



COST MW-Gaia WG1/WG4 Workshop  
Gaia – Beyond the Milky Way



# Study of internal kinematics of the SMC using Gaia DR3 data

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# Small Magellanic Cloud

Nearby dwarf galaxy (Distance: 62 kpc,  
*Scowcroft 2016*)

Interacts both with LMC and MW

## SMC Sample

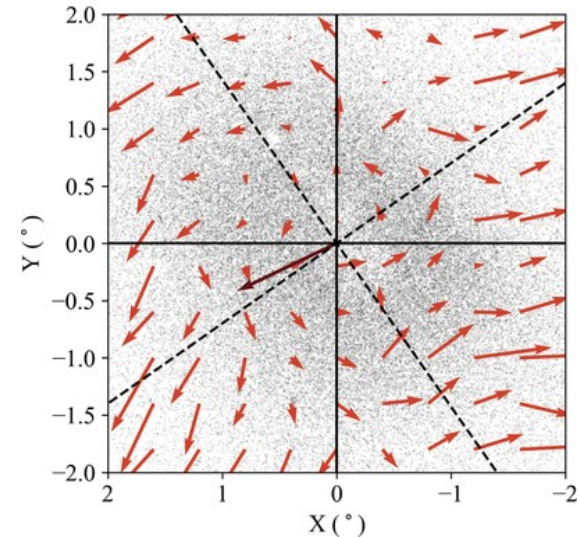
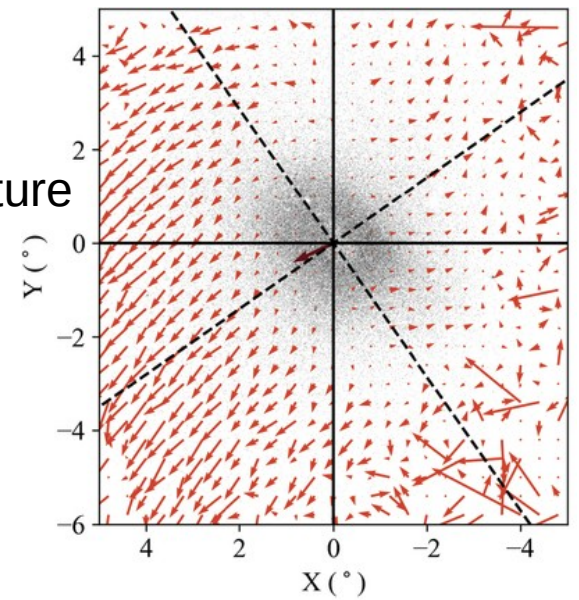
Gaia Data Release 3

Dynamic Center, RA: 12.8 deg  
DEC: -73.5 deg, *Gaia Collaboration  
et al. 2020*

