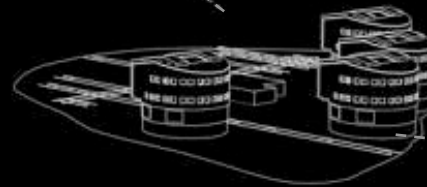
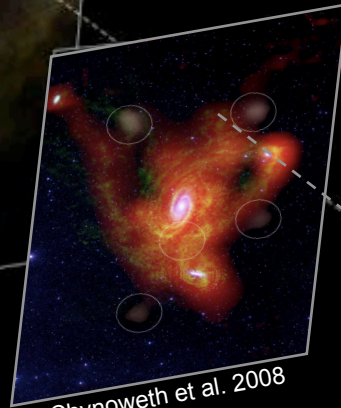


Evidence of Accretion Traced by MgII Absorption at $z \sim 0.5$

Glenn G. Kacprzak (Swinburne University of Technology)

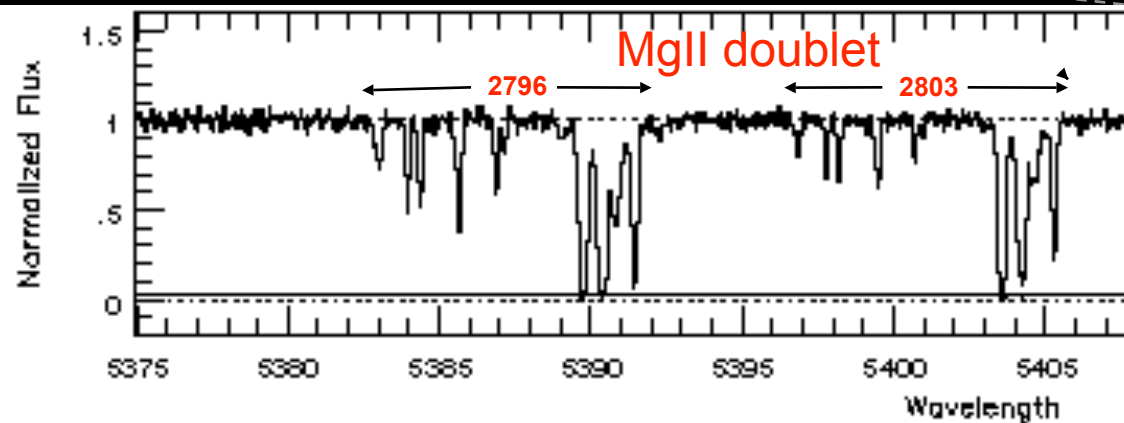
Collaborators:

D. Ceverino (HUJ)
C. Churchill (NMSU)
J. Evans (NMSU)
A. Klypin (NMSU)
M. Murphy (Swinburne)
C. Steidel (Caltech)



• MgII selects gas with $16.5 < \log[N(\text{HI})] < 22$.

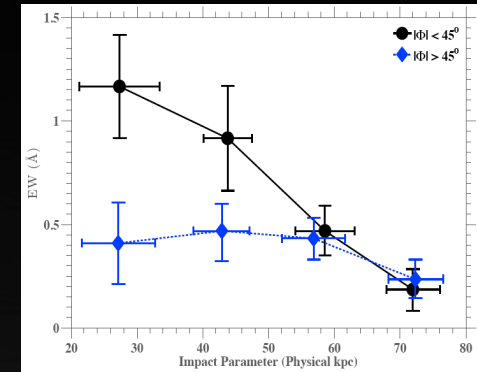
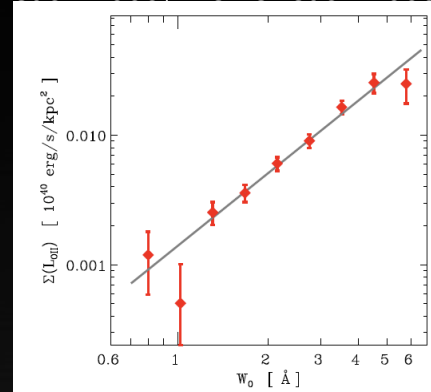
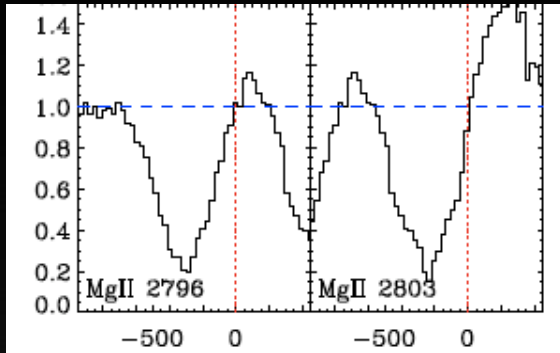
• Detected over $D = \text{few-120 kpc}$



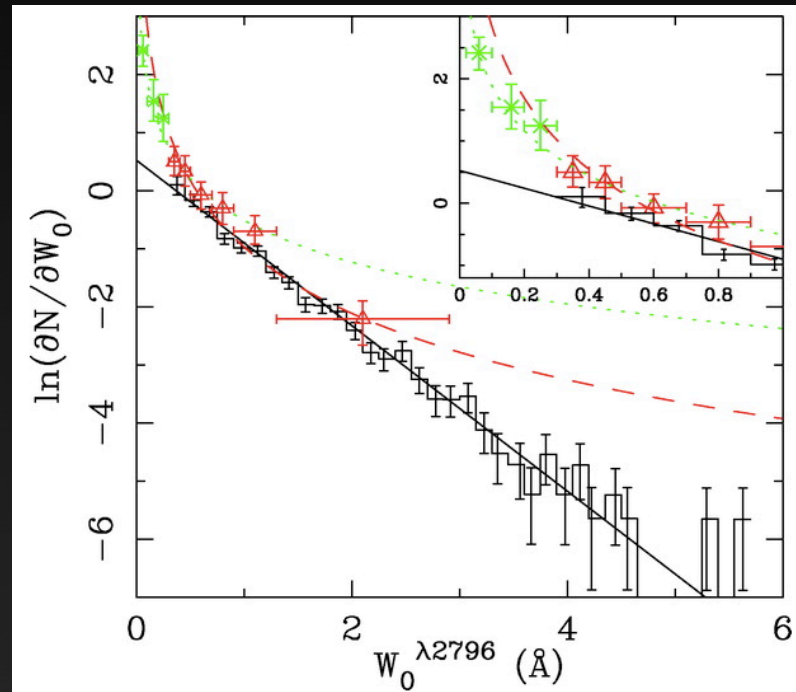
Outflow vs. Infall

- Lots of evidence that **Strong MgII systems arise in/from outflowing gas**

Bordoloi et al. 2011, Rubin et al. 2010, Menard et al. 2009, Weiner et al. 2009, Martin & Bouche 2009, Zibetti et al. 2007



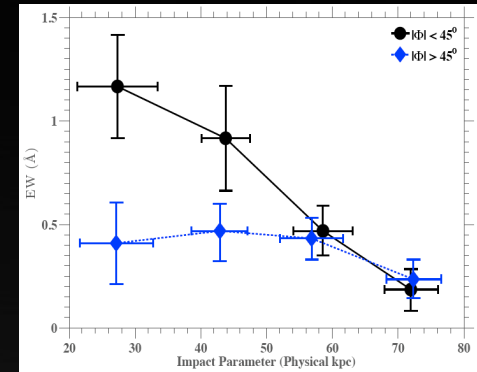
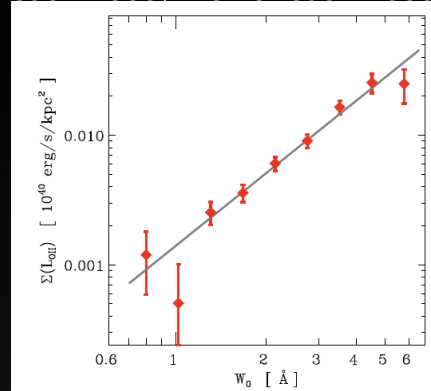
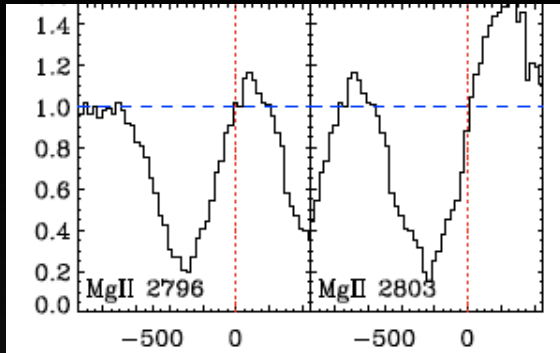
- Evidence of Infalling gas?



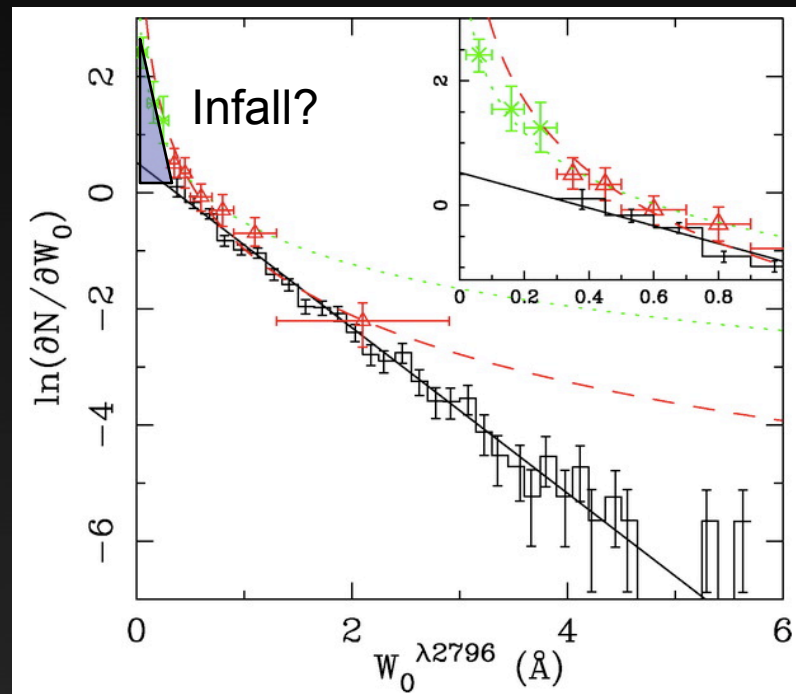
Outflow vs. Infall

•Lots of evidence that **Strong MgII systems arise in/from outflowing gas**

Bordoloi et al. 2011, Rubin et al. 2010, Menard et al. 2009, Weiner et al. 2009, Martin & Bouche 2009, Zibetti et al. 2007



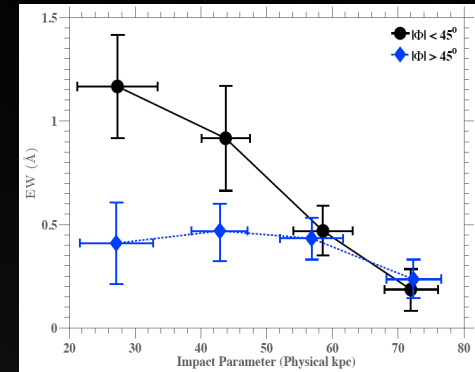
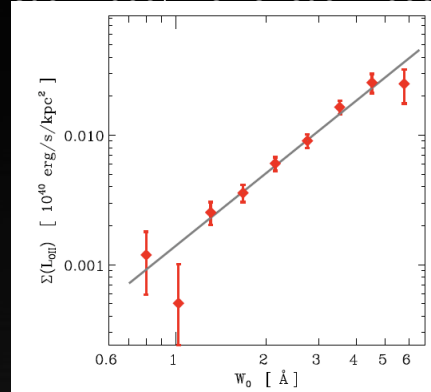
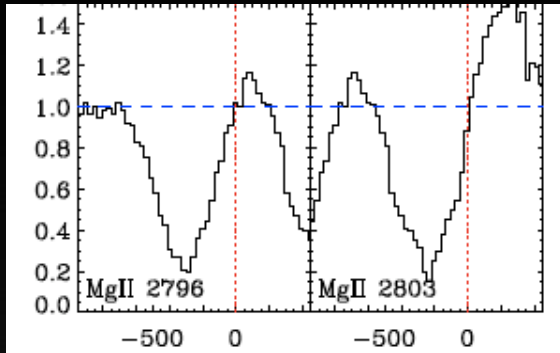
•Evidence of Infalling gas?



