

Observations

We have observed the nearest galaxies of the **Sculptor group** in neutral hydrogen (HI) emission with the Australia Telescope Compact Array (ATCA) to

- ★ Study the kinematics and dynamics of the galaxies,
- ★ Search for extra-planar gas and “missing satellites”.

Parameters

- ★ Array configurations: EW 352 / EW 367
- ★ Covered area: $2^\circ \times 2^\circ$
- ★ Number of pointings: 32
- ★ Integration time: 96 h per galaxy
- ★ Angular resolution: $90'' \times 180''$ (≈ 1 kpc)
- ★ Velocity resolution: 4 km s^{-1}
- ★ 5σ HI sensitivity: $10^{19} \text{ cm}^{-2} / 10^5 M_\odot$

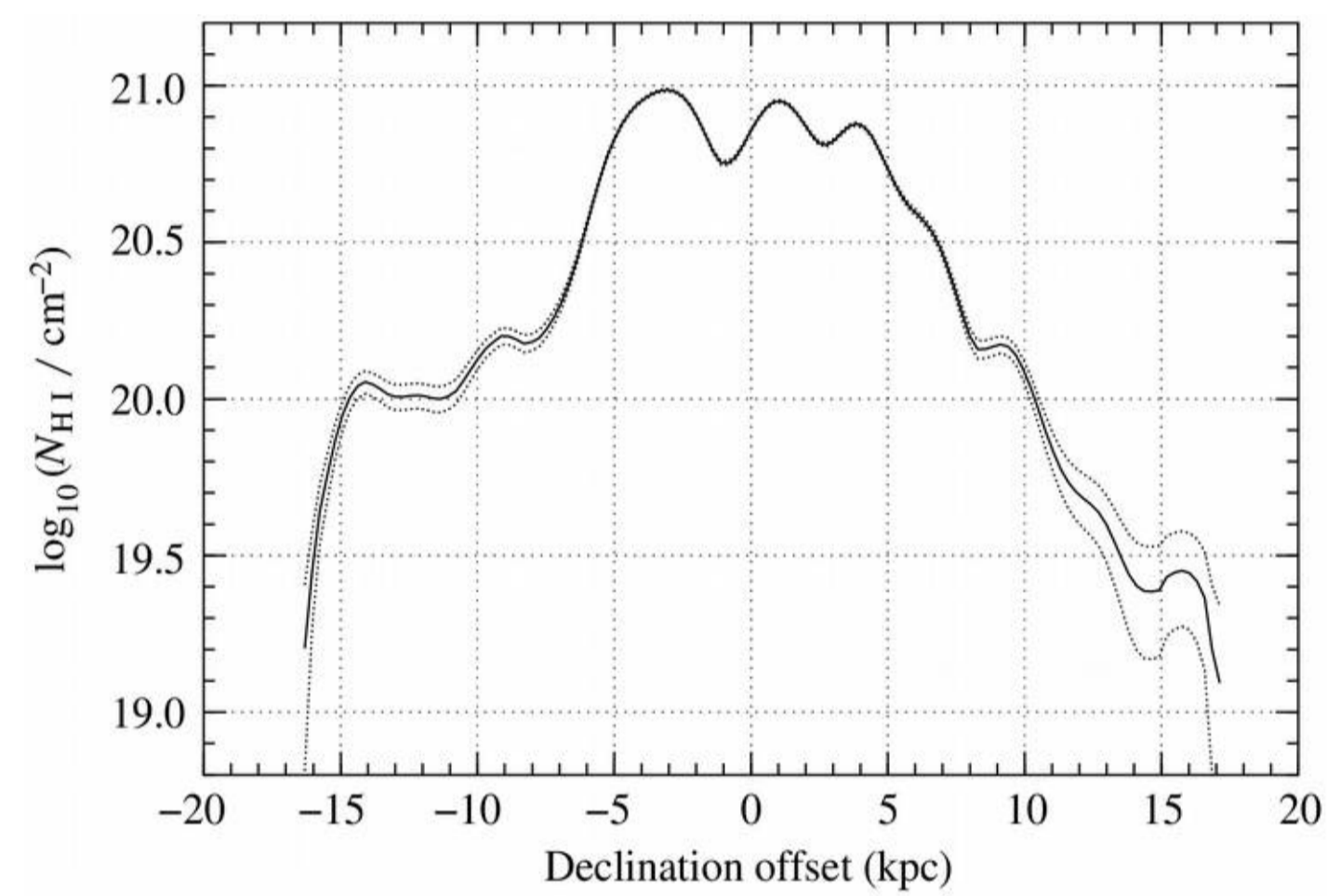


Figure 3: HI column density profile along a line of constant right ascension through the centre of NGC 300. There is an almost perfectly exponential slope on the northern side of the galaxy, but a plateau followed by a steep drop on the southern side, suggesting ram-pressure interaction with the IGM of the Sculptor group.

