The LMC's Bar: A Rare Gem in the Vast Crowd of Gaia Stars

Himansh Rathore[(1)] , Yumi Choi[(2)] , Knut Olsen[(2)] , Gurtina Besla[(1)]

(1) University of Arizona (2) NSF NOIRLab

We aim to precisely measure the LMC Bar's properties using red clump stars in Gaia DR3, to place the bar in context of other barred spirals and for discerning the origin of its strange nature. We present a novel method to tackle crowding incompleteness in the LMC through the Gaia color excess. We use Fourier decomposition of the LMC's disk to isolate its bar. After correcting for incompleteness, we find that the LMC hosts a bar comparable in strength to the Milky Way. Moreover, the LMC bar's properties are consistent with a numerical model in which the SMC has recently collided with the LMC.

1) The LMC's Strange Bar

- The LMC's Bar has strange properties typically not seen in galactic bars. It is offset from the disk center (Fig 1), is tilted out of the disk plane and is not evident in any ISM tracer.
- SMC's interactions with the LMC might be responsible.

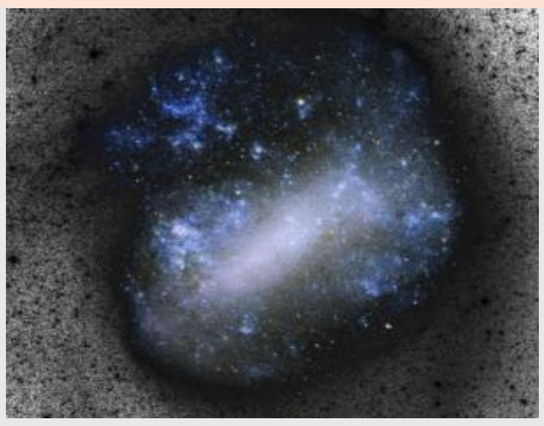

Fig 1: The LMC's bar in optical [1]

2) Why Measure the LMC's Bar ?

Precise measurements of the LMC's bar is important for understanding its strange properties and their origin, and for placing the LMC in the context of other barred spiral galaxies.

3) Stellar Crowding is a Significant Challenge

- Gaia DR3 offers a golden opportunity to study the LMC's bar in detail through its vast astrometric and kinematics datasets.
- We use red clump stars, since they are a good tracer of the LMC's bar and enable comparisons with N-body simulations.
- However, in the era of big datasets like Gaia, stellar crowding is a major challenge in the inference of galaxy structure (Fig 2).
- Artificial Star Tests are computationally expensive and impractical for such vast datasets; thus, a novel solution is needed !

4) A Novel Solution to Crowding Induced Incompleteness Using the Gaia BP-RP Color Excess

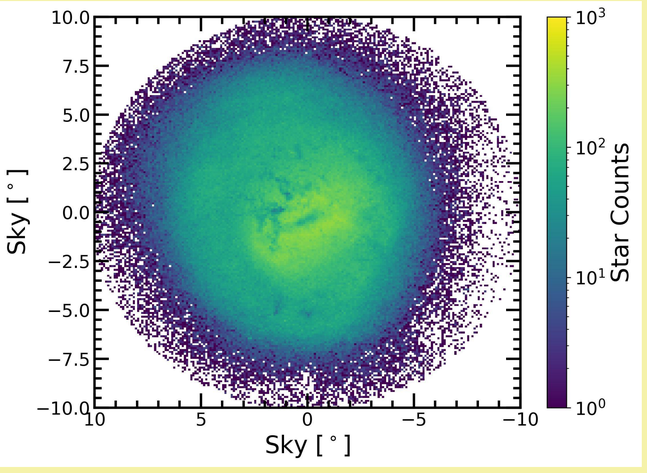

Fig 2: The LMC disk in Gaia DR3 red clump. Central region is very crowded and incomplete.

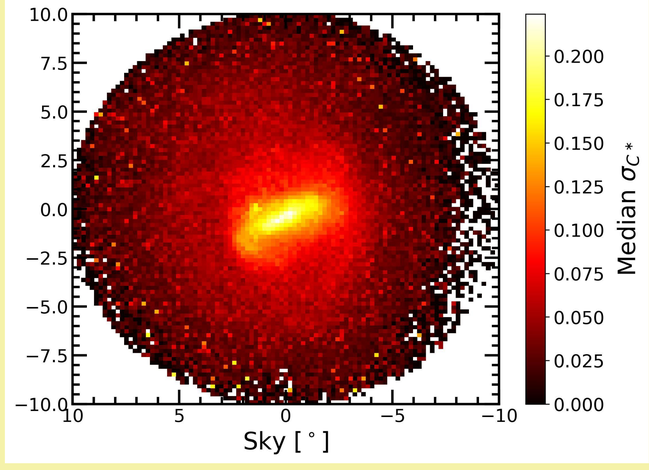

Fig 3: Spread in Gaia BP-RP color excess probes crowding and can be used to correct incompleteness.

