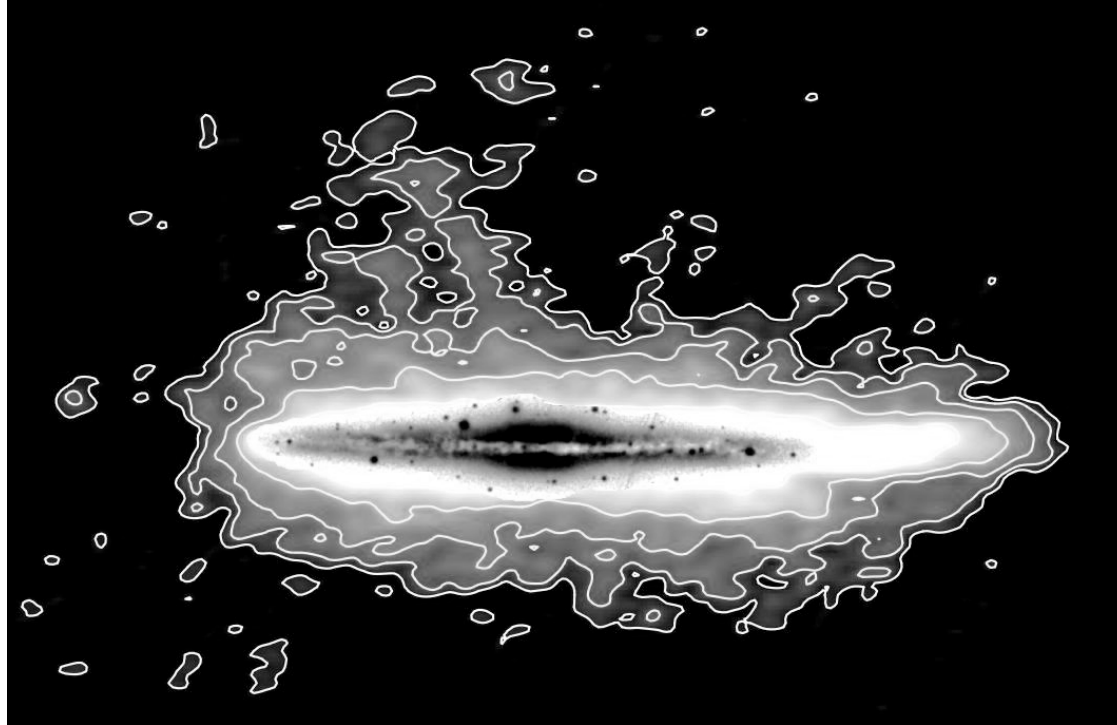


The Gaseous Haloes of Disc Galaxies



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Renzo Sancisi

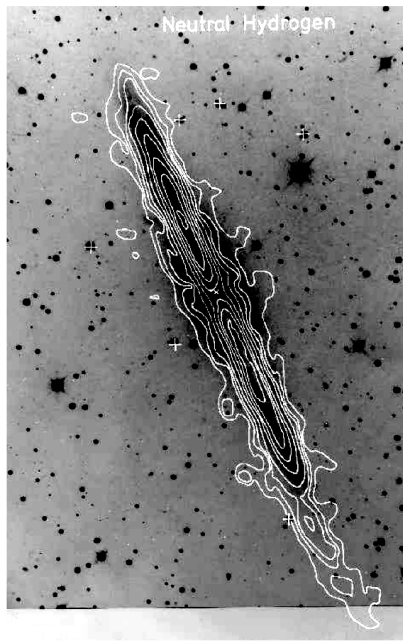
Two Points

- 1) *Some* galaxies have massive haloes of neutral gas
- 2) Halo gas can be used to quantify gas accretion

