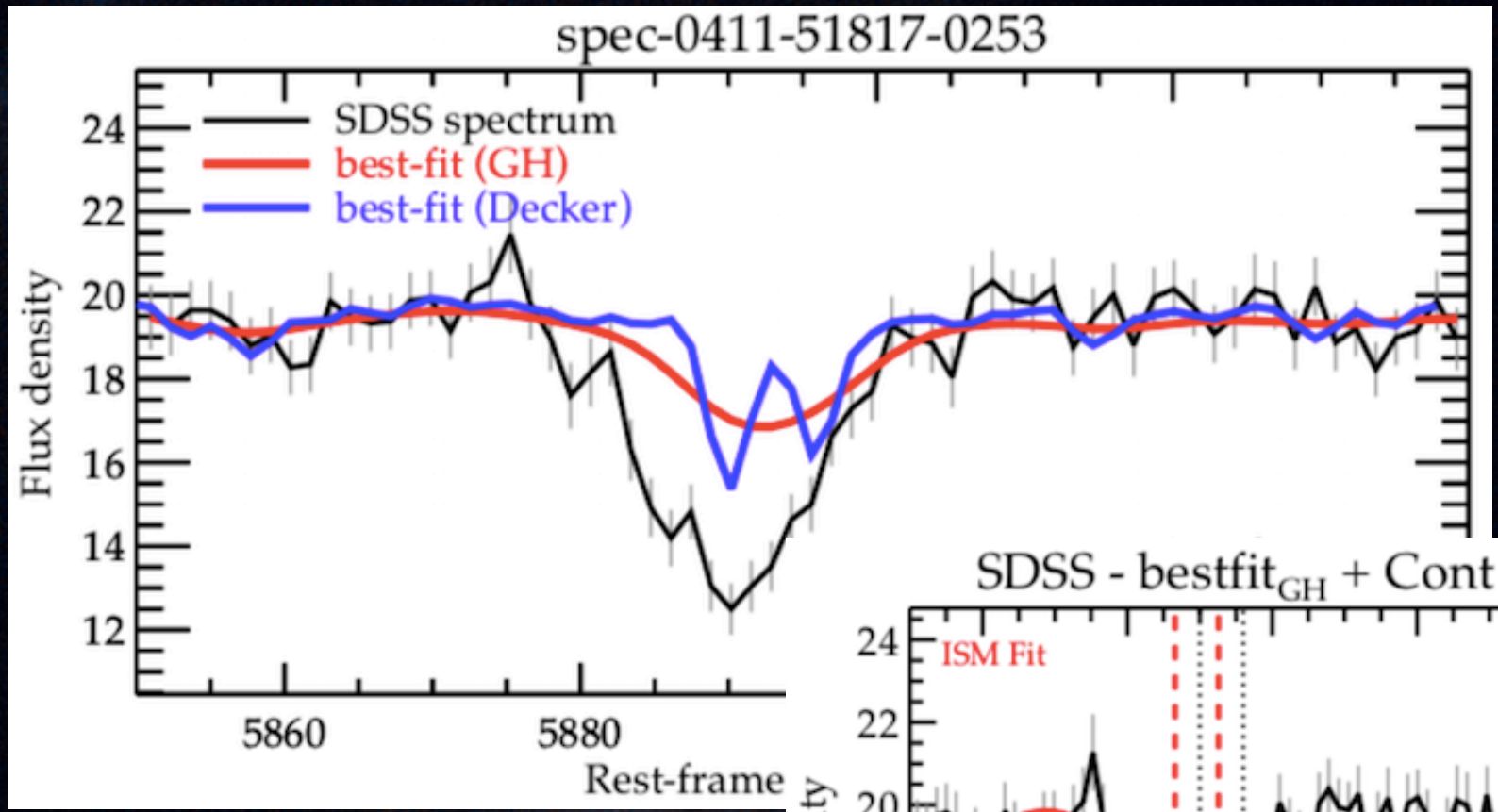


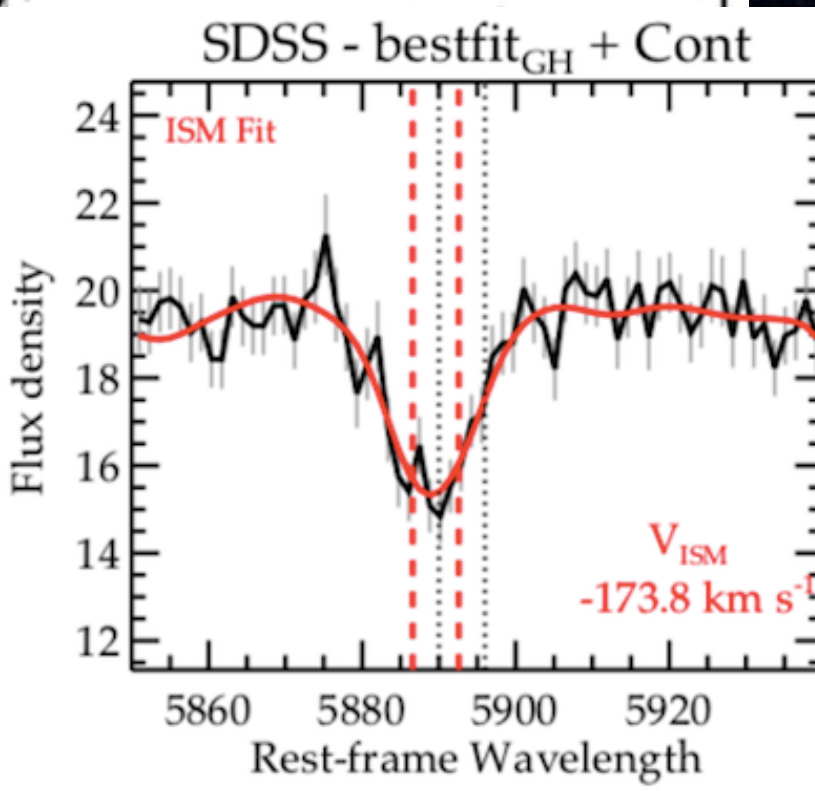
large, declining CO reservoirs
no denser gas

feedback depletes CO
AND inhibits its collapse?