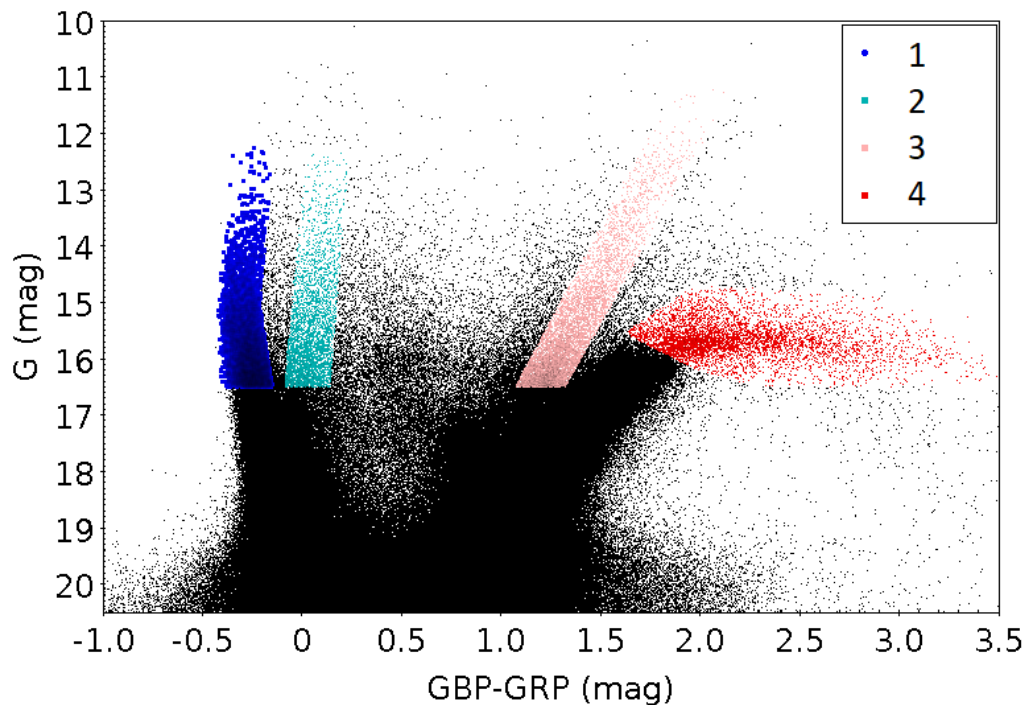
Radius:  $15^\circ$

Zivick et al 2021

Red Giants  
Kinematical Structure  
Gaia DR2



# CMD Gaia DR3



## Limitations

pmra	-3 mas/y	3 mas/y
pmdec	-3 mas/y	3 mas/y
parallax	-0.2	0.2

Limiting Magnitude G (mag)=16.5

We study 4 different stellar populations that correspond to different regions of the CMD and of different ranges of ages.

# Age Group 1

## PARSEC Isochrones

Metallicity:  $z=0.002$

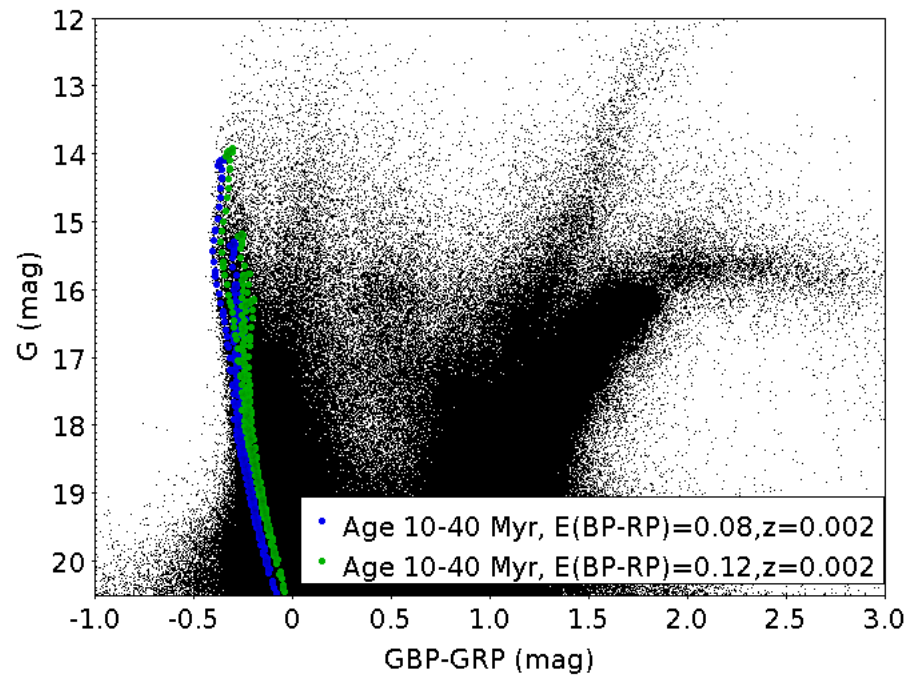
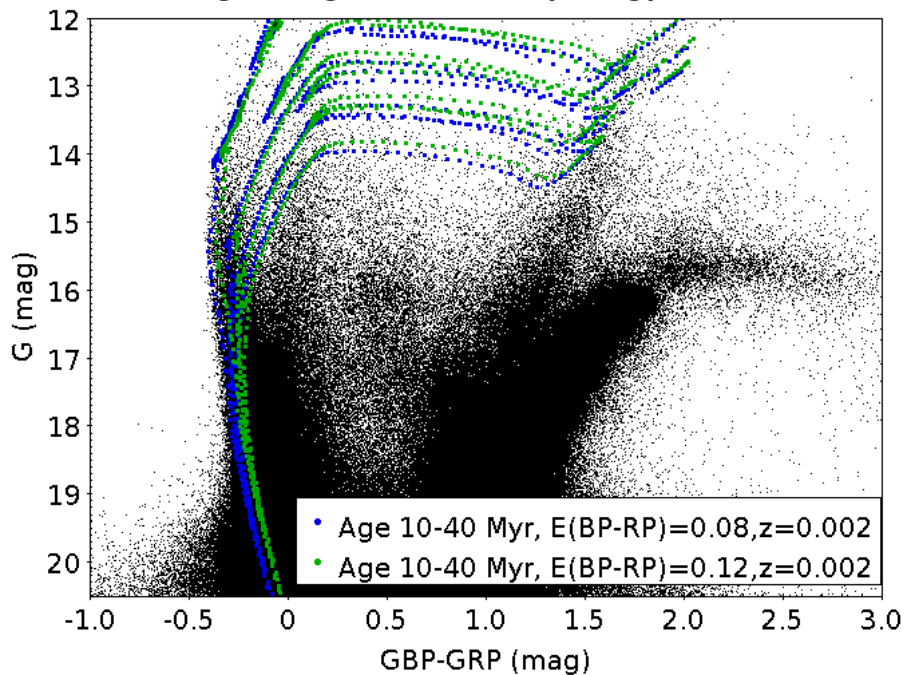
Reddening:  $E(\text{BP-RP})=0.08-0.12$