NGC 300

Westmeier, Braun & Koribalski 2011, MNRAS, 410, 2217

Main results:

- ★ Extended, twisted **HI disc** (Fig. 1), $> 1^\circ$ in diameter.
 - Compact inner gas disc aligned with stellar disc.
 - Extended outer gas disc with different orientation.
- ★ **Rotation curve** measured out to almost 20 kpc (Fig. 2).
 - Maximum rotation velocity of 100 km s^{-1} at 10 kpc.
 - Declining rotation curve across outer disc.
- ★ Asymmetries in HI disc suggest **ram-pressure** distortion of outer gas disc (Fig. 3 & 4).

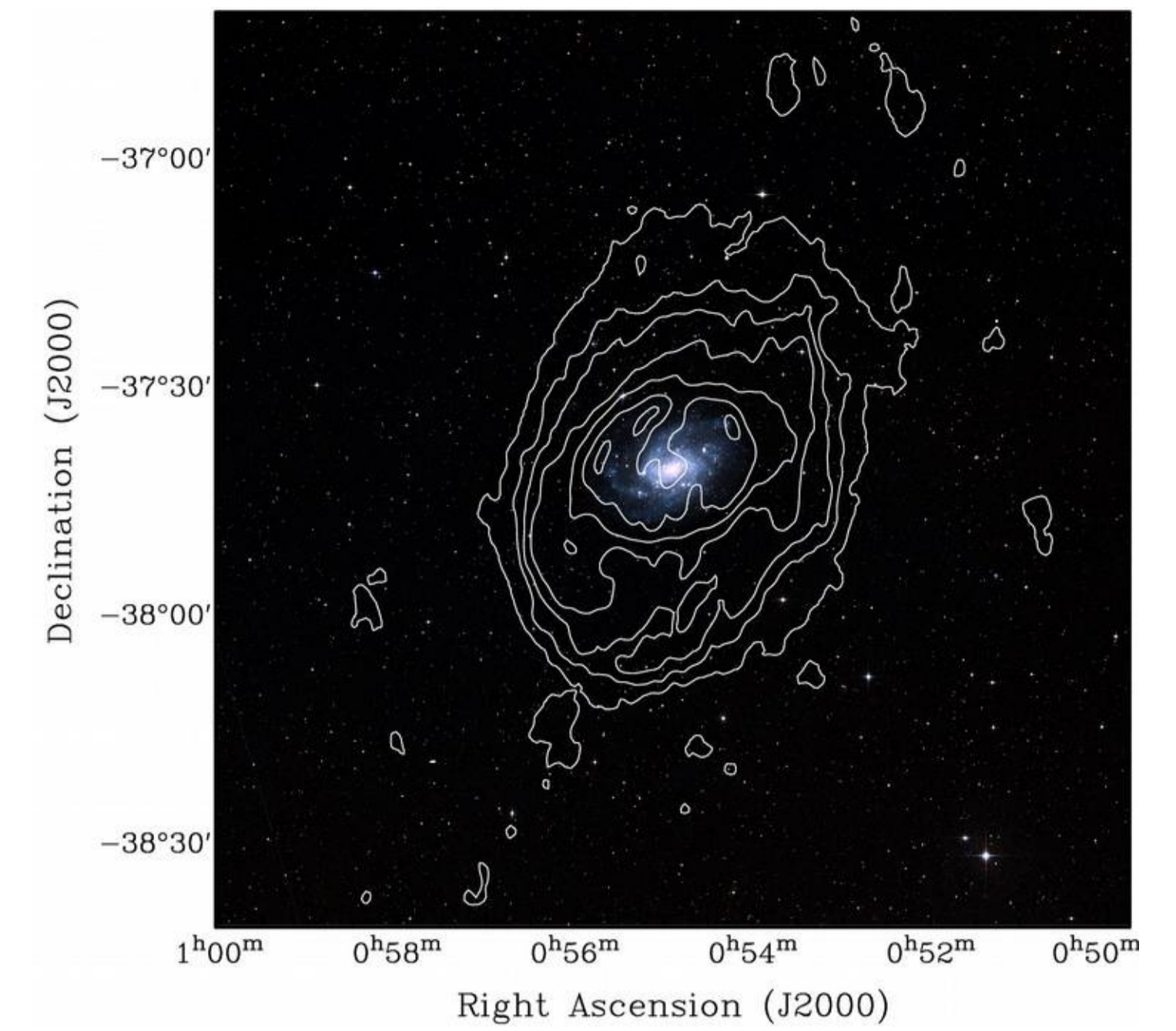


Figure 1: Optical DSS image of NGC 300 with ATCA HI contours overlaid.

