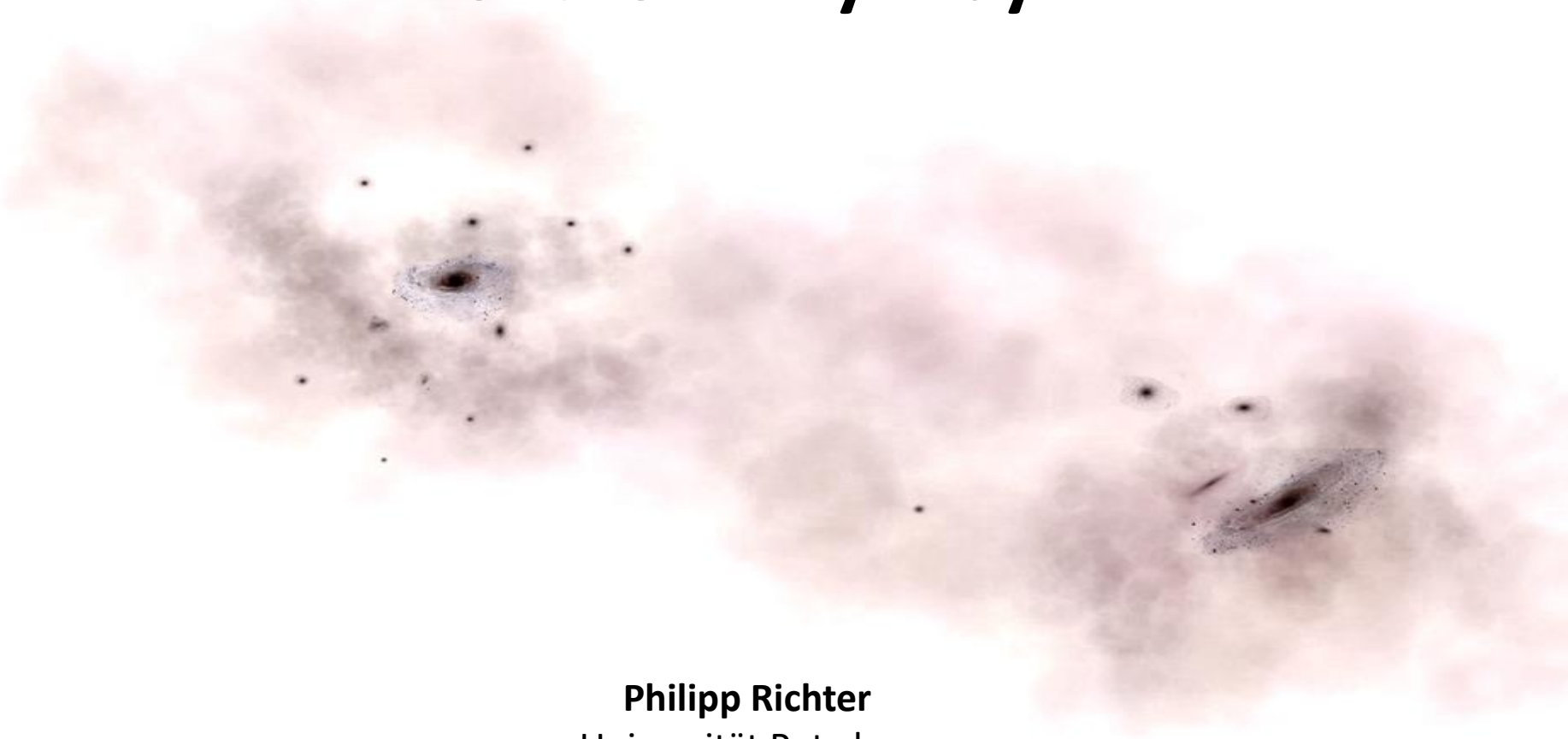
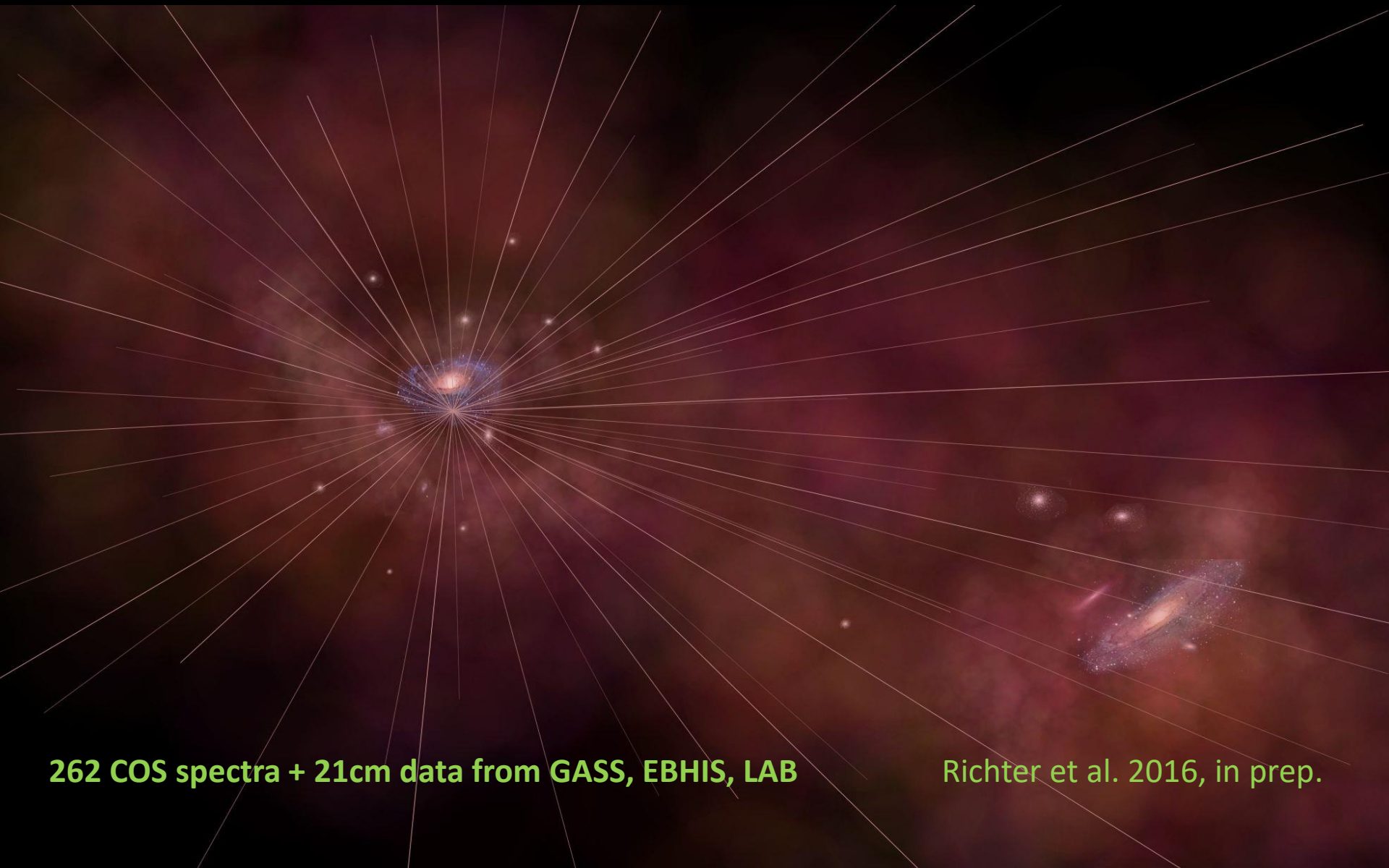
The circumgalactic gaseous environment of the Milky Way