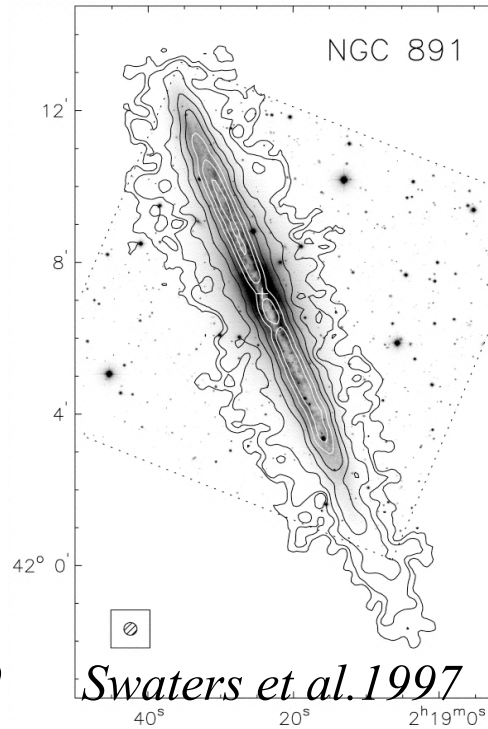
Halo of neutral gas



Perfect edge-on NGC891



Sancisi & Allen 1979

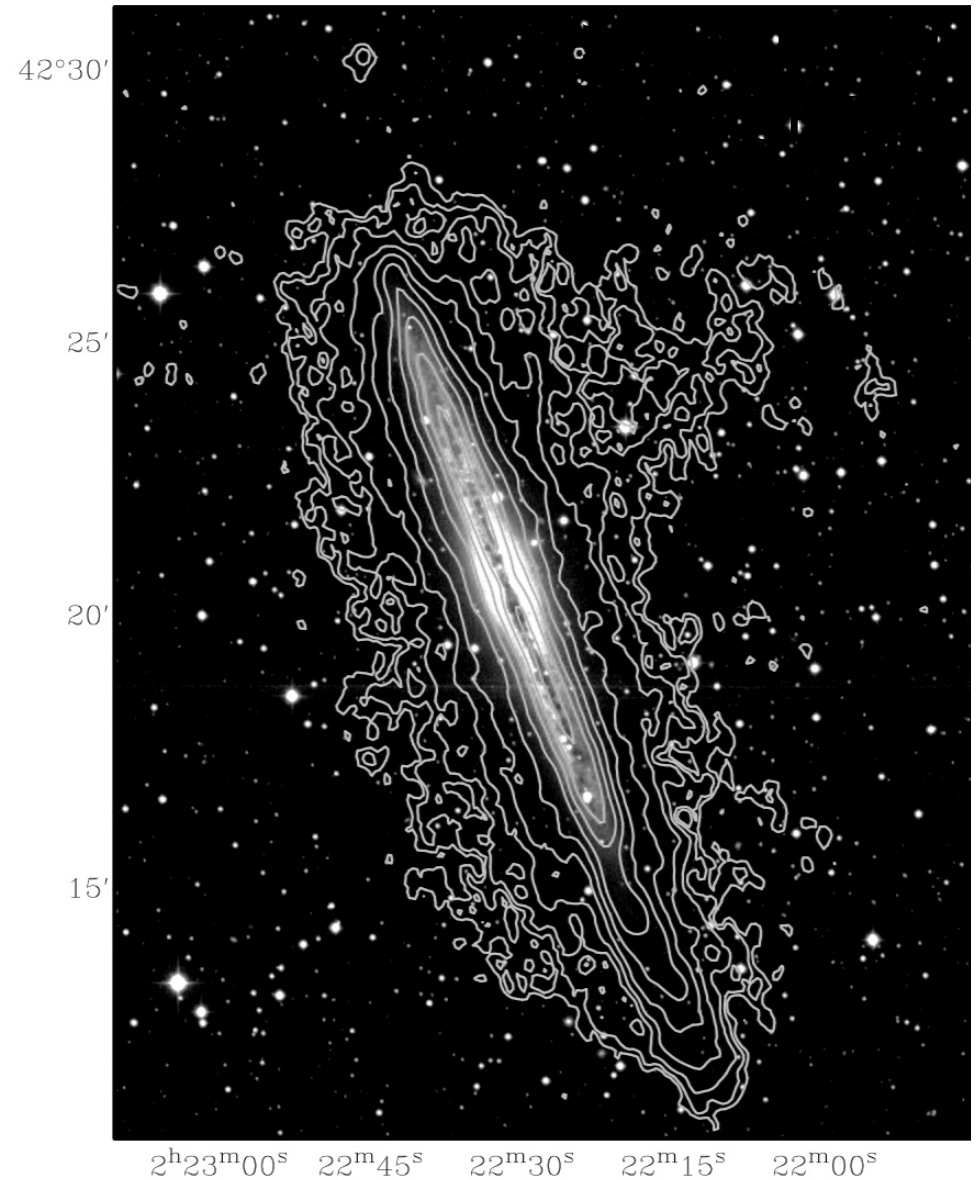


Swaters et al. 1997

Total Mass of the halo

$$M_{\text{HI}} \sim 1 \times 10^9 M_{\odot} \sim 25\% M_{\text{HI tot}}$$

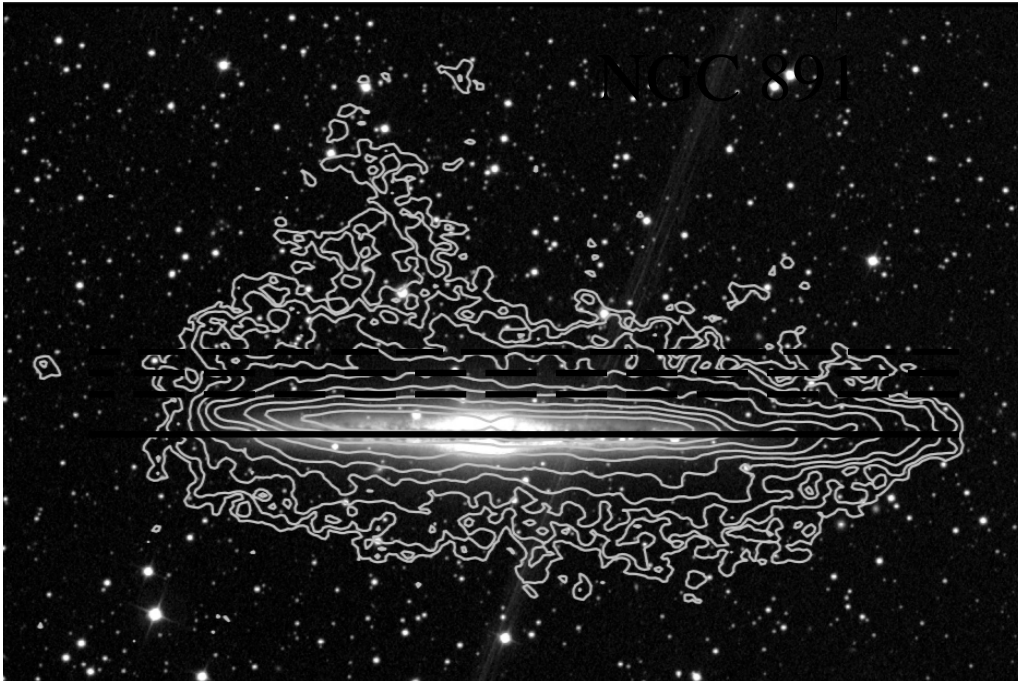
The deeper we look
the larger the halo



Right Ascension

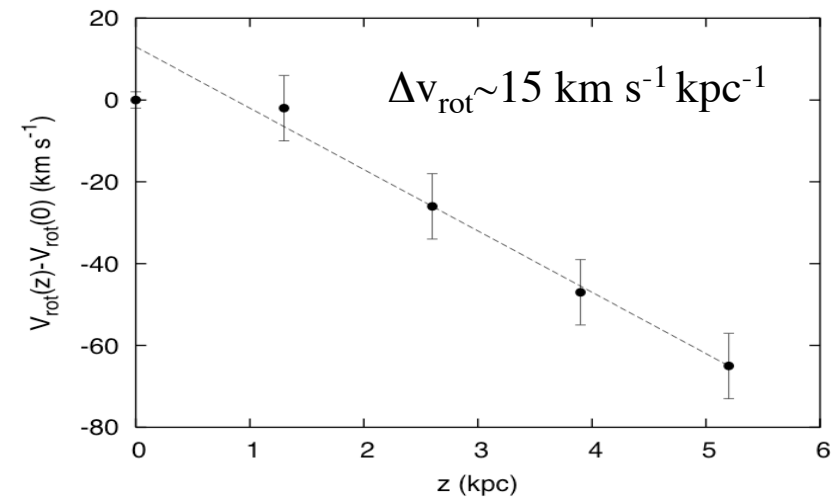
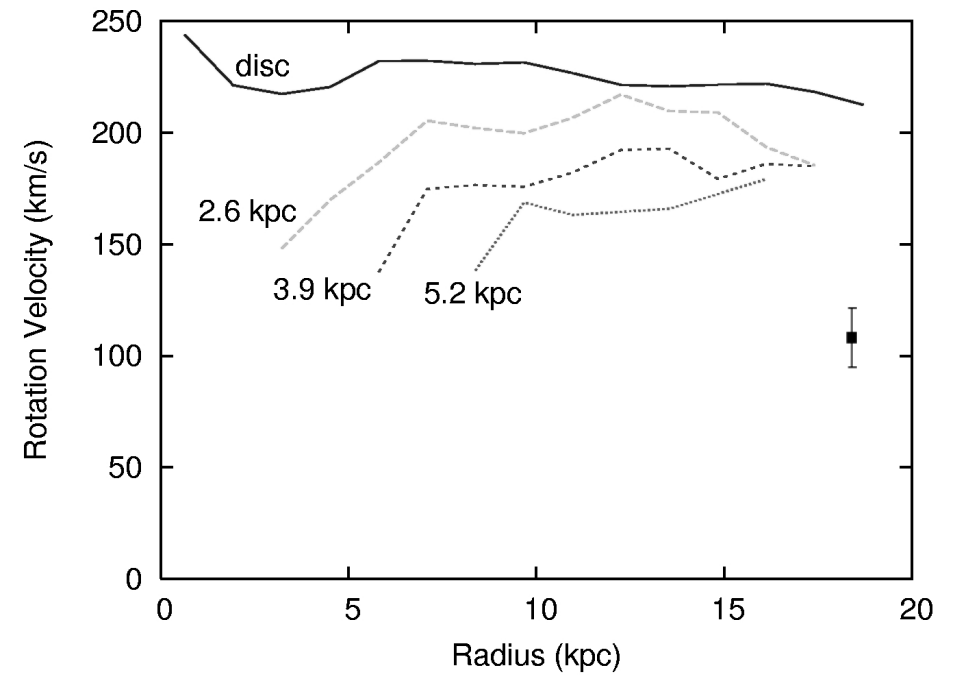
Oosterloo, Fraternali & Sancisi 2007, AJ

