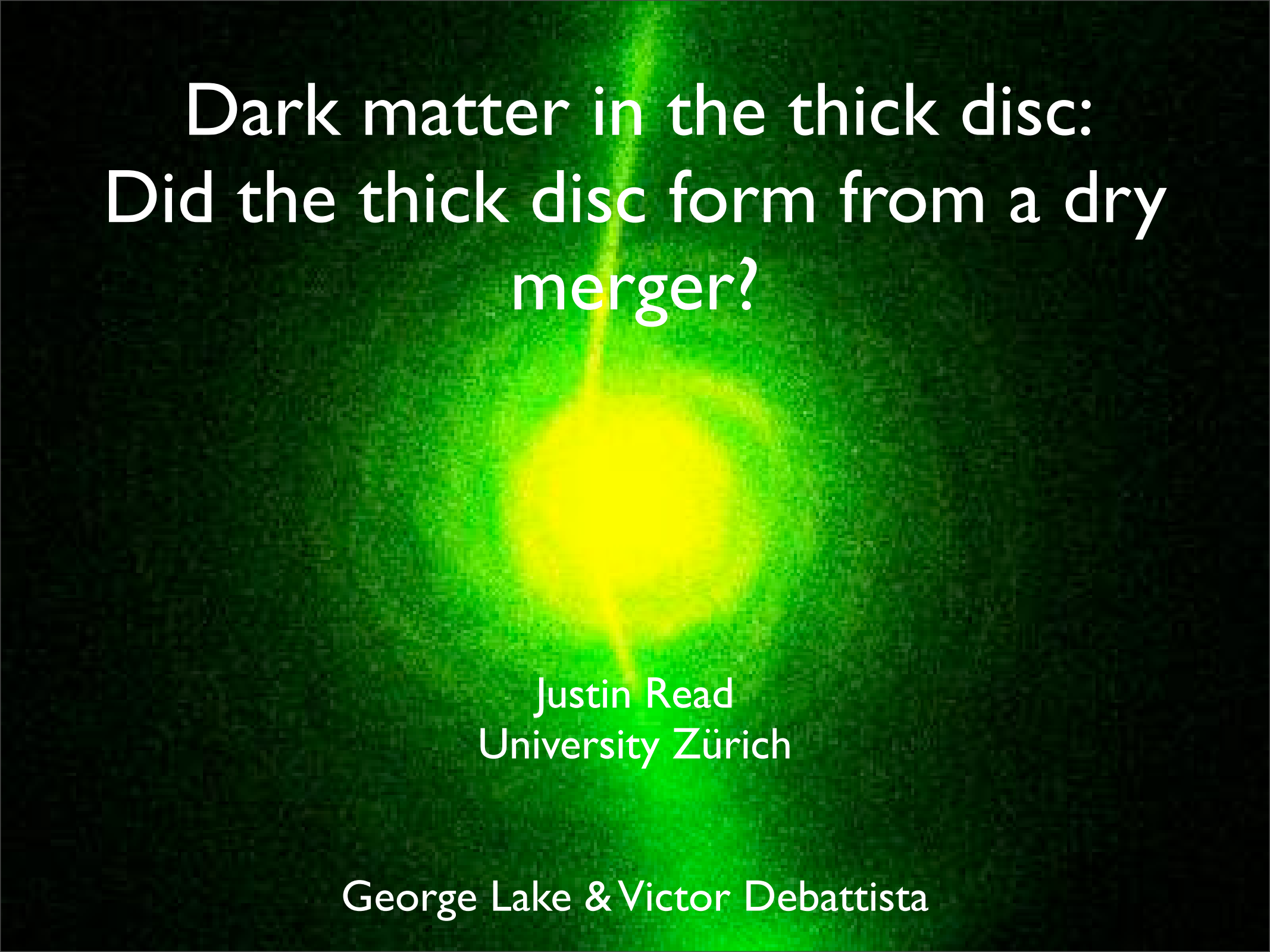
Dark matter in the thick disc: Did the thick disc form from a dry merger?



Justin Read
University Zürich

George Lake & Victor Debattista

Background

What is the thick disc?

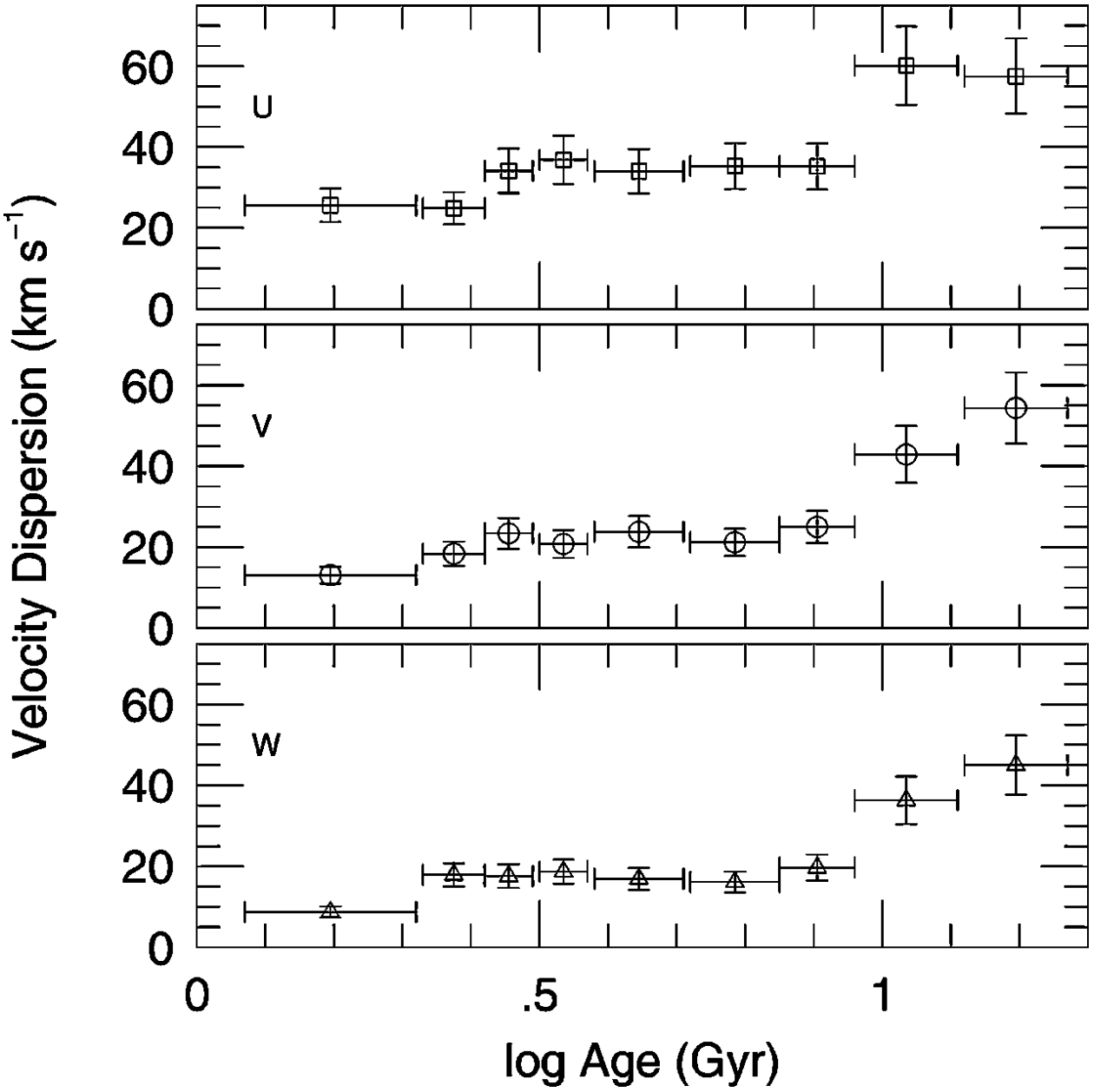
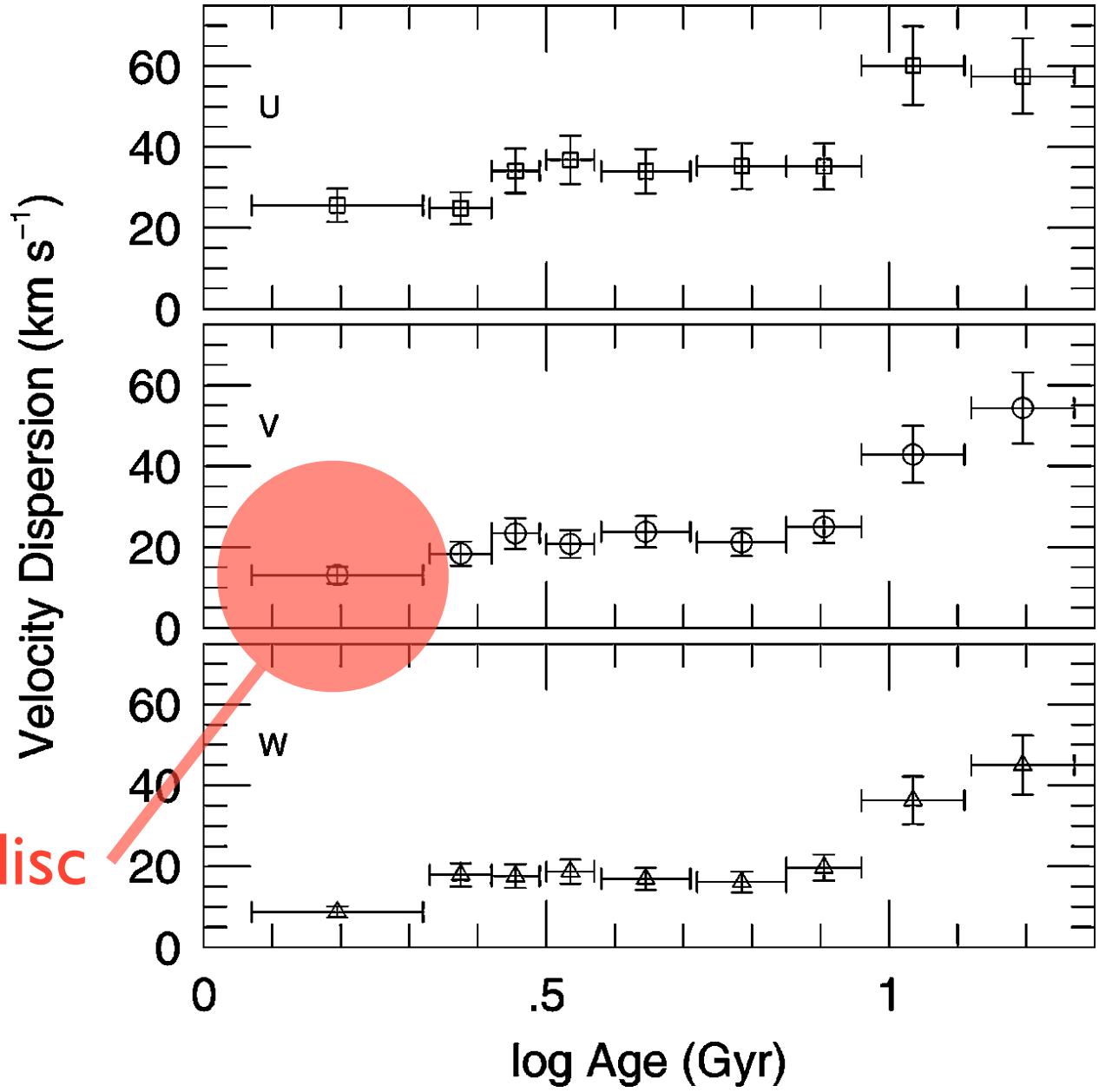


Figure 5 The relation between the three components of the velocity dispersion and the stellar age, as derived by Quillen & Garnett (2001) for stars from the sample of Edvardsson et al. (1993). Stars with ages between 2 and 10 Ga belong to the old thin disk: Their velocity dispersion is independent of 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.



Young disc

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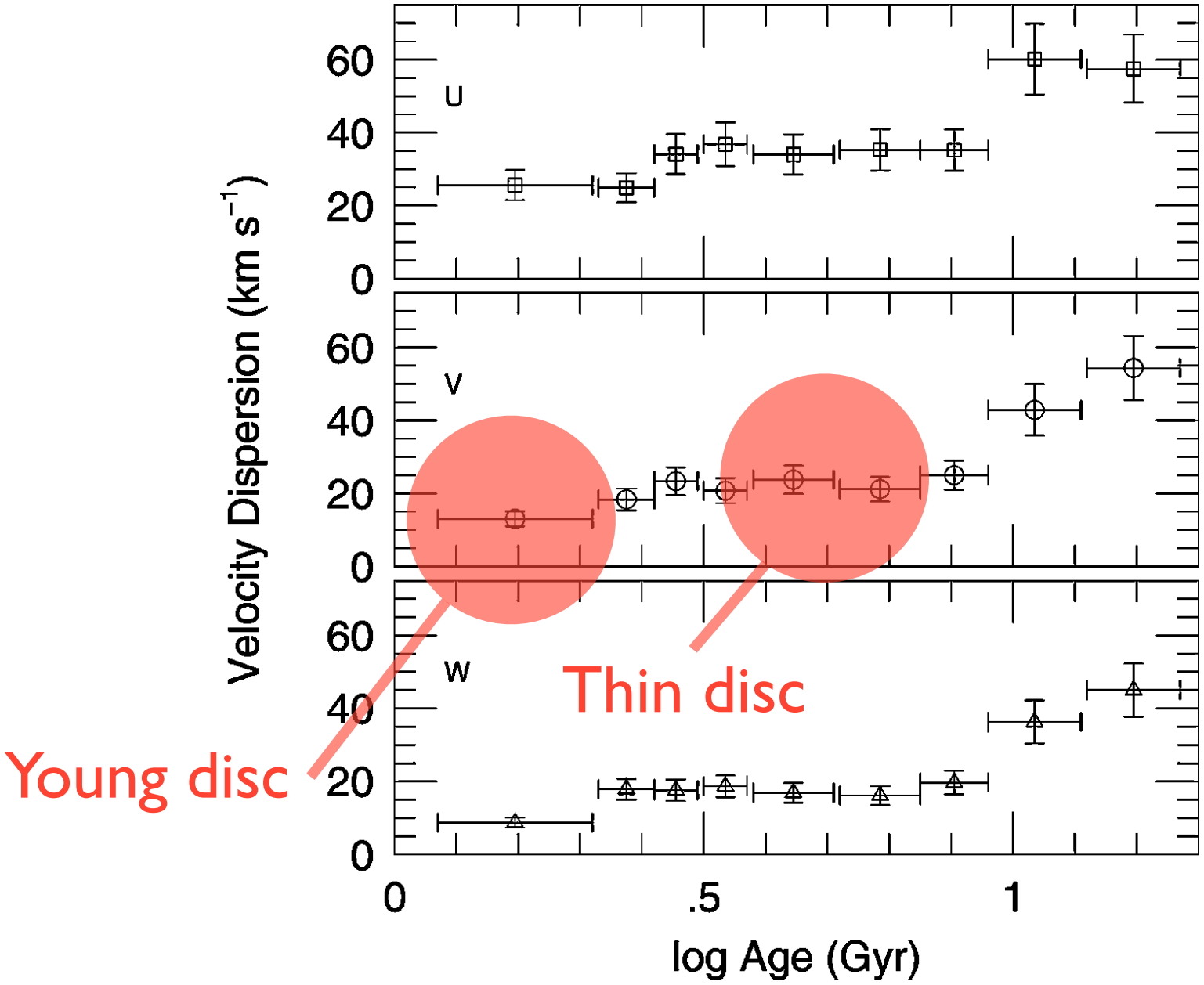
Freeman & Bland-Hawthorn 2002