Philipp Richter
Universität Potsdam

The Milky Way and its environment – Paris, September 2016

The experiment: UV tomography of gas in the Local Group



262 COS spectra + 21cm data from GASS, EBHIS, LAB

Richter et al. 2016, in prep.

The HST/COS legacy survey of the CGM in the Local Group

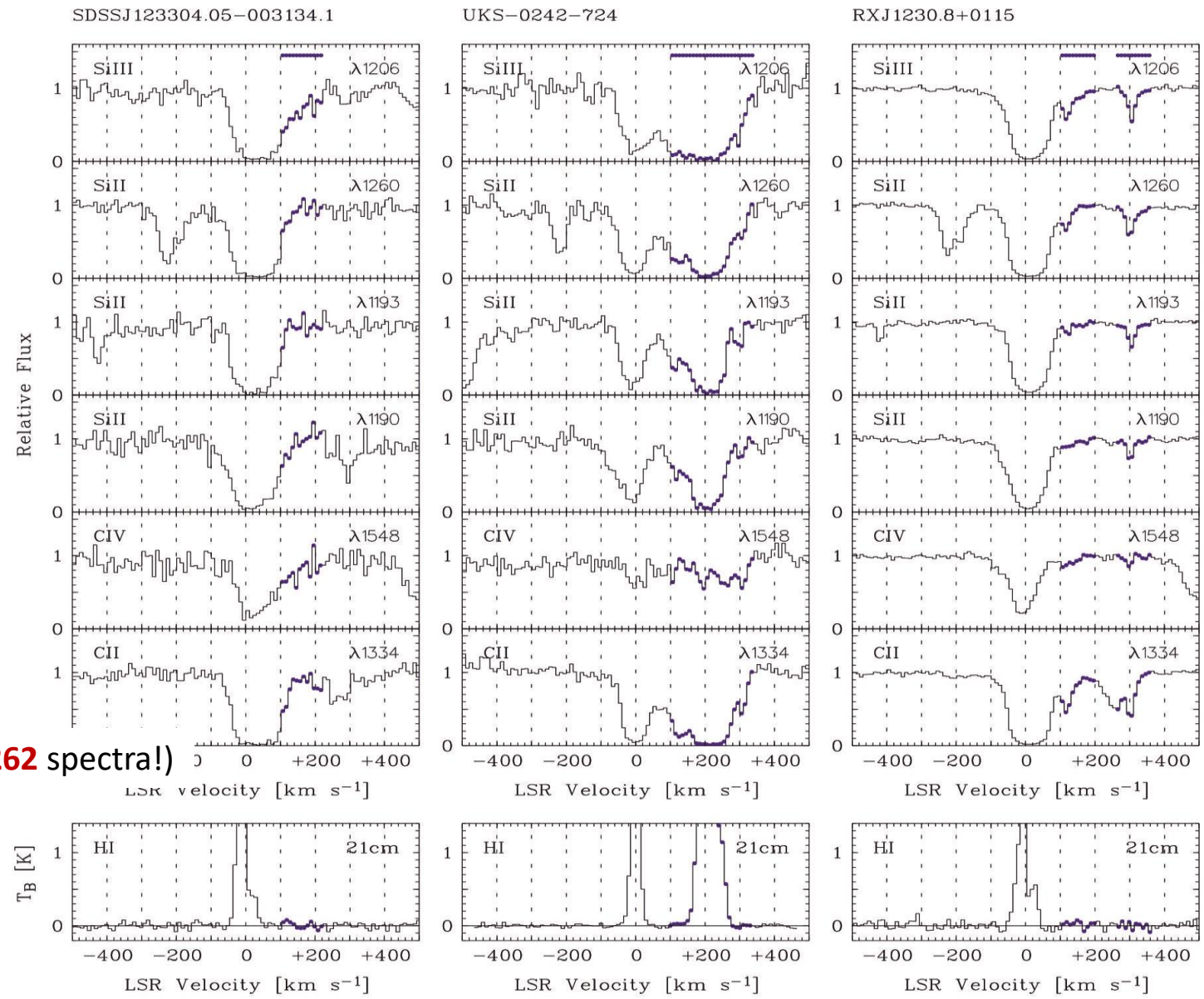
HST/COS provides access to many low and high ions that trace the extended multi-phase CGM of the Milky Way and LG gas at high sensitivity.

