Cold streams: synthesised observations and characteristics

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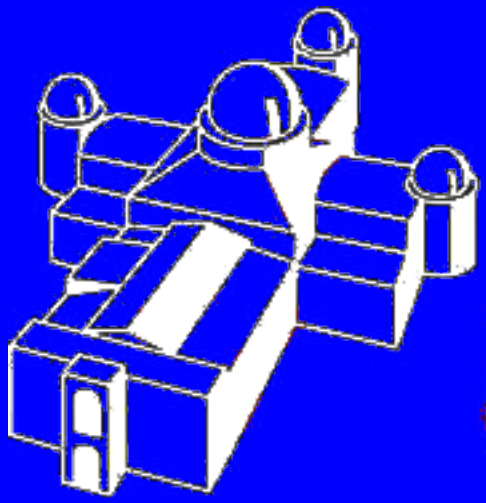
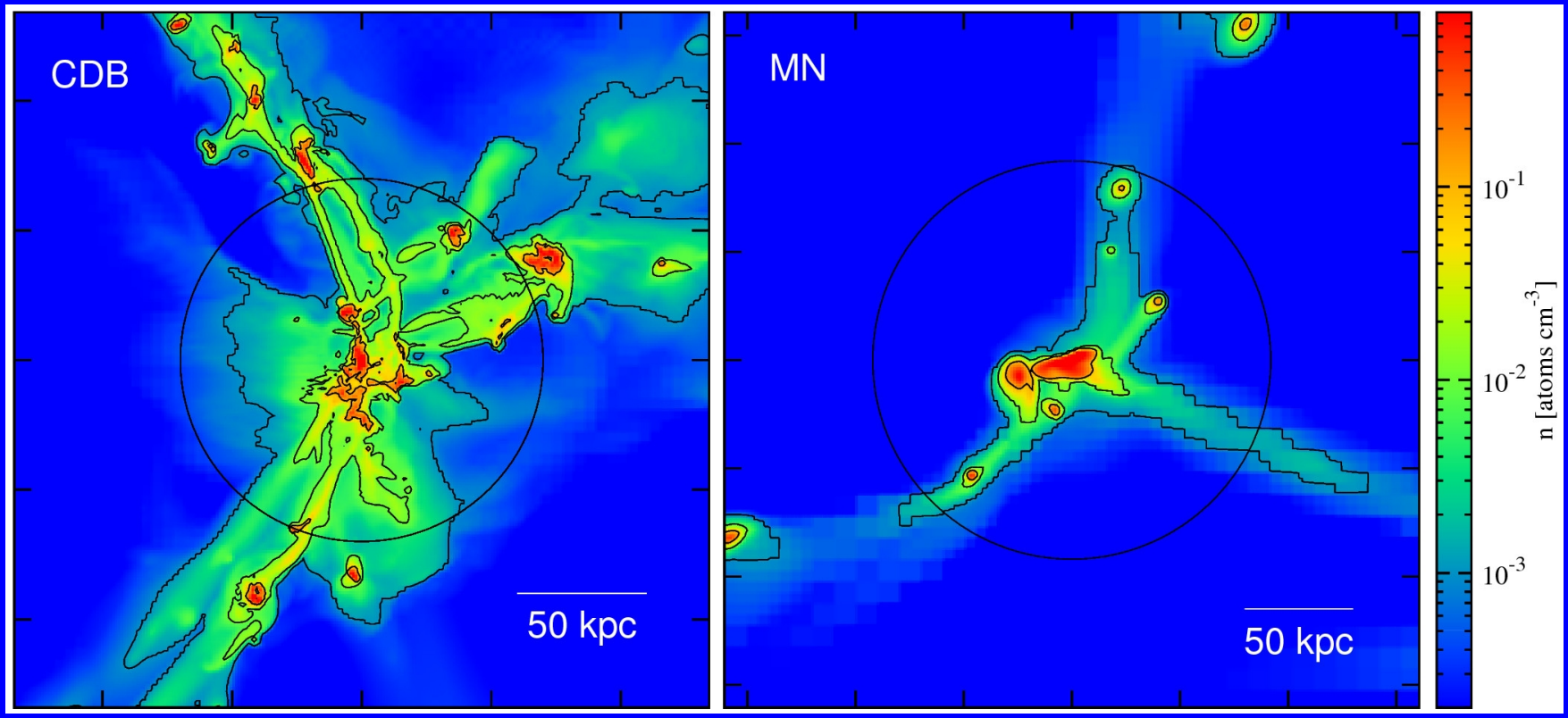


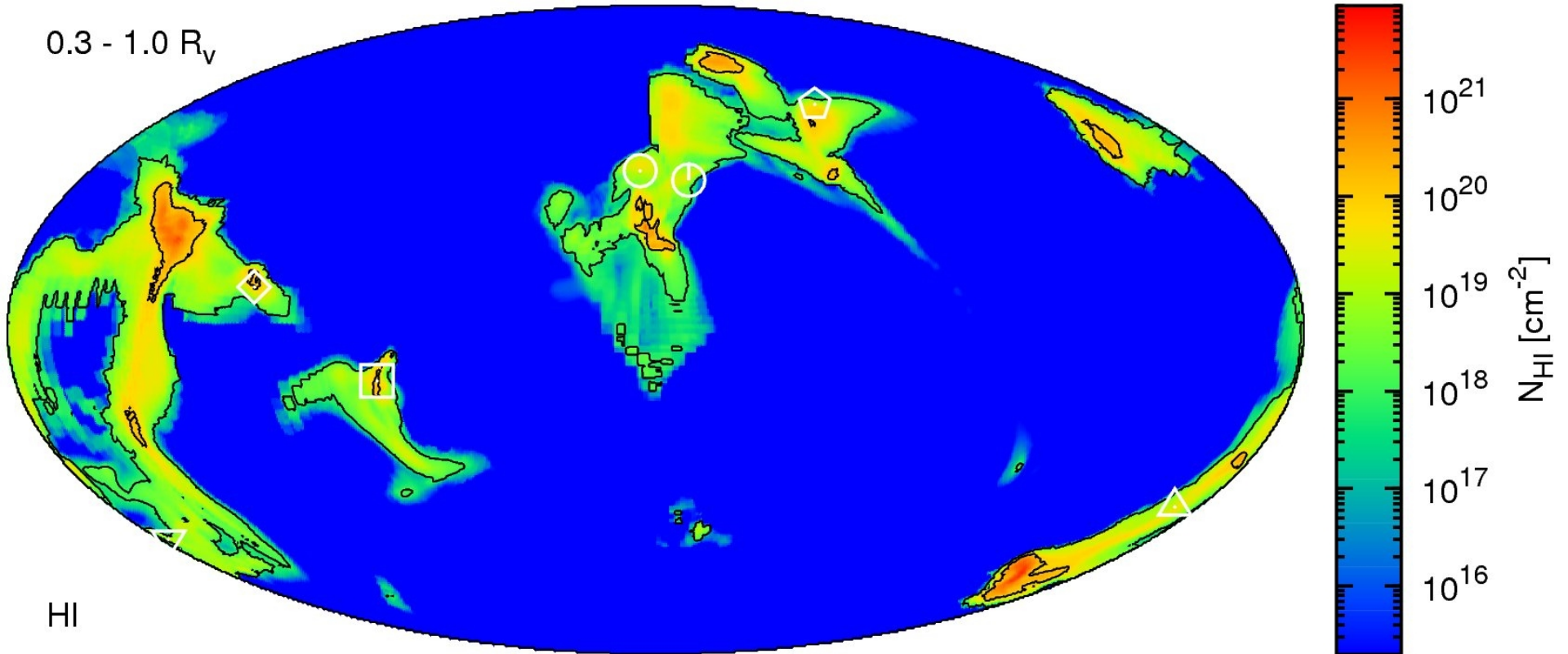
Collaborators: Andi Burkert, Daniel Ceverino, Avishai Dekel, Romain Teyssier