Rotational Gradient

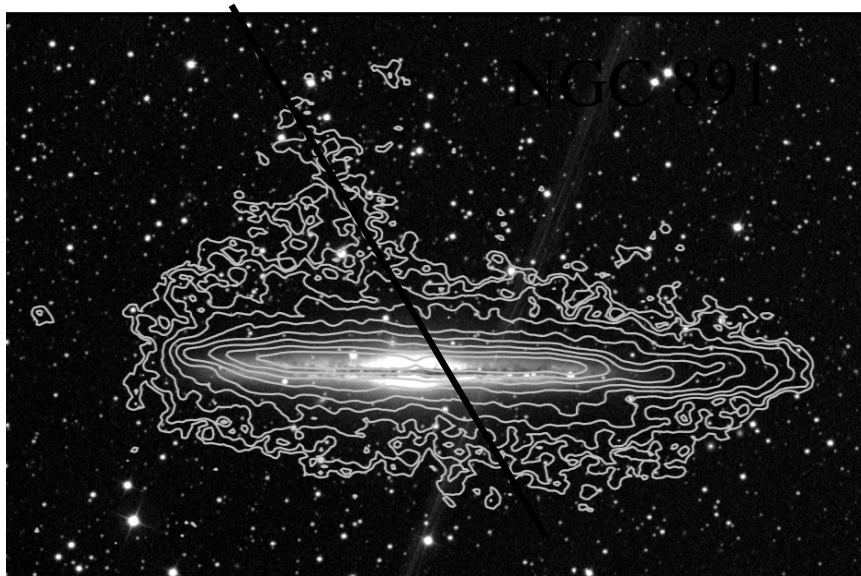


Fraternali et al. 2005

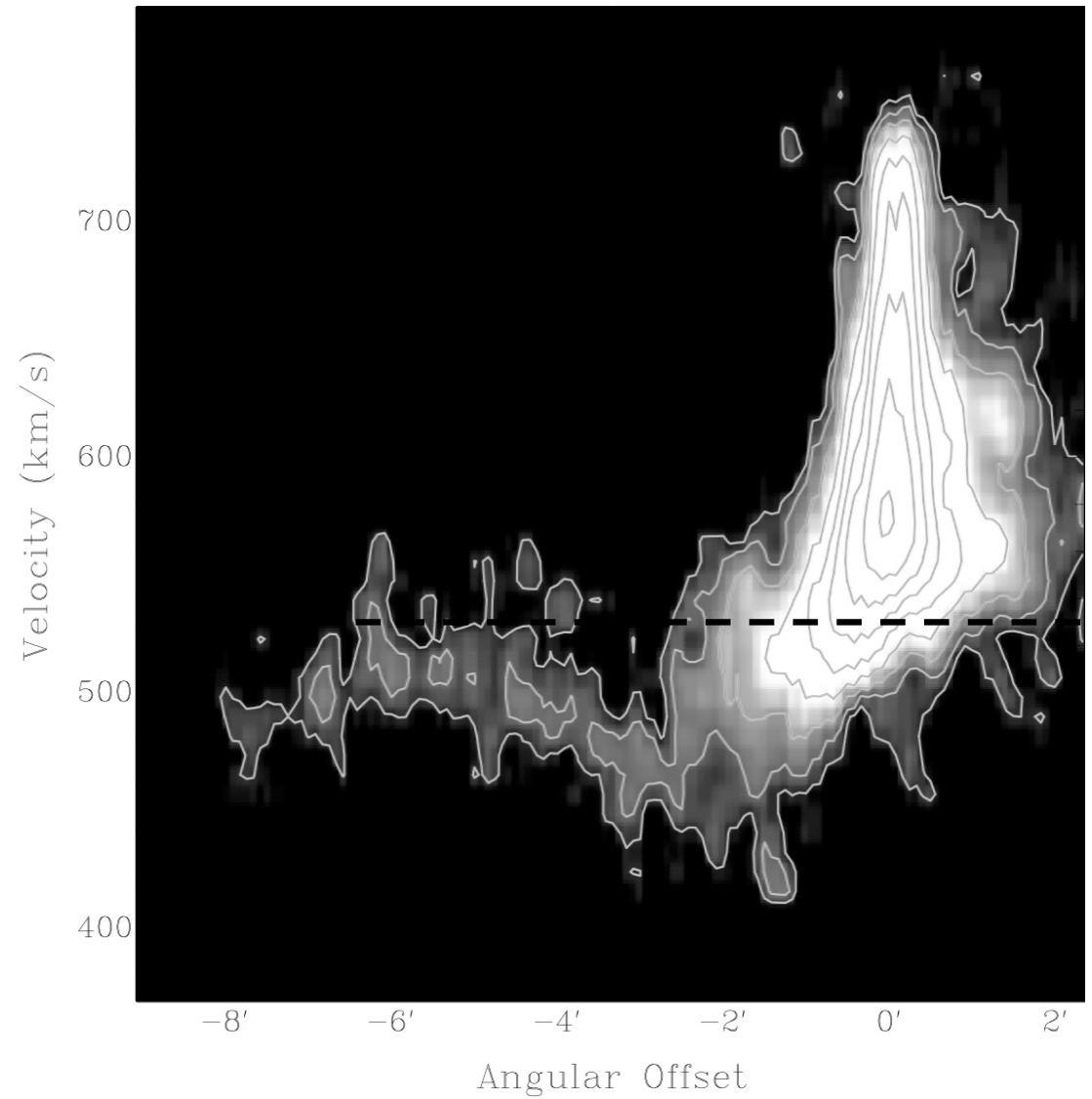
Linear rotational
gradient with z



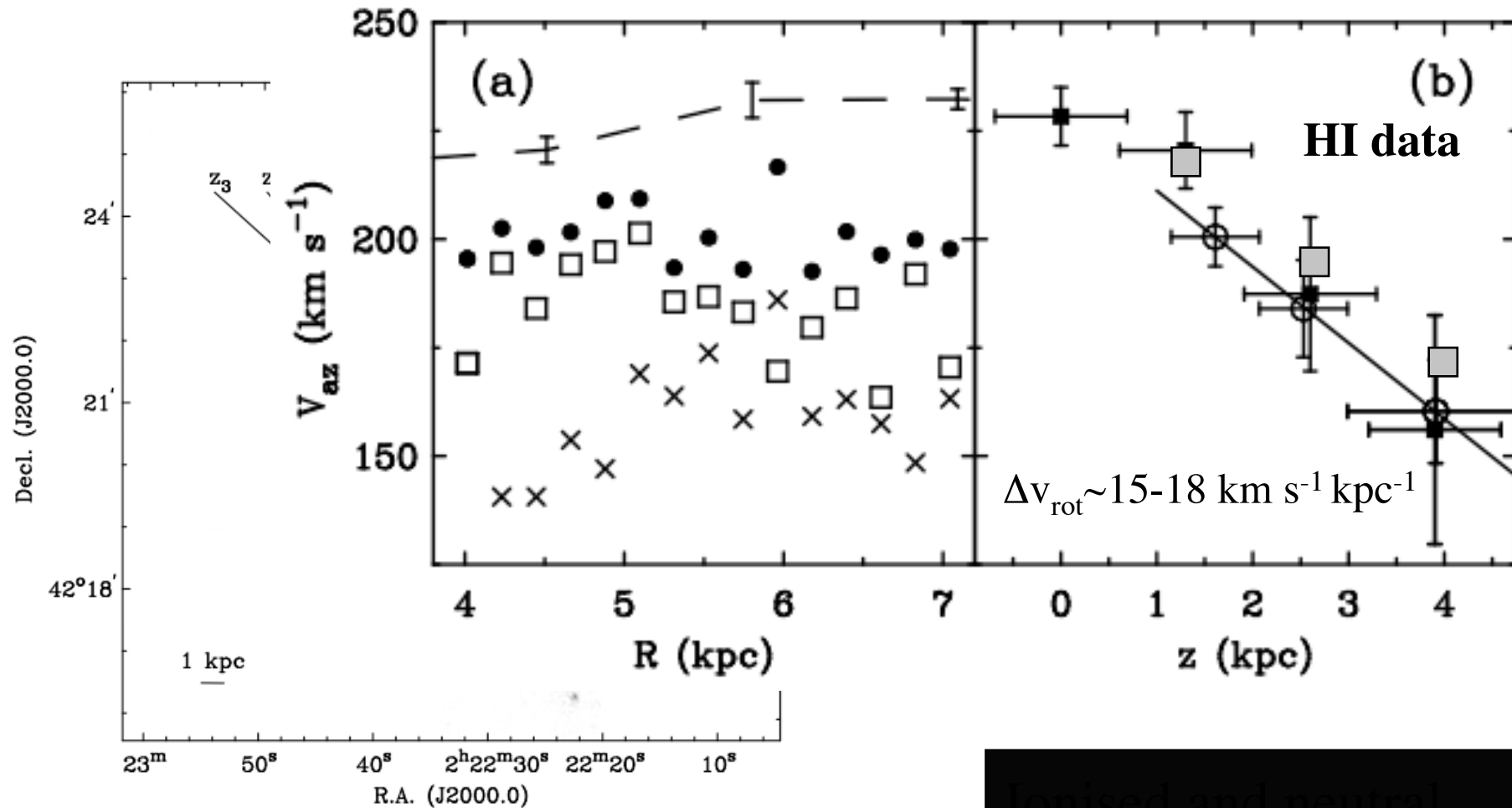
NGC891 Filament



High latitude gas at
systemic velocity



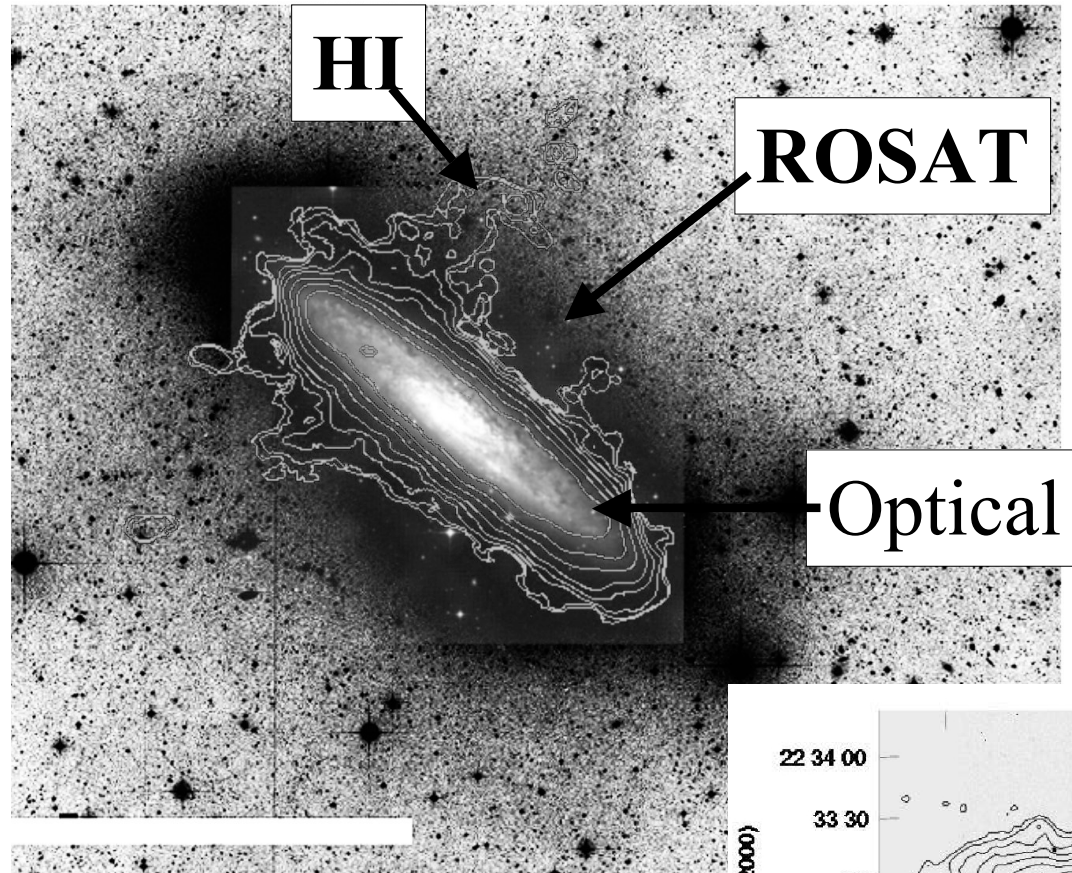