Ages: 10-40 Myr

Limiting Magnitude G (mag)=16.5

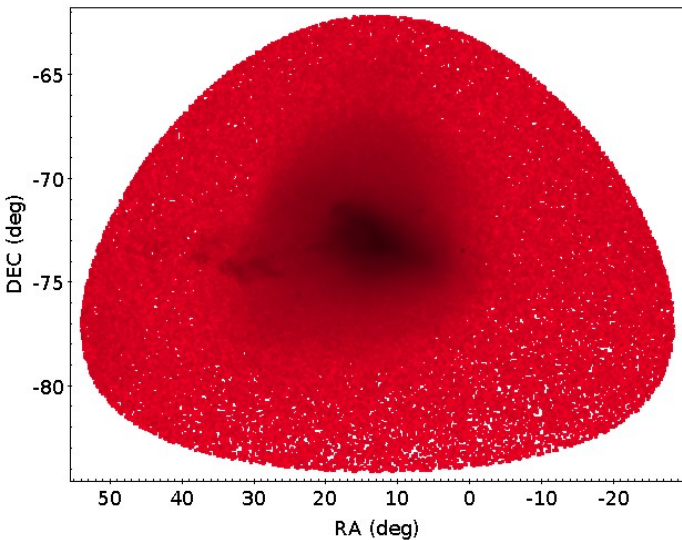
Distance Modulus=18.96 (de Grijs & Bono 2015,  
Scowcroft et al. 2016)

$A_G=2 * E(\text{BP-RP})$  (Rene Andre et al. 2018)

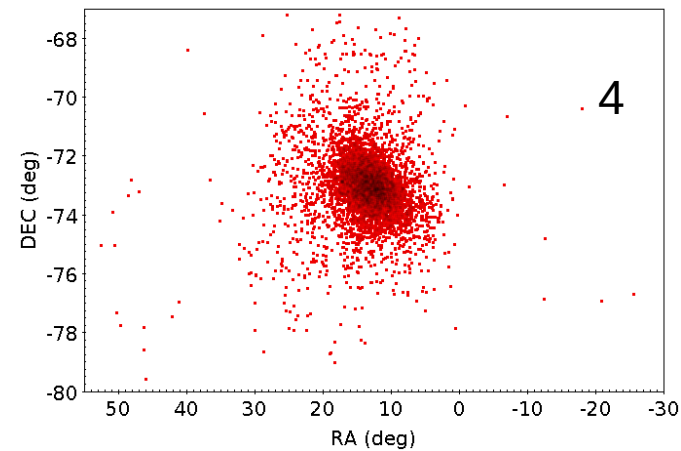
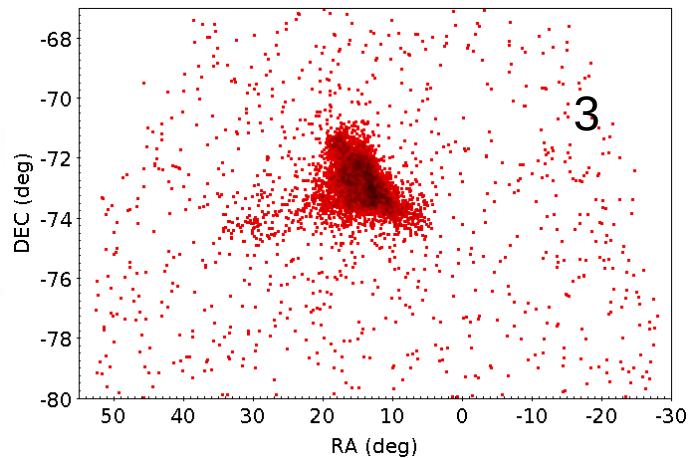
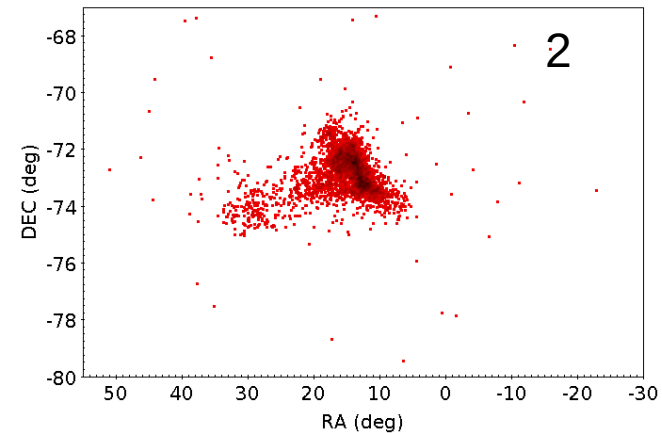
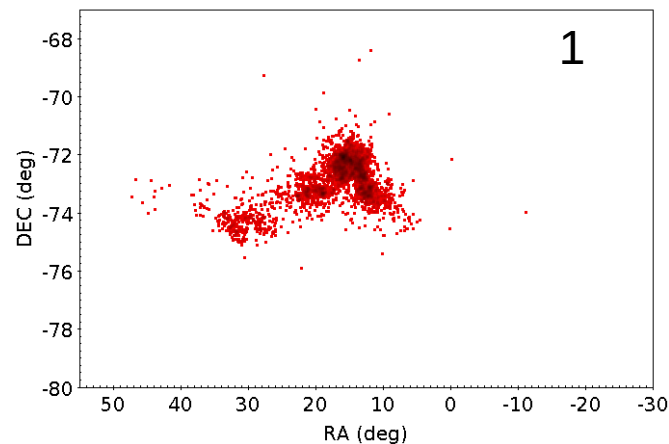