Main goals of the CGM/LG survey:

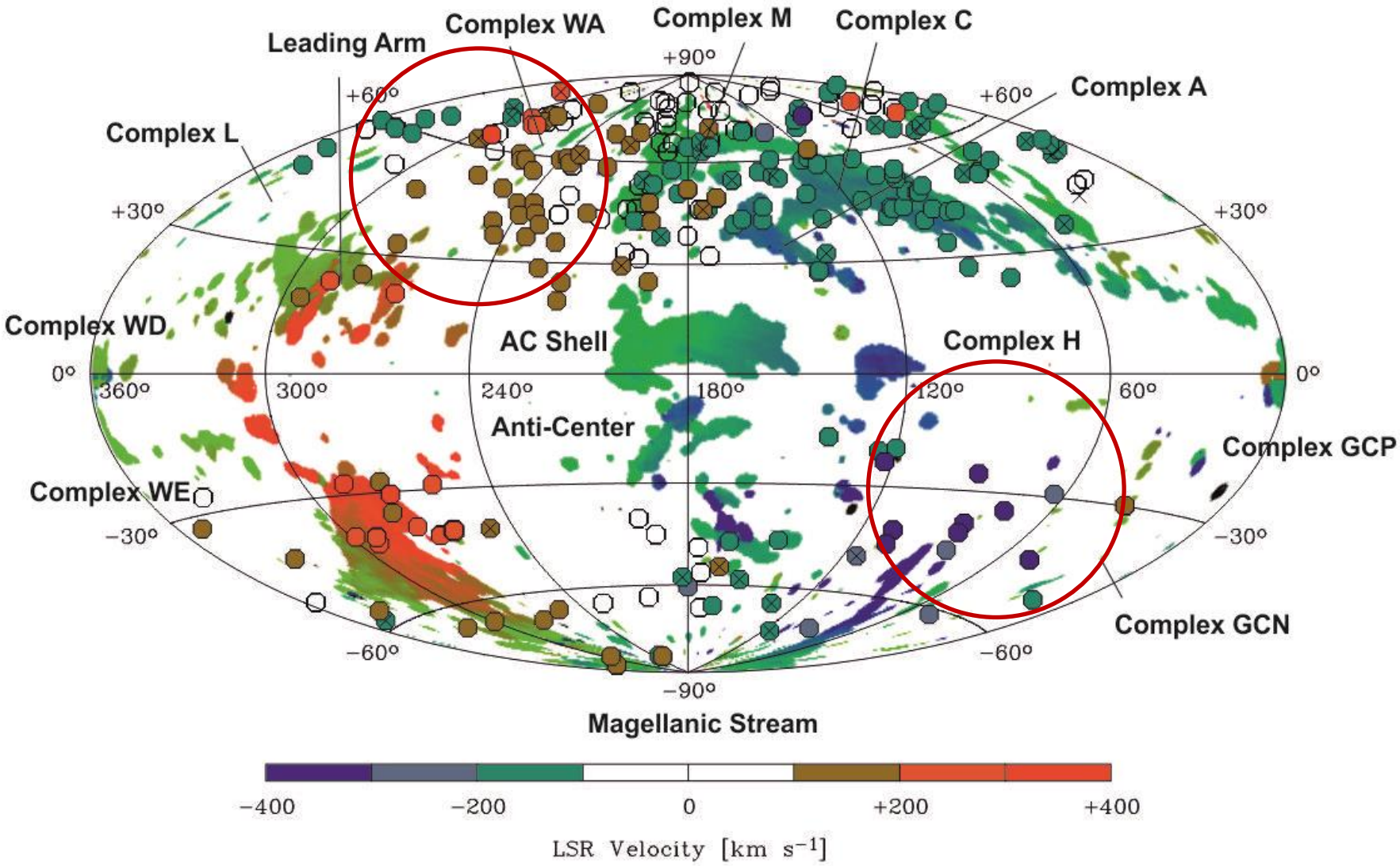
- Study the distribution of neutral and ionized gas in the Milky Way CGM
- Study ionization conditions and small-scale structure
- Estimate total mass of the Milky Way‘s CGM and the gas accretion rate
- Search for gas in the CGM of other Local Group galaxies
- Search for gas bound in the Local Group
- Compare the absorption characteristics of the Milky Way/Local Group with that of DLAs
- Compare the absorption characteristics of the Milky Way/Local Group with that seen in constrained cosmological simulations

Example spectra: COS (UV) + GASS & EBHIS (HI 21cm)

(3 out of **262** spectra!)