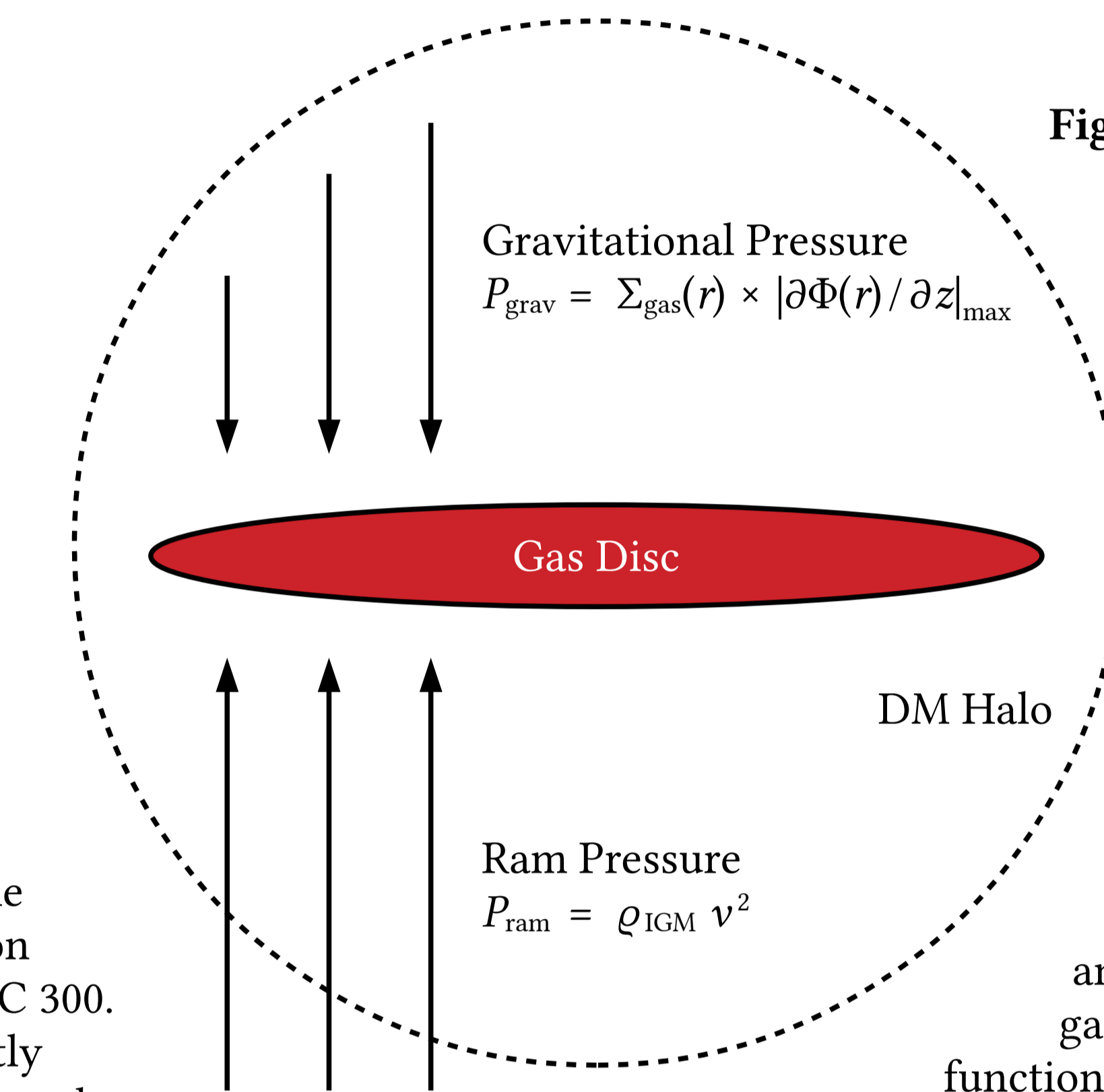


Figure 2: Rotation curve of NGC 300 (red data points). The grey data points show the previous rotation curve derived by Puche et al. (1990) from VLA observations for comparison.

