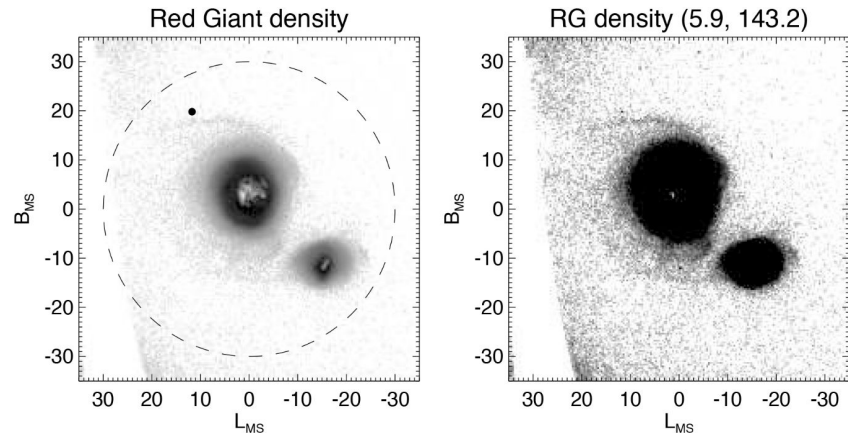


Kinematical Analysis of Substructure in the Southern Periphery of the Large Magellanic Cloud

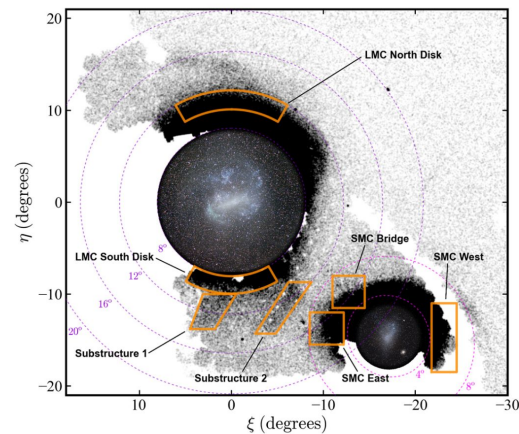
Xinlun Cheng, Yumi Choi, Knut Olsen, David L. Nidever,
Steven R. Majewski, Antonela Monachesi, Gurtina Besla
And APOGEE Team

Introduction

- Recent imaging surveys of LMC/SMC
- Discovery of stellar substructure
 - Northern arm/southern structure (Belokurov & Erkal 2019)
 - “Hook”-like features (Mackey et al. 2018)
- This study:
 - Kinematical analysis
 - 2D: Gaia and 3D: Gaia + APOGEE
 - Comparison with simulations



Belokurov & Erkal 2019



Mackey et al. 2018

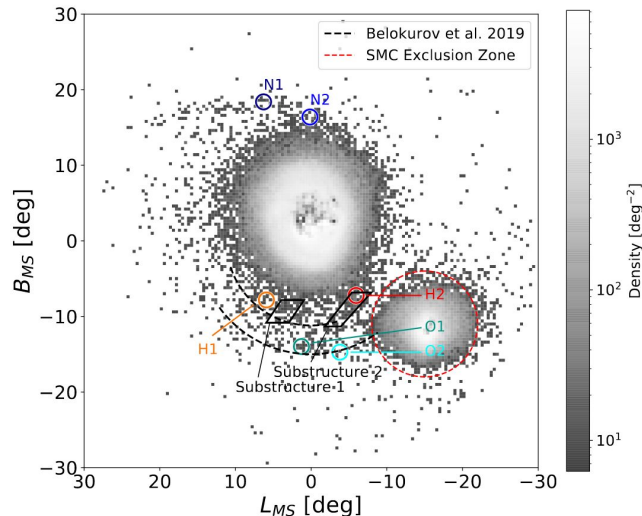
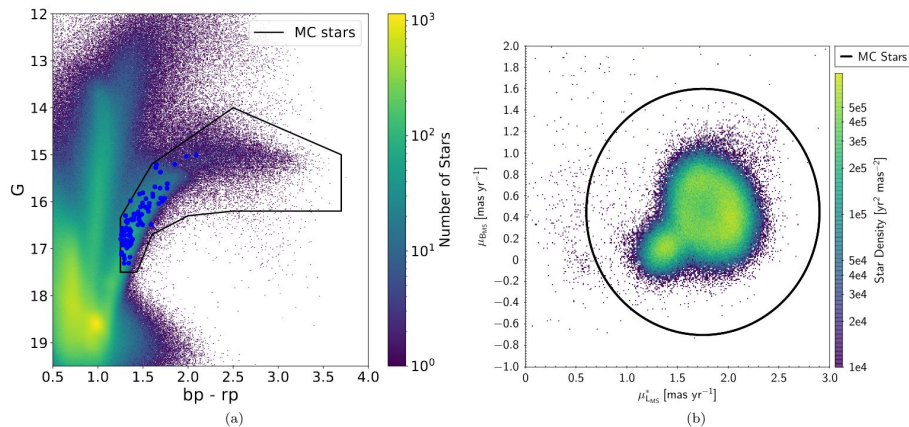
Data

