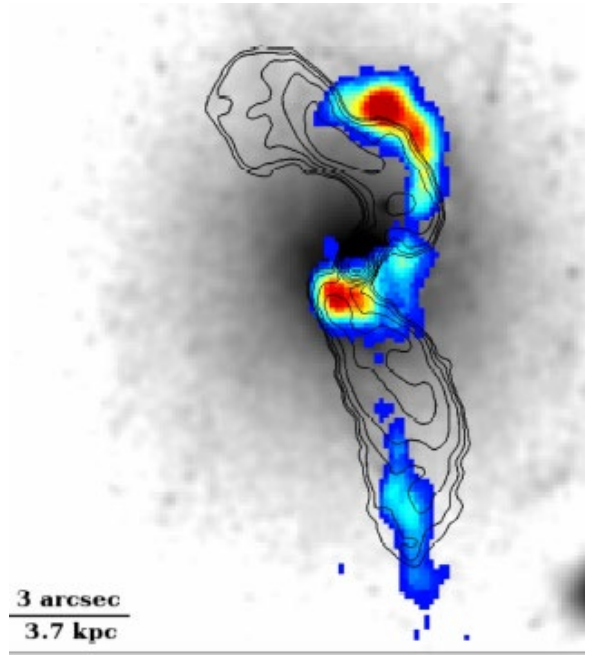
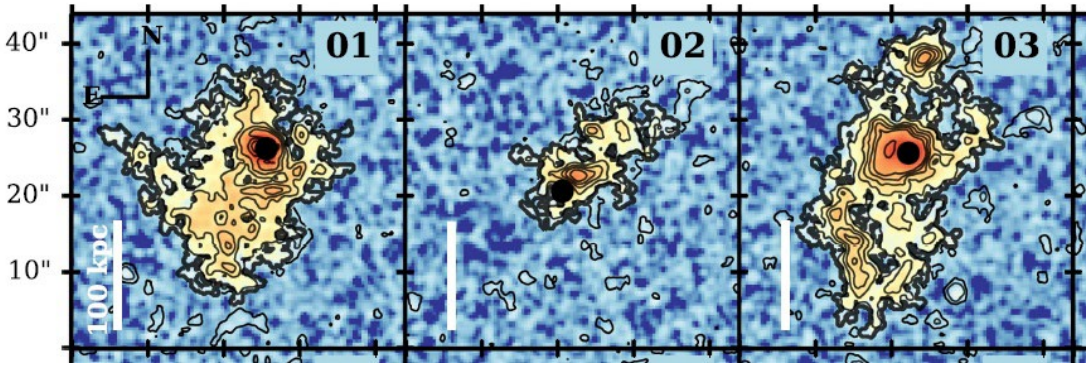
A1795 -- ALMA



Françoise Combes
Observatoire de Paris

November 2022

VLT-MUSE



Outline

High resolution, nearby universe, Galaxy Nuclei

Dusty torus? Or hollow polar cone

Dynamics Rotation curves at high z

Gas extensions around galaxies

Circum-galactic medium

Ionized gas, Lyα haloes, DLAs

Tidal stripping, outflows

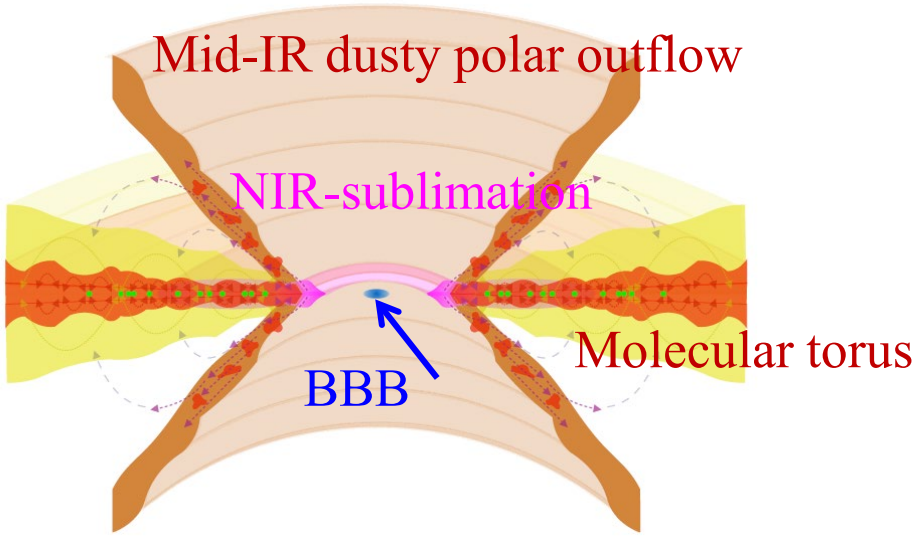
Cooling Flows

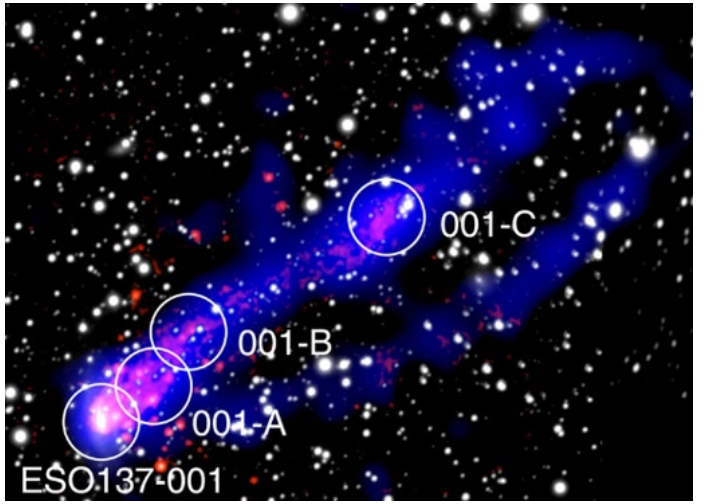
Hα filaments

Molecular gas inflow

Jelly-fish galaxies in clusters

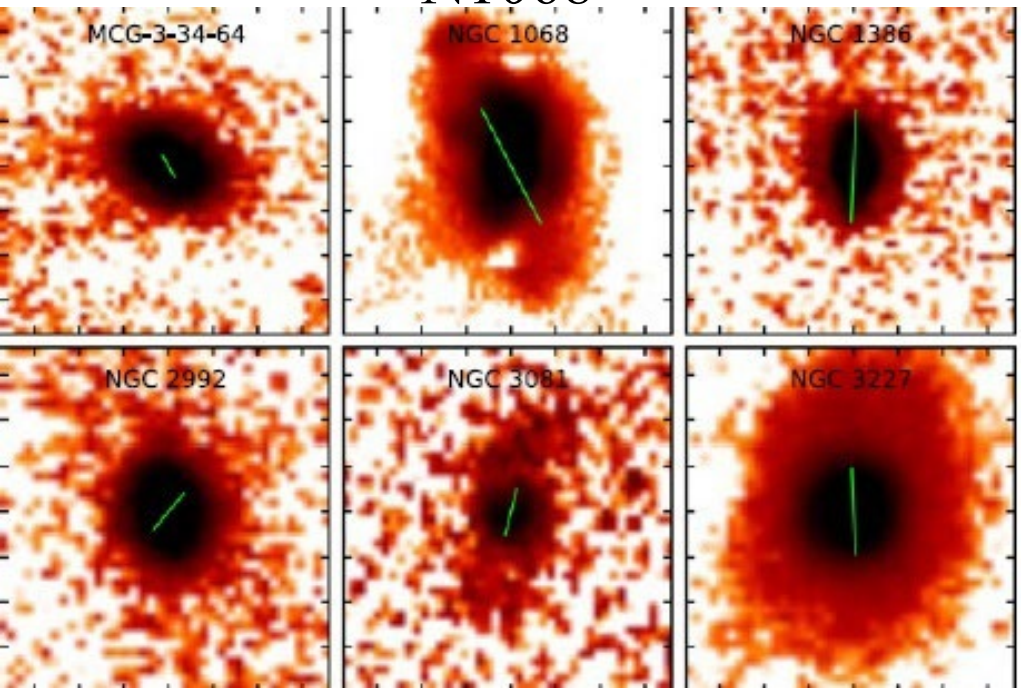
Hα tails, Molecular gas





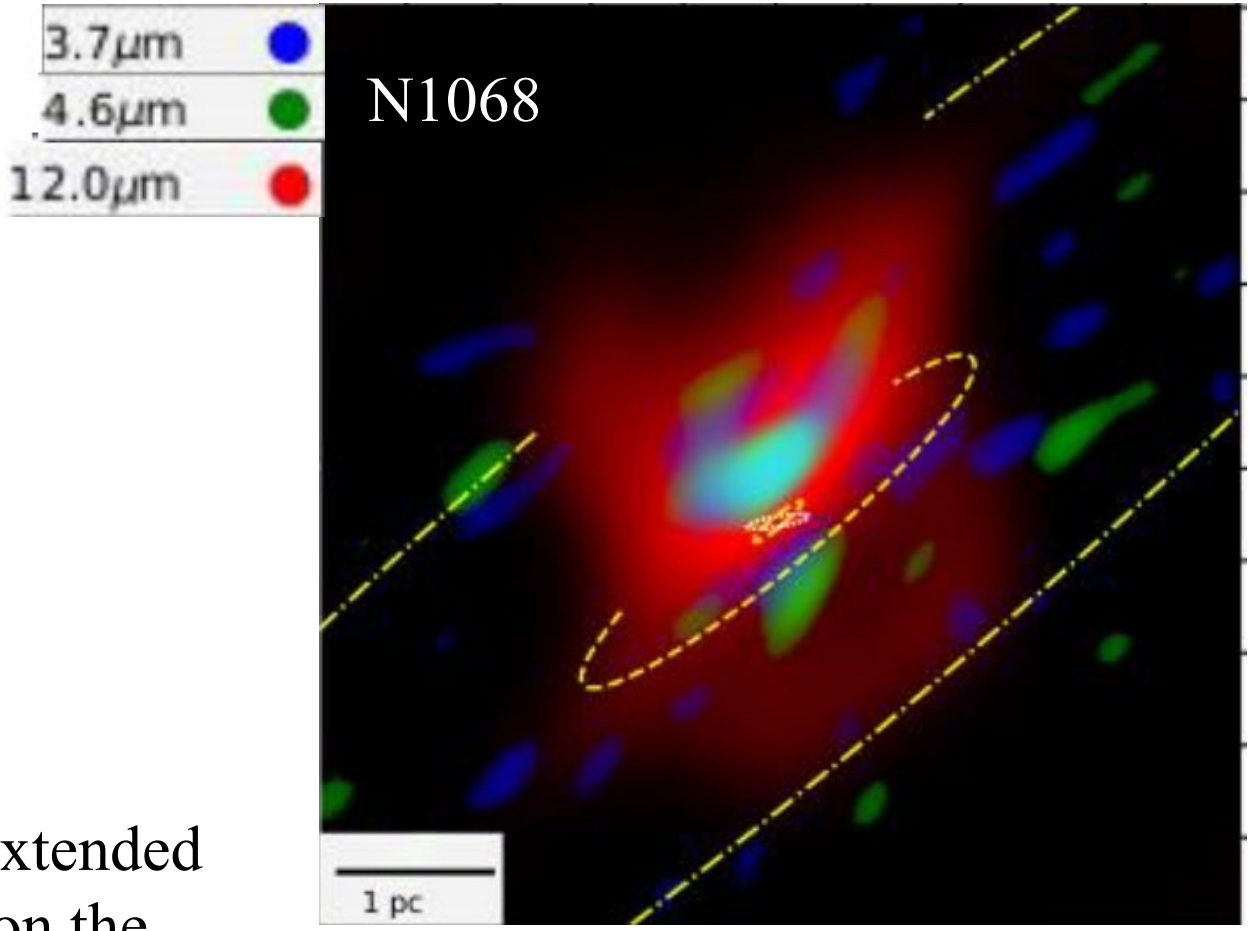
High resolution VLTI: Polar dust distribution