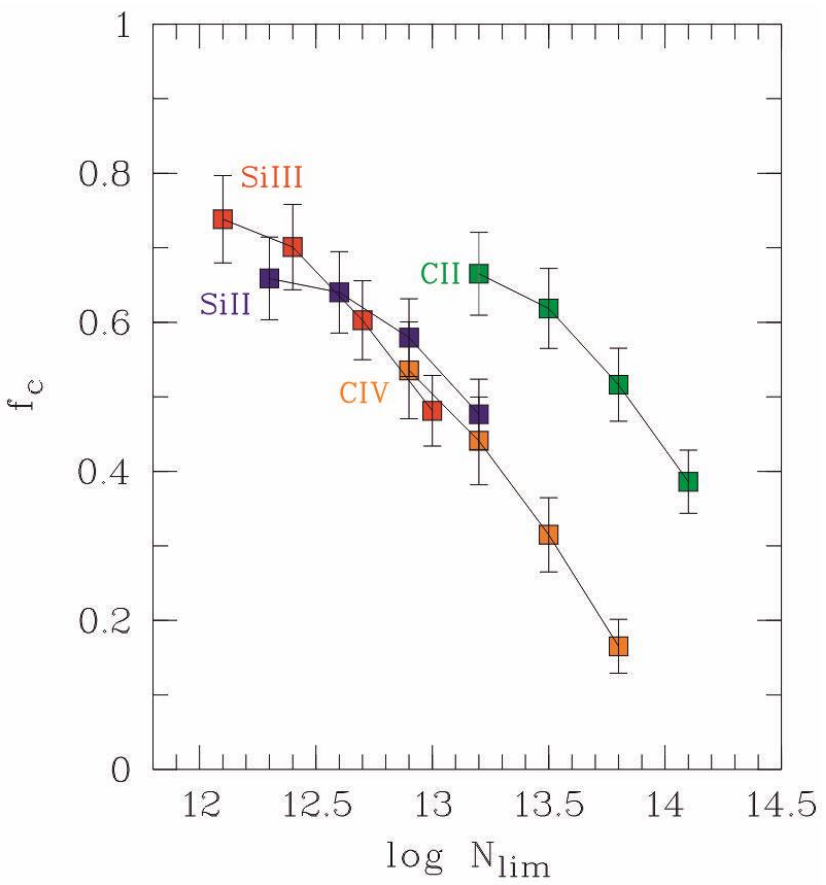


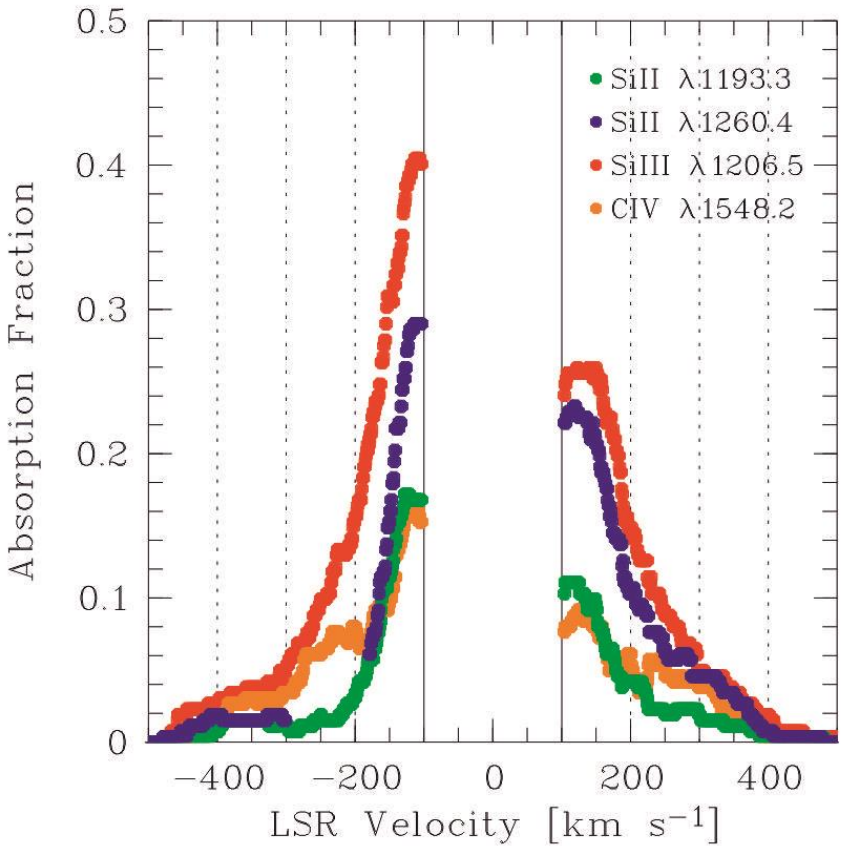
Sky distribution of UV absorption and 21cm emission



UV absorption in high-velocity clouds (HVCs) is much more **extended** than the HI 21cm emission.

UV absorption statistics for different ions





- About 75 per cent of the sky is filled with diffuse ionized gas in the CGM
- Gas at negative velocities has a higher cross section and a higher degree of ionization

➡ **infall of substantial amounts diffuse ionized gas ($10^{4\text{-}5}$ K)**

(see also Lehner et al. 2012; Herenz et al. 2013; Fox et al. 2013,2014)

Total mass and accretion rate of the MW CGM

Total gas mass of the Milky Way CGM:

$\mathbf{M_{cold/warm\ CGM} > 1.1 \times 10^9\ M_{sun}}$

(75 percent is ionized)

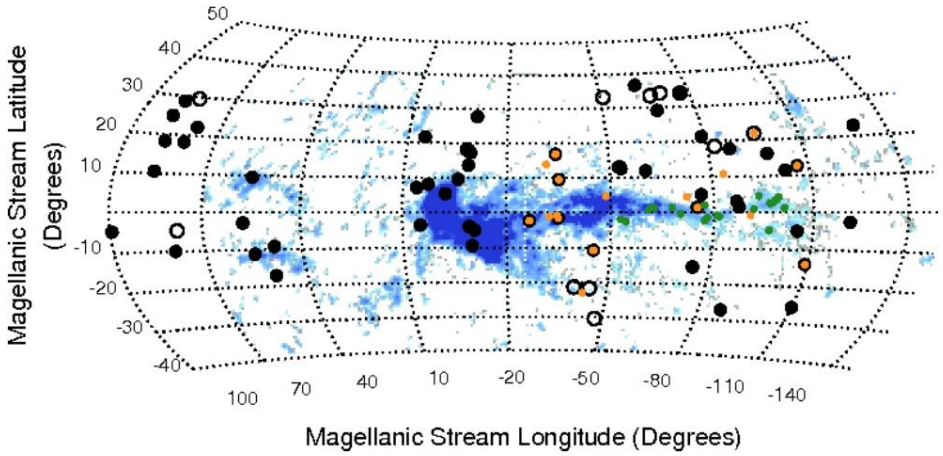
CGM gas accretion rate:

