A SIMPLE way to study superwinds at z~1 and beyond

SIMPLE: The SINFONI MgII program for Line Emitters

Nicolas Bouché (MPE)

M. Murphy (IoA) C. Péroux (Marseille)

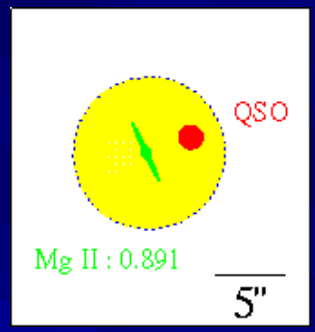
& contributions of

V. Wild (MPA), I. Csabai (Budapest), C. Churchill

+ L. Tacconi, N ForsterSchreiber, R. Genzel (MPE)

A SIMPLE way to study superwinds with z=1 MgII

Objective:



=

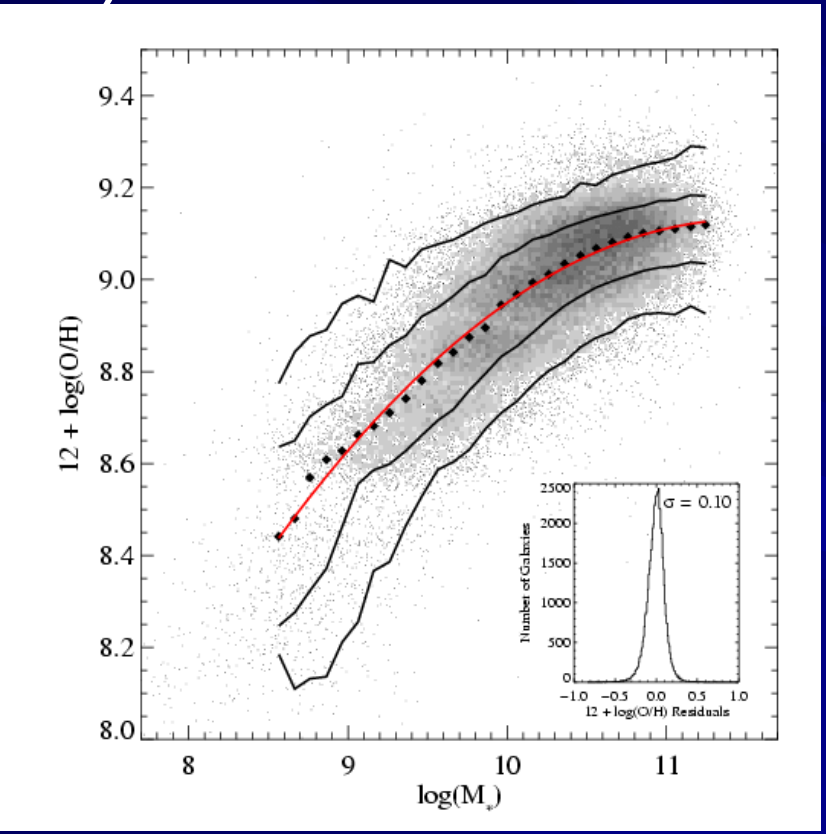
?

Why important: High-z gas Feedback!

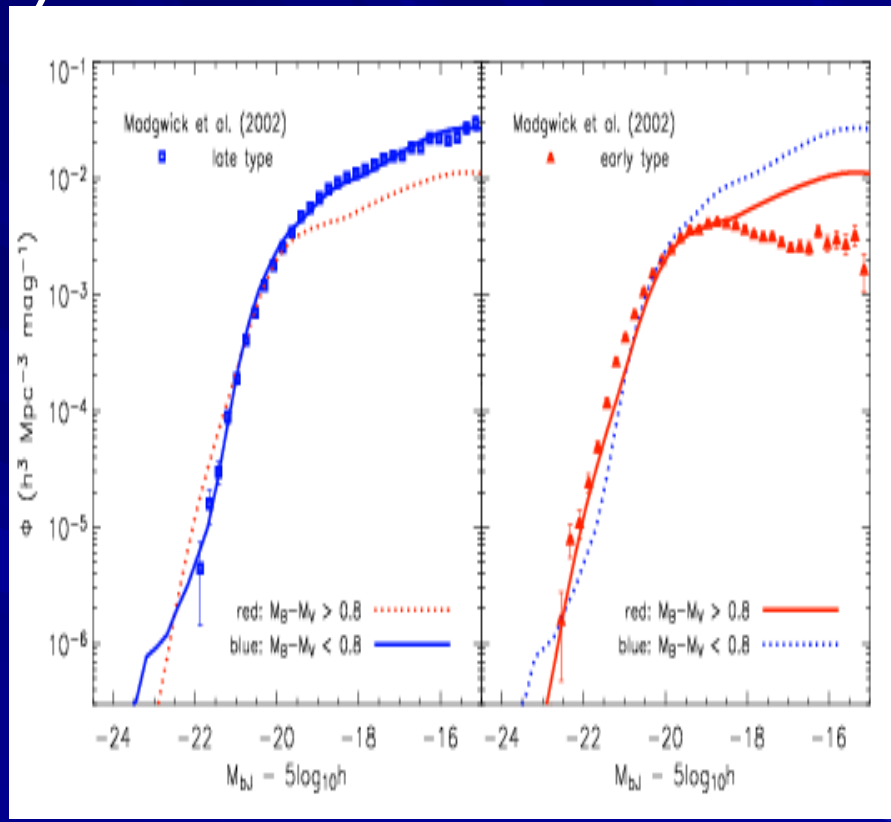
What's next: COS !

Feedback **needed** in low mass galaxies

A) Tremonti et al



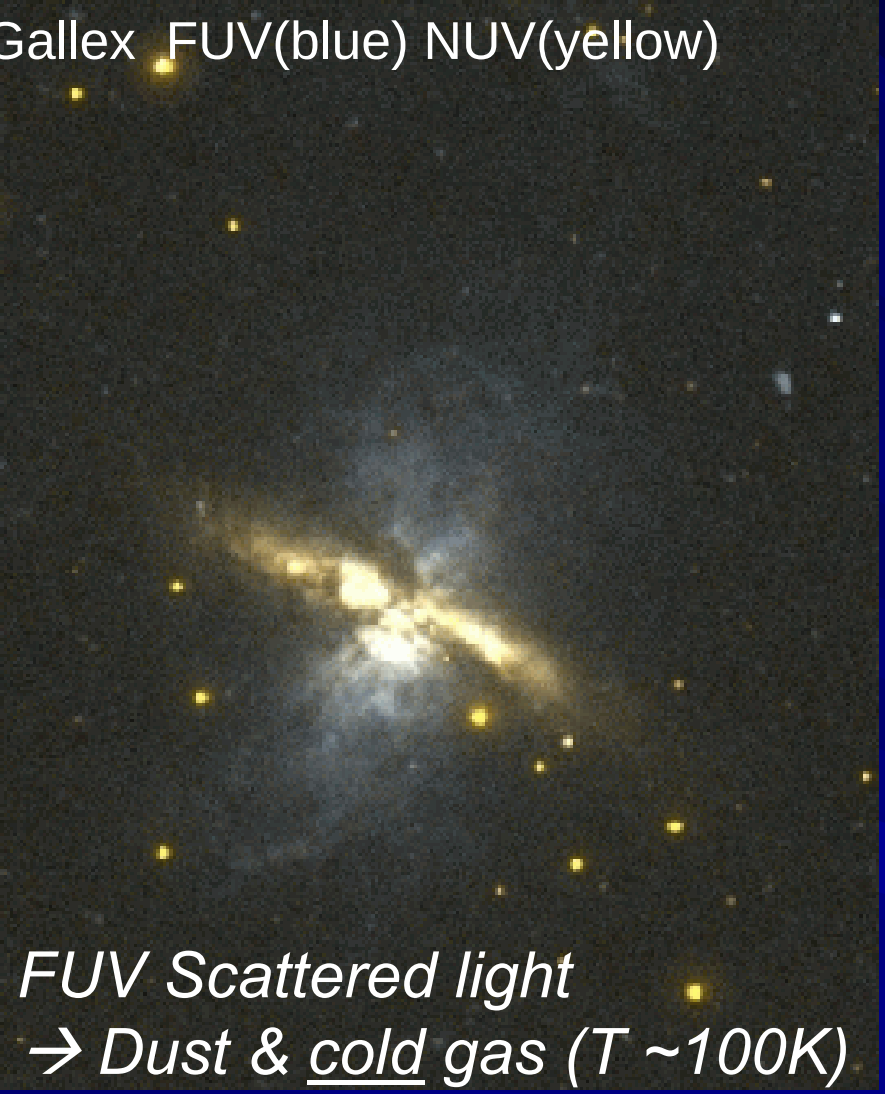
B) Croton 2005



C) Metals in the intergalactic medium (& missing metals)