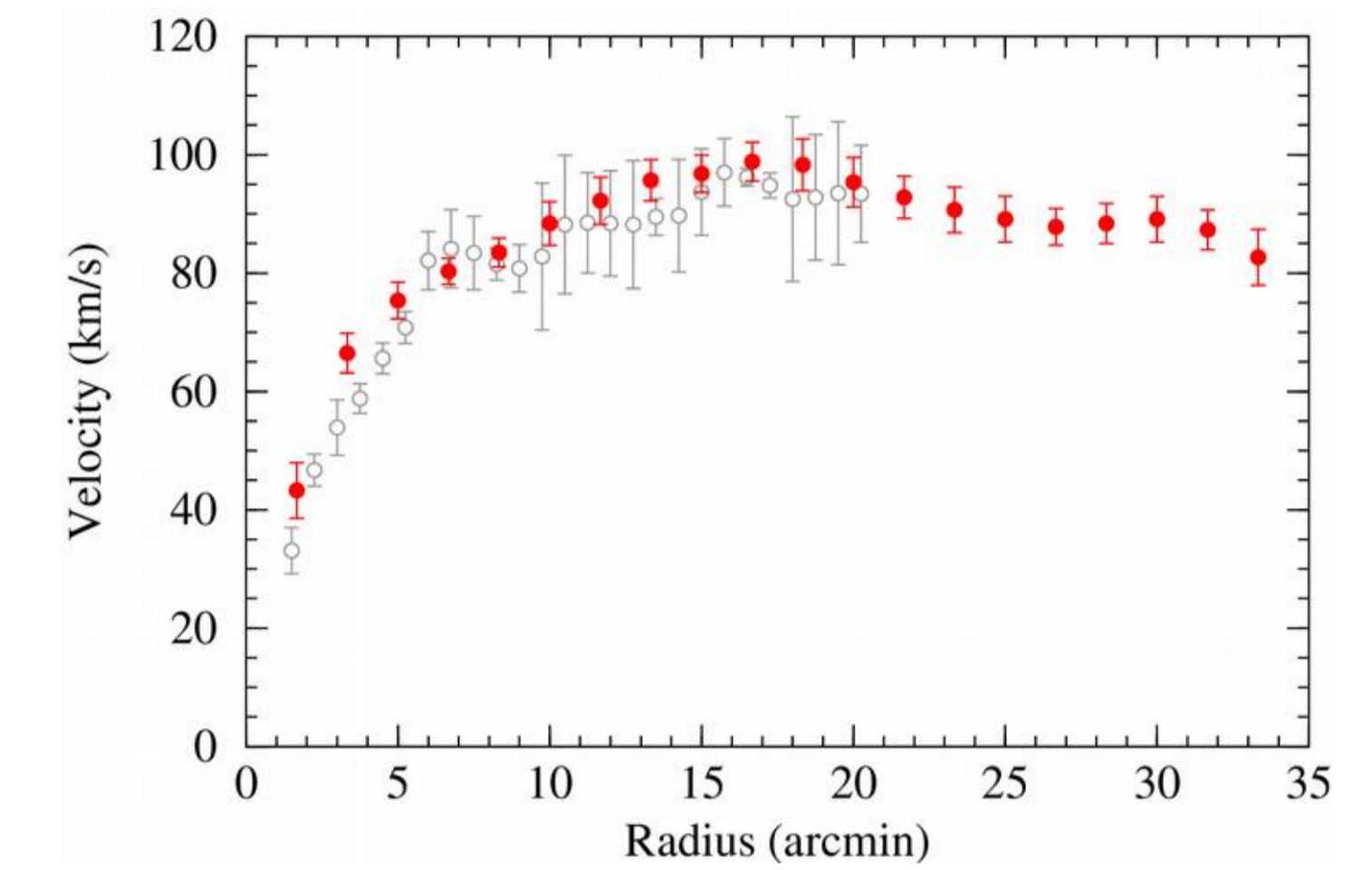
