

Constraining the MW's CGM with the LMC

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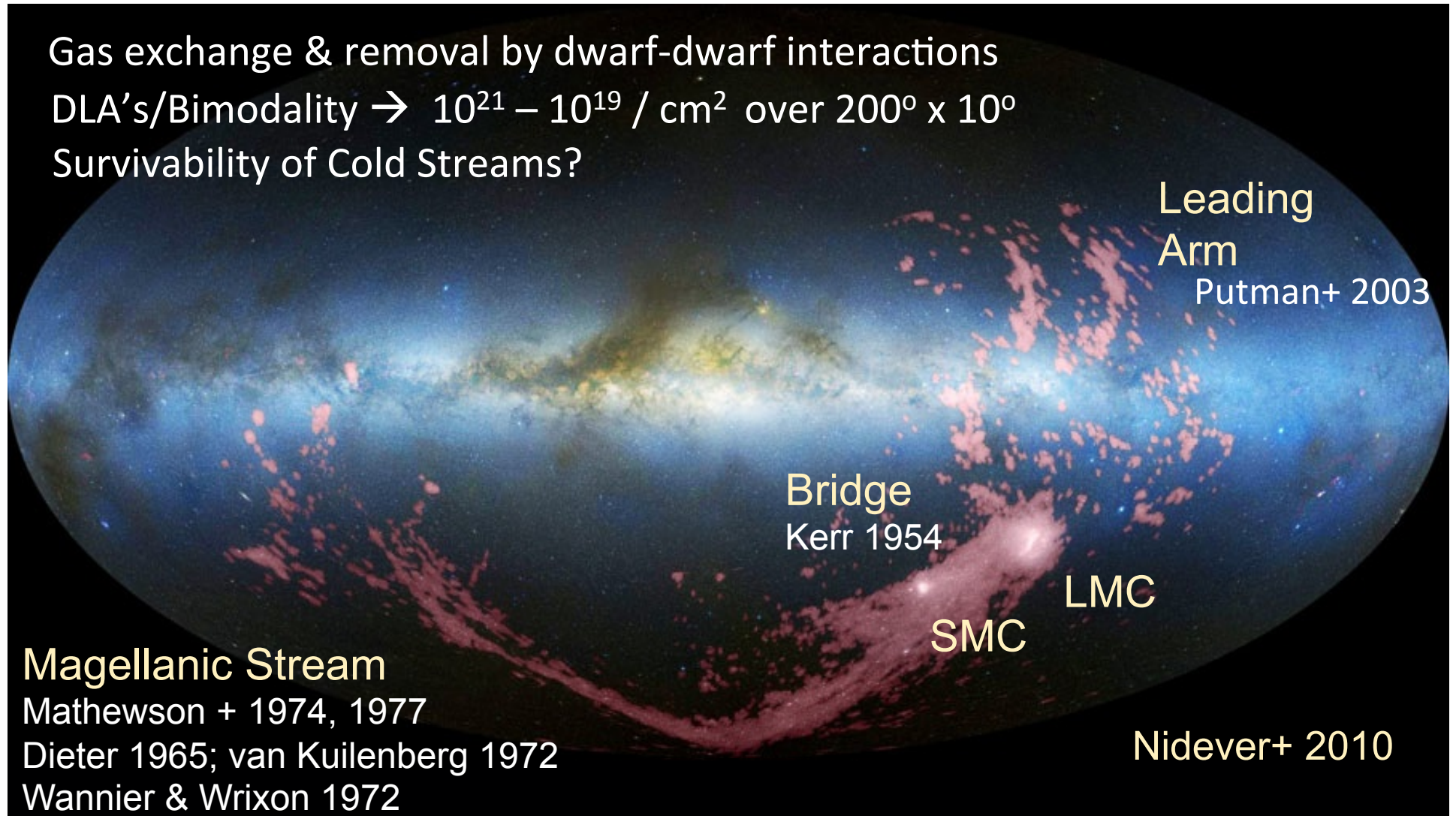
Greg Bryan, Mary Putman, Roeland van der Marel