D) Missing baryons

M82

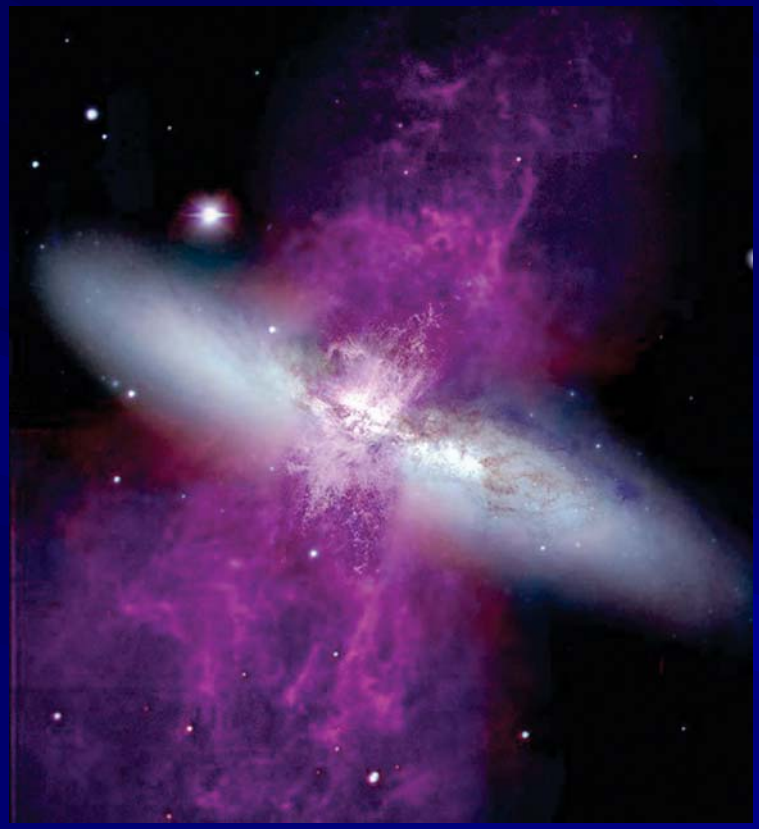


FUV Scattered light
→ Dust & <u>cold</u> gas (T ~100K)

Spitzer PAH

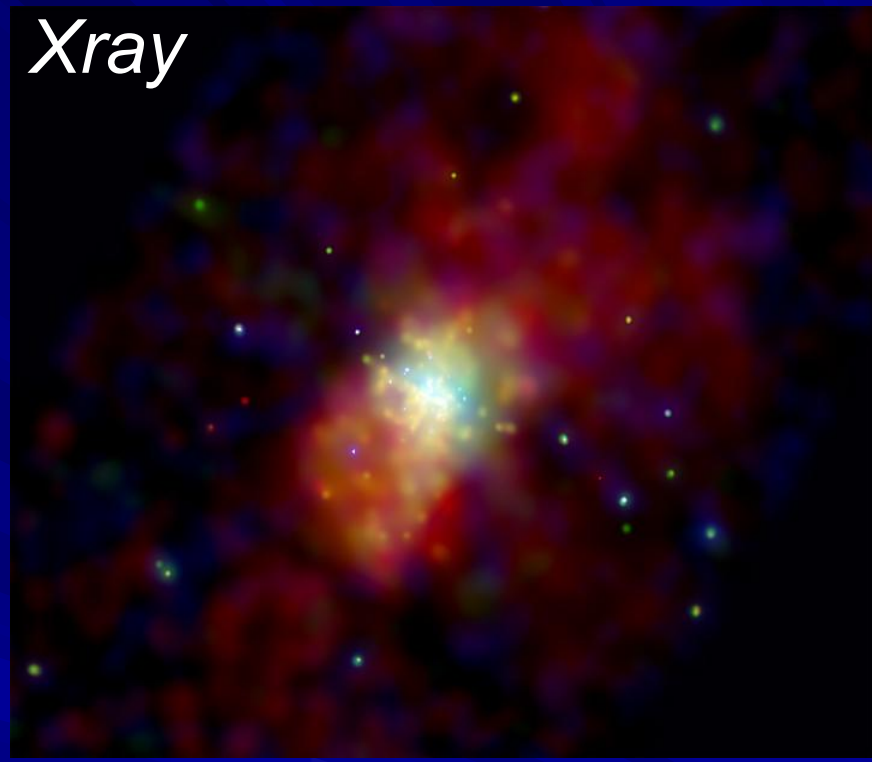
M82

Halpha



→ *Ionized gas (T 10^4K)*

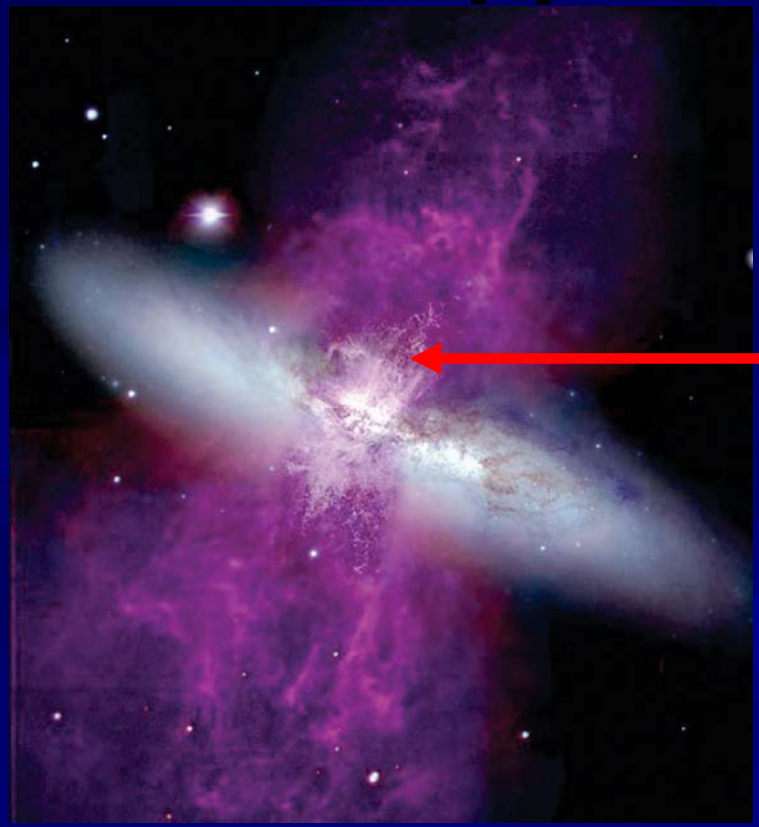
Xray

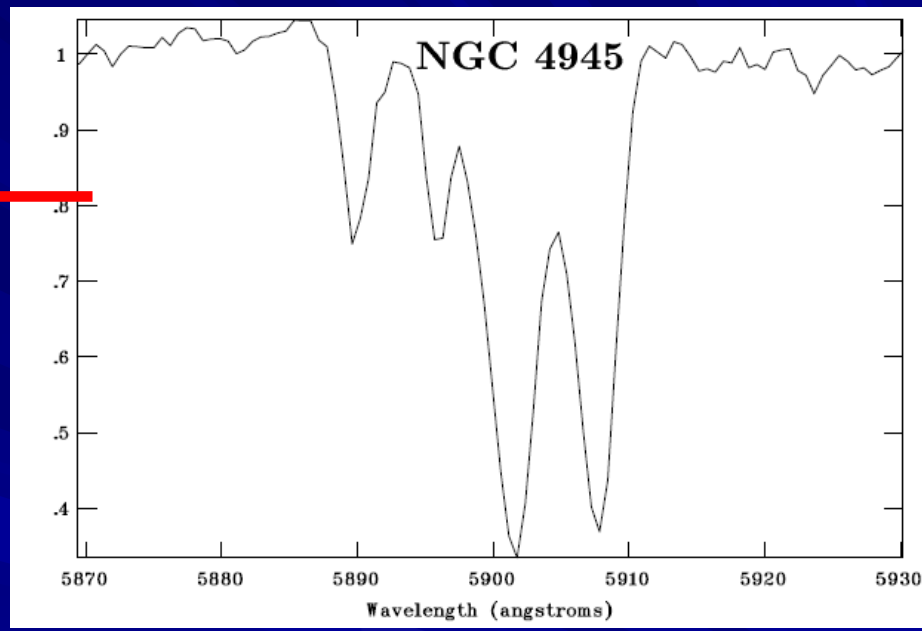


→ *Hot gas (T 10^6K)*

Super winds are <u>multi-phase</u> flows

What happens when looking into a wind?