$\mathbf{dM_{gas}/dt > 2.6\ M_{sun}\ yr^{-1}}$

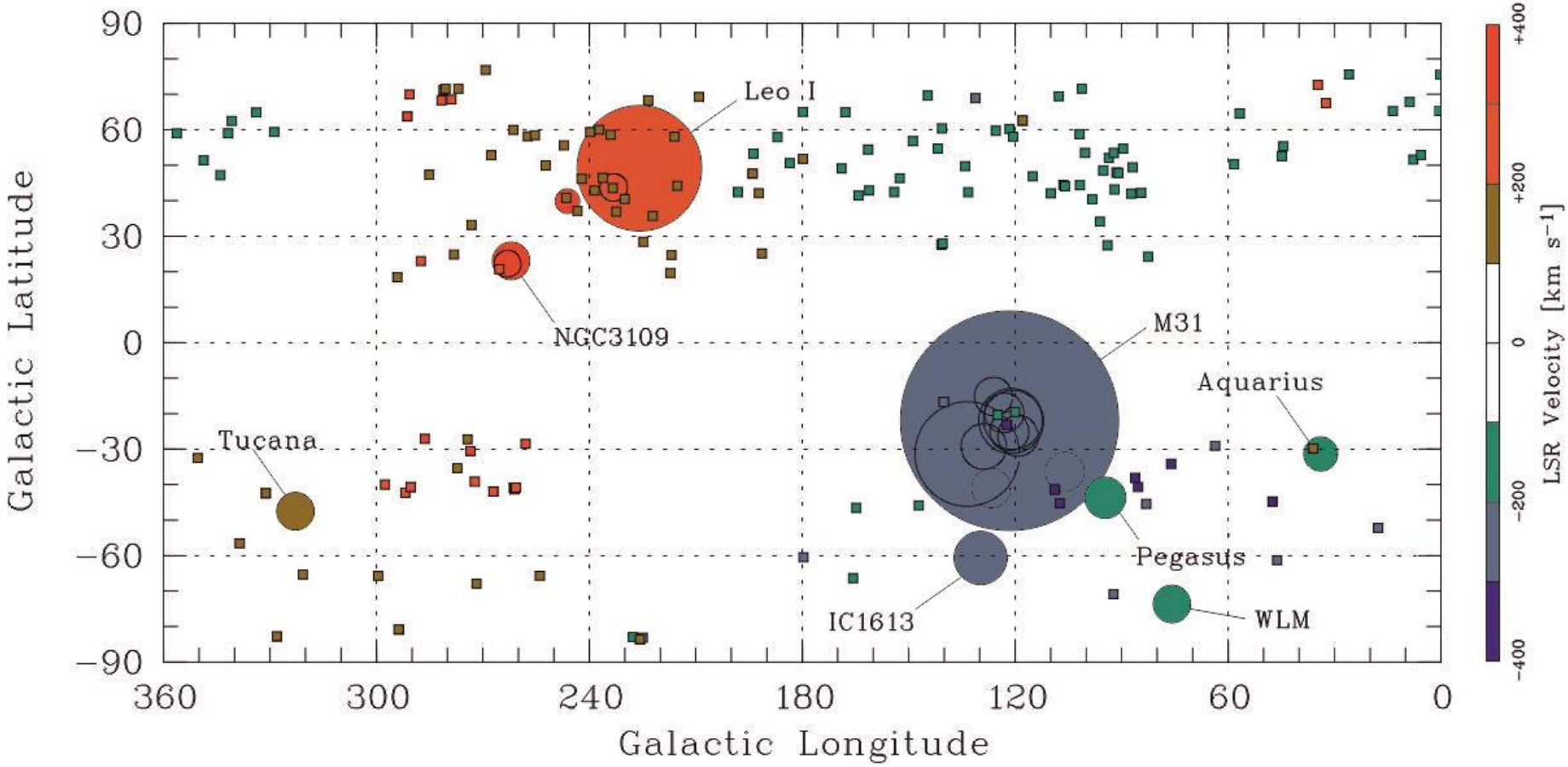
(SFR_{MW} = 0.7- 2.3 M_{sun} yr^{-1})

The Magellanic Stream dominates BY FAR the mass and infall rate of cold/warm gas in the Milky Way halo

(see Fox et al. 2013,2014; Richter et al. 2014)



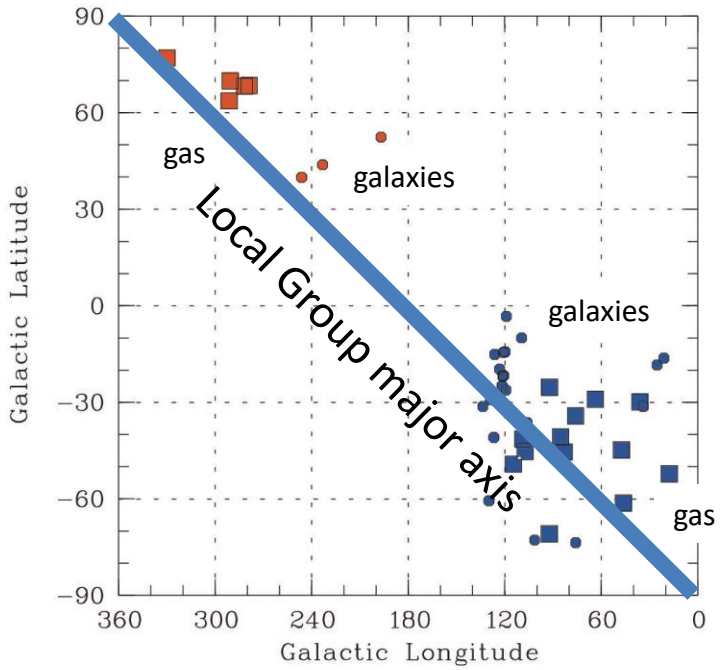
The connection to other Local Group galaxies

