DECam and the Magellanic Clouds

Knut Olsen
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Motivation

• The Magellanic Clouds are rich laboratories of astrophysical phenomena
• Their structure and stellar populations allow us to explore their evolution and history of interaction
• The DES will allow us to map Magellanic structure over a huge area, tens of degrees away from the galaxy centers
• We wish to build on the DES by adding imaging of areas that are of great interest for Magellanic Cloud structure
• This survey will be of great value to the stellar populations community
Magellanic Cloud Surveys

- MCPS (UBVI)
- DENIS (IJK)
- 2MASS (JHK$_s$)
- SAGE (IRAC+MIPS)
- HI 21cm (ATCA, Parkes)
- CO (NANTEN)
- OGLE, OGLE-II, OGLE-III (BVI)
- MACHO (BR)
- SuperMACHO (V+R)
- VMC (YJK$_s$)
- Various optical spectroscopic surveys

Kim et al. (1998); Staveley-Smith et al. (2003)

C. Smith and S. Points

van der Marel (2001)

MCELS

Meixner et al. (2006); courtesy of K. Gordon

Gordon et al. (2011)

Spitzer 160 μm

Zaritsky et al. (2000)
The Larger Scale Environment

Nidever et al. (2010)
Example results from surveys

Supernova light echoes!

For Type Ia SN, assuming:

- Perpendicular dust sheet at z=150 pc
- $V_{\text{max}} = V_{\text{max,1987A}} - 3.5$ mag

  At 500 yr, $\Sigma_V = 22.5$ mag arcsec$^{-2}$, $\rho = 0.29$ (250 pc)

  At 1000 yr, $\Sigma_V = 24$ mag arcsec$^{-2}$, $\rho = 0.5$ (420 pc)
Light Echoes from “Ancient” SNe in the LMC

- Four distinct light echo groups besides SN1987A
- Surface brightness between 22.5 and 24 mag arcsec$^{-2}$ in “VR”
- Apparent proper motion between 0.7c and 1.8c

Rest et. al. (2006)
Population gradients


- Two main events of SF at 8-12 Gyr and 2-5 Gyr ago, at all radii
- depressed SF between 5 and 8 Gyr
- the ratio young/old decreases with radius
- the mean metallicity decreases with radius

Thanks to Matteo Minelli and Alistair Walker for this slide
The LMC’s Geometry

2MASS + DENIS color-magnitude diagram

van der Marel & Cioni (2001)

Deprojected stellar density distribution

\[ i = 34.7 \pm 6.2 \quad \Theta = 122.5 \pm 8.3 \]
The SMC’s Geometry

- Individual SMC Cepheids
- End-to-end depth of ~20 kpc

Caldwell & Coulson (1986)
Structure at large radius

Pointed CTIO Mosaic-2 observations:
- Magellanic Bridge (Harris 2007)
- Carina (Muñoz et al. 2006)
- SMC periphery (Nidever et al. 2011)
- Outer Limits (Saha et al. 2010)

Image credit: S. Janowiecki and the Galactic All Sky Survey (McClure-Griffiths et al. 2009)
The Periphery of the SMC

RGB stars as tracers

Nidever et al. (2011)
The Extended Disk of the LMC

MSTO stars as tracers

Saha et al. (2010)
The Proper Motion of the LMC


The Magellanic Clouds on first infall...?
...but note alternative scenarios (Diaz & Bekki 2011)
The Effect of the LMC’ s large angular extent on understanding kinematics

van der Marel et al. (2002)
A 5000-star LMC kinematic sample

RSGs only

Fitting for $v_{sys}$, $di/dt$, $\theta$, $v_0$, $r_0$

All stars

$\alpha=5h27m36s$ \hspace{5mm} $\delta=-69^\circ52^\prime12^\prime\prime$ \hspace{5mm} $i=34.7^\circ$

Olsen et al. (2011)
An Accreted SMC population in the LMC

- Accreted population comprises ~5% of LMC stars
- Accreted stars share kinematic signature of HI streamers
- 30 Doradus as accretion-induced star-forming event?
A Formation Model for the Magellanic System

- Model of the LMC/SMC interaction only (no Milky Way)
- Magellanic Stream forms in close LMC/SMC passage ~1.2 Gyr ago
- SMC shredded, LMC left relatively undisturbed
- Model forced compact SMC stellar distribution, no stars in Stream
- Discovery of SMC stars in LMC means that there must be stars in the Stream if scenario correct
- Possible measurement of Galactic halo gas density?

Besla et al. (2011)
Magellanic Structure with DES

- DES fills in a large area of sky currently probed to ~1% fill factor
- Magellanic Cloud populations detected *already* within DES survey area

McClure-Griffiths et al. (2009)
Finding MC structure in DES

TRILEGAL (Girardi et al.) simulation
Proposing an extension to the DES

- Survey an area spanning a few hundred to ~1800 sq. deg.
- 10% - 100% fill factor
- gri filters at minimum
- z,u desirable additions
- DES survey strategy over sparse part of the coverage
- Adjust the strategy and filters when observing the main Cloud bodies, include transient detection
- Possible set-up of exposures to detect RR Lyrae
- 30-50 night Survey over 3-5 years
- Possibility of collaboration with DES?
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