

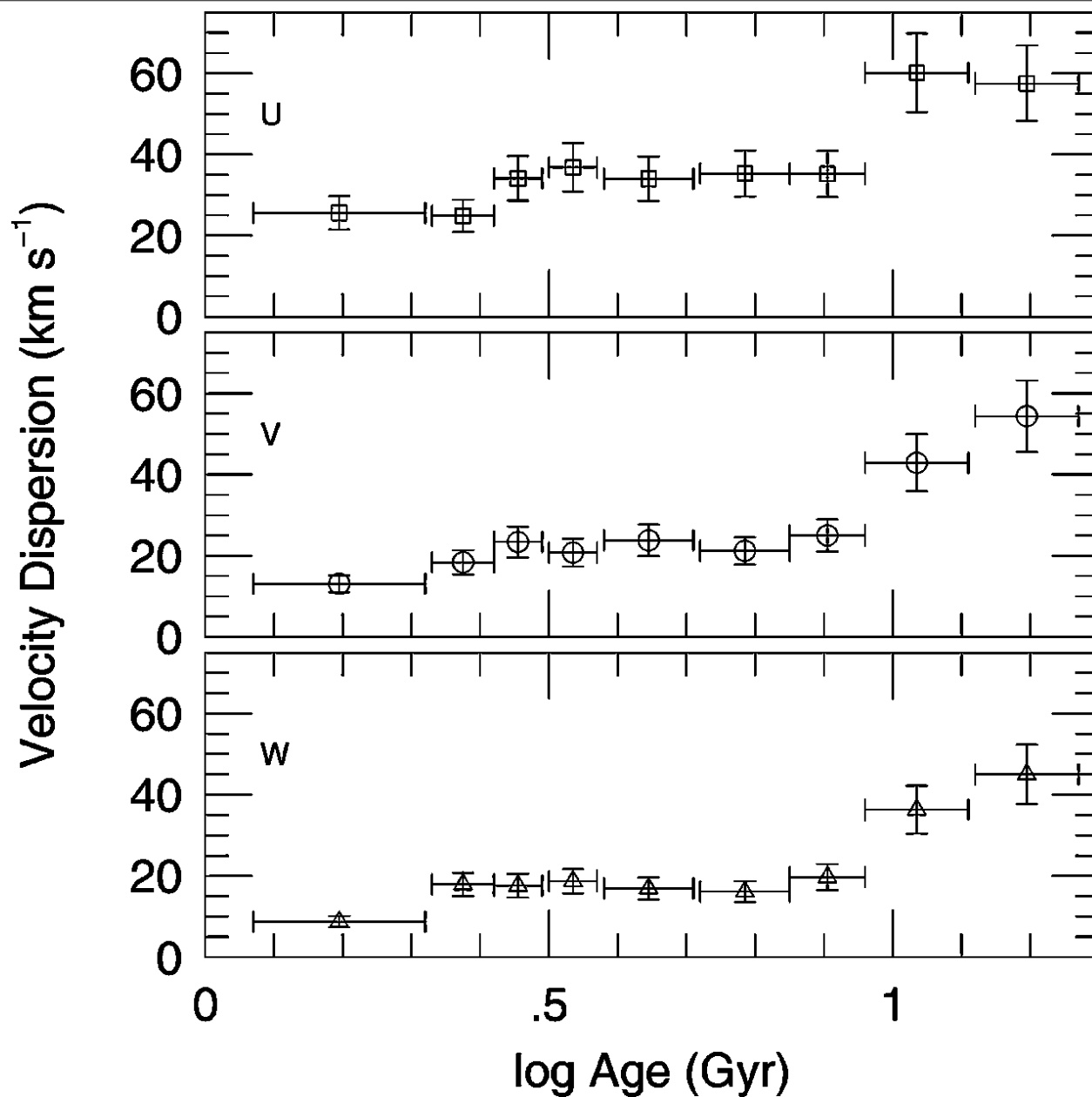
Dark matter in the thick disc:  
Did the thick disc form from a dry  
merger?

Justin Read  
University Zürich

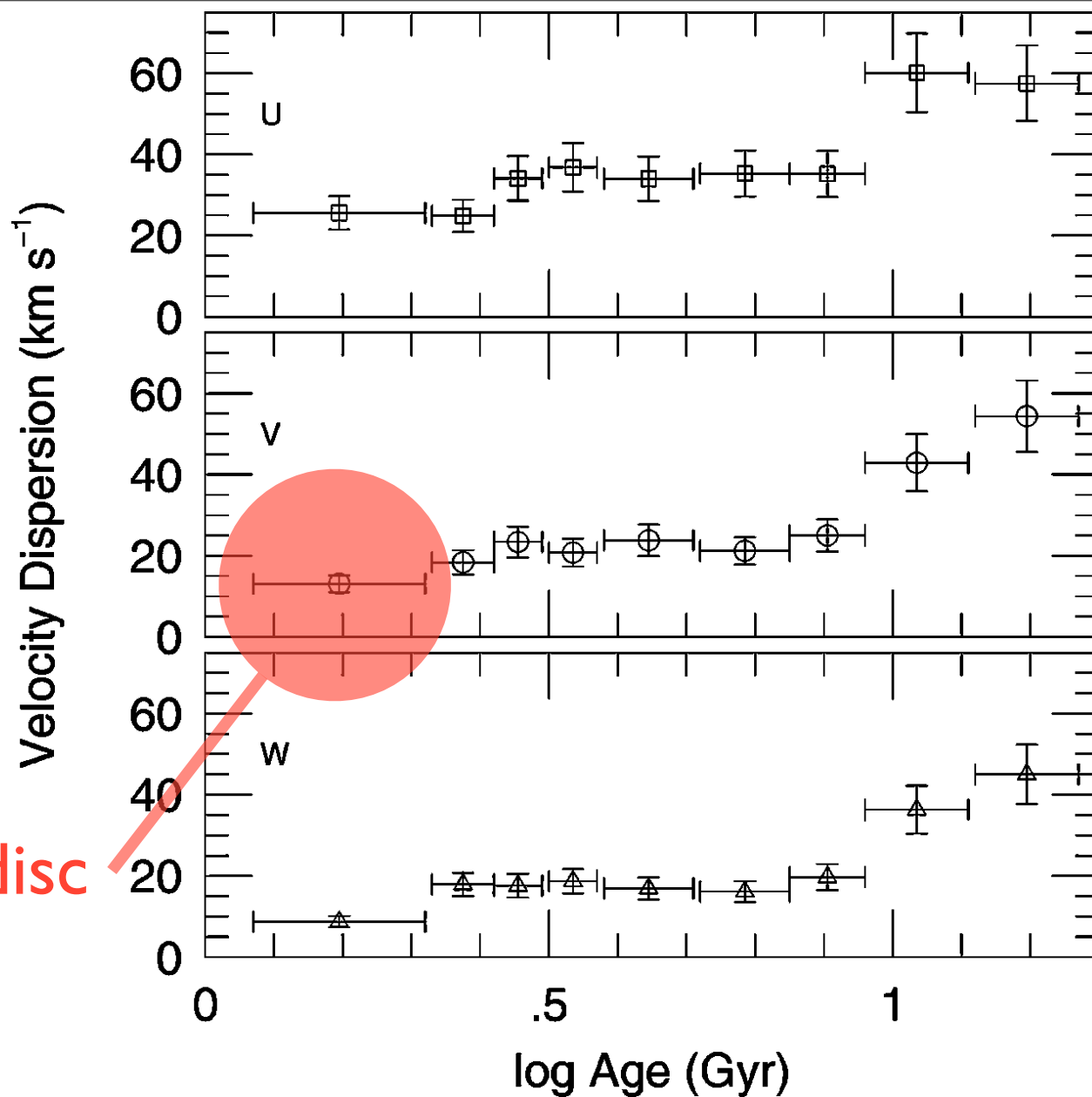
George Lake & Victor Debattista

# Background

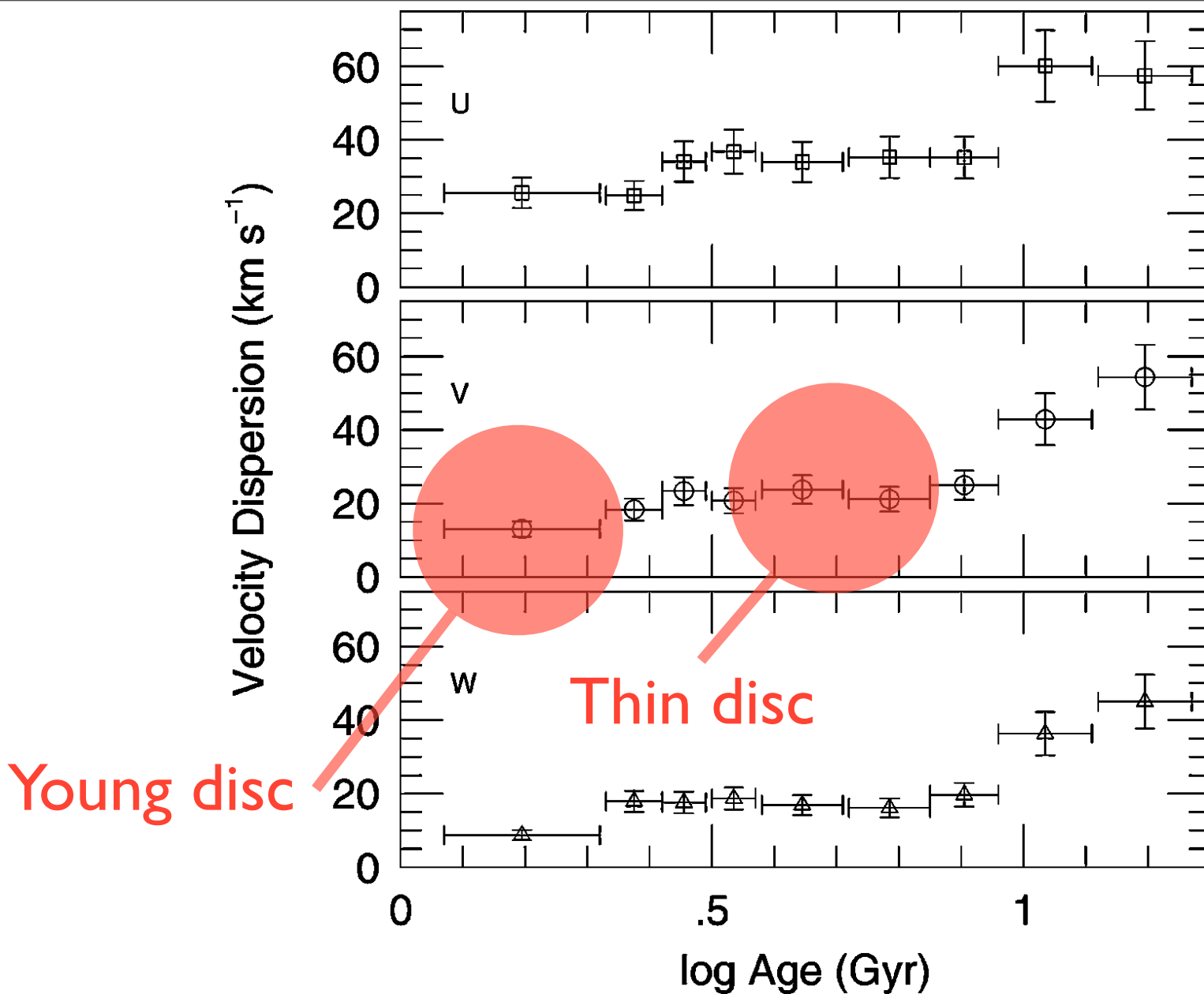
What is the thick disc?



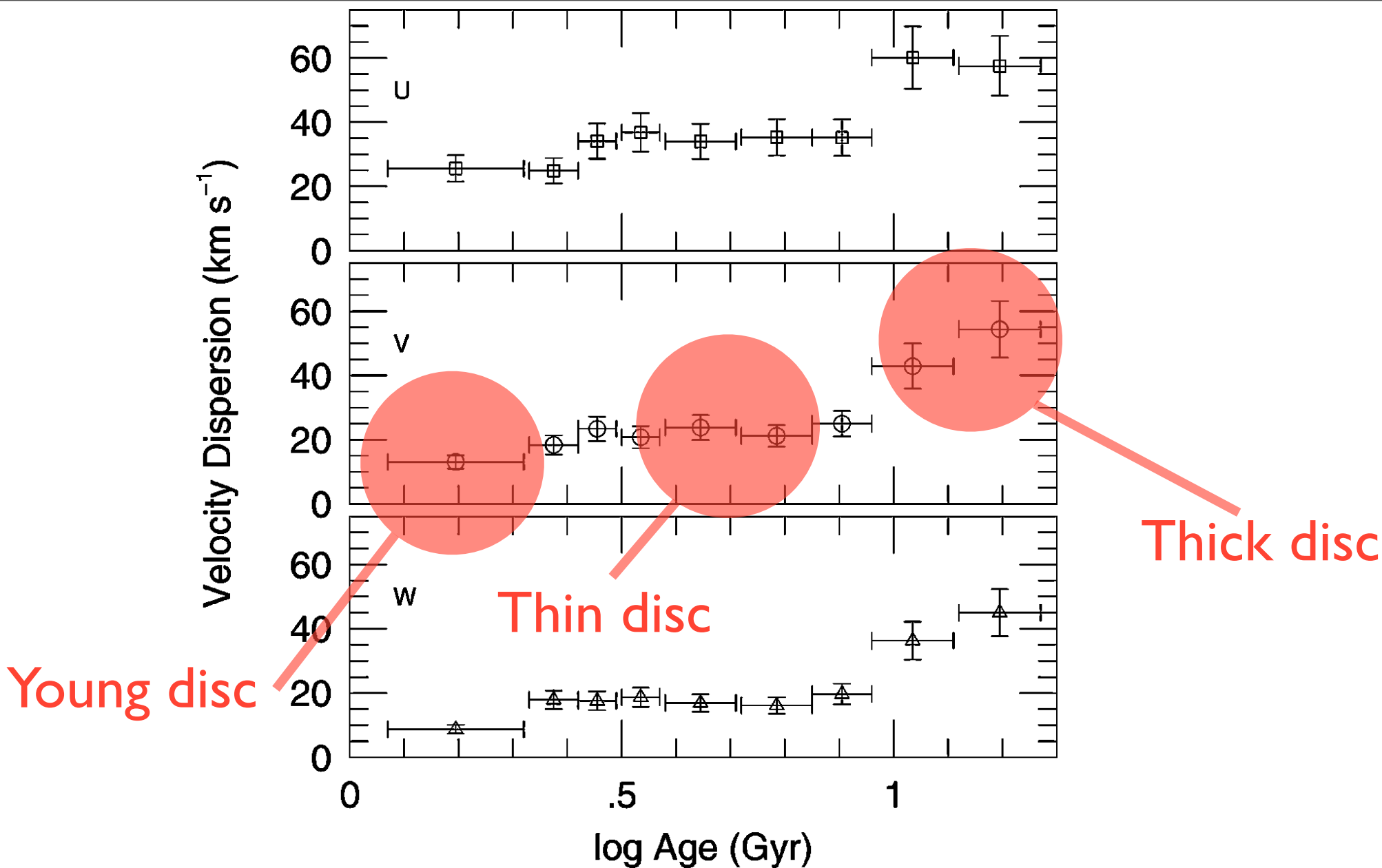
**Figure 5** The relation between the three components of the velocity dispersion and the stellar age, as derived by Quillen & Garnett (2001) for stars from the sample of Edvardsson et al. (1993). Stars with ages between 2 and 10 Ga belong to the old thin disk: Their velocity dispersion is independent of age. The younger stars show a smaller velocity dispersion. The velocity dispersion doubles abruptly at an age of about 10 Ga; these older stars belong to the thick disk.