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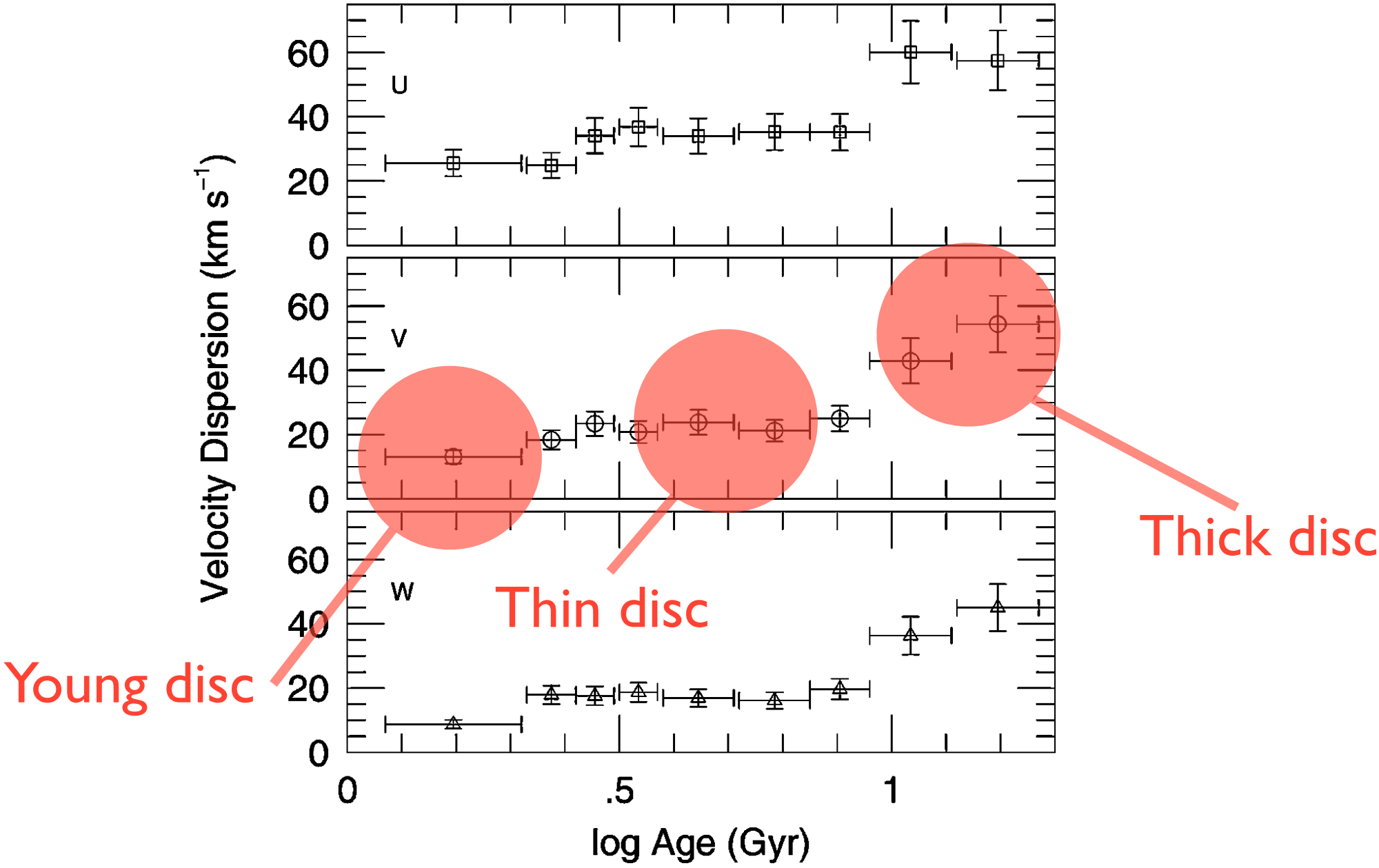

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Freeman & Bland-Hawthorn 2002

Background

What is the thick disc?

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Milky Way

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- Old: < 8 Gyrs.

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- Old: < 8 Gyrs.
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What is the thick disc?

Milky Way

- Old: < 8 Gyrs.
- Metal poor: [Fe/H] ~ -0.6
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- Lags rotation of thin disc by 20-40km/s.
- Warm: σ ~ 40 km/s; h ~ 1kpc.

Background

What is the thick disc?

Extragalactic [Yoachim & Dalcanton 2005]

Background

What is the thick disc?

Extragalactic [Yoachim & Dalcanton 2005]

- Ubiquitous.

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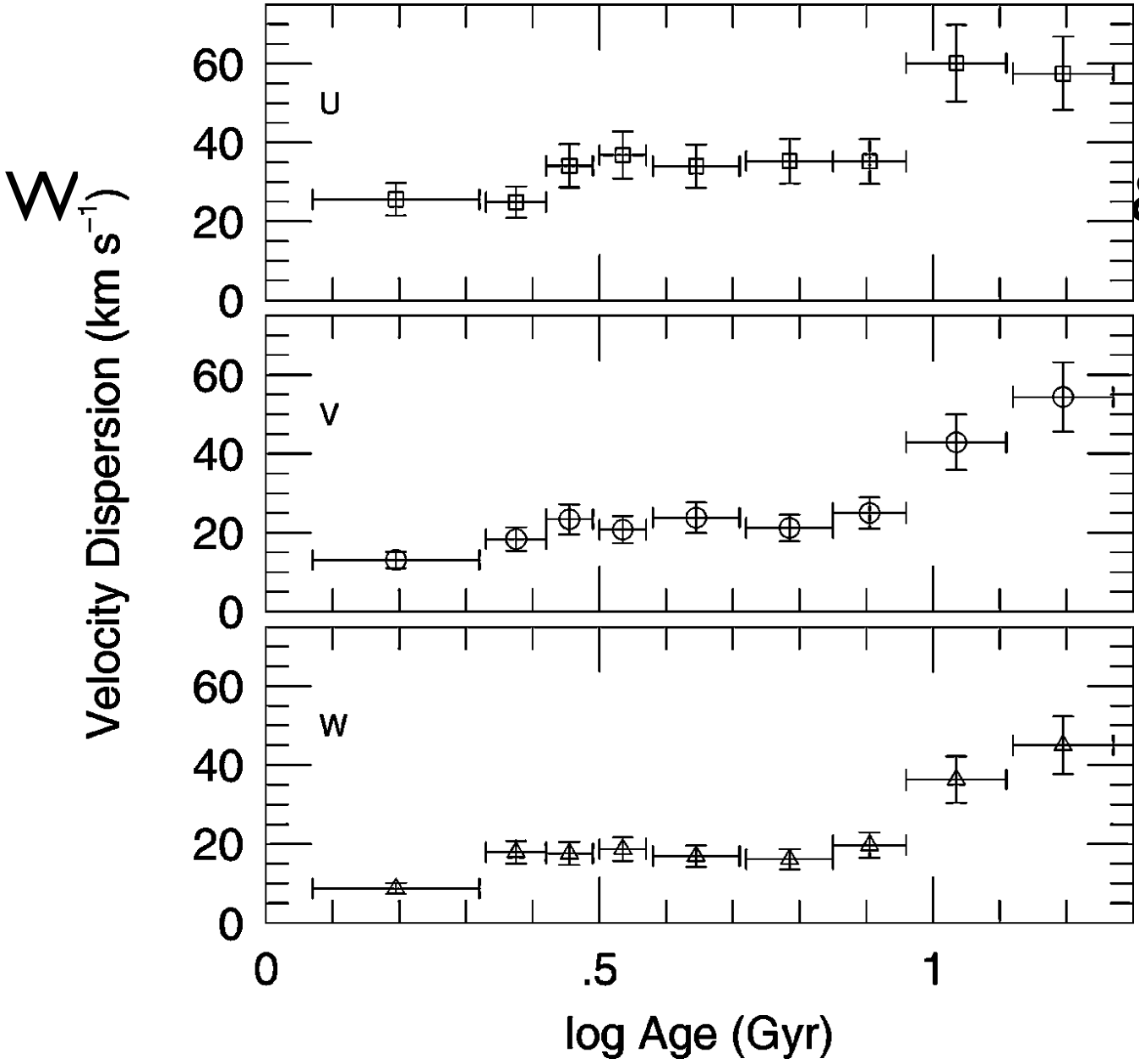
Extragalactic [Yoachim & Dalcanton 2005]

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



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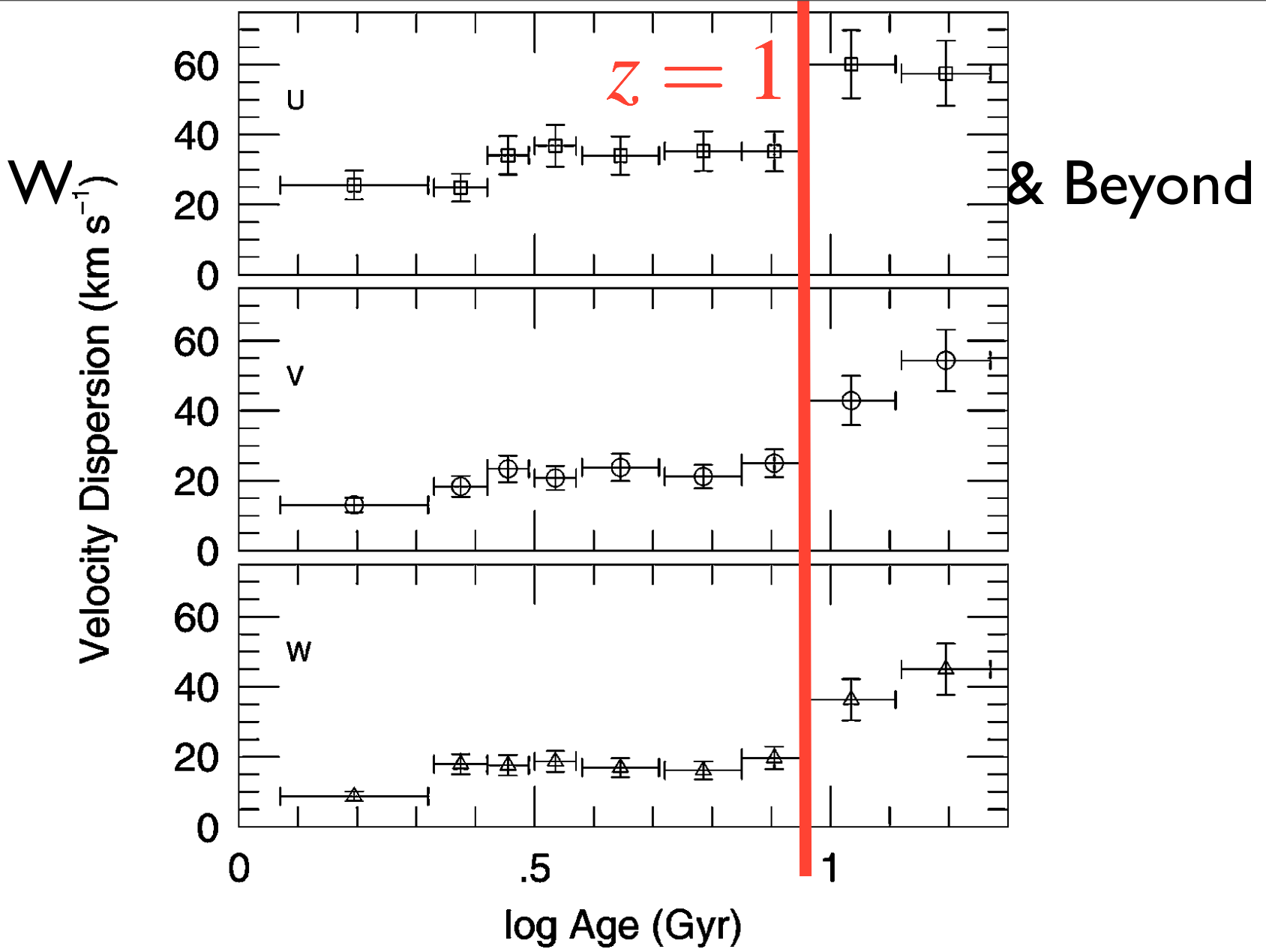

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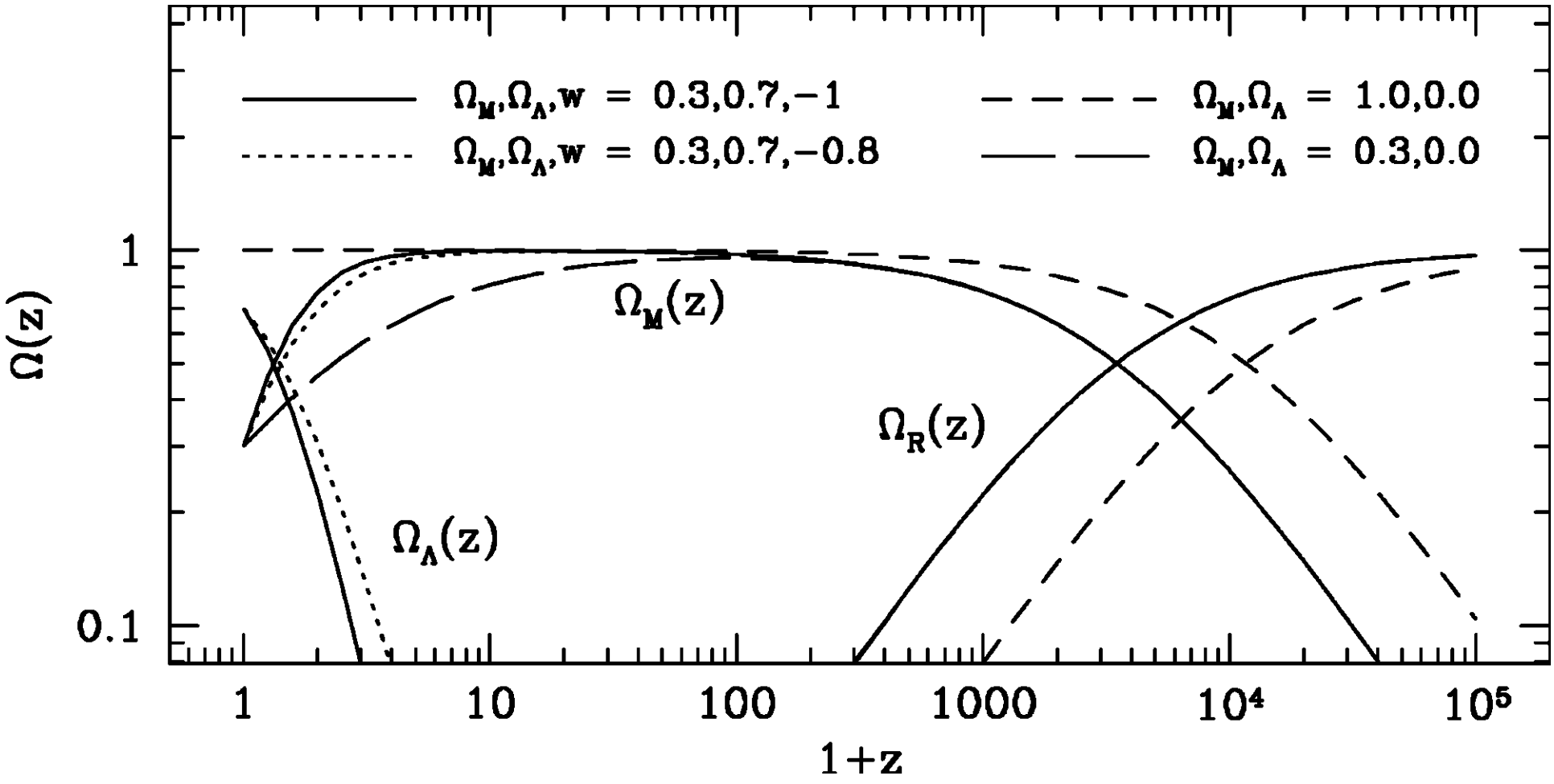
Freeman & Bland-Hawthorn 2002