Cold streams



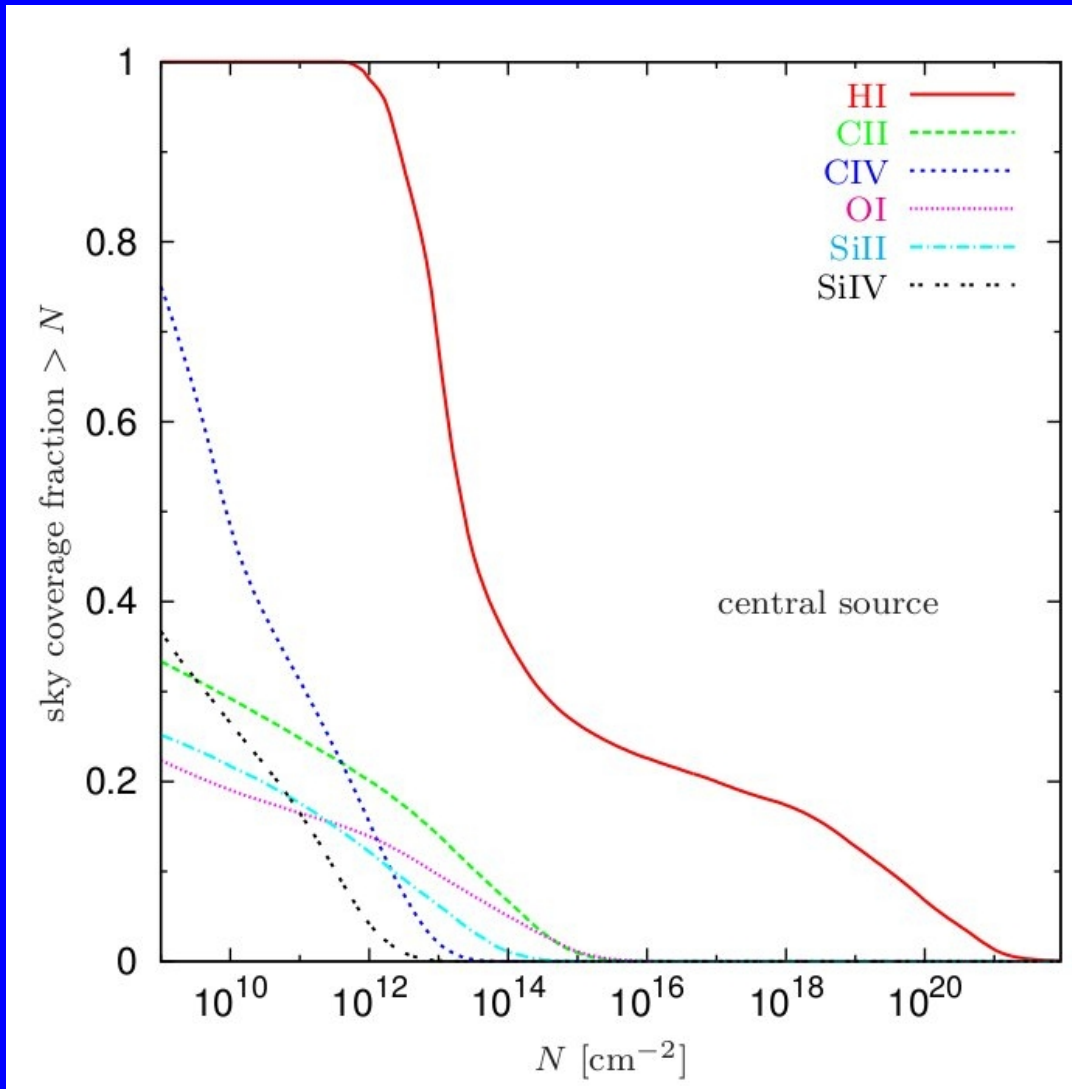
Central geometry

- Observes central galaxy through its own circum galactic medium



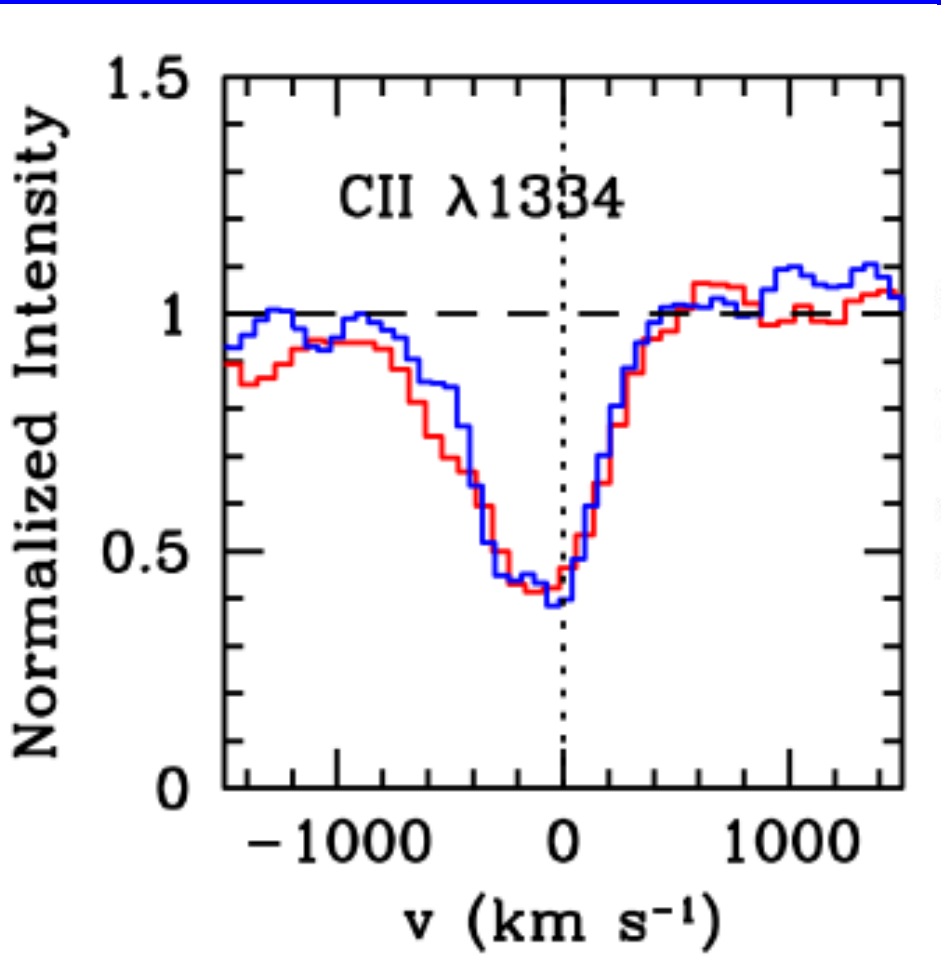
Detectability in absorption: Computed sky covering fraction

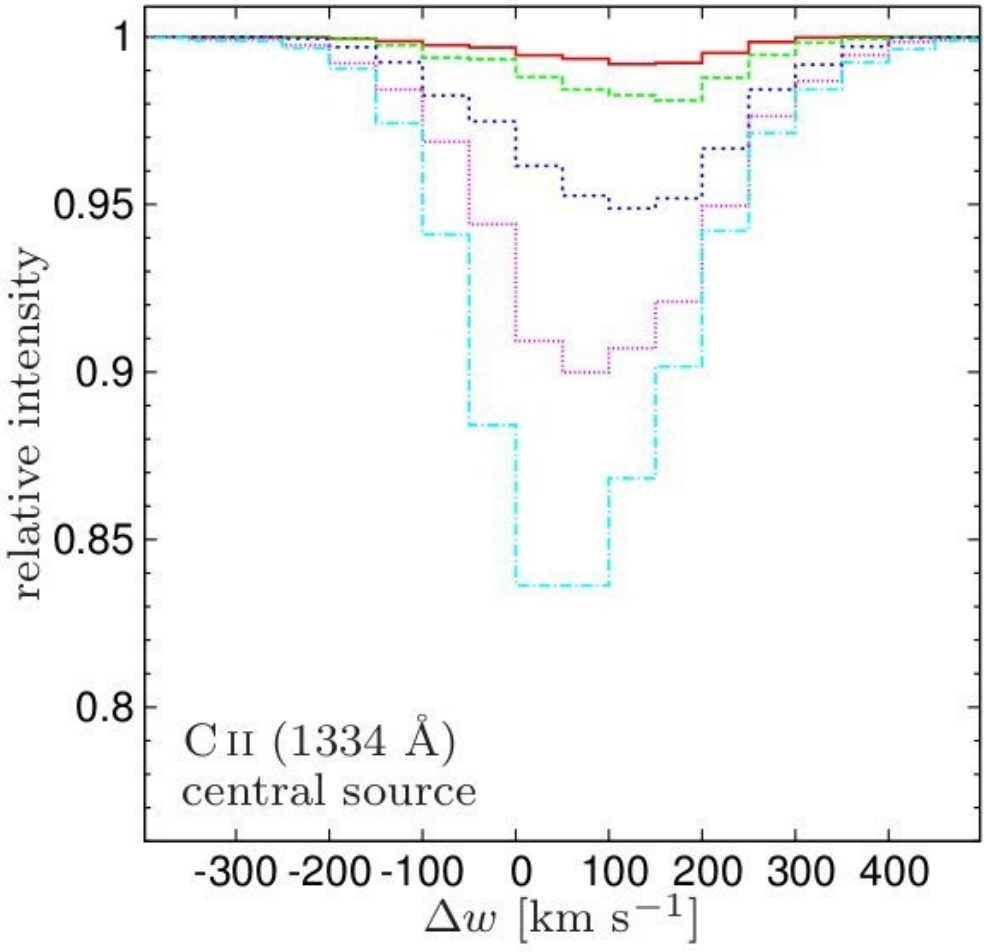
- Very low sky covering fraction
- Low metallicity in streams



Stacked line profile:

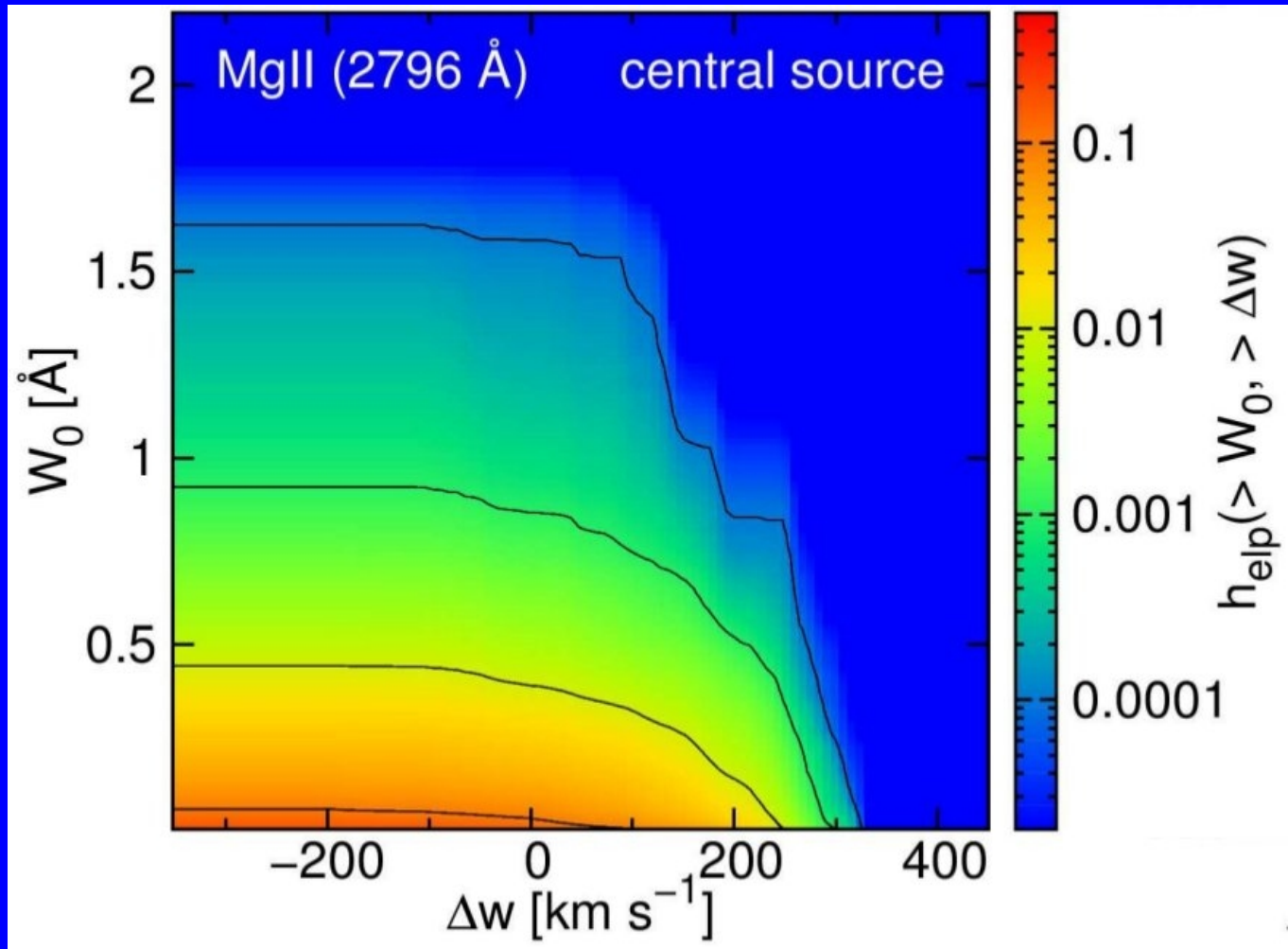
- Averaging over all available example line profiles (3 galaxies, all directions)