N1068



Dust emission in the infrared, MIDI, MATISSE

Hot dust in the polar direction



Gamez-Rosas et al 2022

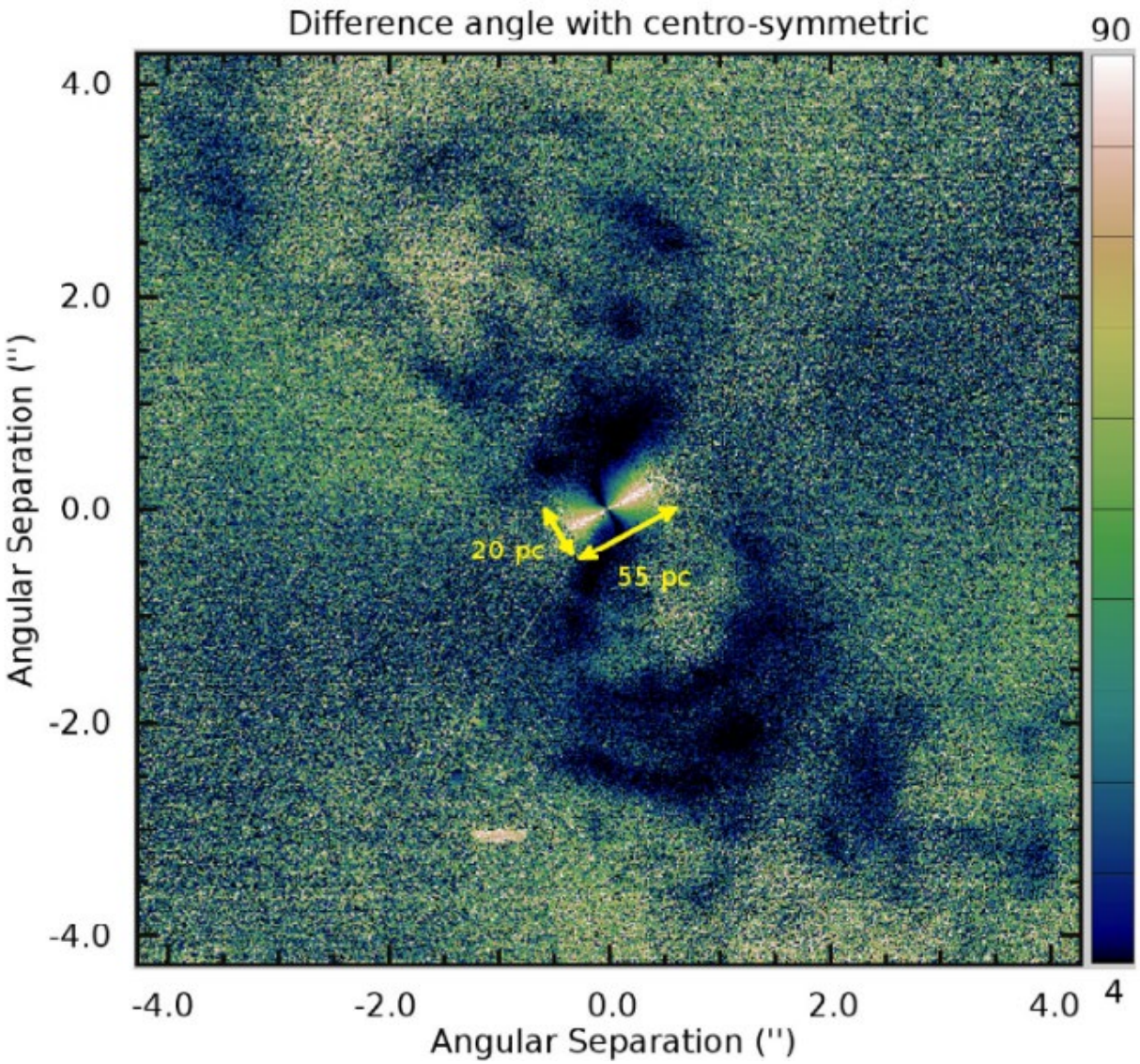
Green: 100pc along the polar axis

Asmus et al 2016

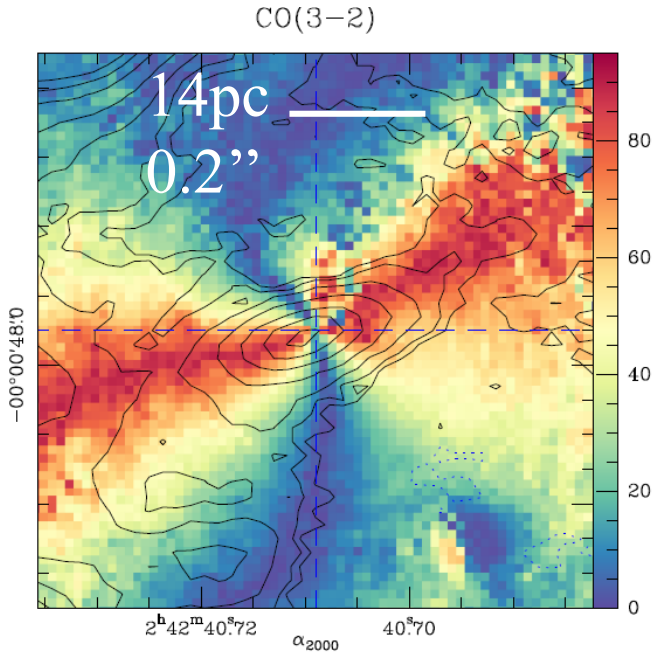
MIR, VLT/Visir

149 AGN, 21 show extended dust distribution, 18 on the polar axis (MIR)

Molecular torus inside a polar dusty cone



1''=70pc, *Gratadour et al 2015* *SPHERE NIR*



CO with ALMA

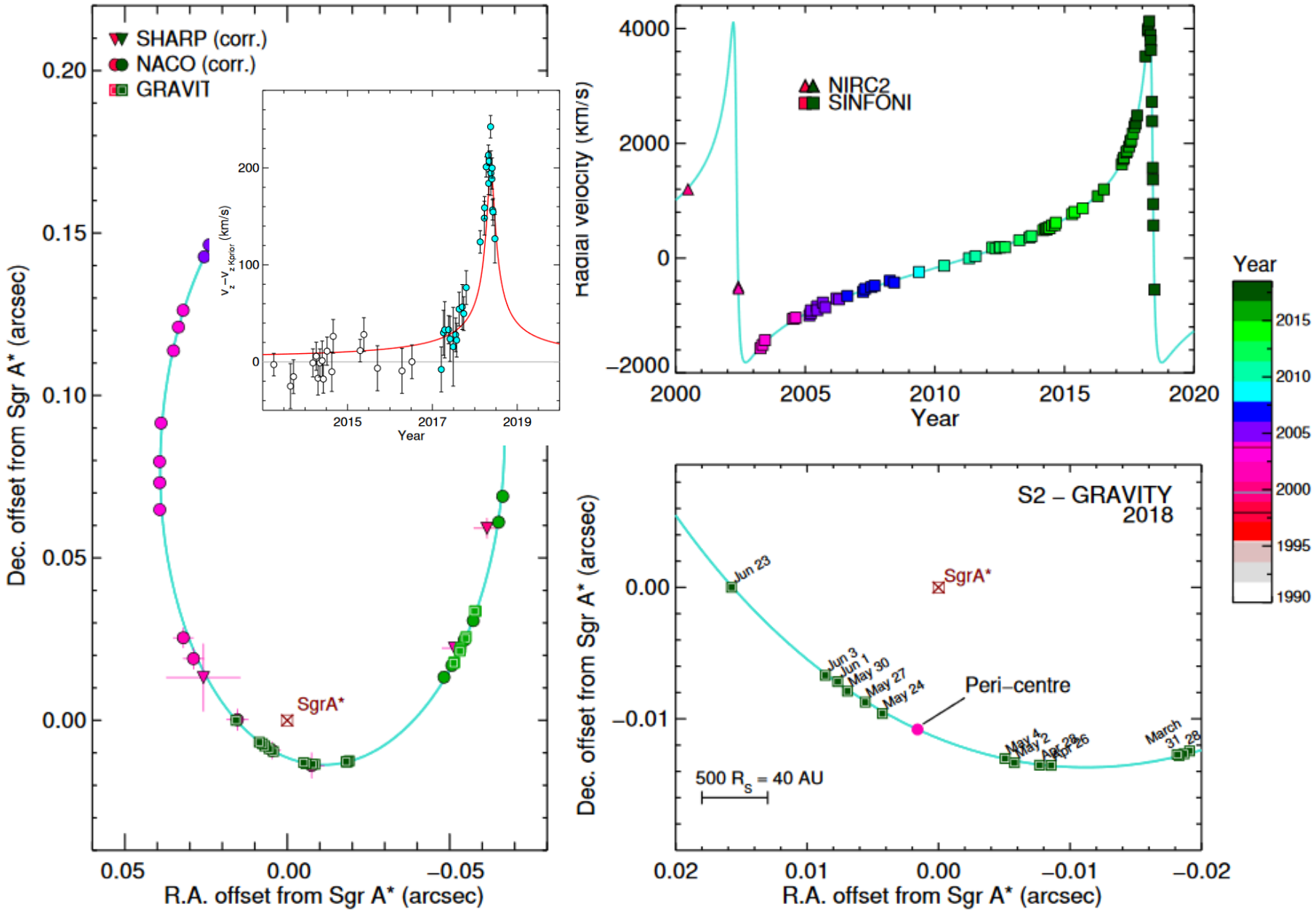
Garcia-Burillo et al 2019

X-rays, from 10^{23} cm^{-2} up to $10^{25}cm^{-2}$

➔Compton-thick

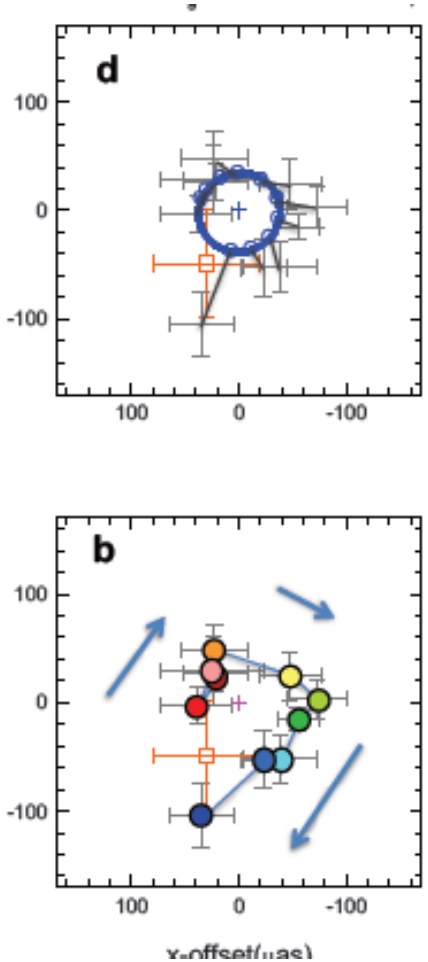
~up to 100pc scale

Detection of gravitationnal redshift, *GRAVITY Coll 2018*

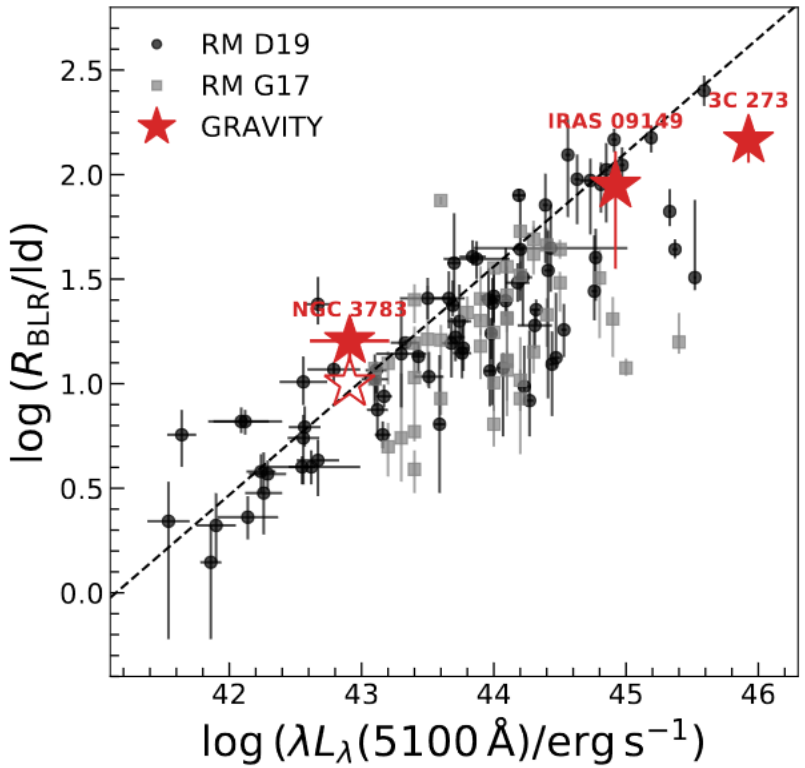


Infrared Flares around the SgrA* black hole

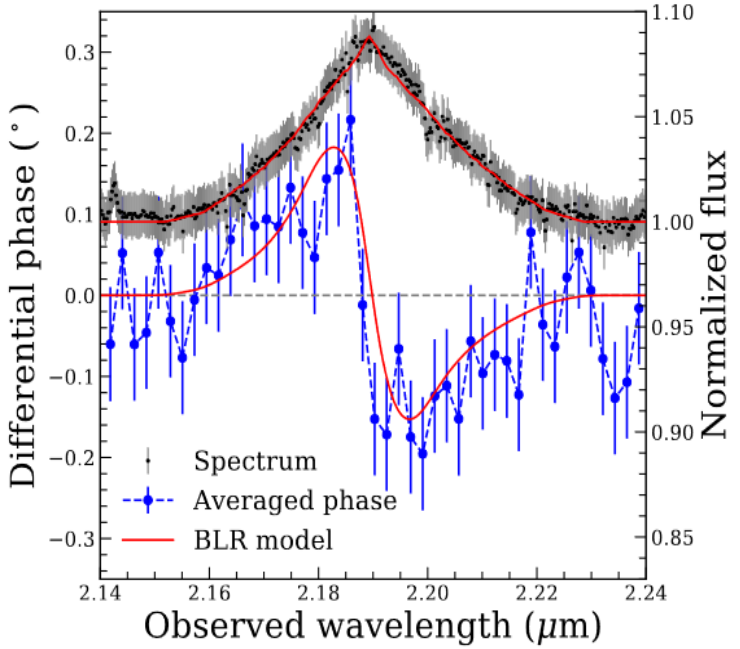