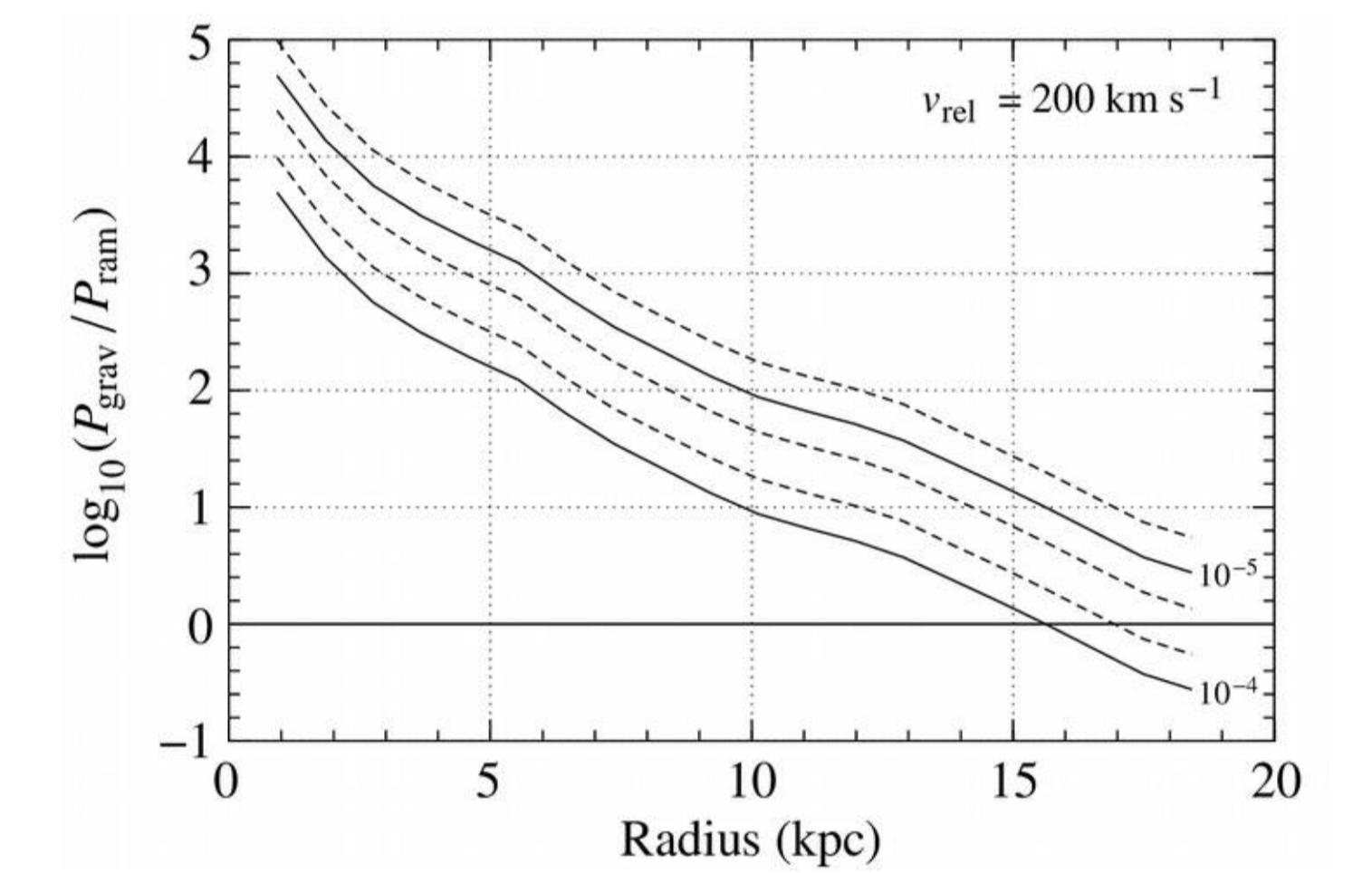