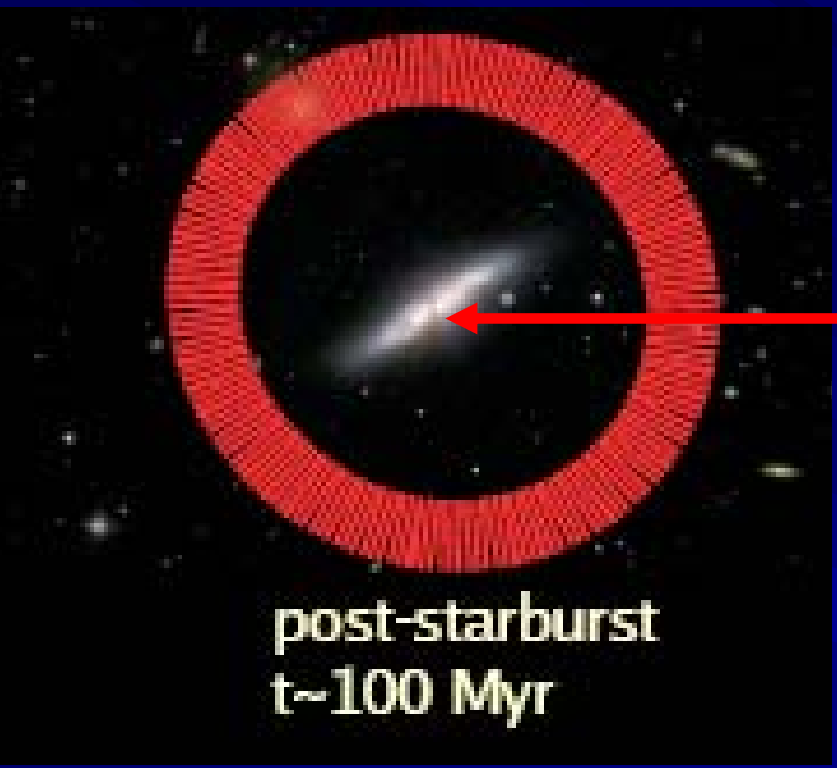


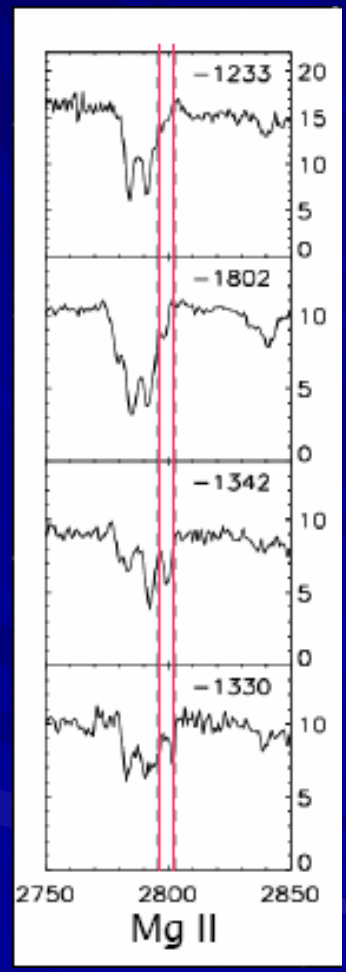
NaD(5890)

always blue shifted by ~400 km/s!

Lehnert, Heckman et al.

What happens when looking into a post-wind?





MgII (2796) (EW 2-10AA)
always blue shifted by ~1000 km/s!

Tremonti et al. 2007

Mg is like Na D?

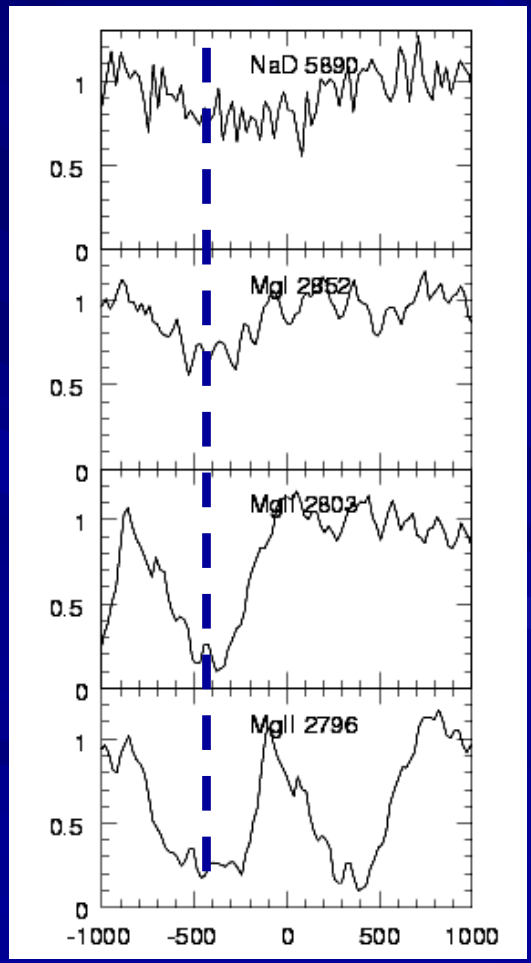
At least in z=0.3 ULIRGs (200M/yr)

NaD

Mg I

Mg II

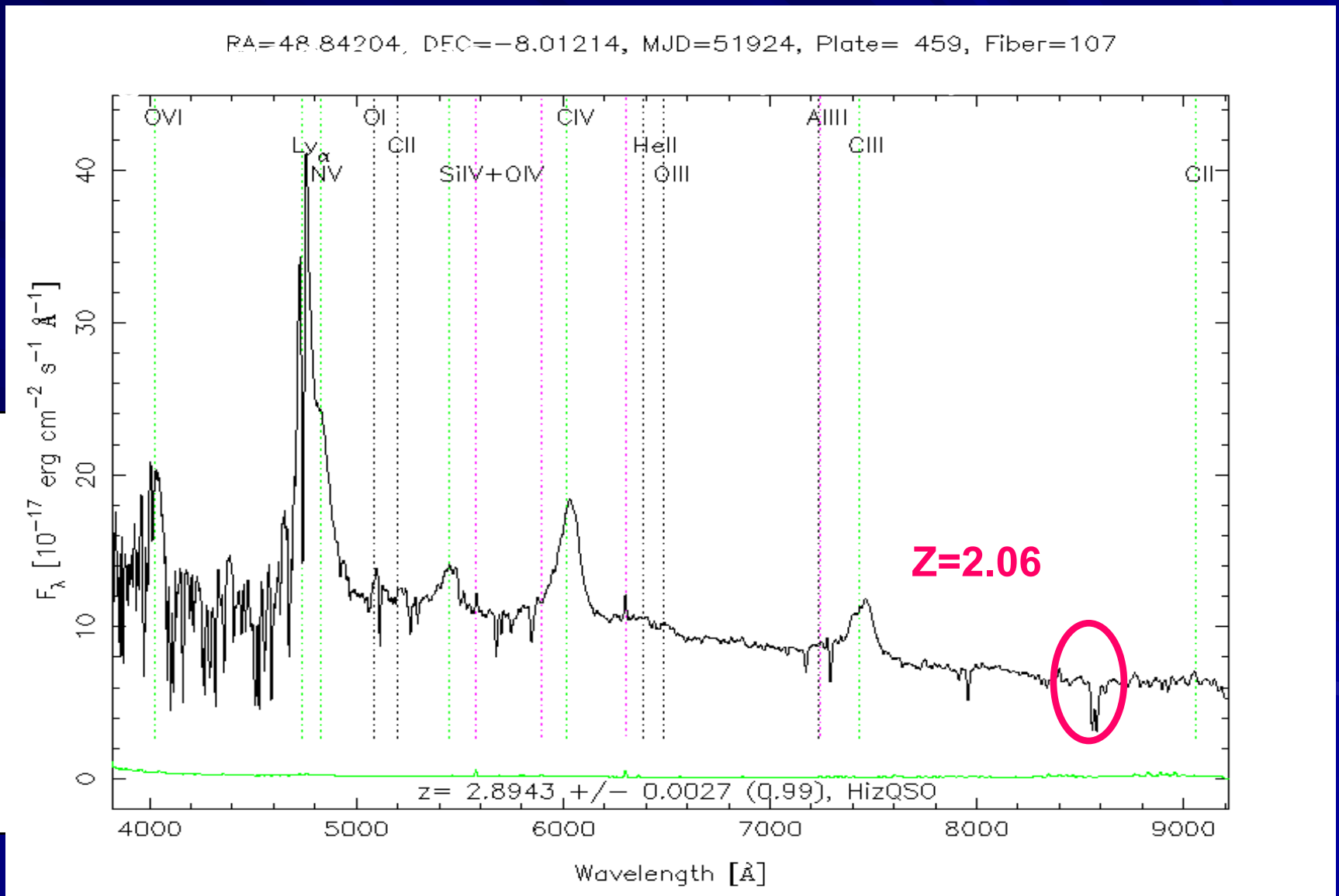
Mg II



Wr(MgII)=7 AA

Martin & Bouche in prep.