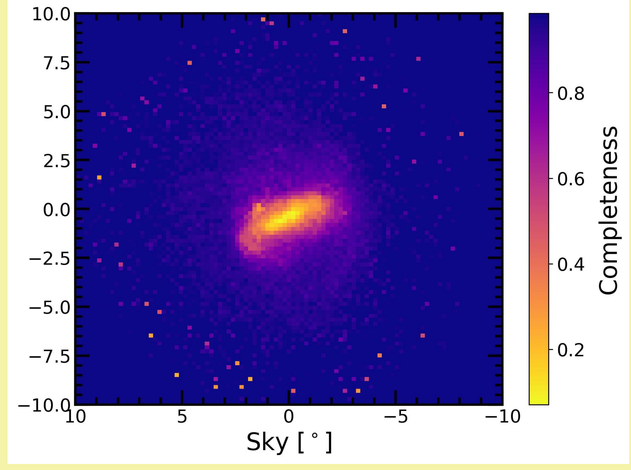

Fig 4: A completeness map for the LMC disk derived from the spread in color excess.

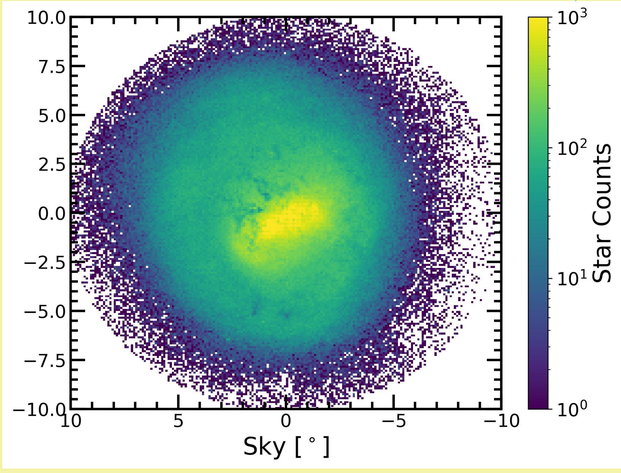

Fig 5: Completeness corrected LMC disk. The central features like the bar become prominent.

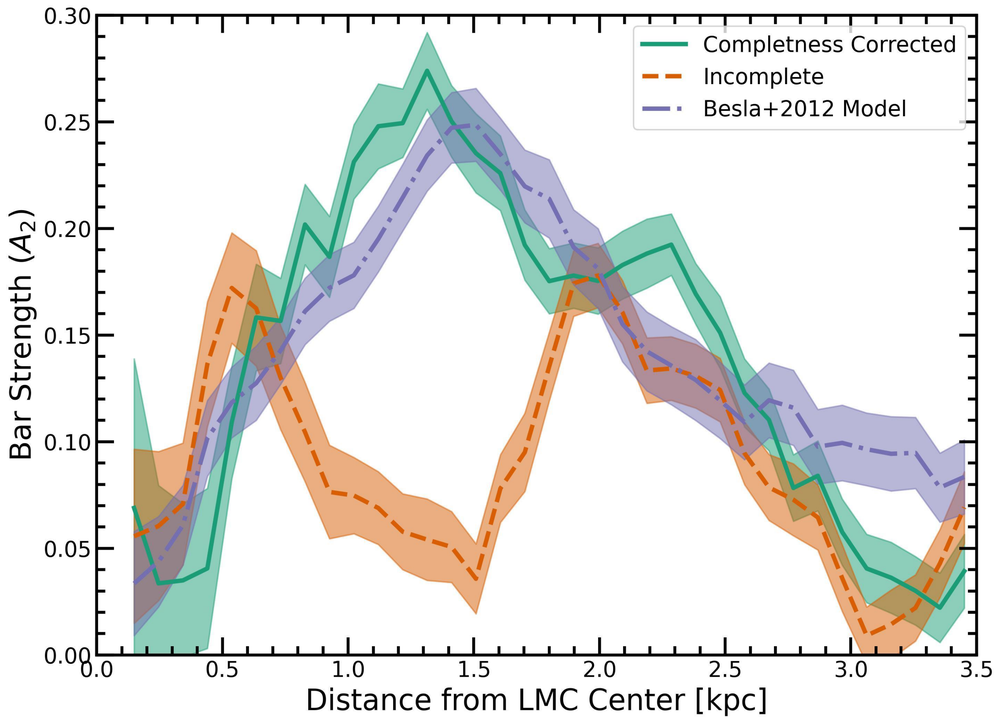

Fig 6. Radial profile of the LMC Bar's Strength.

5) Results and Conclusion

We extract the bi-symmetric component of the Fourier transform of the LMC's disk to isolate the bar and measure its properties. We find that:

- An incomplete sample significantly underestimates the LMC bar's strength (Fig 6).
- After correcting for incompleteness, the LMC has a peak bar strength comparable to the Milky Way.
- The LMC bar's properties are consistent with a model where the SMC recently collided with the LMC.

6) Future Plans

We plan to study how the SMC's interactions with the LMC affects the dynamical properties of the LMC's bar by utilizing numerical simulations.

Major References:

[1] Besla et al. 2016; ApJ 825:20 (10pp), 2016 July 1
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[3] Athanassoula and Misiriotis 2002; MNRAS 330, 35-52 (2002)
[4] Olsen and Blum 2003; AJ 126:452-471, 2003 July
[5] Choi et al. 2022; ApJ 927:153 (13pp), 2022 March 10
[6] Lucey et al. 2023; MNRAS 520, 4779-4792, 2023 February 6

Based on Rathore+2024(a) in-prep. Questions ?
Find me, or email me at himansh@arizona.edu
Website: himanshrathore.github.io (scan QR)