The Magellanic System

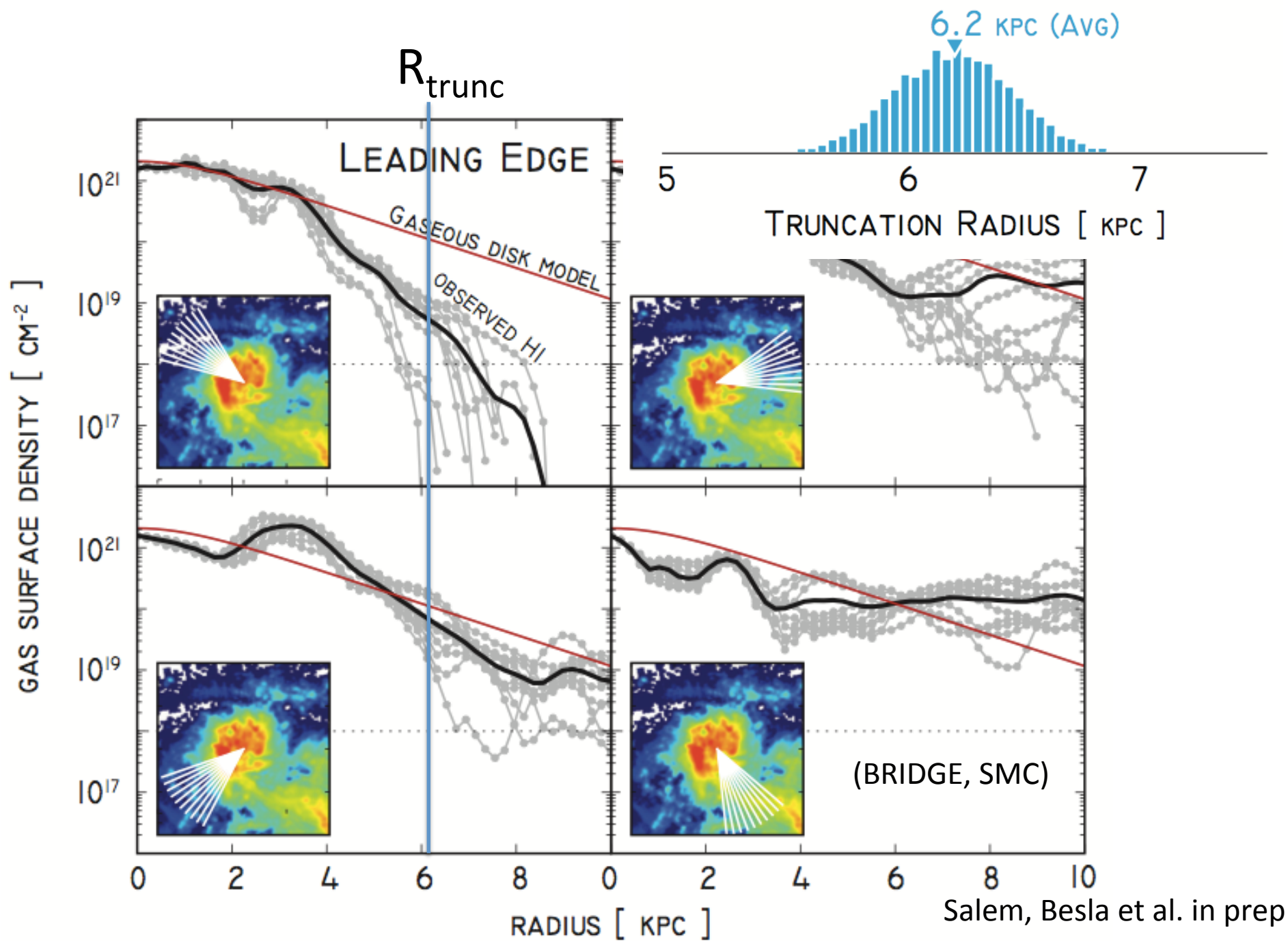
Gas exchange & removal by dwarf-dwarf interactions

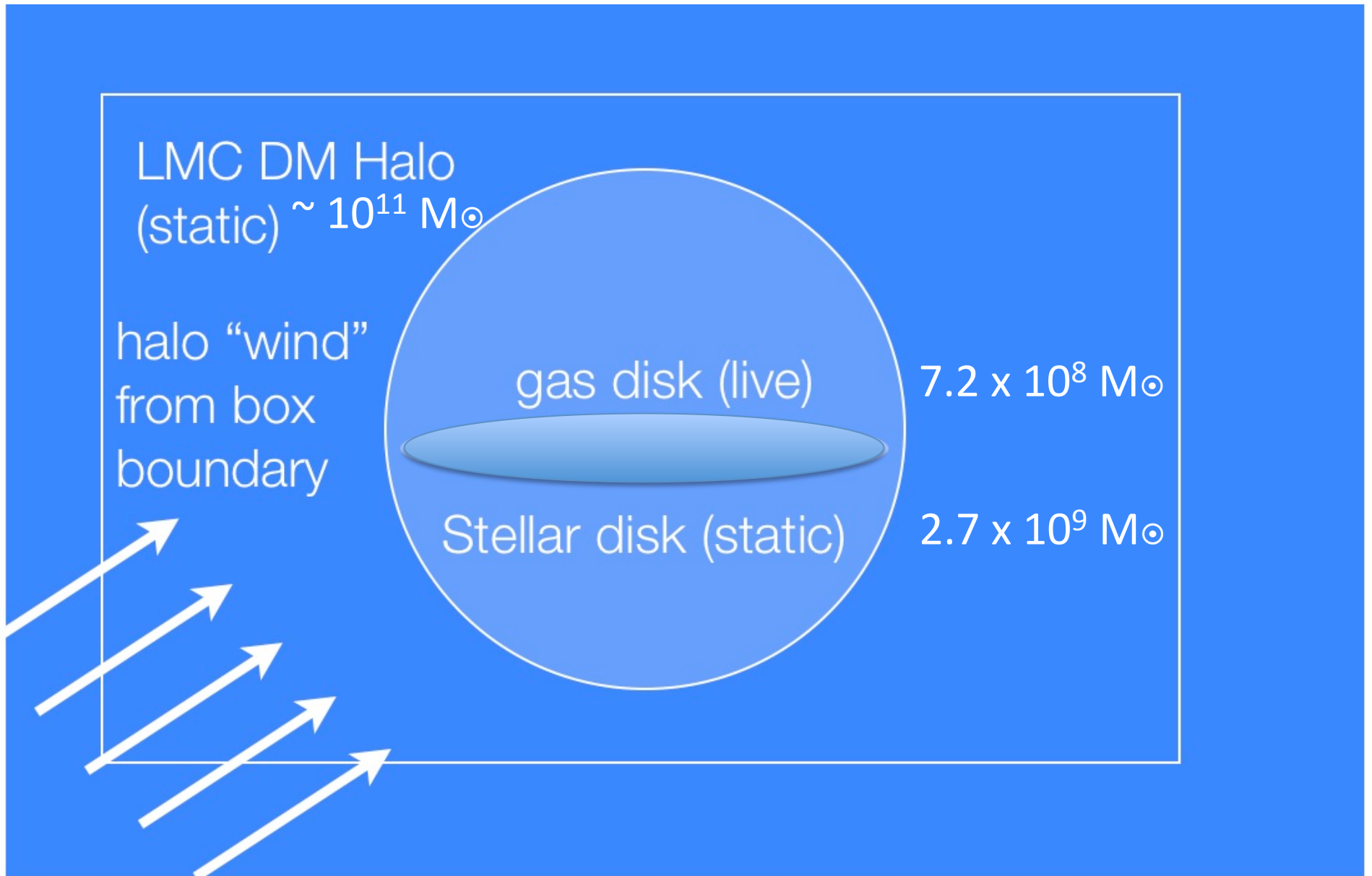
DLA's/Bimodality $\rightarrow 10^{21} - 10^{19} / \text{cm}^2$ over $200^\circ \times 10^\circ$