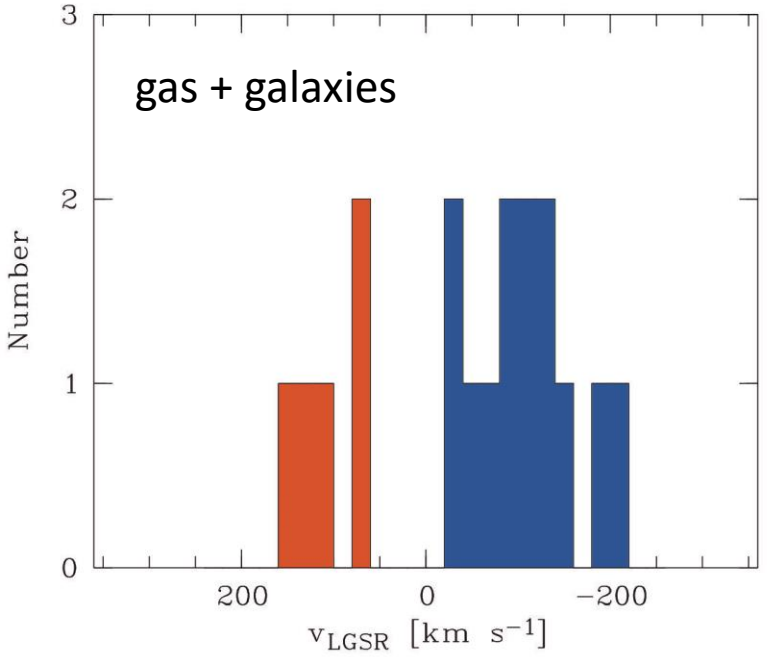


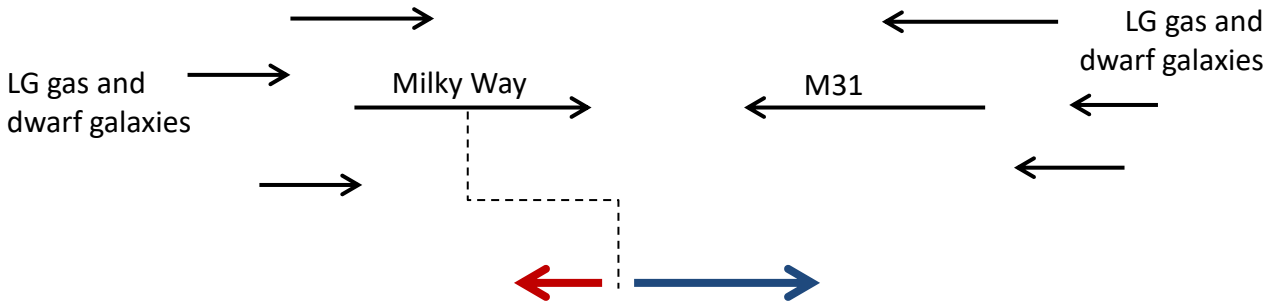
Only for Milky Way and M31 there is evidence for CGM absorption in the LG.

(see also Lehner et al. 2015)

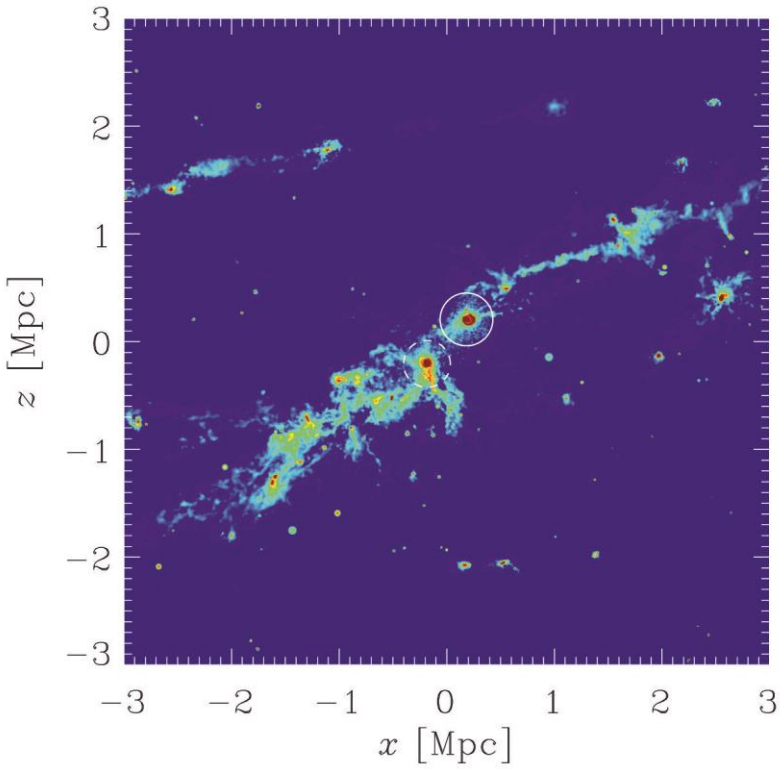
The „CGM dipole“: evidence for Local Group gas?

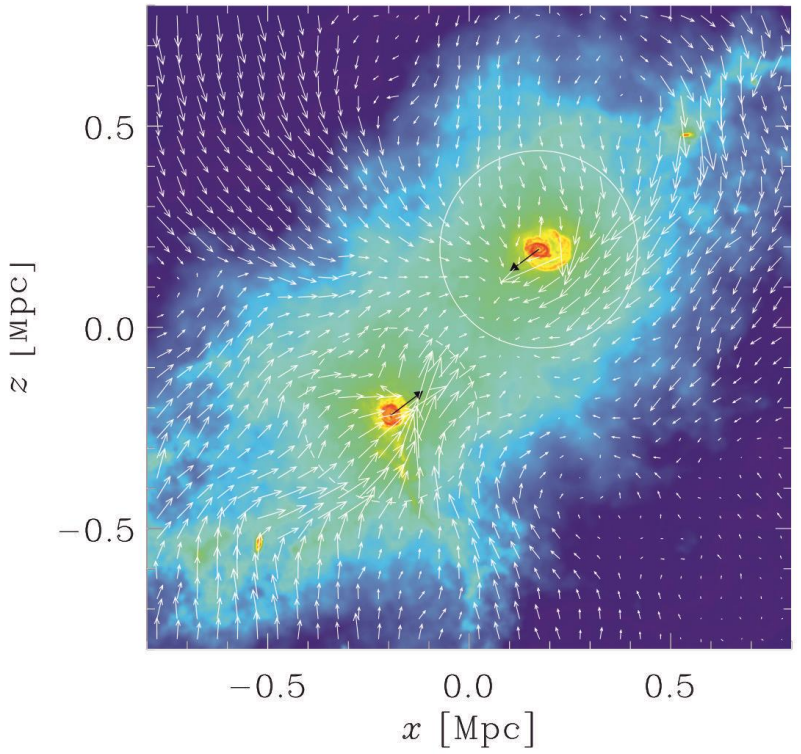






Comparison to constrained cosmological simulations (CLUES)