<b><i>CMD Regions</i></b>	<b><i>Age</i></b>	<b><i>Reddening E(GBP-GRP)</i></b>	<b><i>Metallicity z</i></b>
1	10-40 Myr	0.08-0.12 mag	0.002
2	20-200 Myr	0.08 mag	0.002
3	20-400 Myr	0.04-0.12 mag	0.002
4	2-10 Gyr	0.08-0.12 mag	0.001-0.002

# Spatial Distribution of the Populations of Different Ages of the SMC sample



For the younger age group (1) the distribution is patchy, and along an elongated bar-like feature and the Wing.



As the age increases the patchiness is reduced and for the oldest stars of group 4 the distribution is smooth and elliptical like.

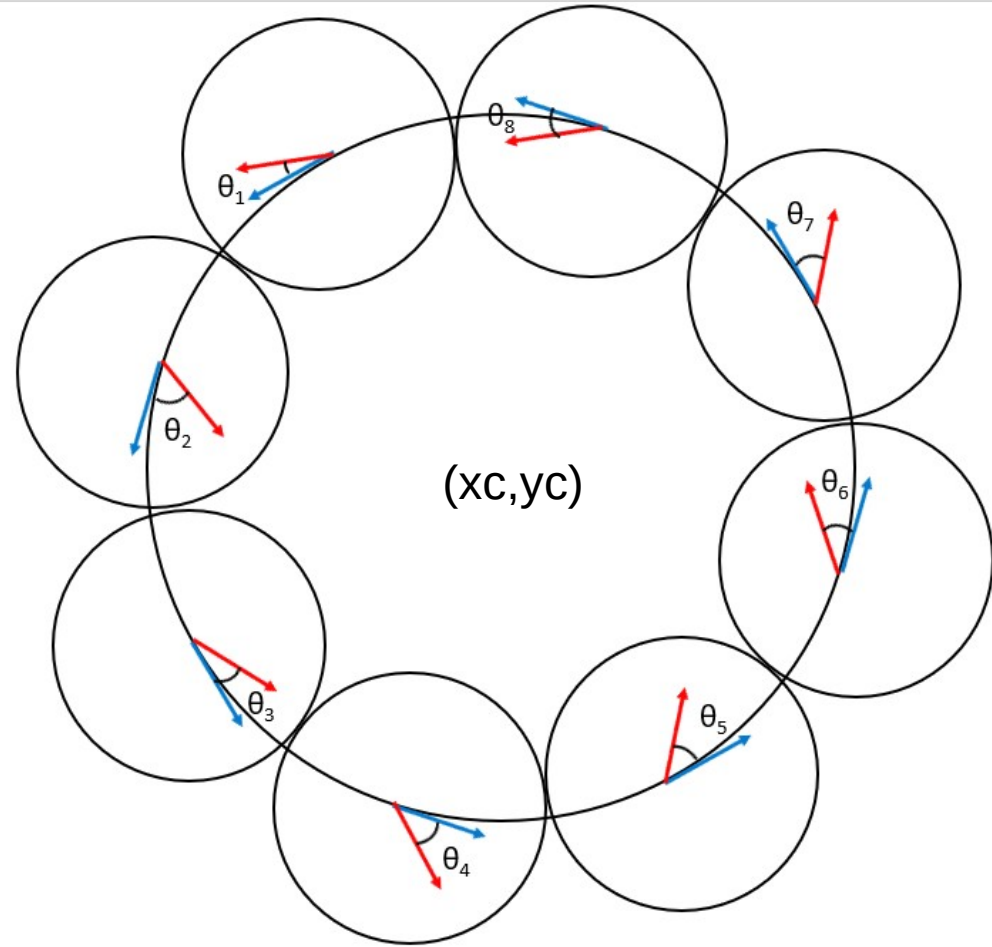


# A WAY TO DETERMINE A CENTER OF ROTATION

The examined region has a diameter of 1.5 degrees around the dynamical center.