Survivability of Cold Streams?



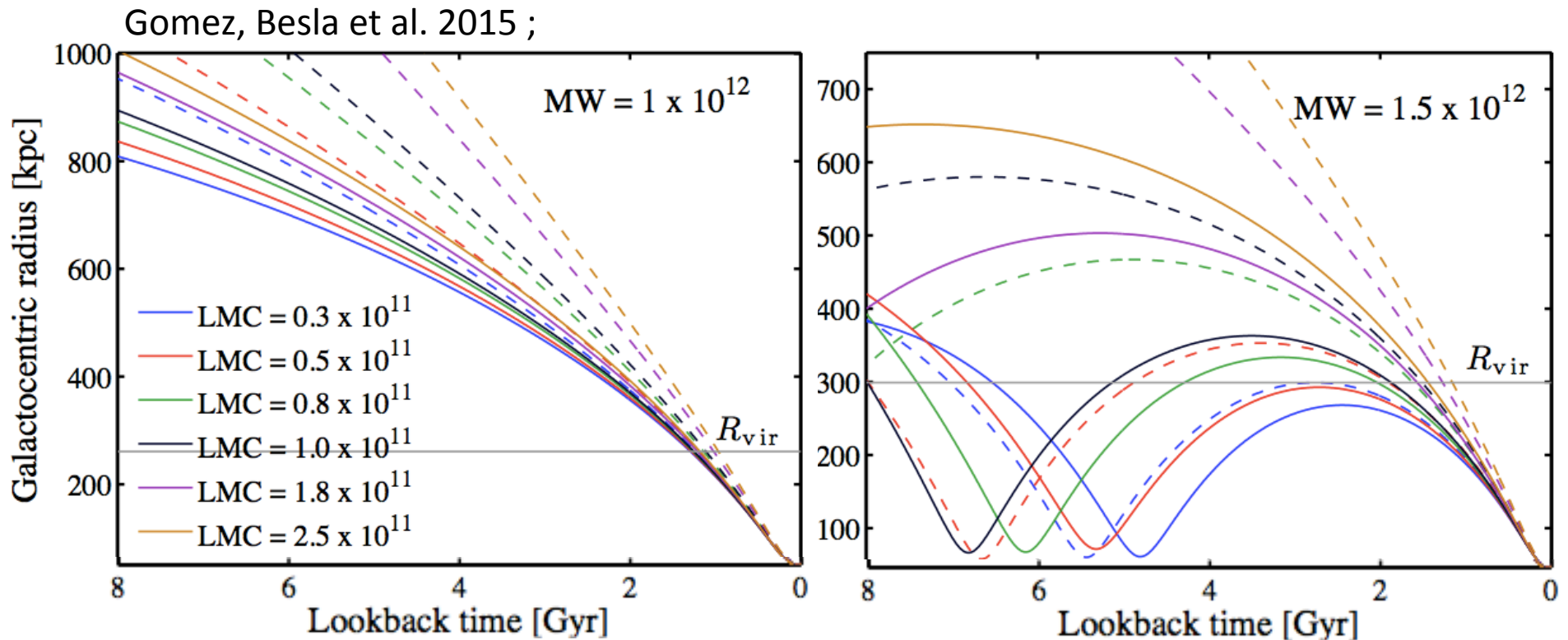
$$M_{\text{Gas outside}} \sim 2 \times 10^9 M_{\odot} (d/55 \text{ kpc})^2 > 2 \times M_{\text{Gas LMC+SMC}} \quad \text{Fox+ 2014}$$