GRAVITY 2018

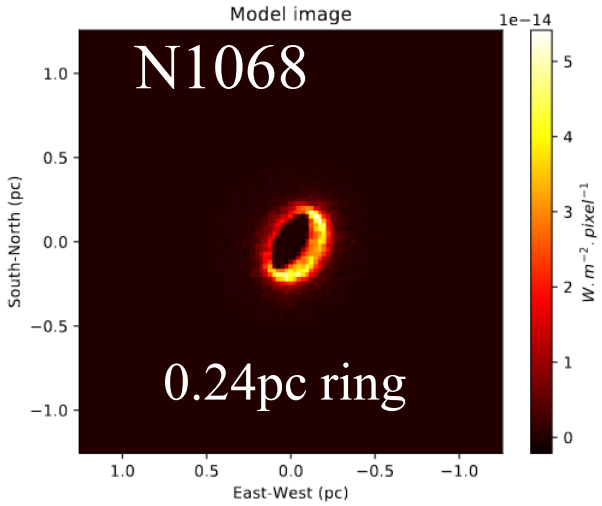


Mass of SMBH
Distance of
NGC 3783
3C273, IRAS09149
GRAVITY 2021



Resolving the BLR





Vermot et al 2021

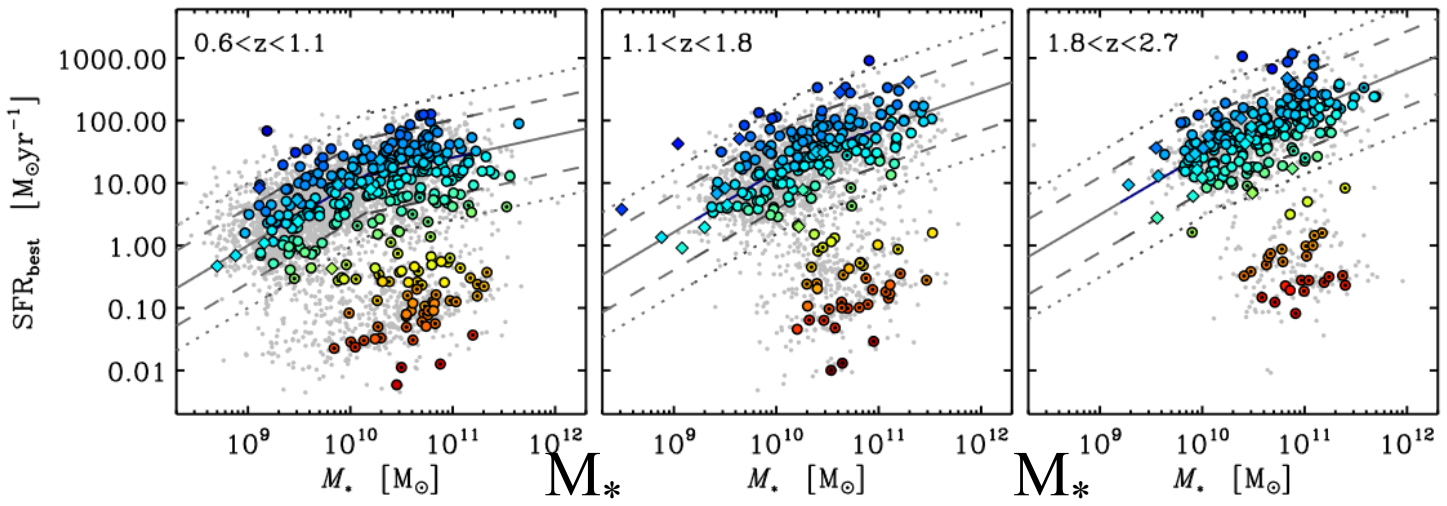
KMOS^{3D} survey

Wisnioski et al 2019

SFR

x10

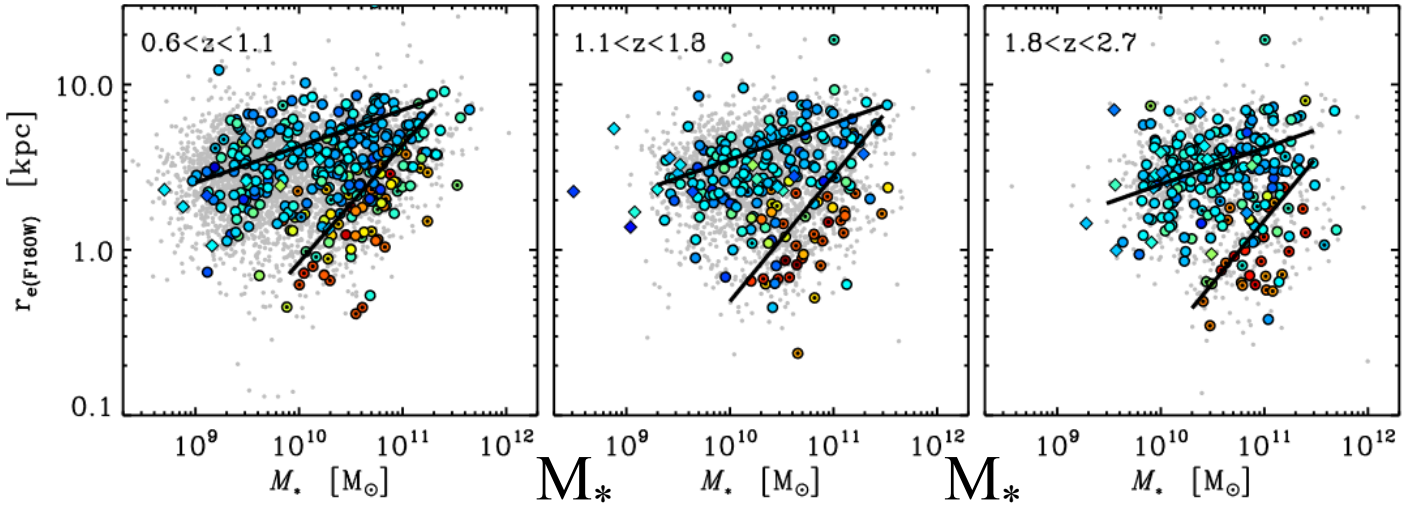
x4



Hα, [NII], [SII]
3D-HST survey

77% of galaxies are rotation dominated (V/σ >~2)

Radius Re



25% quenched

Re ~$M^{0.22}$

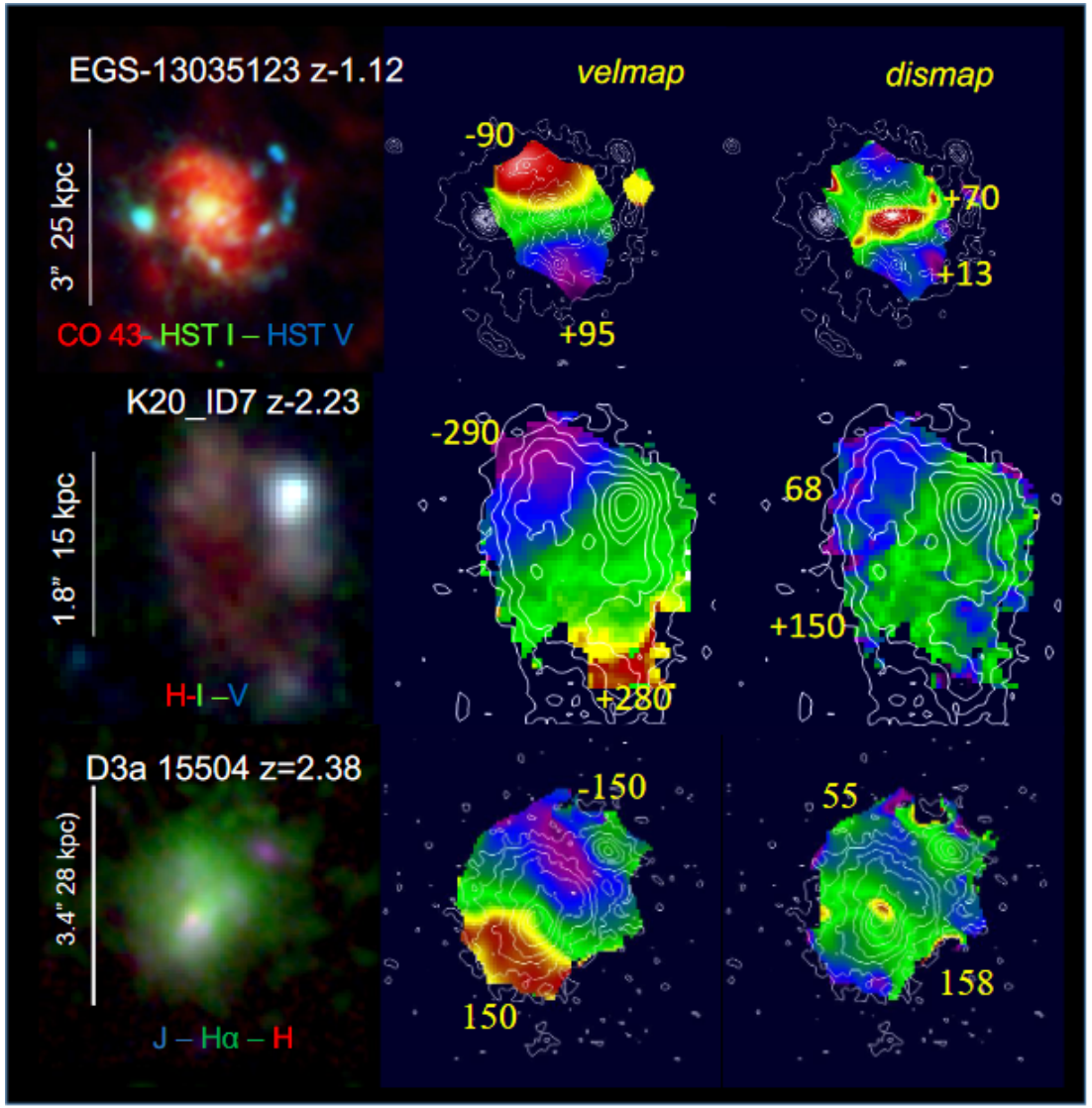
Blue sequence

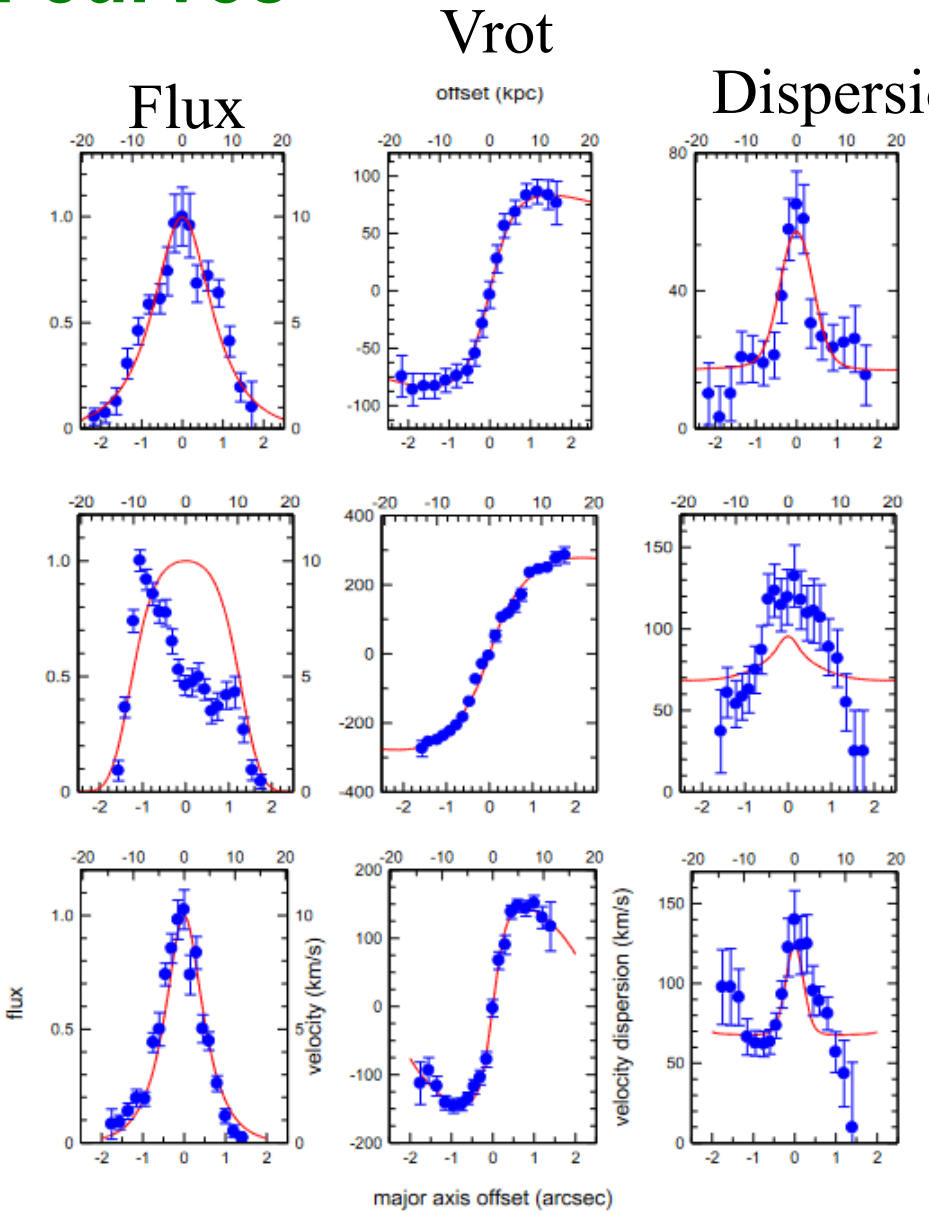
Re ~$M^{0.75}$

Red sequence

Re ~$(1+z)^{-0.75}$ Re ~$(1+z)^{-1.48}$

Hα or CO rotation curves

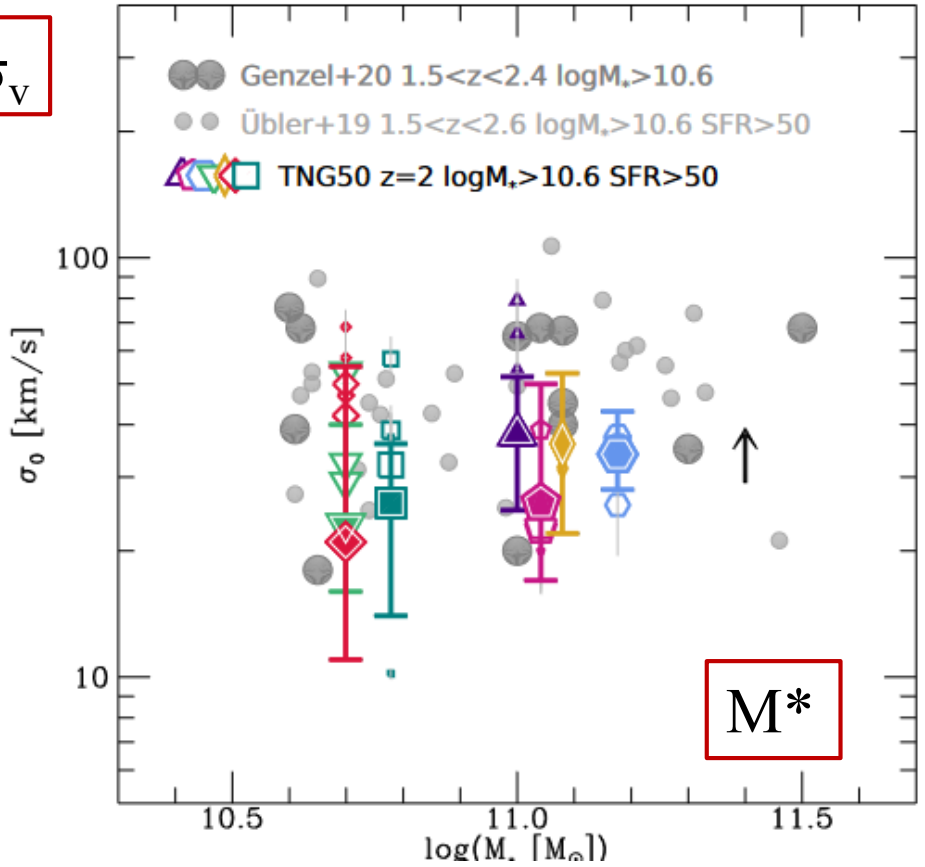




Genzel et al 2020

Kinematics, dispersions

σ_v



Ubler et al 2021

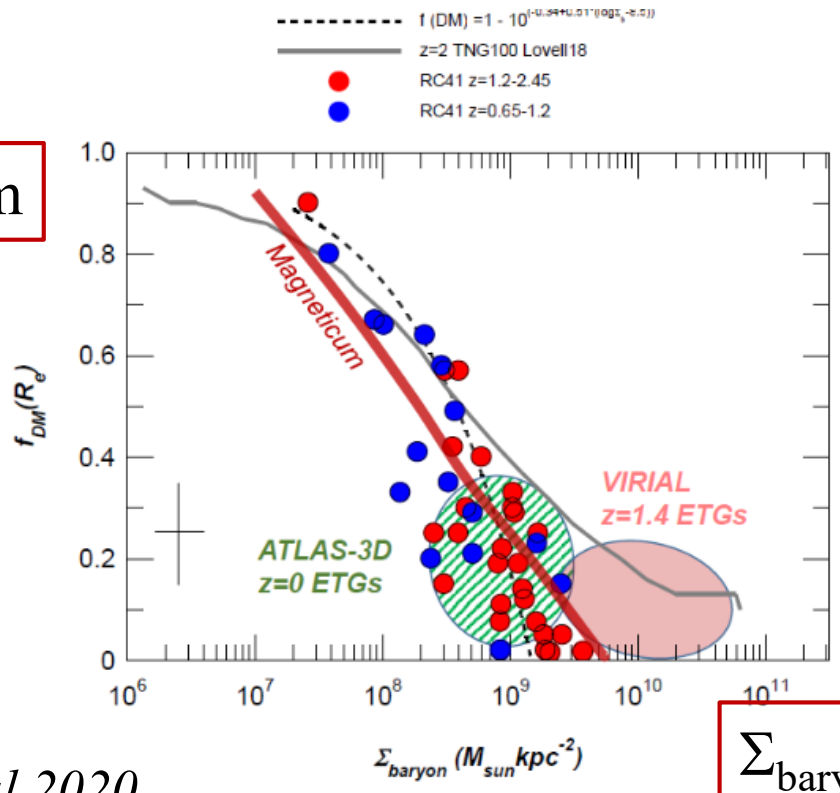
FIRE-2 represents better the observations (higher σ)