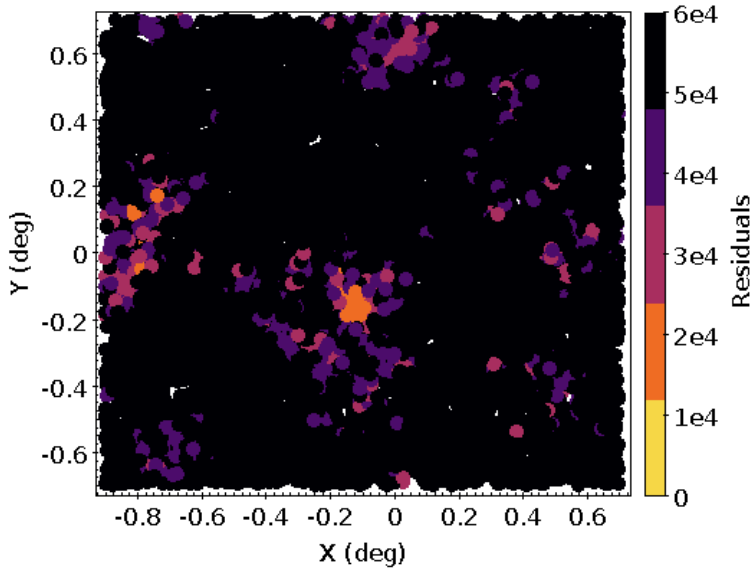
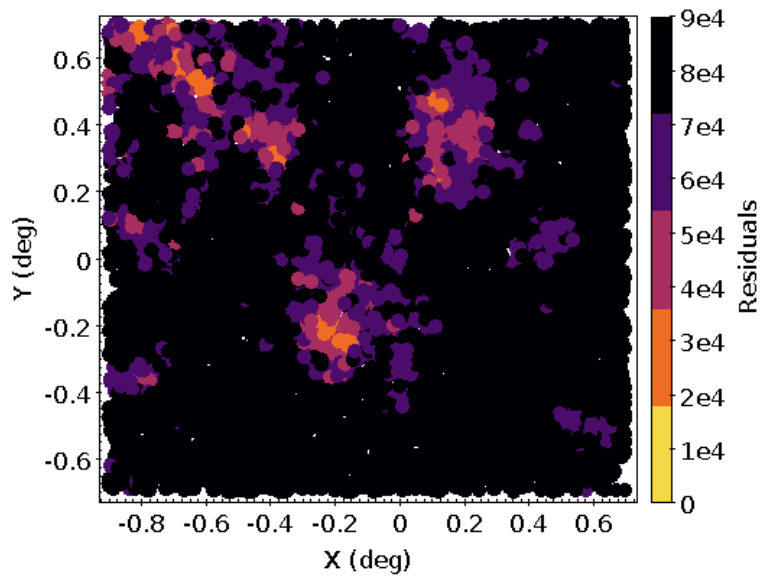
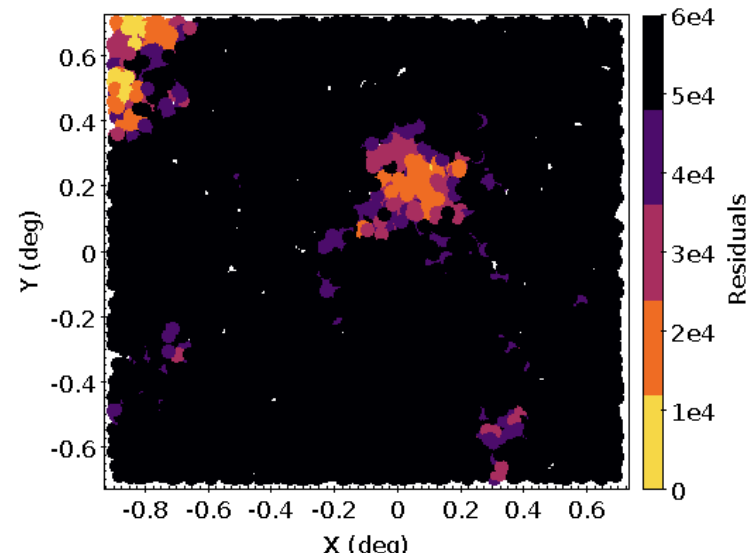
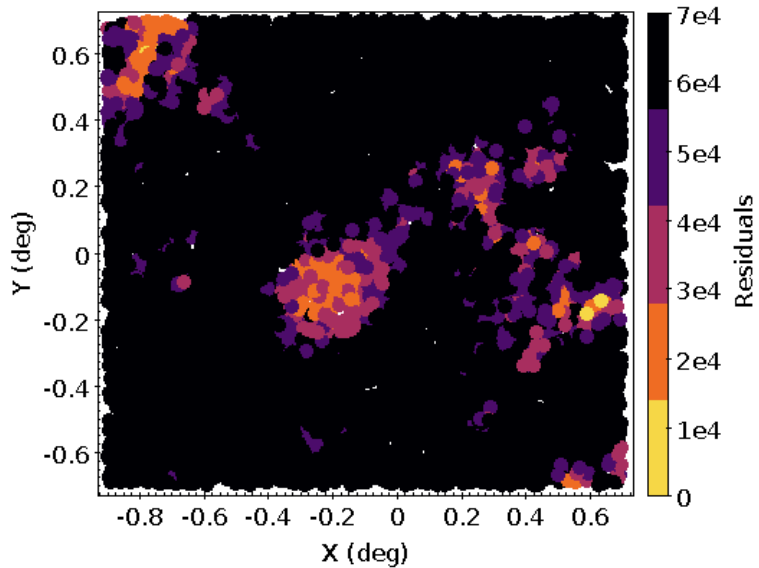
We estimate the residuals for  
10000 centers