Ram Pressure $\rightarrow$ gas density $\times$ velocity²

The Recent Pericentric Passage of the LMC about the MW is Model Independent



$$r_p = 48.1 \pm 2.5 \text{ kpc},$$

$$v_p = 340 \pm 19 \text{ km/s}$$

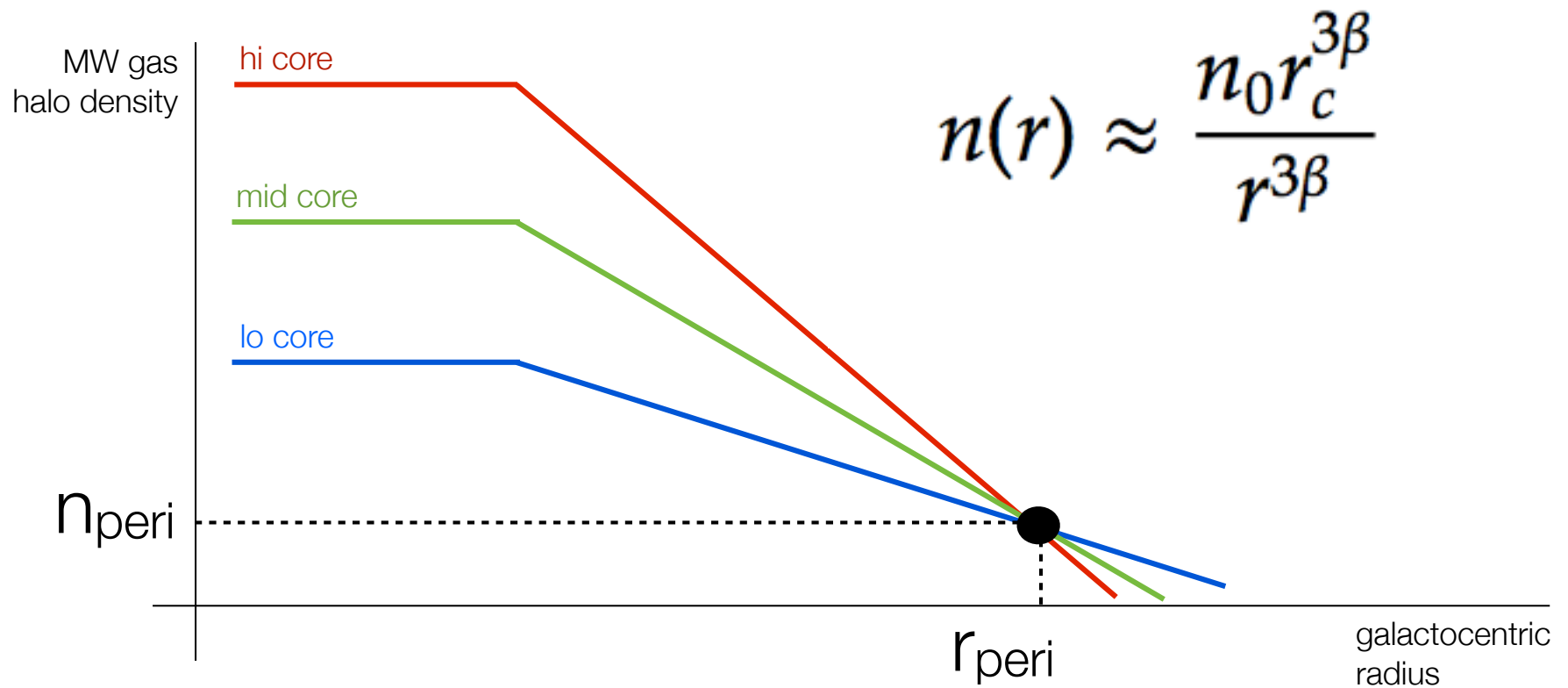
$$t_p = 46.4 \pm 8.5 \text{ Myr},$$