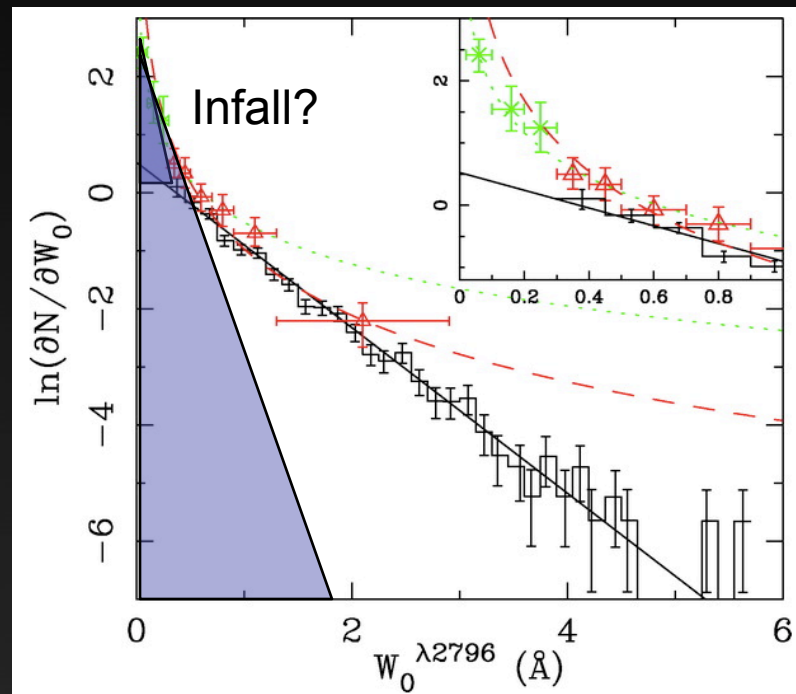
Outflow vs. Infall

•Lots of evidence that **Strong MgII systems arise in/from outflowing gas**

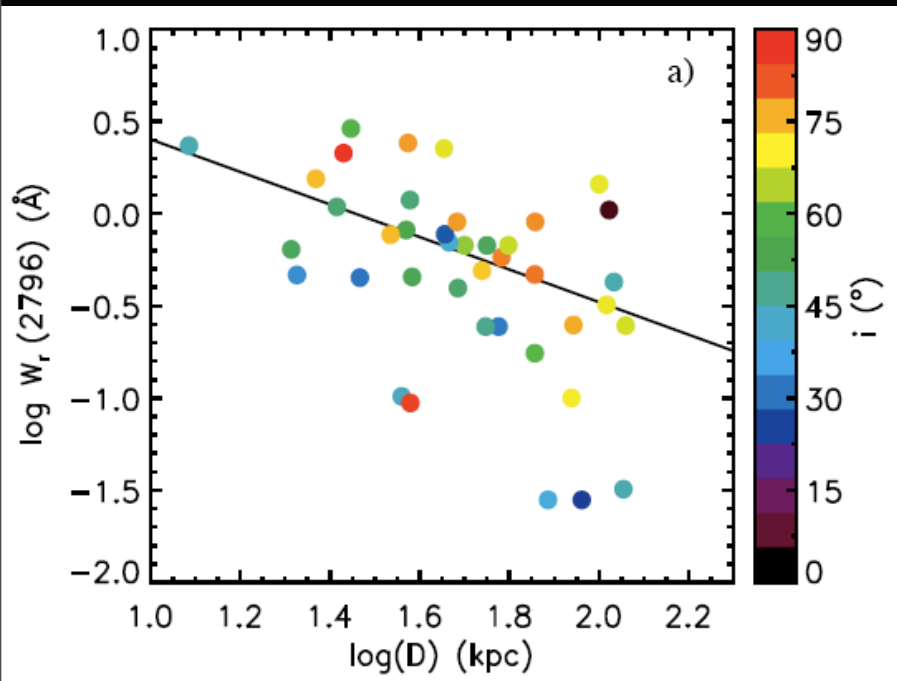
Bordoloi et al. 2011, Rubin et al. 2010, Menard et al. 2009, Weiner et al. 2009, Martin & Bouche 2009, Zibetti et al. 2007



•Evidence of Infalling gas?



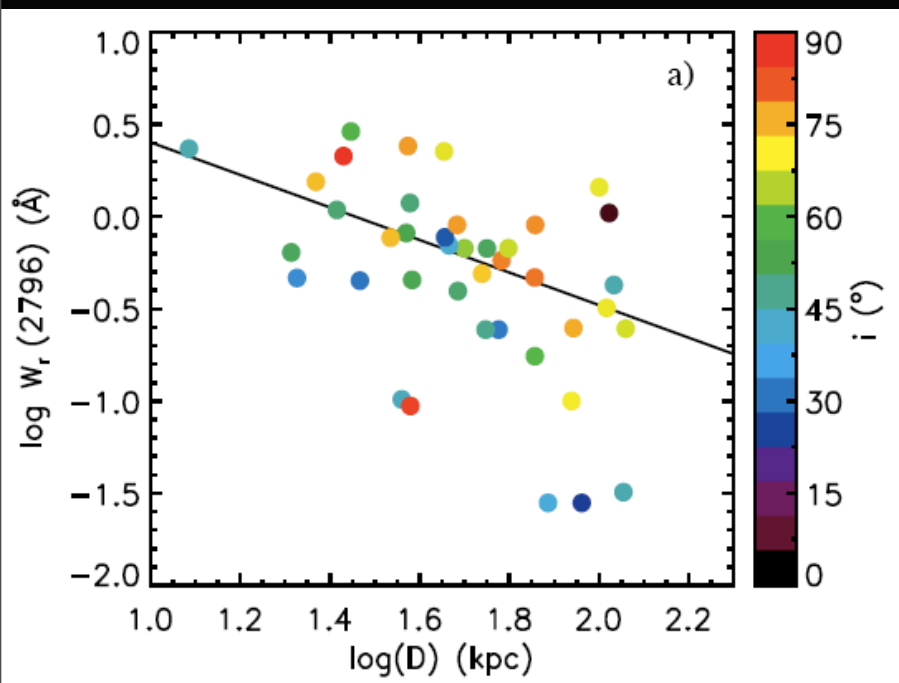
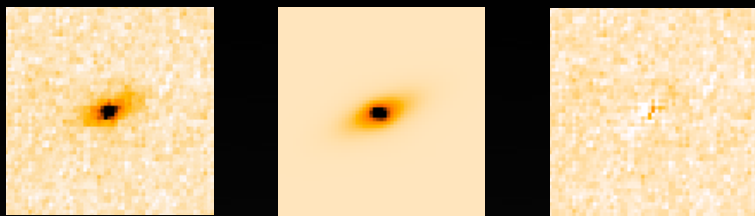
Galaxy Inclination vs. MgII for z~0.5 Galaxies



- Sample of 40 MgII absorbers imaged with HST
- $0.3 < z < 1.0$
- Galaxy morphologies modeled using GIM2D
- 3.3σ correlation between EW and D

Kacprzak et al. (2011, MNRAS, accepted yesterday, astro-ph tomorrow)

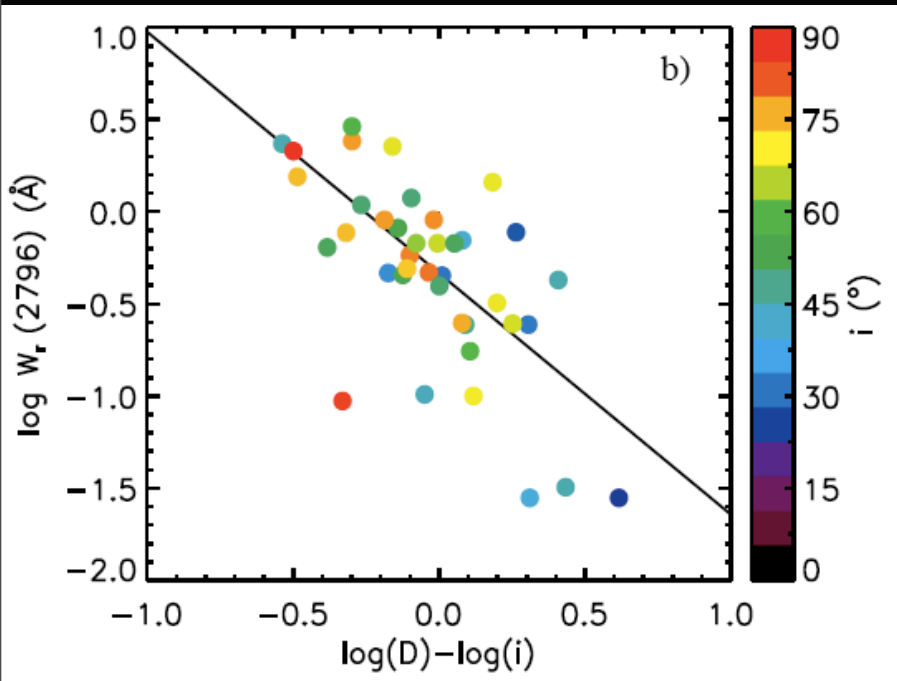
Galaxy Inclination vs. MgII for $z \sim 0.5$ Galaxies



- Sample of 40 MgII absorbers imaged with HST
- $0.3 < z < 1.0$
- Galaxy morphologies modeled using GIM2D
- 3.3σ correlation between EW and D

Kacprzak et al. (2011, MNRAS, accepted yesterday, astro-ph tomorrow)