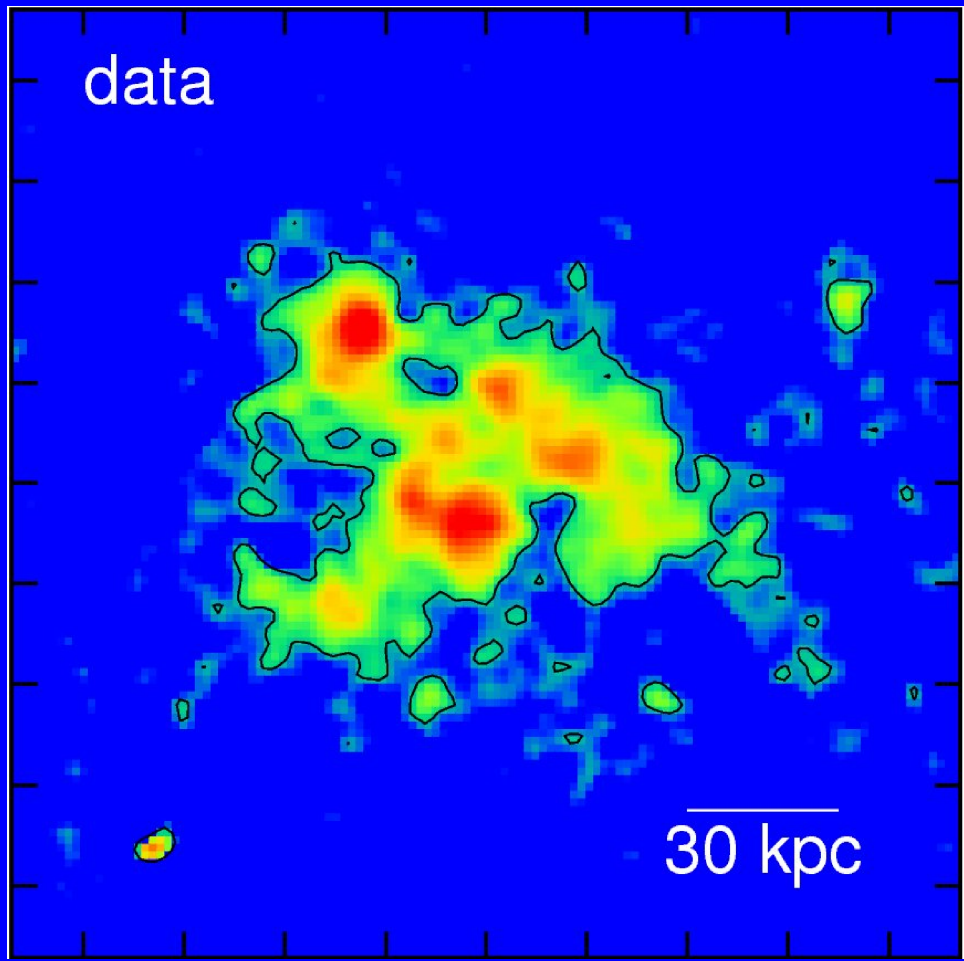
Statistics

- Mg II: inflow > 150 km s^{-1} with an EW > 0.2 Å in 1.3 % of all observations



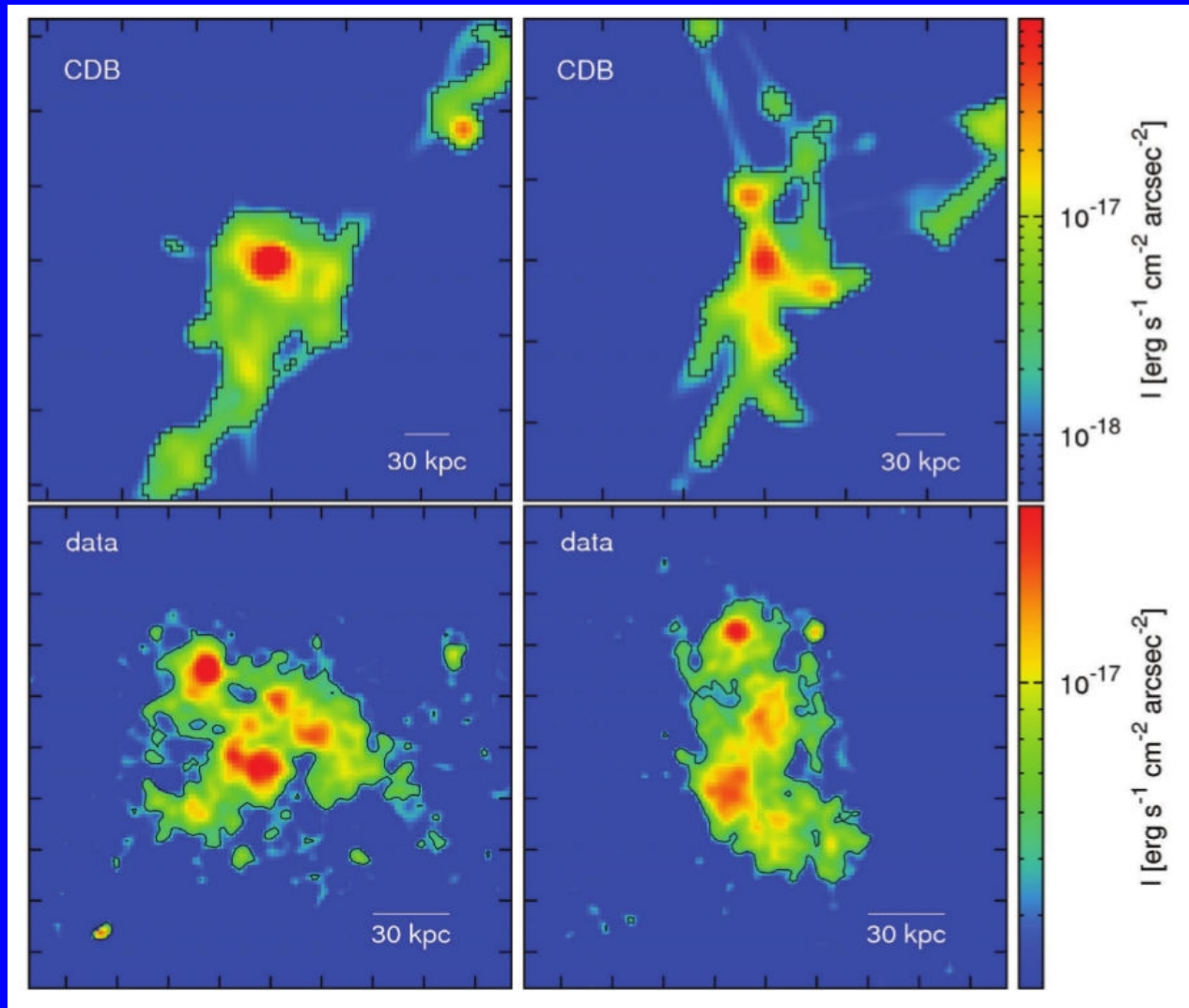
Emission: Lyman alpha blobs

- First observed by Steidel et al. 2000