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- Warm:  $\sigma \sim 40$  km/s;  $h \sim 1$  kpc.

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Extragalactic [Yoachim & Dalcanton 2005]

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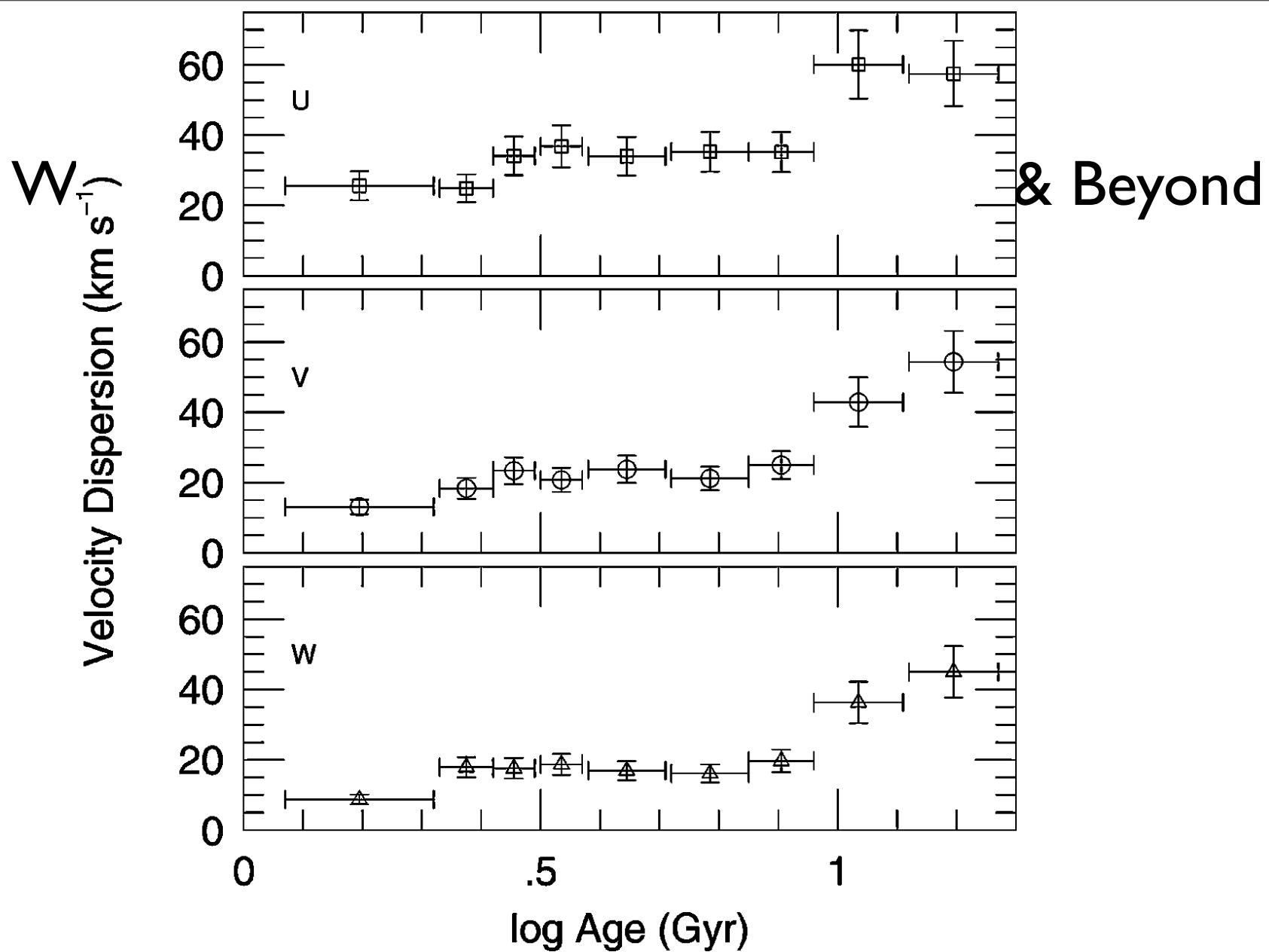


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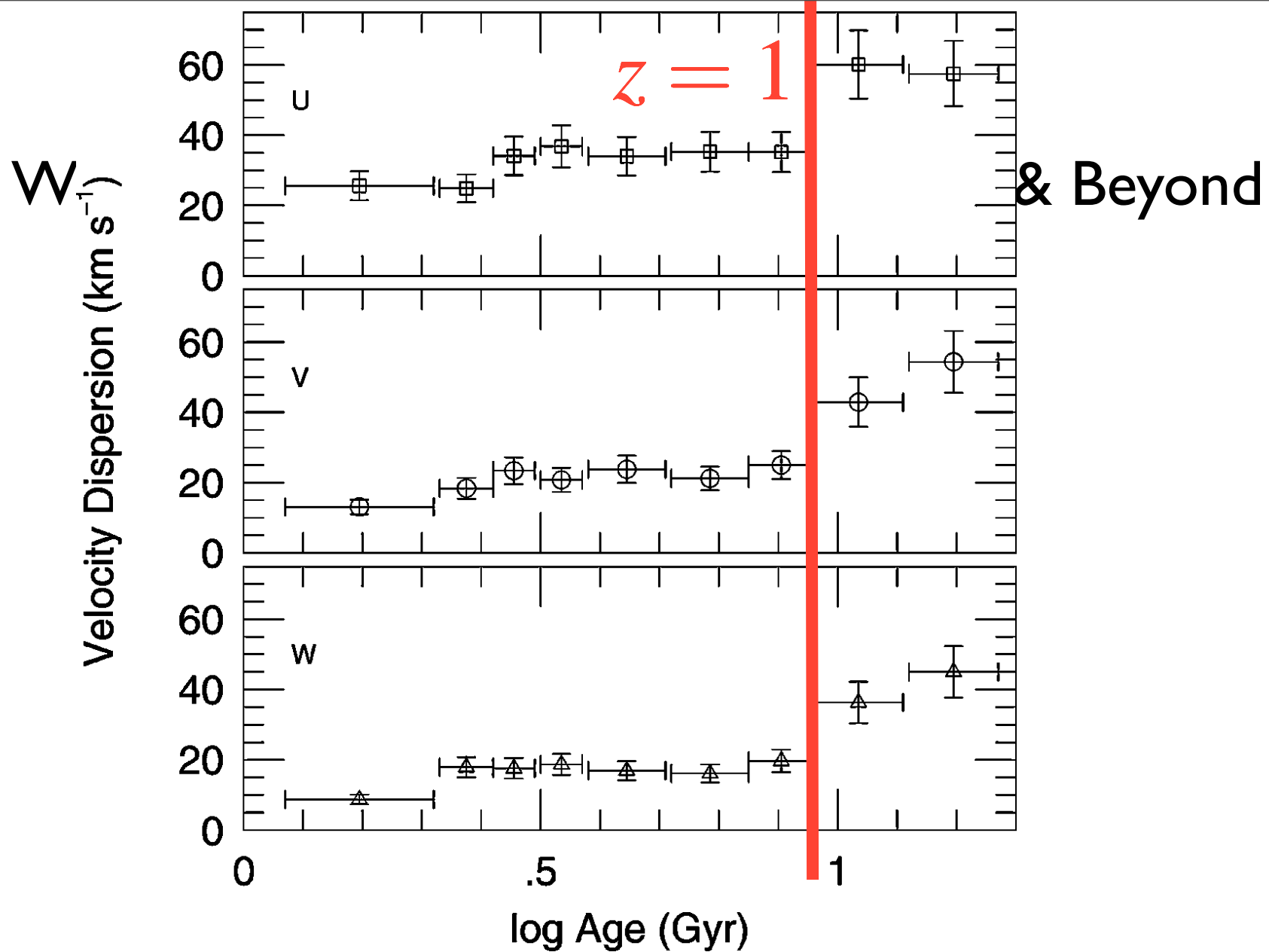
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Extragalactic [Yoachim & Dalcanton 2005]

- Ubiquitous.
- Milky Way-like.
- Tentative evidence for one counter-rotating thick disc.



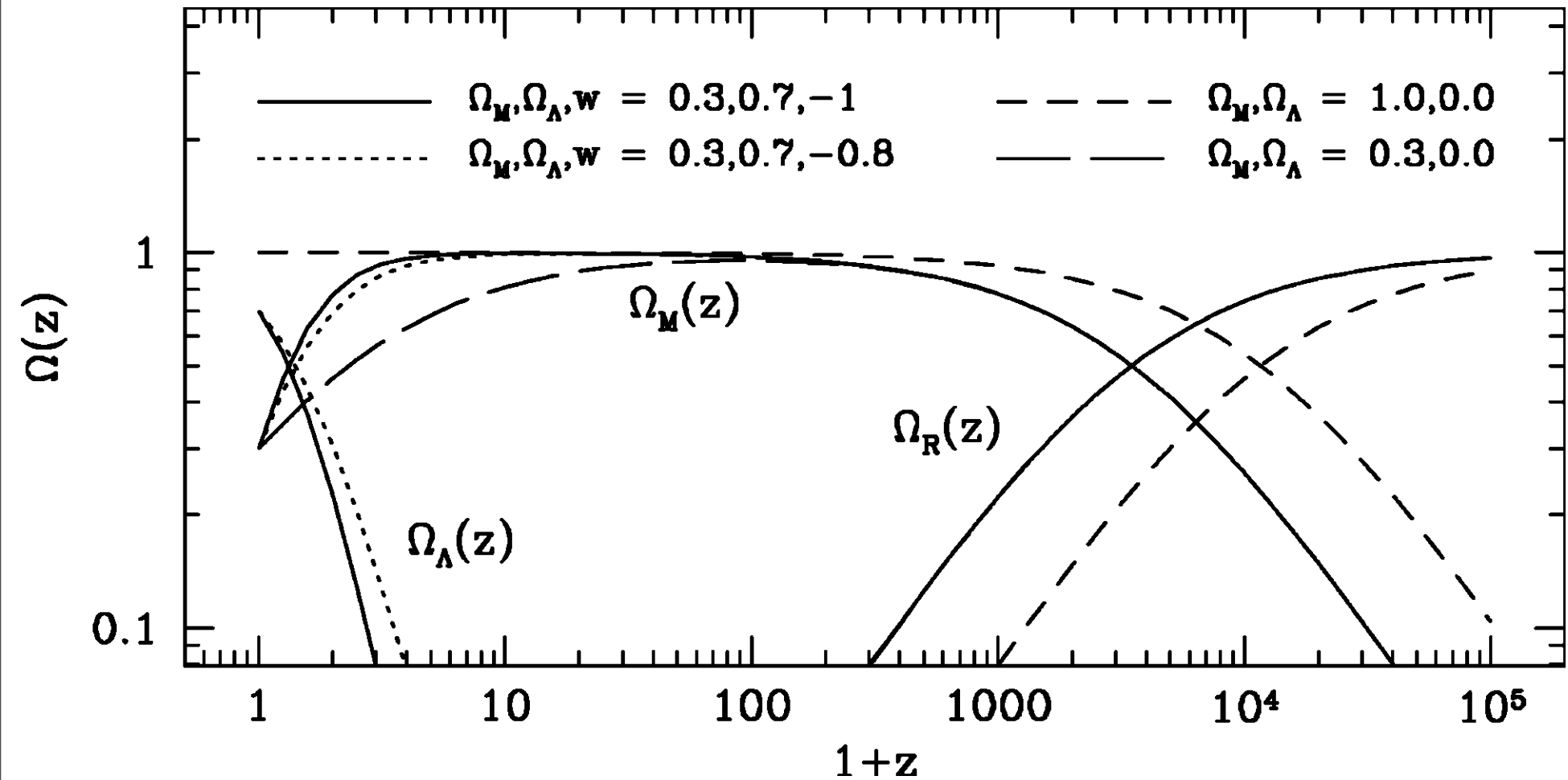
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# Background

What is the thick disc? The Milky Way & Beyond



# Competing models

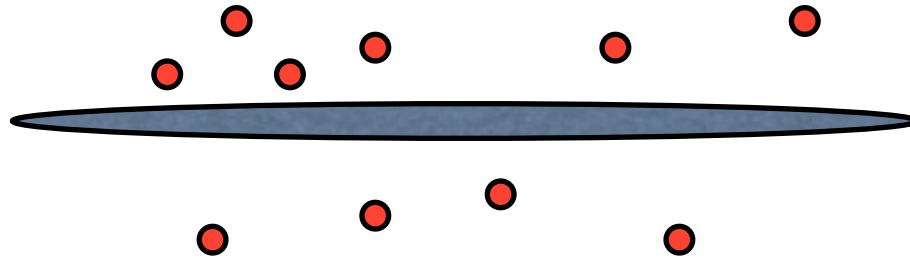
How did the thick disc form?



- Thin disc heating; e.g. Quinn et al. 1993
- Dry satellite mergers; e.g. Abadi et al. 2003
- Pros/cons of each?

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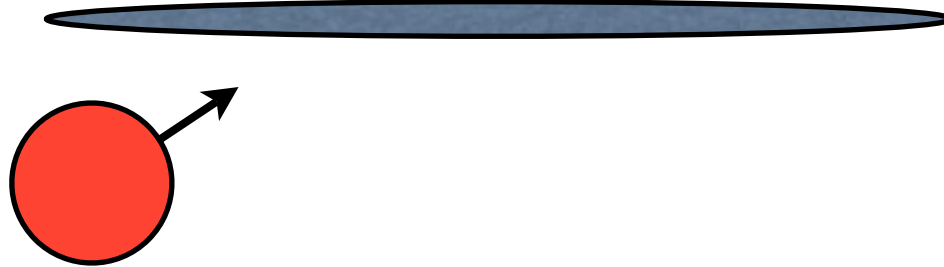