Background

What is the thick disc? The Milky Way & Beyond



Voit et al. 2005

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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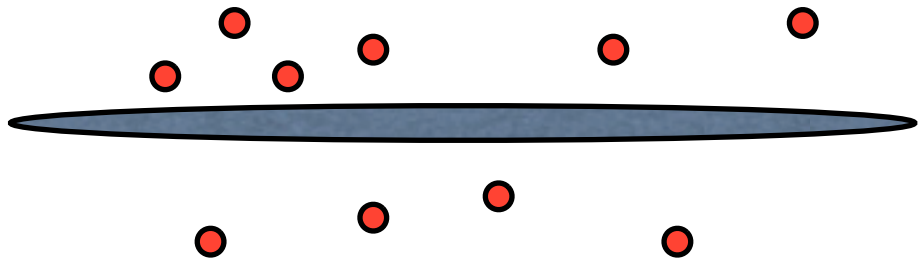

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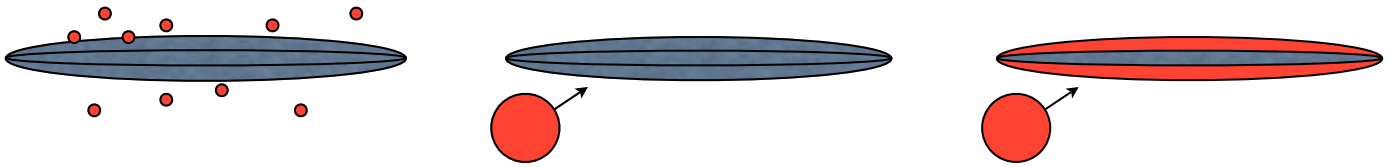

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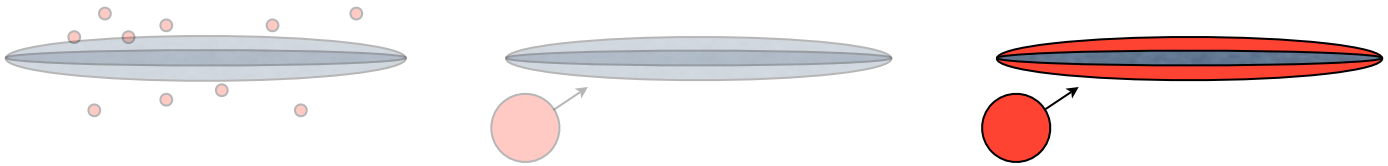

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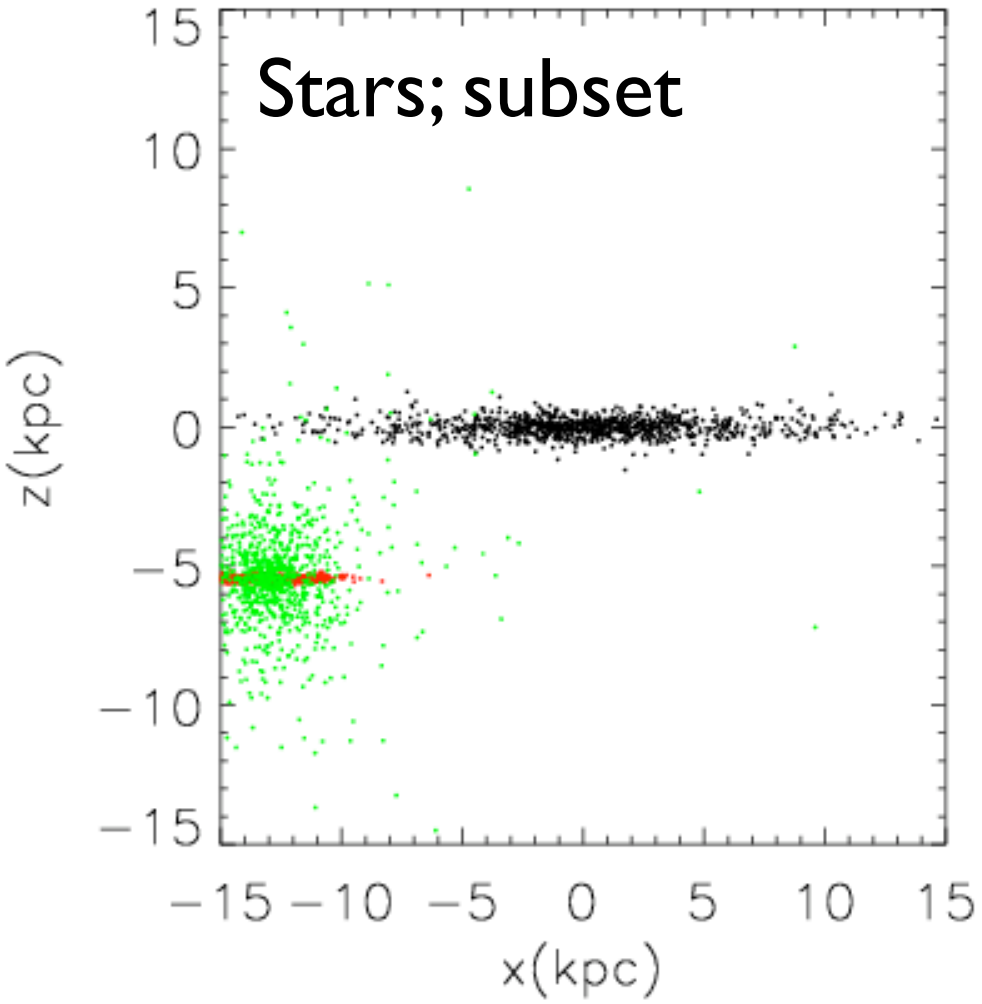
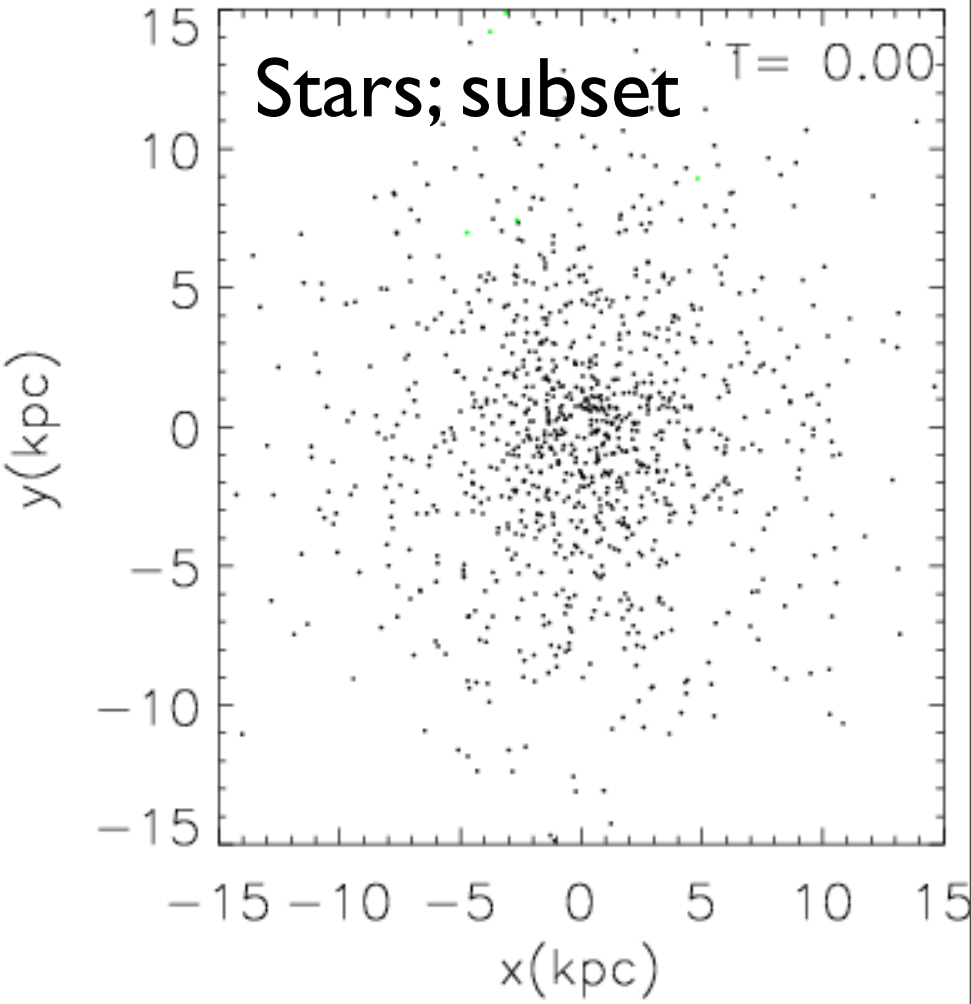
Key idea....

Dry mergers deposit stars and *dark matter*





Read et al. 2007; in prep.

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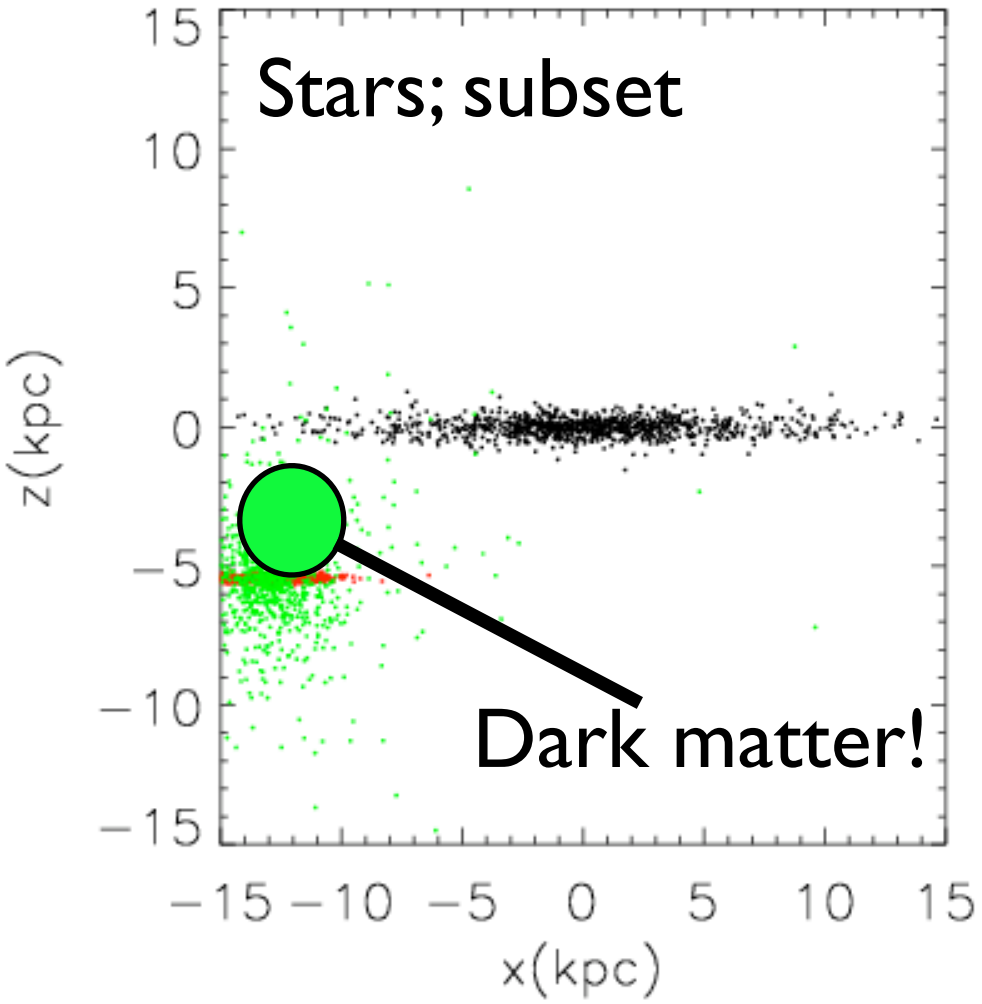