French+ 2018b

Post-Starbursts: Outflow Evolution



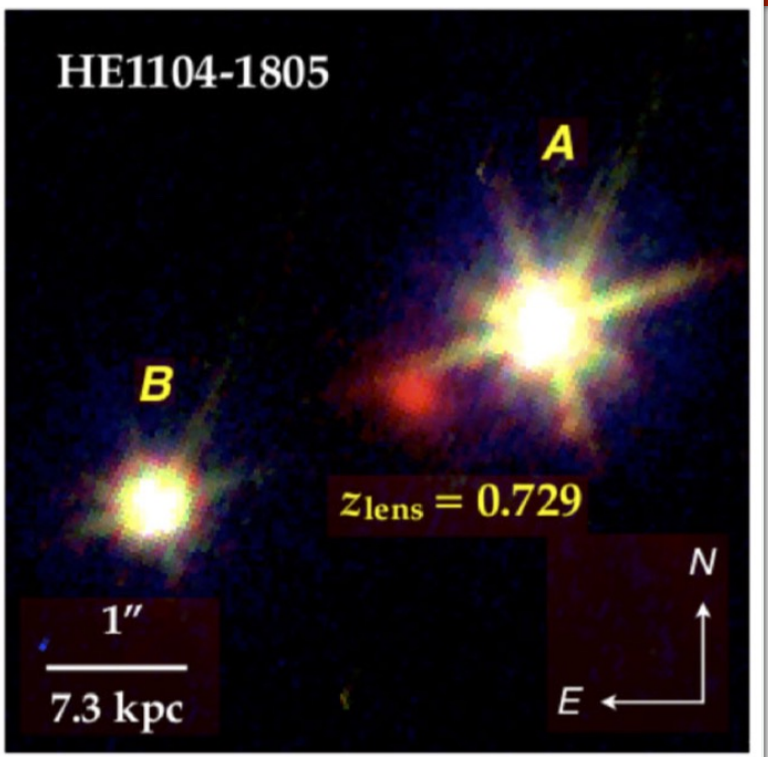


Lee+ 2018 in prep

subtract out stellar spectrum

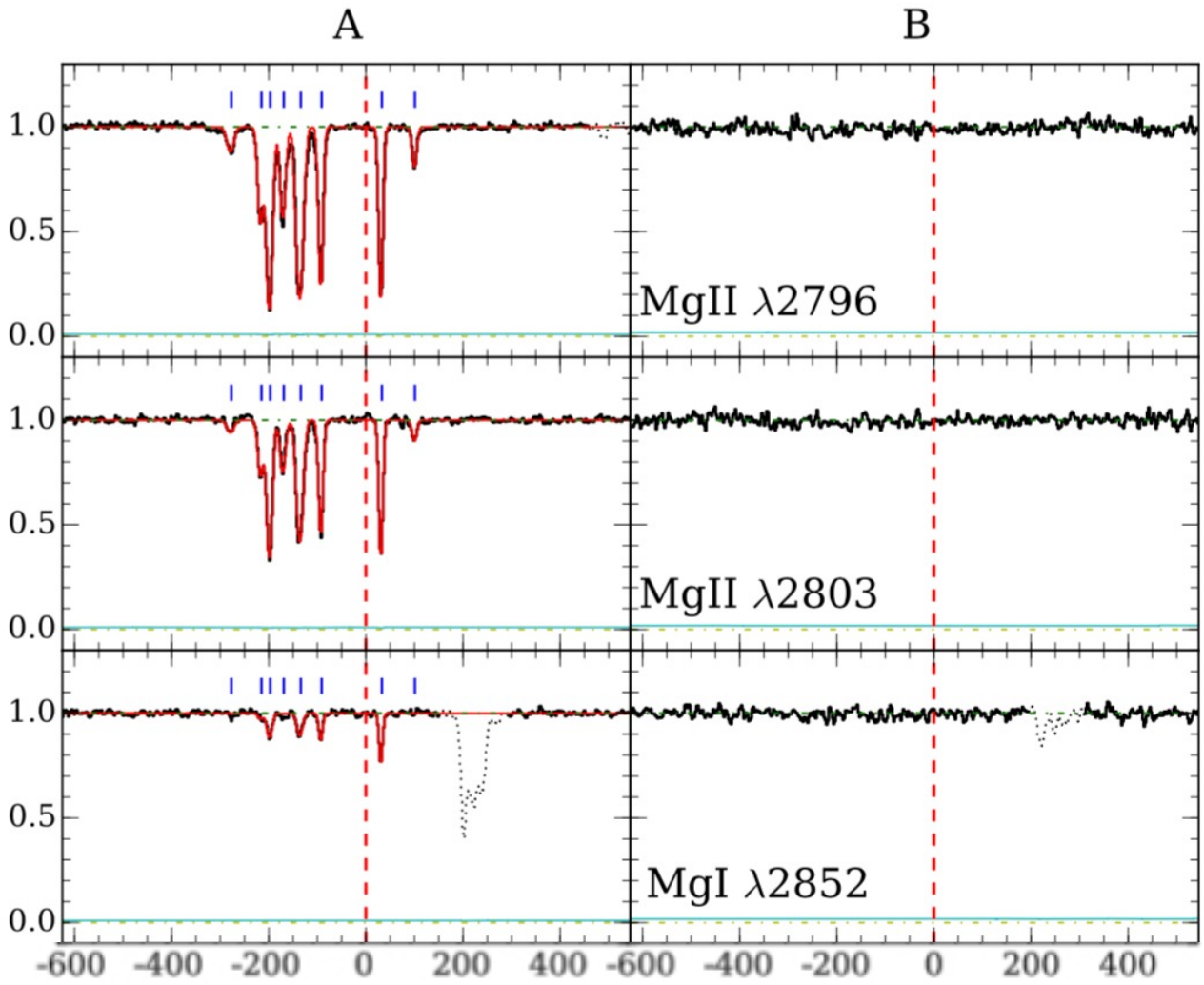
use residual ISM NaD line for inflow/outflow speed