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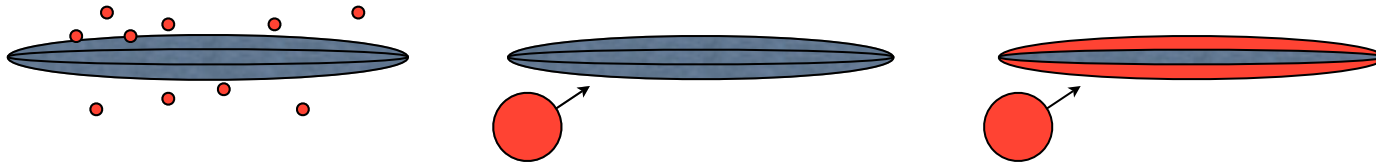
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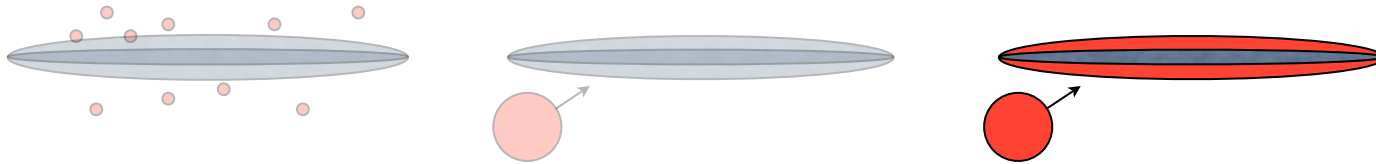
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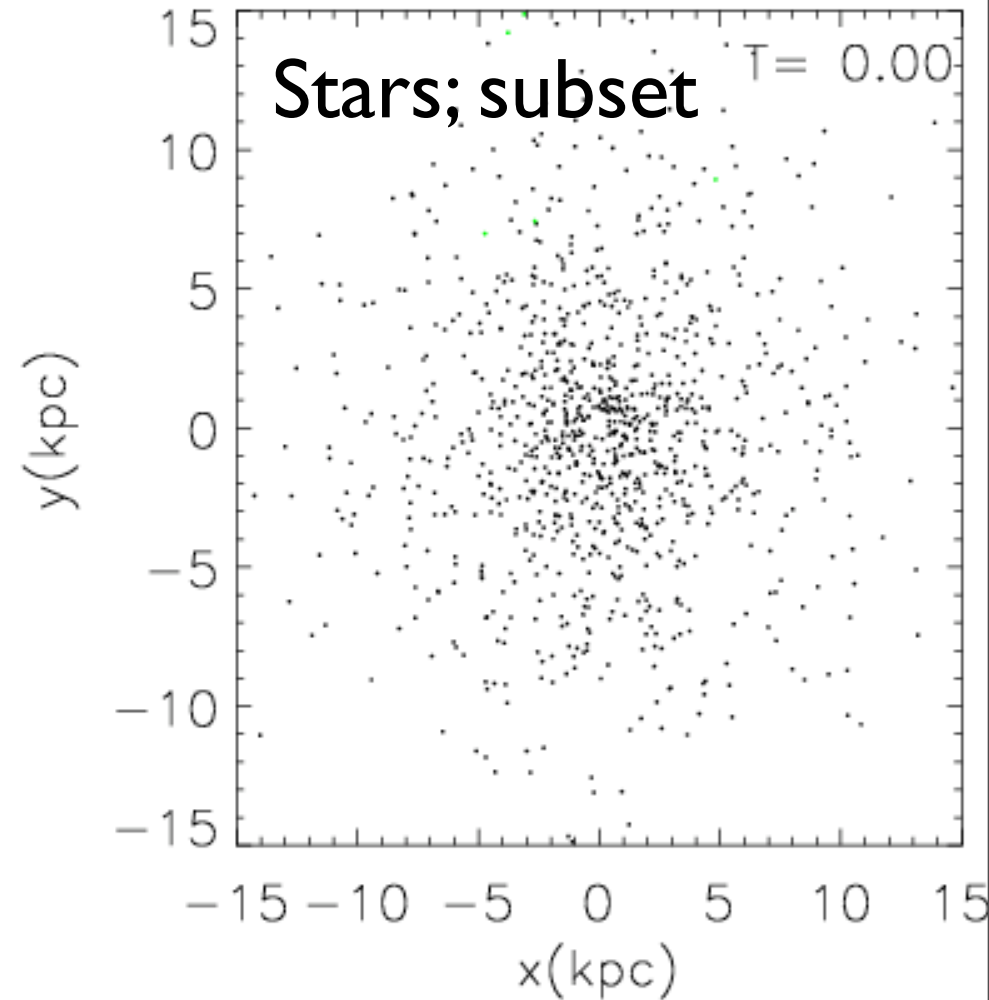
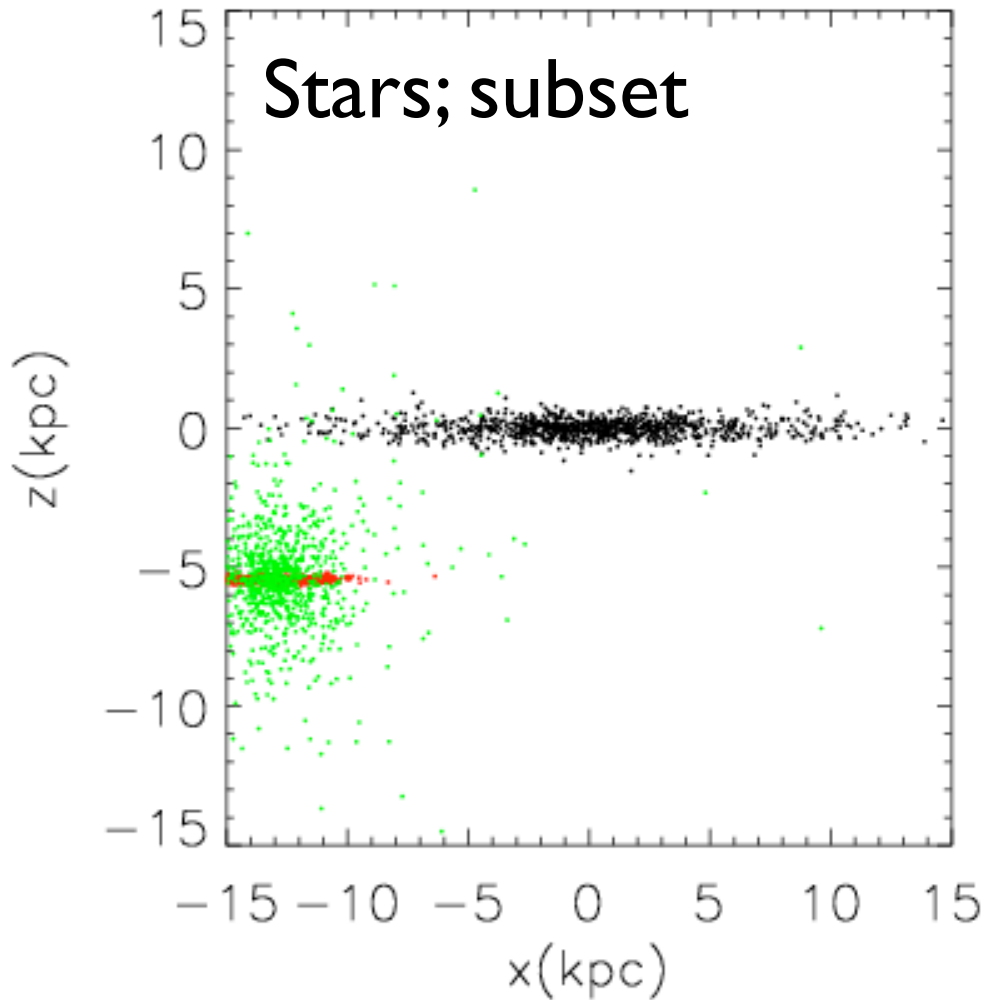
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# Key idea....

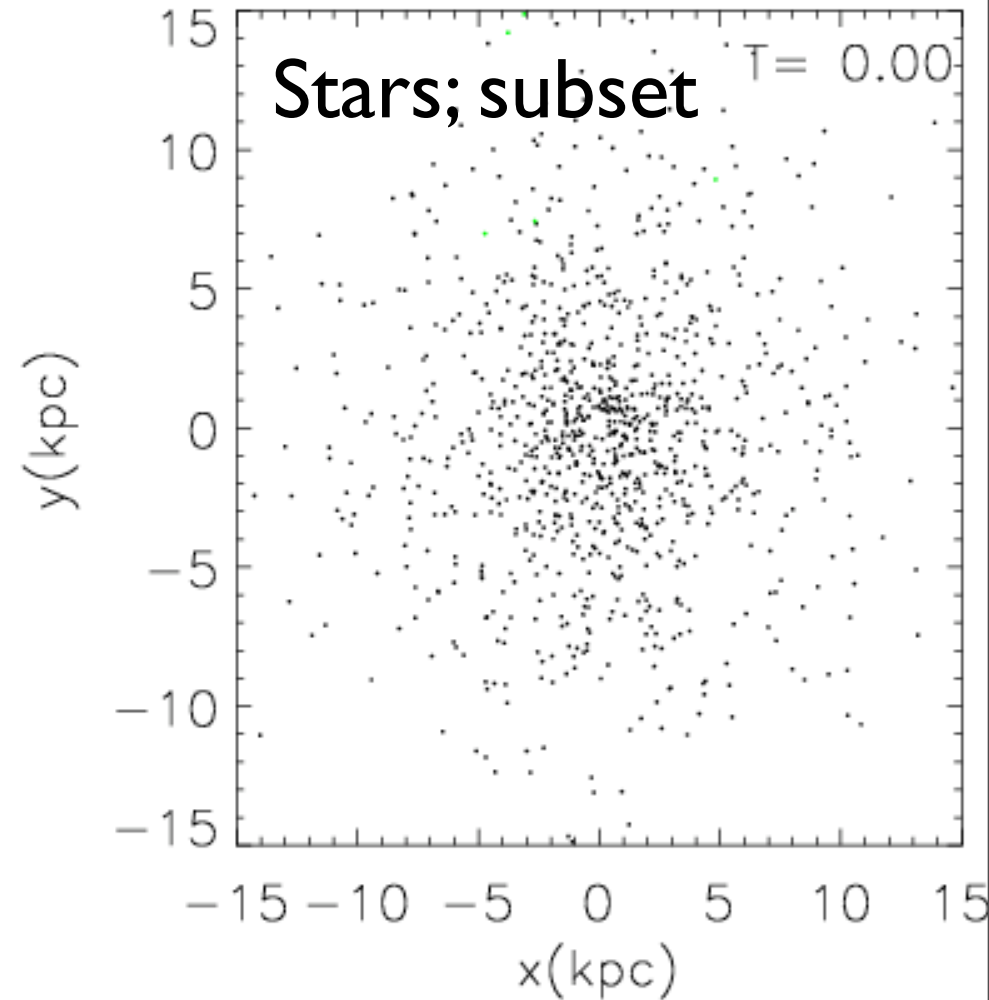
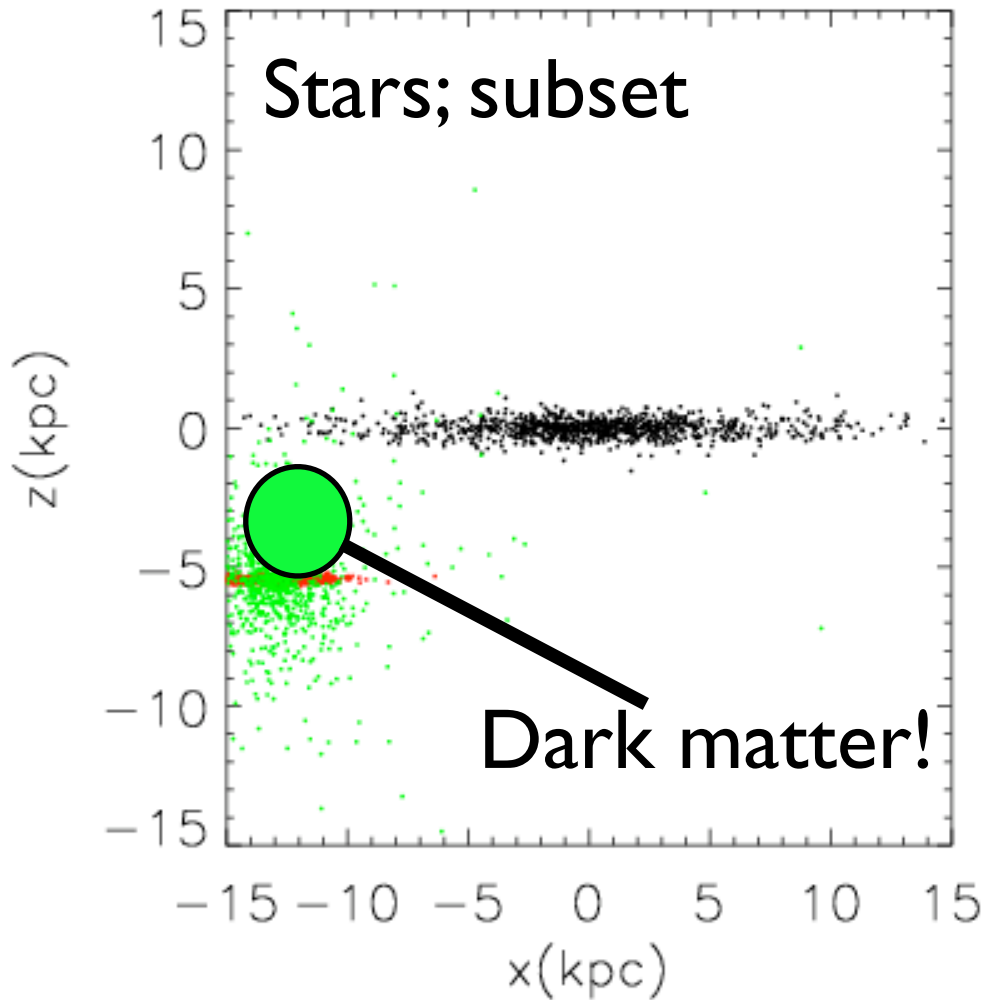
Dry mergers deposit stars *and dark matter*