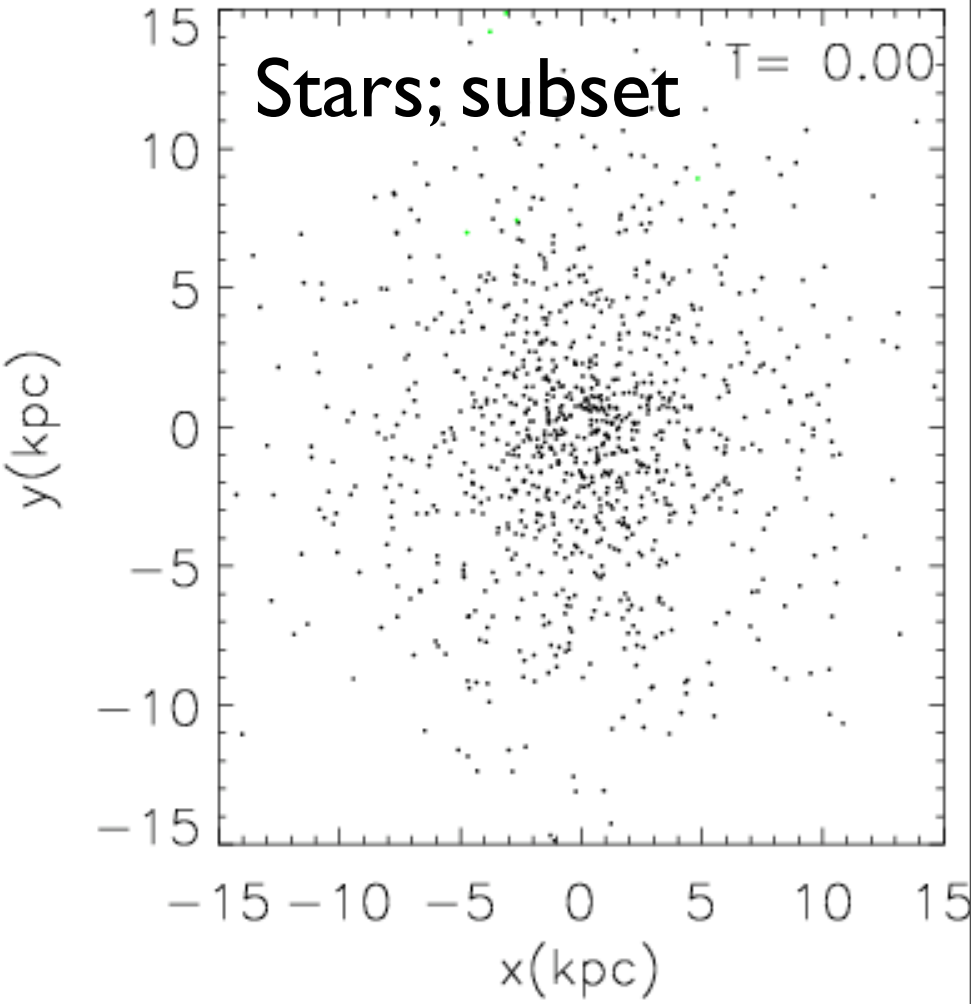

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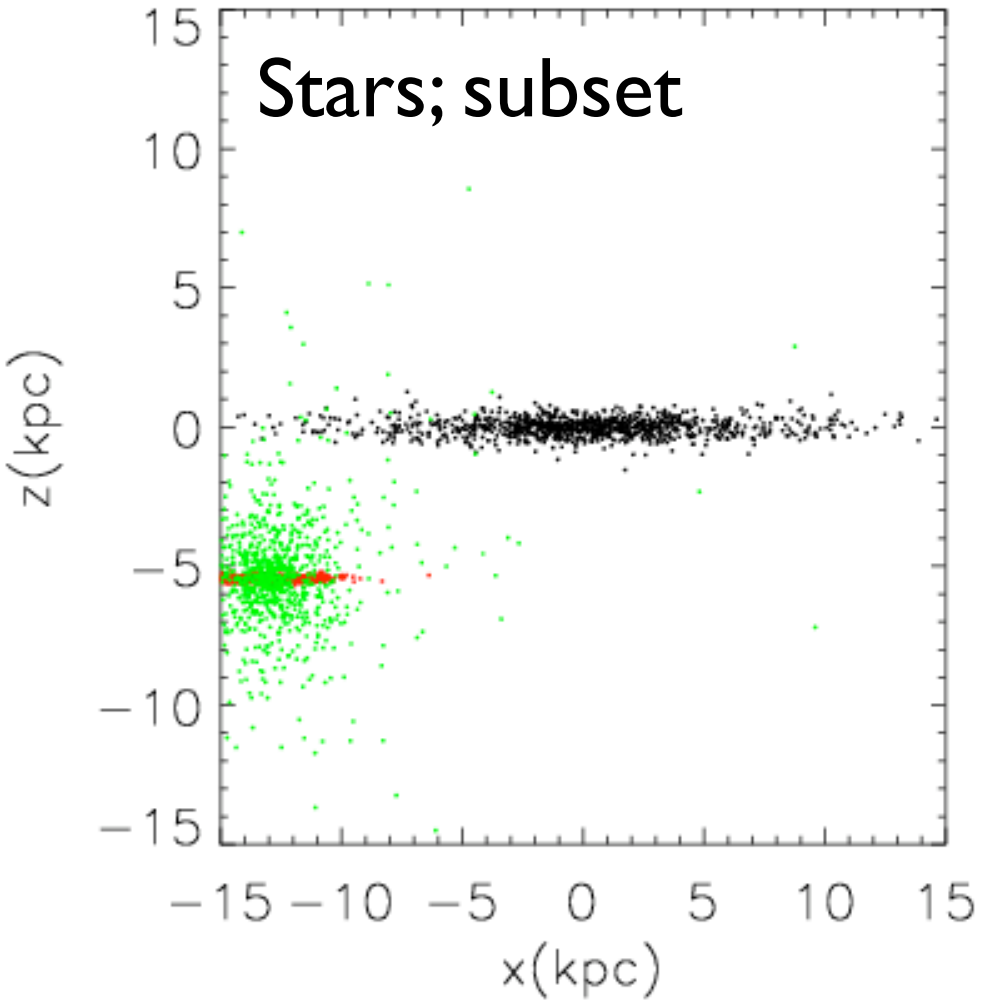

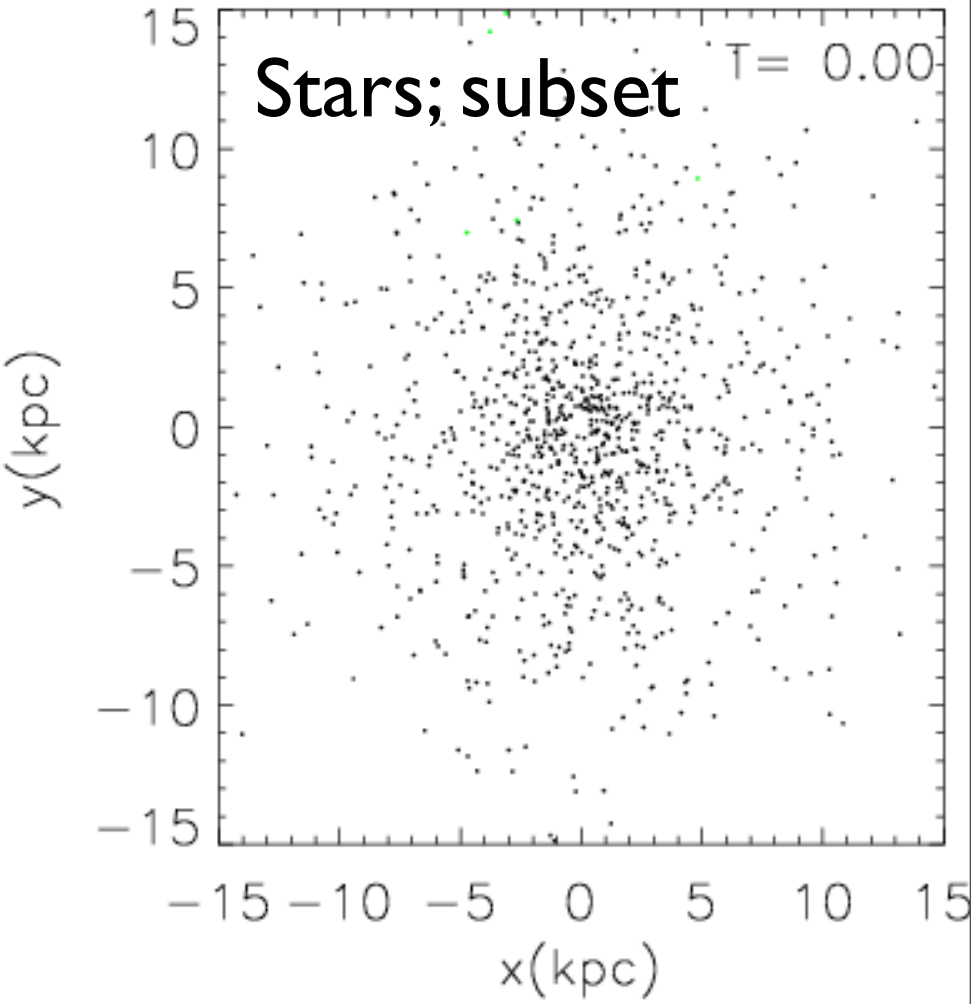

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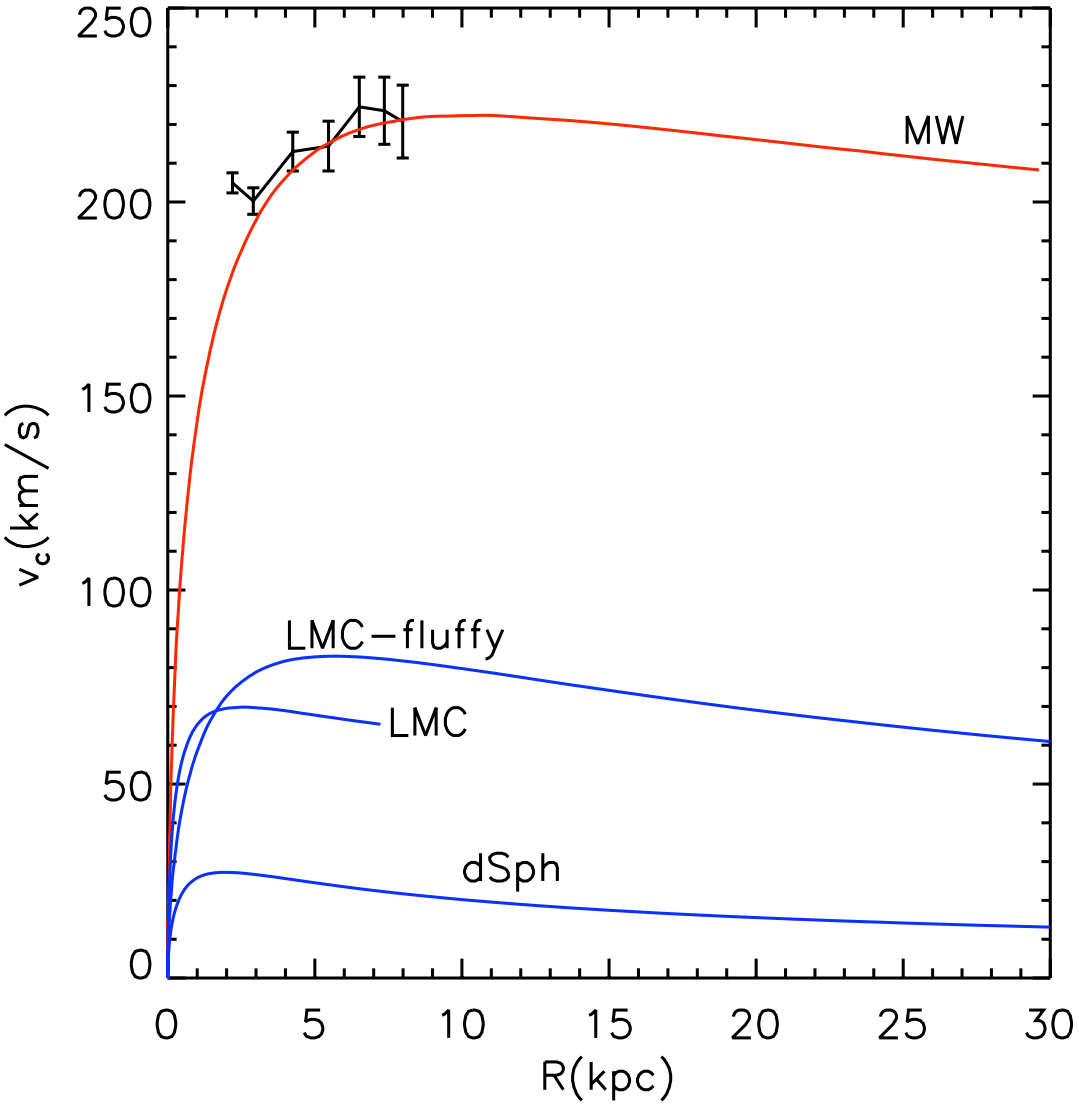
The simulations

Initial conditions



$N_* = 7.5 \times 10^5; \varepsilon_* = 0.06\,\mathrm{kpc}$

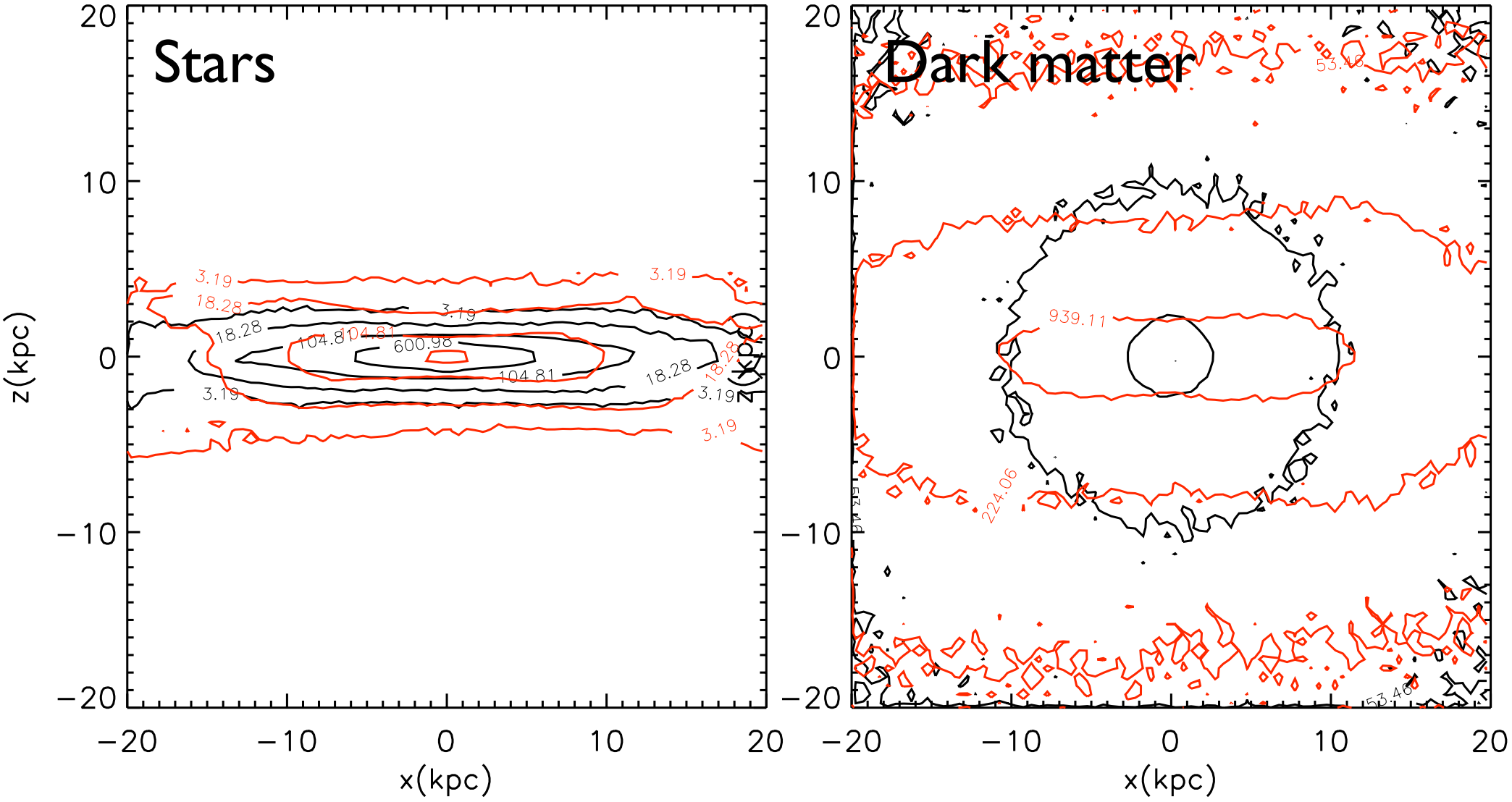
$N_{dm} = 2 \times 10^6; \varepsilon_{dm} = 0.1\,\mathrm{kpc}$