Galaxies at z> 1.2 are more baryon-dominated within Re than at z=0

They have more dispersion

➔No NFW-cusp but a core

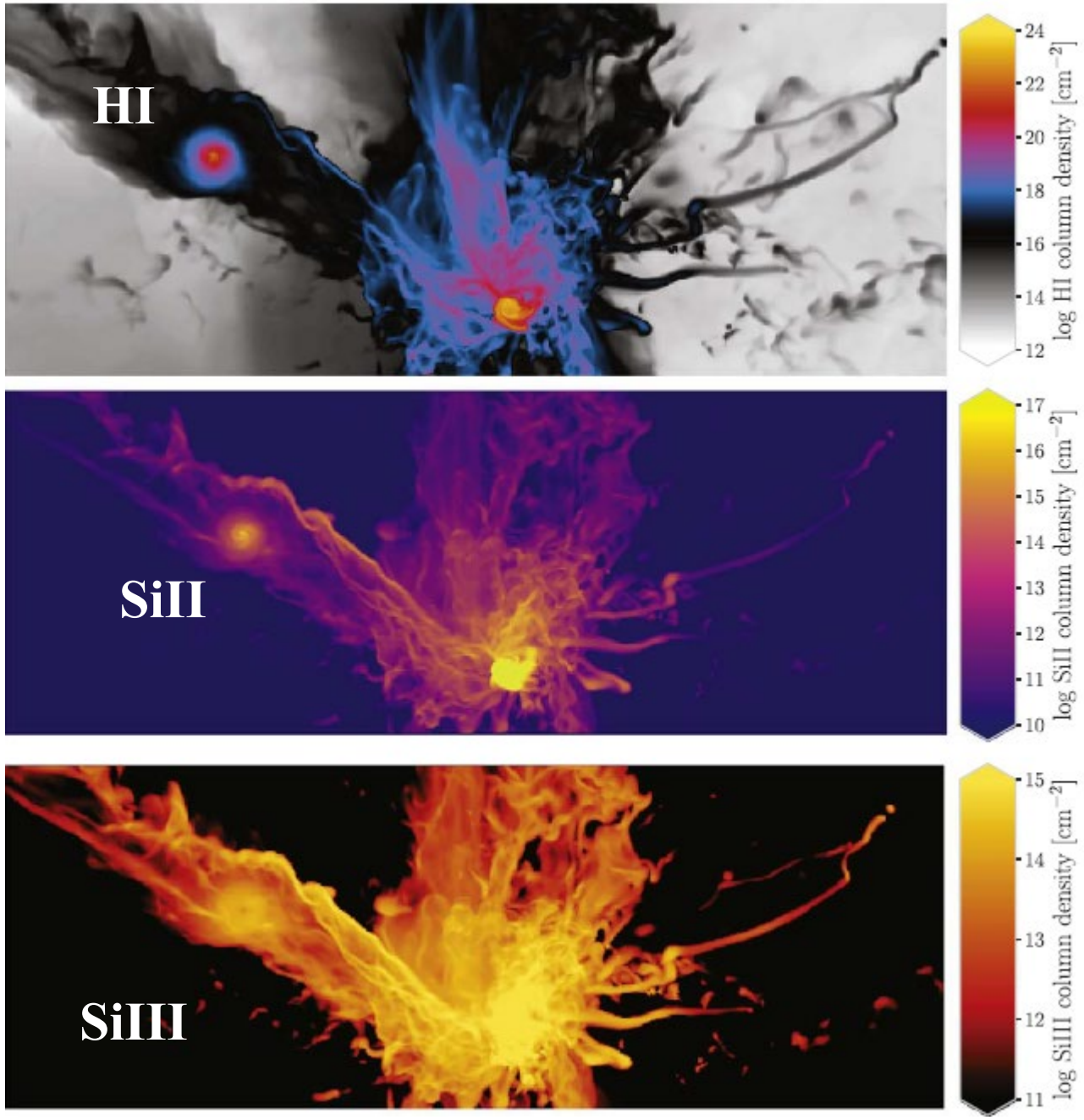
fdm



Genzel et al 2020

Σ_{baryon}

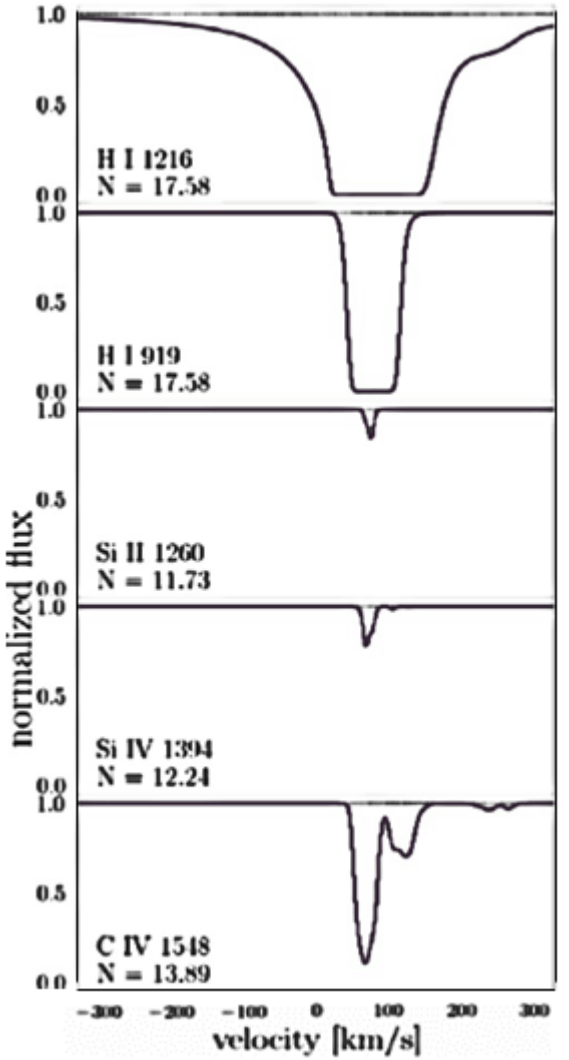
Simulations of CGM



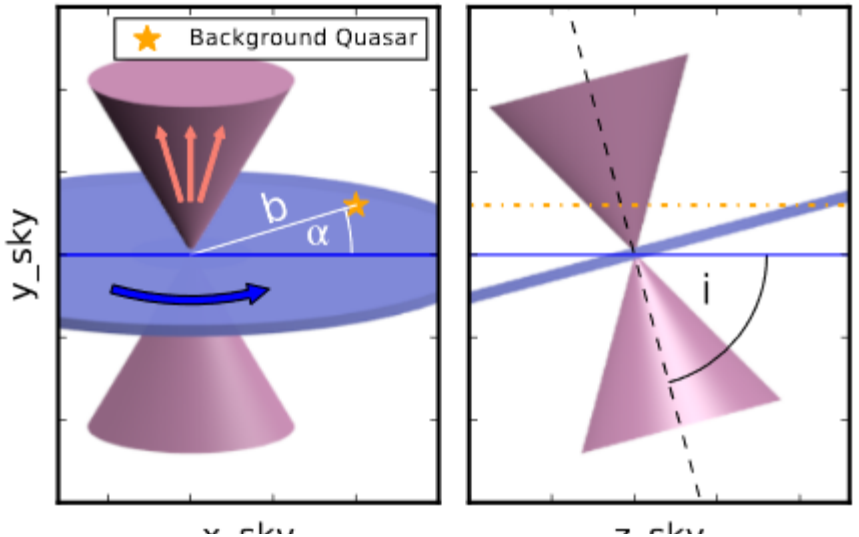
Peeples et al 2019

Black/Blue Ly-limit

Orange/red, DLA

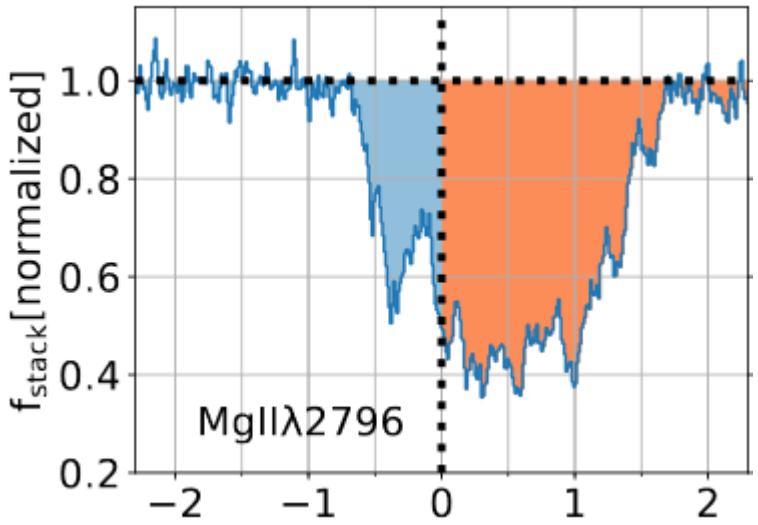


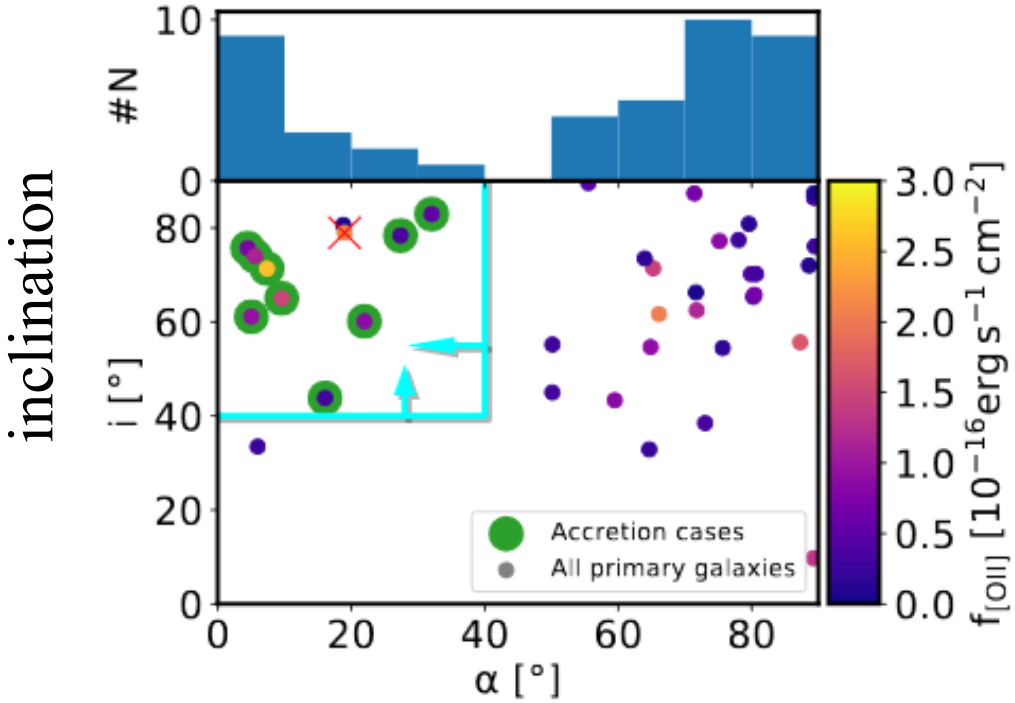
Diagnostic in absorption (MUSE MEGAFLOW)



α is the position angle of the QSO
wrt the major axis of the galaxy
i the inclination of the galaxy on the los

Gas frequently outflowing
When in the disk, it rotates with it

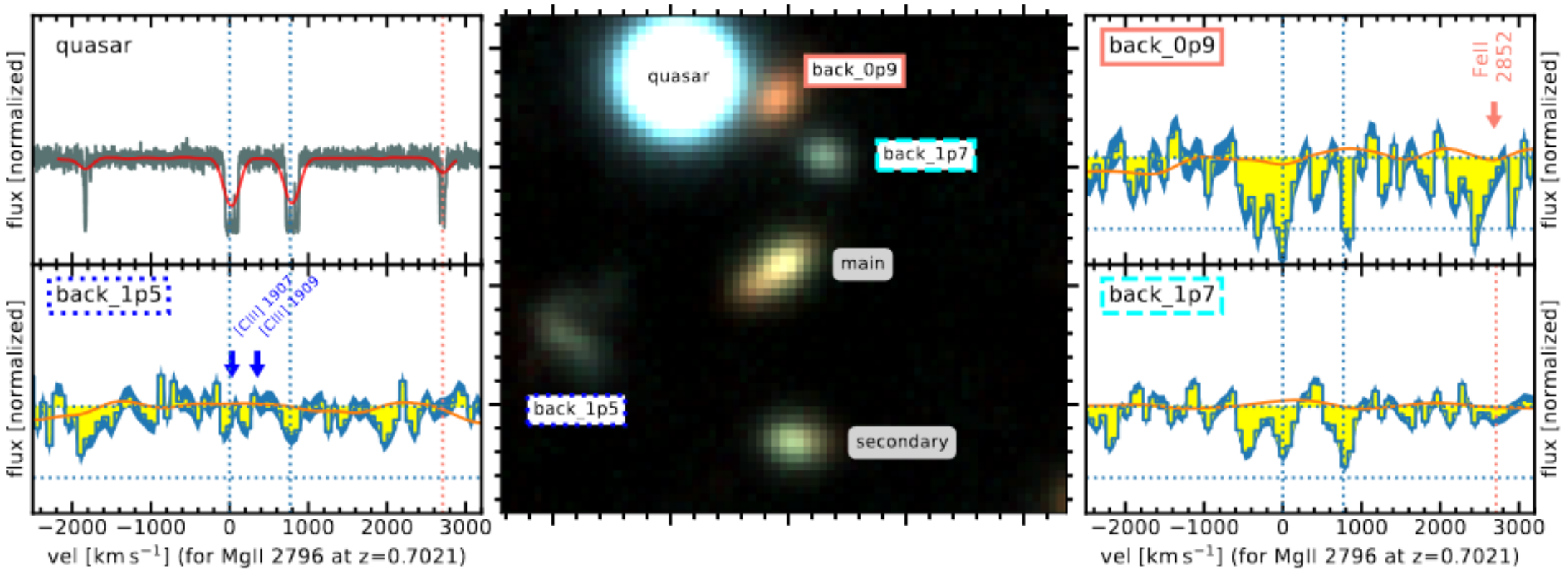




Zabl et al 2019

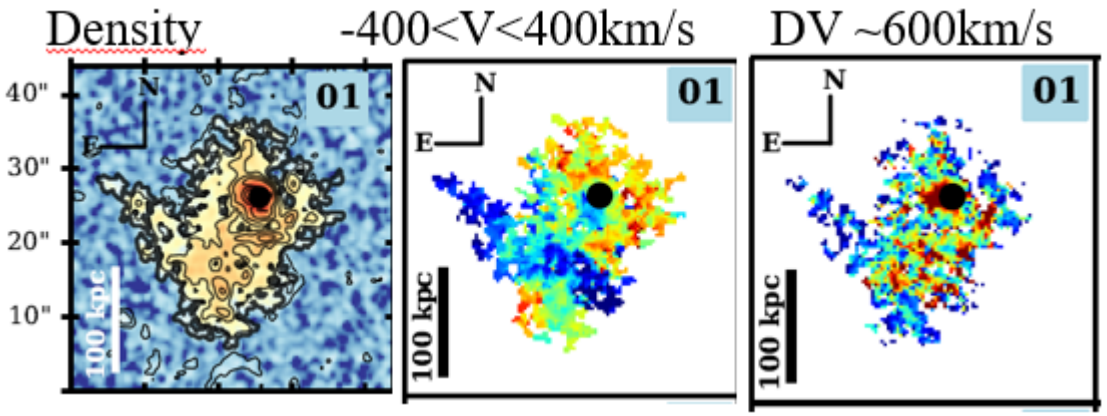
MgII outflowing in a QSO sight line

MUSE Megaflow: **first MgII emission detection** from a QSO absorption
Extension 25kpc z=0.7 Origin from the outflow? (minor axis),
Excited by shocks at large distance