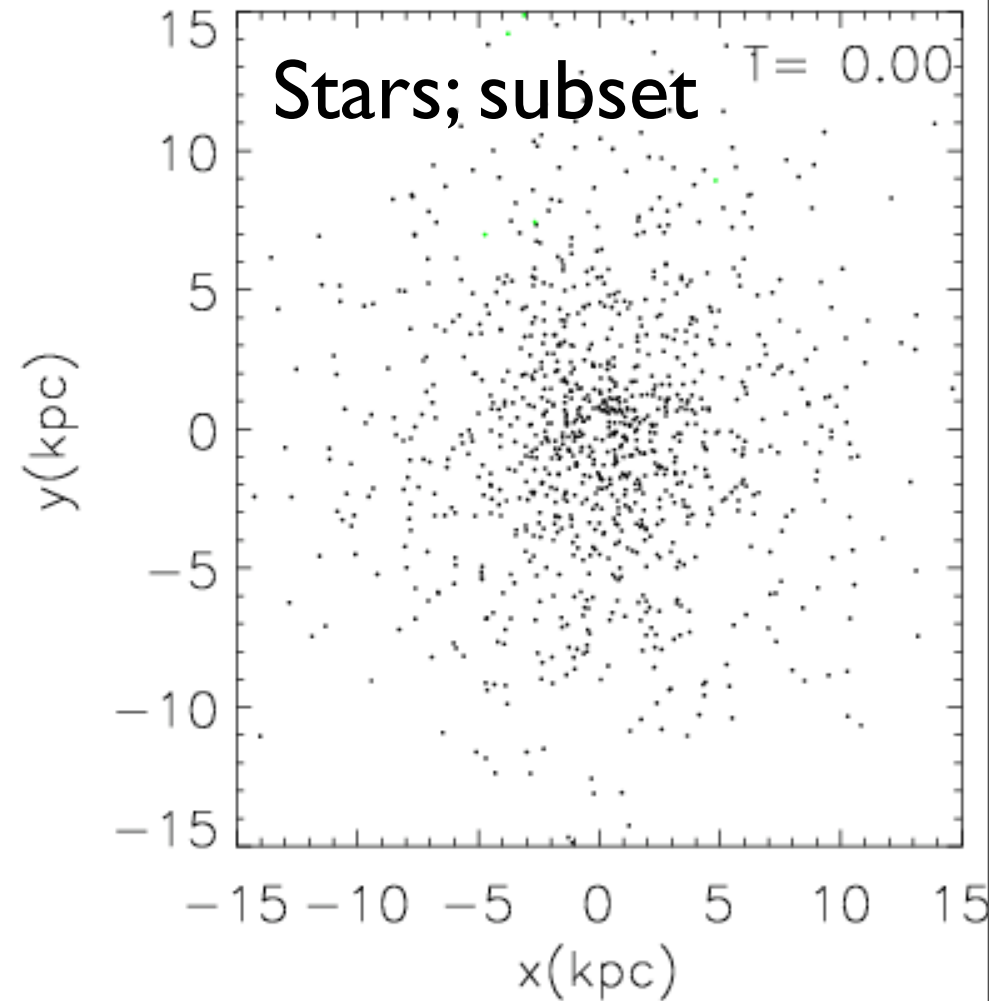
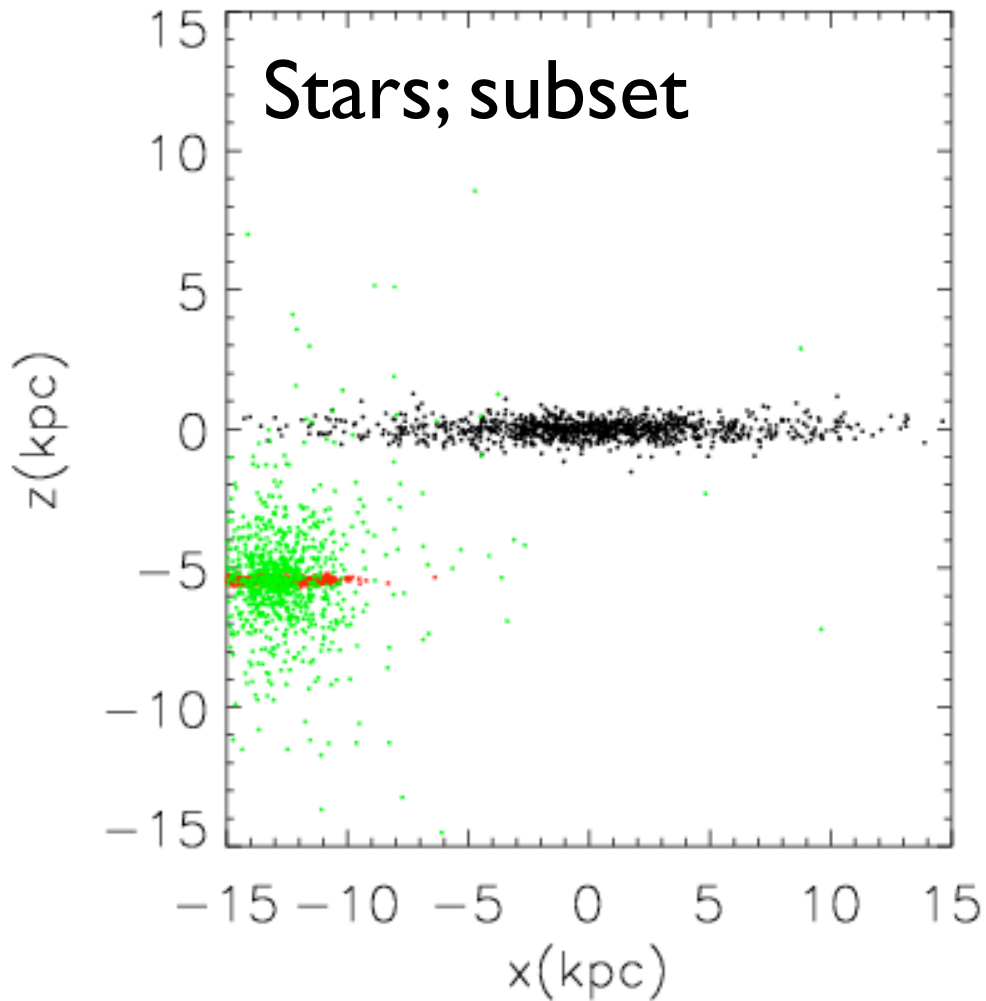
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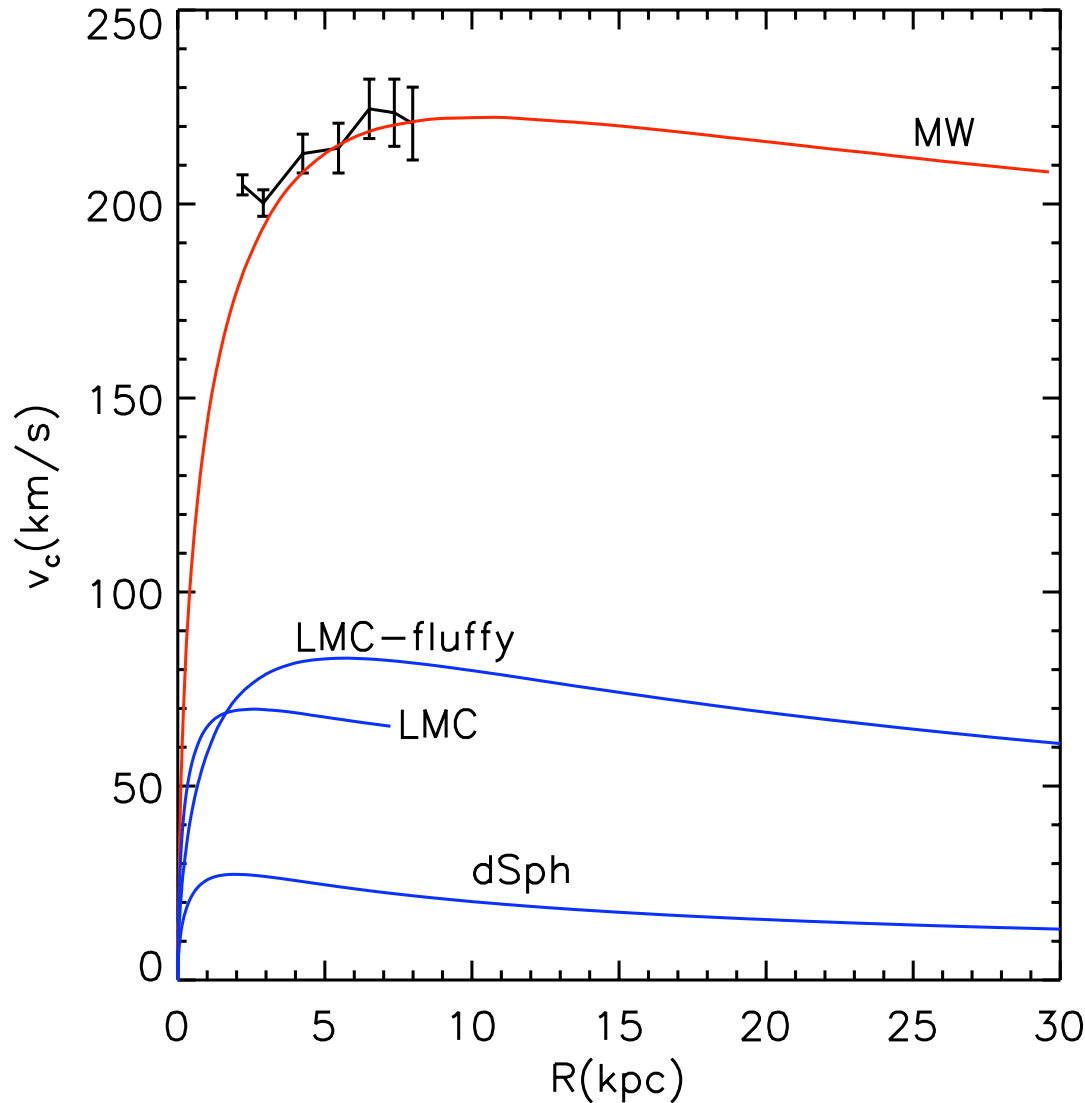
# Key idea....

Dry mergers deposit stars *and dark matter*



# The simulations

## Initial conditions



$$N_* = 7.5 \times 10^5; \epsilon_* = 0.06 \text{ kpc}$$

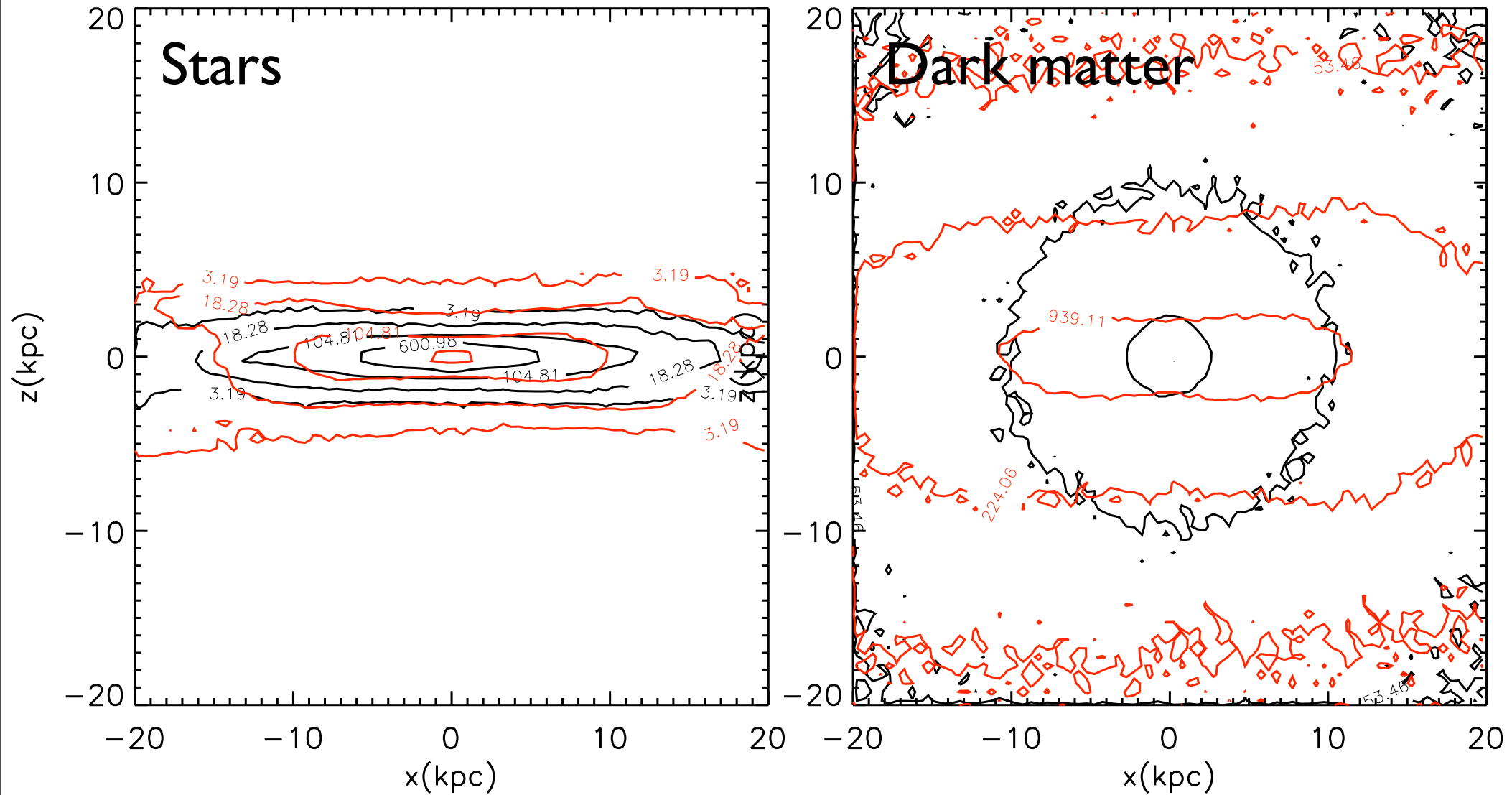
$$N_{dm} = 2 \times 10^6; \epsilon_{dm} = 0.1 \text{ kpc}$$