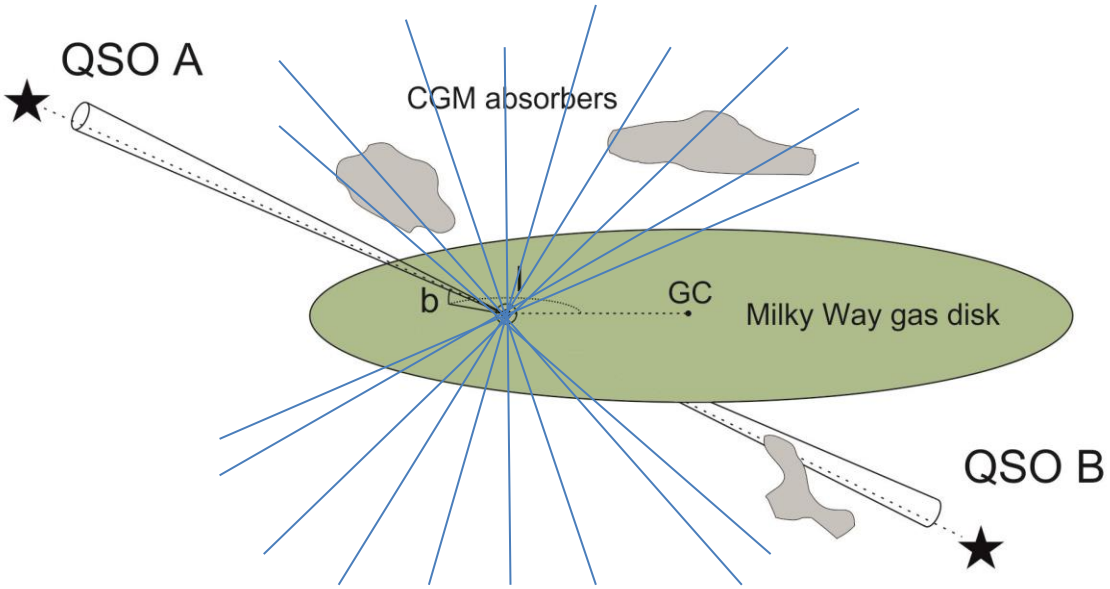


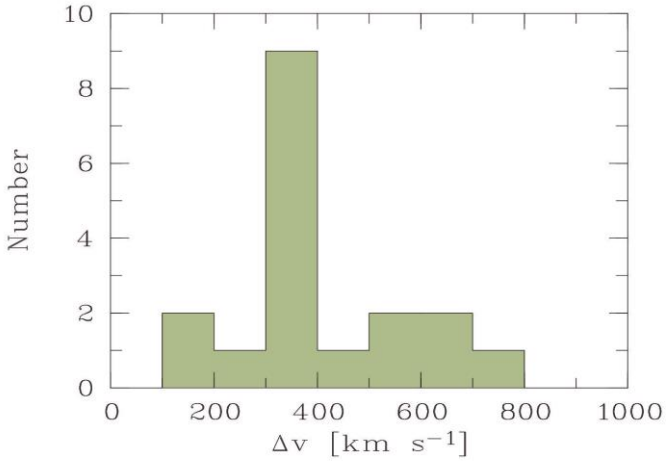


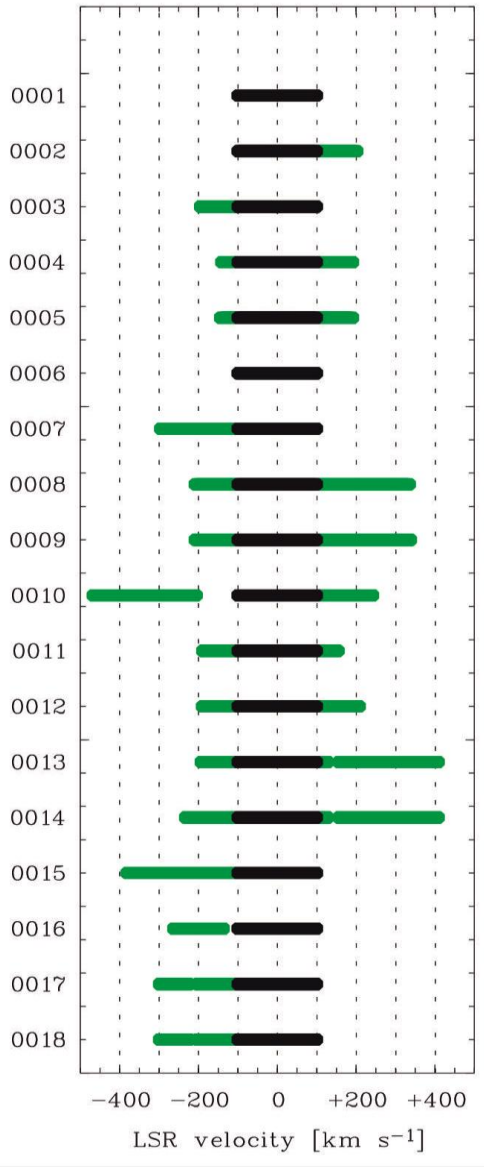
Nuza et al. (2014); Richter et al. (2016)

The Milky Way possibly is ramming into Local Group gas that is pushed into its halo at high negative velocities.