Multiply-Lensed QSOs: ISM/CGM Wind Kinematics, Geometry, Enrichment



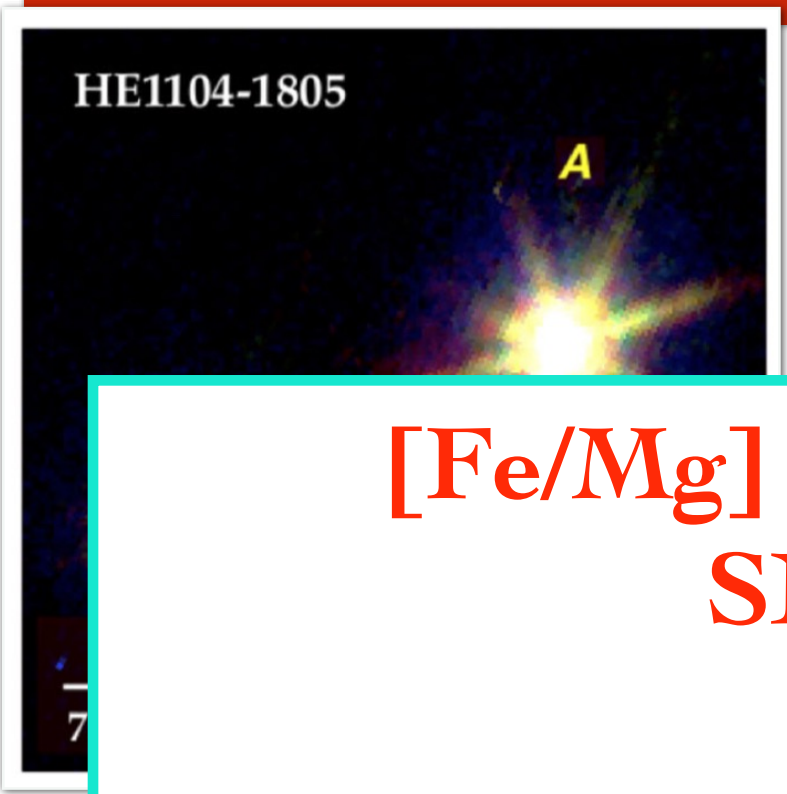
ZAHEDY+ 2016, 2017B, 2018 IN PREP

TWO SIGHTLINES

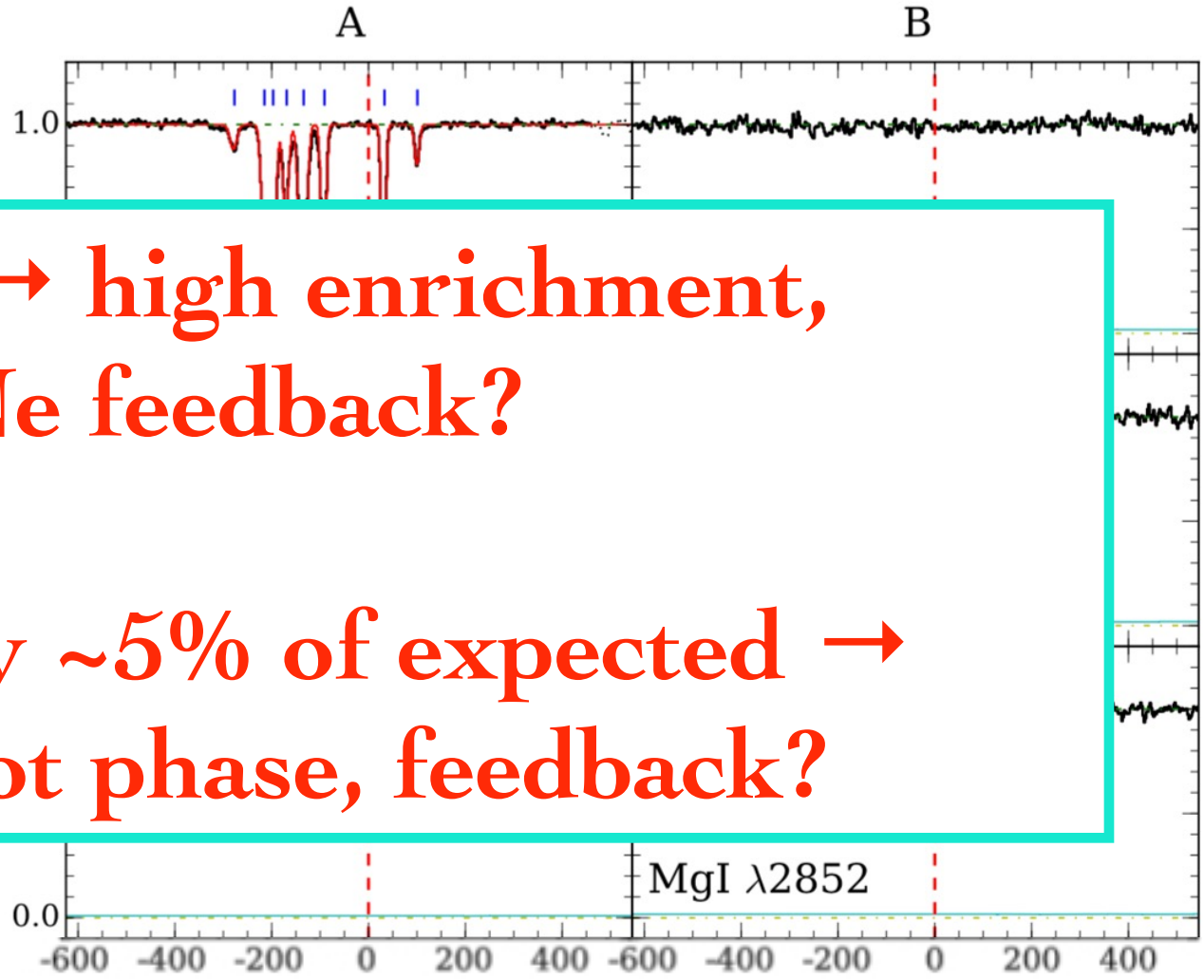


RADIAL VELOCITY [KM/S]