- Redshift range z = 2 – 6.5
- Observation by Matsuda et al. 2004



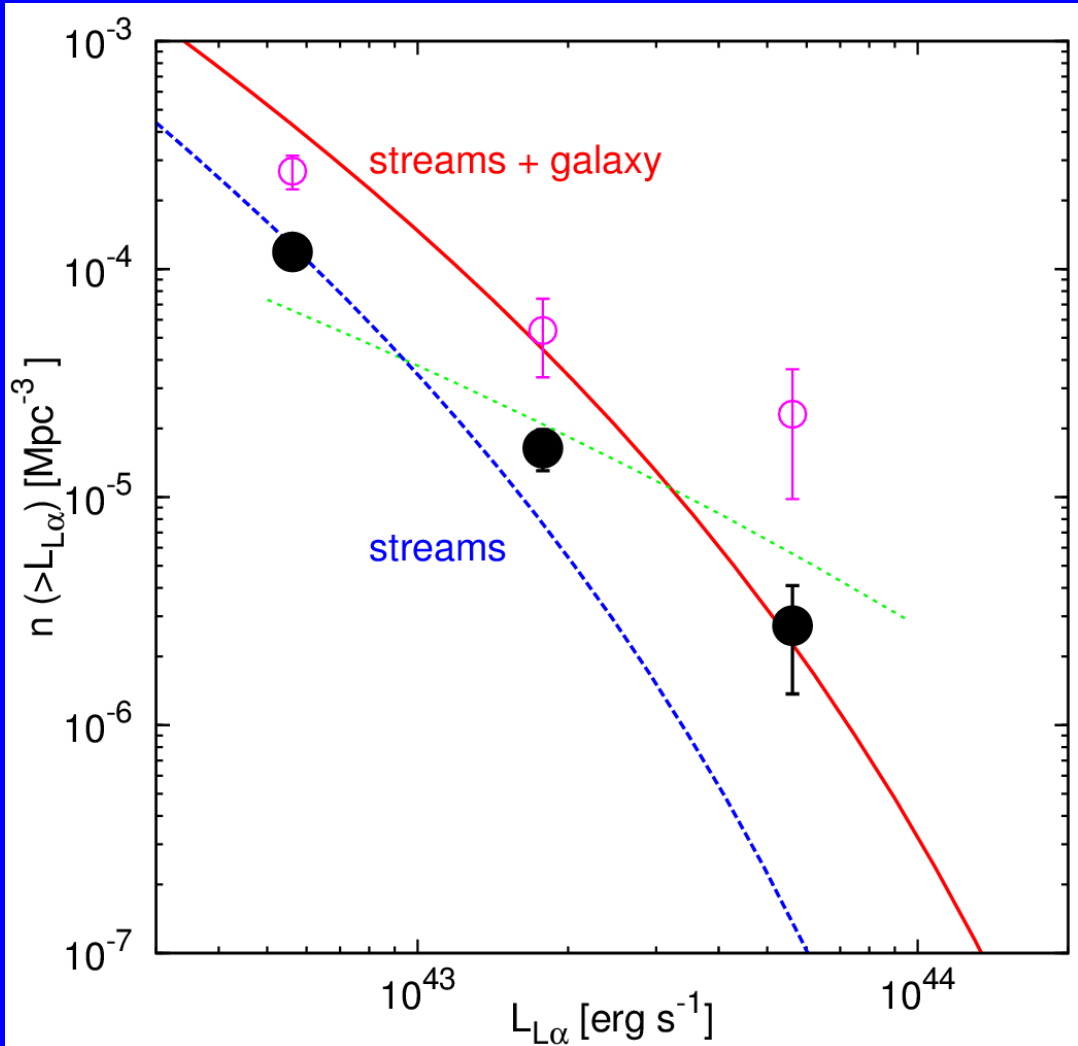
Emission: Lyman alpha blobs

- Cold streams loose potential energy released as Ly alpha photons.
- Computed vs. Observed Surface brightness maps