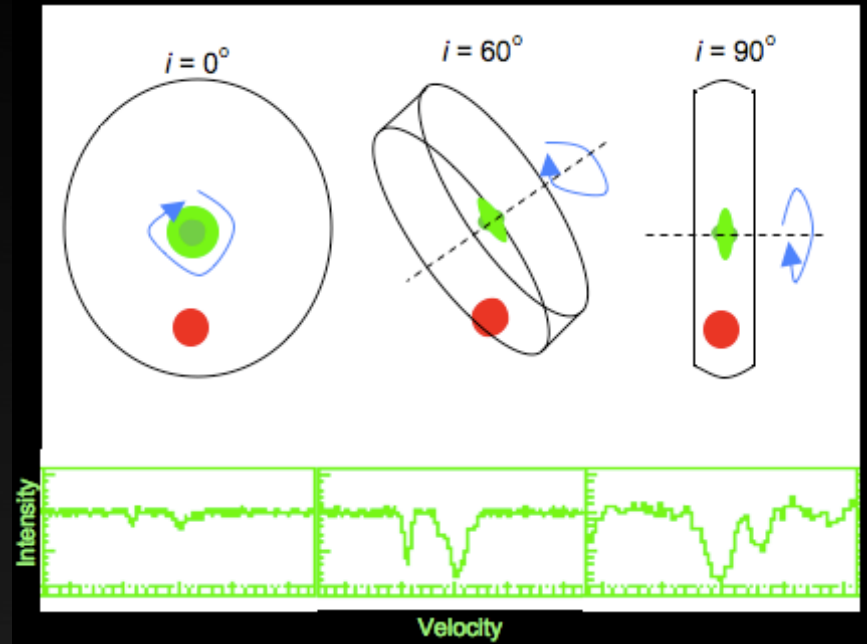
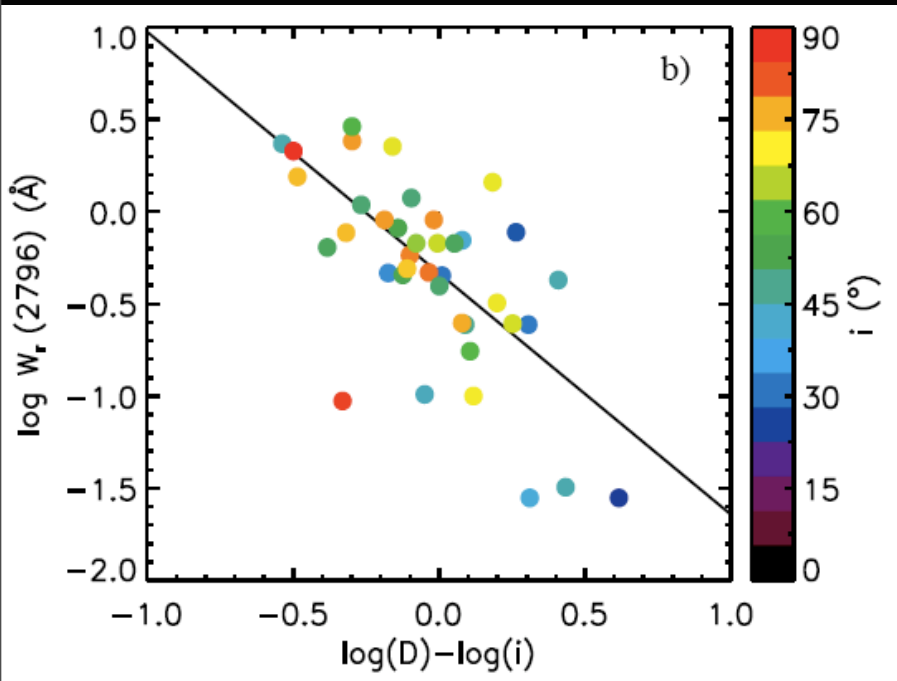
Galaxy Inclination vs. MgII for $z \sim 0.5$ Galaxies



Kacprzak et al. (2011, MNRAS, accepted yesterday, astroph tomorrow)

$\bullet 4.3\sigma$ Correlation between i/D and Absorption Strength. Column density, optical depth and number of clouds all correlate at $>3.5\sigma$

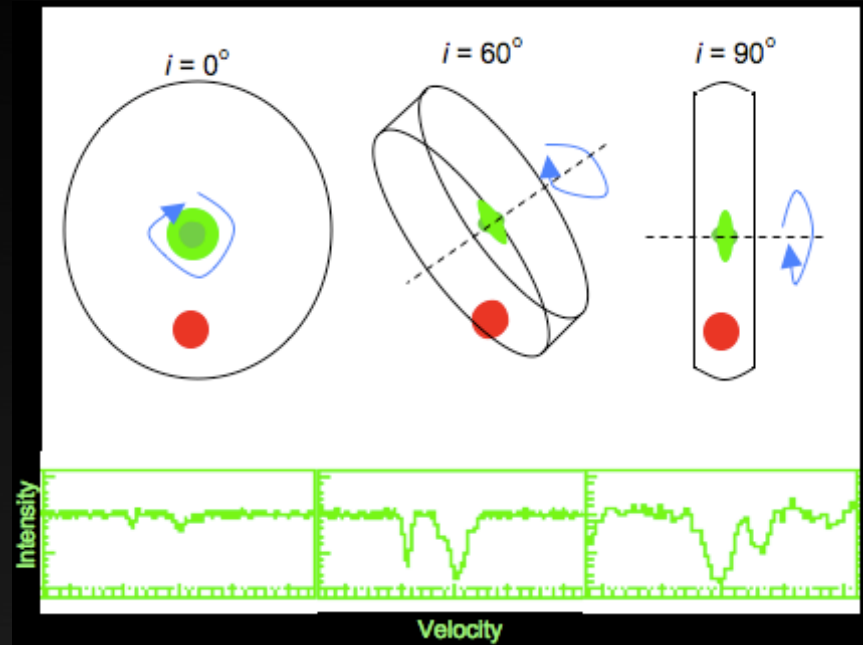
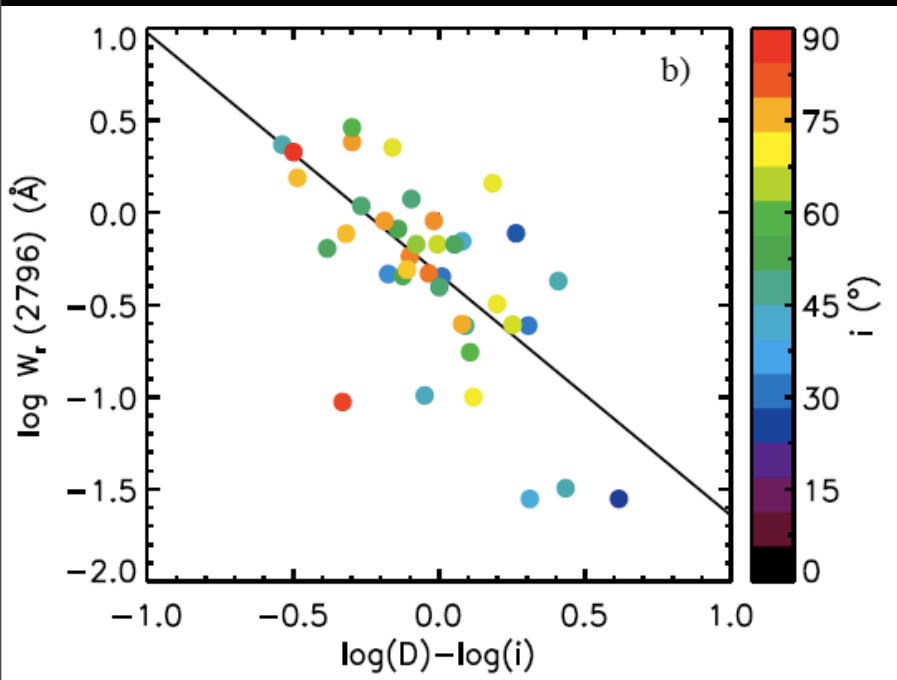
Galaxy Inclination vs. MgII for $z \sim 0.5$ Galaxies



Kacprzak et al. (2011, MNRAS, accepted yesterday, astro-ph tomorrow)

$\bullet 4.3\sigma$ Correlation between i/D and Absorption Strength. Column density, optical depth and number of clouds all correlate at $>3.5\sigma$

Galaxy Inclination vs. MgII for z~0.5 Galaxies



Kacprzak et al. (2011, MNRAS, accepted yesterday, astro-ph tomorrow)

•4.3 σ Correlation between i/D and Absorption Strength. Column density, optical depth and number of clouds all correlate at $>3.5 \sigma$

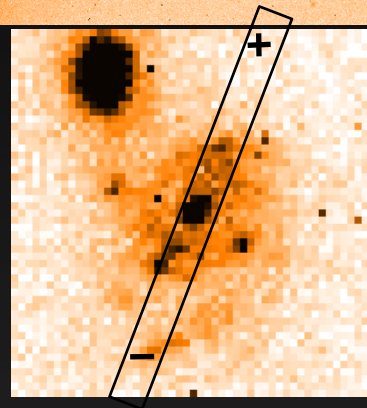
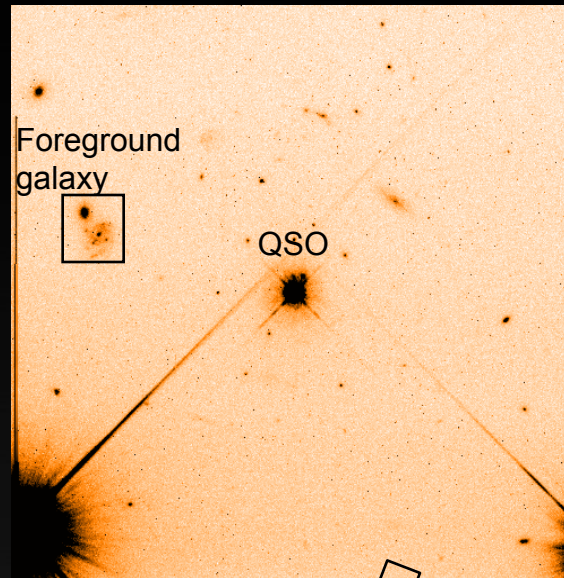
Absorption strength coupled to galaxy major axis orientation: Not produced by winds! (wind would likely cause an anti-correlation)