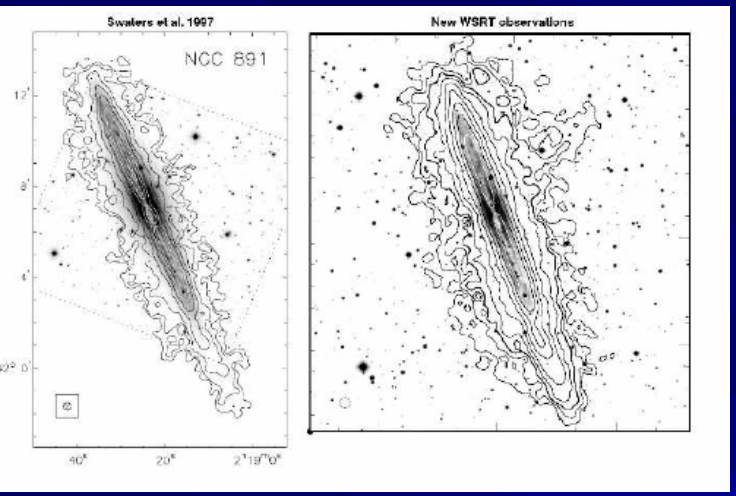
Gas towards QSO probed by (MgII)



Gas is seen everywhere

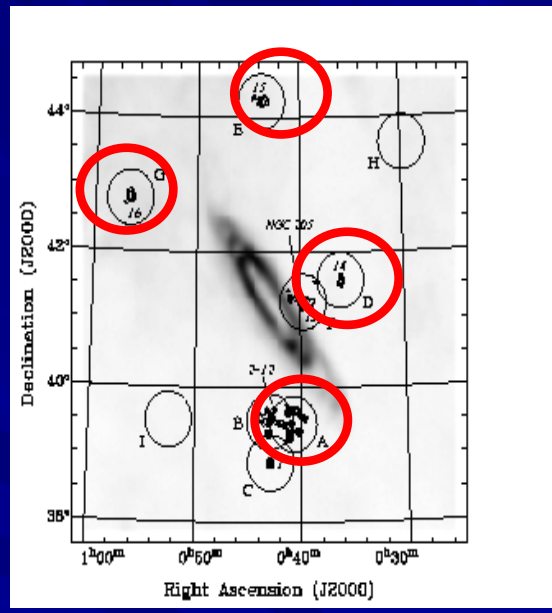
NGC 891

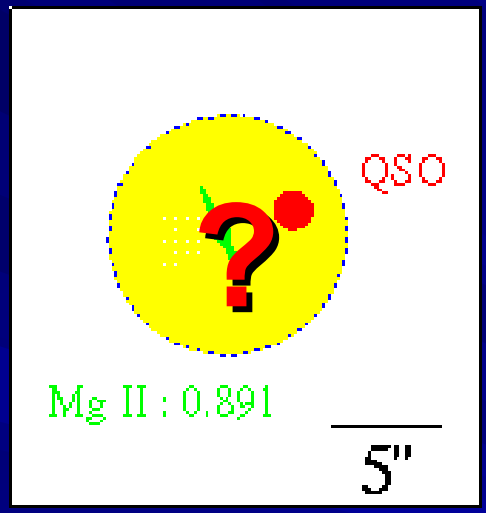
Fraternali 2005



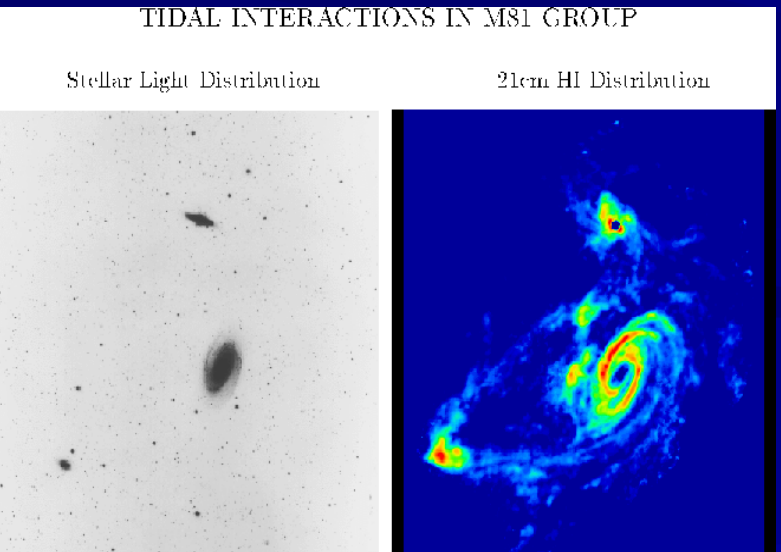
Andromeda(M31)

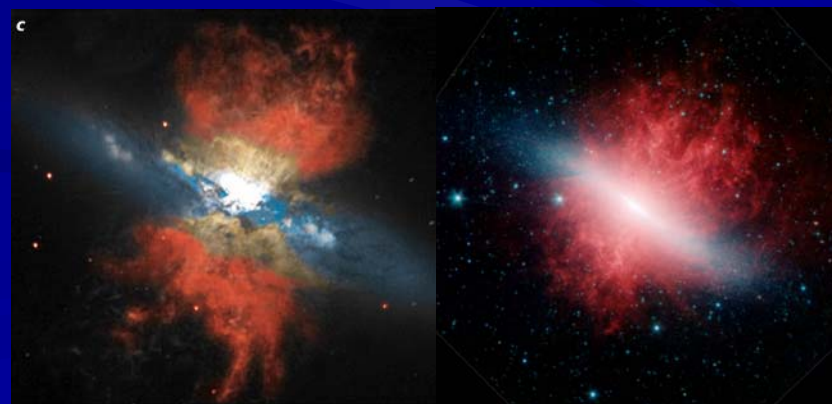
Thilker – Braun - Westmeier 2004,2005





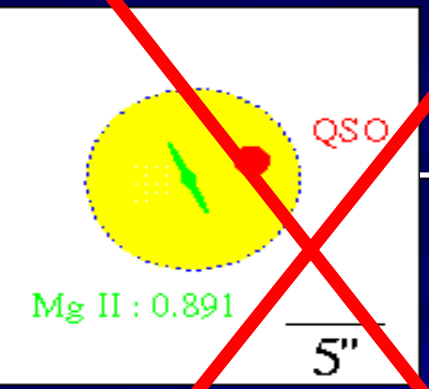
Yun 2000



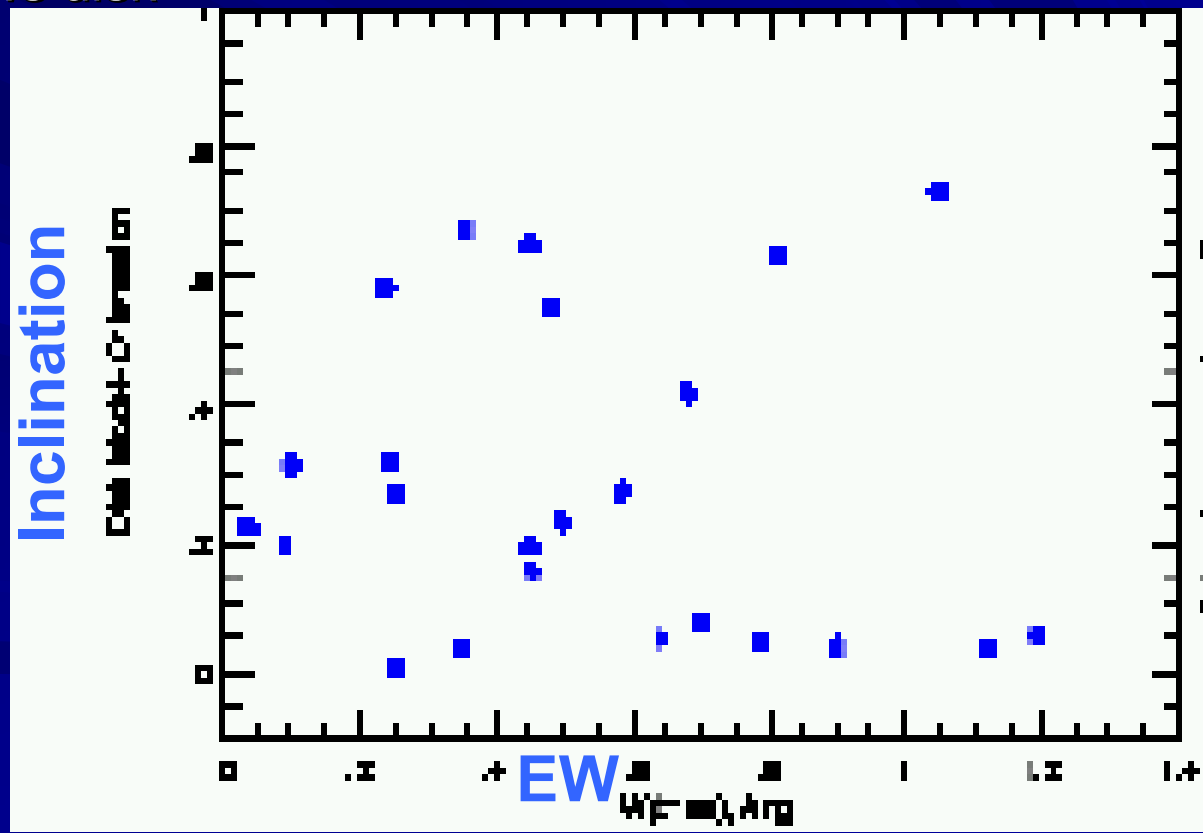


What is the origin of this gas?

- A. ISM of galaxies



→ Gas follows disk

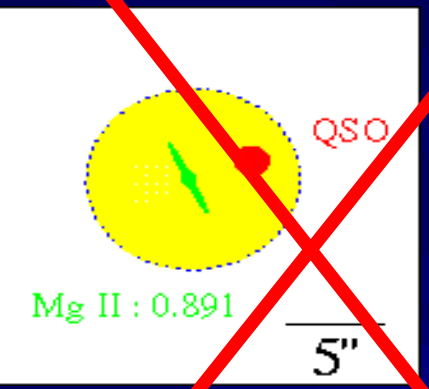


Kacprzak, Churchill 2005

What is the origin of this gas?