N891: lag in the ionised gas



Heald et al. 2006

Ionised and neutral
gas same kinematics

Other galaxies with gaseous haloes



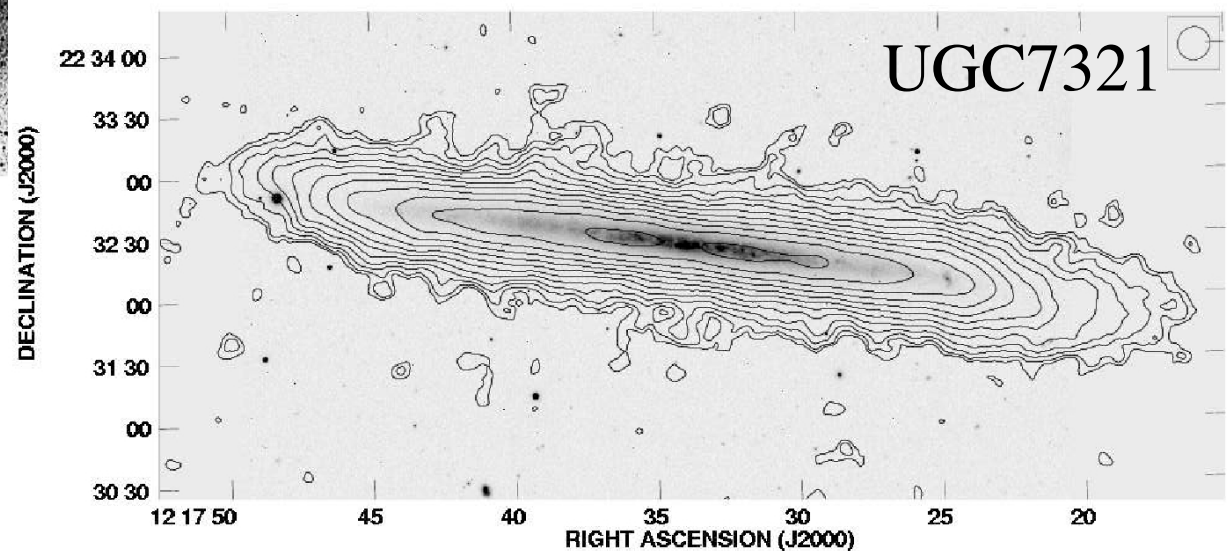
NGC253

High SFR

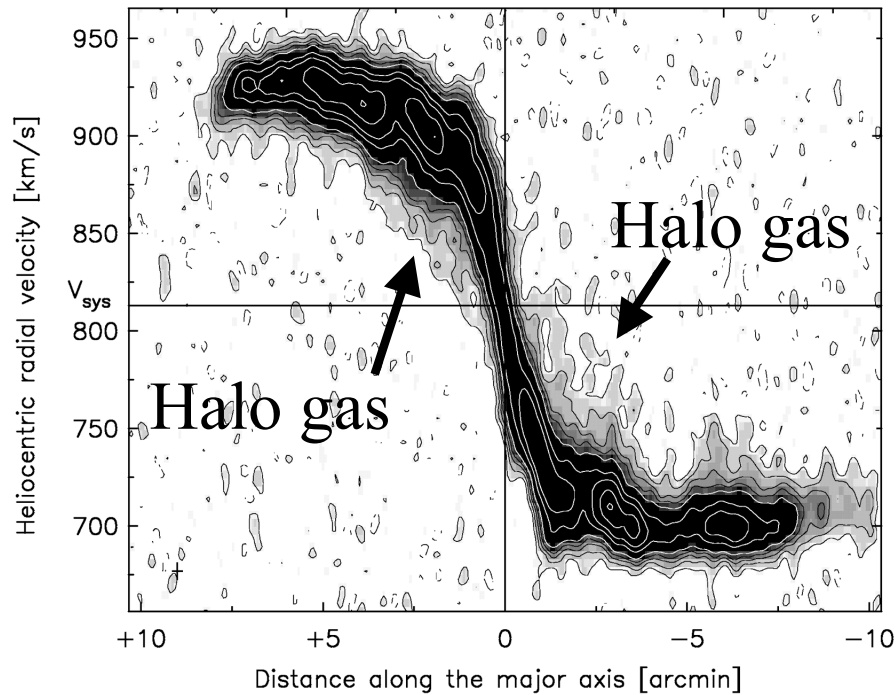
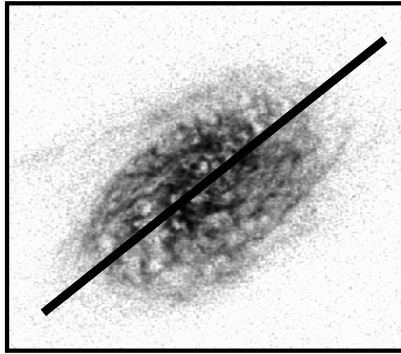
Matthews & Wood 2003, ApJ