$$\theta_R^2 = \theta_1^2 + \theta_2^2 + \theta_3^2 + \theta_4^2 + \theta_5^2 + \theta_6^2 + \theta_7^2 + \theta_8^2$$



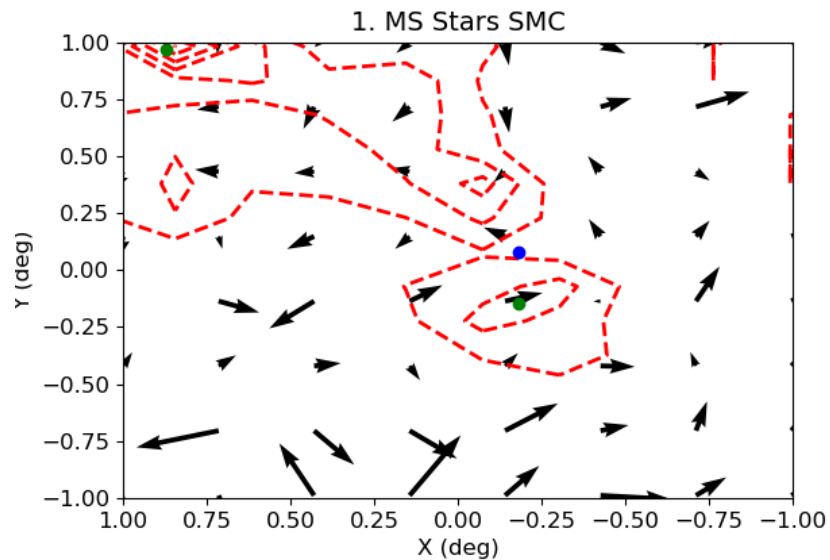
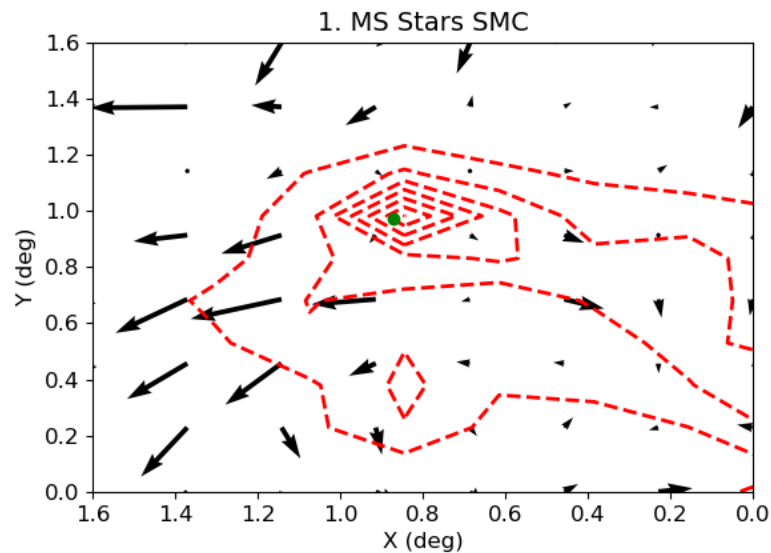
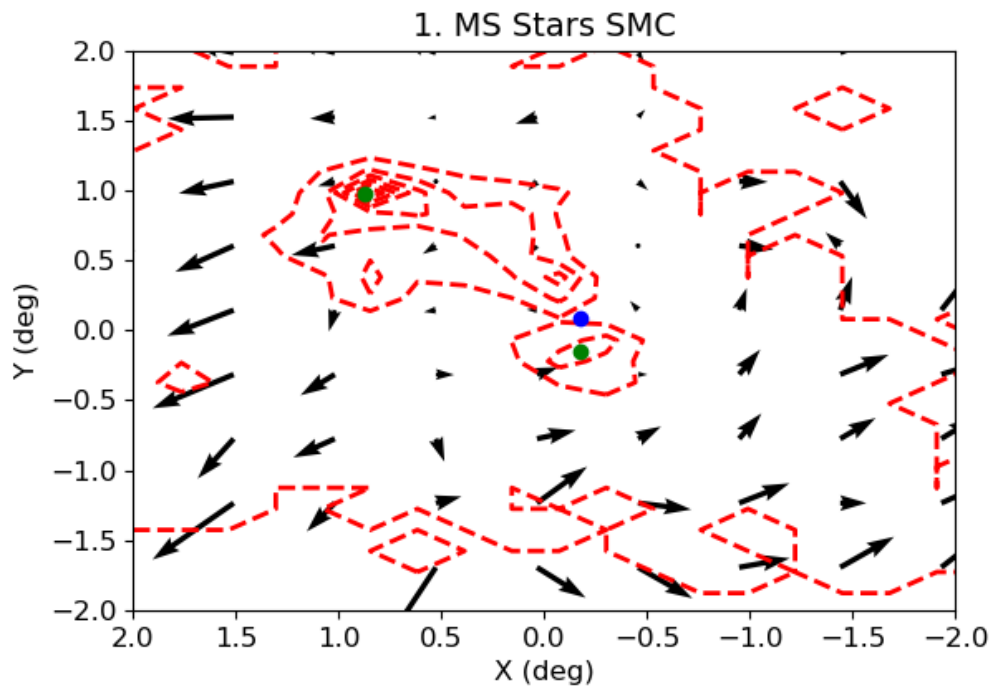
Theoretical Vectors  
Estimated Vectors