Multiply-Lensed QSOs: ISM/CGM Wind Kinematics, Geometry, Enrichment



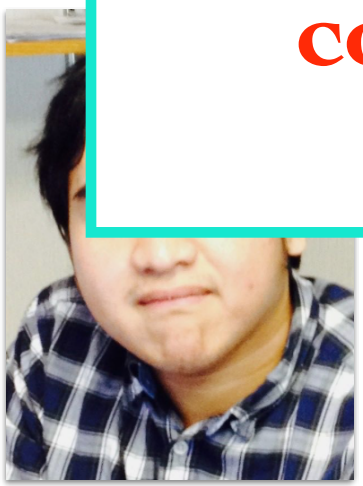
TWO SIGHTLINES



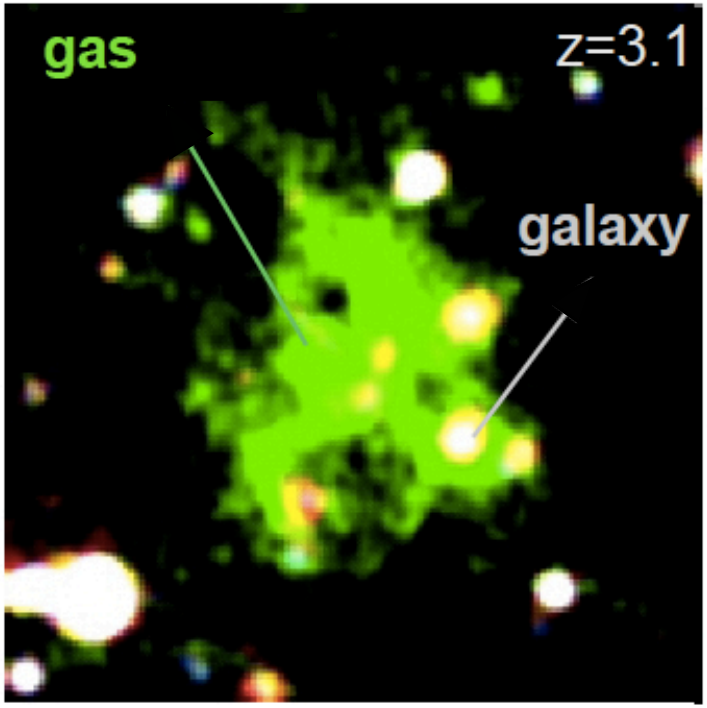
RADIAL VELOCITY [KM/S]

[Fe/Mg] → high enrichment, SNe feedback?

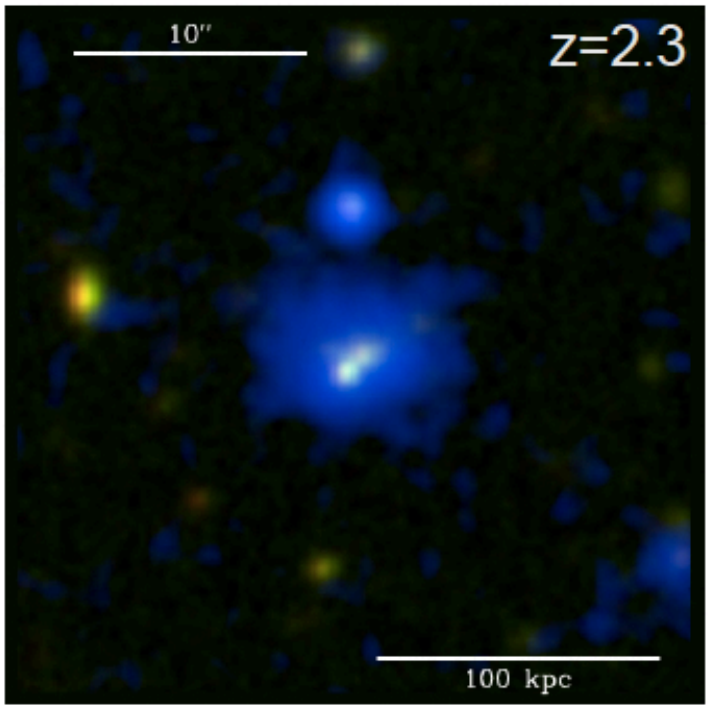
cool Fe only ~5% of expected → most in hot phase, feedback?



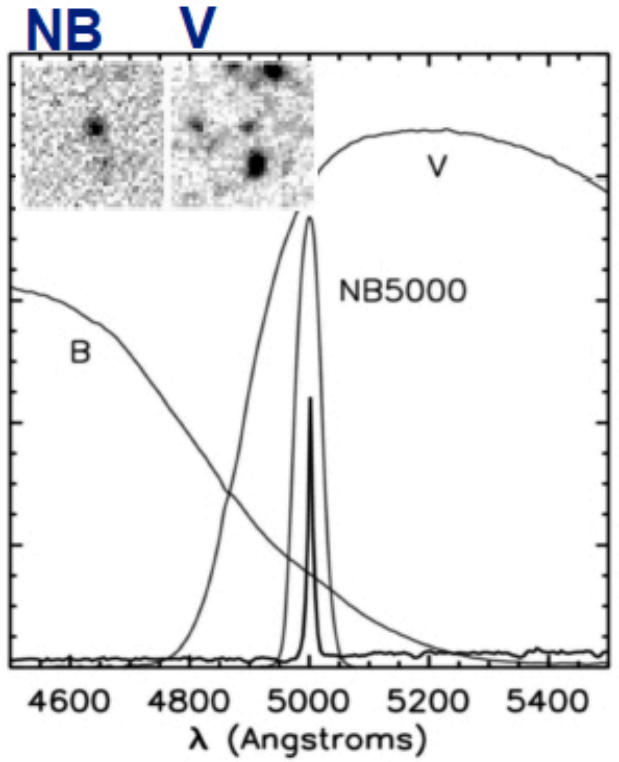
Lyα Blobs: Linking Galaxies to CGM



25” ~ 200kpc
Steidel blob 1 (Matsuda+04)