Boomsma et al. 2005, A&A

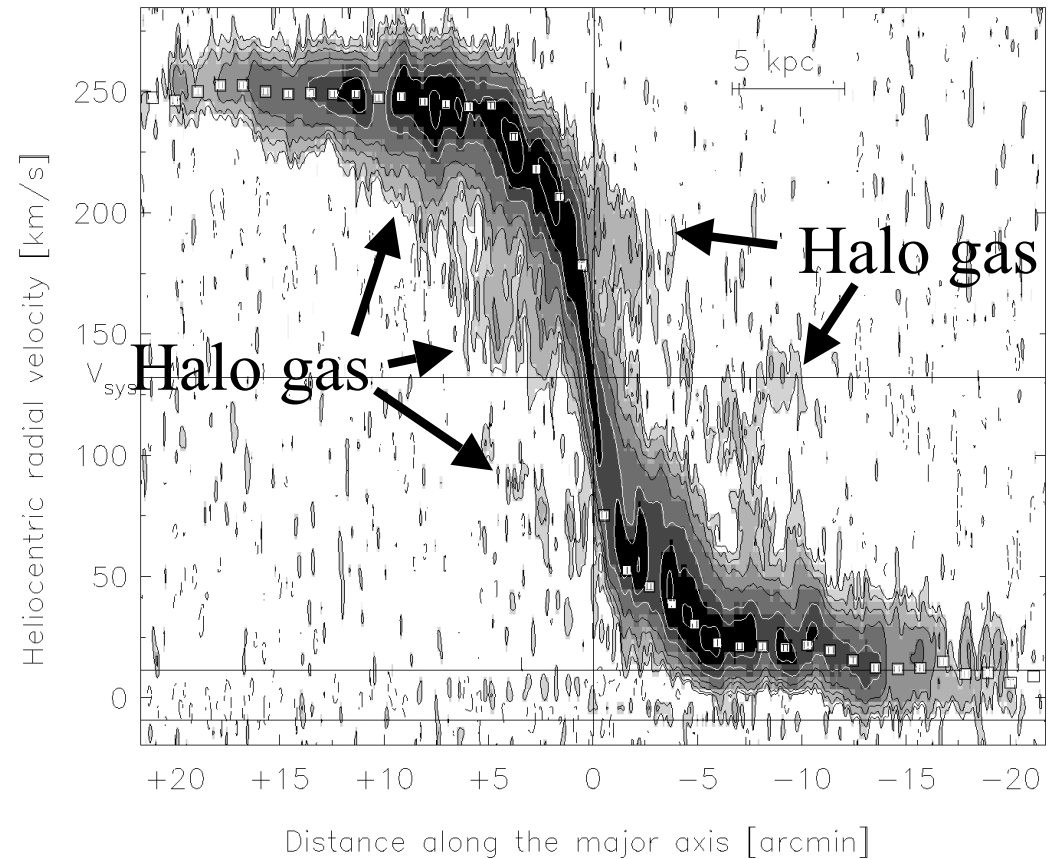
Low SFR



Other galaxies with haloes



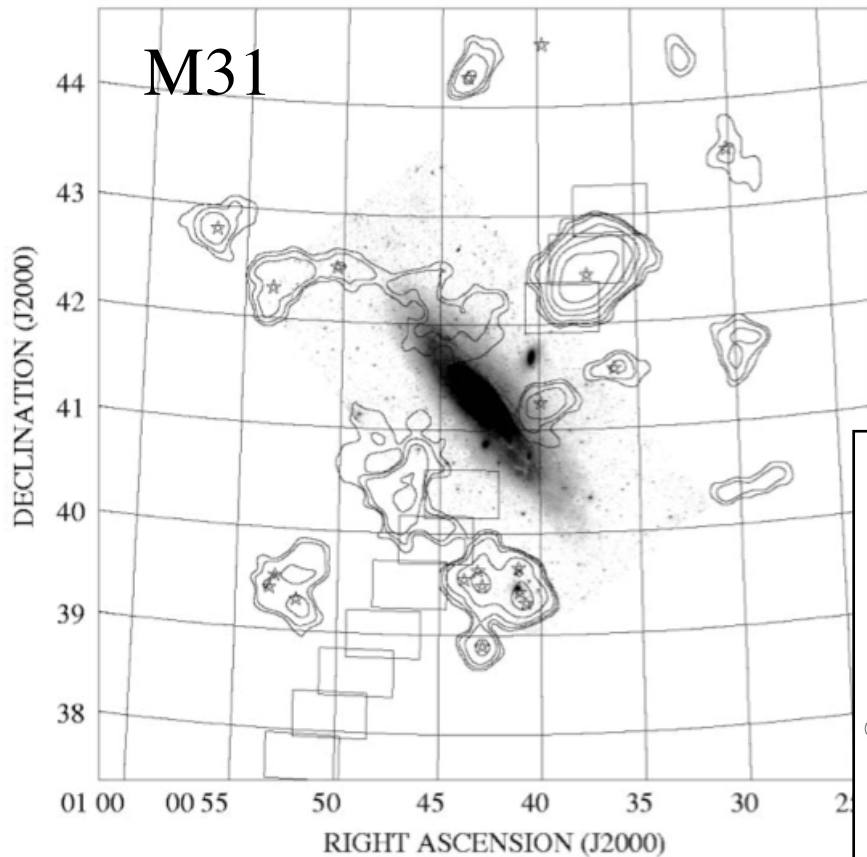
Barbieri et al. 2006, A&A



Fraternali et al. 2001, ApJ

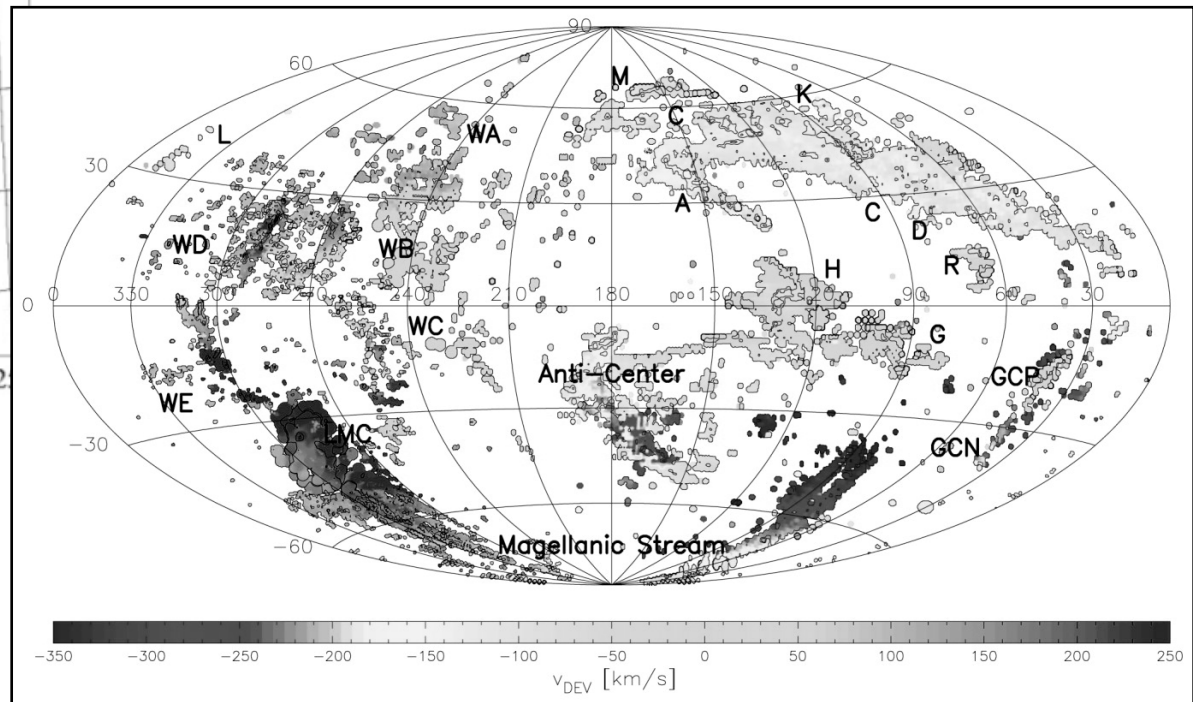
Halo gas seen in
non-edge on gals

Other galaxies with gaseous haloes



Thilker et al. 2004, ApJL

High Velocity Clouds
analogous to Halo gas