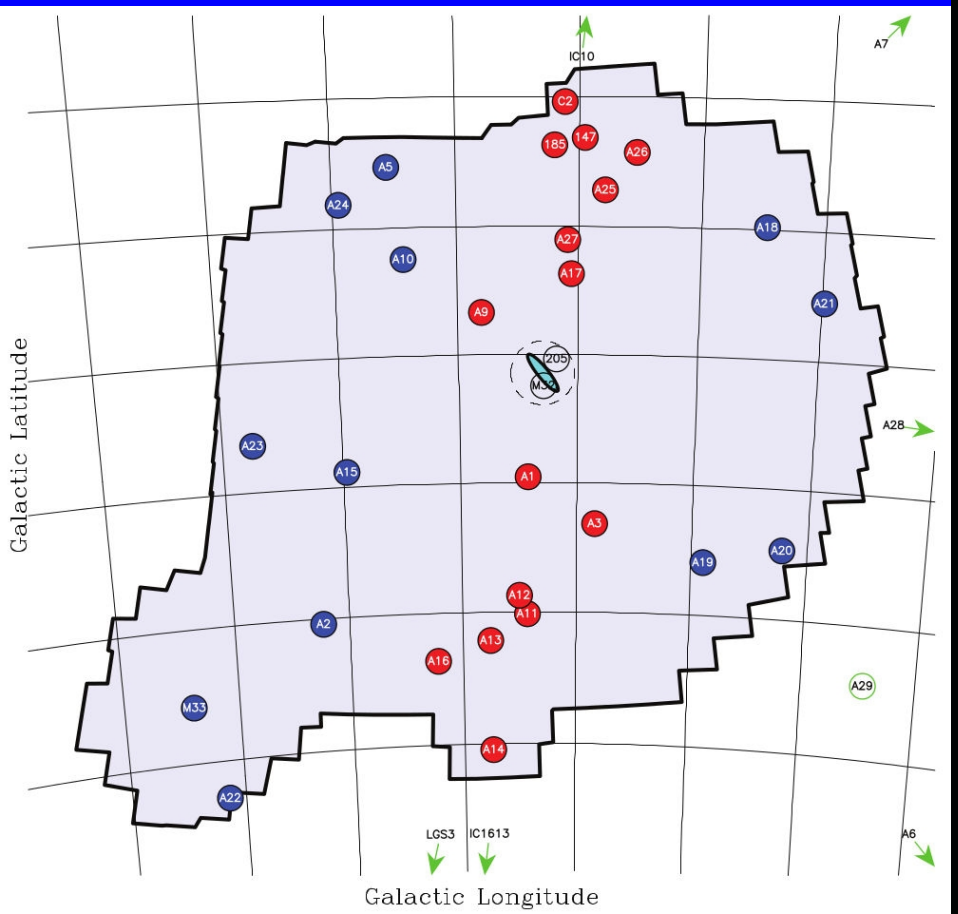
Ly α blob luminosity function

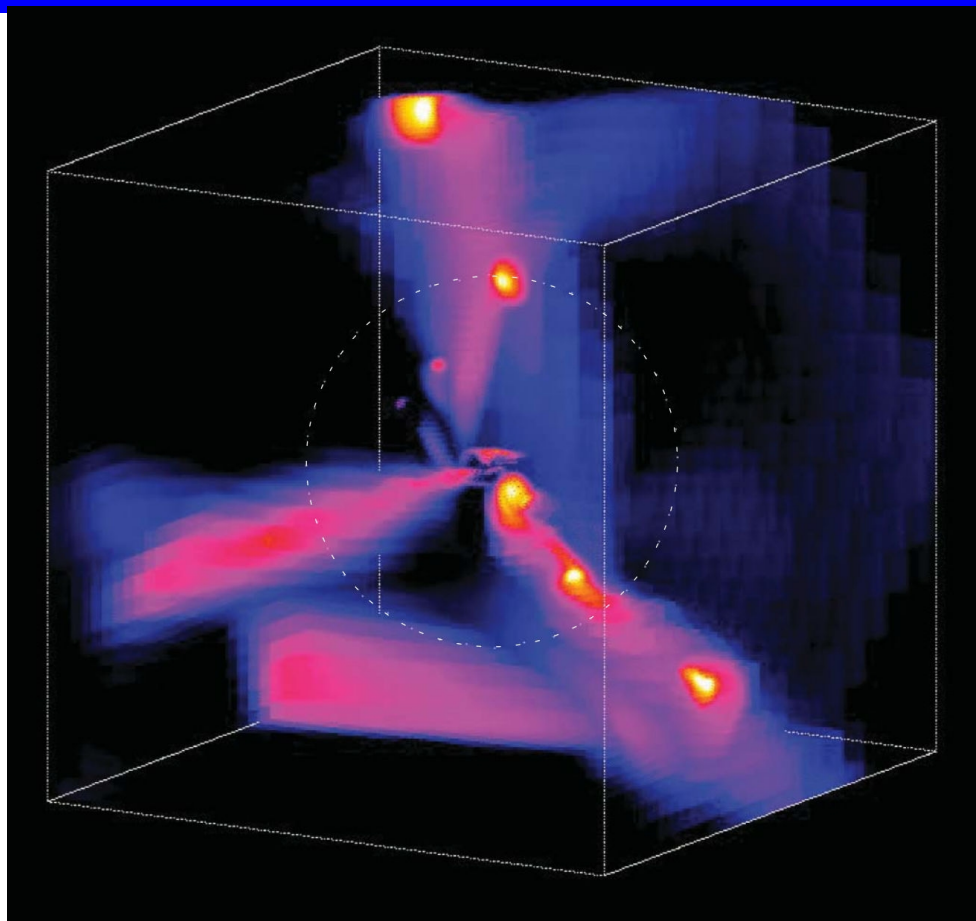
- Mass luminosity scaling relation correlated with Sheth Tormen mass function
- Observational data from Matsuda et al. (2004, 2009)



Relation to structure:

- Ibata et al: Andromeda: thin disk of satellites
- Cold streams carry clumps

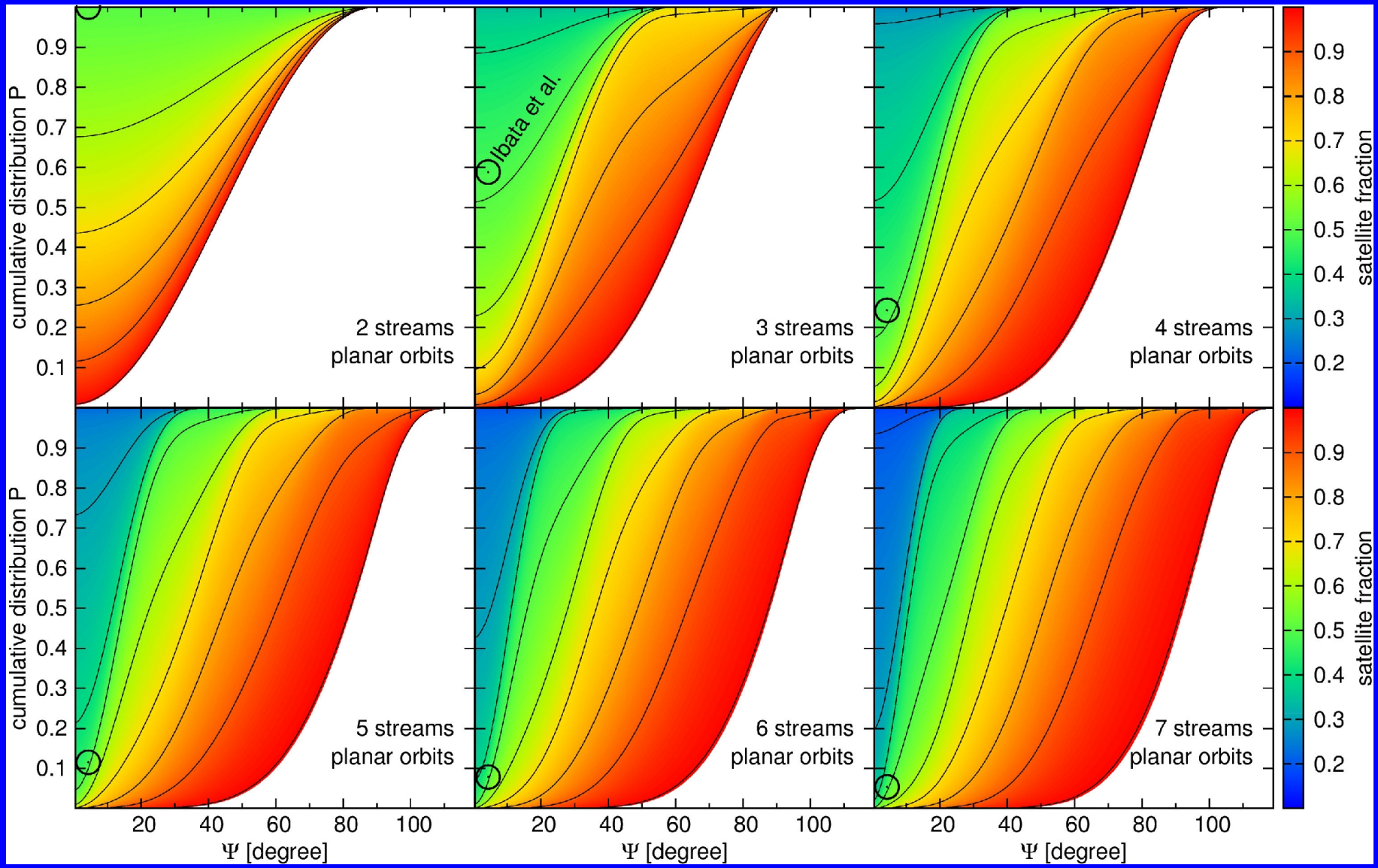




Assumptions:

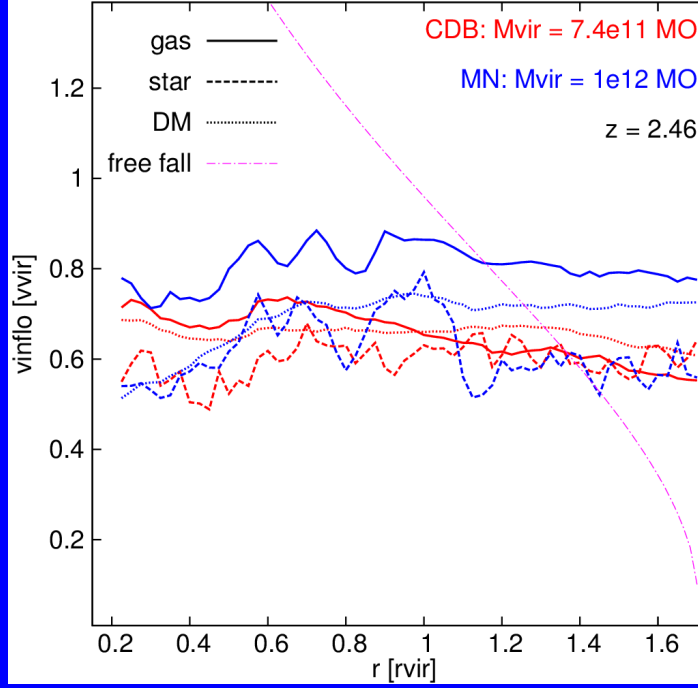
- Majority of incoming satellite galaxies enter the host halo through cold streams
- Orientation of cold streams does NOT change during period of accretion
- Subhaloes stay on planar orbits defined by stream and impact parameter

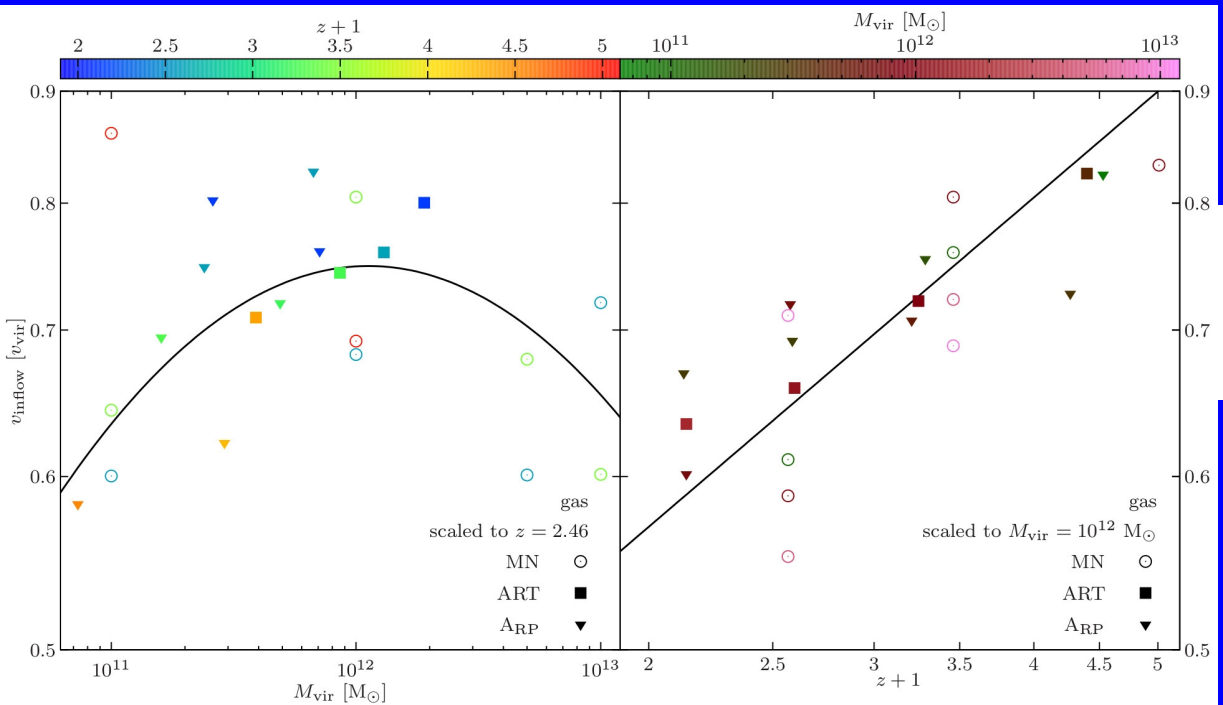
Consequence: Coplanar satellite structure!