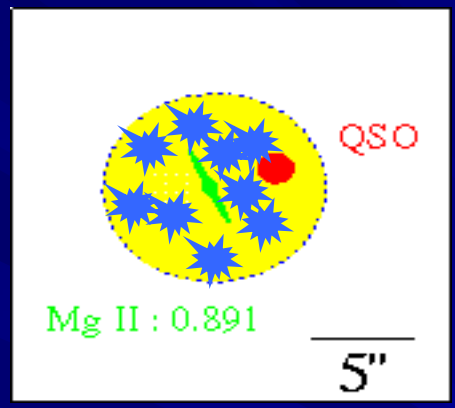
(Mo Miralda-Escude 96; Maller 2004)

- A. ISM of galaxies



→ Gas follows disk

- B. Inflow model



→ Gas is virialized

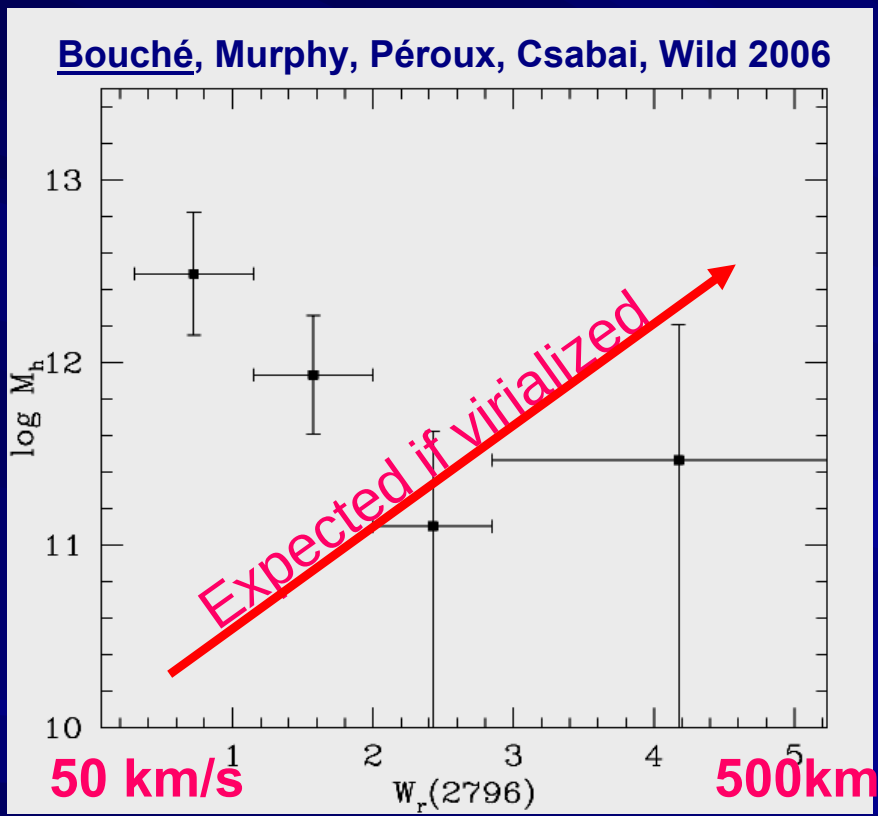
↓

Mass ~ Δ V

But how can we test Mass ~ Δ V ?

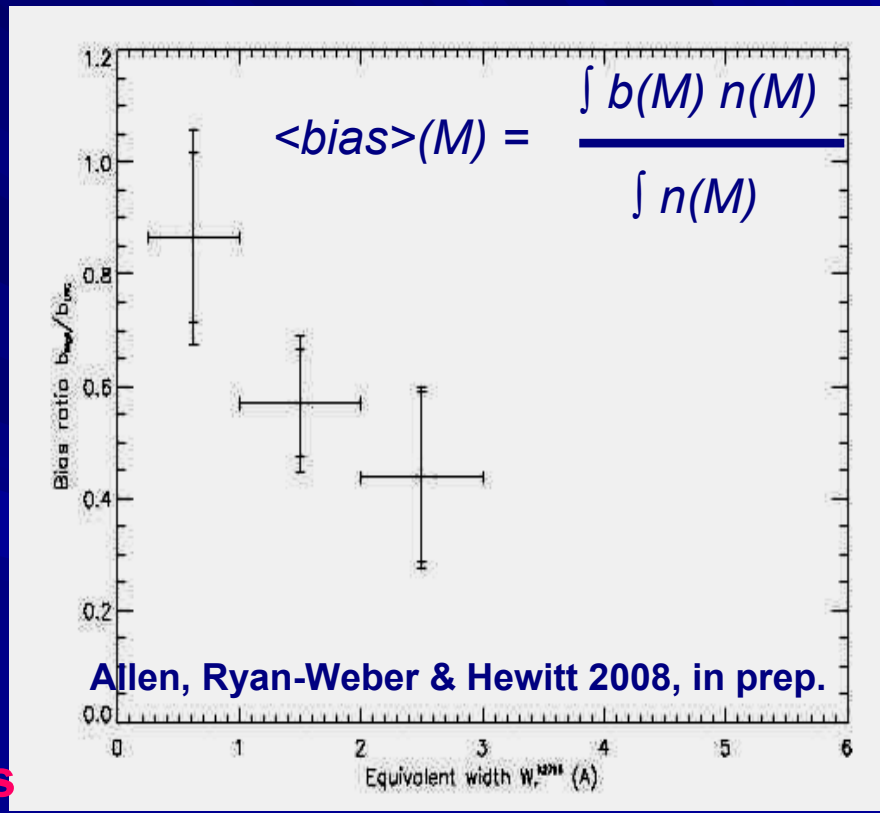
Delta V ≠ Mass !!

Cold MgII Clouds are NOT virialized



EW / Δ V

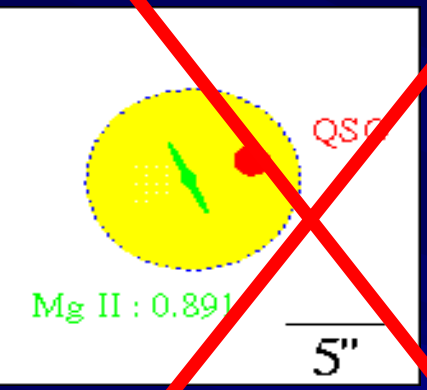
Sample (DR3):
1800 MgII + 250,000 LRGs



DR4 + new weighting scheme

What is the origin of this gas?

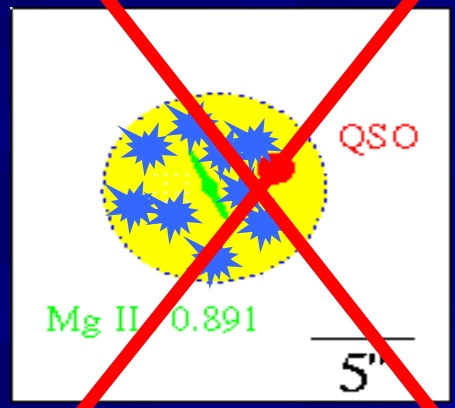
- A. ISM of galaxies



→ Gas follows disk

(Mo Miralda-Escude 96; Maller 2004)

- B. Inflow model

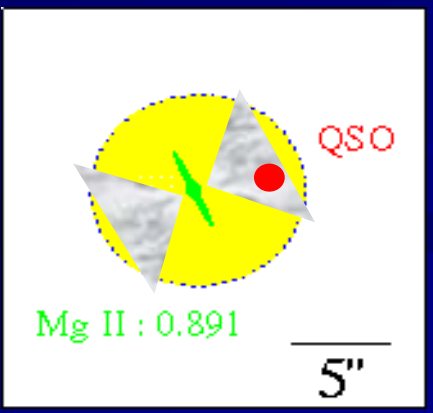


→ Gas is virialized

(Thinker & Chen 2008)

Mass ~ Δ V

- C. Outflow model

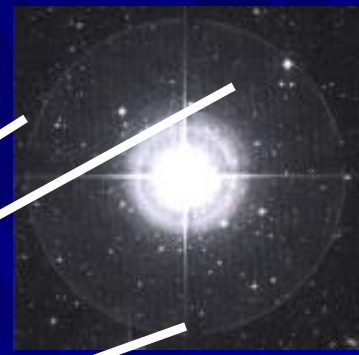


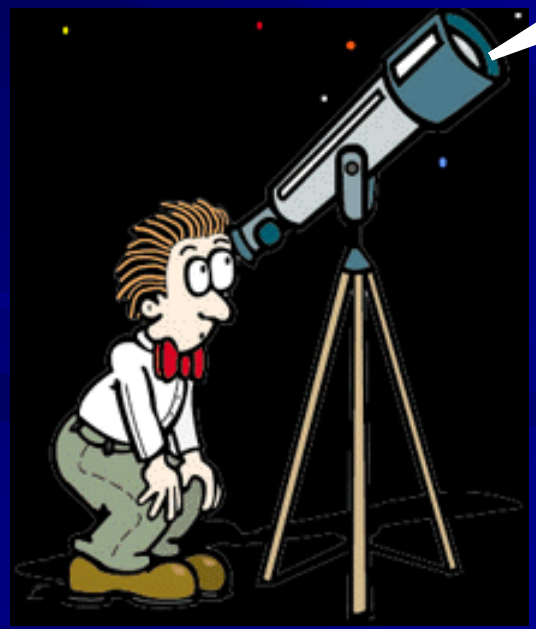
→ Bulk motion

- D.

