The Source and Formation of the Magellanic Stream

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Overview

- We explore the Magellanic Stream (MS) using the Leiden-Argentine-Bonn (LAB) HI all-sky survey [5].
- Using a Gaussian decomposition of the LAB HI velocity profiles, we trace the MS back to its origin in the LMC.
- We use the higher-resolution Parkes HI survey of the LMC [11] to investigate the formation mechanism of the MS and find evidence for gas blowout.

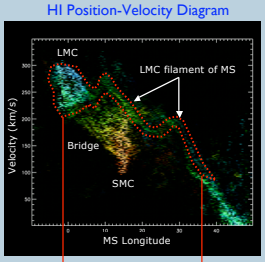
Historical Perspective

- Previously thought the MS originates from SMC/Bridge [3,10].
- Formed by tidal forces or ram pressure [3,4,8].
- Problems with these formation mechanisms:
  If tidal forces: Why no stars in the Stream?
  If ram pressure: Why is there a Leading Arm?
  First Passage Scenario challenges both mechanisms [1].

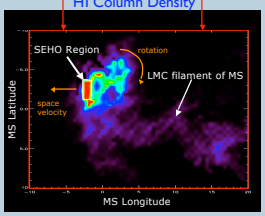
Tracing the MS to the LMC

- The two MS filaments previously identified spatially [10] are seen well-separated in velocity for the first time.
- In the position-velocity diagram, one of the filaments can be traced back to the LMC.
- A position-velocity cut is used to isolate the LMC-originating filament and reveal its full spatial distribution.
- This filament originates in the SouthEast HI Overdensity (SEHO) region of the LMC.

HI Position-Velocity Diagram



HI Column Density

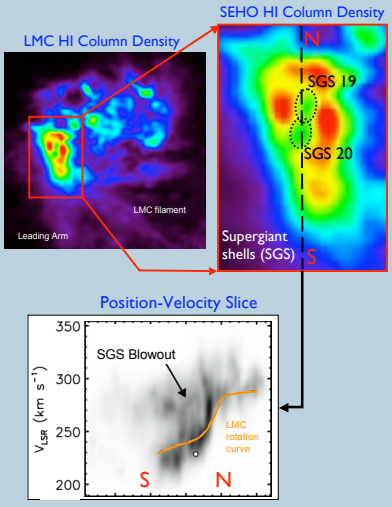


- The sinusoidal pattern in position and velocity of the LMC filament can be used to estimate the MS drift rate and age (assuming pattern arises from LMC rotation).

MS drift rate ~ 49 km/s
MS age ~ 1.7 Gyr

The Formation of the MS: Evidence for Blowout

- We use the high-resolution Parkes HI survey of the LMC [11] to investigate the formation of the MS in the SEHO region.
- The SEHO region is a natural place for an HI stream to originate: high density of HI [7], position at end of the stellar LMC bar, leading edge of LMC motion, rich in CO [12], Hα emission [6], GMCs [12], young stellar clusters [2], and supergiant shells [6].
- The Parkes HI survey shows evidence that gas is being blown out of the SEHO region to high velocity by supergiant shells (SGS 19 & 20 [6]). This high-velocity gas connects to the LMC filament and the Leading Arm [9].



The Blowout Model

- New formation mechanism for the Magellanic Stream:

  1. Star formation in SEHO creates superbubbles/supergiant shells.
  2. Supergiant shells blowout SEHO gas with LMC escape velocity.
  3. Once gas is far enough away from LMC, tidal forces and ram pressure pull/push the gas to form the MS and Leading Arm.

- Tidal/ram pressure forces do not strip the gas, but shape the gas into a stream.
- Explains why there are no stars in the MS.
- Explains the existence of both trailing and leading arms.
- Consistent with hyperbolic orbit predicted by First Passage Model.

Comparison of MS Formation Mechanisms

	Tidal	Ram Pressure	Blowout
LMC origin	✖	✔	✔
Leading Arm	✔	✖	✔
N(HI) gradient	✖	✔	✔
Bifurcation	✔?	✖	✔?
No Stars	✖	✔	✔
First Passage	✖?	✖?	✔?

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