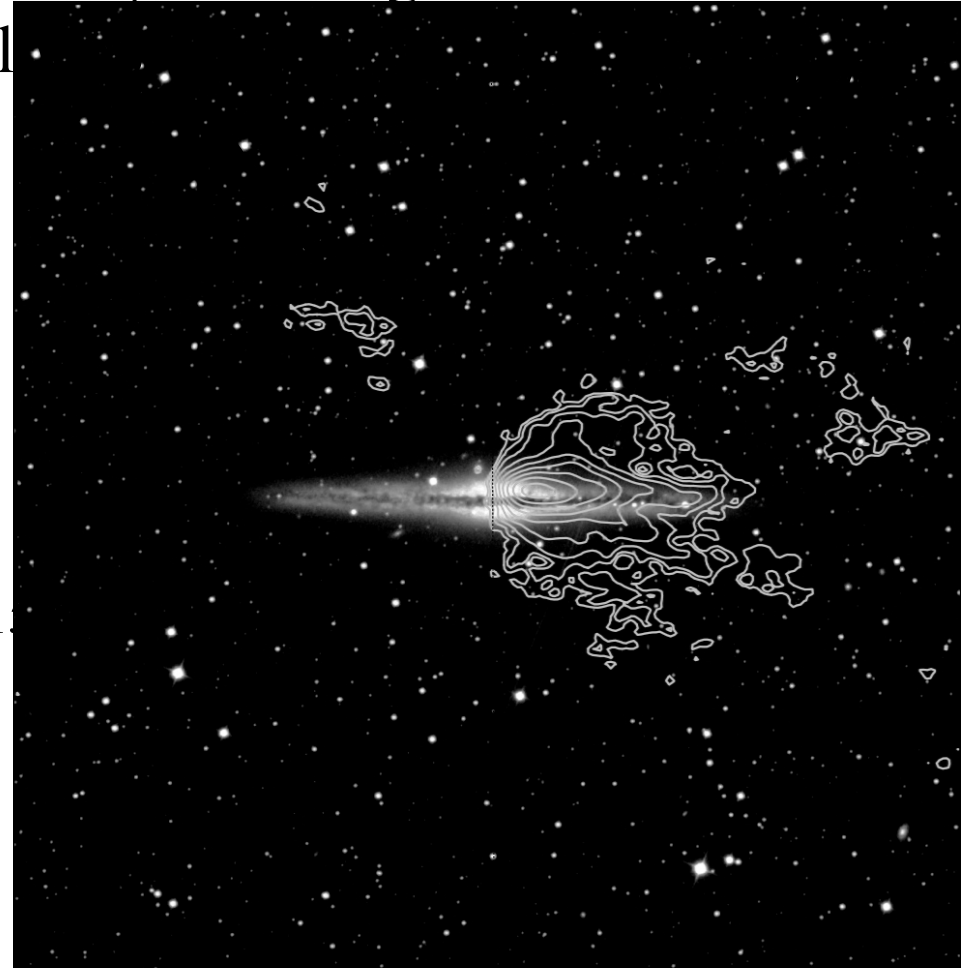
Wakker & van Woerden 1997, ARA&A

Gaseous haloes and gas accretion

Some direct evidence for accretion

Filament

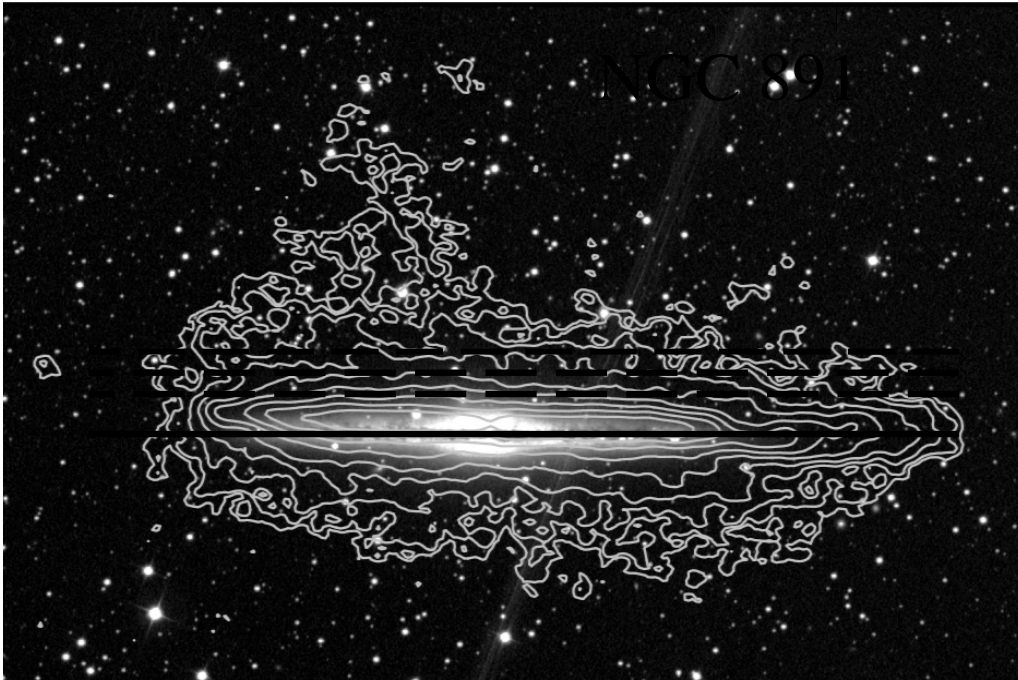
Counter-rotating



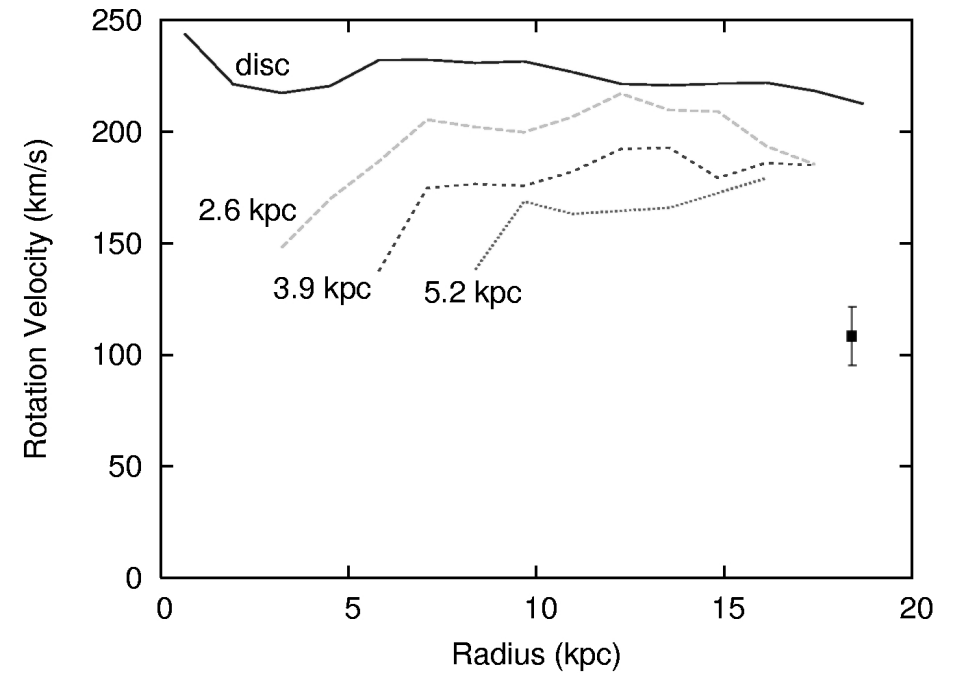
Accretion $\sim \text{few } 10^7 \text{ M}_\odot / \text{few } 10^8 \text{ yr} \sim 0.1 \text{ M}_\odot \text{ yr}^{-1}$

Is that all?