?

Can it be outflows?

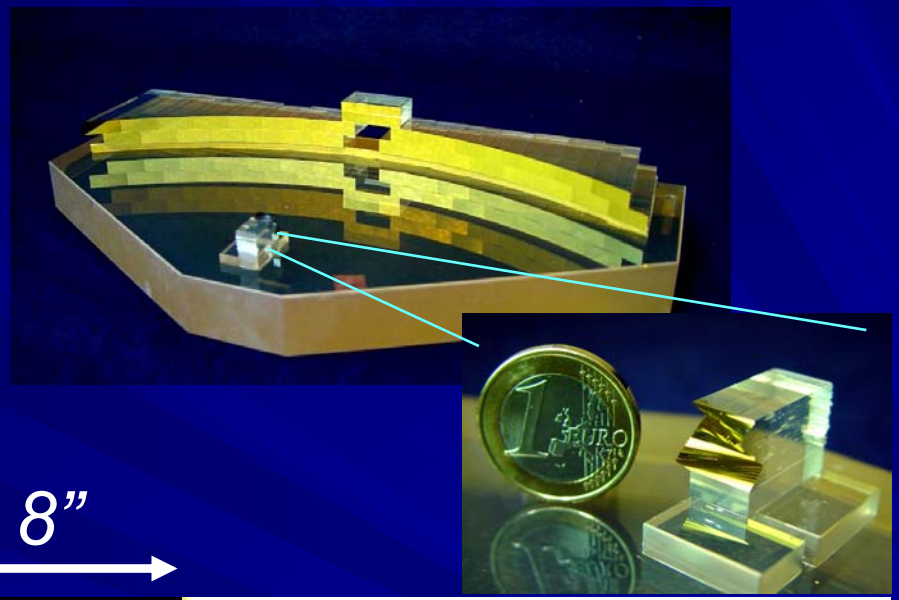


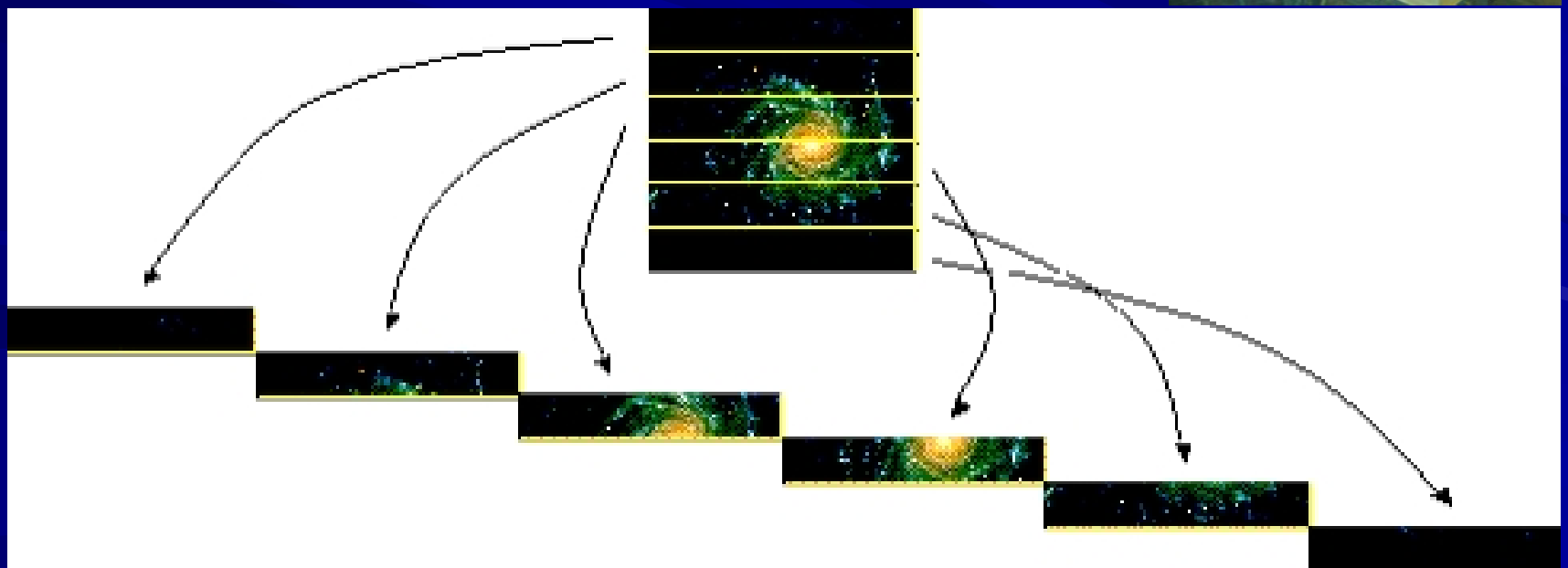


Test against direct data w/ SINFONI

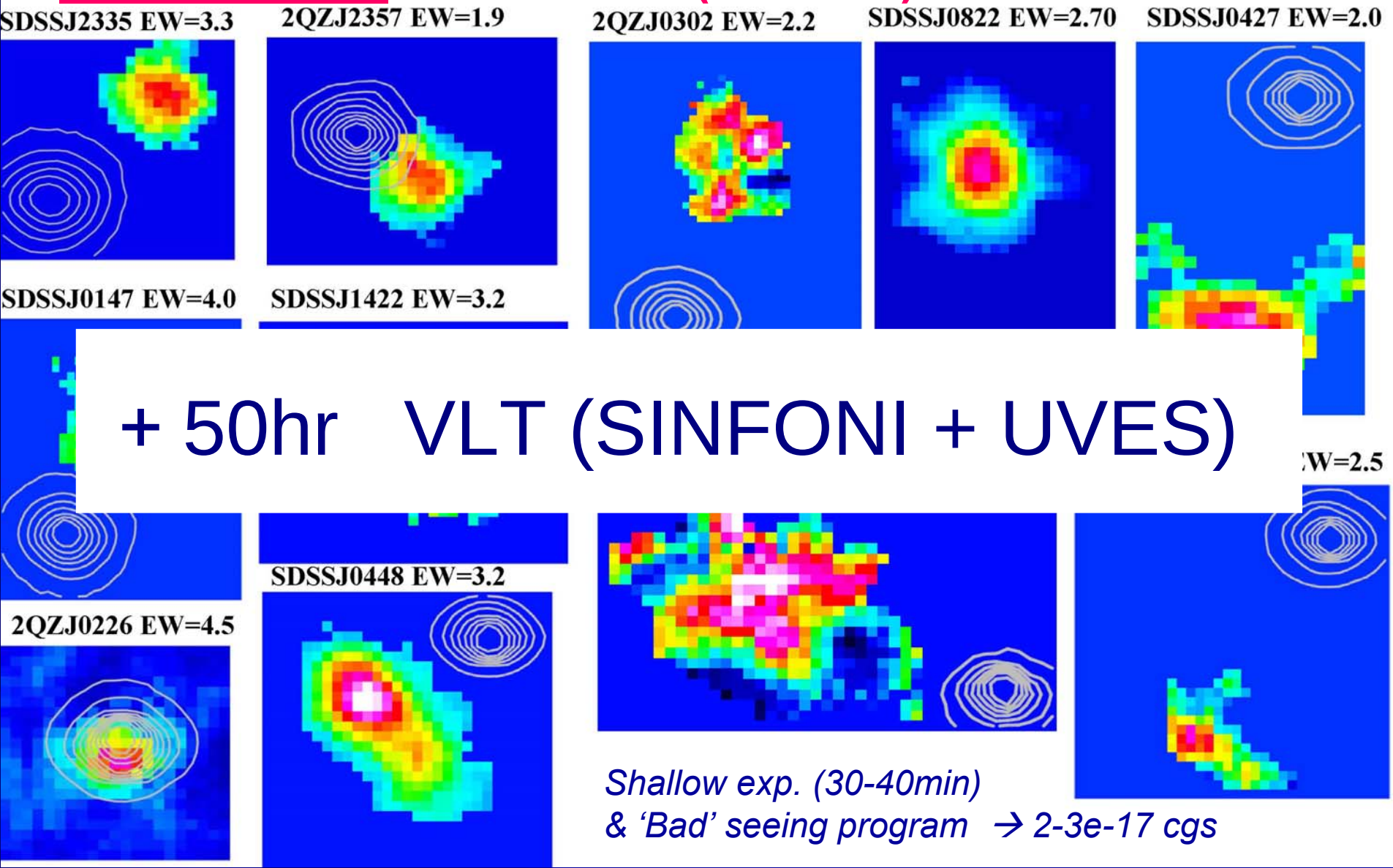
SINFONI build @MPE:

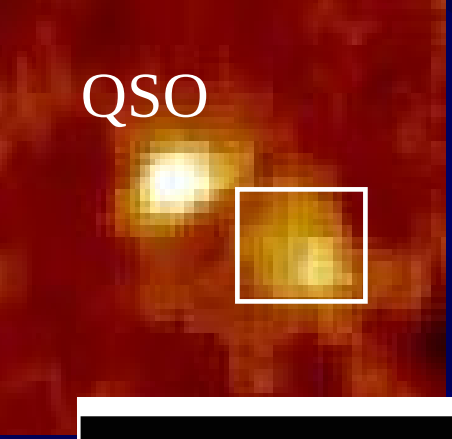
PIs: F.Eisenhauer (MPE)
H.Bonnet (ESO)