$N_* = 7.5 \times 10^5; \varepsilon_* = 0.01\,\mathrm{kpc}$

$N_{dm} = 2 \times 10^6; \varepsilon_{dm} = 0.03\,\mathrm{kpc}$

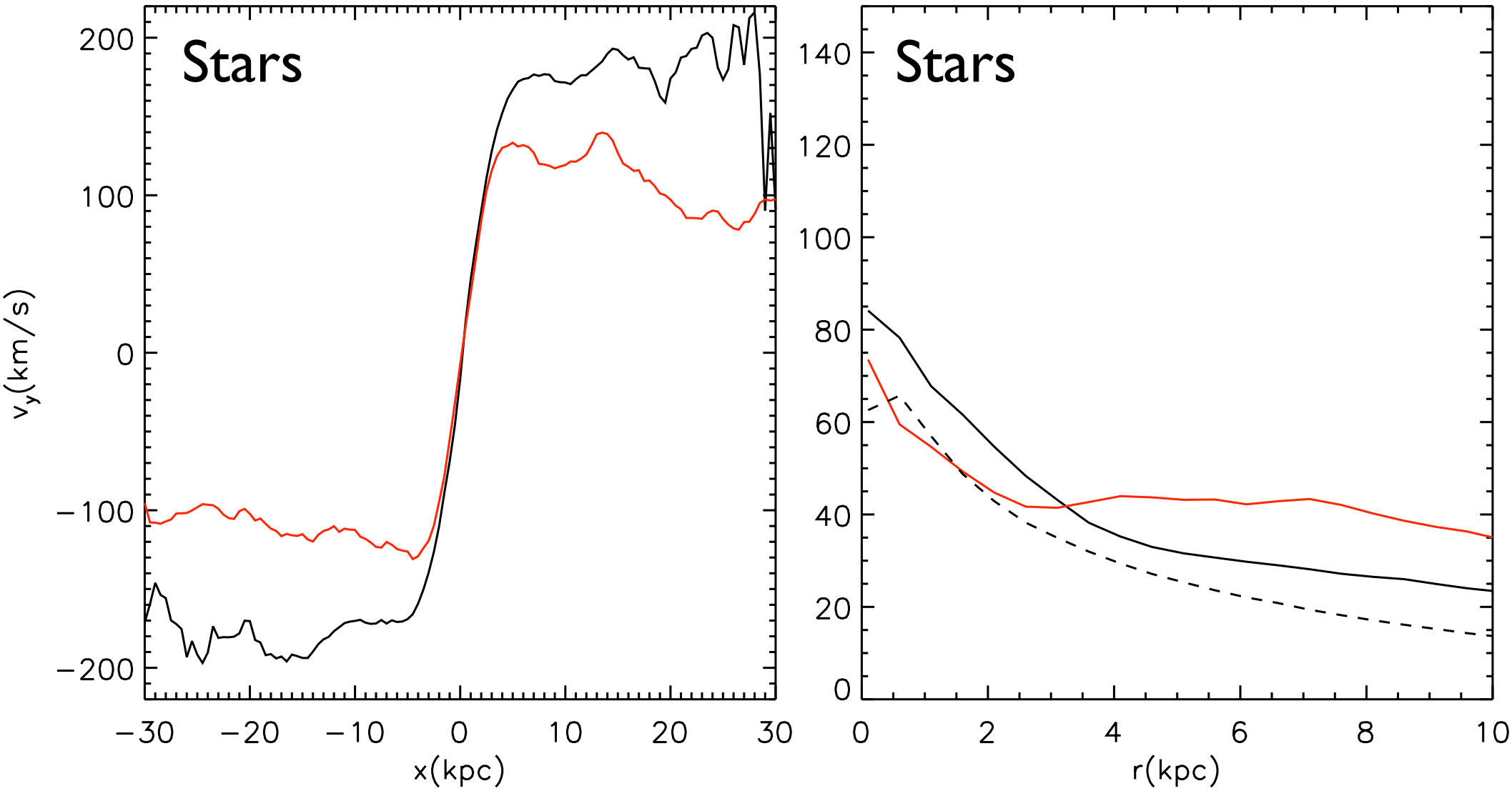
The simulations

LMC



The simulations

LMC



The simulations

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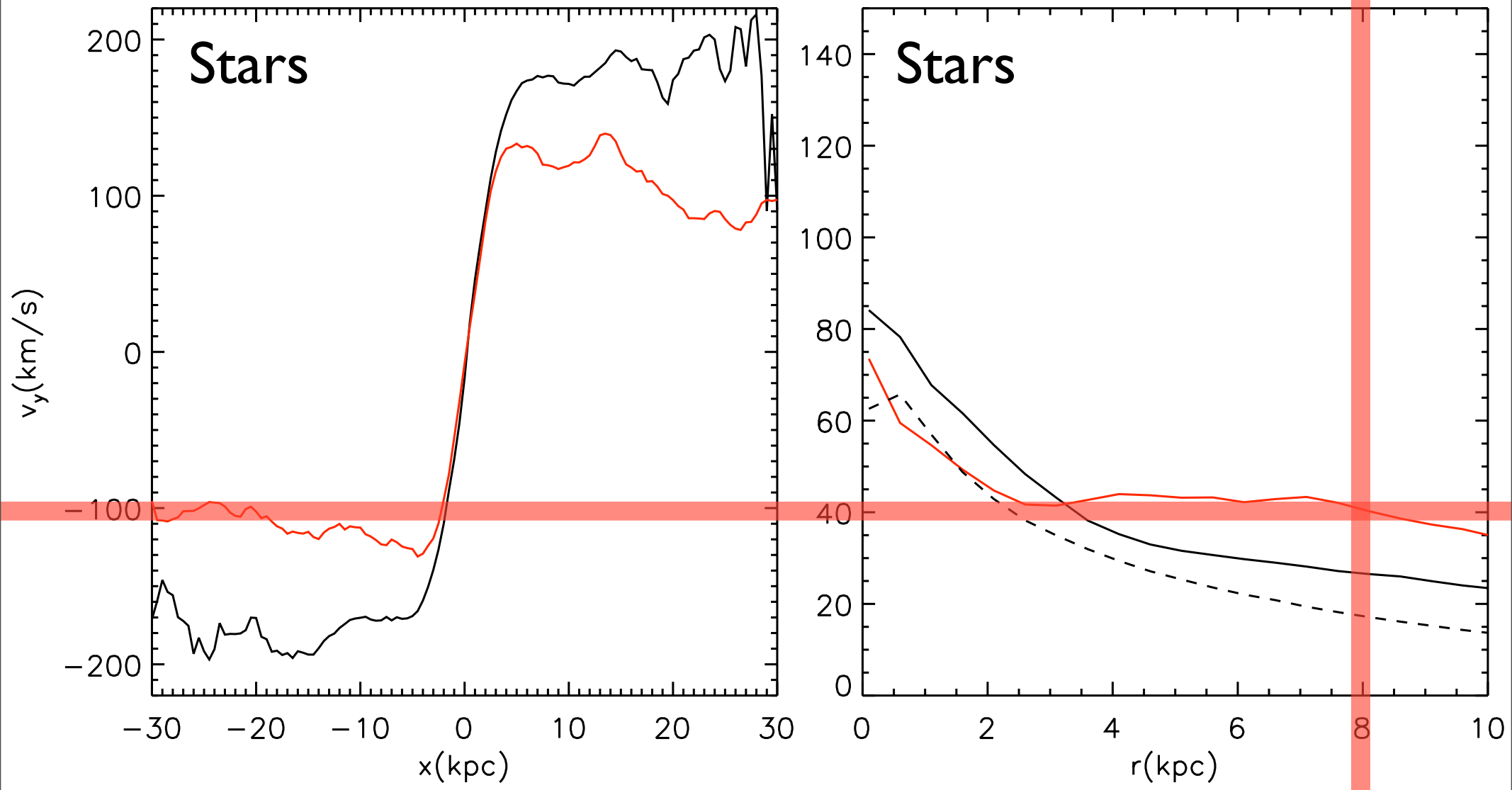

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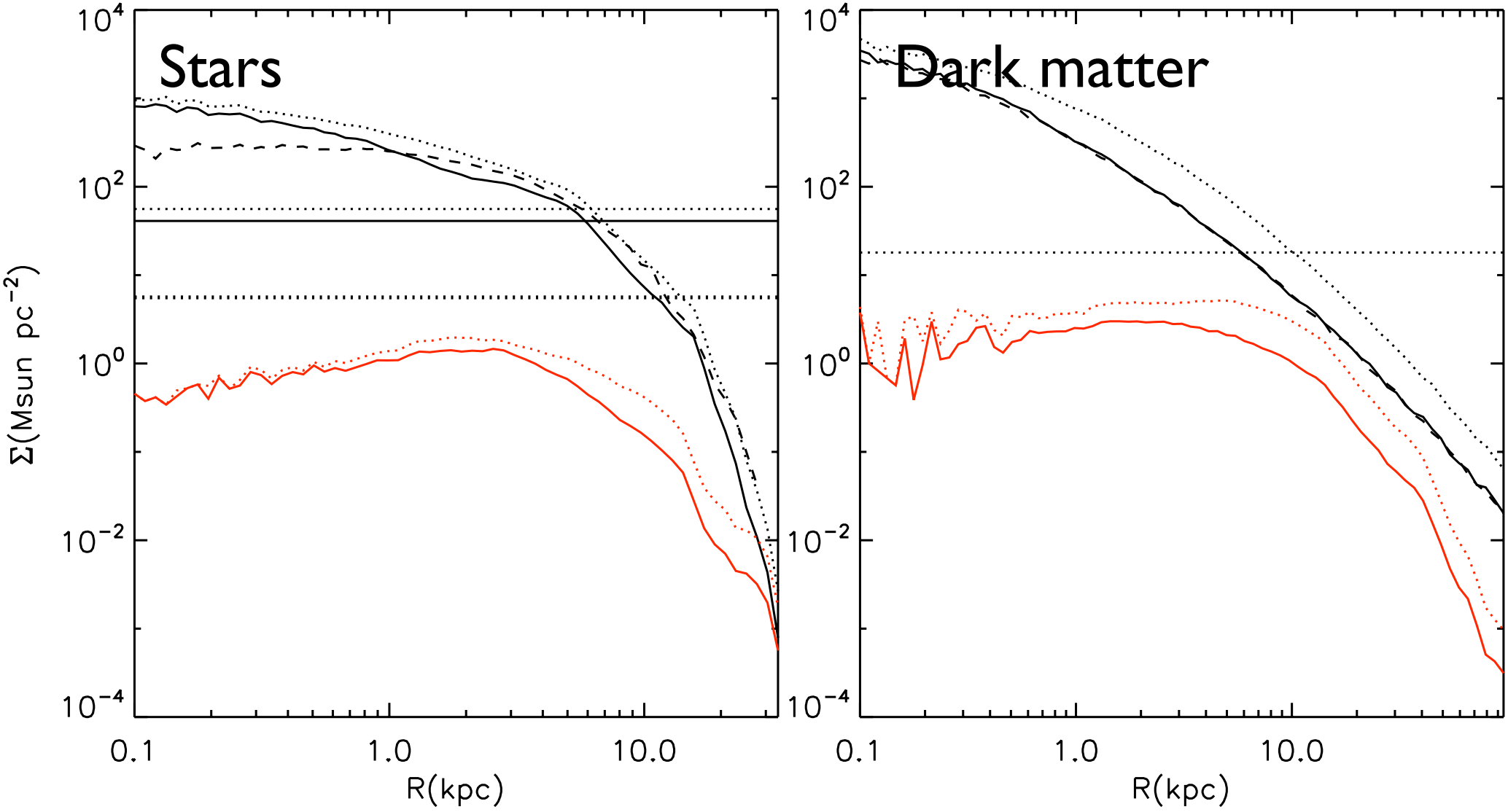

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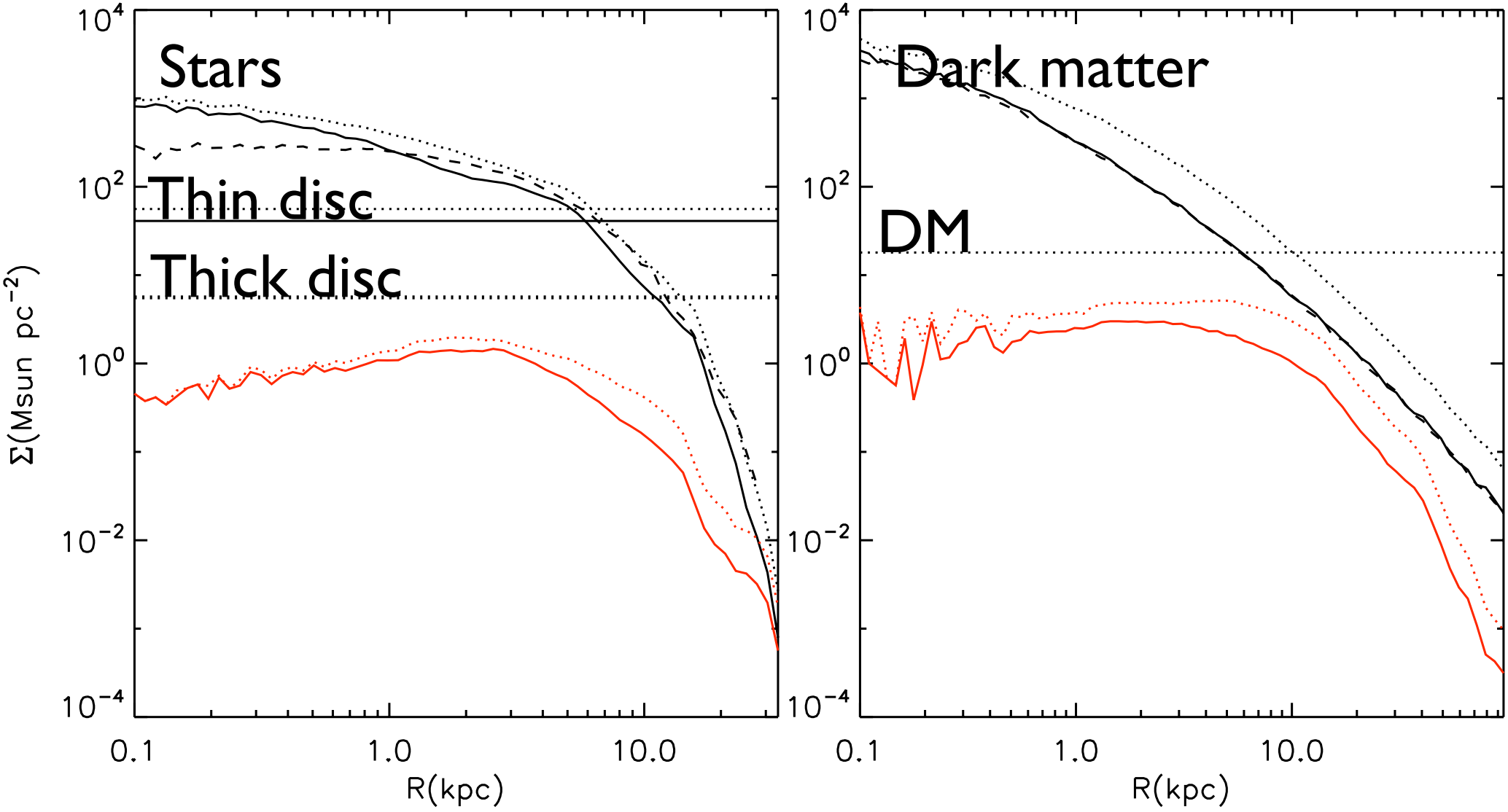

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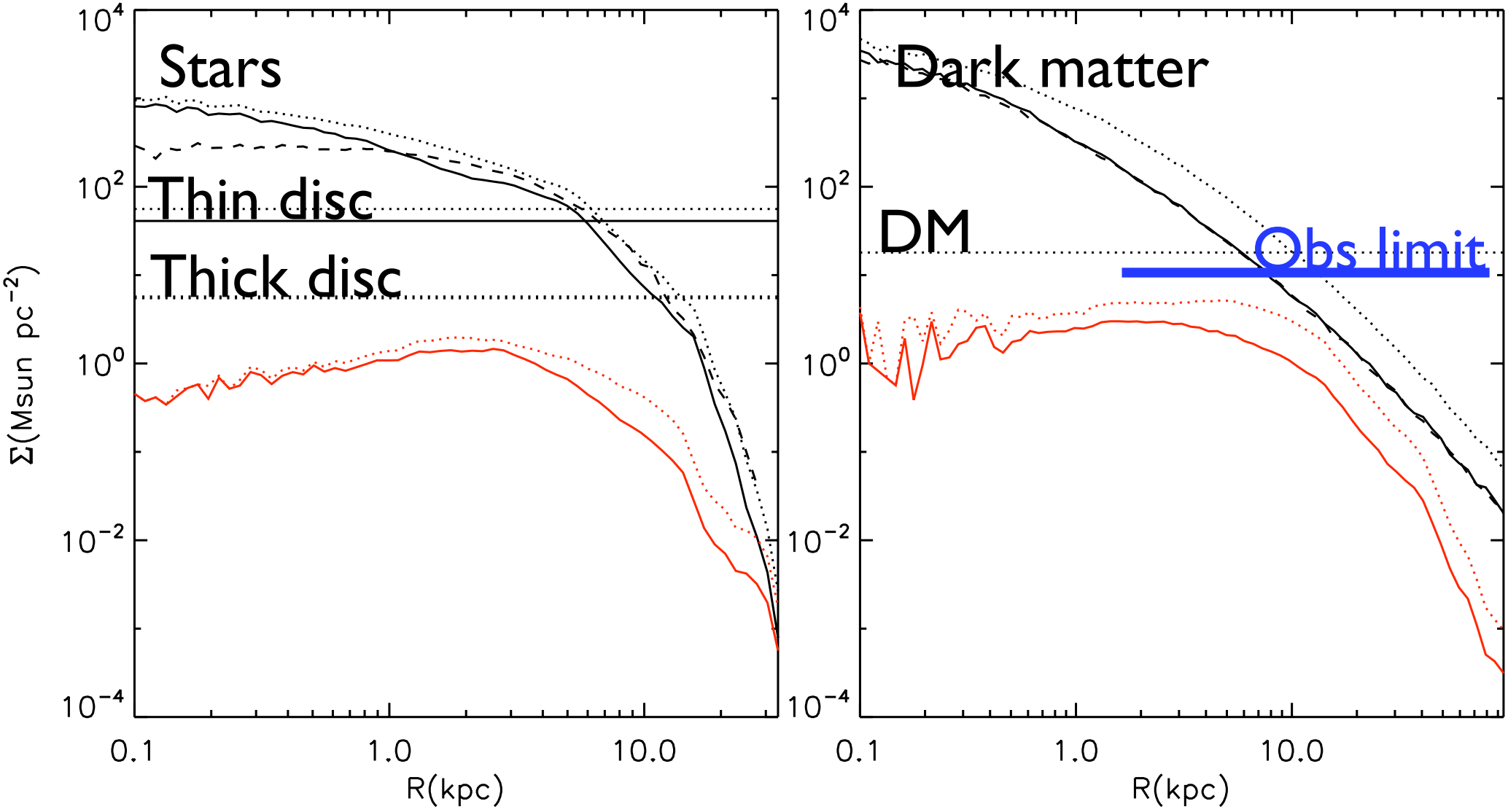