Figure 4: Ratio of gravitational pressure and ram pressure in the gas disc of NGC 300 as a function of radius for different IGM densities (in cm^{-3}). Ram-pressure effects start to dominate near the outer edge of the disc.



NGC 55

Westmeier et al., in prep.

Main results:

- ★ Extended, asymmetric **HI disc** (Fig. 5).
 - Asymmetries again suggestive of ram-pressure.
 - Apparent “thickness” of the disc due to warping of the outer disc, not gas in the halo.
- ★ We discovered a population of **extra-planar gas clouds** (Fig. 5 and 6) around NGC 55.
 - Typical HI masses of a few times $10^6 M_\odot$.
 - Six clouds presumably at distance of NGC 55, two clouds (6 and 7) most likely foreground from the Milky Way or Magellanic Stream (Fig. 7).

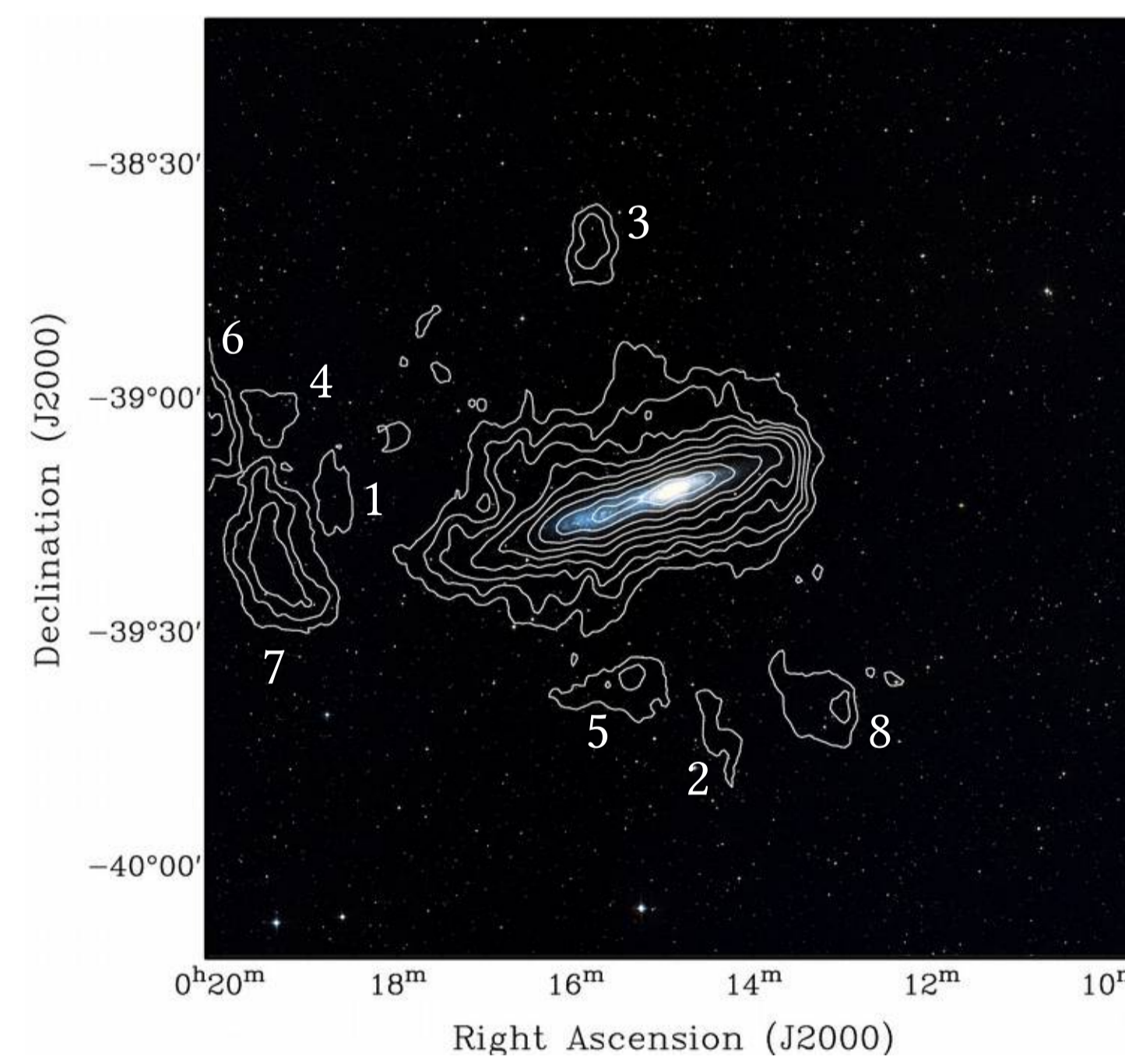


Figure 5: Optical DSS image of NGC 55 with ATCA HI contours overlaid.