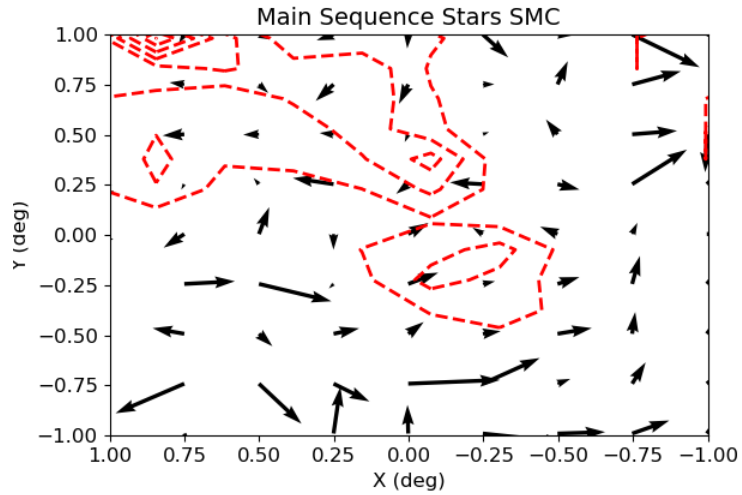
# Residuals





# KINEMATICAL STRUCTURE OF AGE GROUP 1.



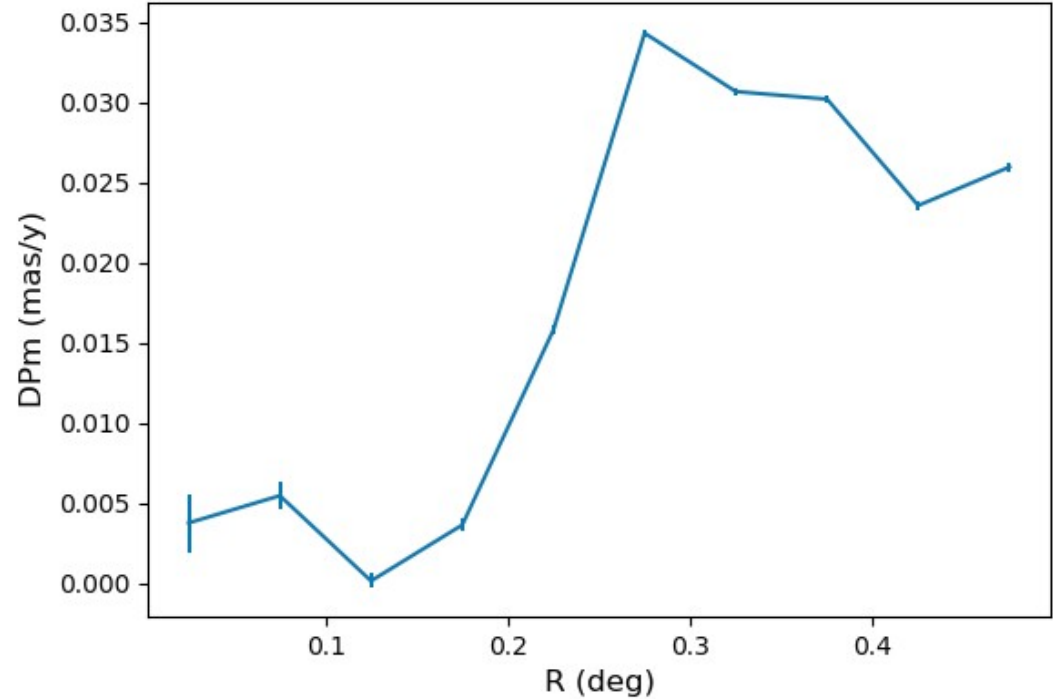


The Central Region has a  
Mass (lower limit)