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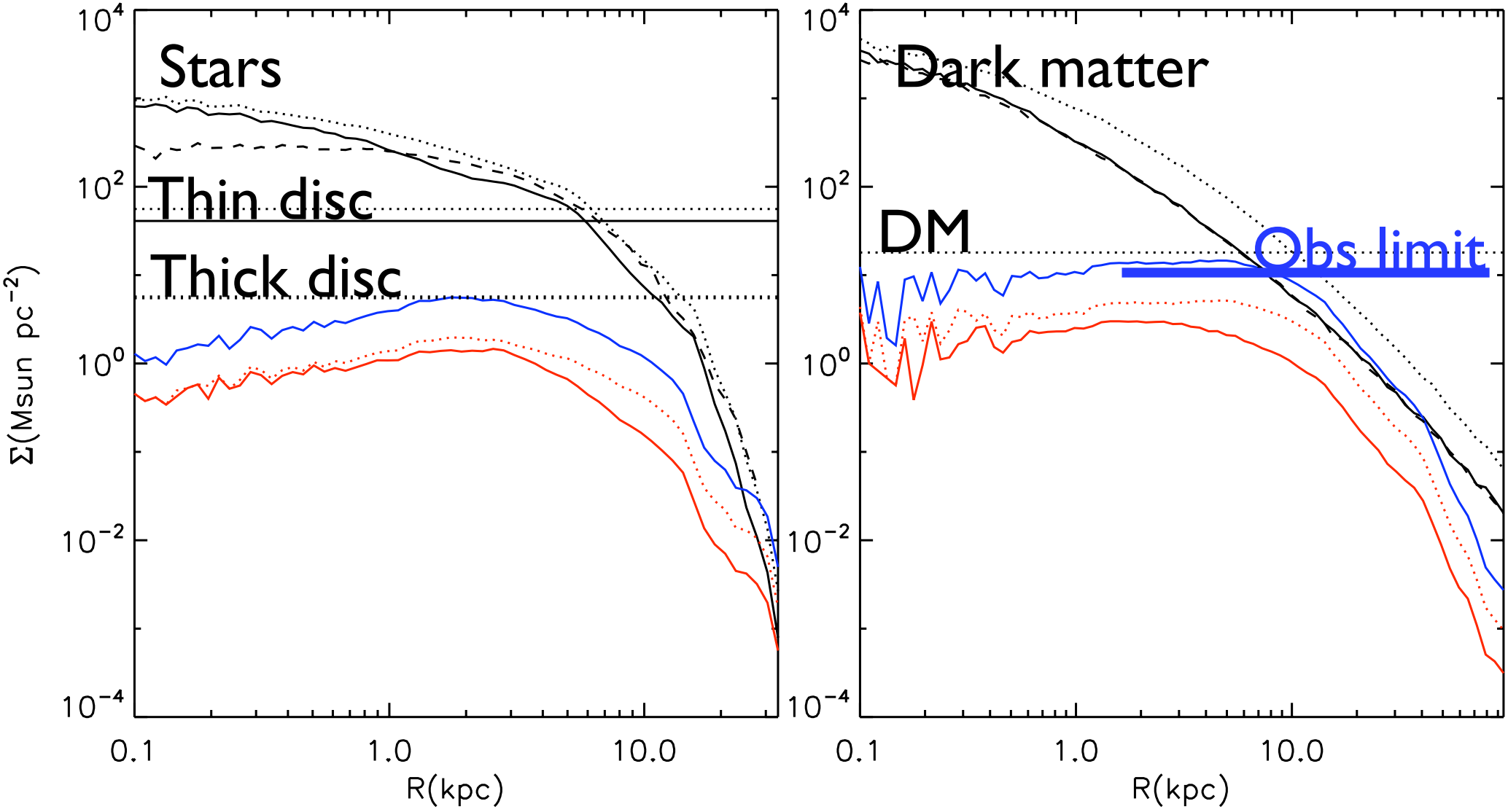
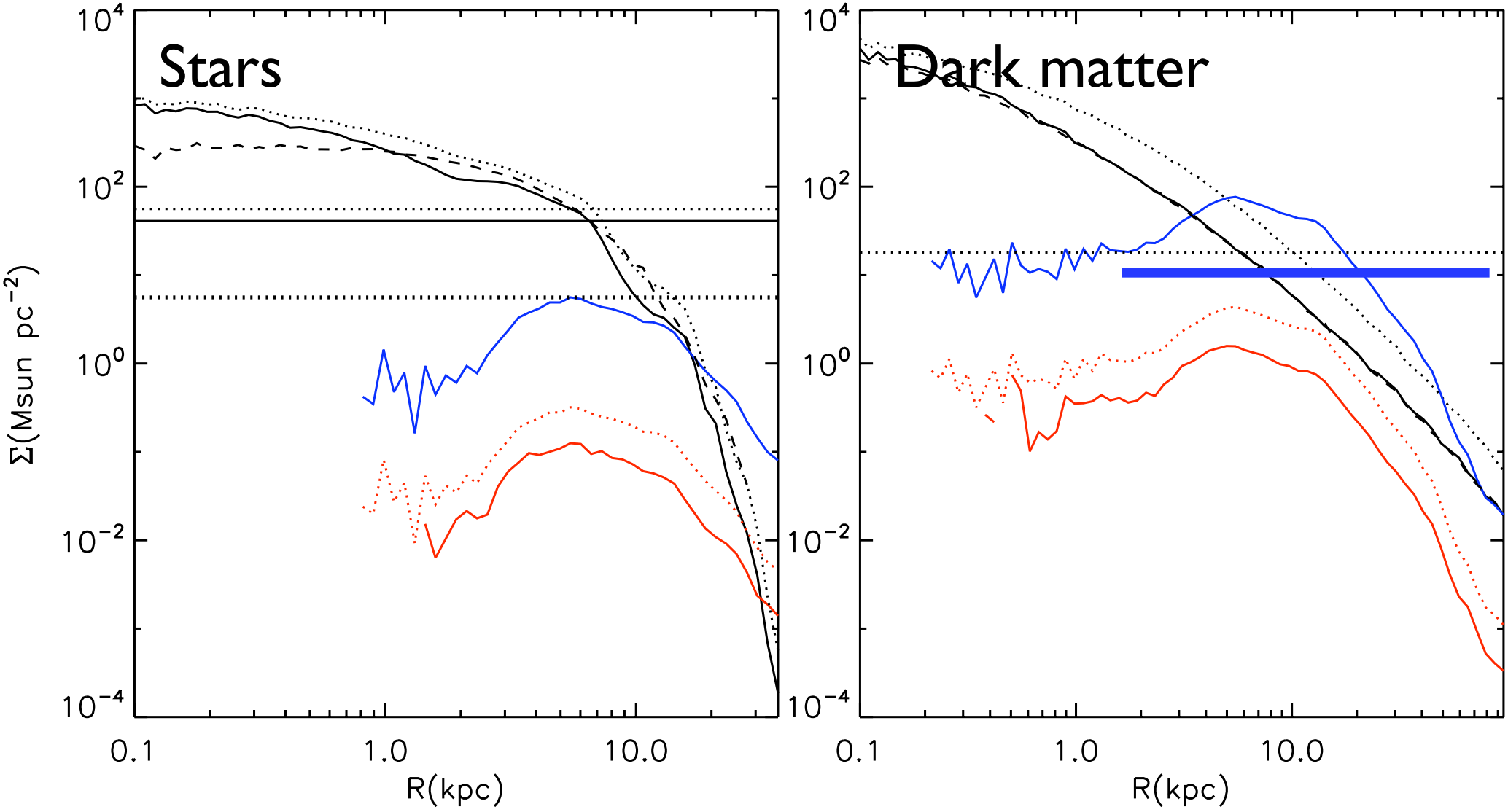