Yang et al. (2010)
CDFS-LAB2

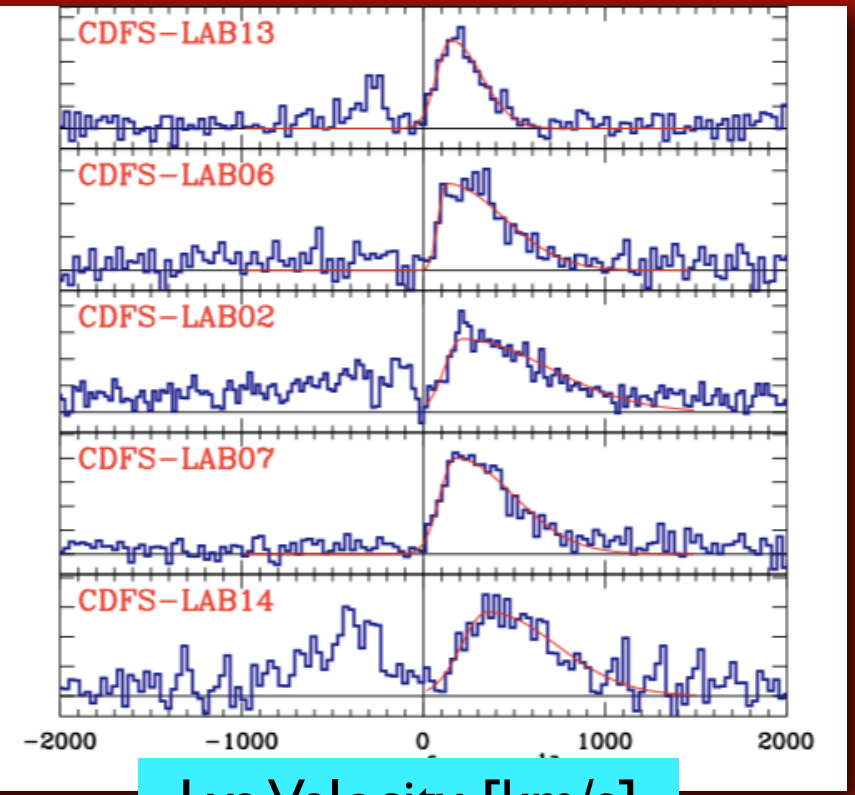


(e.g. Gronwall+07)

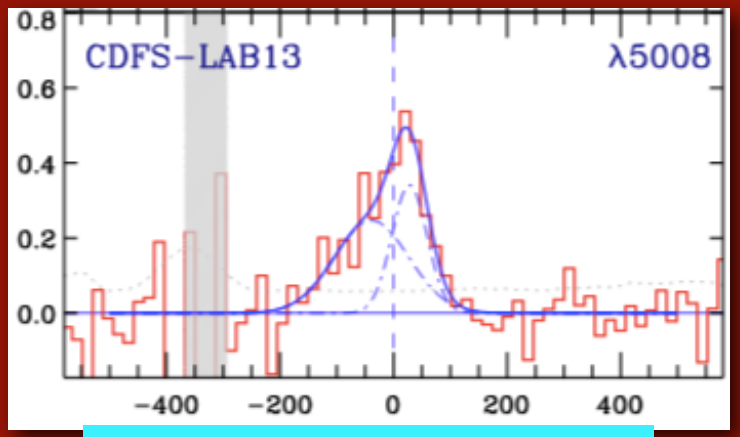
discovered by narrow-band imaging

direct 2-D image of IGM and CGM!