Copy of manuscript available at: <http://astronomy.swin.edu.au/~gkacprzak/>

Galaxy Halo Kinematics: Disk-like or Infall

D = 107 kpc

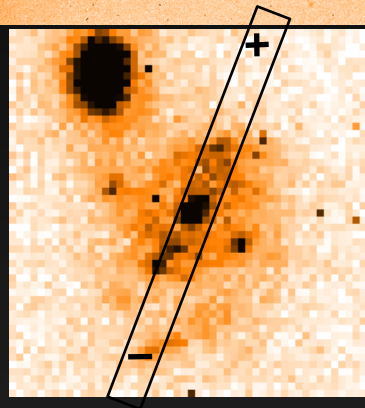
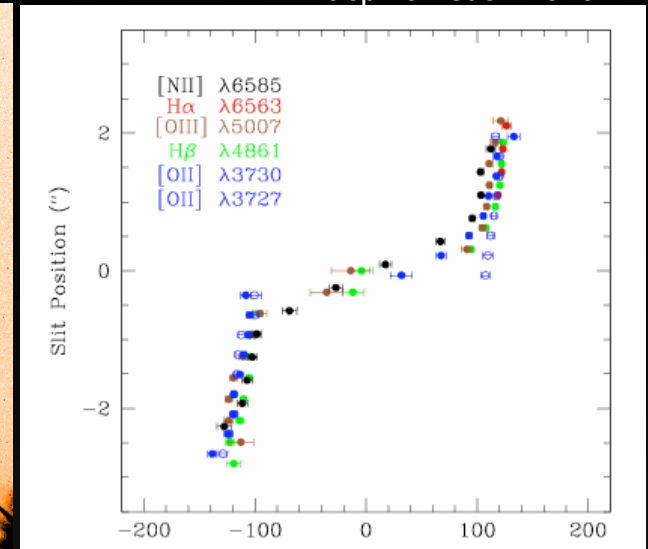
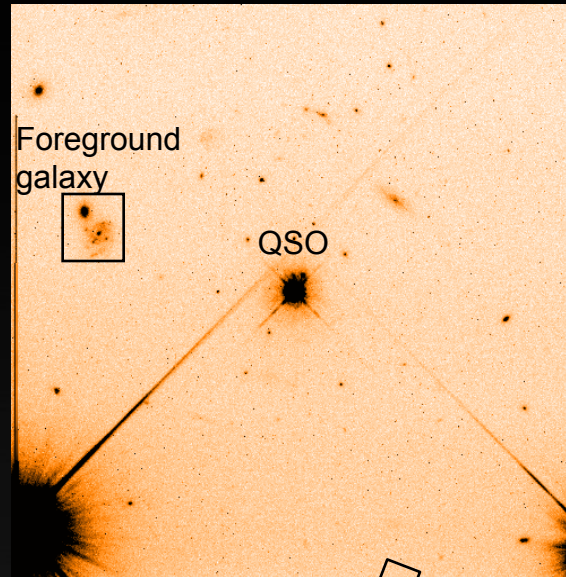
Kacprzak et al. 2010



Galaxy Halo Kinematics: Disk-like or Infall

D = 107 kpc

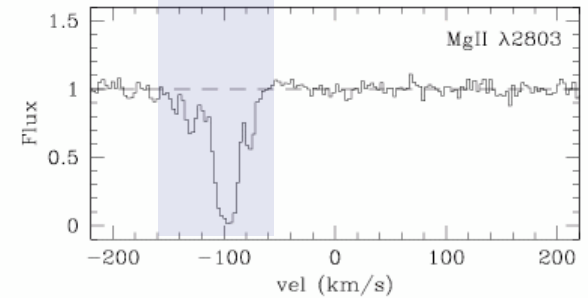
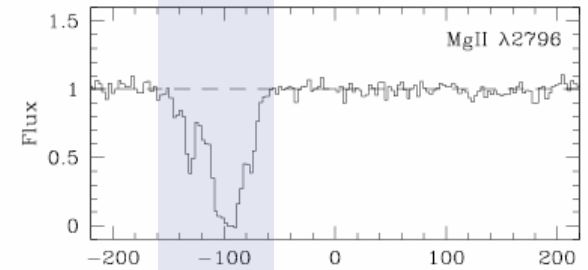
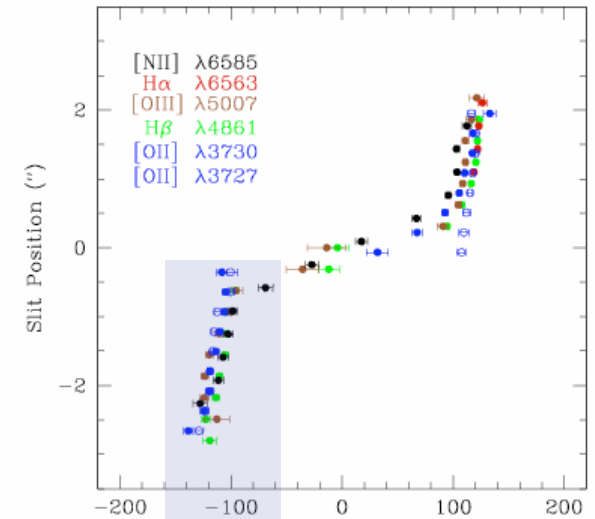
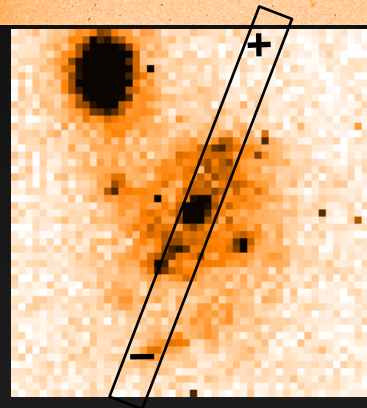
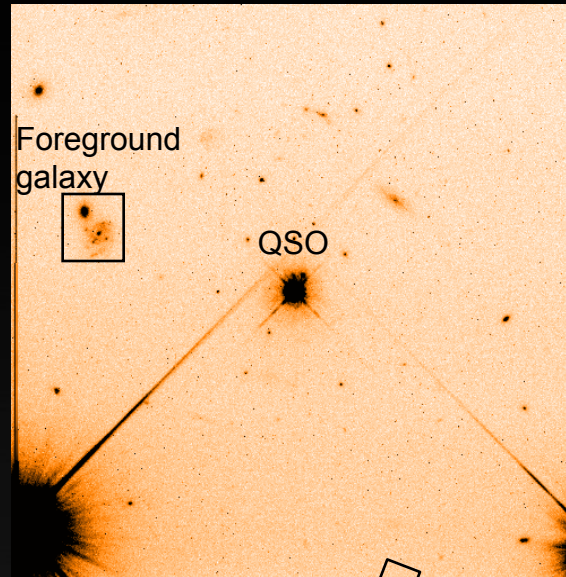
Kacprzak et al. 2010



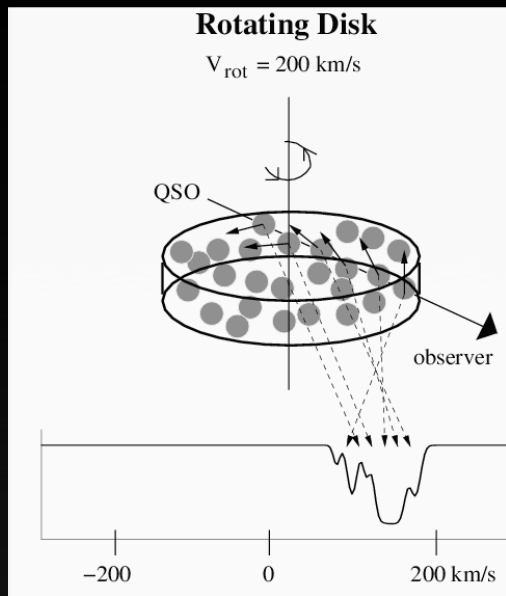
Galaxy Halo Kinematics: Disk-like or Infall

D = 107 kpc

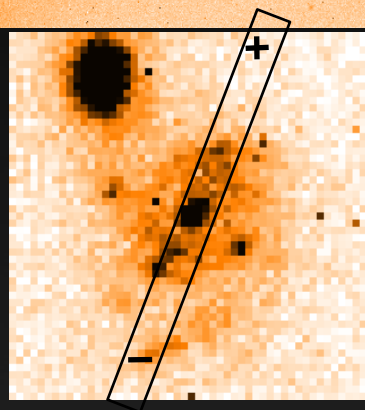
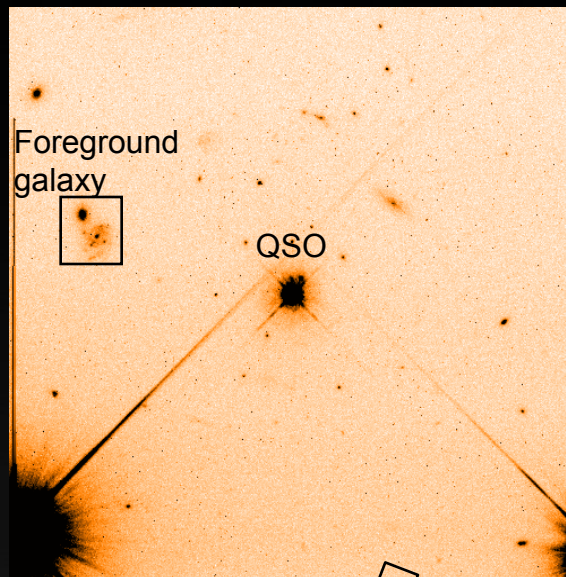
Kacprzak et al. 2010



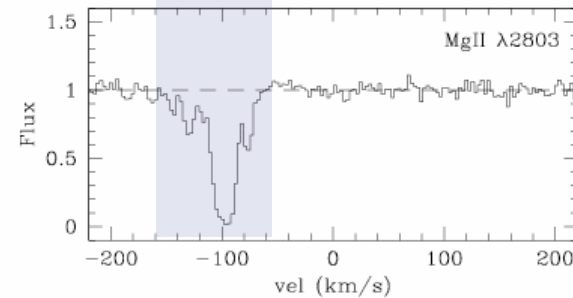
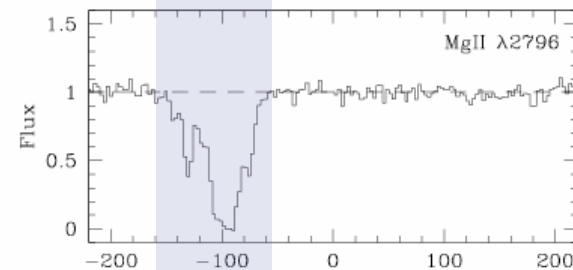
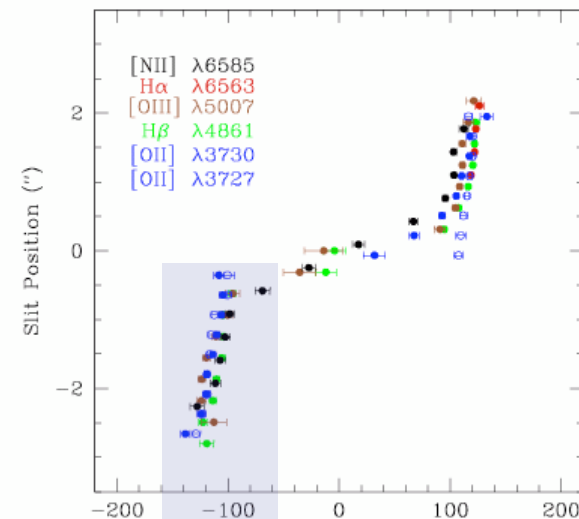
Galaxy Halo Kinematics: Disk-like or Infall