Indirect estimate of gas accretion?

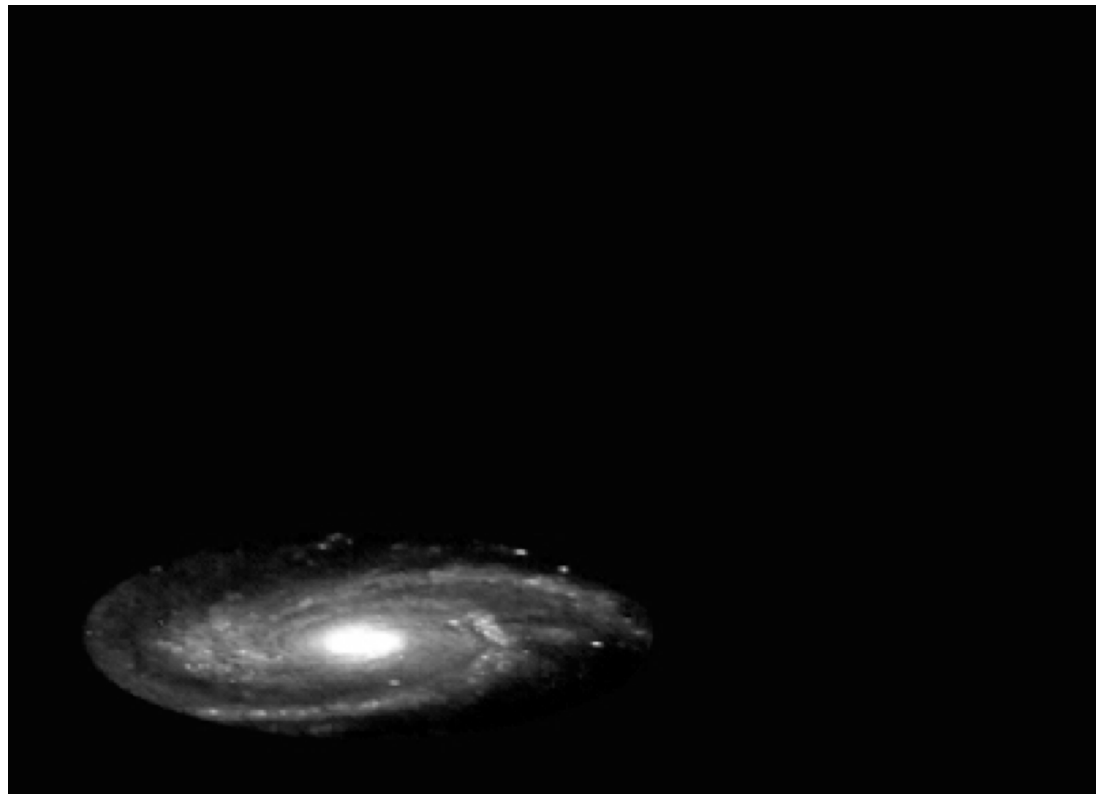


Fraternali et al. 2005



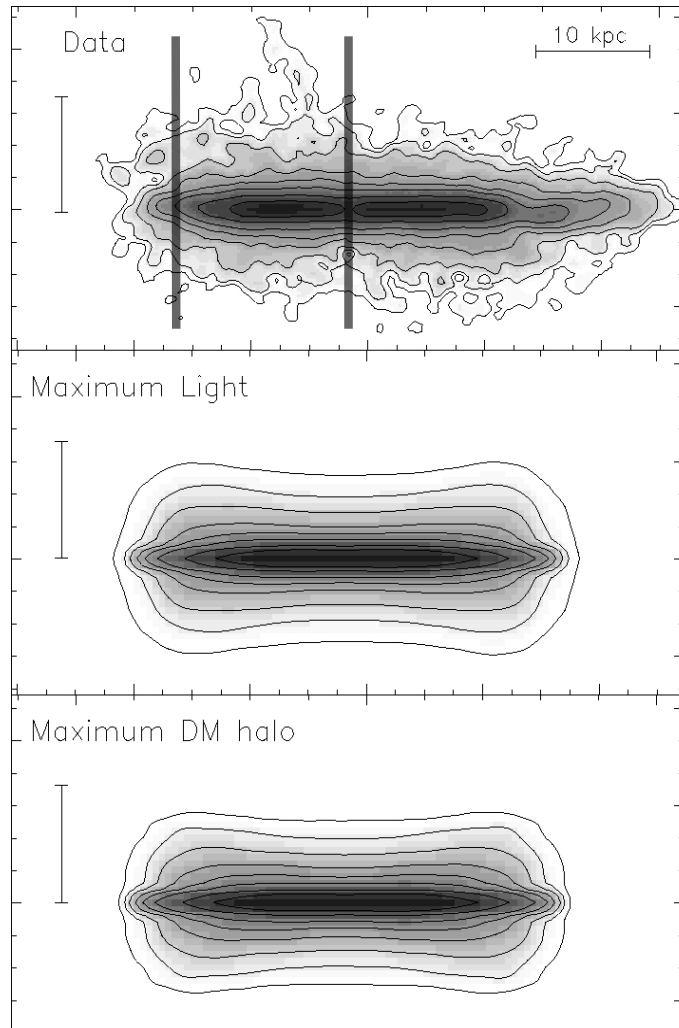
Dynamics Model

- Continuous flow of particles from the disc to the halo
- At each dt projection along the line of sight
- *Pseudo-cube* to be compared with HI data cube