Zabl et al 2021

MUSE: Cold atomic gas illuminated by quasars

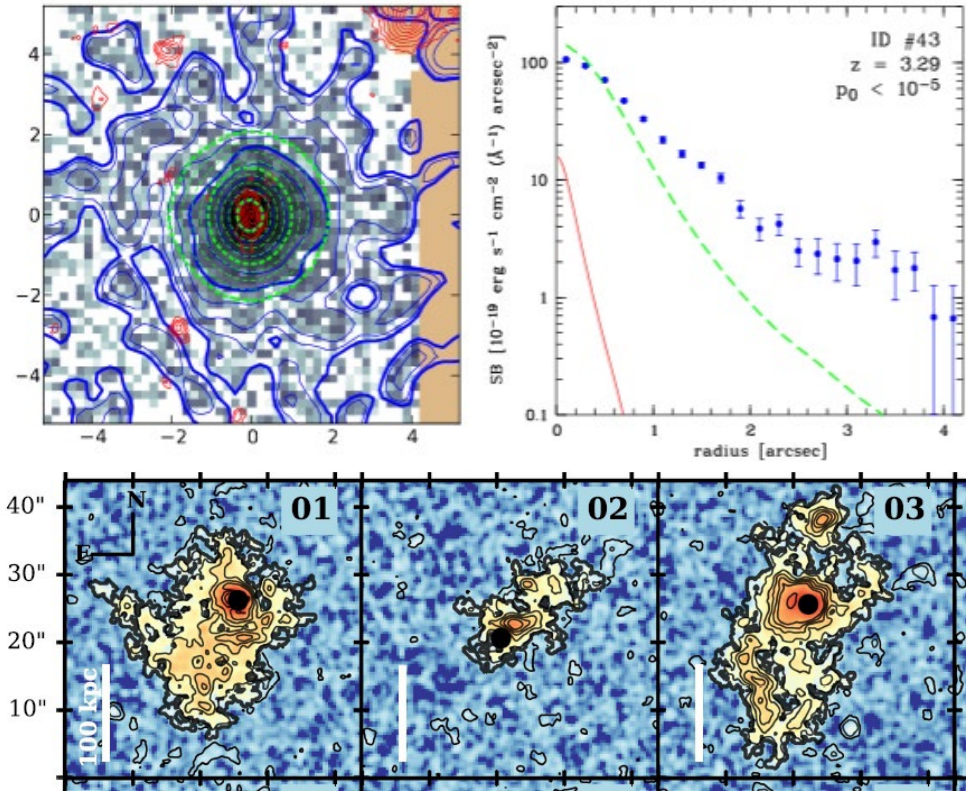


Blind survey for giant Ly-α nebulae around
17 bright RQQ at 3<z<4
All QSO have 100-320kpc Ly-α nebulae
Borisova et al 2016

Extended Lyα haloes

Galaxies between 3 < z < 6
Lyα 5-15 x extended than UV continuum

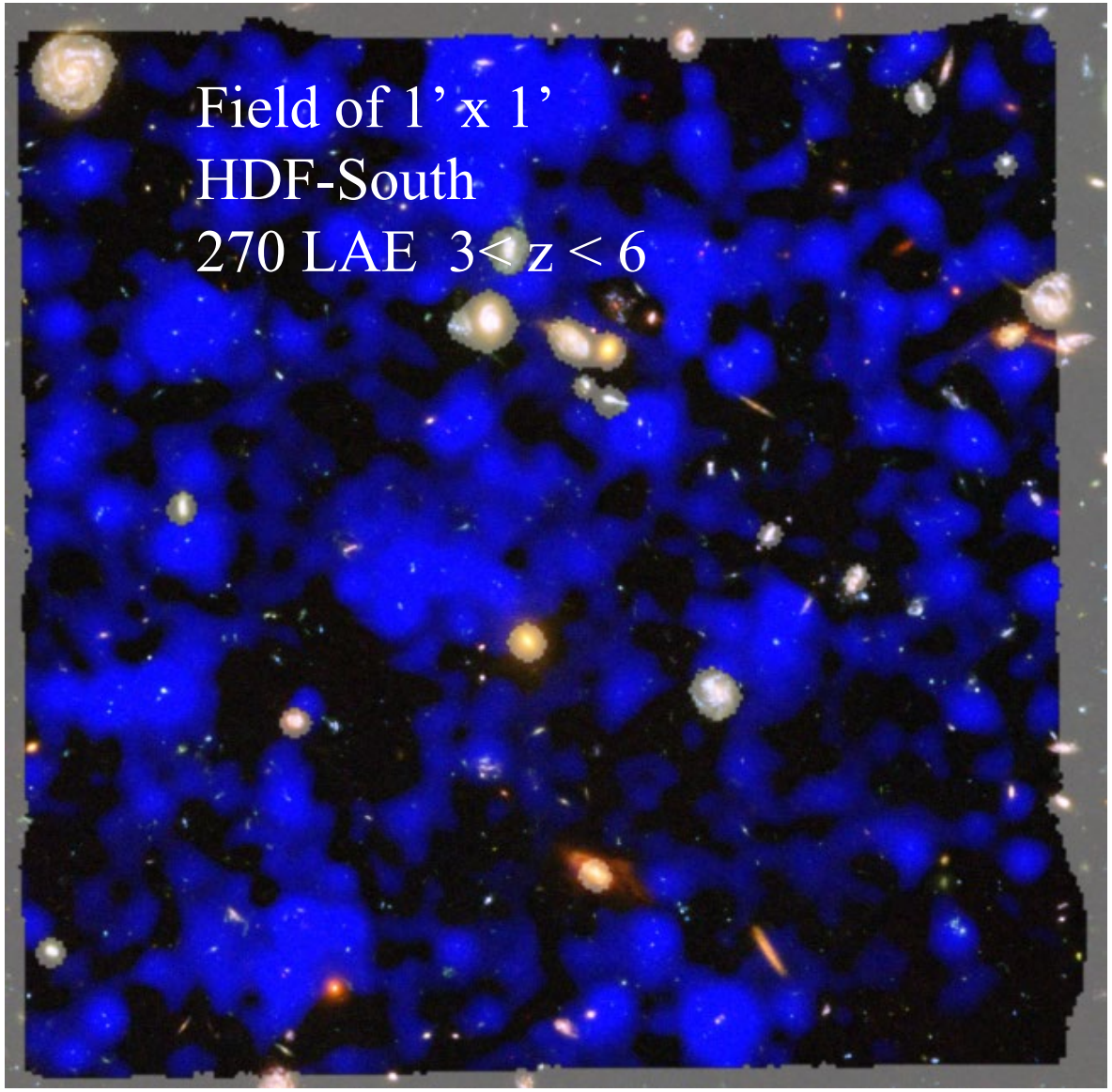
Neutral medium of several kpc



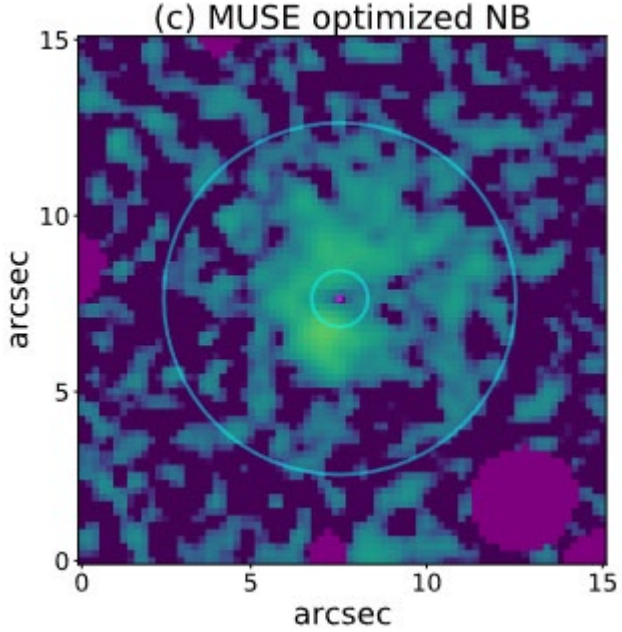
Wisotzki, Bacon, Blaizot et al 2016

MUSE Deep Field: Circum-galactic gas everywhere

Wisotzki, Bacon, Brinchman et al 2018



UV-selected galaxies



81% of LAE have an extended Lyα halo -40kpc
Kusakabe, Verhamme, Blaizot et al 2022

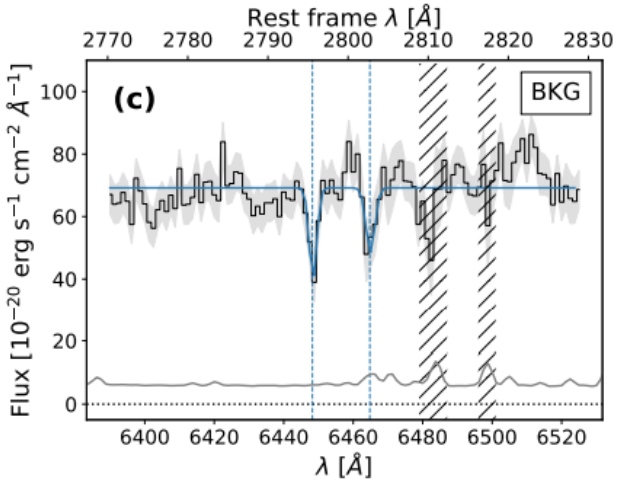
Large gas reservoirs:
inflows, outflows, both

Also traced by absorption
DLA, sub-DLA or Lyα forest

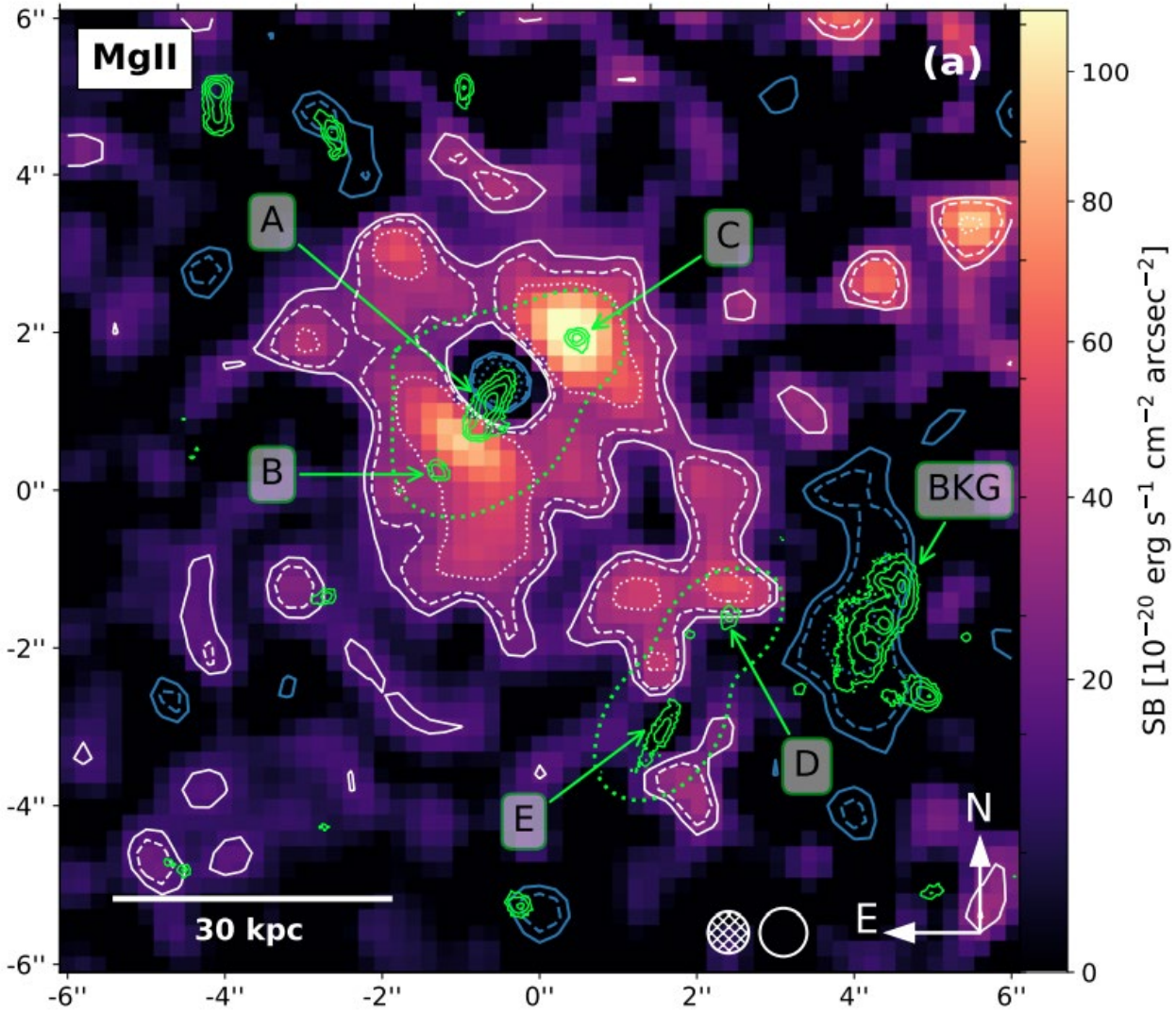
MgII in a galaxy group, z=1.31

White contours 1.5, 2, 3σ Blue contours: absorption
Over 1000 kpc^2
Outflow in the central
galaxy (P-cygni) + [FeII] minor axis