- Gaia

- 30 deg radius
- SMC distance > 7 deg
- $G < 17.5$ RGB branch
- Parallax < 0.2 mas & $b < -5$ deg
- Proper motion

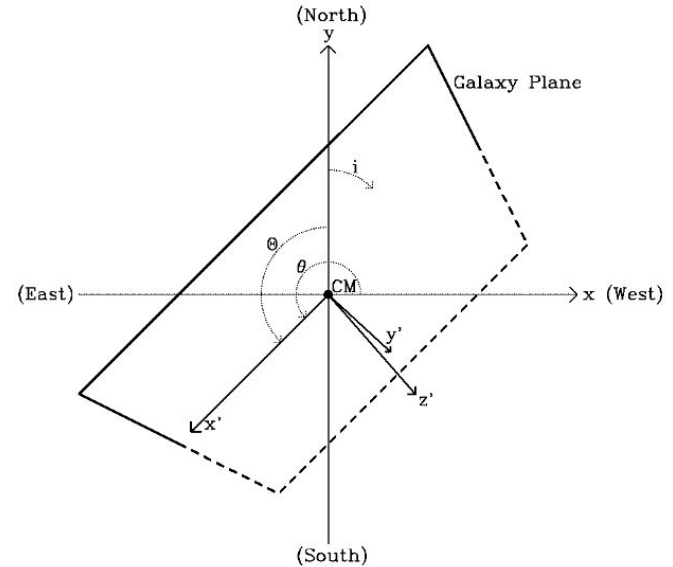
- APOGEE

- 6 CNTAC fields: 2N4S
- $G < 17.5$ RGB branch
- Parallax < 0.2 mas & $b < -5$ deg
- Proper motion
- $100 < V_{\text{helio}} < 350$ km/s
- $T < 5400$ & $\log g < 4$