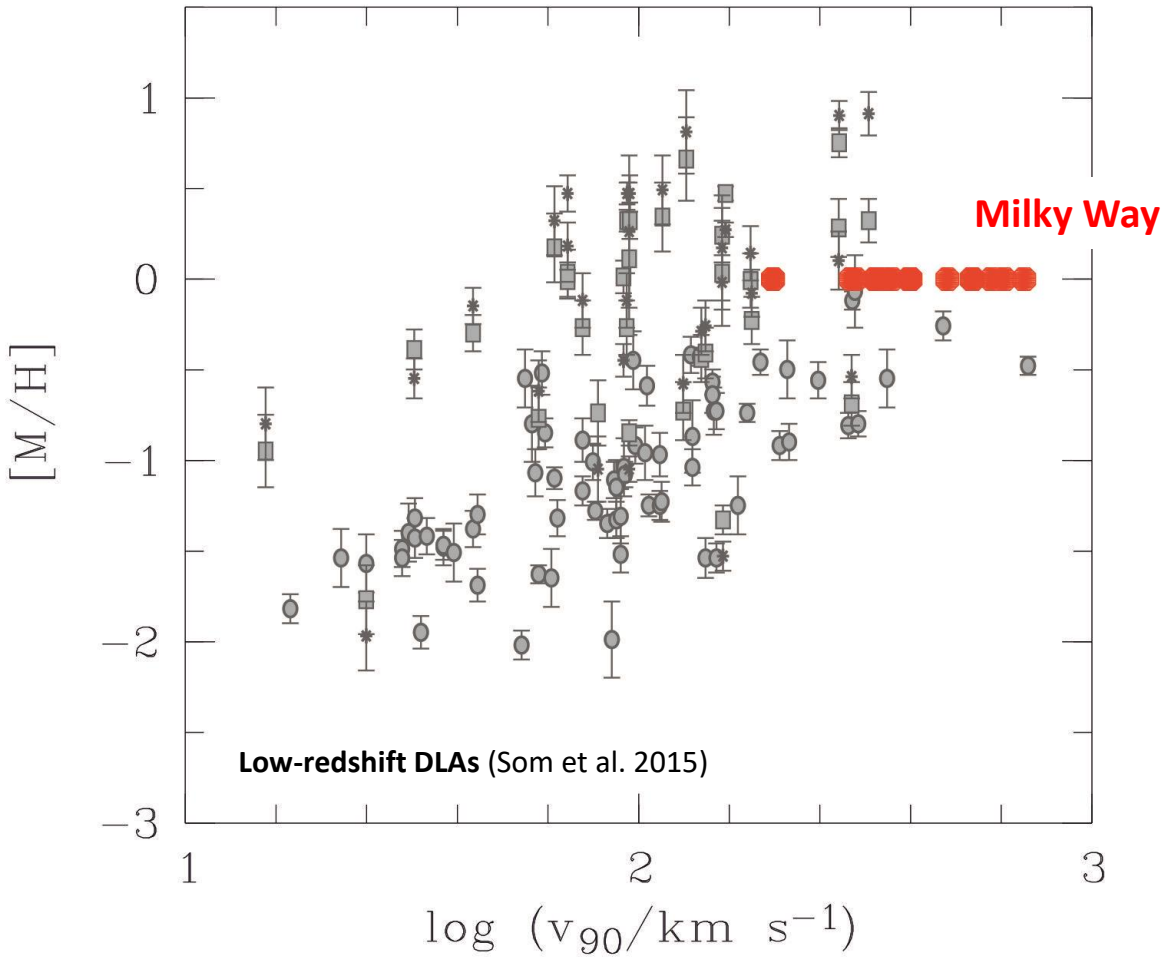
The Milky Way as a DLA: a study of antipodal sightlines

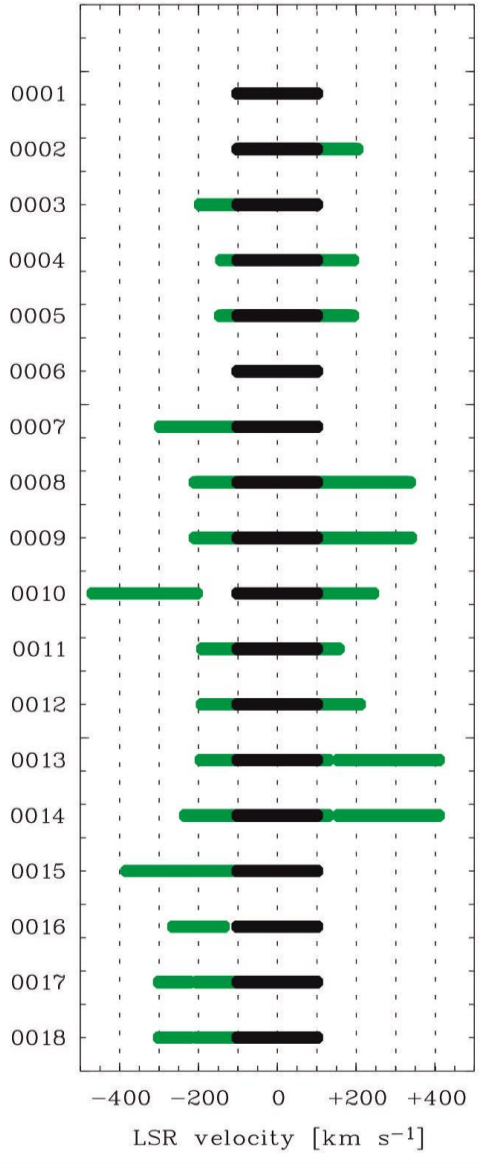






The Milky Way as a DLA: a study of antipodal sightlines





Conclusions

The Milky Way and its Local Group environment represents an excellent laboratory to study circumgalactic gas!

What we learn:

- The Milky Way CGM is an extreme multi-phase medium
- Mass and accretion rate of the Milky Way CGM are in line with the star-formation rate in the disk
- The Magellanic Stream dominates mass and gas accretion rate of cold/warm gas in the halo
- There is evidence that Milky Way is ramming into Local Group gas that pushes highly-ionized gas into the halo
- From an external vantage point, the absorption properties of the Milky Way and its CGM vary dramatically

What we should take home:

CGM studies at higher redshift should carefully take into account the obvious complexity of circumgalactic gas as seen in the Milky Way halo.