$$N_* = 7.5 \times 10^5; \epsilon_* = 0.01 \text{ kpc}$$

$$N_{dm} = 2 \times 10^6; \epsilon_{dm} = 0.03 \text{ kpc}$$

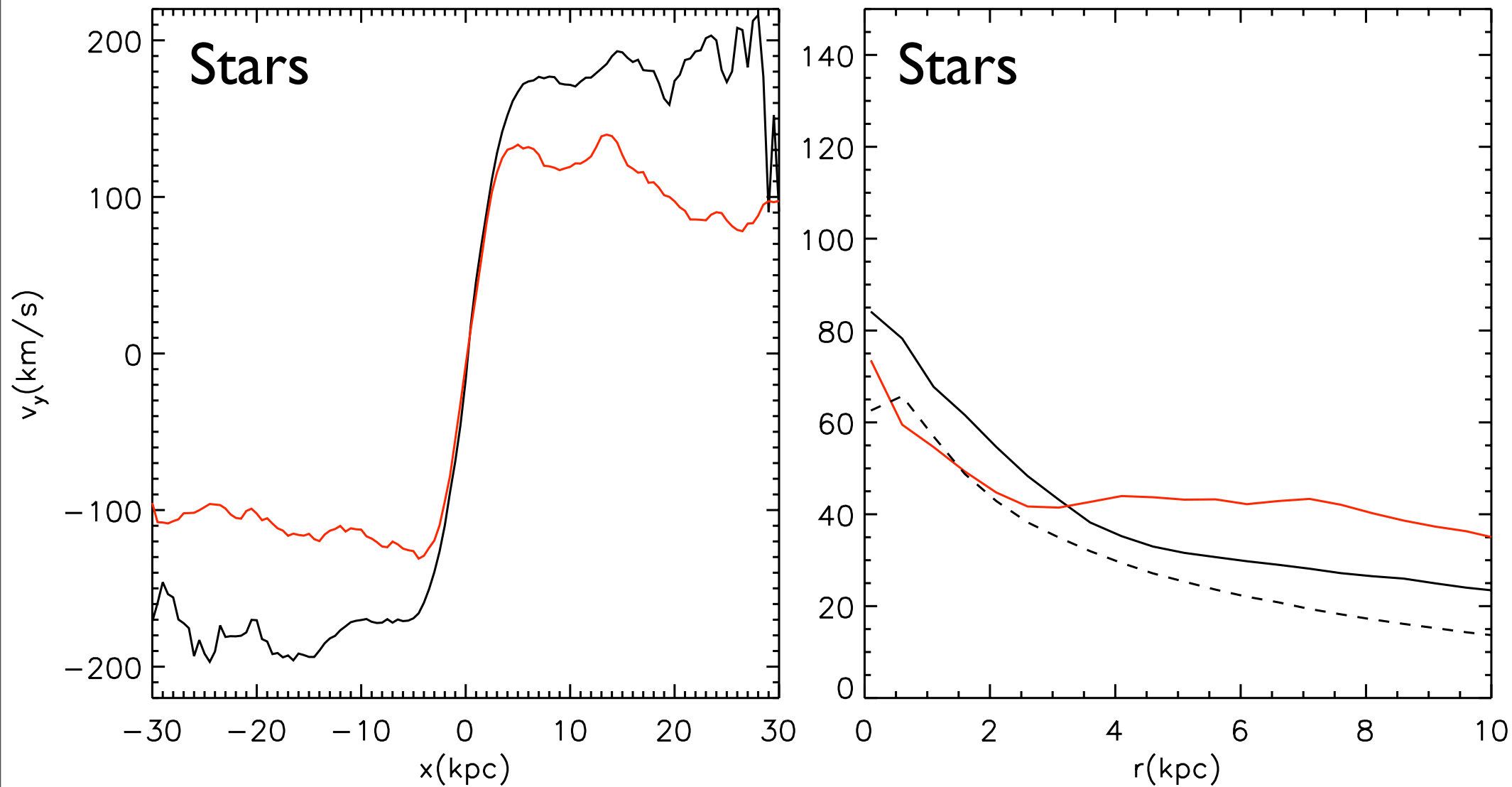
# The simulations

## LMC



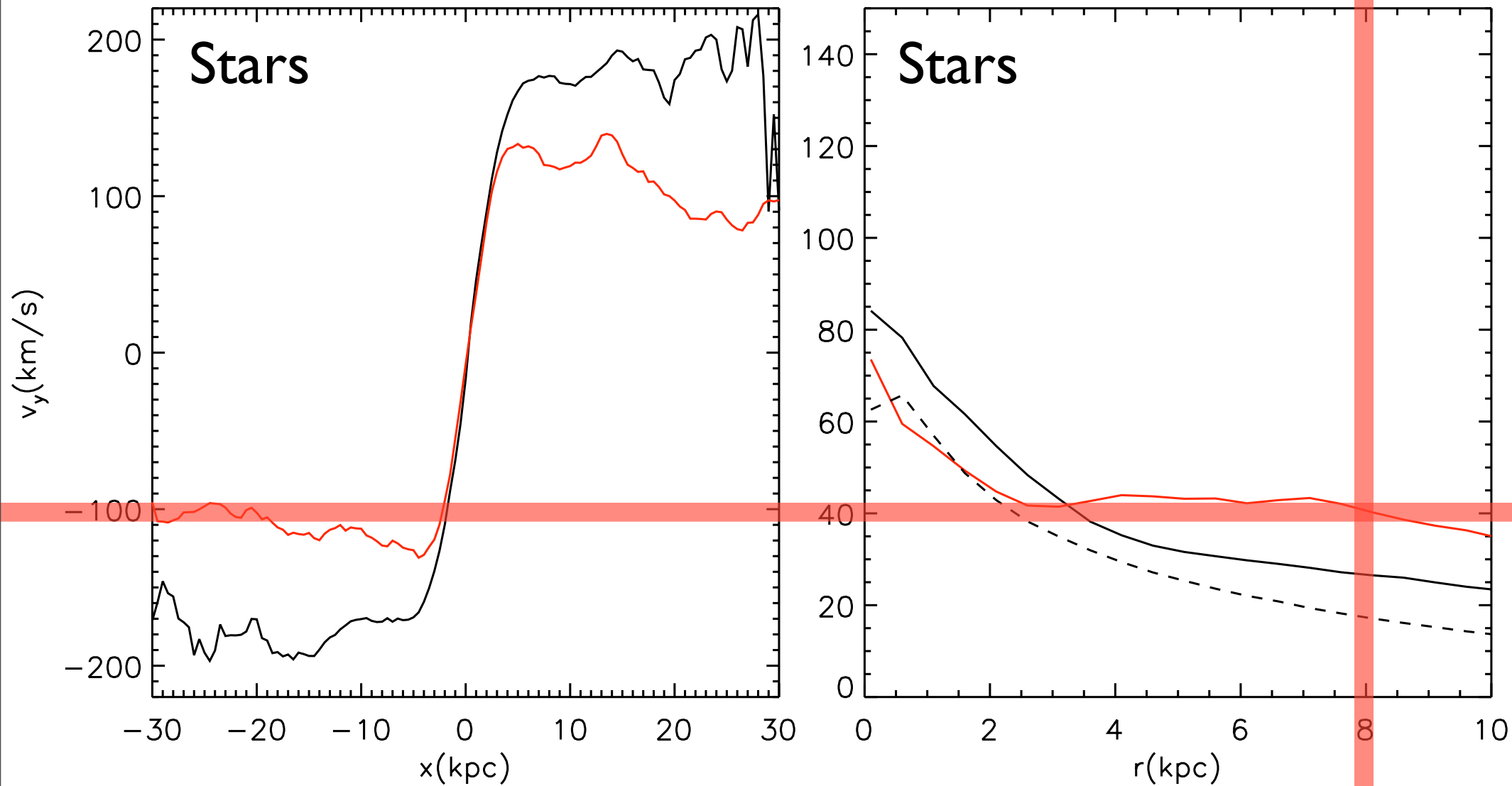
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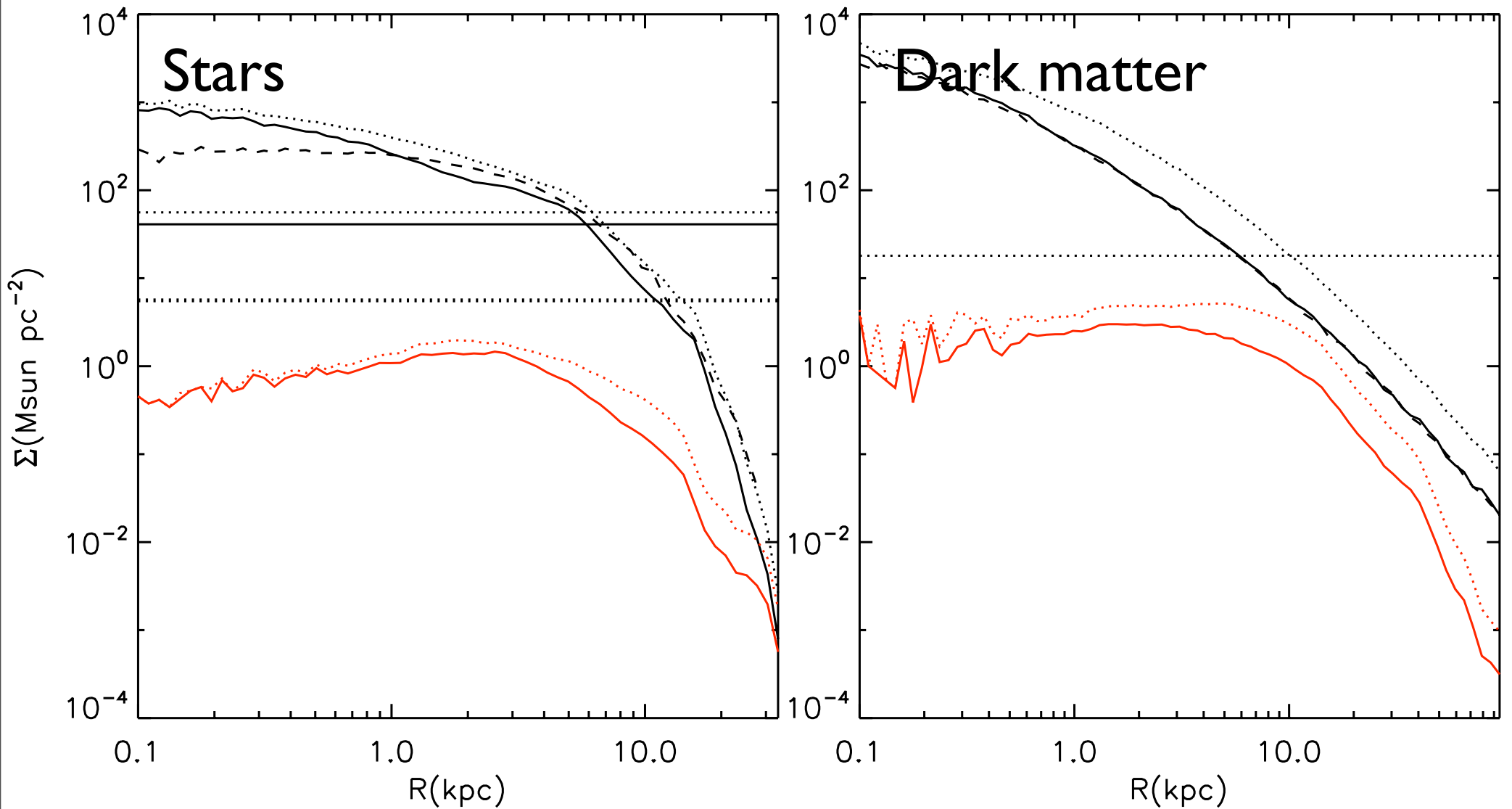
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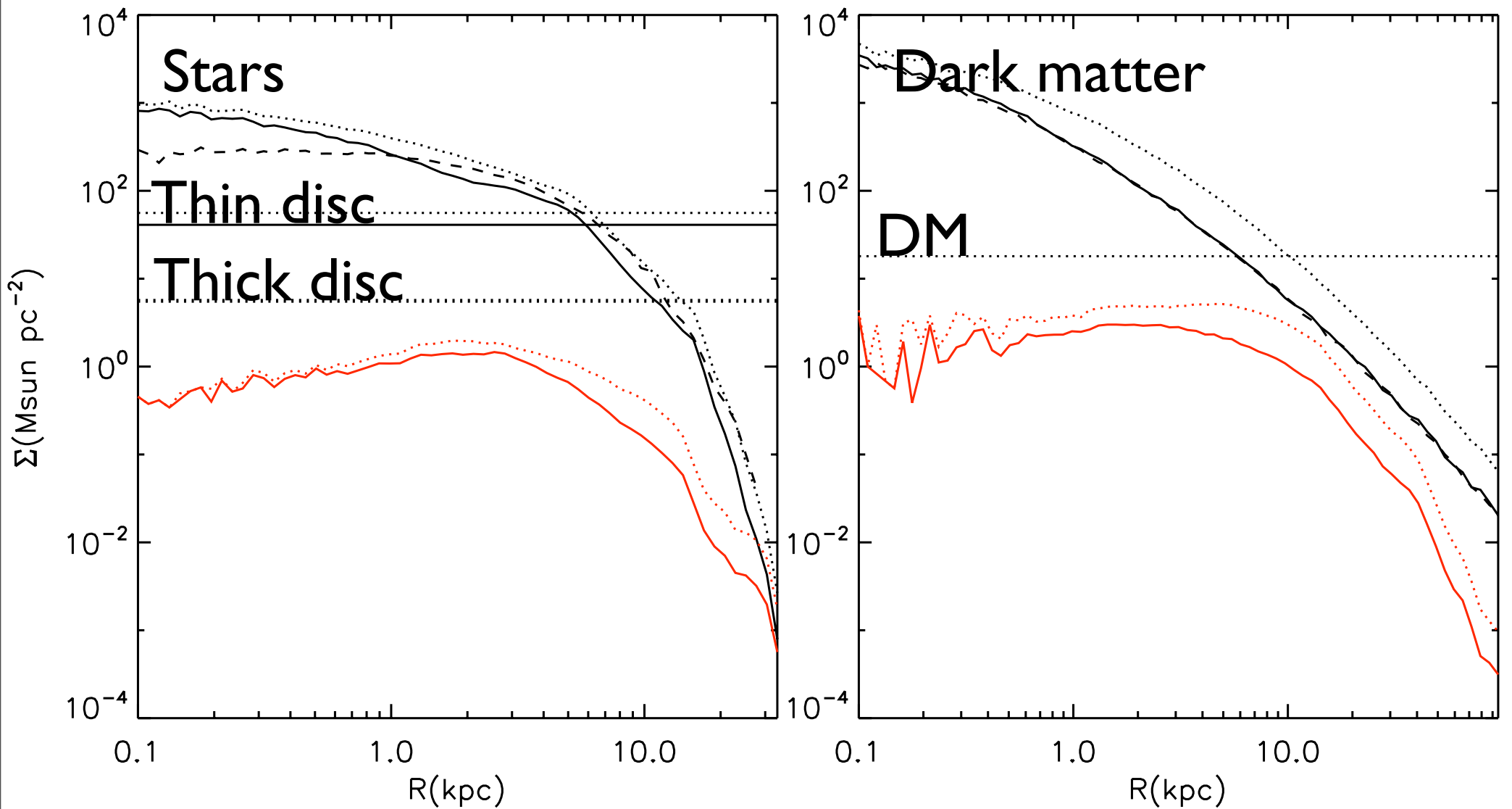