Results: Velocity projection model

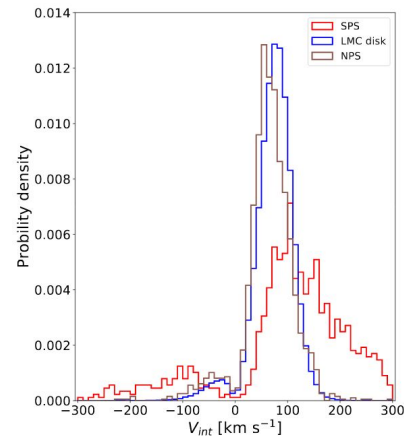
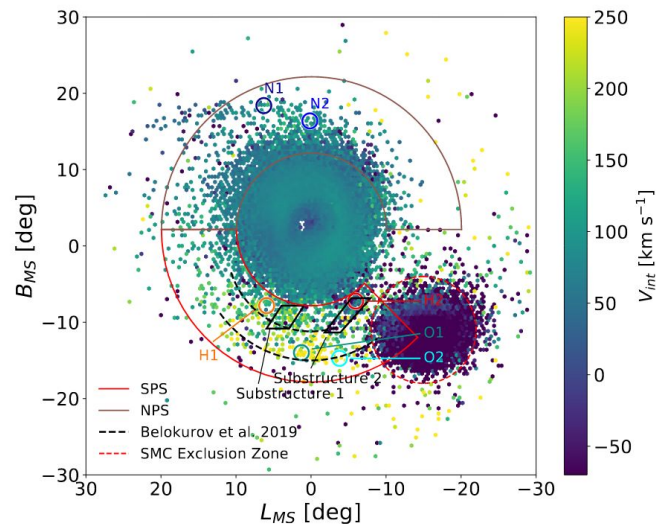
- Choi et al. 2021, submitted
- Based on formalism of van der Marel et al. (2002)
 - Kinematic center
 - Line-of-node position and inclination angles of LMC disk
 - Bulk motion + internal rotation
 - Parameters obtained by fitting $\sim 10,000$ LMC stars with Gaia EDR3 PM and Hydra-CTIO/APOGEE line-of-sight velocity measurements



van der Marel et al. 2002

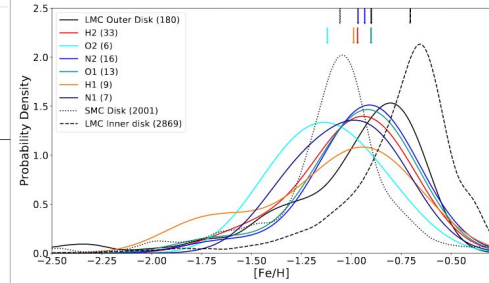
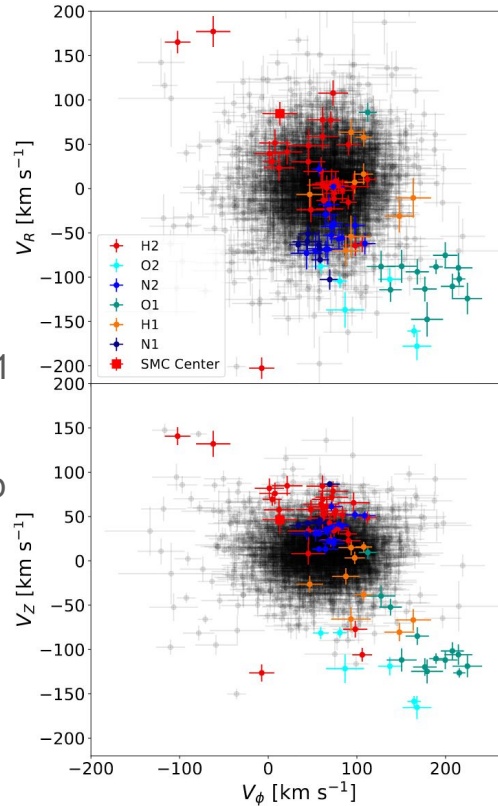
Results: 2D motion

- De-projected in-plane velocity
- Southern Periphery Sample (SPS)
 - High vint
 - Large range of vint (~ 600 km/s)
 - Different vint distribution with LMC disk
- Northern Periphery Sample (NPS)
 - Similar vint distribution with LMC disk