Kallivayalil, van der Marel, Besla et al. 2013

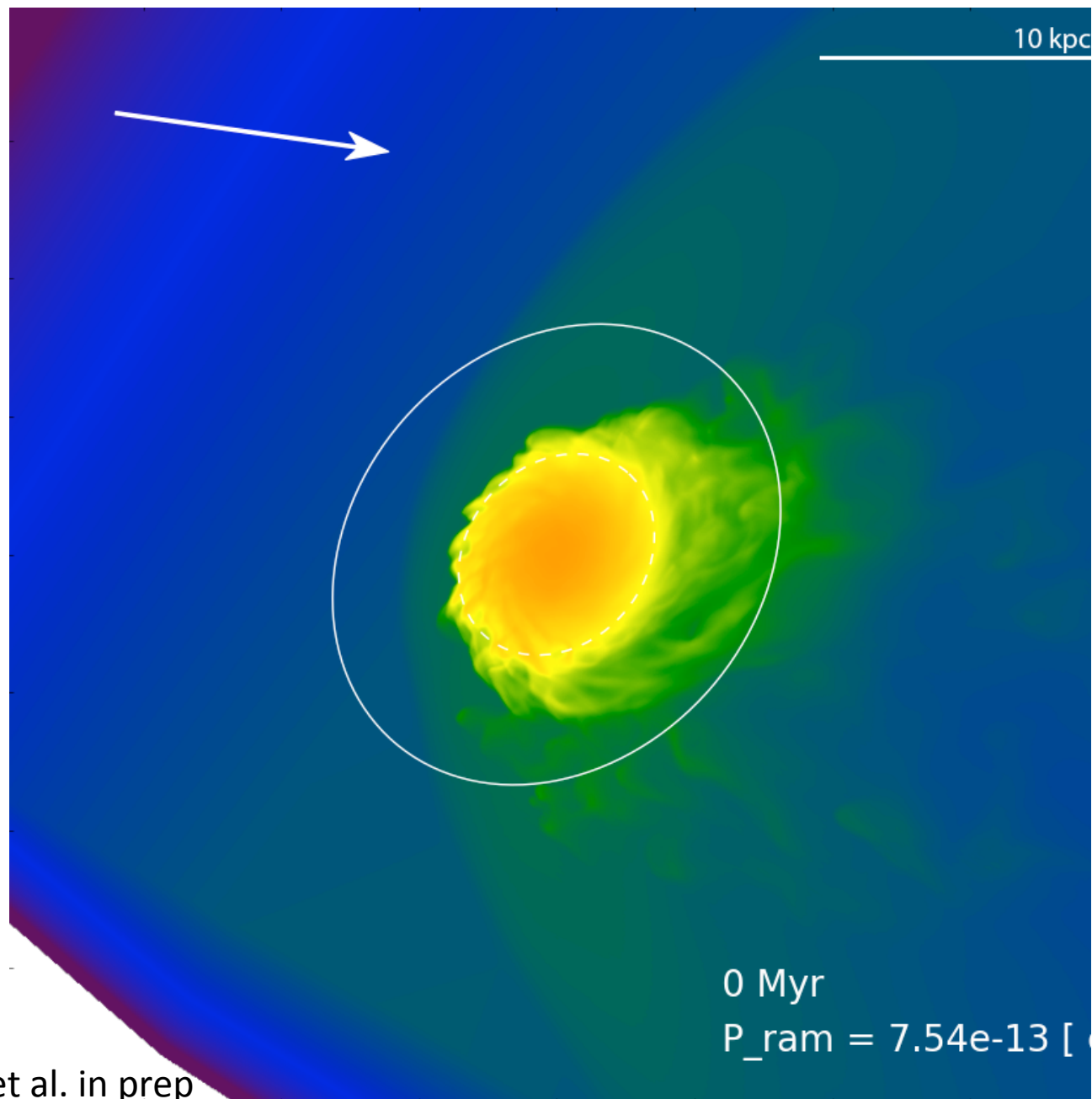
Following Miller & Bregman 2015, 2013

$$n(r) = n_0 \left[1 + \left(\frac{r}{r_c} \right)^2 \right]^{-3\beta/2}$$

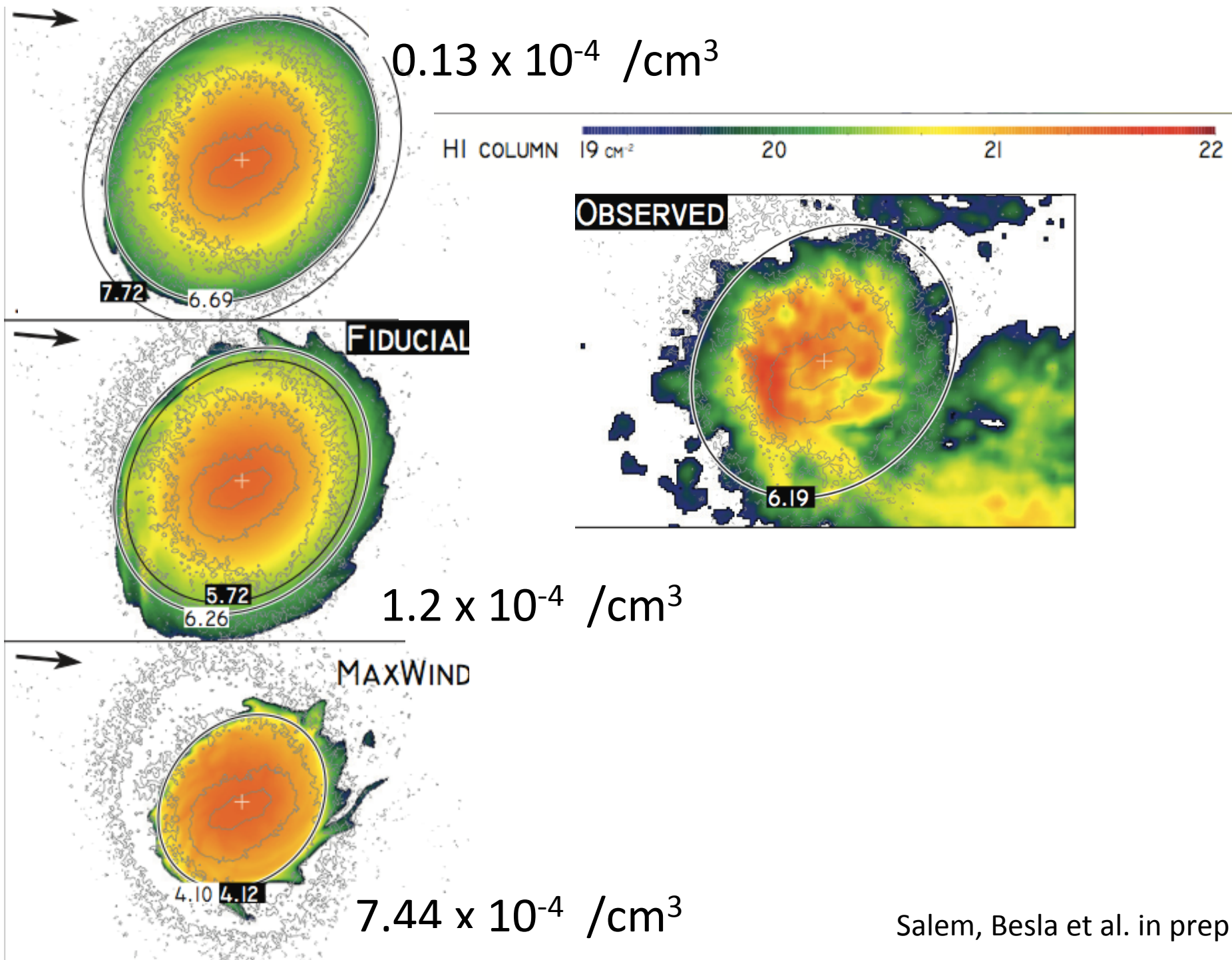
$$n(r) \approx \frac{n_0 r_c^{3\beta}}{r^{3\beta}}$$