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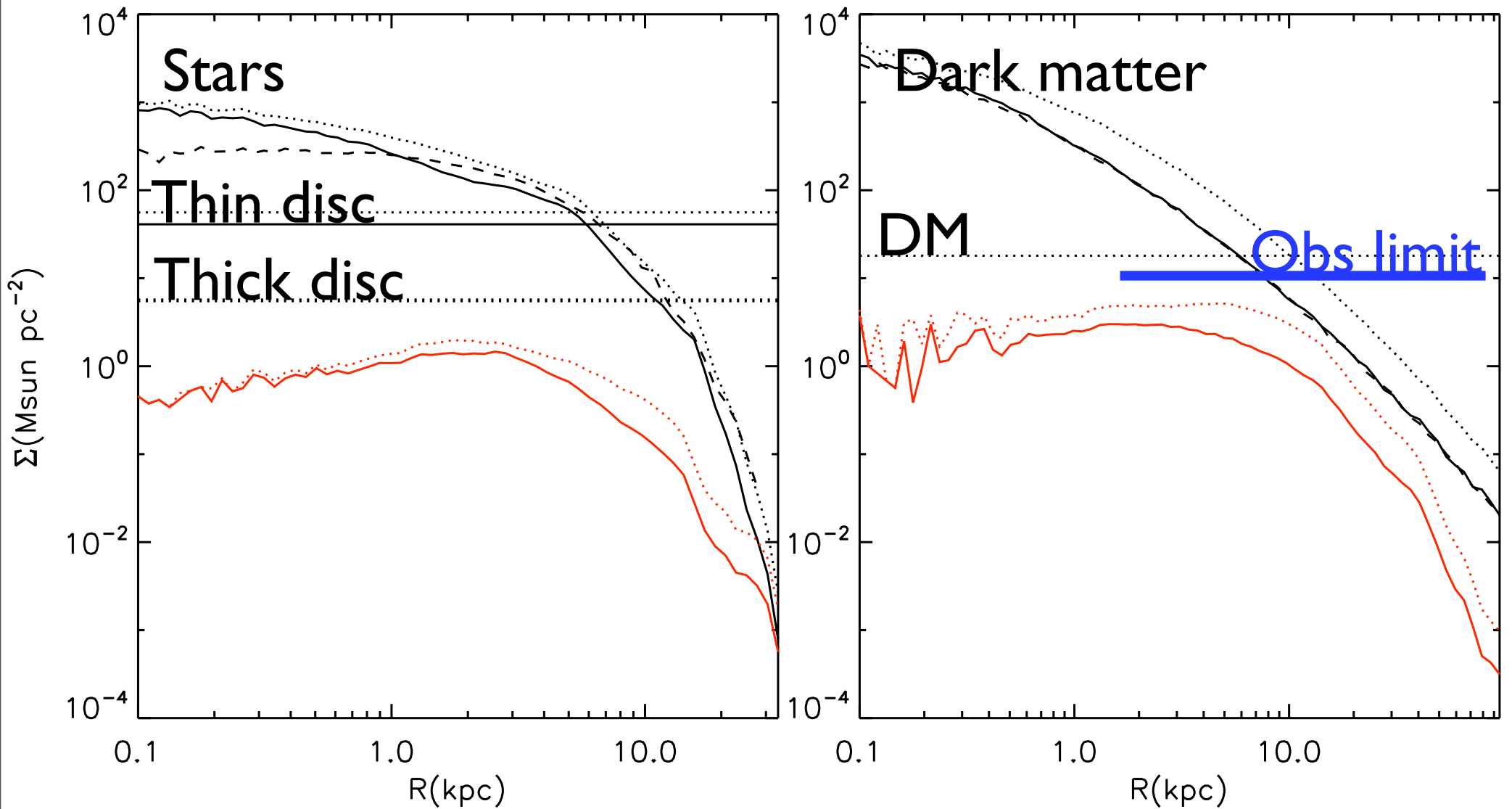
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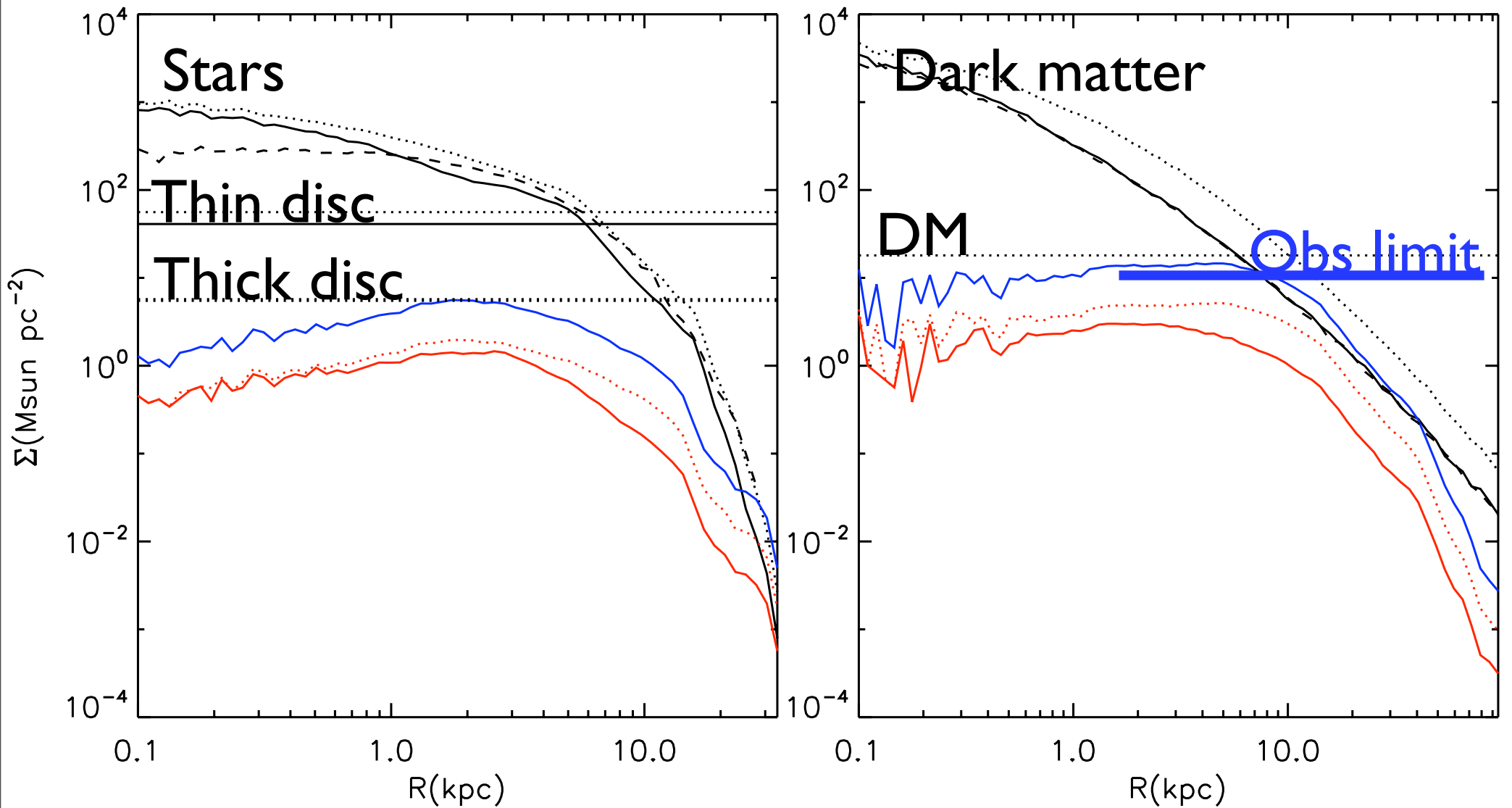
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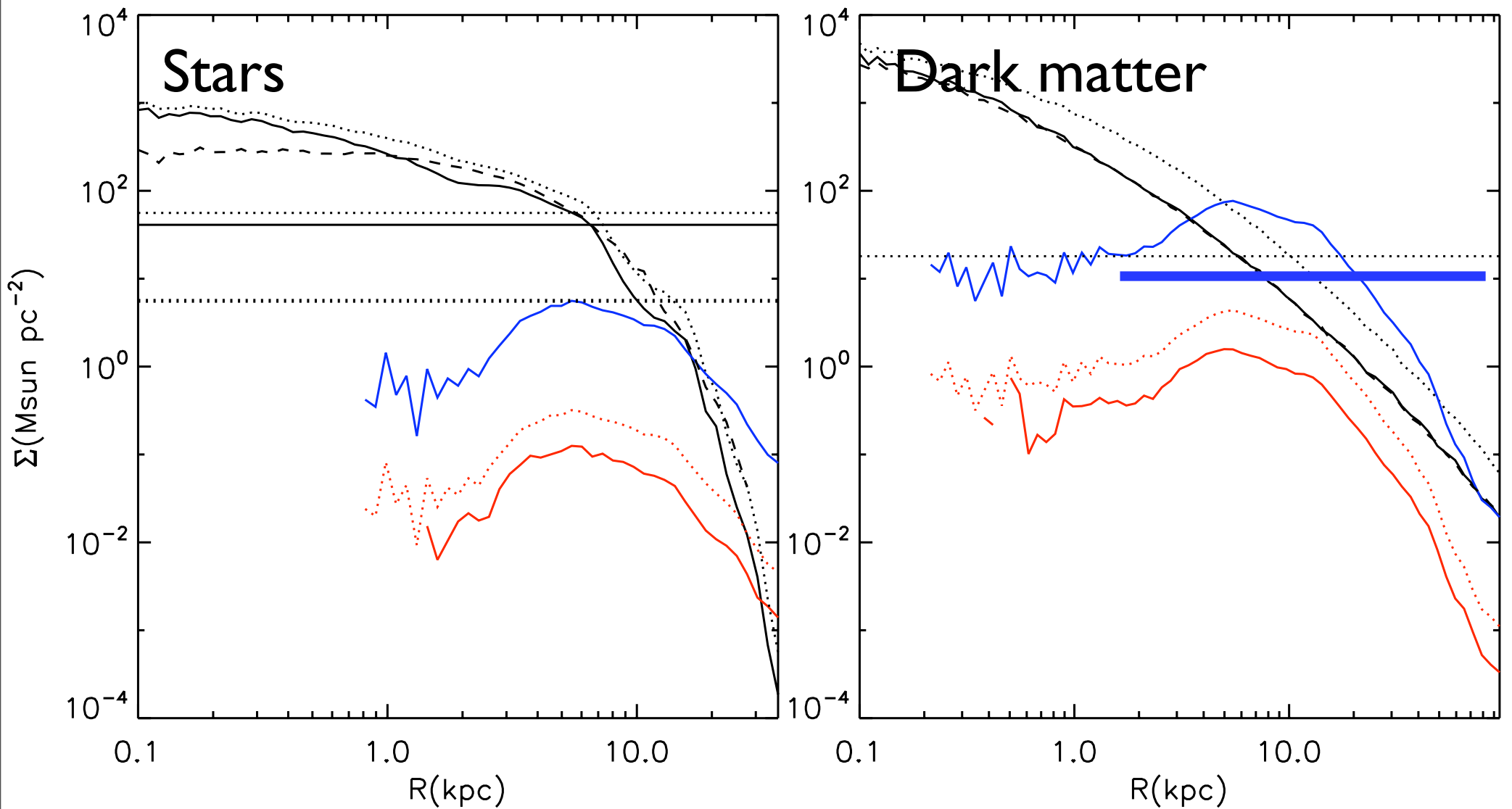
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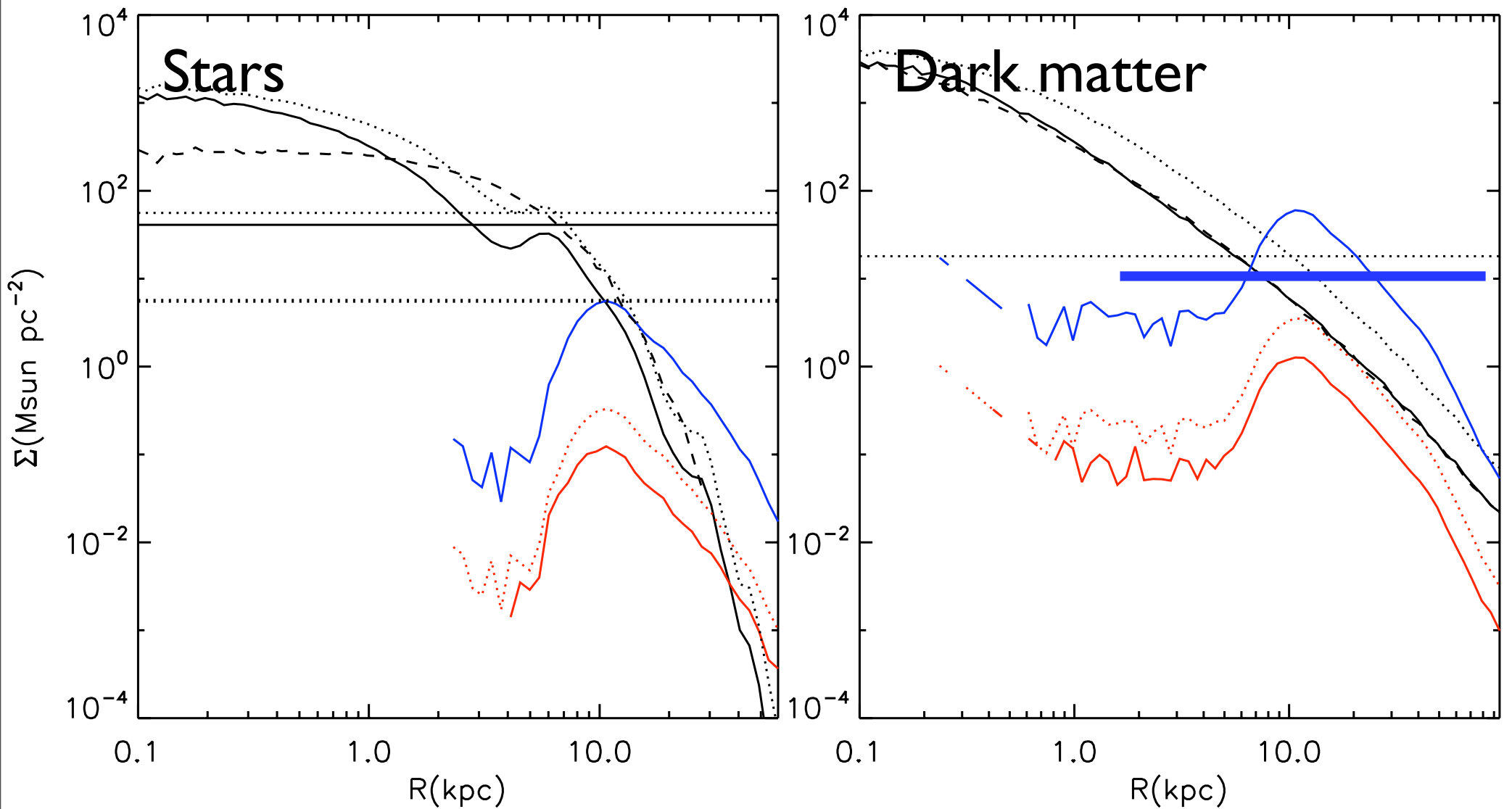
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LMC - fluffy