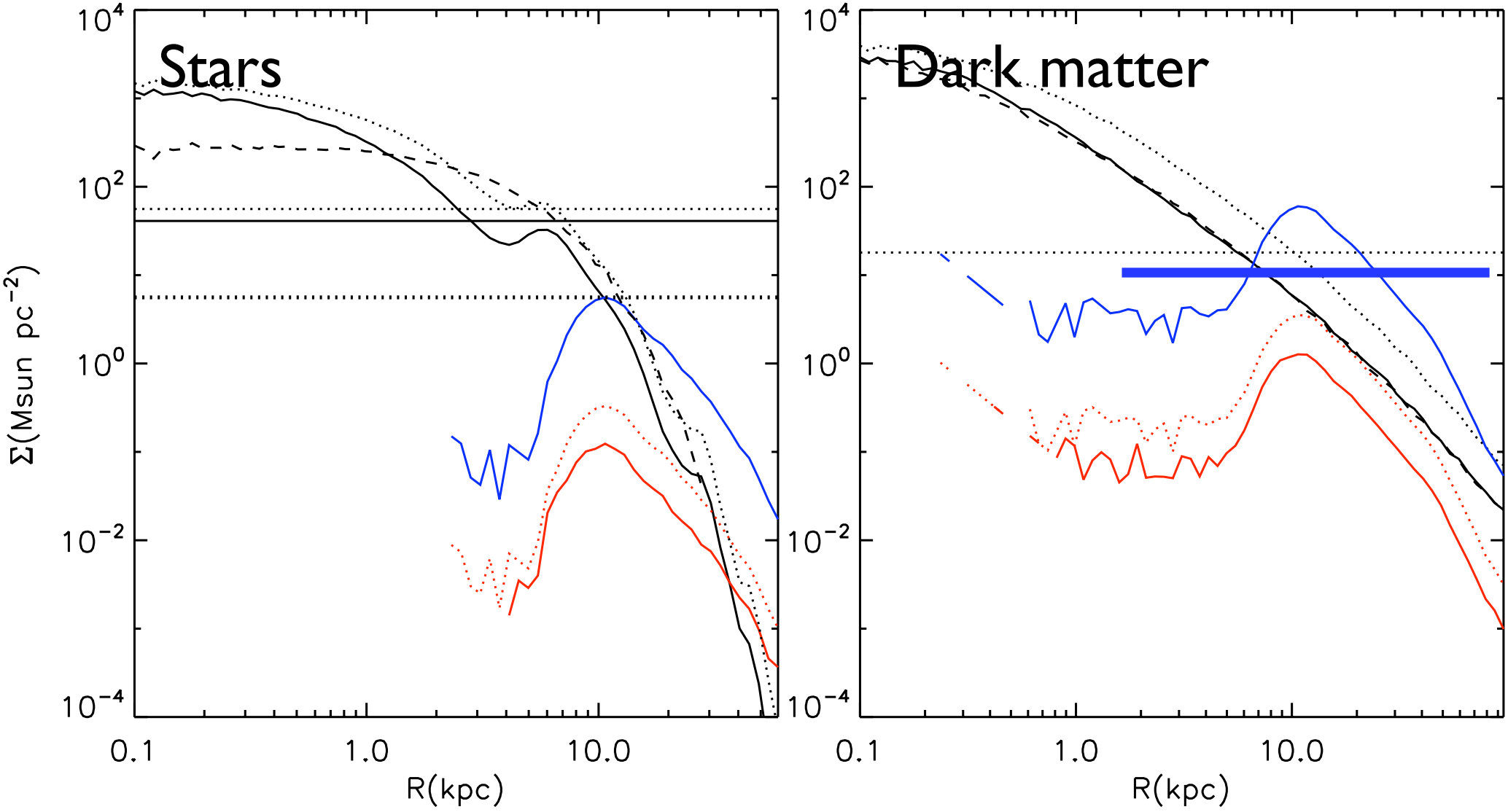
The simulations

LMC - fluffy



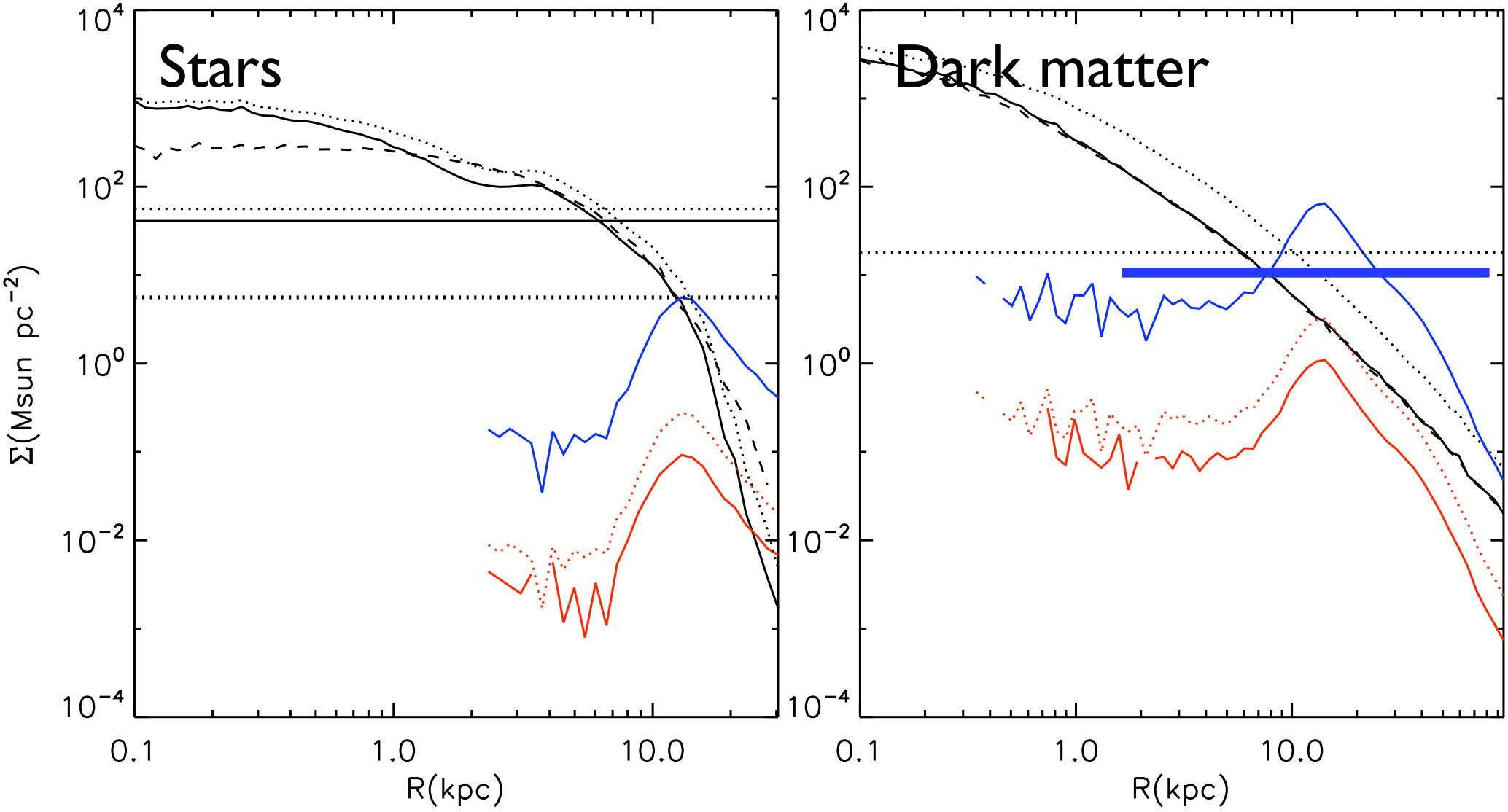
The simulations

LMC - fluffy; circular



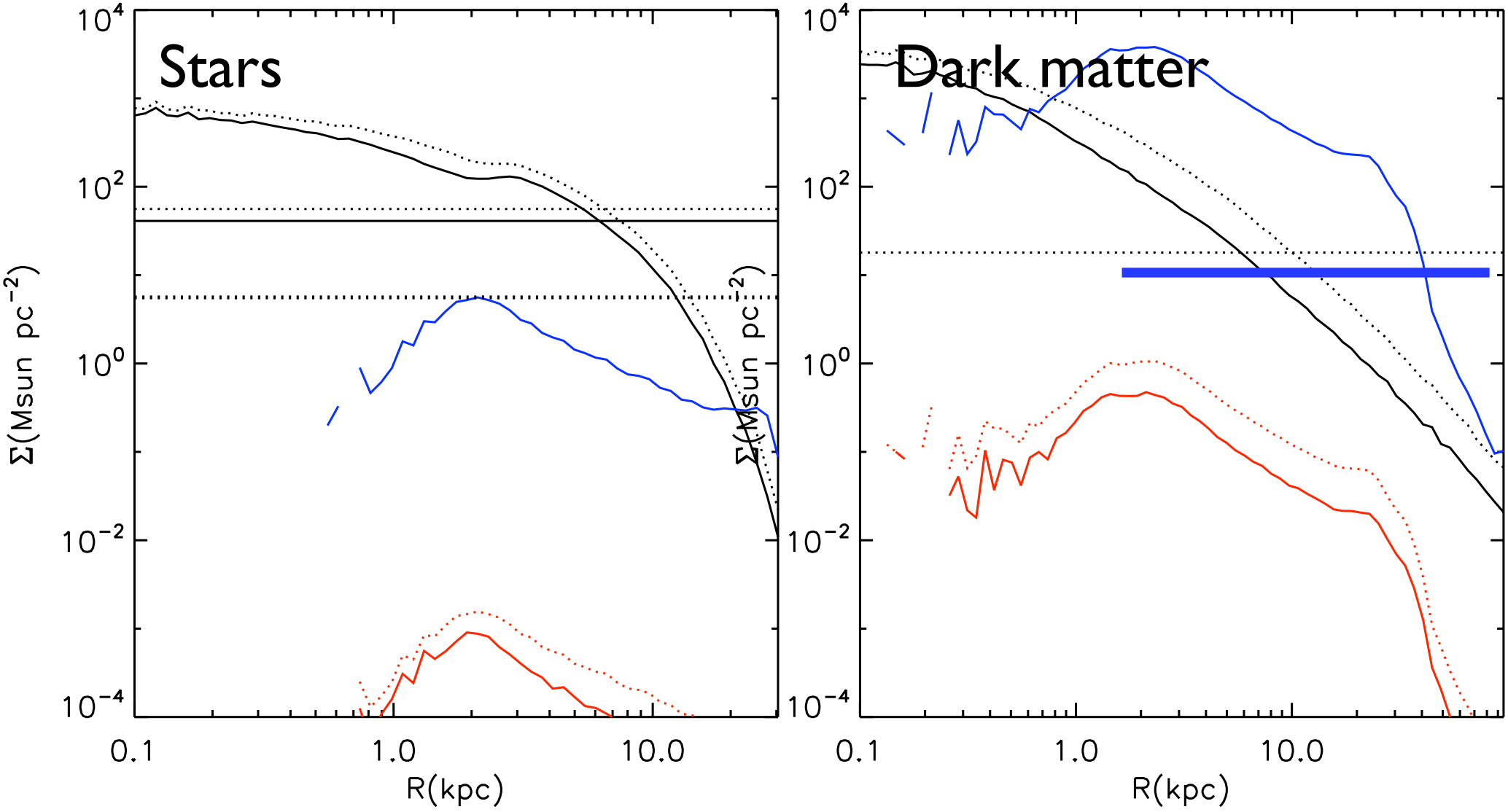
The simulations

LMC - fluffy; circular; retrograde



The simulations

dSph; very radial



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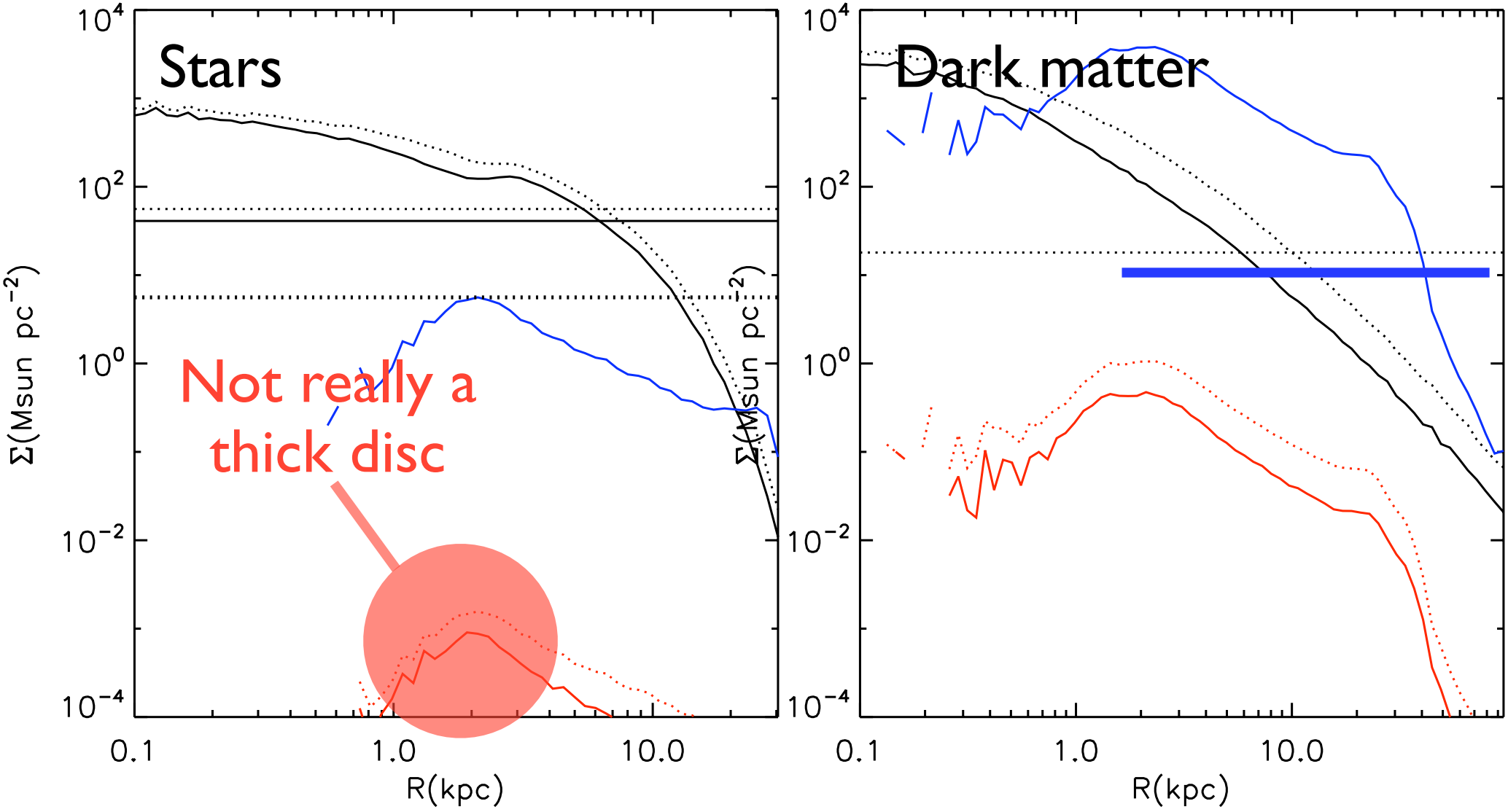

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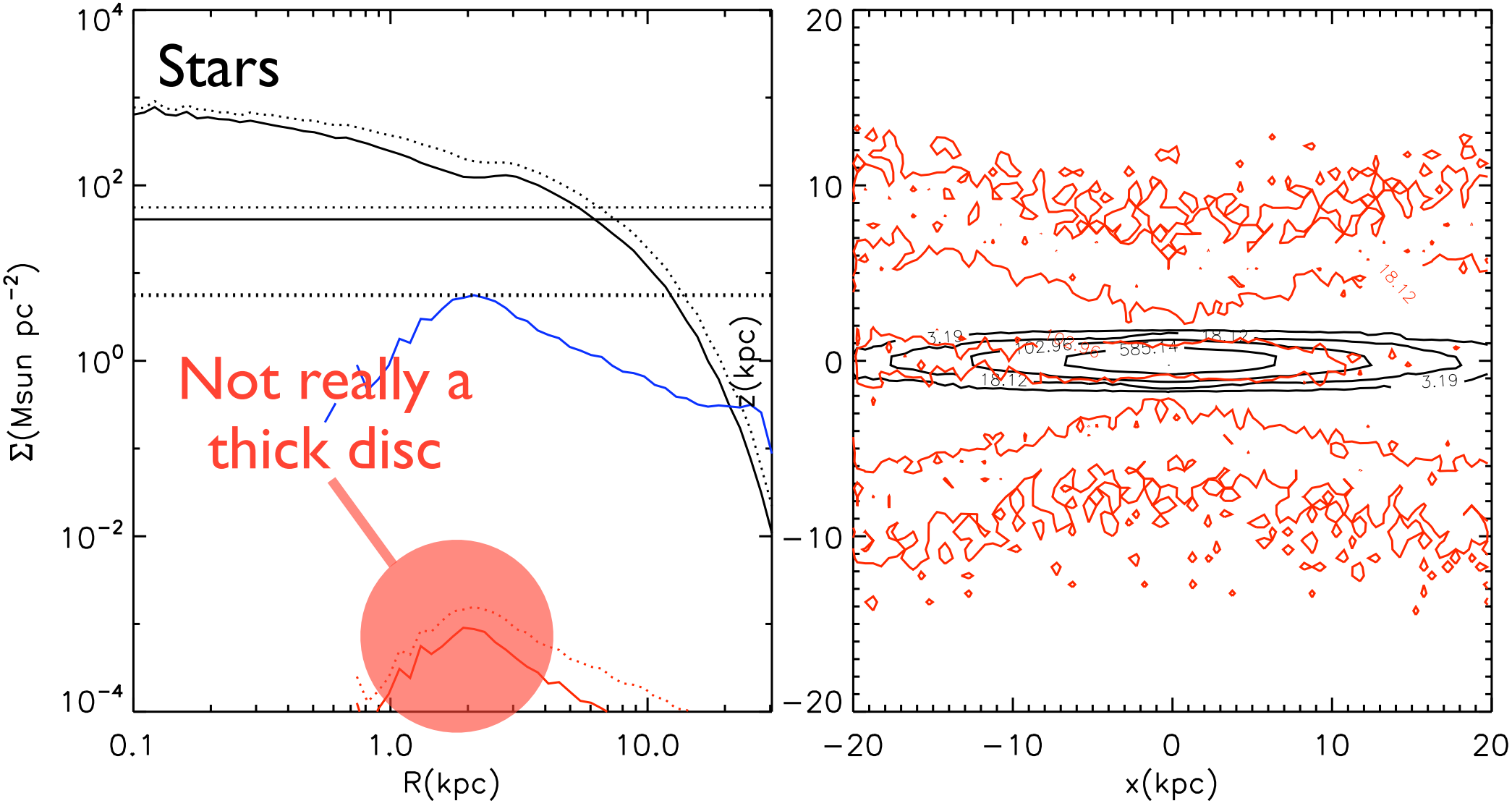
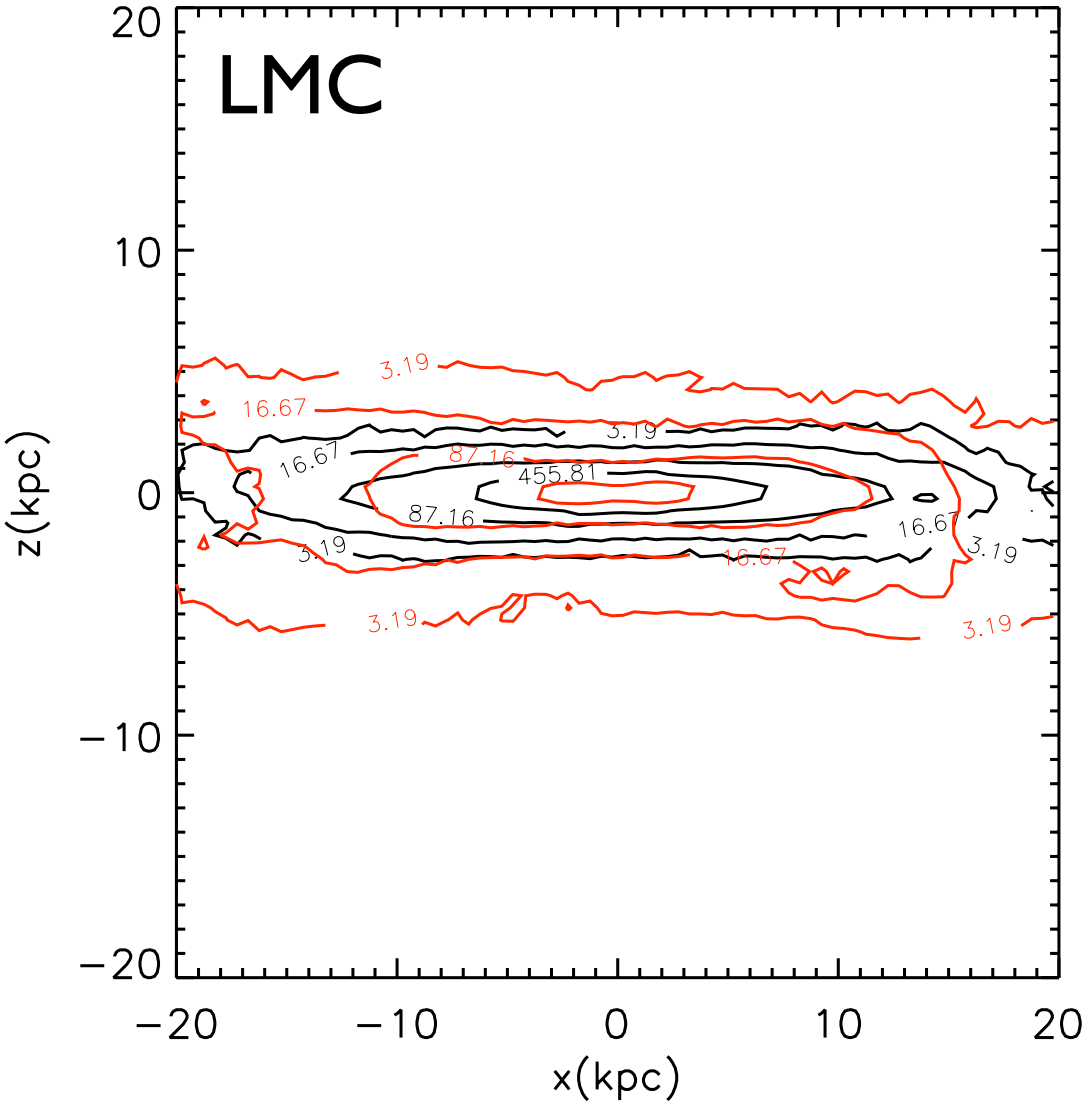