Inflow velocity

- In units of virial velocity
- Constant with radius →
- Power law with redshift ↓
- "Parabula-like" with mass ↓



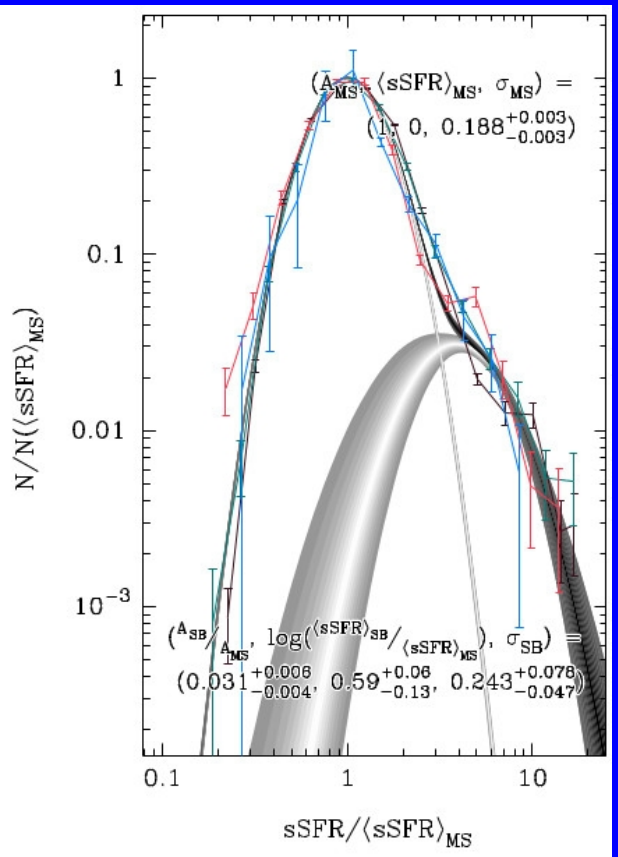


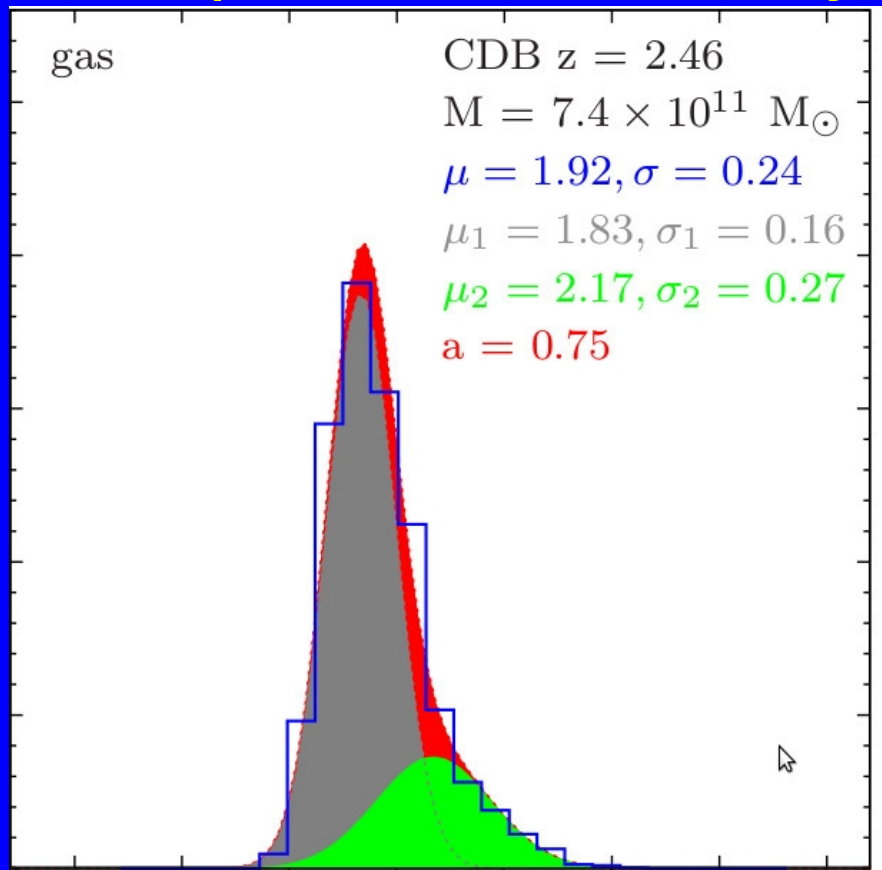
- Emerging equation:

$$\frac{v_{\rm inflow}(M_{\rm vir}, z)}{v_{\rm vir}(M_{\rm vir}, z)} = \frac{A\ \sqrt{z+1}}{\sigma\ (M_{\rm vir}/{\rm M}_\odot)} \times \exp\left\{-\frac{[\ln(M_{\rm vir}/{\rm M}_\odot) - \mu]^2}{2\ \sigma^2}\right\}$$

Inflow distribution

- Double Gaussian
- Represents mergers and smooth infall
- Observationally found by Sargent et al. (2012): star formation: main sequence | starburst activity





- Detectability in absorption:
  - Difficult (low sky covering fraction / metallicity)
- Cold stream emission: Lyα blobs
  - Simulation maps very similar to observations in extent, shape, luminosity
  - Luminosity function fits data
- Relation to structure:
  - Thin satellite disks: natural consequence of streams
- Characteristics:
  - Velocity vs. radius: constant
  - Velocity vs. redshift: power law
  - Velocity vs. mass: “parabola-like”
  - Inflow distribution: double Gaussian (like Sargent et al's star formation observations)