

Universiteit Leiden

Leiden Observatory

The LMC: Past, Present and Future

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(Leiden Obs. / Durham Univ.*)

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Small Galaxies, Cosmic Questions Durham 2 August 2019



Shao, MC+ (2018b) – MNRAS, arXiv:1803.07269 MC+ (2019) – MNRAS, arXiv:1809.09116



The Large Magellanic Cloud



Credit: AAO / ROE.

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The brightest MW satellite.

• Unusually massive for a MW mass galaxy (expected ~10% of similarly sized galaxies).

 Has 5% of the MW stellar mass (van der Marel + 2002), but potentially 25% of the total mass (Pennarubia+ 2016)





The EAGLE galaxy formation simulation





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EAGLE matches the observations for:

- Galaxy mass function
- Galaxy sizes





The sample of LMC-sized dwarfs



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Stellar mass selected LMC-analogues:

$$M_{\star} = [1 - 4] \times 10^9 M_{\odot}$$

Three samples:

- Field, i.e. dwarfs that are central galaxies
- Satellites
- Satellites of MW-mass hosts

Shao, MC+ 2018



 LMC was accreted about ~1.5 Gyrs ago when it had a ~10% lower stellar mass than today:

$$M_{\star} = 2.4 \times 10^9 M_{\odot}$$

- Abundance matching (Moster + 2013): • $M_{200} = 1.8^{+0.5}_{-0.3} \times 10^{11} M_{\odot}$
- **EAGLE all LMC-sized dwarfs:** $M_{200} = 2.0^{+0.6}_{-0.5} \times 10^{11} M_{\odot}$
- **EAGLE LMCs with an SMC-sized satellite:** $M_{200} = 3.2^{+1.0}_{-0.9} \times 10^{11} M_{\odot}$ (only 2% have an SMC-sized satellite)

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The LMC's total mass



The colour distribution



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The colour distribution



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The colour distribution



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Bluer LMC-mass dwarfs in MW-mass host



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Bluer LMC-mass dwarfs in MW-mass host



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Most LMC-mass satellites were accreted in the last 7 Gyrs, much more recently than the MW classical satellites. This is because:

- It takes longer for massive satellites to grow.
- Enhanced dynamical friction => rapid orbital decay and merger with their central galaxy.

Shao, MC+ 2018a, Shao, MC+ 2018b





What is the LMC fate? - low LMC mass -



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• Light LMC: $M_{200}^{LMC} = 0.5 \times 10^{11} M_{\odot}$



What is the LMC fate? — current values of LMC mass —



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What are the consequences of a MW-LMC merger?

Investigate similar mergers in EAGLE:

- Select mergers that took place between 1 and 8 Gyrs ago. \bigcirc
- Require that the LMC-analogue has the LMC's stellar mass. \bigcirc
- Match the MW-analogue to the following present day properties of the 0 MW:
 - 1. Halo mass
 - 2. Supermassive black hole mass
 - 3. Cold gas mass

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8 MW-LMC analogues





The MW supermassive black hole





The MW supermassive black hole



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The MW stellar halo





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The MW stellar halo





The merger aftermath for the stellar halo









Summary

- - MW in ~2.5 Gyrs.

• The presence of the SMC suggests that the LMC has a very massive halo for its stellar mass. $M_{200} = 3 \pm 1 \times 10^{11} M_{\odot}$

LMC-mass dwarfs in MW-mass hosts are bluer than isolated analogues due to enhanced SF and long quenching timescales.

If the LMC is as massive as recently estimated, it will merge with the

Despite its puny stellar mass, the LMC collision will have large effects on our galaxy, increasing by many factors the mass of the central supermassive black hole and that of the stellar halo.