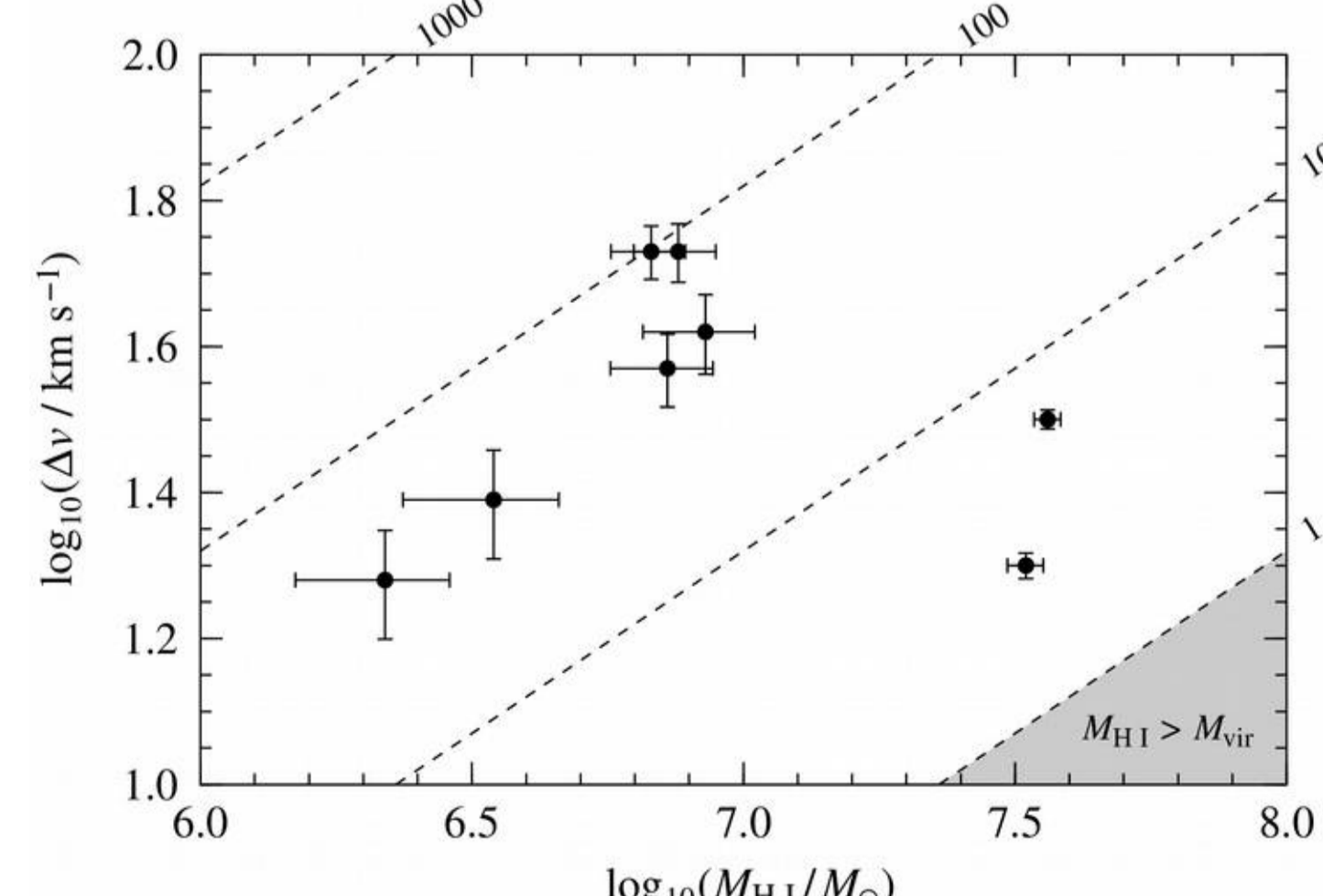


Figure 7: Line width vs. HI mass of the extra-planar gas clouds near NGC 55. Diagonal lines indicate lines of constant virial-to-HI mass ratio, $\alpha = M_{\text{vir}} / M_{\text{HI}}$. Six of the clouds are aligned near values of $\alpha \approx 50 \dots 100$, suggesting a common origin. Two of the clouds (6 and 7 in Fig. 5) have very different mass ratios, suggesting that they are foreground objects.