D = 107 kpc



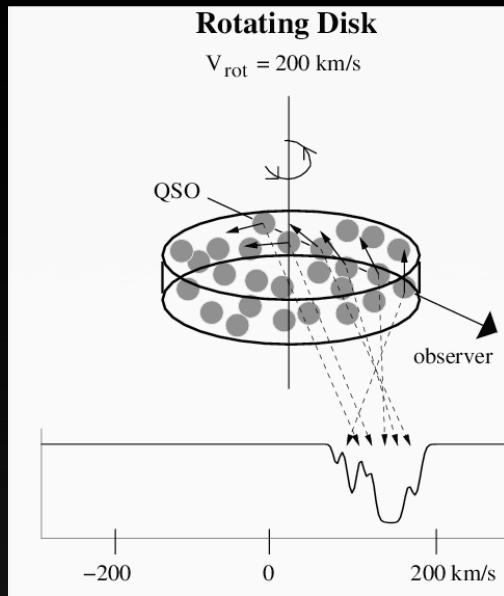
Kacprzak et al. 2010



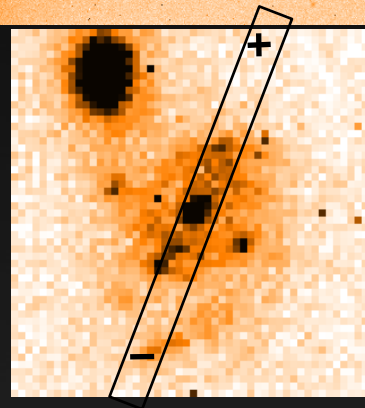
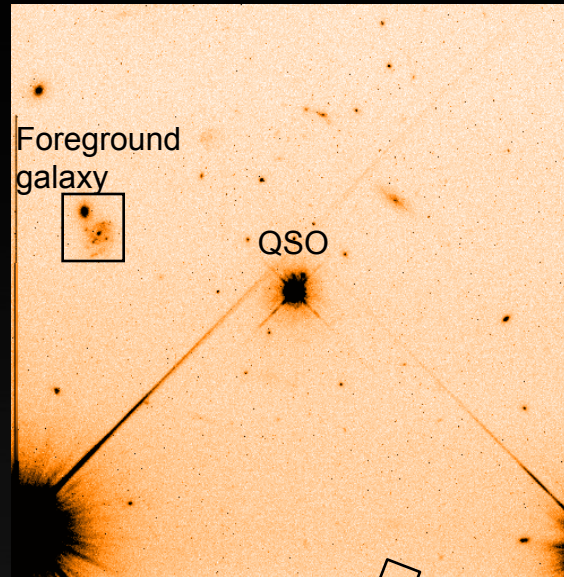
•14/19 cases, all the absorbing gas resides on one side of the systemic velocity of the galaxy.

- 10- Kacprzak et al. 2010,
- 3- Chen et al. 2005,
- 5 - Steidel et al. 2002,
- 1- Ellison et al. 2003

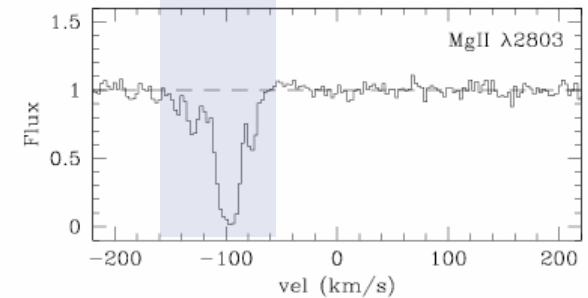
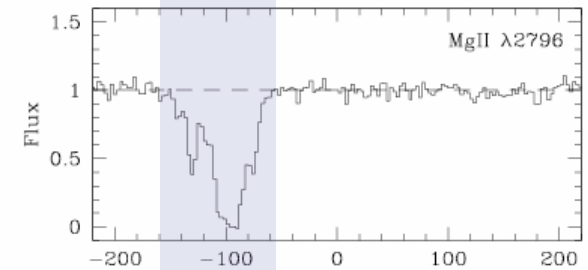
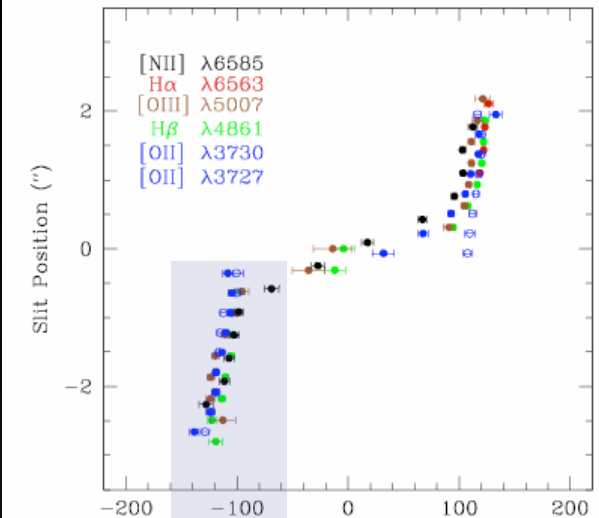
Galaxy Halo Kinematics: Disk-like or Infall



D = 107 kpc



Kacprzak et al. 2010



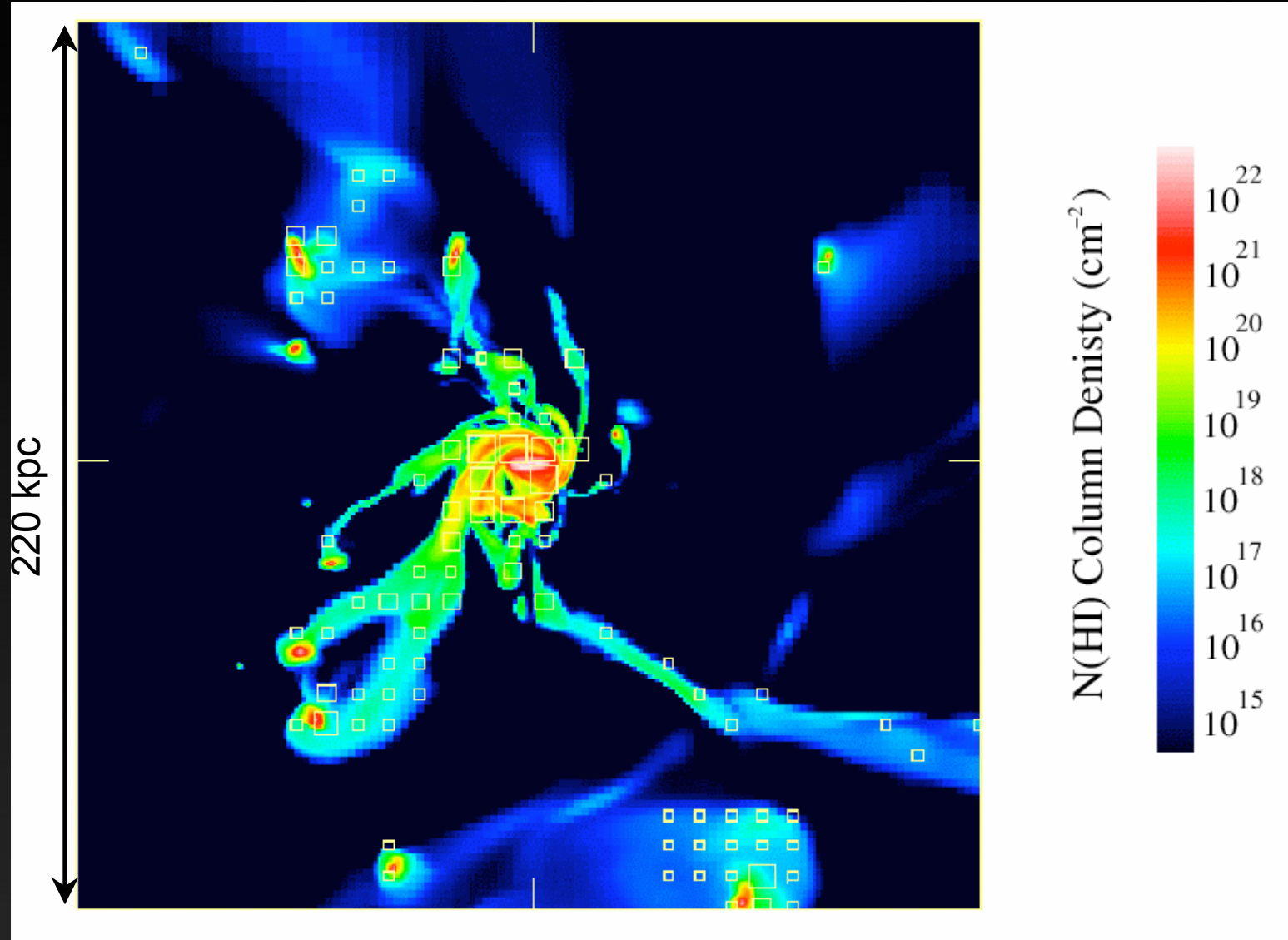
•14/19 cases, all the absorbing gas resides on one side of the systemic velocity of the galaxy.

•However, the a rotating halo model cannot reproduce the observed velocity spread in the gas.

- 10- Kacprzak et al. 2010,
- 3- Chen et al. 2005,
- 5 - Steidel et al. 2002,
- 1- Ellison et al. 2003

Galaxy Halo Kinematics: Disk-like or Infall

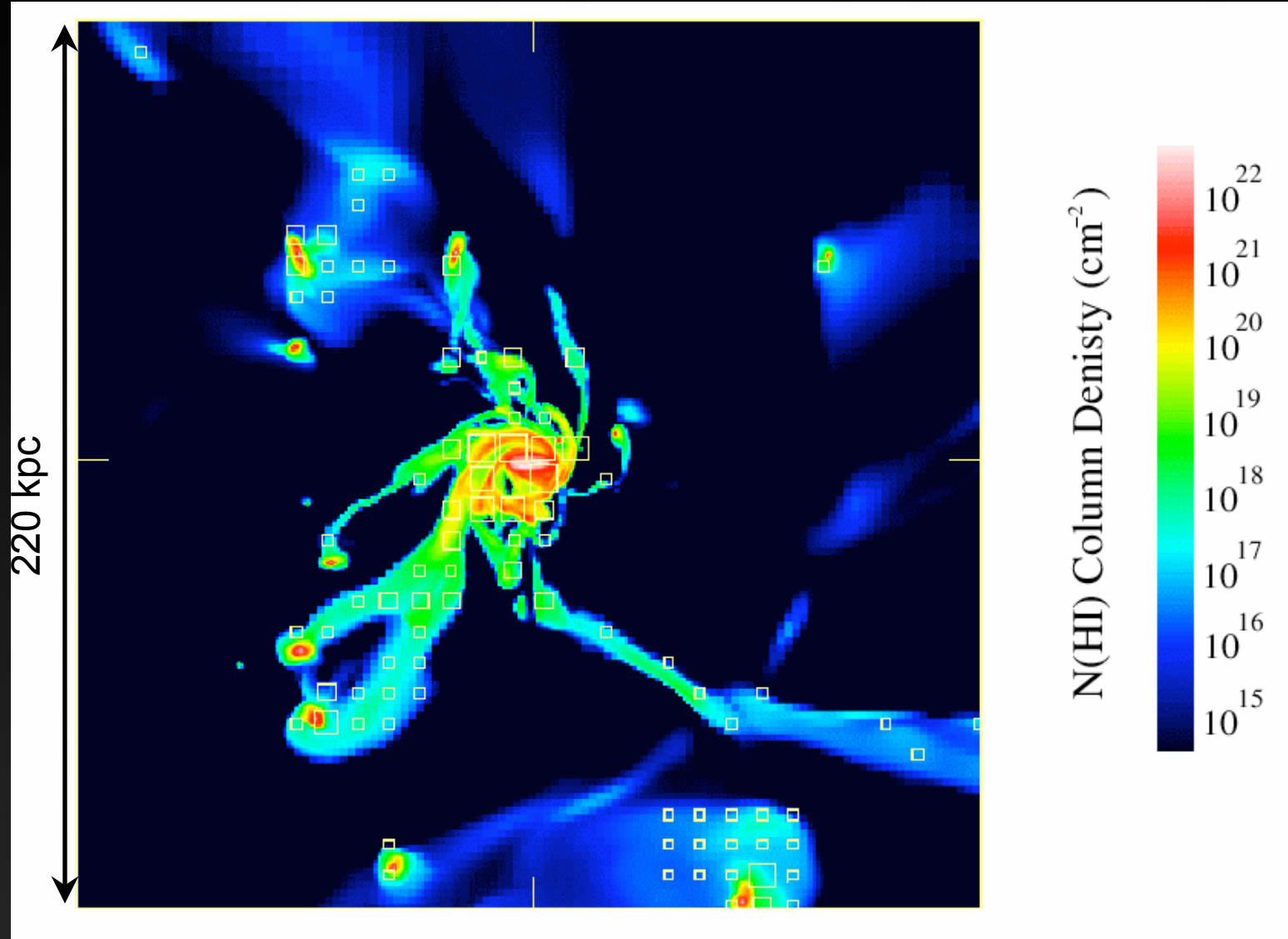
- 900 sightlines, sampling at 7.5 kpc intervals.
- Galaxy: $v_{rot} = 180$ km/s, $L = 0.4 L_B^*$