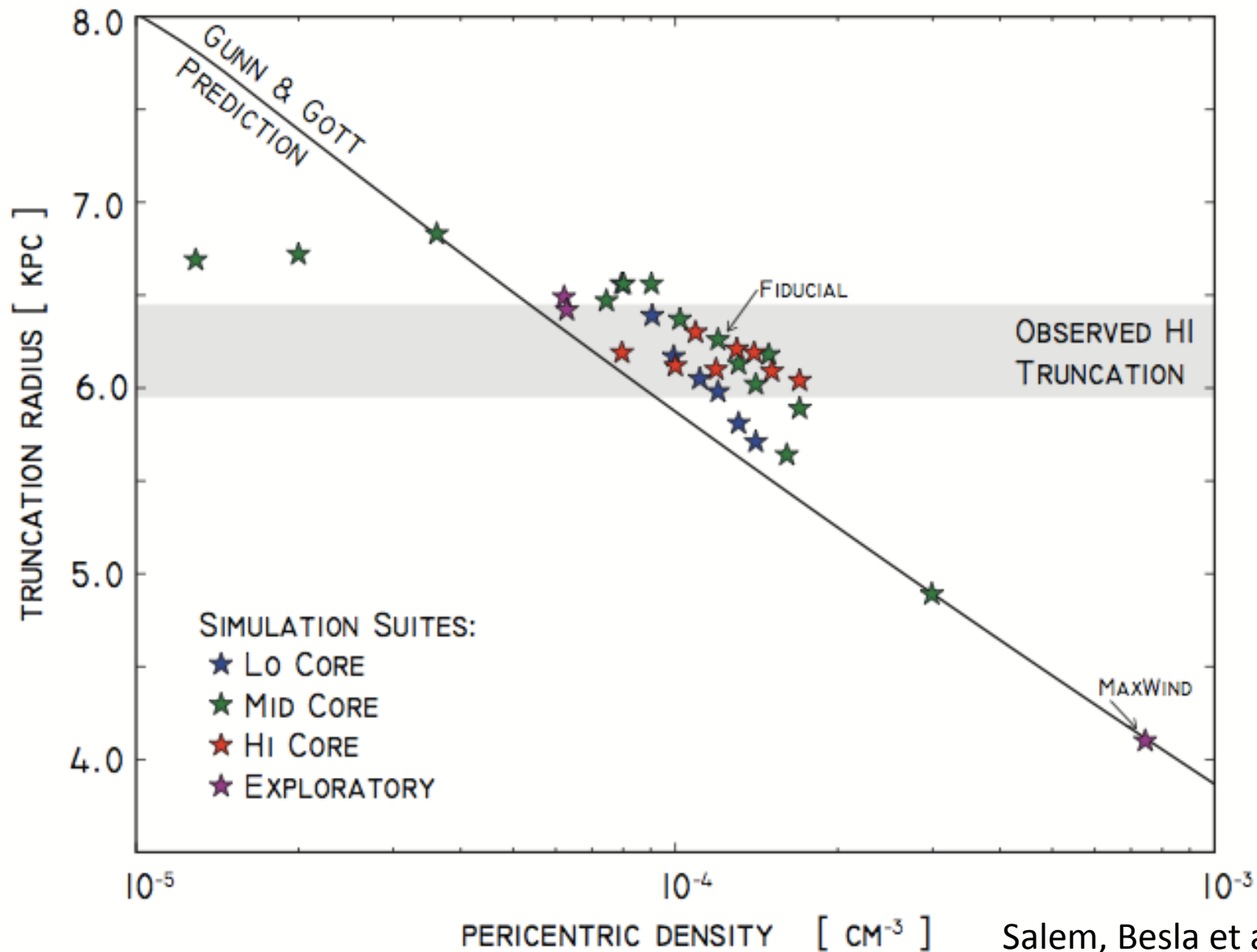
$$r_p = 48.1 \pm 2.5 \text{ kpc}$$



Salem, Besla et al. in prep
Enzo AMR Simulations

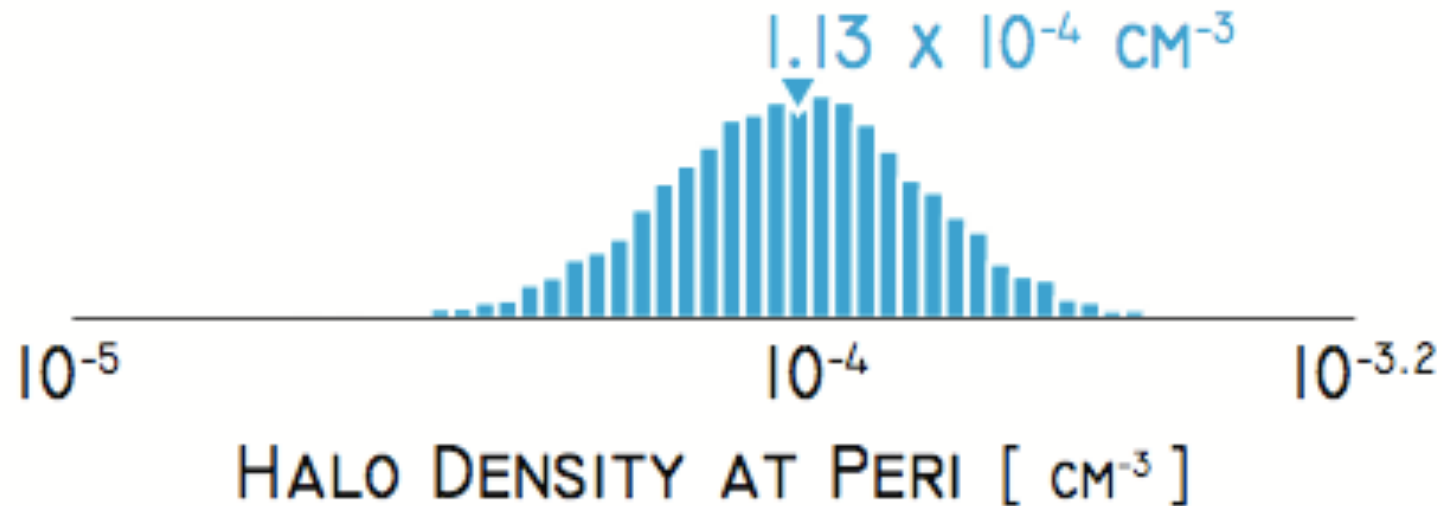


Calibrating the Gunn-Gott Relation



Salem, Besla et al. in prep