➔tides and outflows
Create the IGM

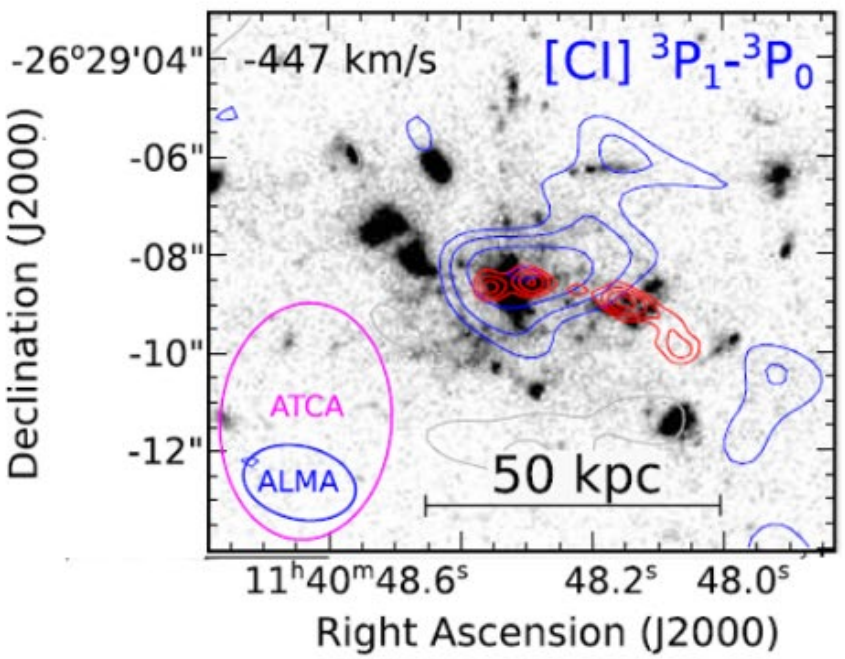


Leclercq et al 2022



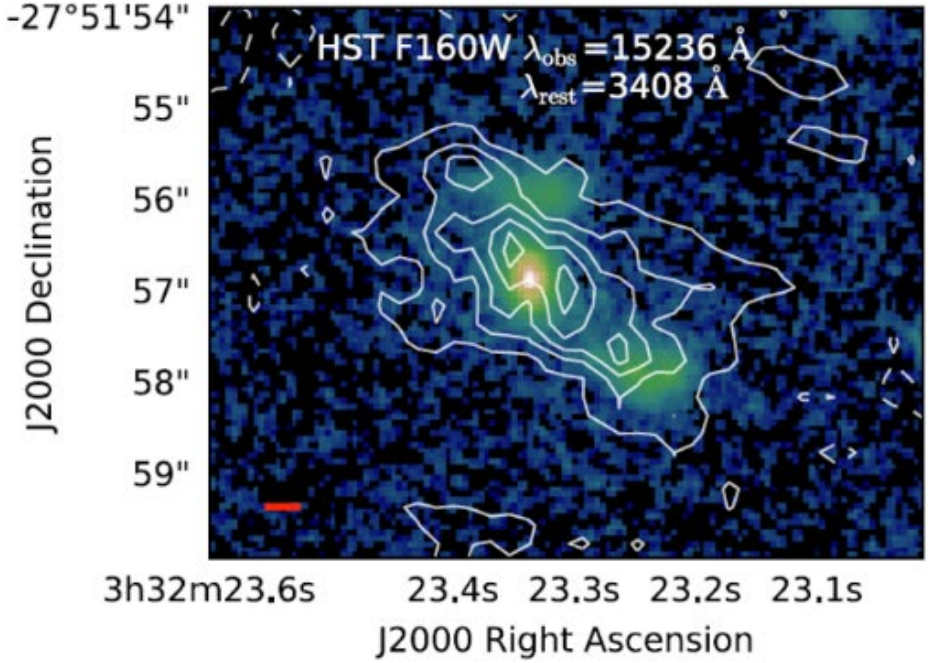
Extended cold gas

Spiderweb (Emonts et al 18)



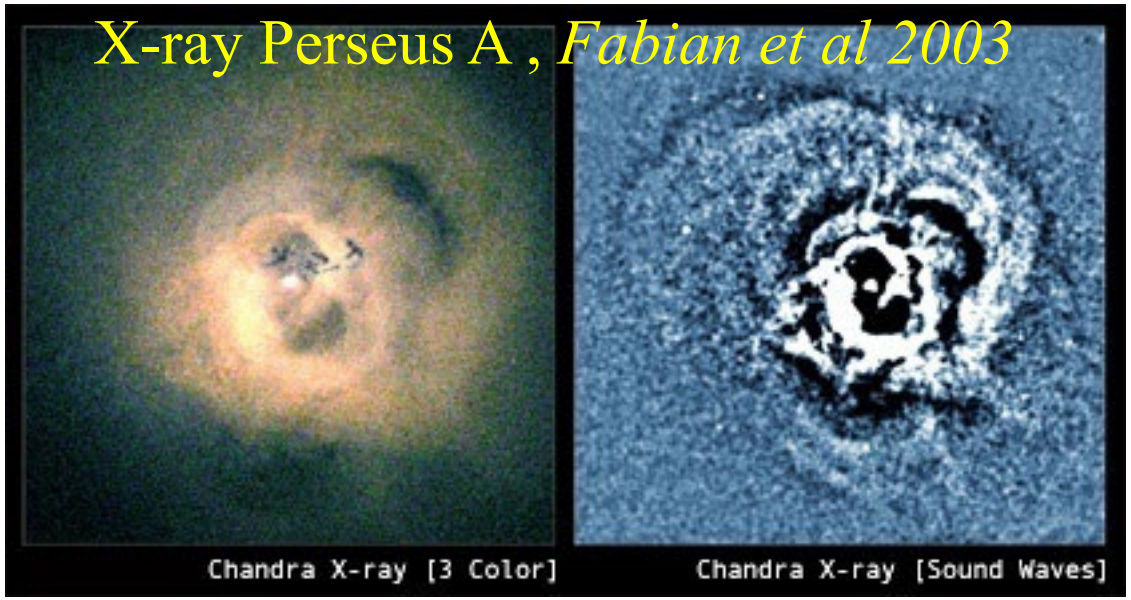
CI contours with ALMA
Red contours, radio cont

CANDELS-5001, (Ginolfi et al 17)

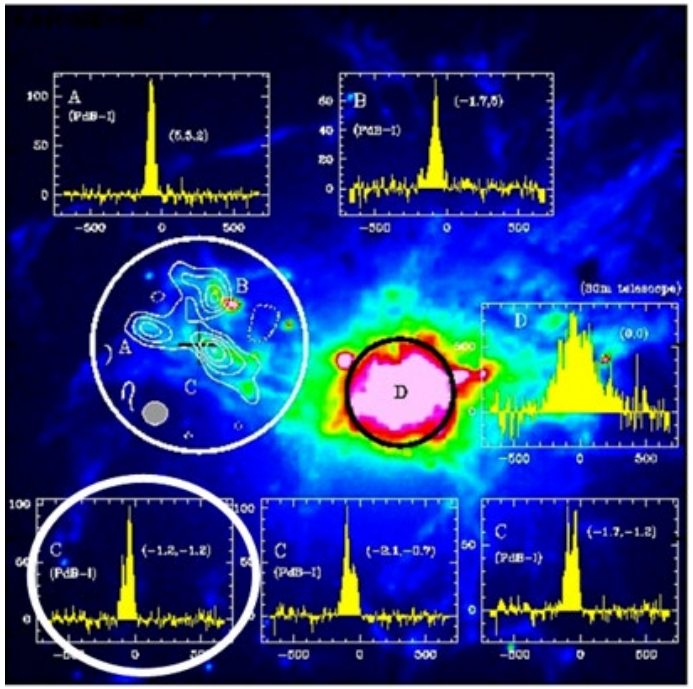


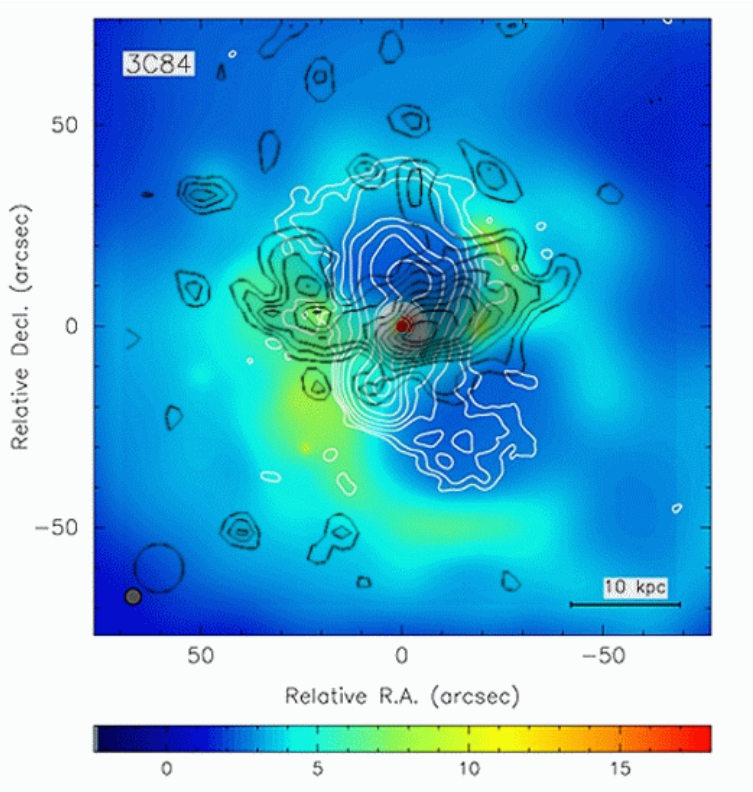
CO(4-3) on HST
z=3.5 protocluster

Cooling flows: Perseus



Salome et al 2008, 2011

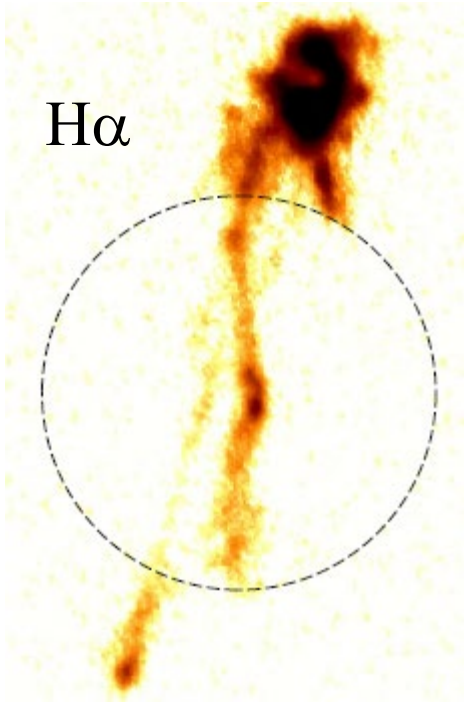




Molecular Gas
Salomé et al 2006
$M(H_2) \sim 10^{10}\ M_\odot$

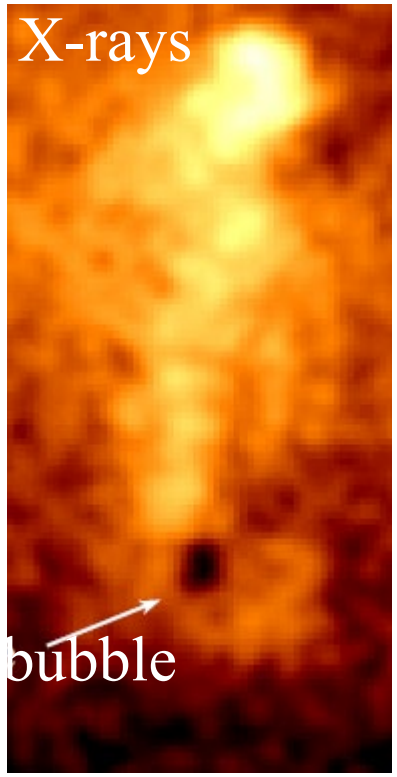
The bubbles create inhomogeneities and further cooling
At R~20kpc, tc/tff ~10
➔thermal instability *(McCourt et al 12)*