Galaxy Halo Kinematics: Disk-like or Infall

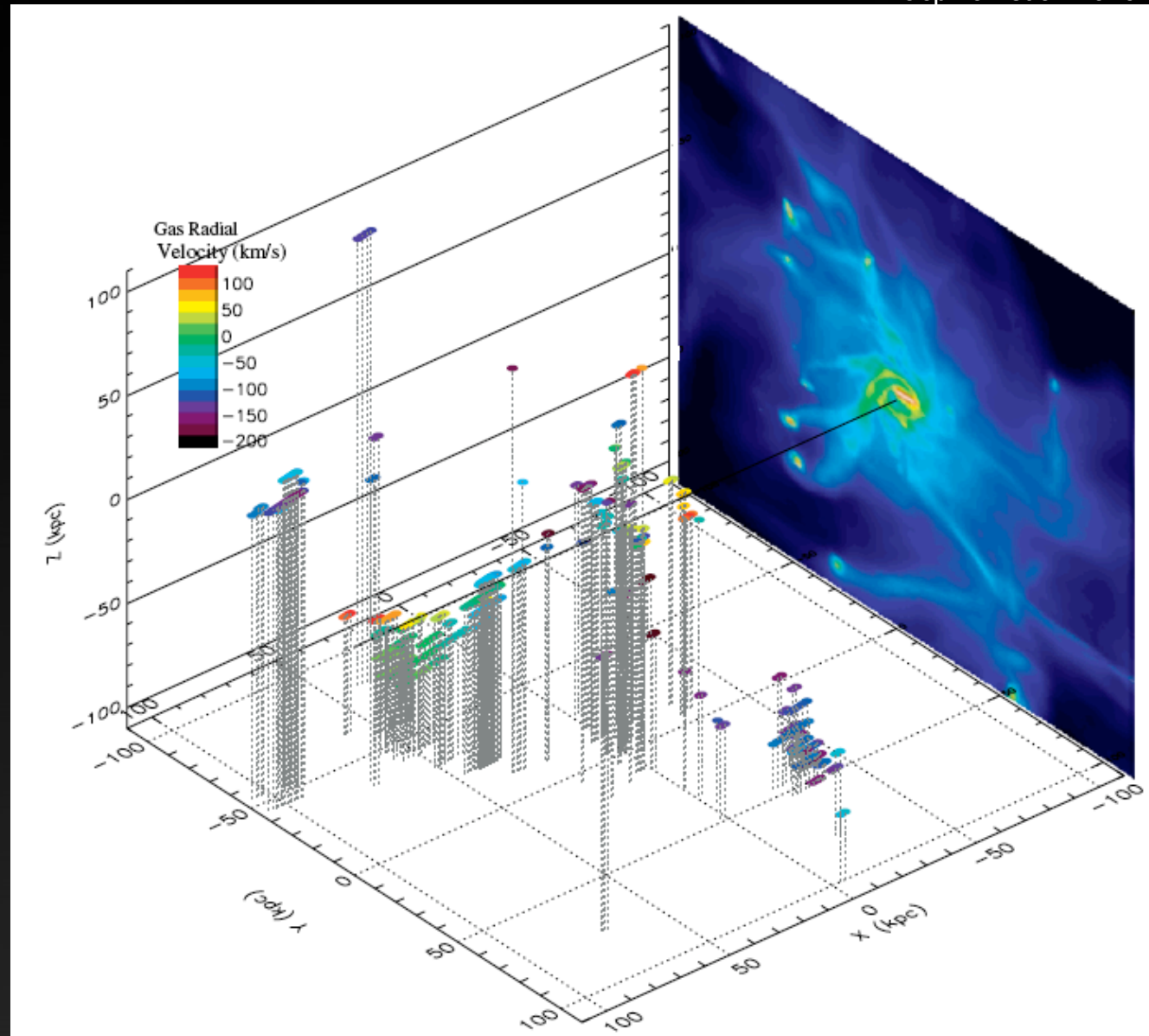
- 900 sightlines, sampling at 7.5 kpc intervals.
- Galaxy: $v_{rot} = 180$ km/s, $L = 0.4 L_B^*$

Kacprzak et al. 2010



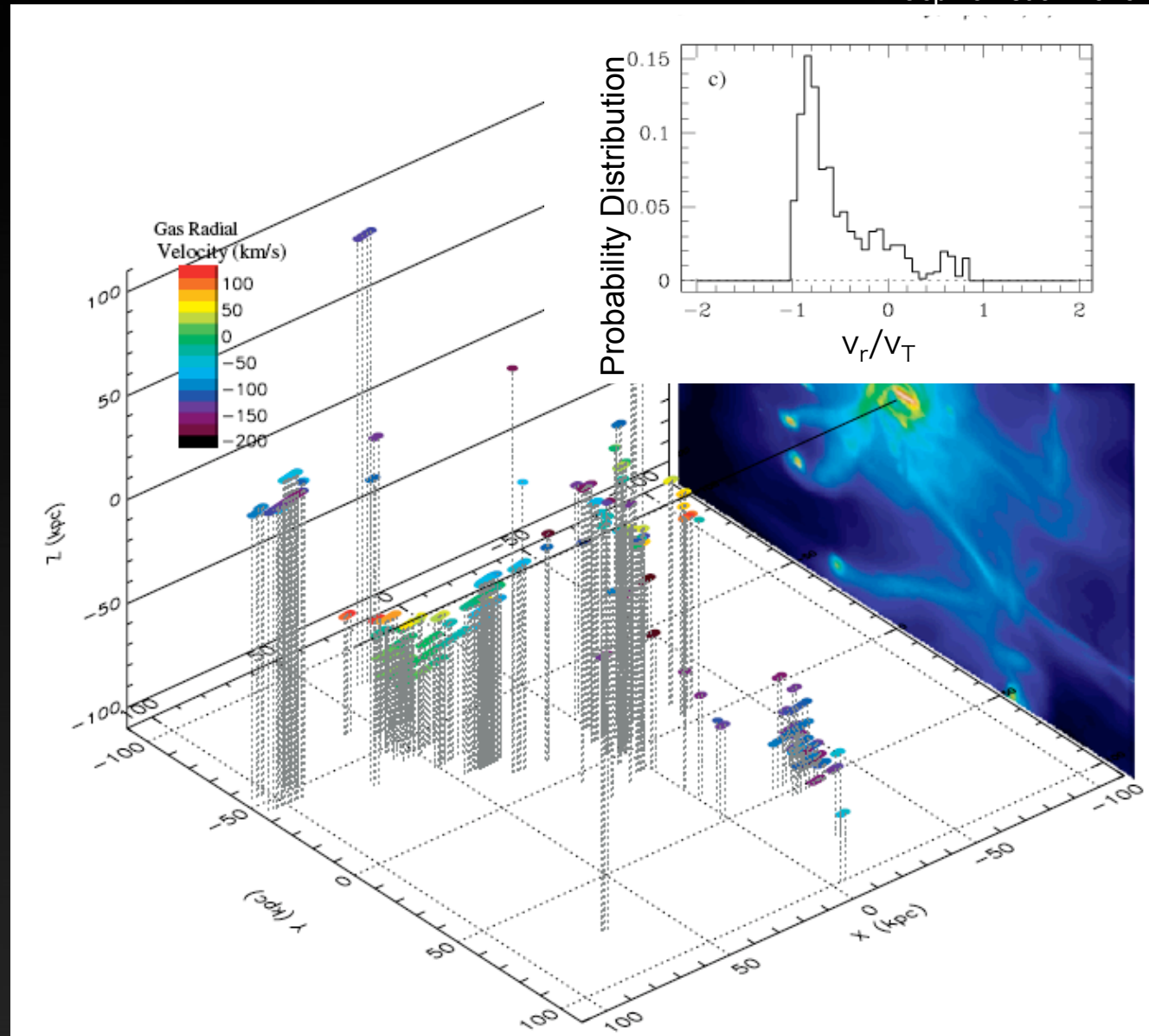
Galaxy Halo Kinematics: Disk-like or Infall

Kacprzak et al. 2010



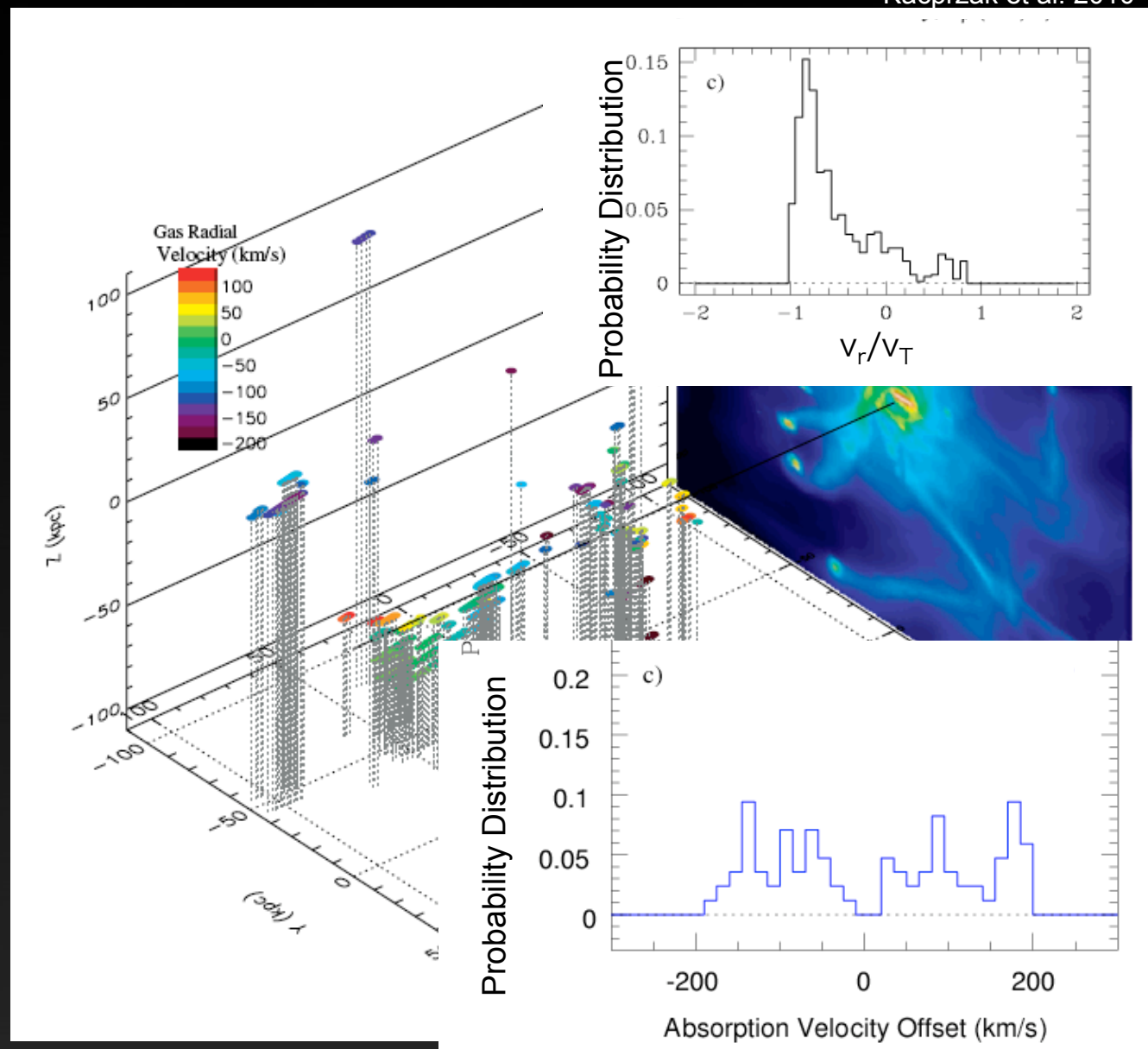
Galaxy Halo Kinematics: Disk-like or Infall