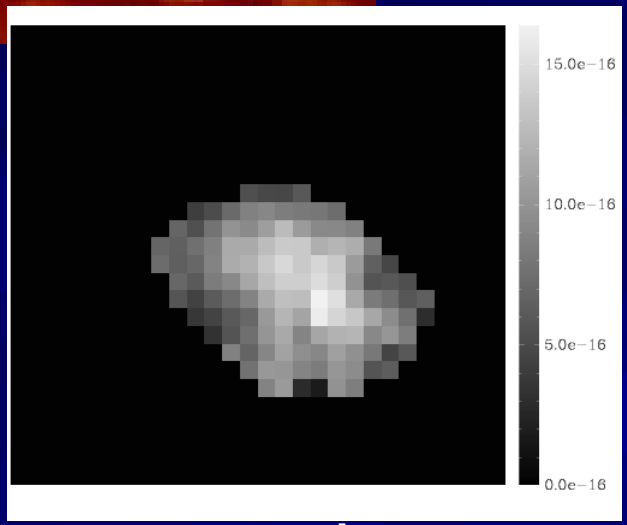


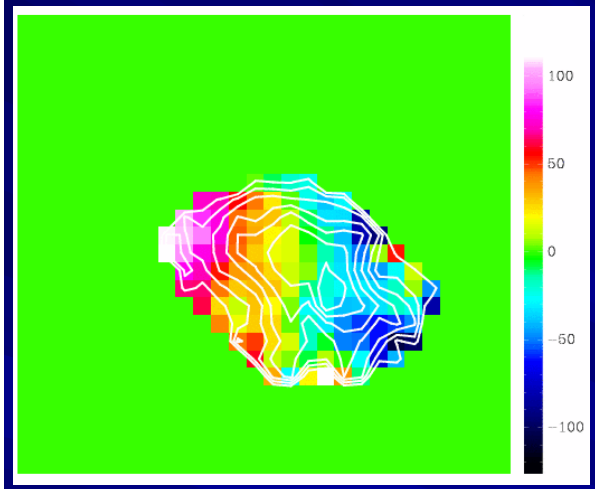
SINFONI MgII Program for Line Emitters (SIMPLE): 14/21 (70%) detections (Wr>2 Å)

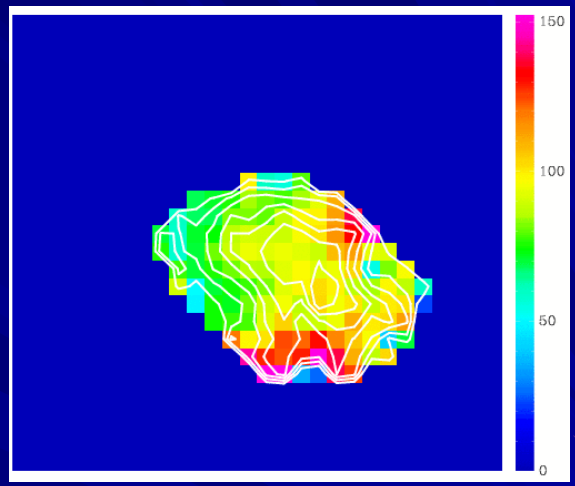




z=1 SDSS J1422
Wr(MgII) ~ 3.0 Å



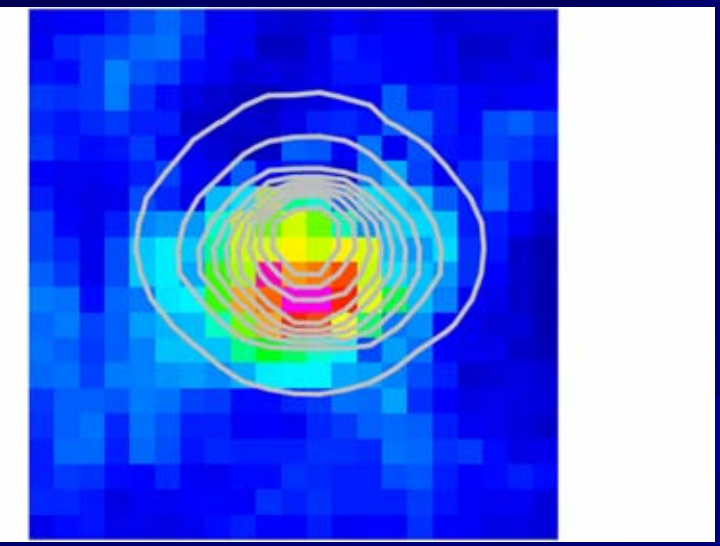


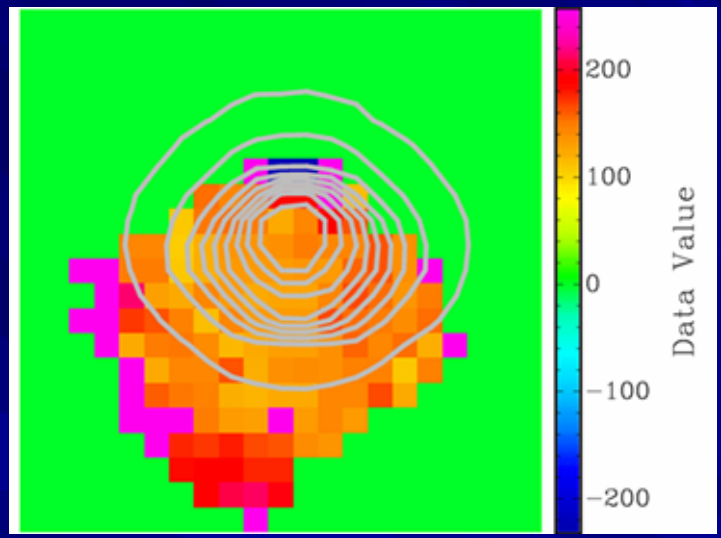


- 1.5”=8 kpc
- SFR = 6 M/yr
- Vc ~ 100 km/s → log M = 11.11
- Voffset: ~ -90 km/s

Bouche et al. 2007, 2008, in prep.

z=1 SDSS J0226
Wr(MgII) ~ 4.5 Å



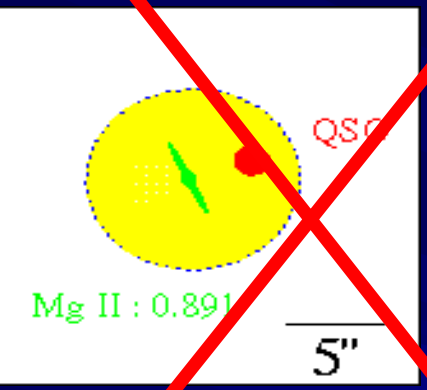


- 0.3”= 2.4 kpc
- SFR = 10 M/yr
- Voffset: ~ -200 km/s

Bouche et al. 2007, 2008, in prep.

What is the origin of this gas?

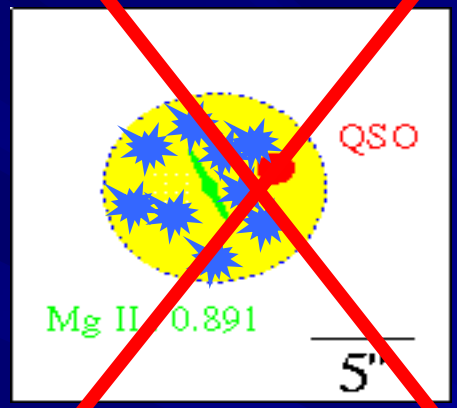
- A. ISM of galaxies



→ Gas follows disk

(Mo Miralda-Escude 96; Maller 2004)

- B. Inflow model

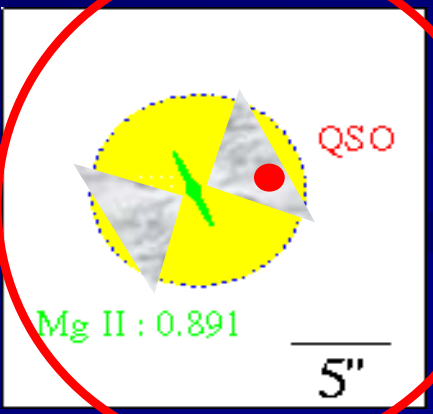


→ Gas is virialized

(HW Chen 2008)