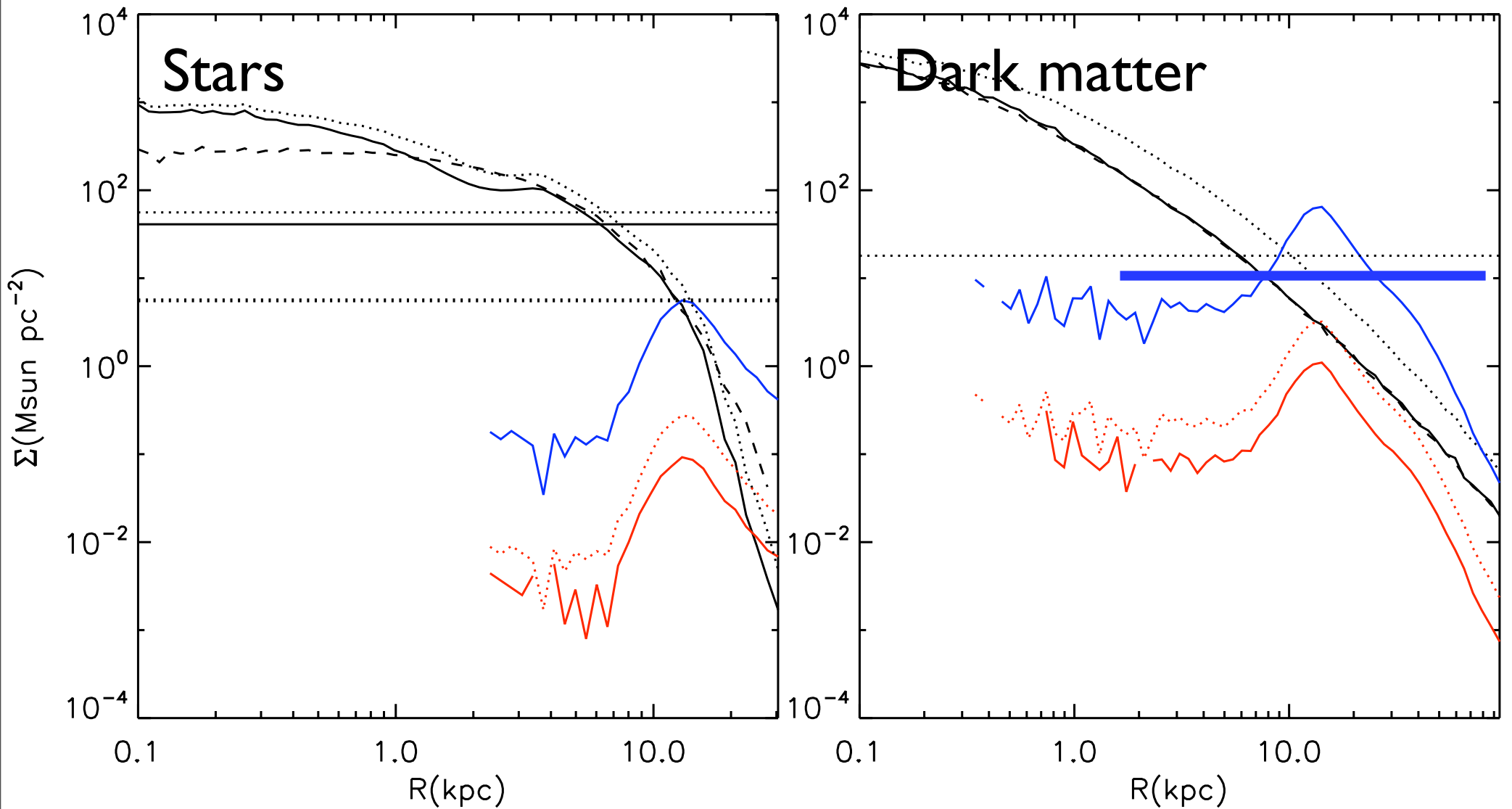
# The simulations

LMC - fluffy; circular



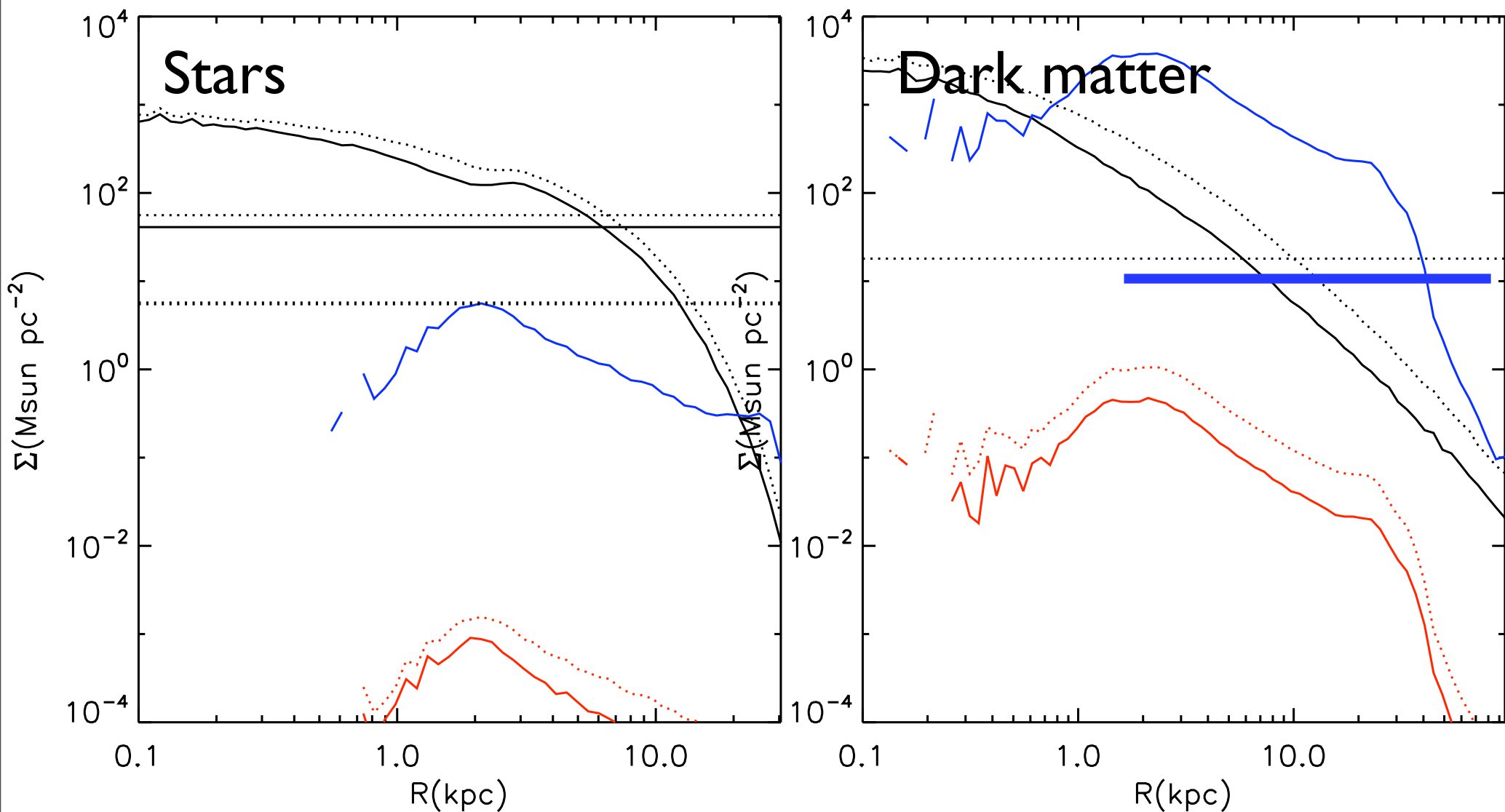
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LMC - fluffy; circular; retrograde



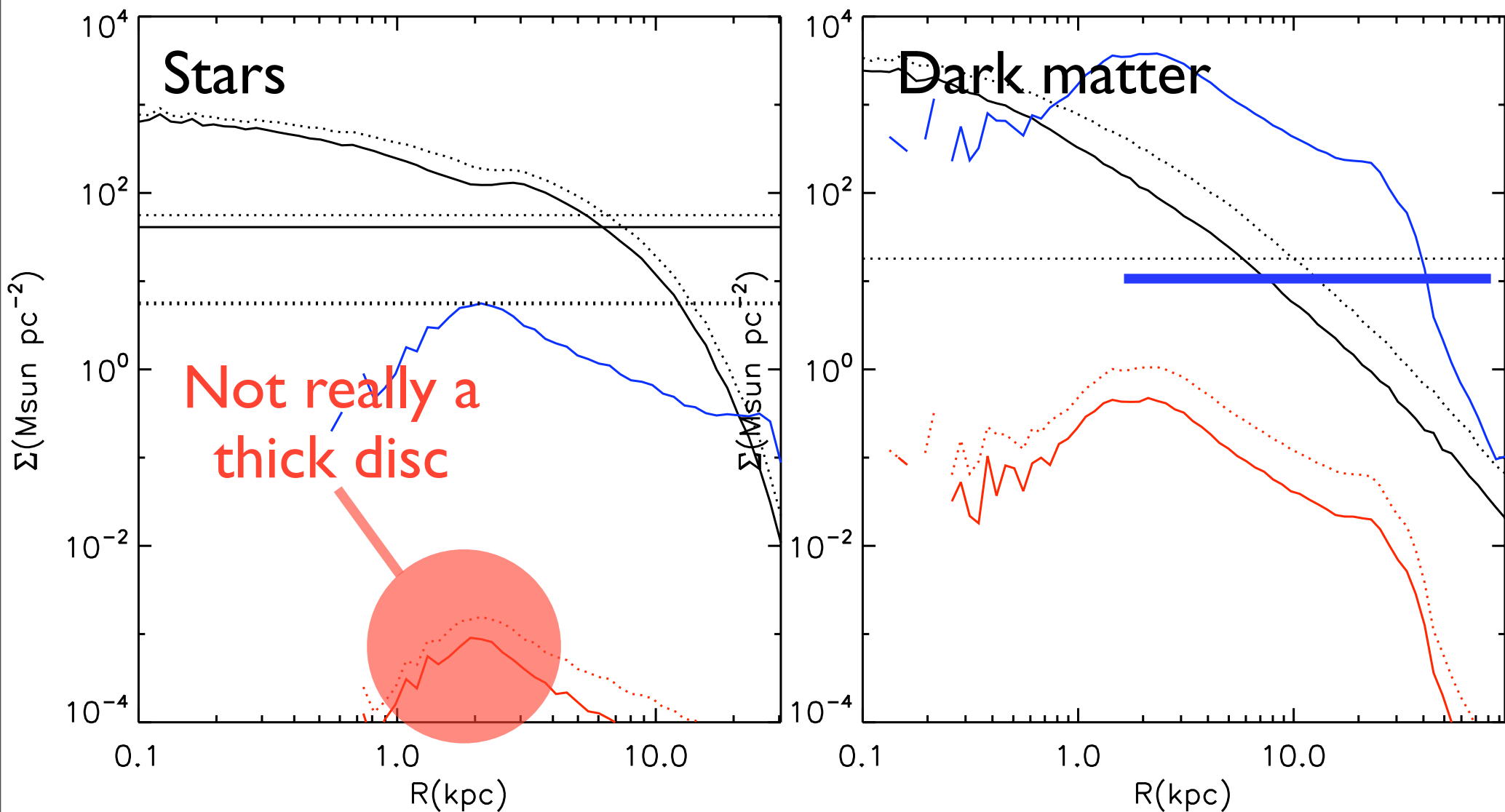
# The simulations

dSph; very radial



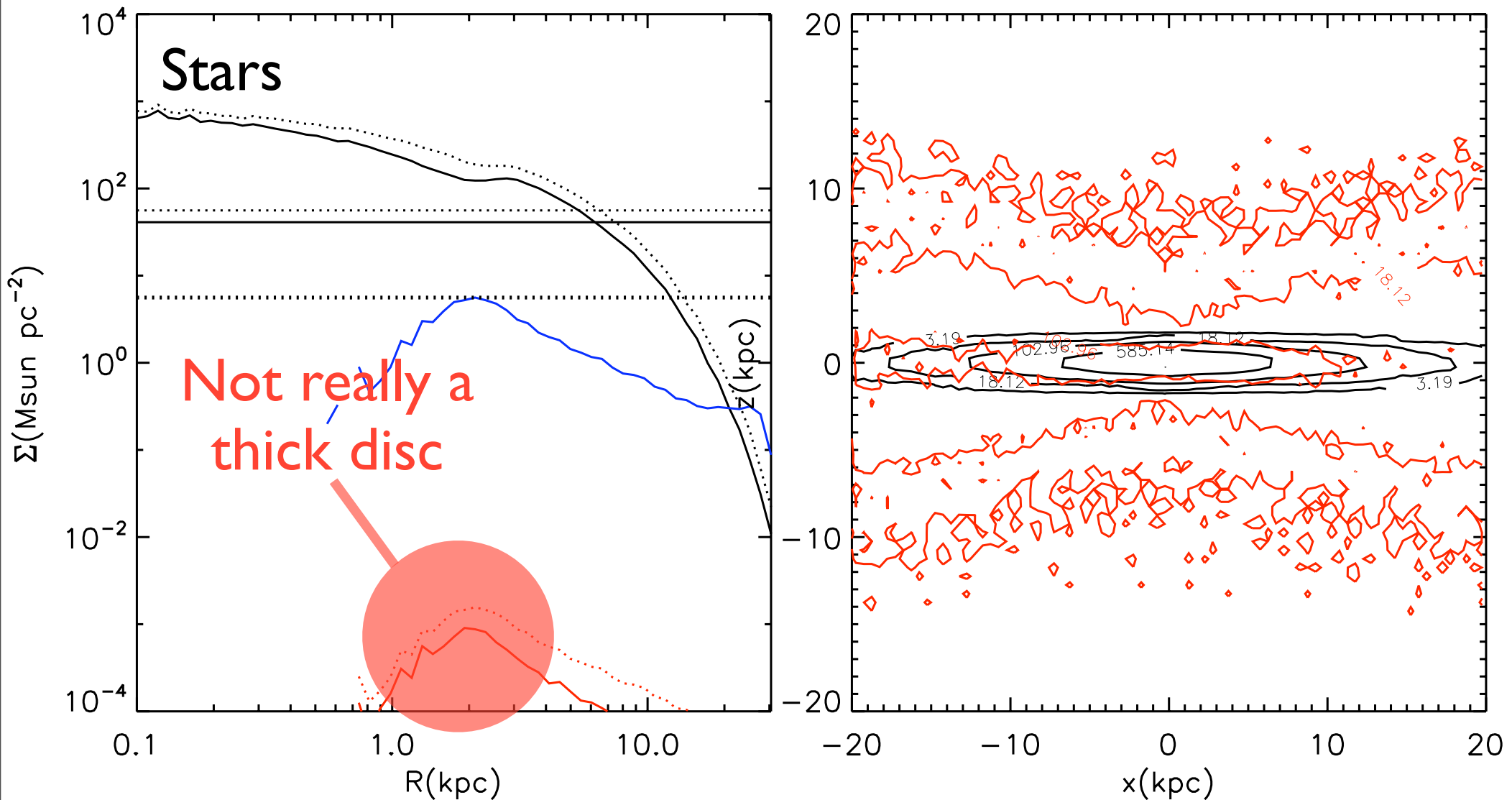
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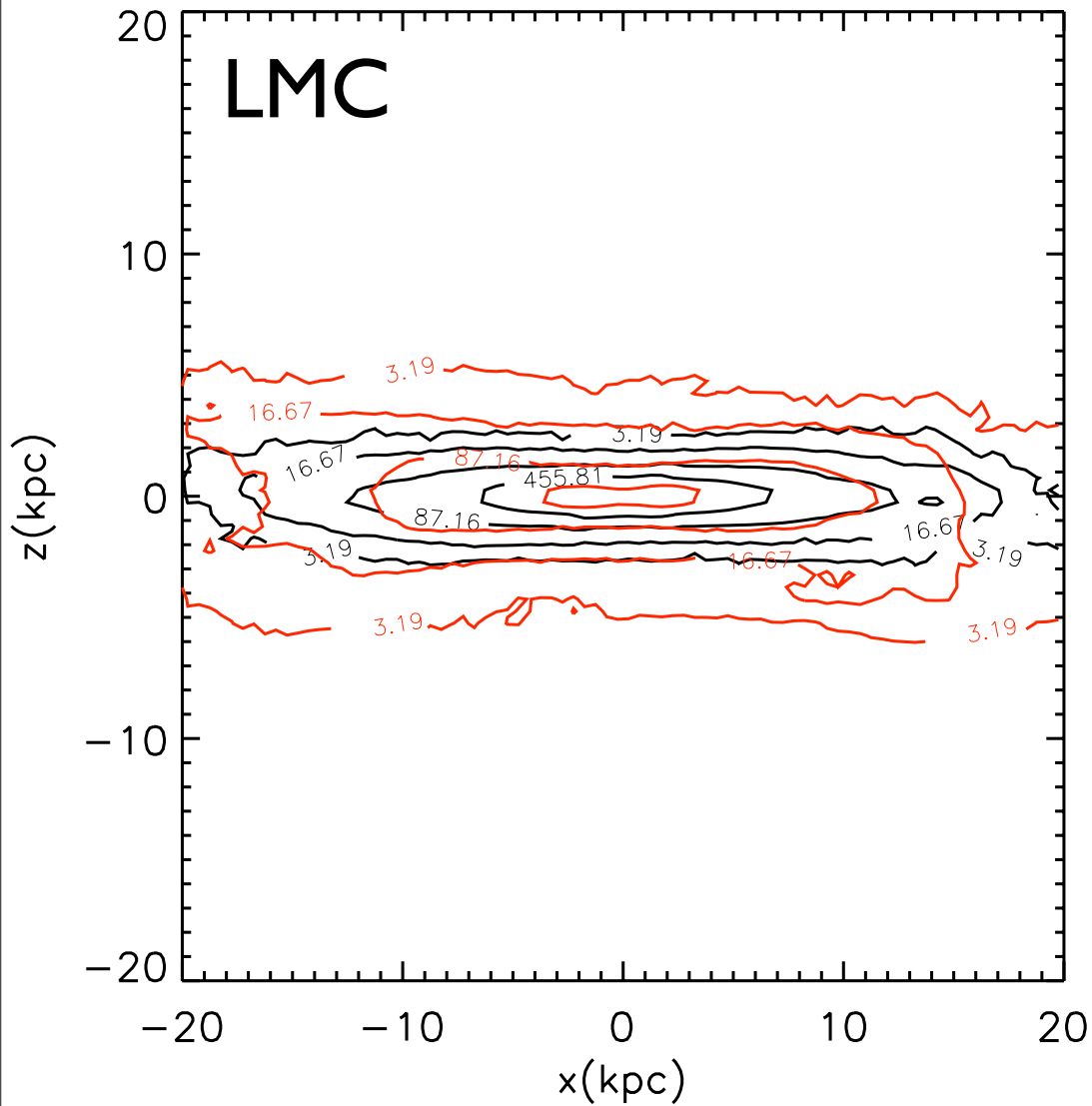
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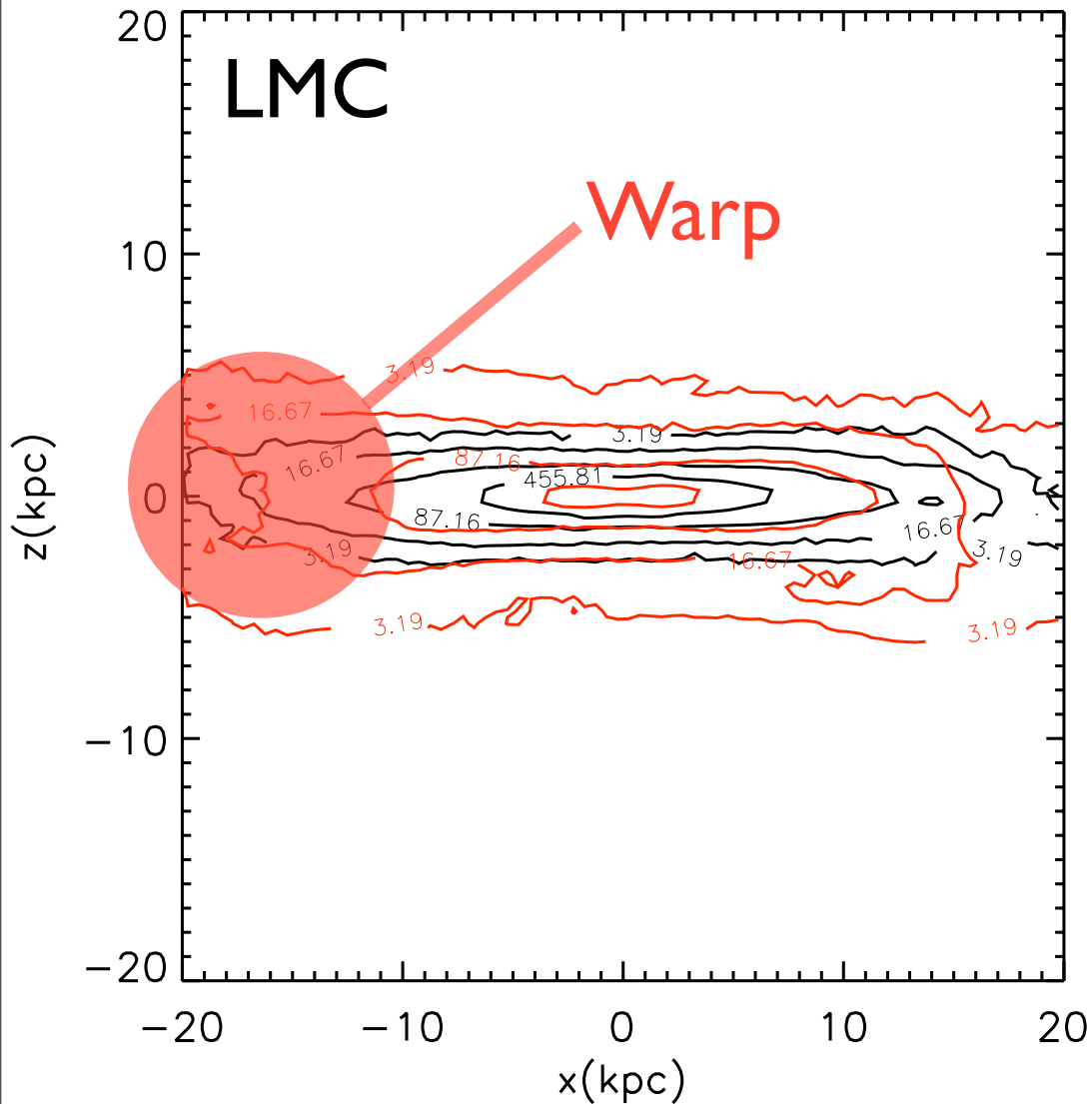
# The simulations