Fraternali & Binney, 2006, MNRAS

Gas distribution in a pure fountain

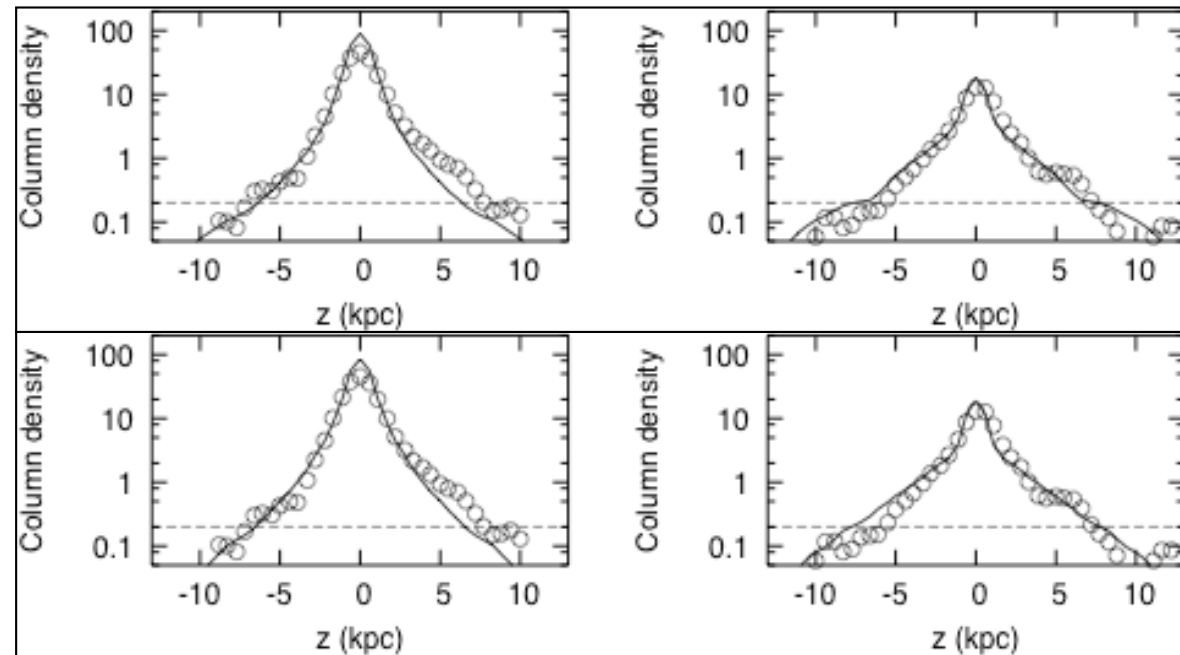


$$V_{\text{kick}} \sim 75 \text{ km s}^{-1}$$

$$M_{\text{halo}} \sim 2 \cdot 10^9 M_{\odot}$$

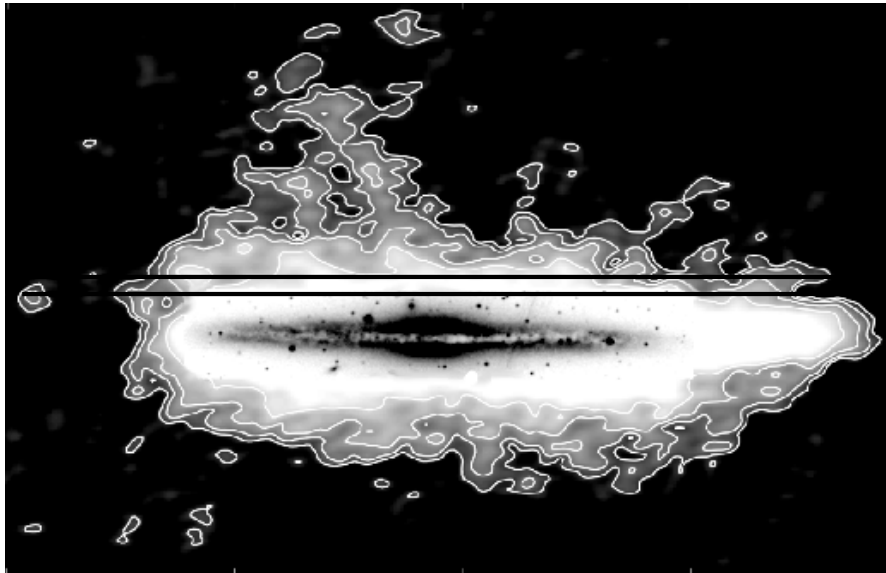
Energy input

<4 % of energy from SNe



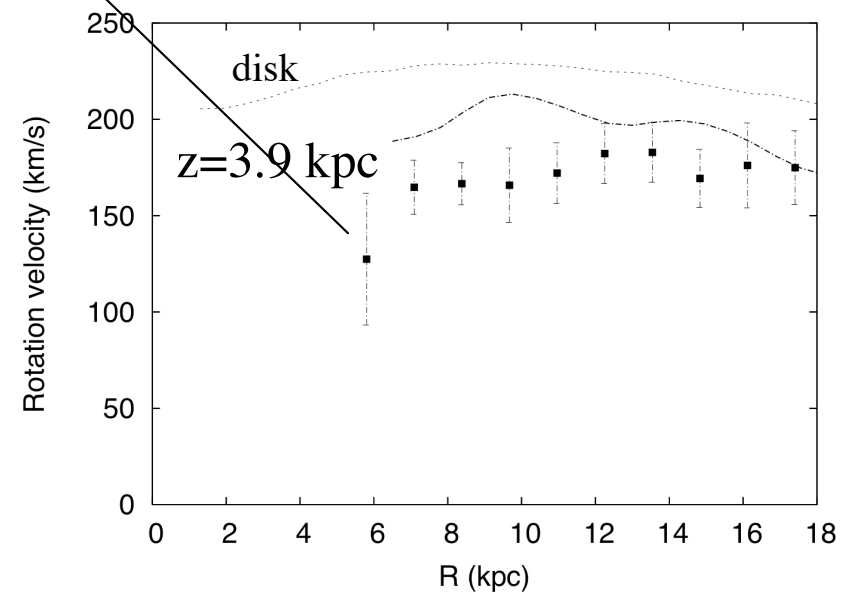
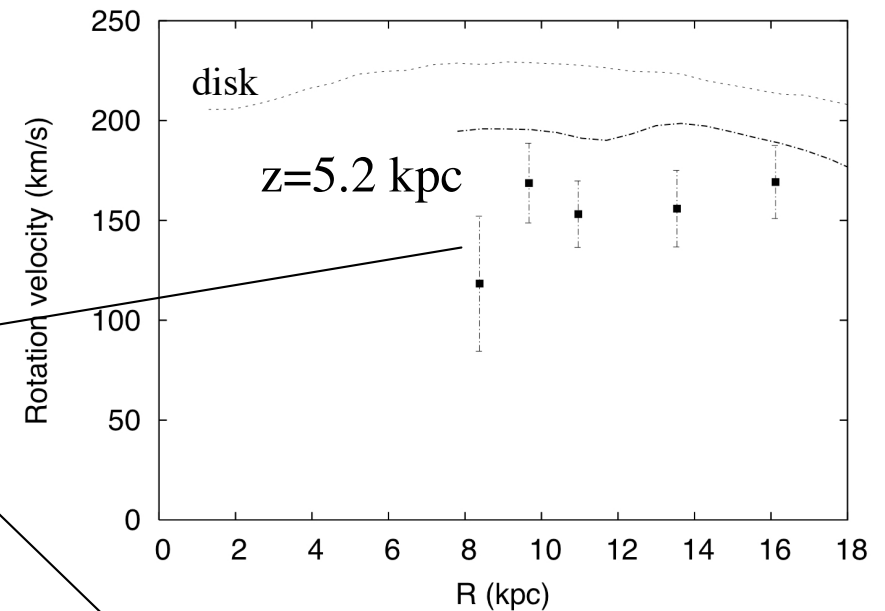
Fountain reproduces the
halo gas distribution

Gas dynamics in a pure fountain



Fountain does NOT reproduce
the halo gas rotation

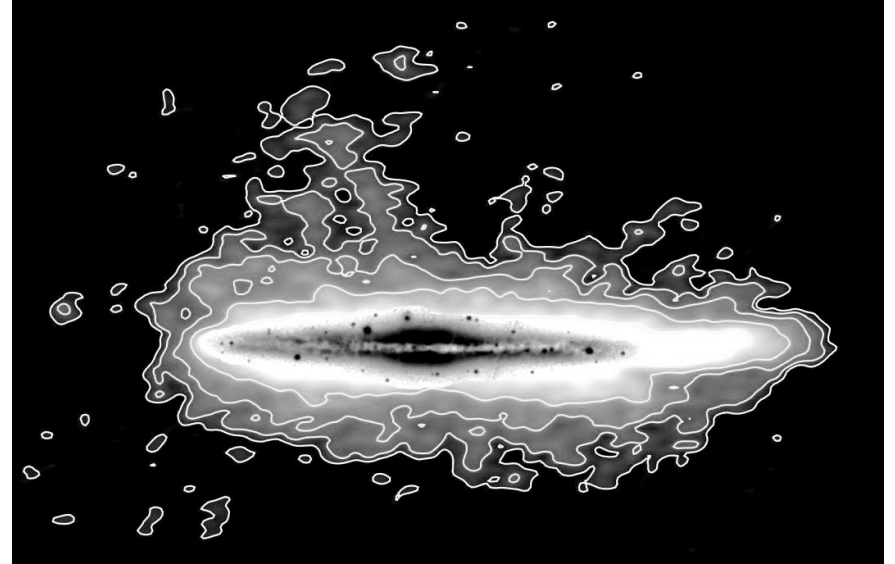
Need for loss of
angular momentum



Conclusions

1. Halo gas common (all galaxies?)

2. Halo gas provides some direct evidence for accretion



1. Most of the accretion seen indirectly as velocity gradient?