Kacprzak et al. 2010

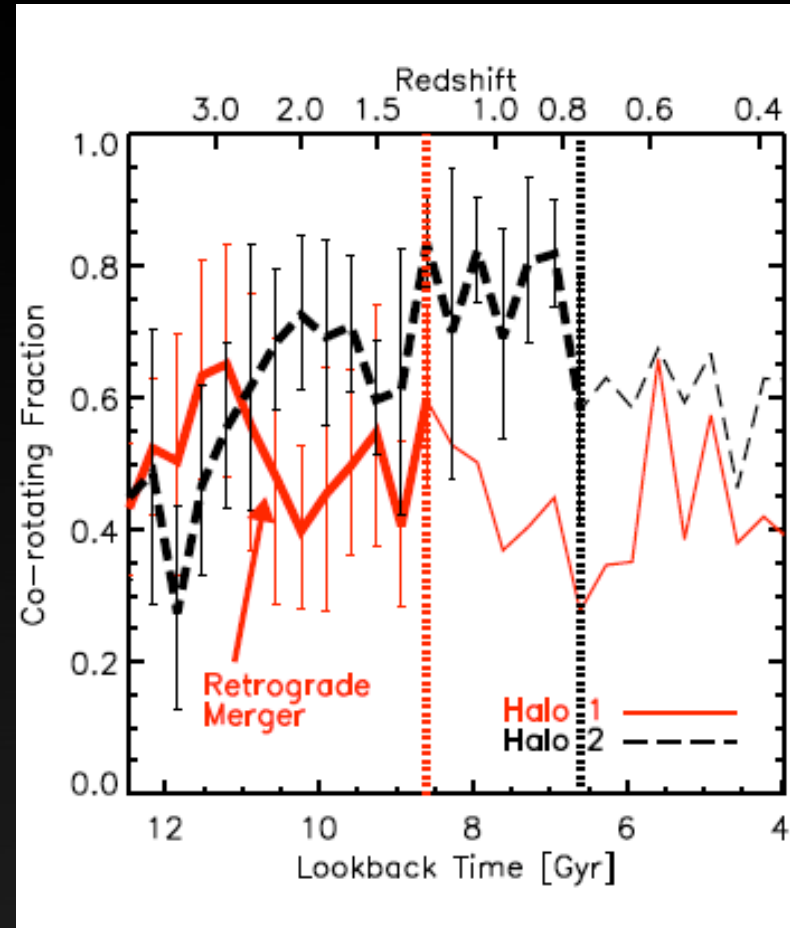
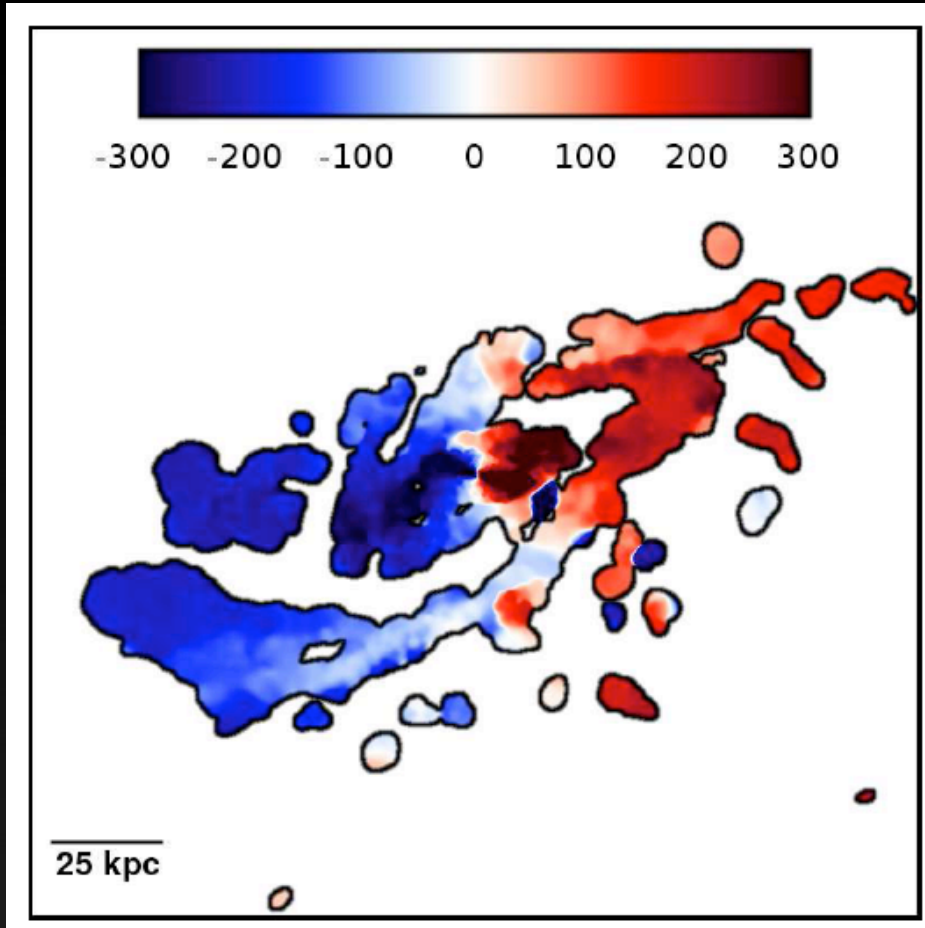


Galaxy Halo Kinematics: Disk-like or Infall

Kacprzak et al. 2010

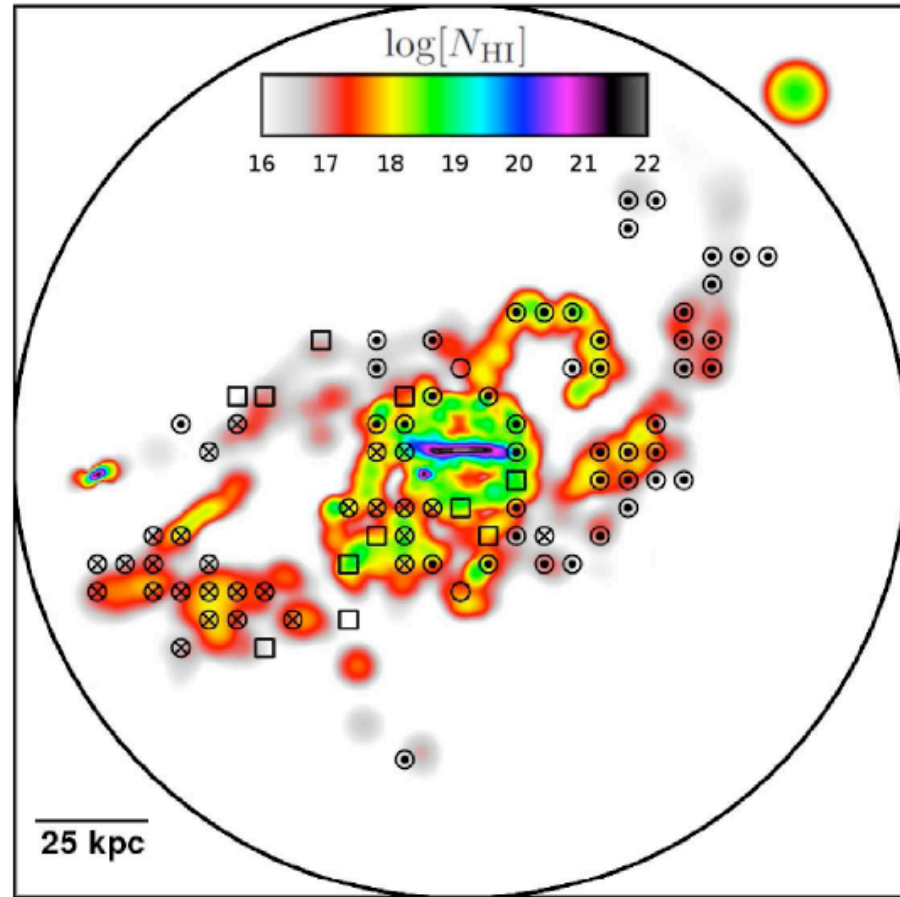
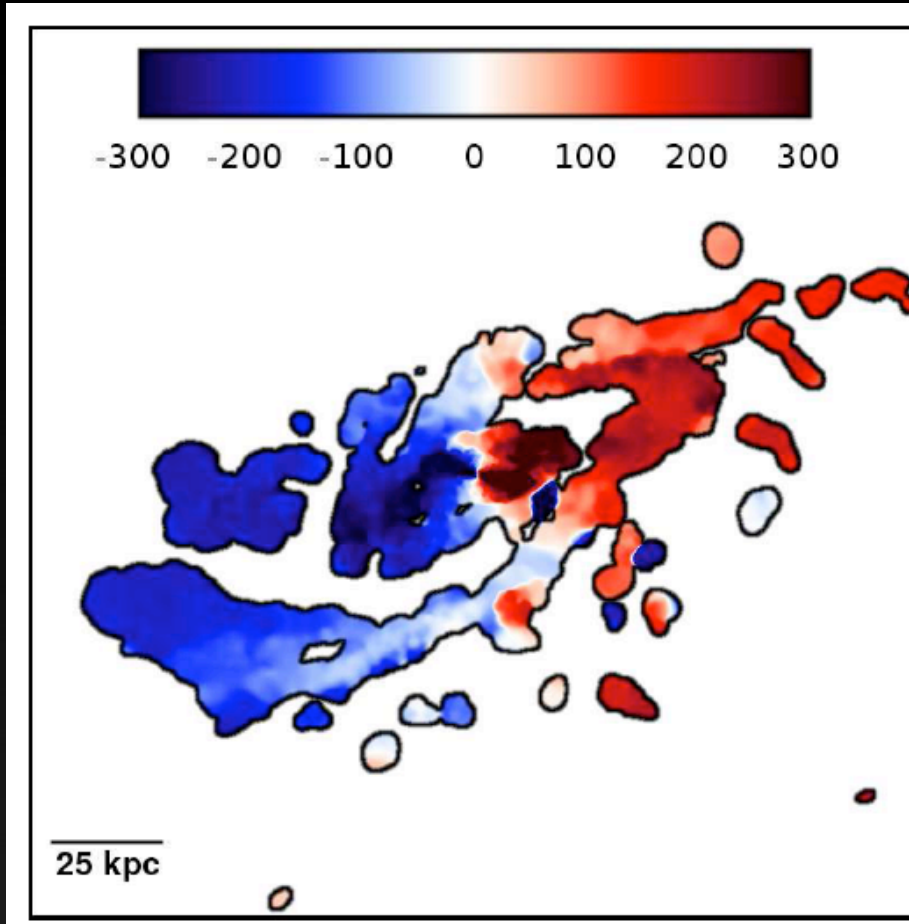