The effect on the thin disc



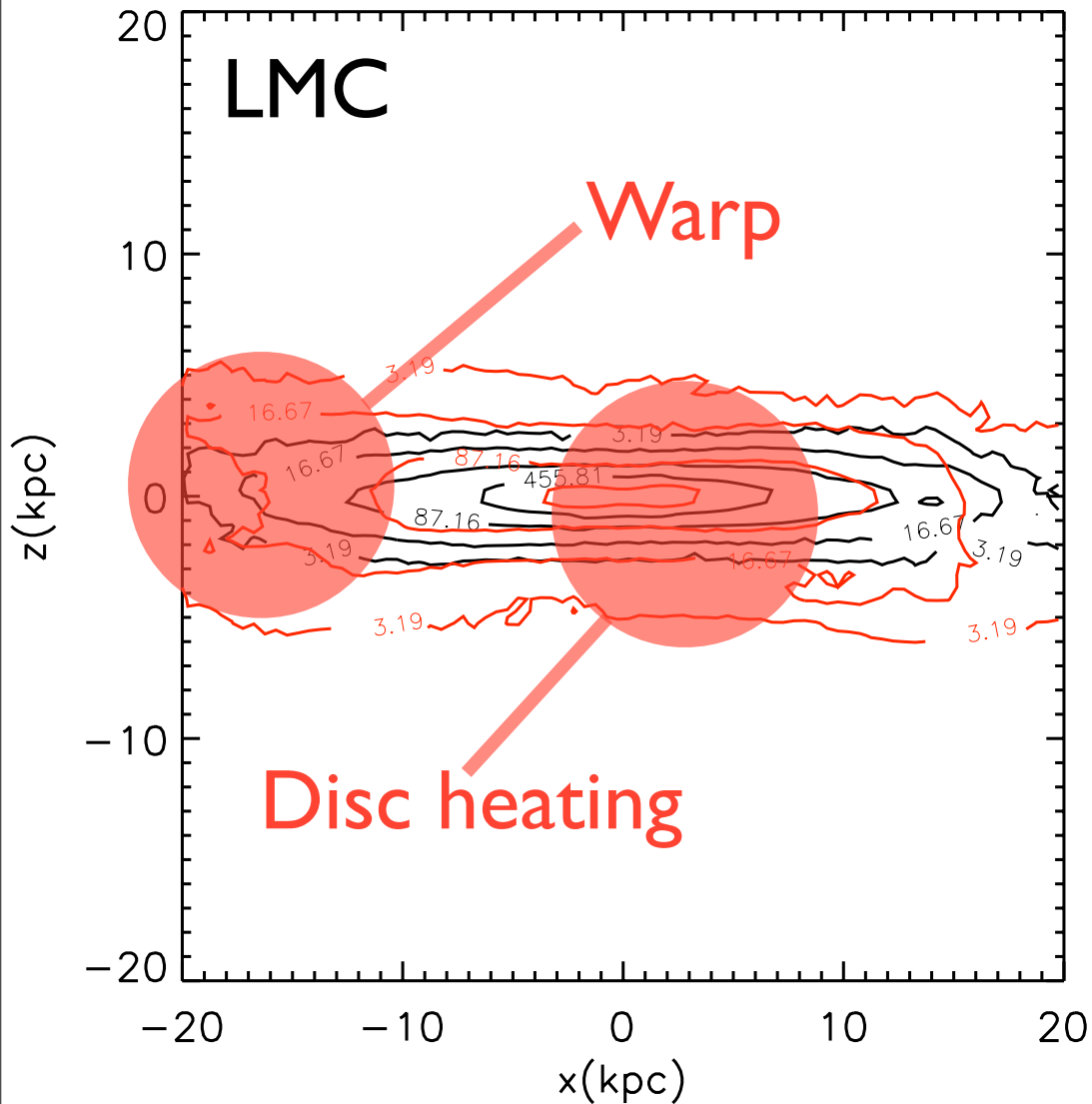
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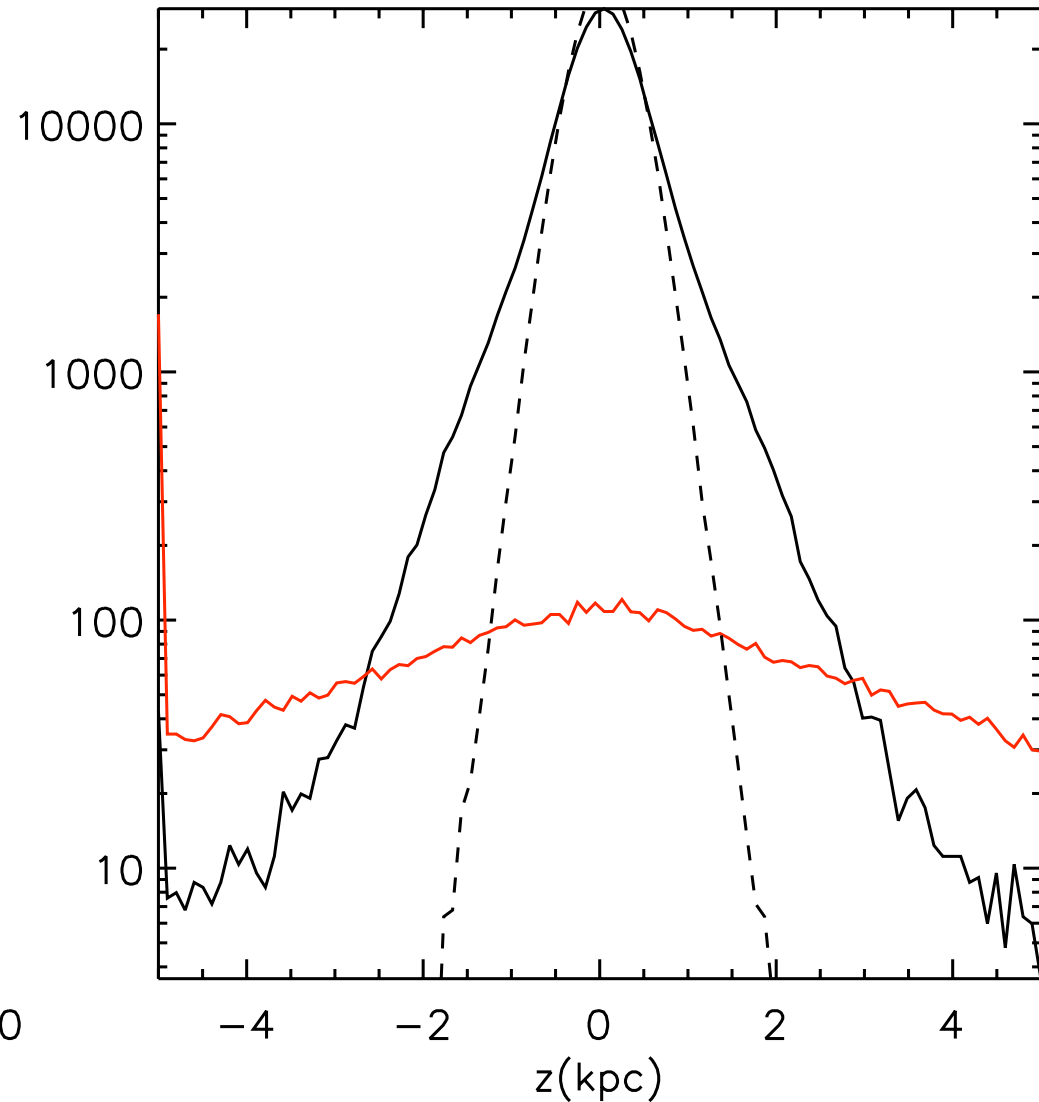
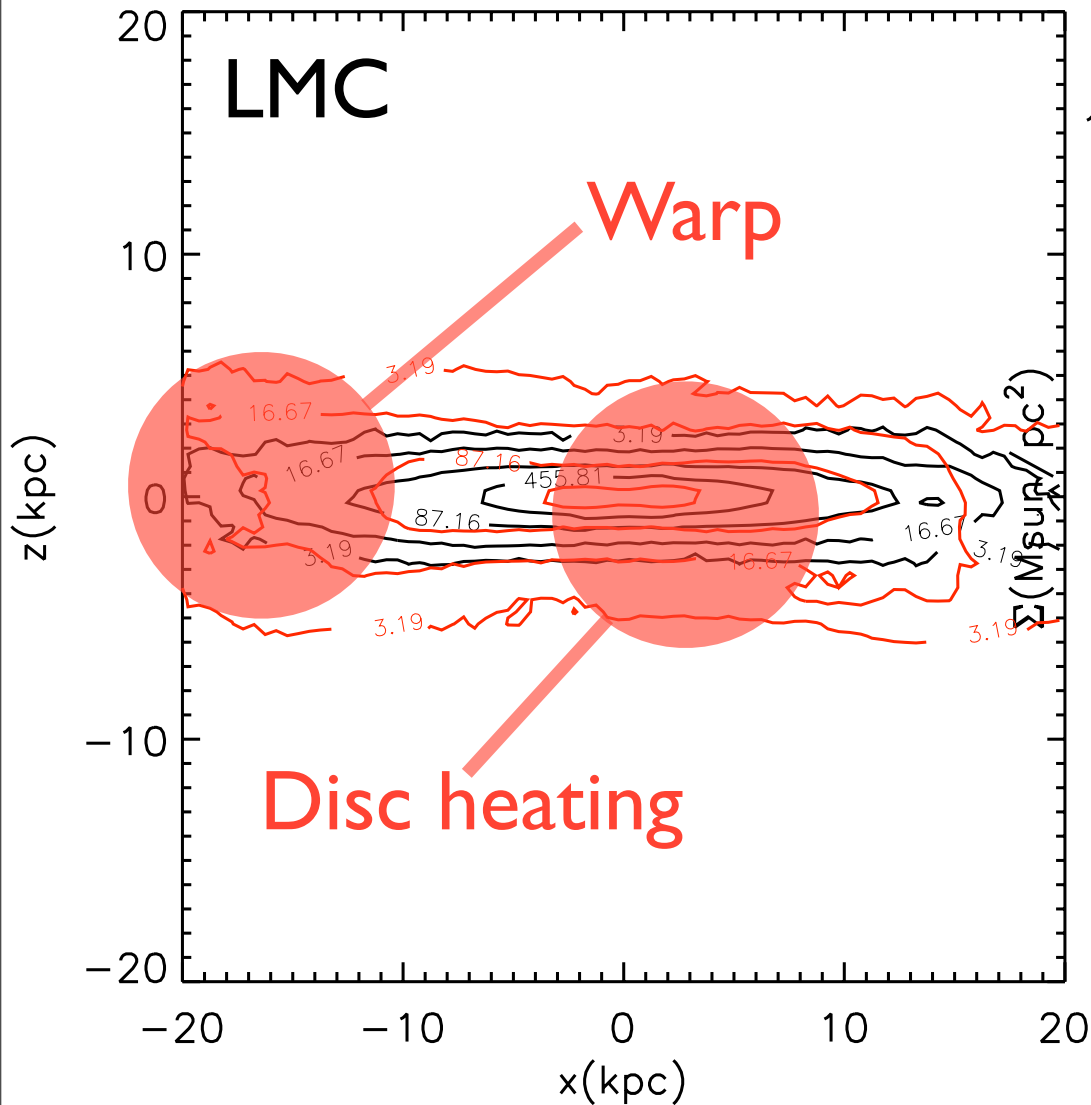
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# The simulations

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# The simulations

The satellite mass to light ratio

	$M_{\text{tot}}/M_*$	$M_{\text{tot}}/M_*( < 3 \text{ kpc} )$
LMC	35	5
10 Msun / pc <sup>2</sup>	24	3.85
1 Msun / pc <sup>2</sup>	2.6	1.68

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- Such a merger does not heat the thin disc too greatly [within observational constraints].
- It can lead to a warp -- but that's OK. We see warp in the Milky Way.
- Mergers like this bring dark matter into the disc. But it seems, for a satellite with the above properties, we cannot detect it within obs. errors.... yet!