Outflows Detected

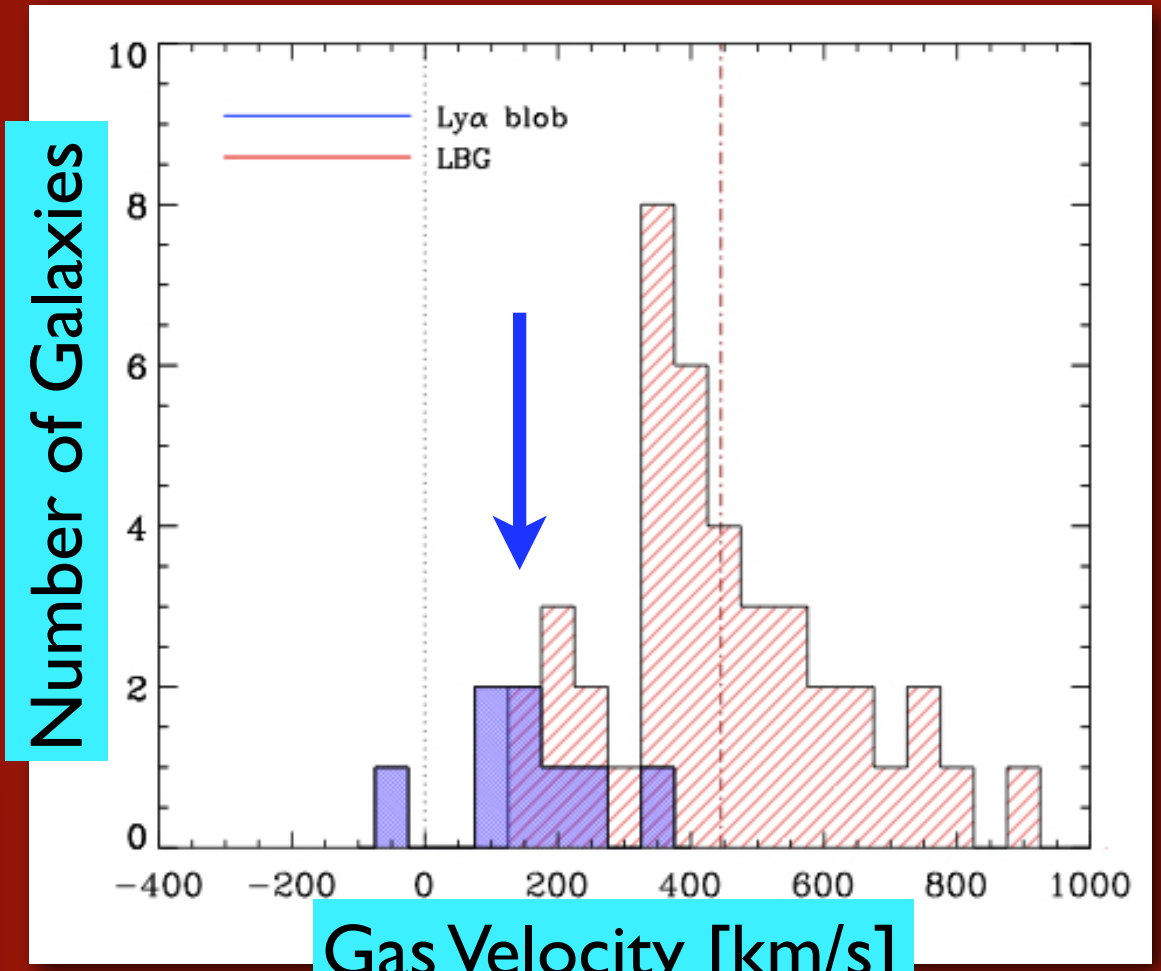


Lya Velocity [km/s]



[OIII] Velocity [km/s]