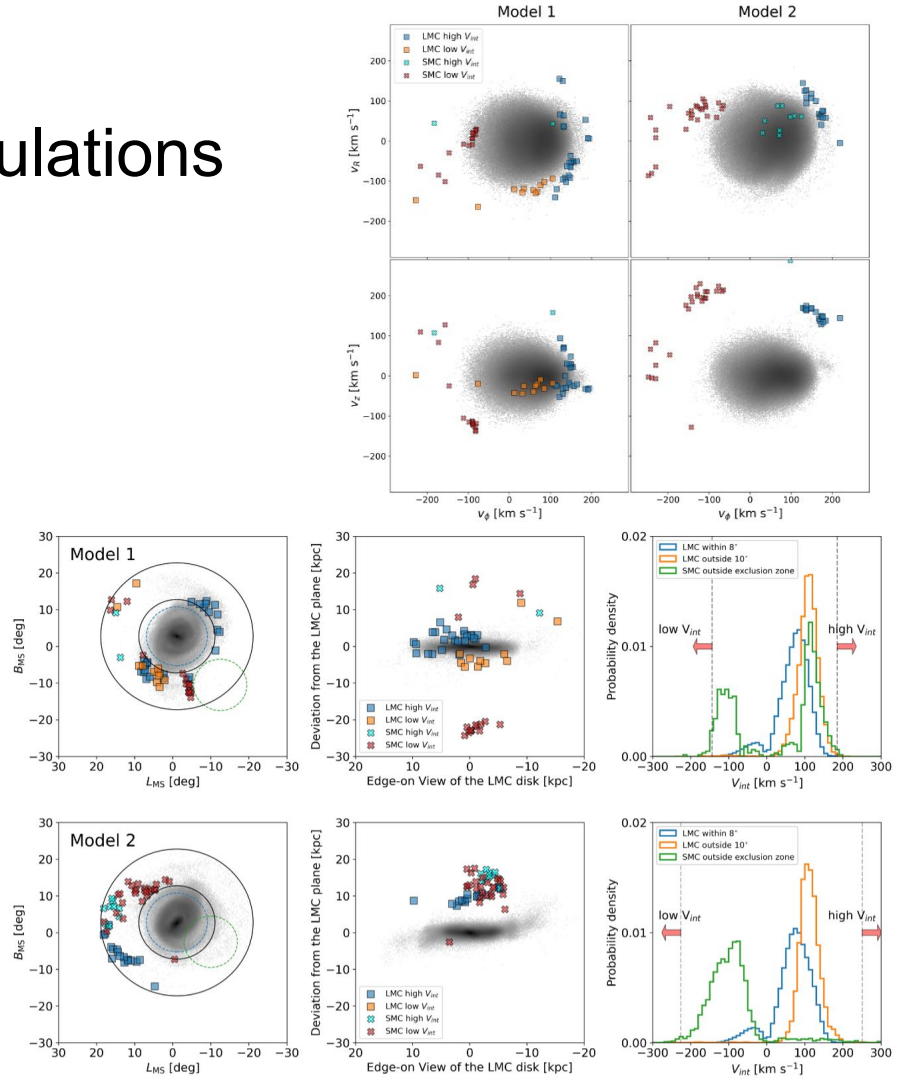
Results: 3D motion & Fe/H

- Proper motion + RV \rightarrow 3D velocity in LMC frame
- 3D velocities:
 - Outer fields (O1 + O2)
 - Significant deviance from LMC disk
 - Hook fields (H1 + H2) & Northern fields (N1 + N2)
 - Similar to LMC disk
 - Albeit closer to the “edge” of envelop
- Metallicity
 - Mostly between LMC and SMC
 - O2: lower than SMC
- More chemistry analysis: Munoz et al. 2021



Results: comparison with simulations

- Besla et al. 2012
 - LMC + SMC analogue
 - MW potential, first infall
- Impact parameter of the latest encounter
 - Model 1: ~ 20 kpc
 - Model 2: ~ 2 kpc
- Comparable offsets in each velocity component
- Kinematic outliers are mostly extra-planar
- Possible origin: a mixture of LMC and SMC debris



Conclusion

- Periphery of the LMC contains stars from a variety of origins
 - A clear north-south dichotomy
- Hook feature: 3D velocities and MDFs like those of the outer LMC disk
- Even further: more extreme kinematics
 - LMC/SMC interaction
 - Or possible LMC-equivalent of accreted halo substructure
 - Suggest a stronger interaction between LMC and SMC

Questions ?