The MW—LMC Great Collision: MW’s return to normality

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MC+ 2018
Why return to normality?

The Milky Way is not the typical spiral galaxy, especially when it concerns the following properties:

- The mass of the central supermassive black hole
- The mass and metallicity of the stellar halo
- The presence of an unusually bright satellite

1) Are these observations connected?
2) If so, what is the common thread?

e.g. Bell+ (2017)
The supermassive black hole

Savorgnan+ (2017)
The stellar halo

Bell+ (2017)
The Large Magellanic Cloud

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

- Has 5% of the MW stellar mass, but roughly 25% of the total mass (Pennarubia+ 2016)
  \[ M_{\text{LMC}} \sim 2.5 \times 10^{11} M_{\text{sun}} \]

- Abundance matching in the EAGLE galaxy formation simulation (Shao, MC+ 2018):
  \[ \text{LMC only} \sim 2 \times 10^{11} M_{\text{sun}} \]
  \[ \text{LMC + SMC} \sim 3 \times 10^{11} M_{\text{sun}} \]
What is the LMC fate?
— low LMC mass —

![Graph showing the distance from the MW to LMC and Andromeda as a function of time from today in Gyrs. The graph illustrates the close approach and subsequent rebound of the LMC and Andromeda.]
What is the LMC fate?
— current values of LMC mass —

- fiducial case, $M_{\text{LMC}} = 1/4 \, M_{\text{MW}}$
- light LMC, $M_{\text{LMC}} = 1/20 \, M_{\text{MW}}$

![Graph showing the evolution of distance from the MW over time for different mass scenarios.](image)
What are the consequences of a MW—LMC merger?

Use the EAGLE simulation of galaxy formation.
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.
- Require that the LMC-analogue has the LMC’s stellar mass.
- Match the MW-analogue to the following present day properties of the MW:
  1. Halo mass
  2. Supermassive black hole mass
  3. Cold gas mass

8 MW—LMC analogues
The MW supermassive black hole

![Graph showing black hole mass vs. spheroid stellar mass](image_url)
The MW stellar halo

- Plot 1: Stellar halo mass, $M_{\text{halo}} [M_\odot]$ vs. galaxy stellar mass, $M_{\text{gal}} [M_\odot]$
- Plot 2: Stellar halo metallicity, [Fe/H] [dex] vs. galaxy stellar mass, $M_{\text{gal}} [M_\odot]$

- Symbols:
  - Blue circles: External galaxies
  - Black square: Andromeda
  - Black star: MW today
  - Orange star: MW after LMC merger

- Typical errors indicated on the plots.
The MW stellar halo metallicity

PDF

MW today
MW after LMC merger

stellar halo metallicity, [Fe/H]
A dearth of mergers for the MW?
1) the central black hole

Split the EAGLE MW-sized haloes according to the lookback time since the latest merger with a SMC-like or more massive satellite:

- recent merger (< 5 Gyrs)
- intermediate merger (5-10 Gyrs)
- early merger (>10 Gyrs)
A dearth of mergers for the MW?

2) the stellar halo
Summary

- The MW has several anomalous properties: it has an undersized supermassive black hole; it is surrounded by a very low mass, excessively metal-poor stellar; and it has an unusually large satellite.

- If the LMC is as massive as recently estimated, it will merge with the MW in \(~2.5\) Gyrs and will return the MW to normality.

- The LMC merger is long overdue, with the anomalous MW properties possibly indicating a lack of massive satellite mergers during the MW formation history.