Constraints on CGM density at ~ 48 kpc



$$n_{\text{MWHalo}}(R = 48.2 \pm 2.5 \text{ kpc}) = 1.1_{-.45}^{+.44} \times 10^{-4} \text{ cm}^{-3}$$

Salem, Besla et al. in prep

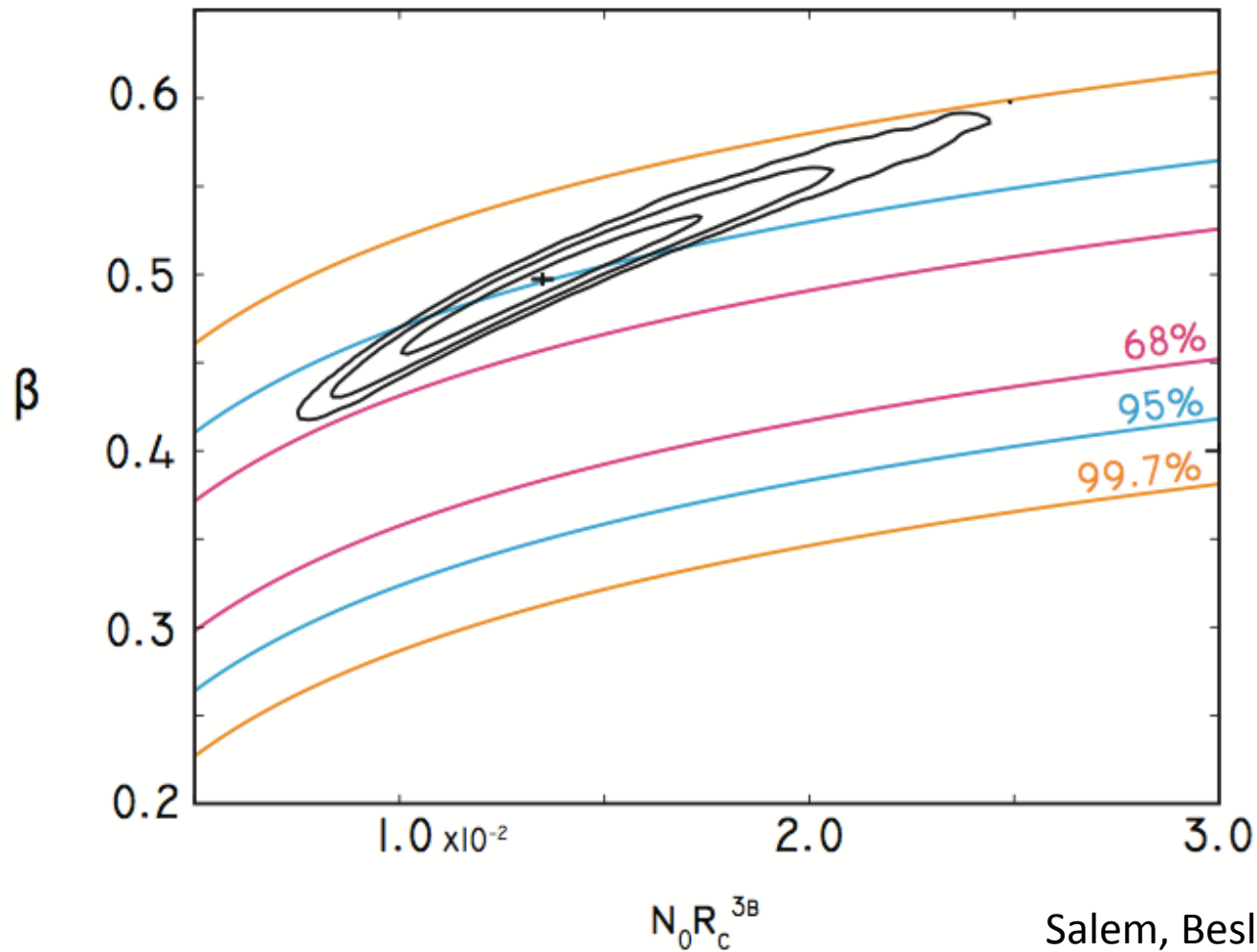
Estimates from stripping simulations of other MW Satellites:

Gatto, Fraternali et al. (2013) $(1.3 - 3.6) \times 10^{-4} \text{ /cm}^3$

Grcevich & Putman (2009) $(0.1-10) \times 10^{-4} \text{ /cm}^3$

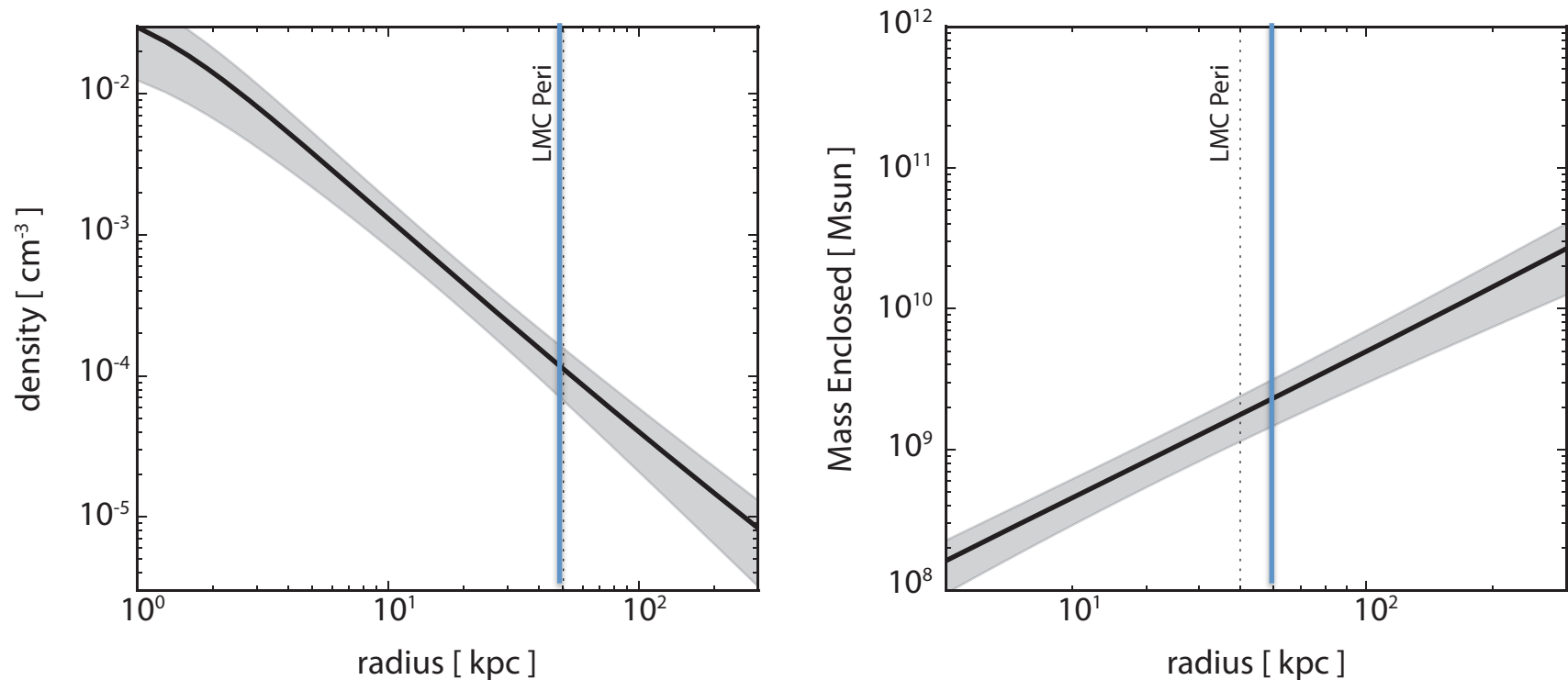
Constraints on CGM Density Profile

Black Curves: Constraints from Miller & Bregman 2015



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Constraints on CGM of the Milky Way



$$n_{\text{MWHalo}}(R = 48.2 \pm 2.5 \text{ kpc}) = 1.1^{+0.44}_{-0.45} \times 10^{-4} \text{ cm}^{-3}$$

$$M_{\text{gas smooth}}(R < 300 \text{ kpc}) = 2.6 (+/- 1.4) \times 10^{10} M_{\odot}$$

(~12-40% of Missing Baryons in $1e12$ halo)

Salem, Besla et al. in prep

Conclusions

- The LMC HI disk shows evidence of truncation by ram pressure stripping in the direction of motion ($r_{\text{trunc}} = 6.2 \pm 0.25$ kpc)
- Maximal truncation occurs at pericenter, where LMC orbital properties are well known.
- This provides a direct constraint on the gas density of the MW's CGM at ~ 48 kpc

$$n_{\text{MWHalo}}(R = 48.2 \pm 2.5 \text{ kpc}) = 1.1^{+.44}_{-.45} \times 10^{-4} \text{ cm}^{-3}$$