The simulations

The effect on the thin disc



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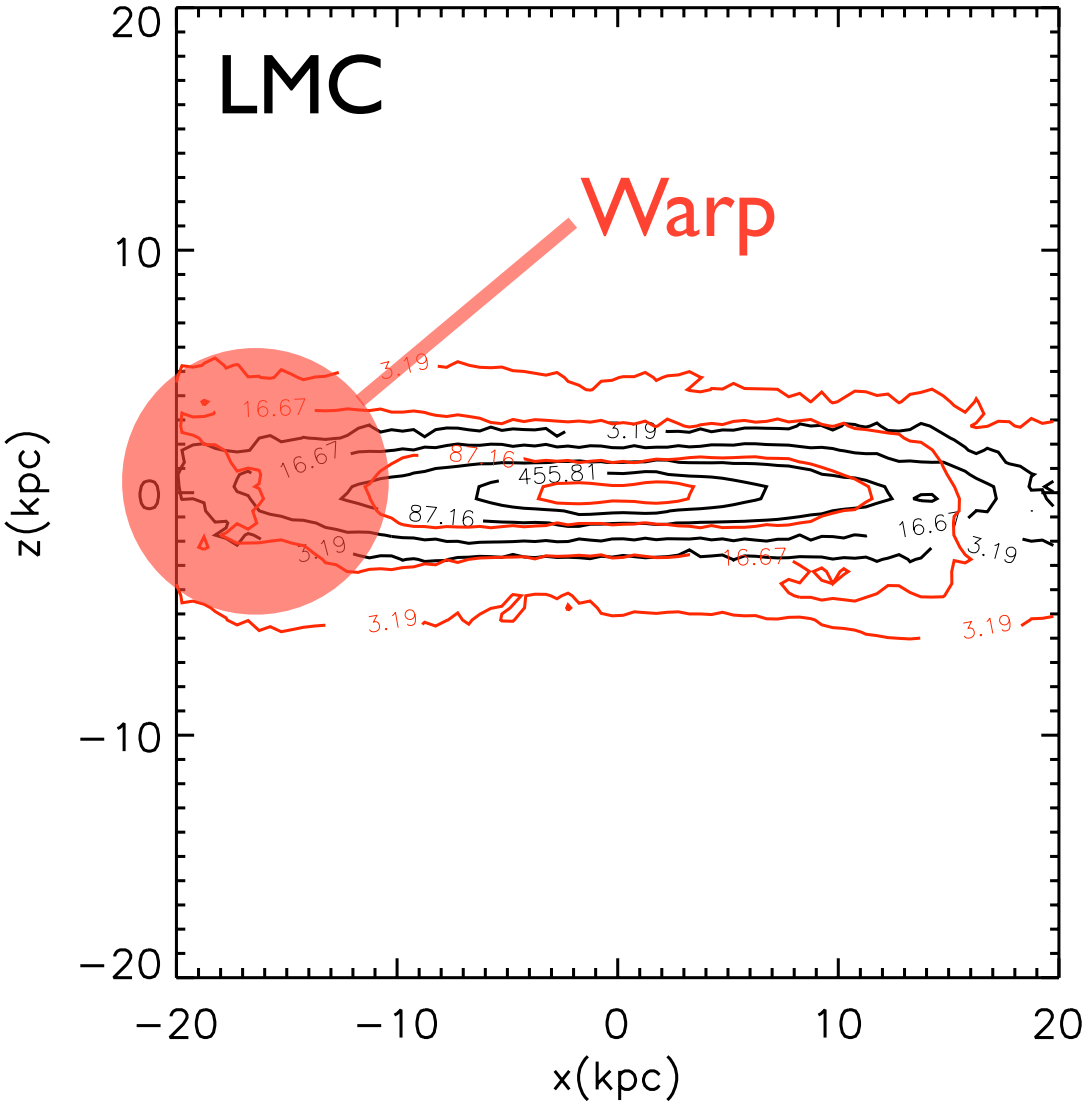

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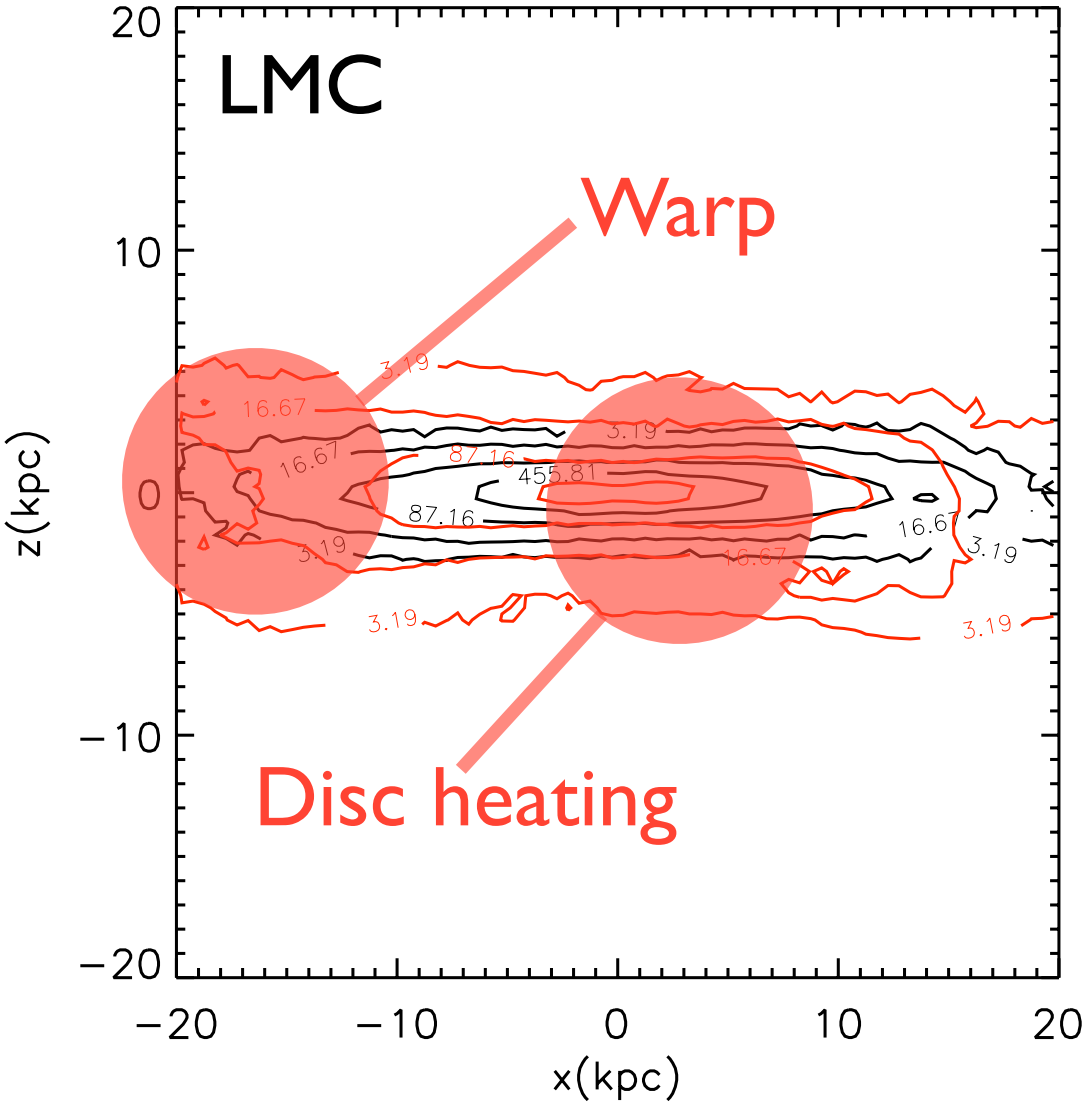

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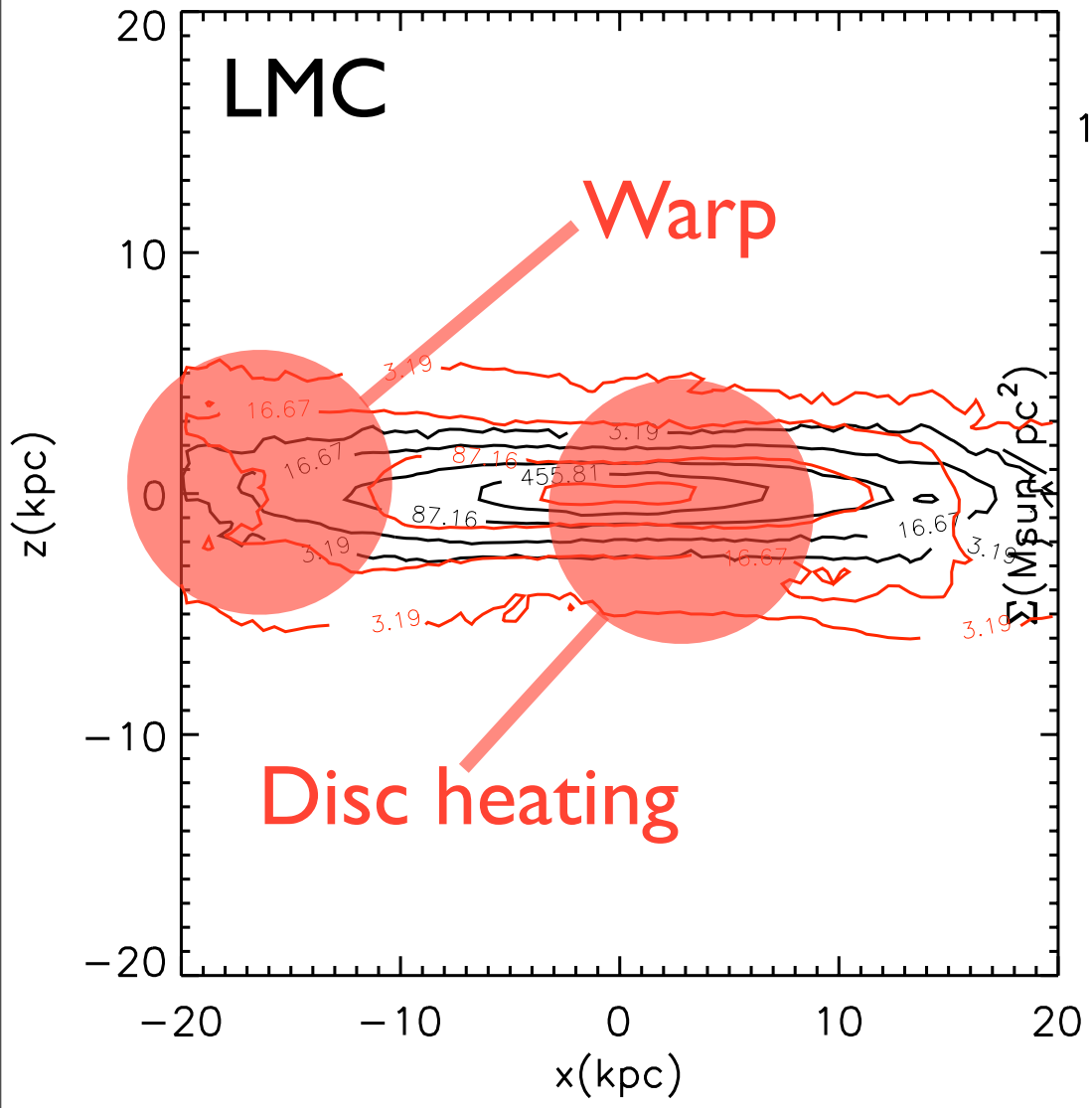

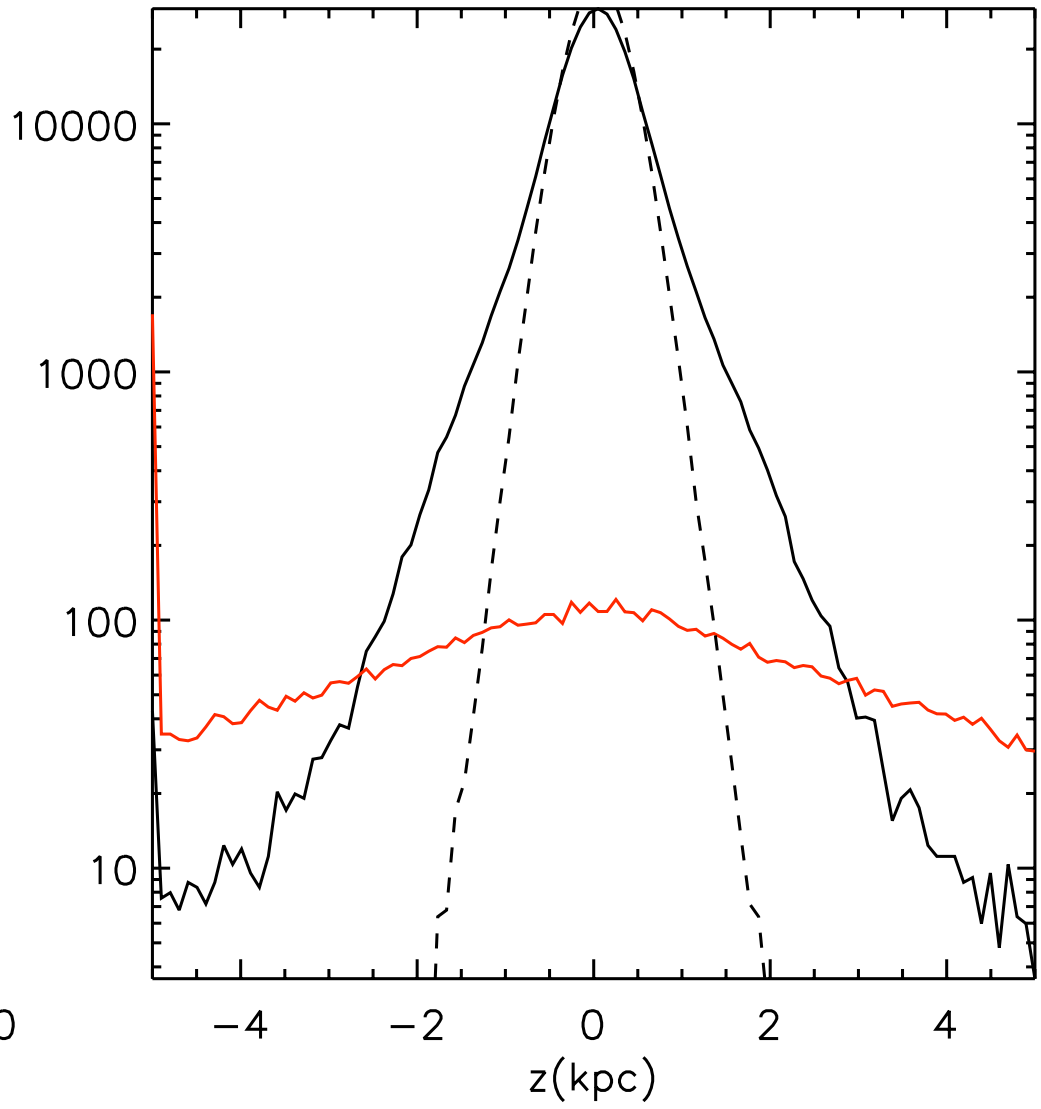

The simulations

The satellite mass to light ratio

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

Conclusions

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- 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!