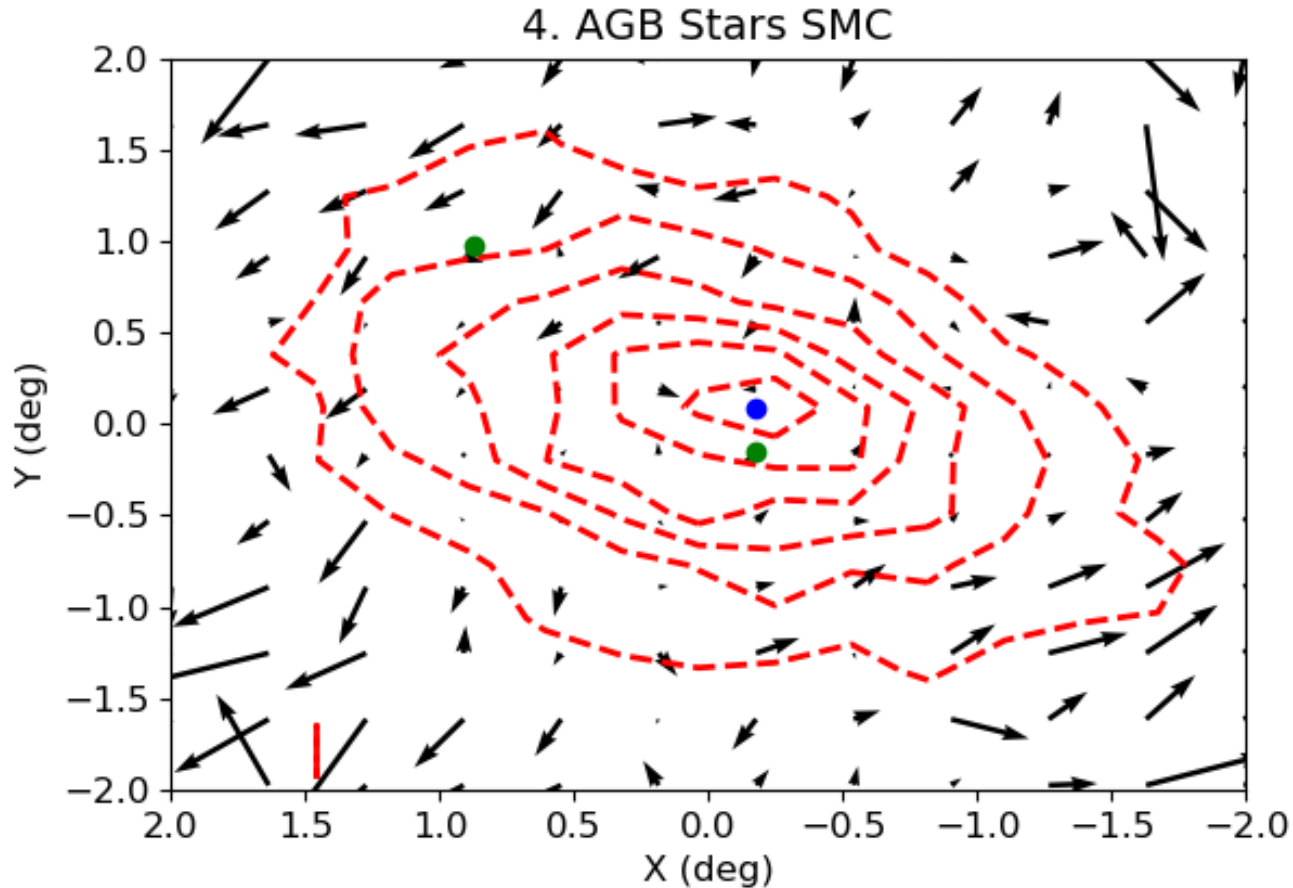
$$\sim 2 \cdot 10^6 M_{\odot}$$

## Rotation Curve of Main Sequence Stars

0.03 mas/yr  $\rightarrow$  8.5 km/s



# Kinematical Structure of Age Group 4.



# Conclusions

- Different substructures connected with populations of different ages.
- Clear indications of rotation for the younger populations.
- There is a weak rotational signature for the older populations
- The rotational center of the young stars coincides with the center of mass (both for young and old stars).

# FUTURE WORK

- Approach the problem take into account the deprojection of the SMC.
- Compare with theoretical dynamical simulations.
- Use next Data Release of GAIA.