Mass ~ Δ V

- C. Outflow model



→ Bulk motion

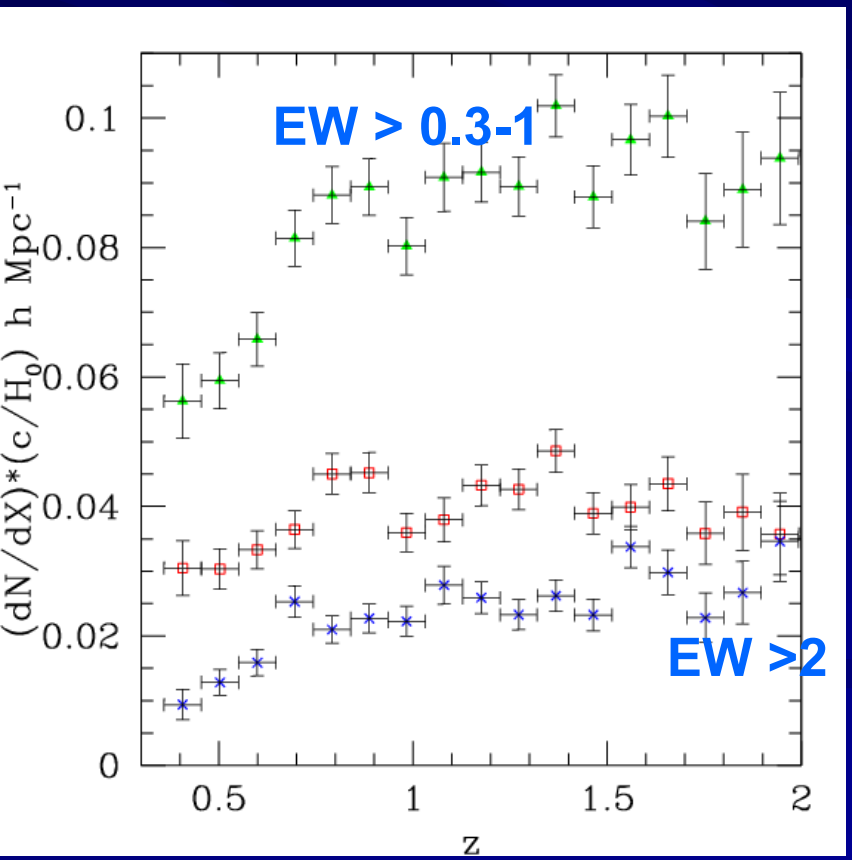
- D.

?

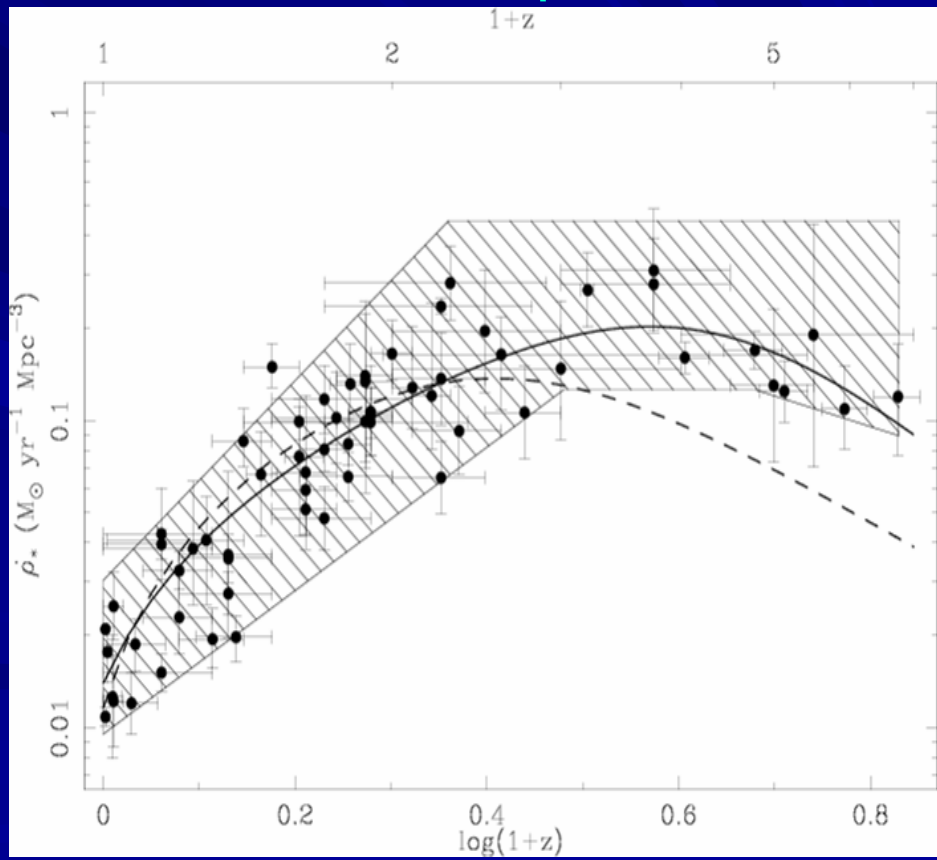
Is it surprising?

Given that clouds activity traces SFH

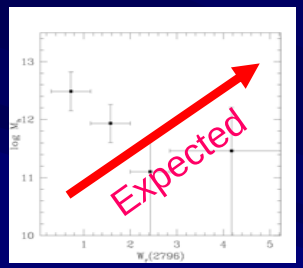
Prochter 2005



Hopkins 2004

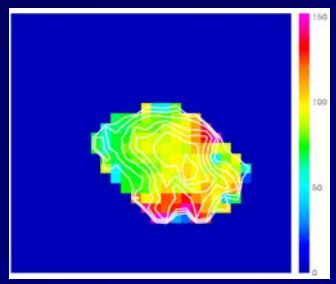


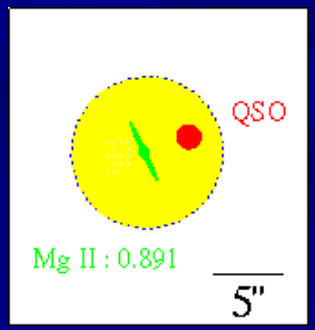
CONCLUSION:
A SIMPLE way to study superwinds with z=1 MgII



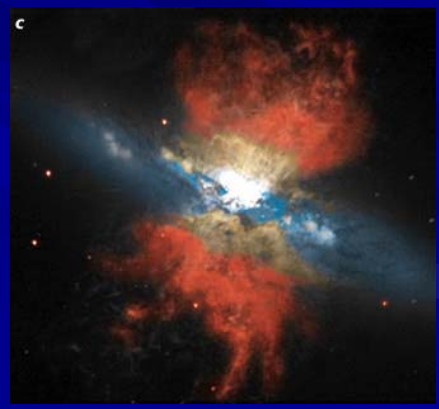
(EW>1 Å)

Strong MgII clouds are not virialized





→



(EW>2 Å)

→ **New era for absorption lines**

The role of HST / COS

- We have a handle on ionized gas (Mg+), COS will get us

-N(HI) total gas column (Lya)

-OVI (Hot gas)

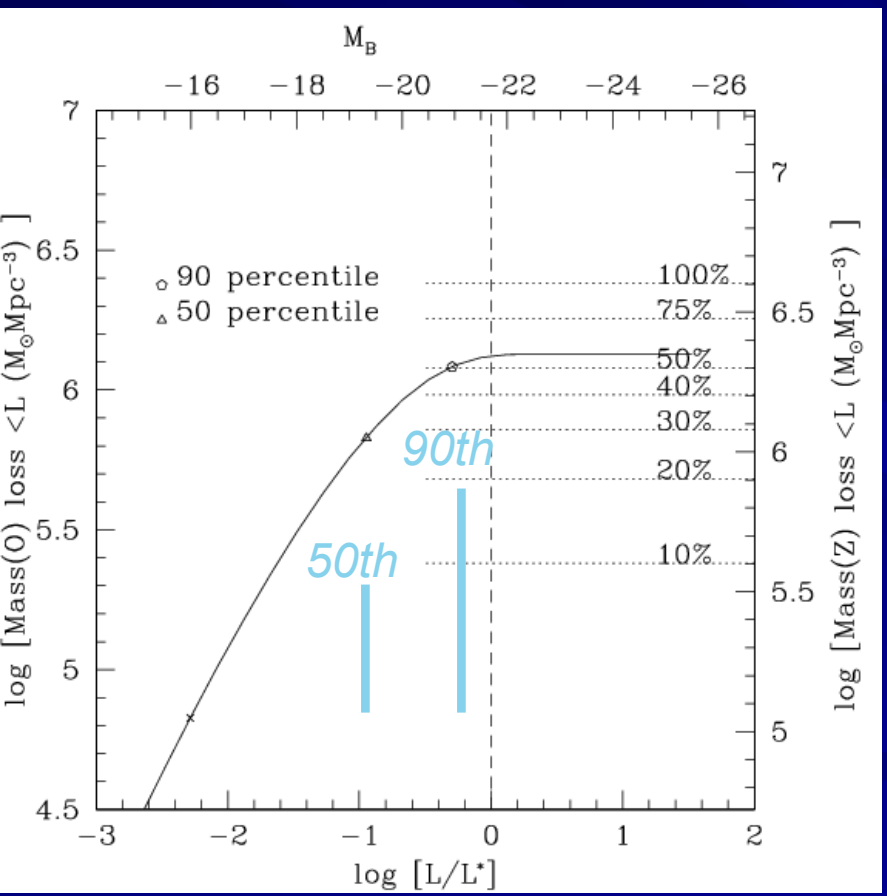
-CiV

→Gas metallicities,

→Mass outflow rates (to compare to SFR, b)

Gas `ejected' at z=2 by low-mass

Bouché et al., 2007



Bertone et al., 2007