Velocity much lower than free-fall

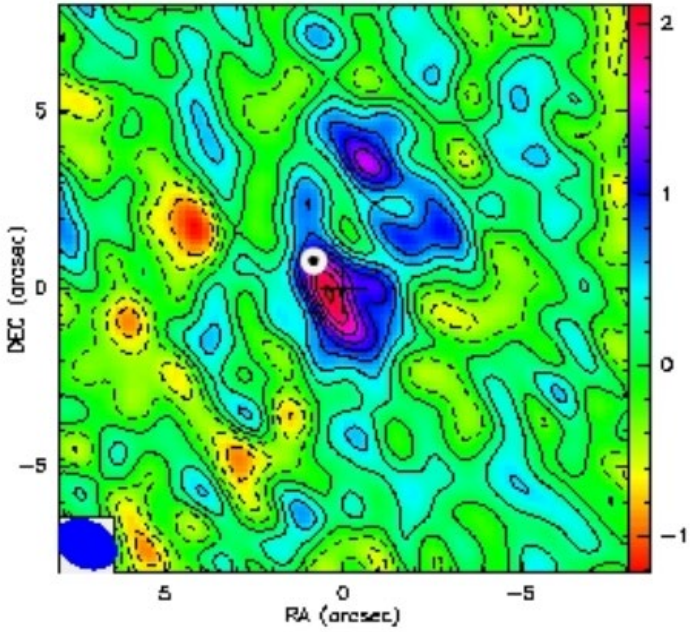


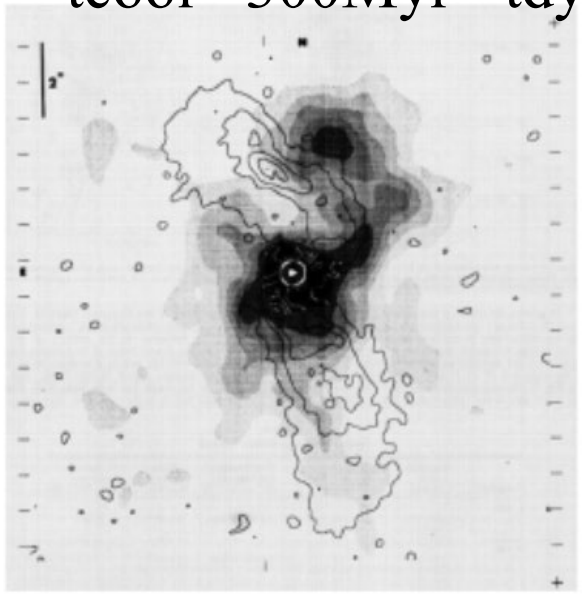
McDonald et al 2009
60kpc tail

Trailing wake A1795

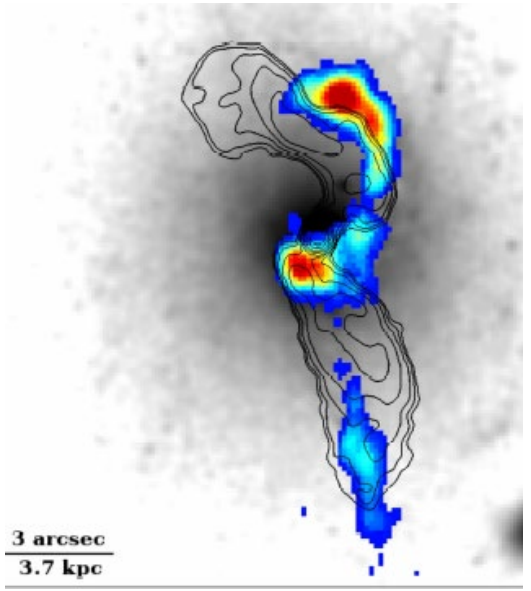


tcool= 300Myr= tdyn



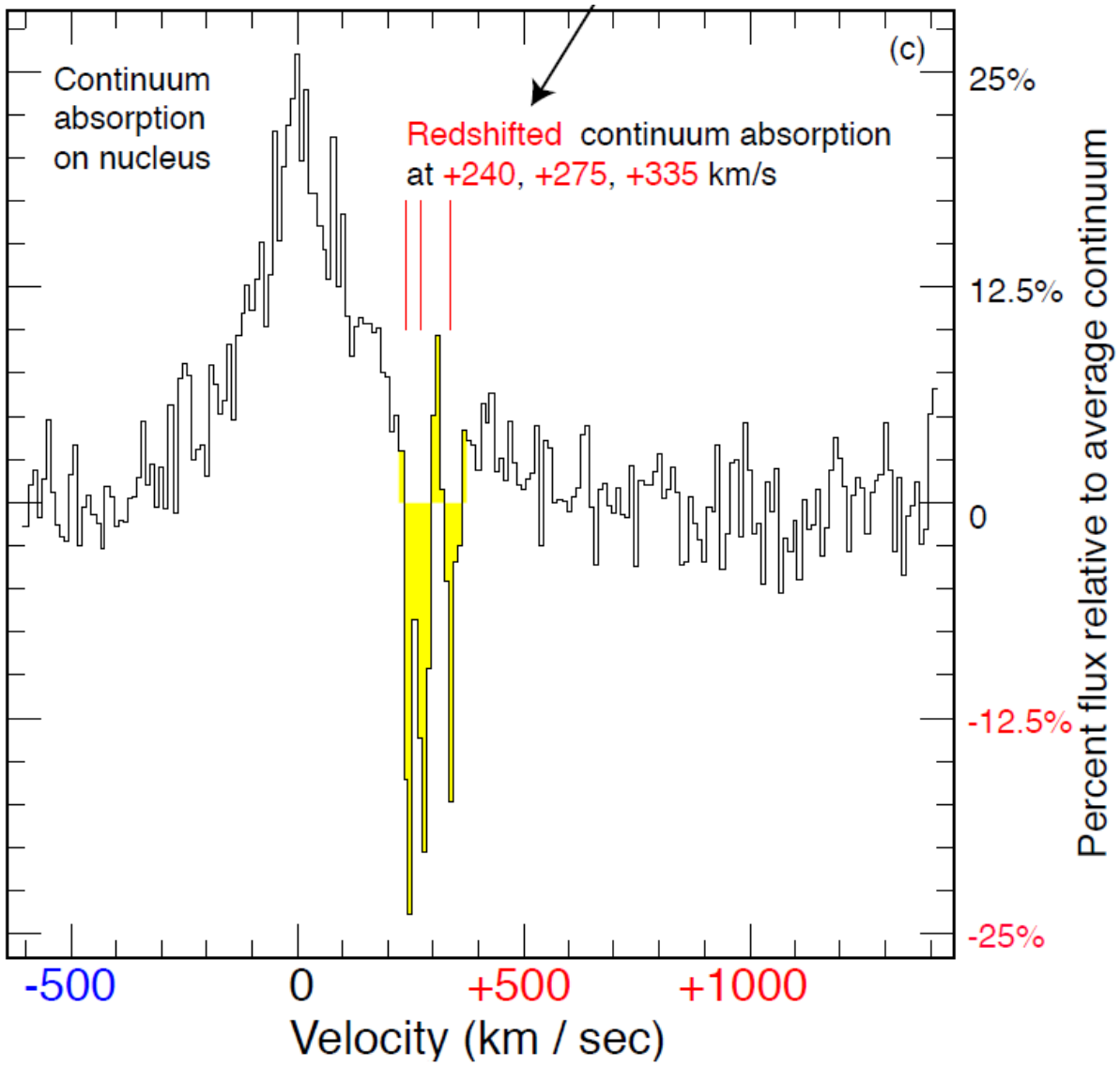


Salome & Combes 2004



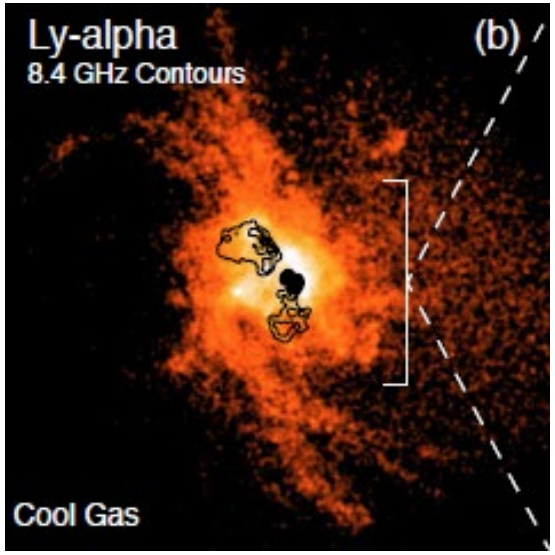
Russell et al 2017

ALMA: cold gas in cool core clusters



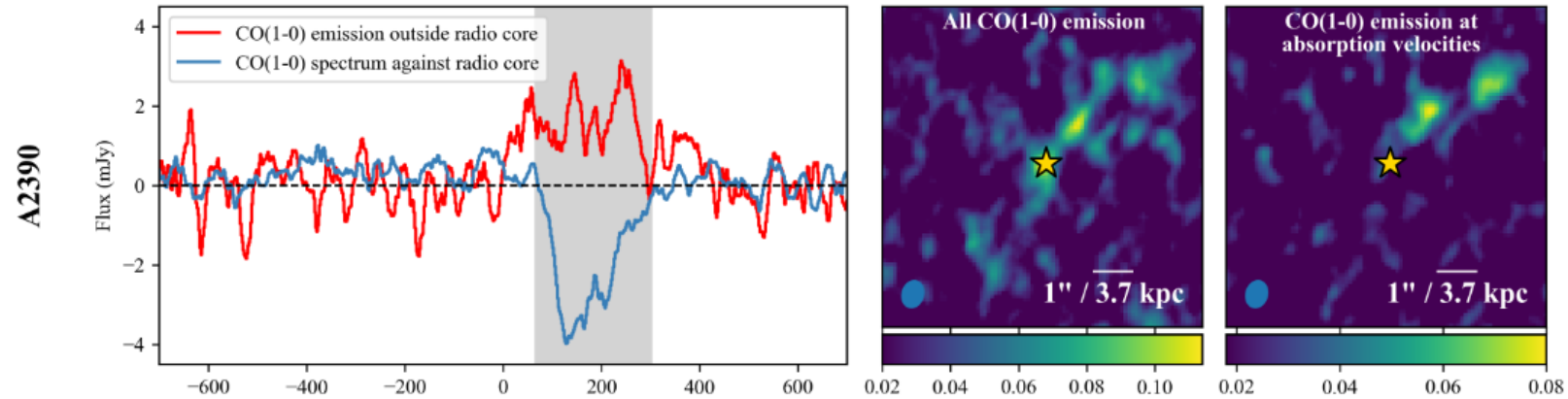
Abell 2597 ALMA
CO(2-1) absorption
in front of the AGN synchrotron

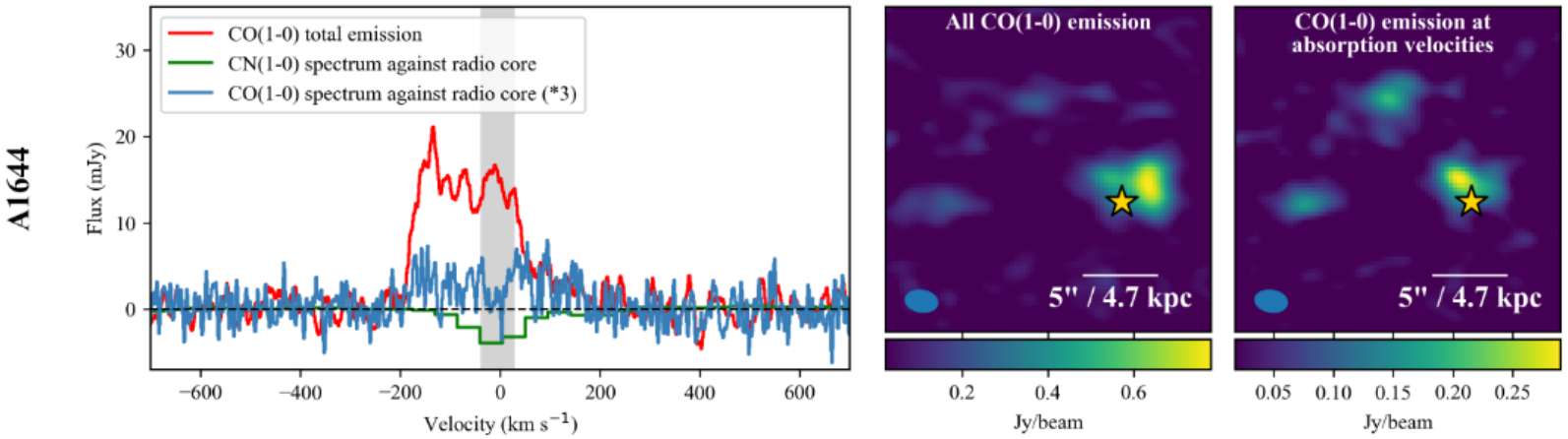
Red-shifted only
Dense clouds fueling the AGN