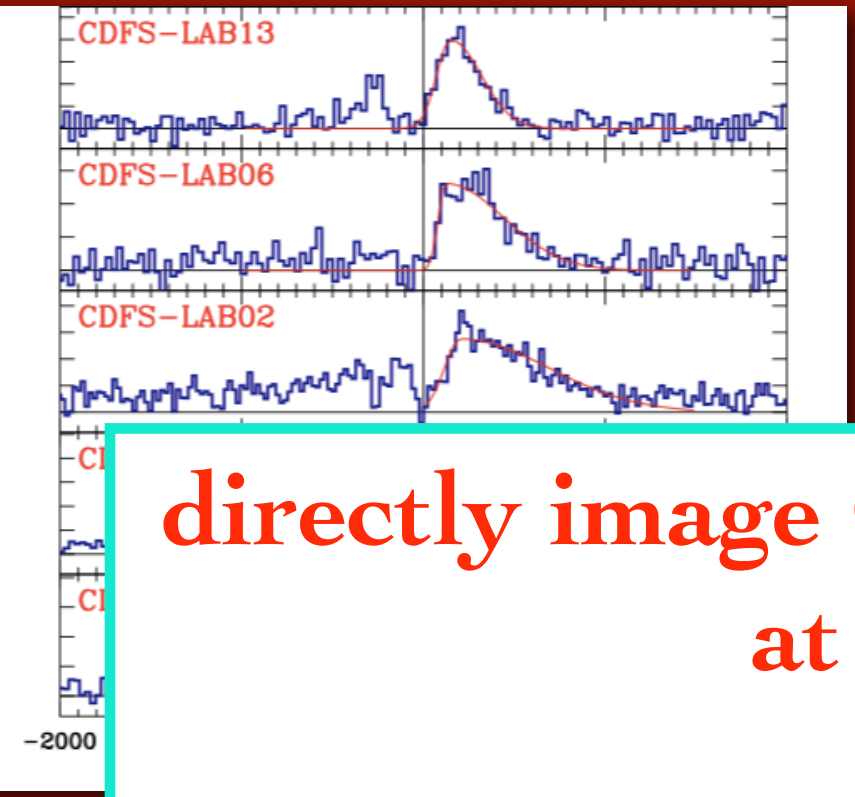
Yang, Zabludoff+14



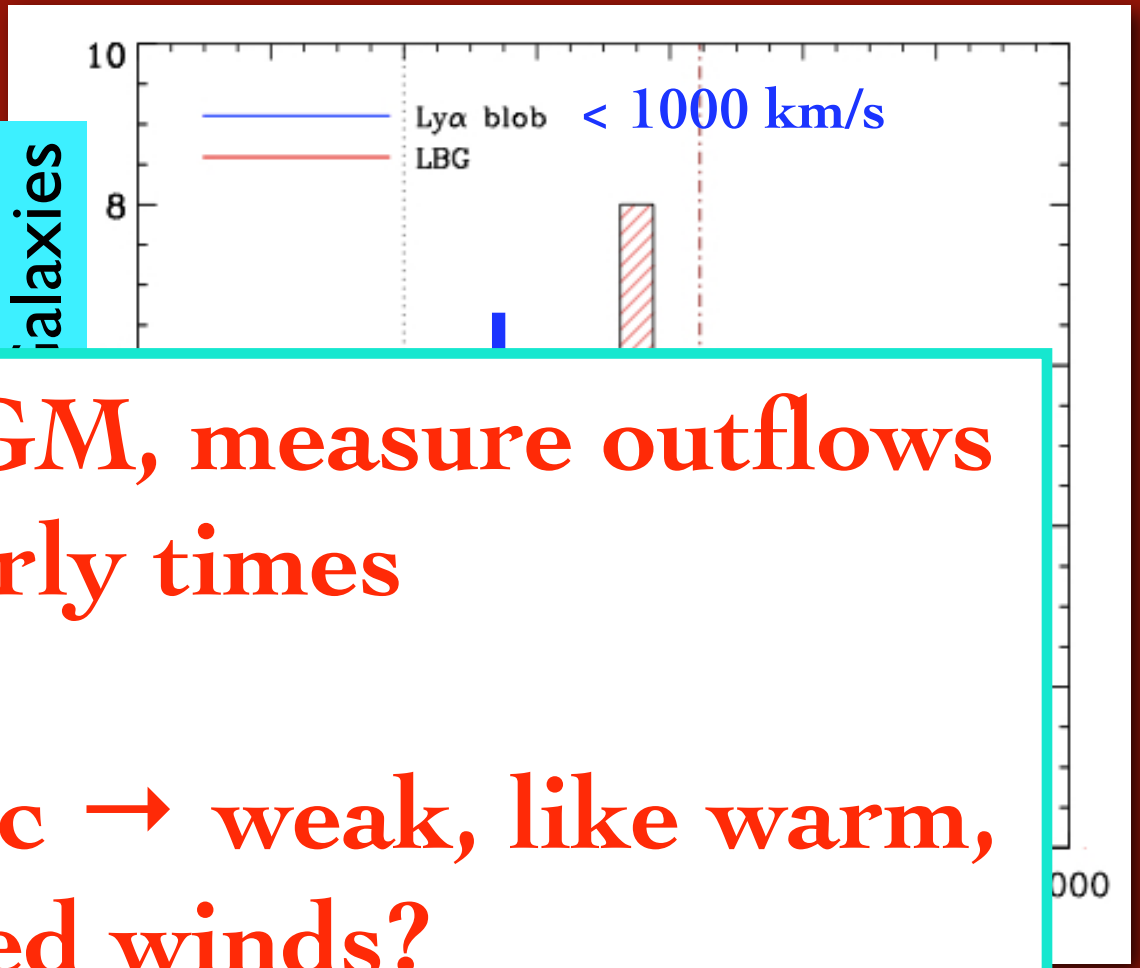
Gas Velocity [km/s]

weak, ~warm, ionized winds from SNe, stars?

Outflows Detected

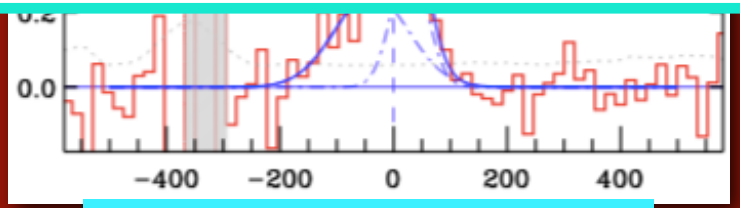


Yang, Zabludoff+14



directly image CGM, measure outflows at early times

+[OIII] diagnostic → weak, like warm, ionized winds?



weak, ~warm, ionized winds from SNe, stars?

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IMPORTANT IN POST-STARBURSTS
AGN/LINER WINDS
NEGATIVE FEEDBACK

RADIO MODE NOT REQUIRED?

NEW STRATEGIES FOR DETECTION

Role of CRs?
Linking AGN accretion to feedback, jets
Ionized vs. neutral gas outflows
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