Galaxy Halo Kinematics: Disk-like or Infall



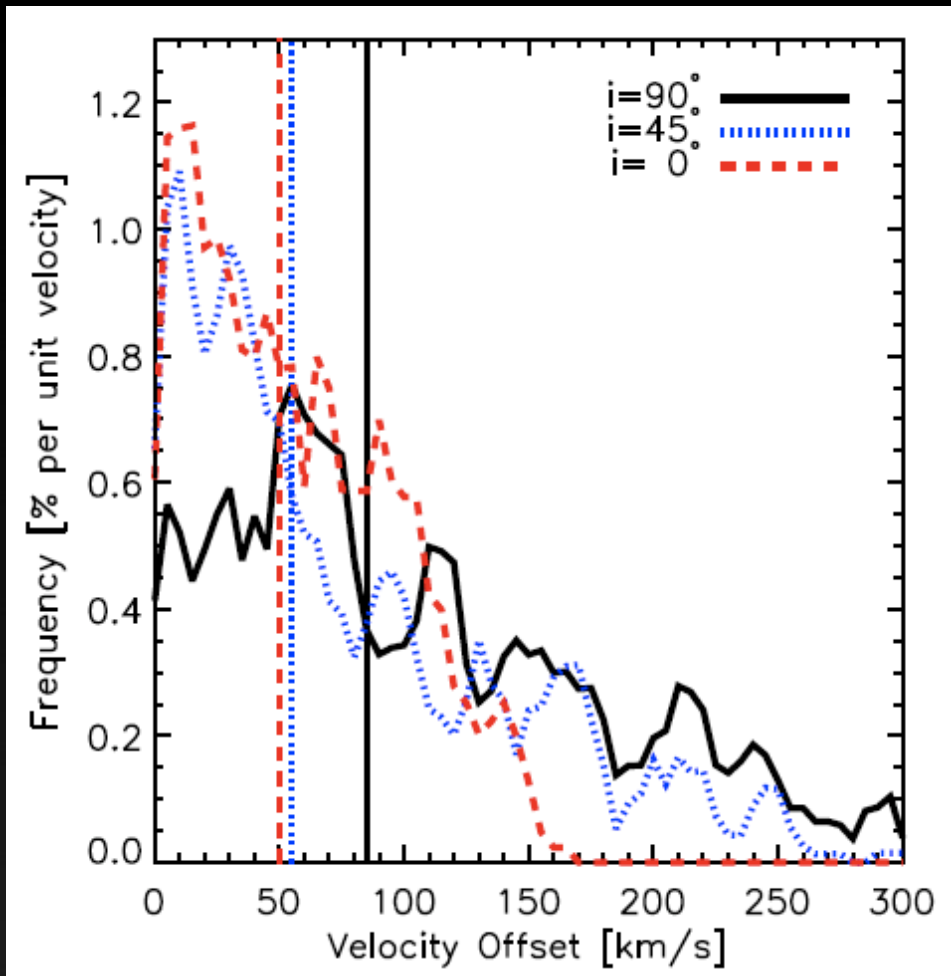
Stewart et al. 2011 arXiv:1103.4388

Galaxy Halo Kinematics: Disk-like or Infall



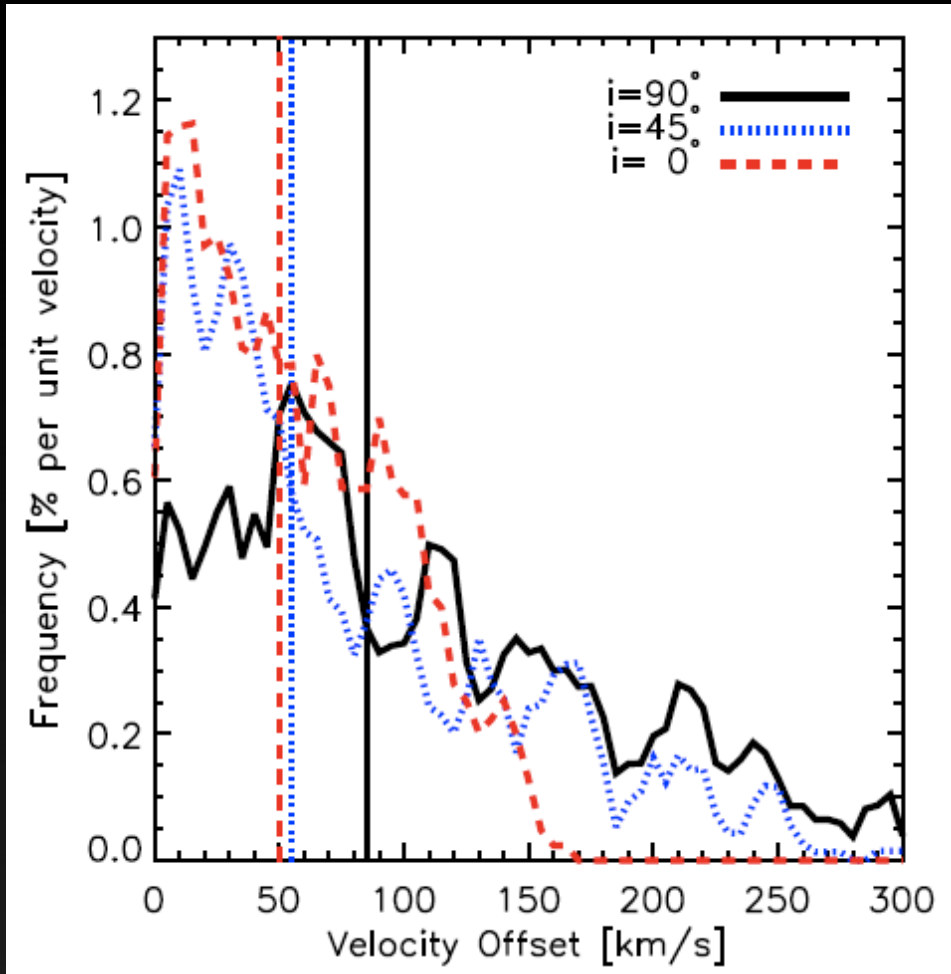
Stewart et al. 2011 arXiv:1103.4388

Galaxy Halo Kinematics: Disk-like or Infall

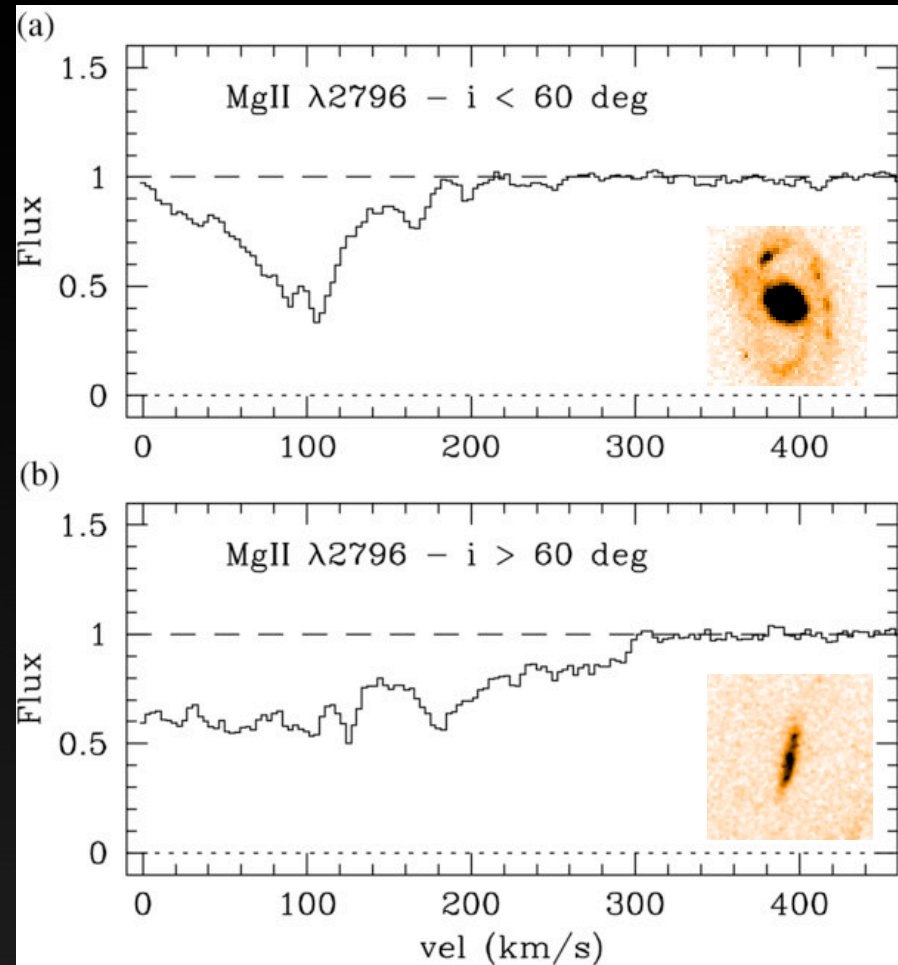


Stewart et al. 2011 arXiv:1103.4388

Galaxy Halo Kinematics: Disk-like or Infall



Stewart et al. 2011 arXiv:1103.4388



Kacprzak et al. 2010

The velocity spread of the absorption is consistent with the simulations, again hinting at an infall model.

Summary

Likely:

- Strong systems ($EW > 1A$) trace winds.
- Weak systems ($EW < 1A$) trace infalling gas.

Evidence for infall:

- Galaxy inclination and EW correlation: MgII strength correlated with galaxy major axis, thus likely not outflow.
- Halo gas and galaxy kinematics suggest halo gas is coupled to galaxy rotation, however simple models can not explain velocity widths. Simulations show that inflow is a possible explanation.

The interesting questions now:

What is the infall/outflow fraction as a function of EW?

OR infall/outflow fraction as a function of D?

How can you tell the difference between them? Multiphase gas probes?