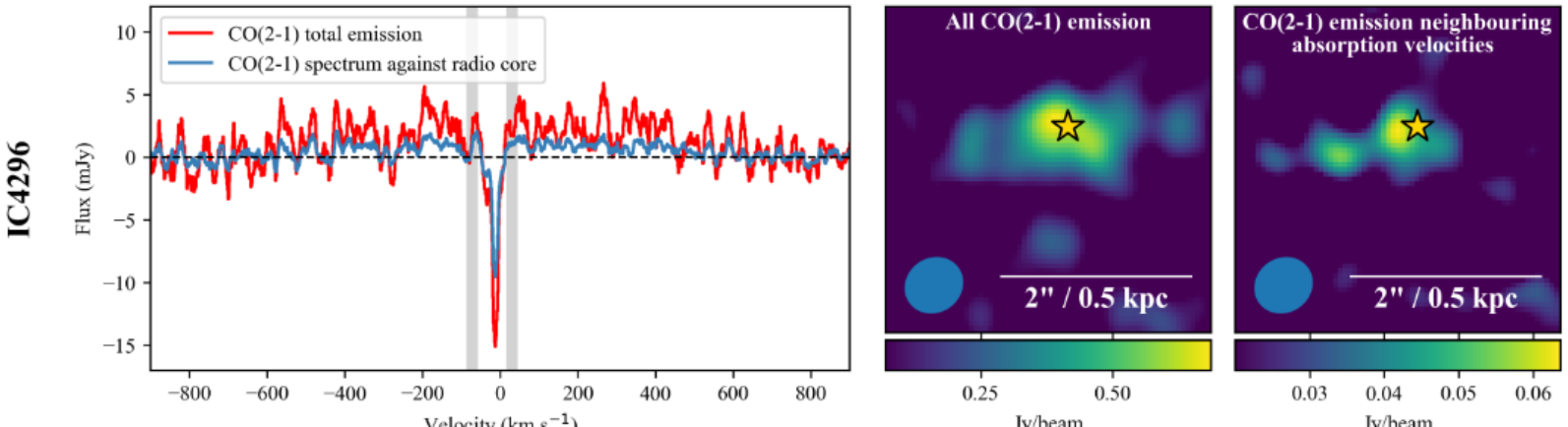


Tremblay et al 2016

ALMA, cold gas in absorption and emission







Most often, gas is inflowing towards the nucleus
Fueling the AGN

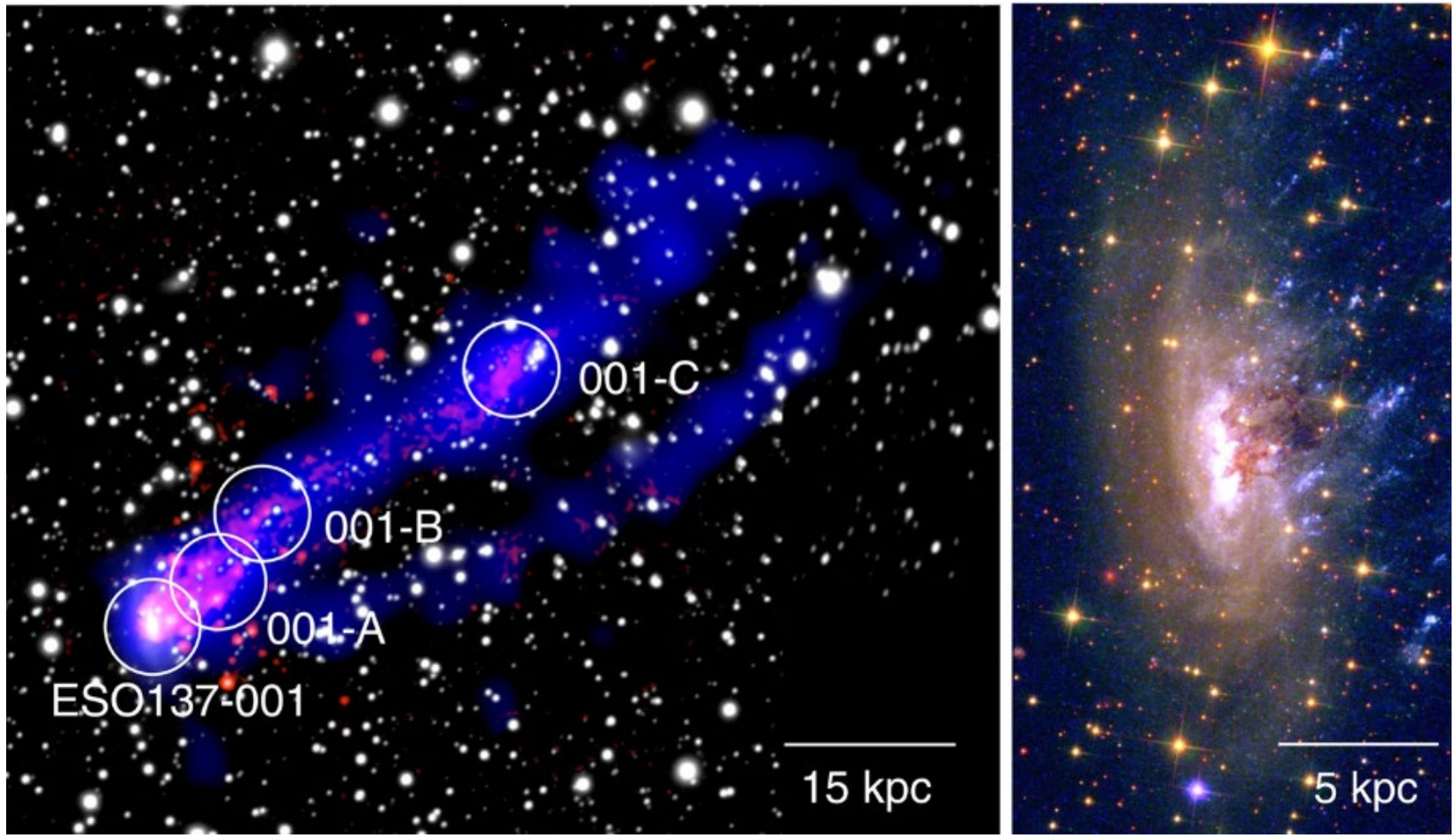
Rarely, it is far from the center

Rose et al 2022

Ram-pressure stripping: resilient tails

ESO137-001: violent ram-pressure, bu CO gas remains, and reforms

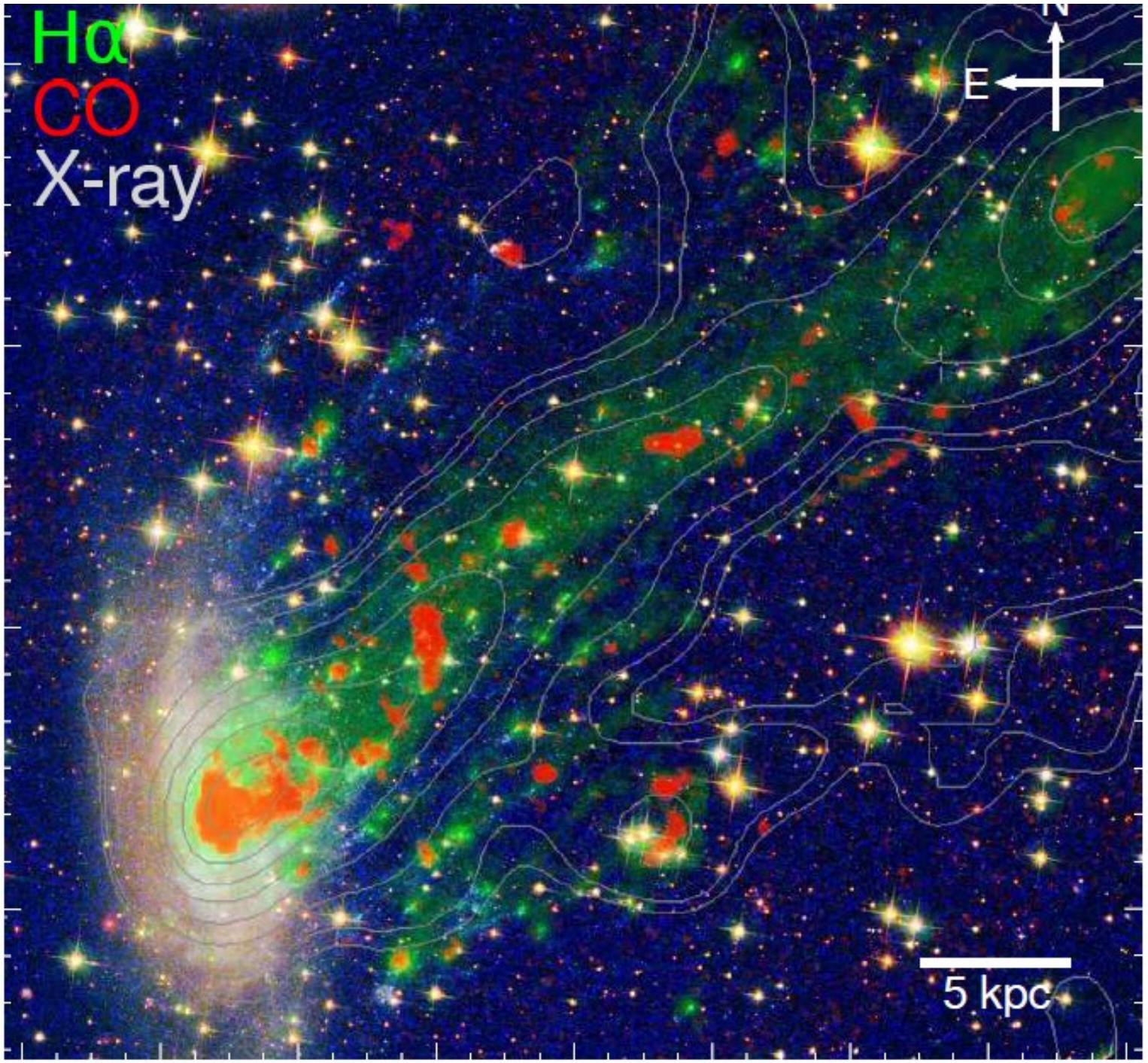
➔ **molecular filaments**, with Hα and X-rays



Jachym et al 2014: Norma cluster

ALMA CO
more H_2 in
the tail than in disk

➔ in situ formation

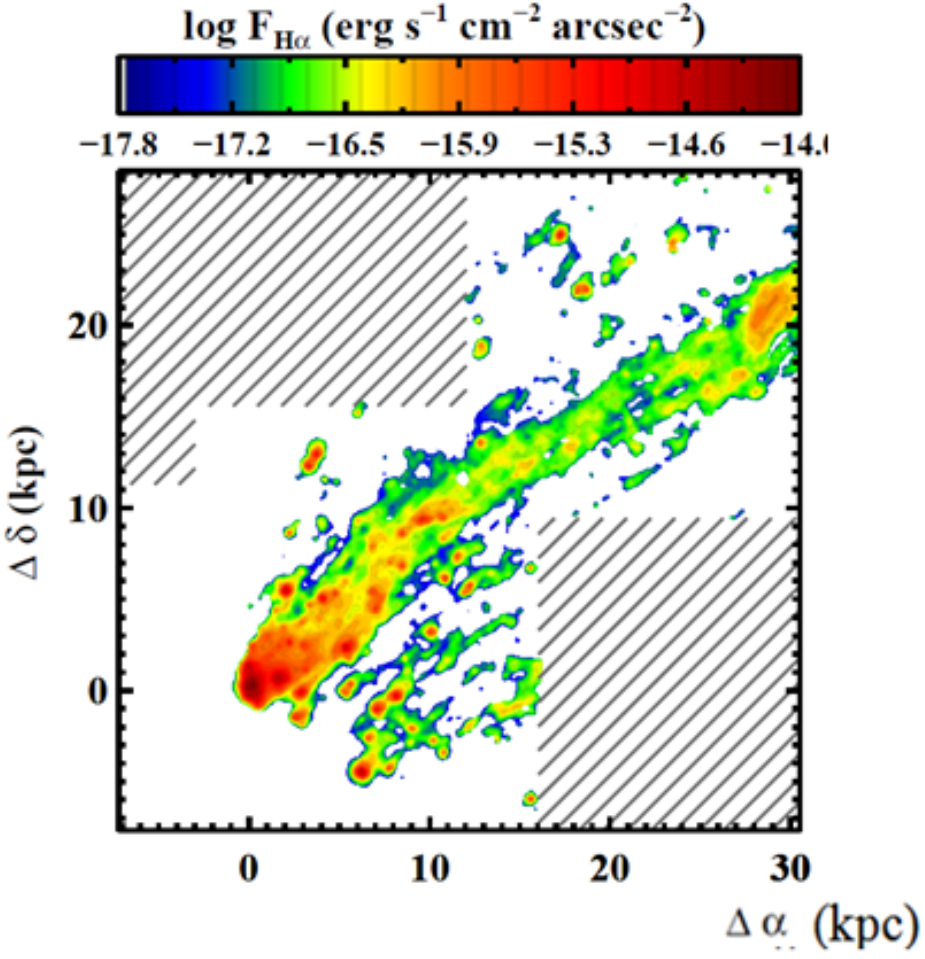


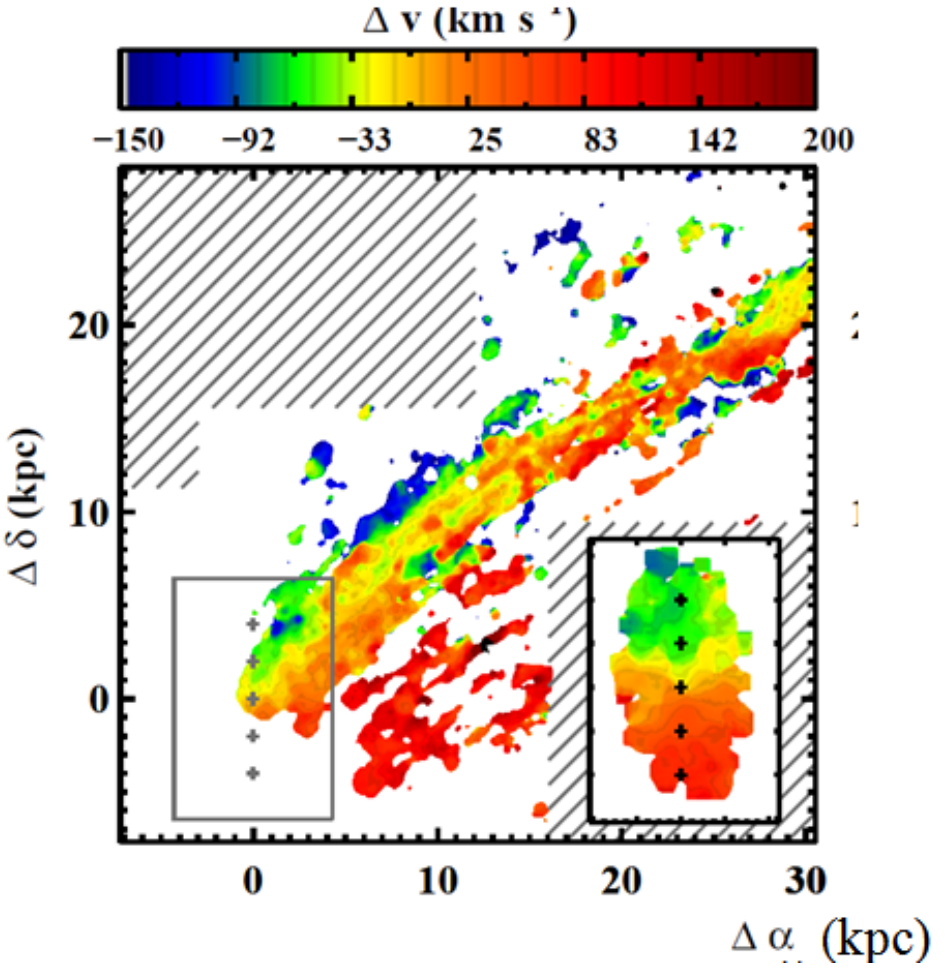
Jachym et al 2019

Halpha with MUSE (VLT)

Outer regions swept first: remains the center

Transition from laminar to turbulent > 6.5 Myr

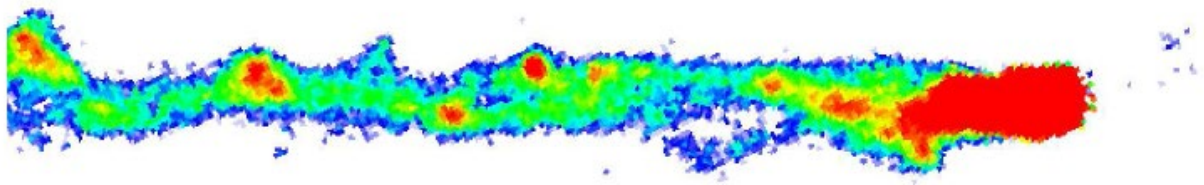




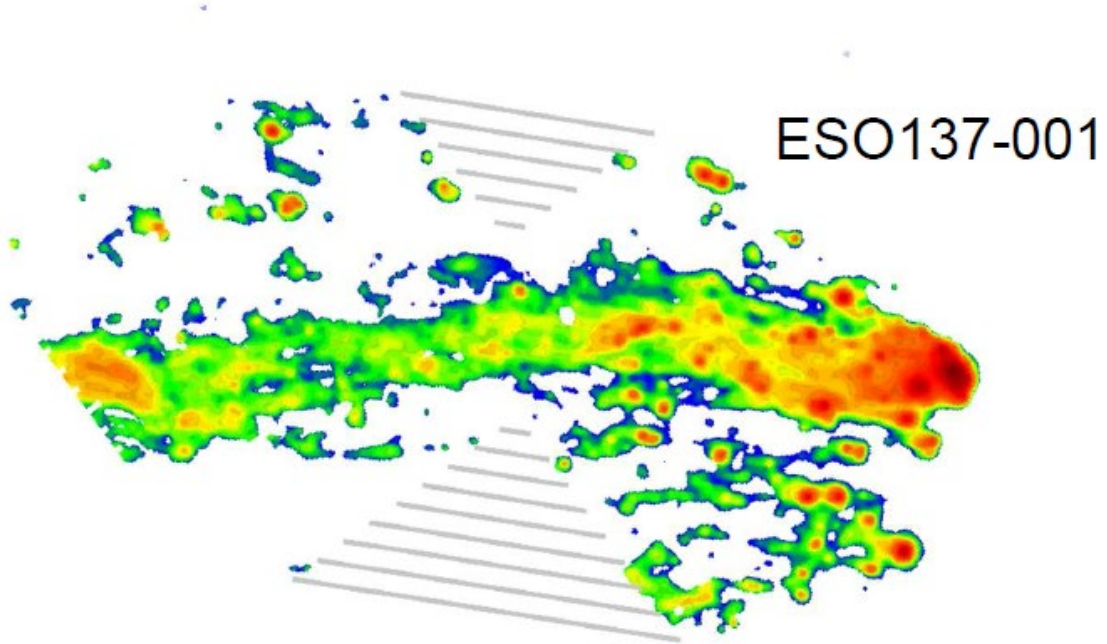
Fumagalli et al 2014

Comparison D100 & ESO137-001

Width of the ram-pressure tail decreases with time?



➔Older stripping in D100



Recalibrate to the same scale, same length *Jachym et al 2015*

Summary

➔ **High resolution near AGN**: polar dust, molecular tori

➔ **Rotation curves at high z**

➔ **CGM detected now in emission (Lyα, CI, CO..)**
Due to outflows, some inflows, excited by starbursts and AGN

➔ **Cooling flows and wakes,** when the BCG is in motion
Molecules reform in the filaments

➔ Molecular filaments + Hα through **tides and ram-pressure** from galaxies in clusters