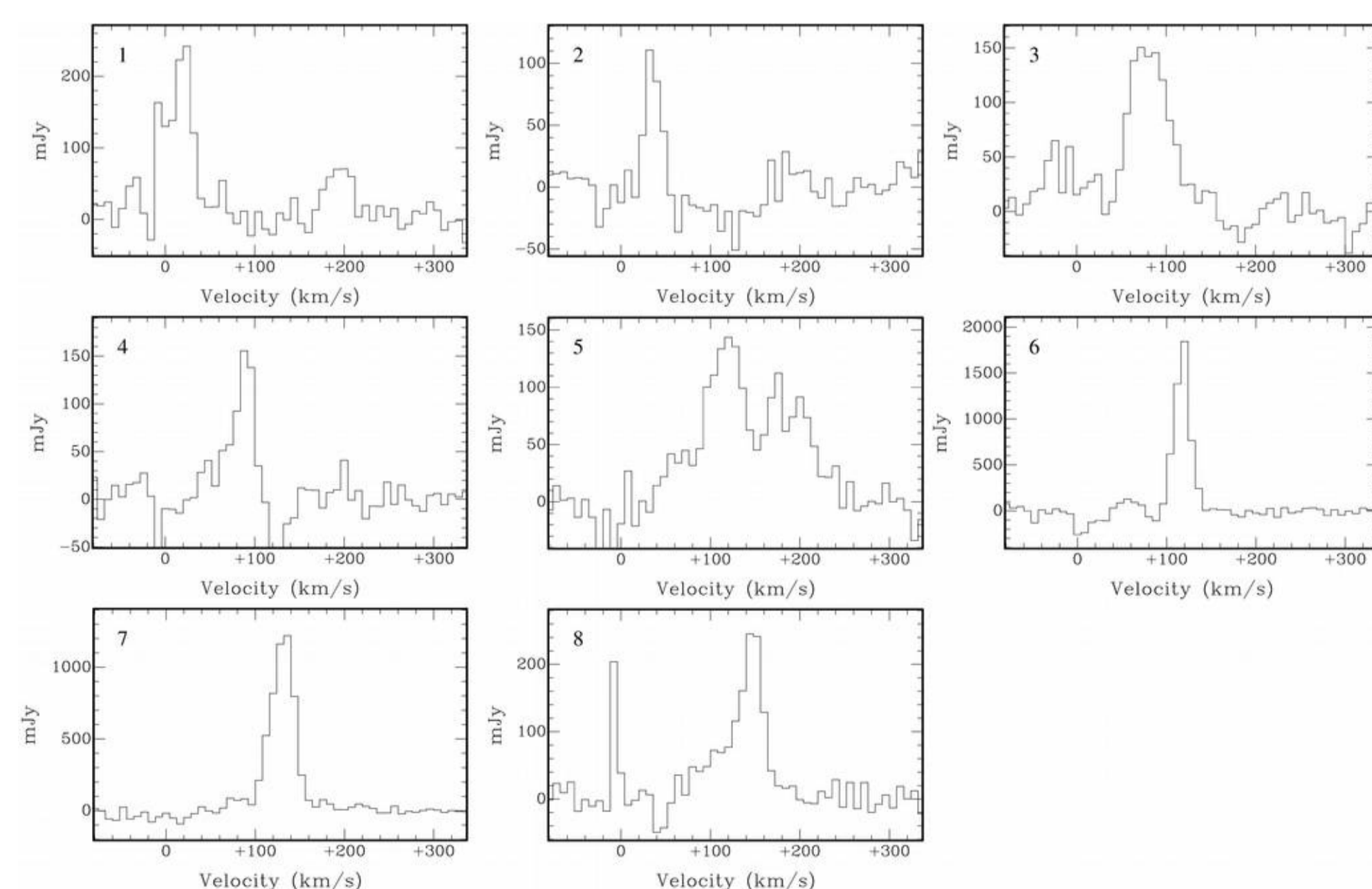


Figure 6: HI spectra of the 8 extra-planar gas clouds discovered near NGC 55. The numbers correspond to the ones shown in Fig. 5.

Summary & Conclusions

- ★ **Ram-pressure** interaction does occur in **groups** (not just massive clusters) under reasonable assumptions on the density of the IGM and relative velocity of galaxies.
 - We find strong **asymmetries** in the outer gas discs of NGC 55 and 300 suggesting the presence of ram pressure.
 - We are currently working on **numerical simulations** (Bekki et al., in prep.) to support the observations and determine the density of the IGM.
- ★ NGC 55 is surrounded by a population of **extra-planar gas clouds** or high-velocity clouds (HVCs).
 - HI masses comparable to **HVCs** around the Milky Way (e.g. complex C; Wakker et al. 2007; Thom et al. 2008).
 - **Origin** of gas clouds around NGC 55 not yet clear, but similar detections near M31 (Thilker et al. 2004; Westmeier et al. 2005) suggest combination of different origins (tidal stripping, gaseous satellites, outflows, etc.).
- ★ Future HI surveys with **ASKAP** and **MeerKAT** will allow us to study the evolution and interaction of galaxies in the nearby universe in much greater detail:
 - WALLABY (PIs: B. Koribalski, L. Staveley-Smith)
 - MHONGOOSE (PI: E. de Blok)

References

- ★ Puche, Carignan & Bosma 1990, AJ, 100, 1468
- ★ Thilker et al. 2004, ApJ, 601, L39
- ★ Thom et al. 2008, ApJ, 684, 364
- ★ Wakker et al. 2007, ApJ, 670, L113
- ★ Westmeier, Braun & Thilker 2005, A&A, 436, 101
- ★ Westmeier, Braun & Koribalski 2011, MNRAS, 410, 2217